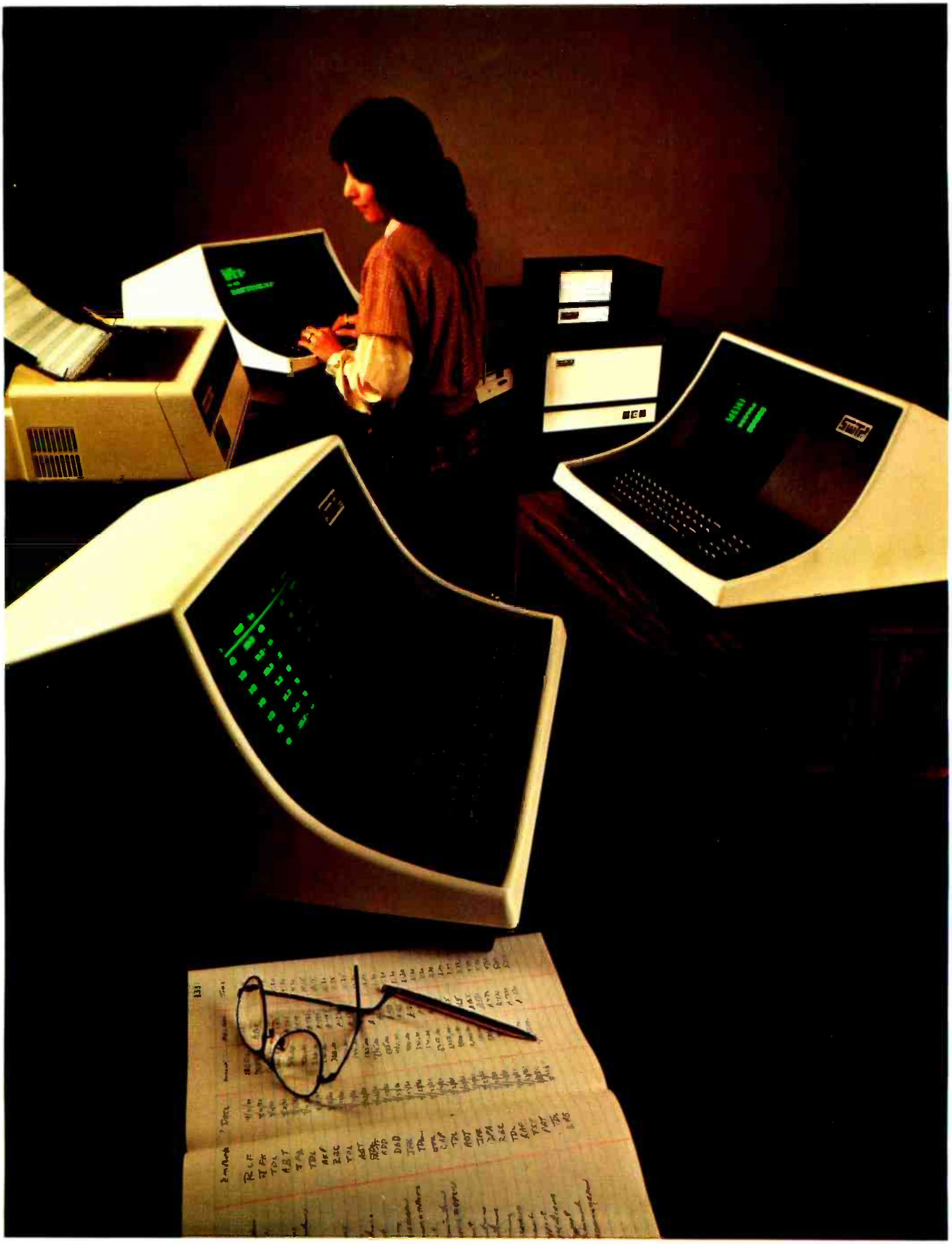
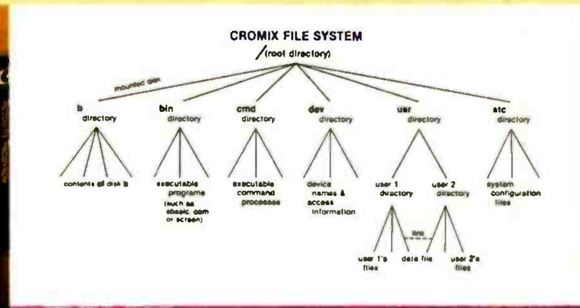
BYTE®

the small system

AUGUST 1981 Vol. 6, No. 8
$2.50 in USA/$2.95 in Canada

A McGraw-Hill Publication





CROMIX*— Cromemco's outstanding UNIX†–like operating system

CROMIX is just the kind of major development you've come to expect from Cromemco. After all, we're already well-known for the most respected software in the microcomputer field.

And now we've come up with the industry's first UNIX-lookalike for microcomputers. It's a tried and proven operating system. It's available on both 5″ and 8″ diskettes for Cromemco systems with 128K or more of memory.

Here are just some of the features you get in this powerful Cromemco system:

- Multi-user and multi-tasking capability
- Hierarchical directories
- Completely compatible file, device, and interprocess I/O
- Extensive subsystem support

FILE SYSTEM

One of the important features of our CROMIX is its file system comprised of hierarchical directories. It's a tree structure of three types of files: data files, directories, and device files. File, device, and interprocess I/O are compatible among these file types (input and output may be redirected interchangeably from and to any source or destination).

The tree structure allows different directories to be maintained for different users or functions with no chance of conflict.

PROTECTED FILES

Because of the hierarchical structure of the file system, CROMIX maintains separate ownership of every file and directory. All files can thus be protected from access by other users of the system. In fact, each file is protected by **four separate access privileges** in each of the three user categories.

TREMENDOUS ADDRESS SPACE, FAST ACCESS

The flexible file system and generalized disk structure of CROMIX give a disk address space in excess of one gigabyte per volume — file size is limited only by available disk capacity.

Speed of access to disk files has also been optimized. Average access speeds far surpass any yet implemented on microcomputers.

'C' COMPILER AVAILABLE, TOO

Cromemco offers a wide range of languages that operate under CROMIX. These include a high-level command process language and extensive subsystem support such as COBOL, FORTRAN IV, RATFOR, LISP, and 32K and 16K BASICs.

There is even our highly-acclaimed 'C' compiler which allows a programmer fingertip access to CROMIX system calls.

THE STANDARD O-S FOR THE FUTURE

The power and breadth of its features make CROMIX the standard for the next generation of microcomputer operating systems.

And yet it is available for a surprisingly low $595.

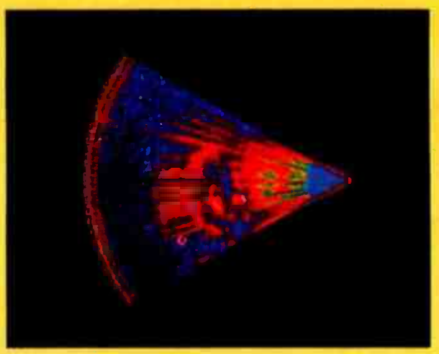
The thing to do is to get all this capability working for you now. Get in touch with your Cromemco rep today.

*CROMIX is a trademark of Cromemco, Inc.
†UNIX is a trademark of Bell Telephone Laboratories

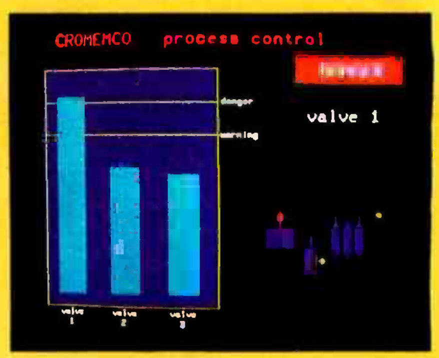
Cromemco™ incorporated
280 BERNARDO AVE., MOUNTAIN VIEW, CA 94040 • (415) 964-7400
Tomorrow's computers today

Circle 96 on Inquiry card.

Management Information Display



Ultrasonic heart sector scan



Process Control

Get the professional color display that has BASIC/FORTRAN simplicity

LOW-PRICED, TOO

Here's a color display that has everything: professional-level resolution, enormous color range, easy software, NTSC conformance, and low price.

Basically, this new Cromemco Model SDI* is a two-board interface that plugs into any Cromemco computer.

The SDI then maps computer display memory content onto a convenient color monitor to give high-quality, high-resolution displays (756 H x 482 V pixels).

When we say the SDI results in a high-quality professional display, we mean **you can't get higher resolution than this system offers in an** NTSC-conforming display.

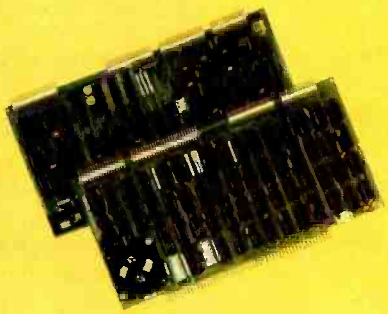
The resolution surpasses that of a color TV picture.

BASIC/FORTRAN programming

Besides its high resolution and low price, the new SDI lets you control with optional Cromemco software packages that use simple BASIC- and FORTRAN-like commands.

Pick any of 16 colors (from a 4096-color palette) with instructions like DEFCLR (c, R, G, B). Or obtain a circle of specified size, location, and color with XCIRC (x, y, r, c).

*U.S. Pat. No. 4121283



Model SDI High-Resolution Color Graphics Interface

HIGH RESOLUTION

The SDI's high resolution gives a professional-quality display that strictly meets NTSC requirements. You get 756 pixels on every visible line of the NTSC standard display of 482 image lines. Vertical line spacing is 1 pixel.

To achieve the high-quality display, a separate output signal is produced for each of the three component colors (red, green, blue). This yields a sharper image than is possible using an NTSC-composite video signal and color TV set. Full image quality is readily realized with our high-quality RGB Monitor or any conventional red/green/blue monitor common in TV work.

Model SDI plugs into Z-2H 11-megabyte hard disk computer or any Cromemco computer

DISPLAY MEMORY

Along with the SDI we also offer an optional fast and novel **two-port** memory that gives independent high-speed access to the computer memory. The two-port memory stores one full display, permitting fast computer operation even during display.

CONTACT YOUR REP NOW

The Model SDI has been used in scientific work, engineering, business, TV, color graphics, and other areas. It's a good example of how Cromemco keeps computers in the field up to date, since it turns any Cromemco computer into an up-to-date color display computer.

The SDI has still more features that you should be informed about. So contact your Cromemco representative now and see all that the SDI will do for you.

Cromemco
incorporated
280 BERNARDO AVE., MOUNTAIN VIEW, CA 94040 • (415) 964-7400
Tomorrow's computers today

Circle 96 on Inquiry card.

In The Queue

Volume 6, Number 8 August 1981

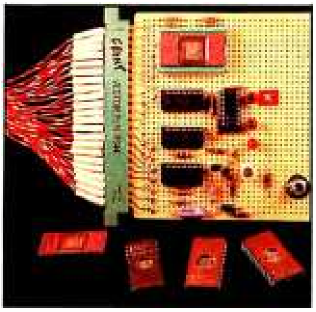
Features

Reviews

Nucleus

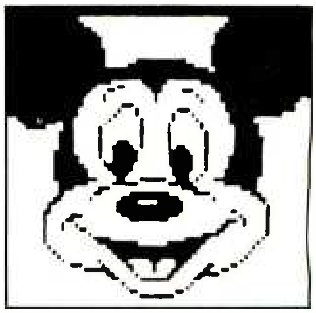
BYTE

Page 14

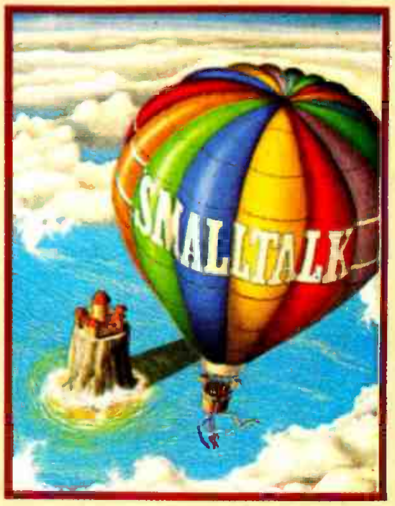


Page 50

Page 90



Page 168



In This Issue

Smalltalk isn't small talk any more. Three years ago, the cover of BYTE depicted the island kingdom of Smalltalk as a place where great and magical things happen, though its "craggy aloofness" kept it out of the mainstream of the computer programming community. During the past three years the Xerox Learning Research Group has continued developing Smalltalk, and this month we present the culmination of its work — the debut of the Smalltalk-80 system.

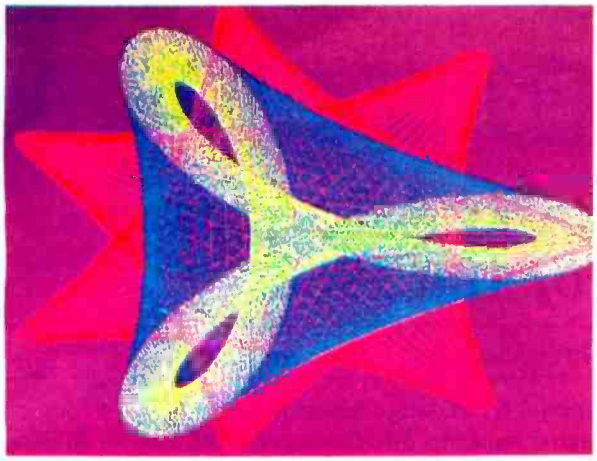
Because of the special nature of this issue, we have added a special introduction by Adele Goldberg, manager of the Xerox Learning Research Group based in Palo Alto, California. Adele guides you gently through the array of articles describing the Smalltalk-80 system and related topics.

In addition to our regular features, we also have the concluding part of Steve Ciarcia's article, "Build a Z8-Based Control Computer with BASIC." And Stan Miastkowski presents an in-depth report on what we can expect from Japan in his article, "The Japanese Computer Invasion."

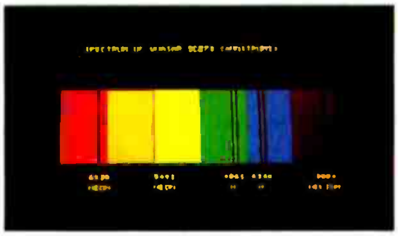
BYTE is published monthly by BYTE Publications Inc, 70 Main St, Peterborough NH 03458, phone (603) 924-9281, a wholly-owned subsidiary of McGraw-Hill, Inc. Address subscriptions, change of address, USPS Form 3579, and fulfillment questions to BYTE Subscriptions, POB 590, Martinsville NJ 08836. Controlled circulation postage paid at Waseca, Minnesota 56093 - USPS Publication No. 528890 (ISSN 0360-5280). Canadian second class registration number 9321. Subscriptions are $19 for one year, $34 for two years, and $49 for three years in the USA and its possessions. In Canada and Mexico, $21 for one year, $38 for two years, $55 for three years. $43 for one year air delivery to Europe. $35 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $2.50 in the USA and its possessions, $2.95 in Canada and Mexico, $4.00 in Europe, and $4.50 elsewhere. Foreign subscriptions and sales should be remitted in United States funds drawn on a US bank. Printed in United States of America.

BYTE® is available in microform from University Microfilms International, 300 N Zeeb Rd, Dept PR, Ann Arbor MI 48106 USA or 18 Bedford Row, Dept PR, London WC1R 4EJ England.

Subscription WATS Line: (800) 258-5485
Office hours: Mon-Thur 8:30 AM - 4:30 PM, Friday 8:30 AM - Noon, Eastern Time



"...stands well above other S-100 graphics displays in its price and performance range."
BYTE, Product Review



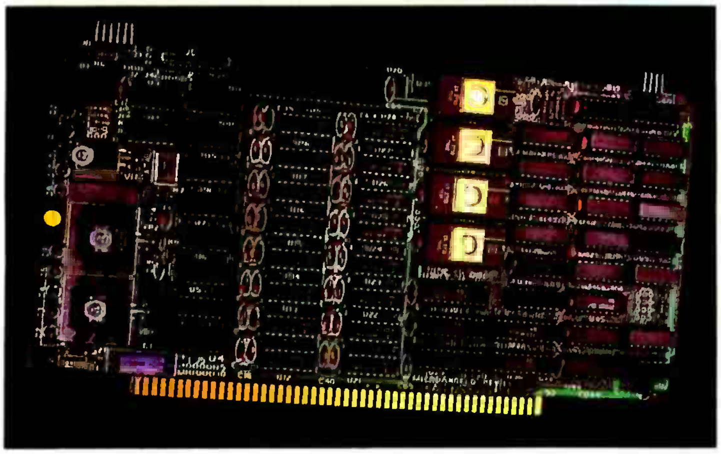
"...better monochromatic ...display...."
ELECTRONIC DESIGN, 1981 Technology Forecast

MICROANGELO

HIGH RESOLUTION GRAPHICS SINGLE BOARD COMPUTER

512 x 480 resolution black and white **and** vivid color displays

- RS-170 composite or direct drive output
- Local or external sync generation
- 4 Mhz Z80 microprocessor
- 60 hertz real-time clock
- 8 level interrupt tie-in
- IEEE S100 bus compatible



- Light pen interface
- Time multiplexed refresh
- 4K resident Screenware™ Pak I operating system
- 32K RAM isolated from host address space
- High speed communications over parallel bus ports

Screenware™ Pak I

A 4K byte operating system resident in PROM on MicroAngelo™. Pak I emulates an 85 character by 40 line graphics terminal and provides over 40 graphics commands. Provisions exist for user defined character sets and directly callable user extensions to Screenware™ Pak I.

Screenware™ Pak II

An optional software superset of Pak I which adds circle generation, polygon flood, programmable split screen for separate graphics and terminal I/O, relative coordinates, faster vector and character plotting, a macro facility, full UCSD Pascal compatibility, and more.

And now...COLOR!!

The new MicroAngelo™ Palette board treats from 2 to 8 MicroAngelos as "bit planes" at a full 512 x 480 resolution. Up to 256 colors may be chosen from 16.8 million through the programmable color lookup table. Overlays, bit plane precedence, fade-in, fade-out, gray levels, blinking bit plane, and a highly visual color editor are standard.

SCION

8455-D Tyco Road • Vienna, Virginia 22180 • TWX: 710-831-9087 • (703) 827-0888

Circle 339 on inquiry card.

Editorial

Smalltalk: A Language for the 1980s

by Chris Morgan, Editor in Chief

Welcome to the fifth annual BYTE language issue. Over the past four years we have devoted our August issues to discussions of APL, Pascal, LISP, and FORTH, respectively. This year we are pleased to present the Smalltalk-80 language, the culmination of ten years of research by the Xerox Learning Research Group located at the Xerox Palo Alto Research Center (PARC) in California.

During the past few months the BYTE staff has been acquainting itself with Smalltalk. I spent some time this spring working with the Smalltalk systems at Xerox PARC and being briefed by Adele Goldberg and Dave Robson. I came away excited by this revolutionary language. I hope the articles in this issue convey some of that excitement.

Smalltalk is an *object-oriented* language, as opposed to *procedure-oriented* languages such as BASIC, Pascal, and FORTRAN. Because of this, programming in Smalltalk is similar to the process of human interaction. An analogy might help to clarify this point. Suppose a person wishes to invest in a good mutual fund. He sends a telegram to his broker. The broker analyzes the current state of the market and picks what he considers to be the best mutual fund for his client. That in a very small nutshell describes the basic activity inherent in all Smalltalk programs: a message is sent to a receiver to invoke some response. In our analogy, the telegram is the message and the broker is the receiver. The telegram has two parts, called the *selector* and the *argument*. Here the selector is "buy" and the argument is "best mutual fund." The broker belongs to a *class* which contains the description of the *method* he uses to pick the best mutual fund. Because of this, the client does not have to tell the broker how to do his job.

Of course, my analogy skims only the thinnest surface of the deep waters of the Smalltalk-80 system, as you'll see when you read the articles in this issue.

When I first worked at a Smalltalk-80 computer terminal, I noticed an interesting phenomenon: I did very little typing, although a full keyboard was available to me. This is because of the window menu format and the presence of the "mouse," a small mechanical box with wheels that lets you quickly move the cursor around the screen. (Stoney Ballard of Digital Equipment Corporation, who has been doing research work lately with the Smalltalk-80 system, points out that he was able to do a significant amount of programming with his experimental system over several weeks even though his keyboard was not working.) Choosing a particular item in a list from a window causes another window to appear on the screen. Additional levels of nested windows can be accessed by continuing to reposition the cursor and pressing the appropriate key on the mouse.

This makes for *fast* programming. Those who saw the remarkable demonstration of the Xerox Star terminal (Xerox's new $16,000 office terminal) at the National Computer Conference (NCC) this past spring got a taste of what a programming environment can do for productivity.

Smalltalk allows the user to solve more problems without becoming a computer expert. Larry Tesler from Apple (who wrote "The Smalltalk Environ-

Smalltalk-80 is a trademark of Xerox Corporation.

Percom Mini-Disk Drive Systems for TRS-80* Computers...

Now! Add-On *and* Add-In Mini-Disk Storage for your Model III.

The industry leader in microcomputer peripherals, Percom not only gives you better design, better quality and first-rate service, but you pay less to *boot*.

New for the TRS-80* Model III

Patterned after our fast-selling TFD Model I drives. And subjected to the same reliability controls. These new TFD mini-disk systems for the Model III provide more features than Tandy drives, yet cost far less.

- **Flippy Capability:** Both internal (add-in) and external (add-on) drives permit recording on either side of a diskette.
- **Greater Storage Capacity:** Available with either 40- or 80-track drive mechanisms, Percom TFD mini-disk systems store more. A 40-track drive stores up to 180 Kbytes — formatted — on one side of a 5-inch diskette. An 80-track drive stores a whopping 364 Kbytes.
- **1.5 Mbyte On-line:** The Percom drive controller (included with the initial drive) handles up to four drives. With four 80-track mini-disk drives you can access over 1.5 million bytes of on-line file data.
  Moreover, the initial drive may be **either** an internal add-in drive or an external add-on drive. And whichever configuration you get, the initial drive kit comes complete with our advanced 4-drive controller, interconnecting cables, power supplies, installation hardware, a DOS and of course the drive mechanism itself.
- **First Drive Includes DOS:** OS-80™, Percom's fast extendable BASIC-language disk operating system, is included on diskette when you purchase an initial drive kit. Originally called MicroDOS, OS-80 was favorably reviewed in the June 1980 issue of Creative Computing magazine.
- **Works with Model III TRSDOS:** Besides being fully hardware compatible, Percom's Model III 40-track drive systems may be operated with Tandy's Model III TRSDOS — without any modifications whatsoever. And, TRSDOS may be easily upgraded with simple software patches for operating 80-track drives.

Percom TFD add-on drives start at only $399. Model III Drive kits start at only $749.95.

Quality Percom products are available at authorized dealers. Call *toll free 1-800-527-1592* for the address of your nearest dealer or to order direct from Percom.

Still #1 for Model I

As if greater storage capacities, exceptional quality control measures and lower prices aren't reasons enough to make Percom your first choice for Model I add-on drives, **all** Percom Model I drives are also rated for double-density operation.

Add our innovative DOUBLER™ adapter to your Model I Expansion Interface, and with Percom drive systems you can enjoy the same double-density storage capability as Model III owners.

The DOUBLER includes a TRSDOS*-like double-density disk operating system called DBLDOS™

We also offer a double-density Model I version of OS-80 as well as DOUBLEZAP programs for modifying NEWDOS/80 and VTOS 4.0† for DOUBLER compatibility.

Of course you don't have to upgrade your computer for double-density operation to use Percom mini-disk drive systems. In single-density operation, our TRS-80* Model I compatible 40-track drives store 102 Kbytes of formatted data on one side of a diskette, and our 80-track drives store 205 Kbytes. By comparison, Tandy's standard drive for the Model I stores just 86 Kbytes.

And like our Model III drives, Model I add-on drives are optionally available with "flippy" storage capability.

System Requirements:

Model III: 16-Kbyte system (min) and Model III BASIC. The second internal drive may be installed after the first internal drive kit is installed, and external drives #2, #3 and #4 may be added if either an internal or external first-drive kit has been installed. External drives #3 and #4 require an optional interconnecting cable.

Model I: 16-Kbyte system (min), Level II BASIC, Expansion Interface, disk operating system and an interconnecting cable. For double-density storage, a Percom DOUBLER must be installed in the Expansion Interface and DBLDOS (comes with the DOUBLER) or other double-density DOS must be used. For single-density operation, a Percom SEPARATOR™ adapter, installed in the Expansion Interface, will virtually eliminate "CRC ERROR — TRACK LOCKED OUT" read errors. Prices and specifications subject to change without notice.

PERCOM

PERCOM DATA COMPANY, INC.
211 N. KIRBY GARLAND, TEXAS 75042
(214) 272-3421

*Trademark of Tandy Radio Shack Corporation which has no relationship to Percom Data Company.
™DOUBLER, DBLDOS, OS-80 and SEPARATOR are trademarks of Percom Data Company, Inc.
†Trademark of Virtual Technology Corporation.

Circle 305 on inquiry card.

A simple algorithm

We work with the serious systems integrator ... on terms that make sense to you. That means giving you a set of products which expand your limits, not reduce them.

We manufacture the most complete family of high quality IEEE/696 S-100 mainframes on the market. Choices include three mainframes in rack-mount or table-top packages with complete board sets, to serve as the building blocks for your 8 or 16 bit system. We also provide other options ranging from complete floppy disk systems right up to our proven Pascal development system.

The ∫ factor: one source.

No matter which option you choose, you get the benefit of working with completely integrated products ... fully assembled and tested ... under one warranty and one price structure ... leaving you free to concentrate on value-added application development and sales.

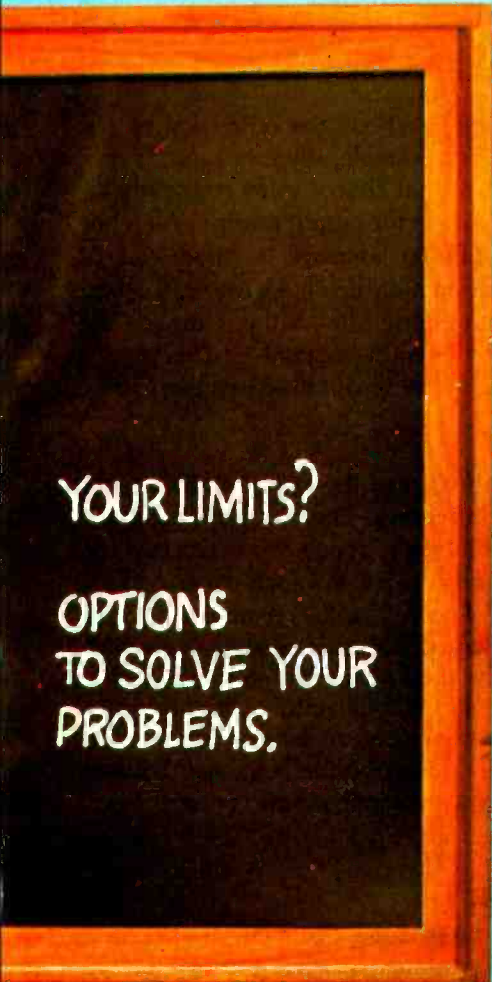
Choose from mainframe options ...

Select from three packaging options: Rack-mount, table-top or front panel models. All three feature our 20 slot S-100 motherboard with 25 amp power supply and are delivered fully assembled and tested with our Series II™ board sets. Any board configuration you choose works with any DPS-1 version, allowing you to vary your package offering, or develop on one version and market another.

- Front Panel model — a powerful development and diagnostic tool for Z-80† systems, which can be used for prototyping, servicing, debugging, and software or hardware development. Use its features to set breakpoints, trigger scopes, single step, slow step and more.
- Front Panelless desk top model—a lower cost option for OEM or other turnkey operations which do not require the extra capability of our Front Panel.
- Rack Mount version — features a heavy gauge frame designed to fit into standard 19" racks. CVT power supply for brown out immunity is standard.

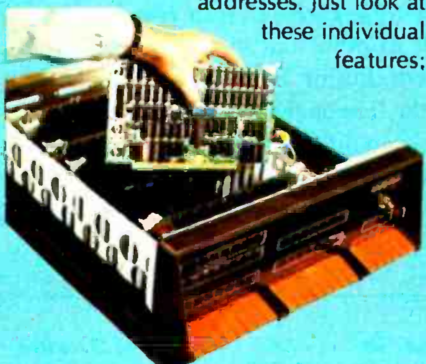
*In Calculus, a fundamental statement in the definition of limit; interpreted here to imply: "For your integration problem, Intersystems has a solution."

† Registered trademark of Zilog, Inc.



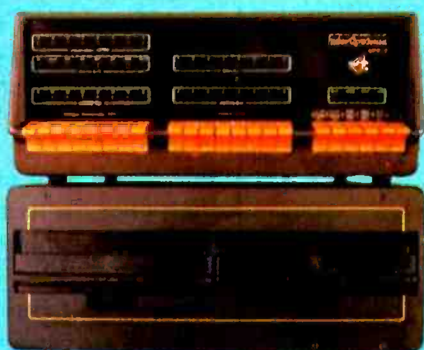
Board level options...

Intersystems mainframe packages, equipped with Series II boards, are operational in both 8 and 16 bit settings and support extended addressing in both I/O and memory space, recognizing 16 bit I/O addresses and 24 bit memory addresses. Just look at these individual features:



- MPU-80—uses a Z-80, 8 vectored interrupt lines and two 4K windows to address up to 1 Megabyte of RAM without bank select.
- 64KDR—sophisticated refresh circuitry allows unlimited DMA and absolutely reliable operation without wait states.
- 6 SI/O — six individually software-controllable serial I/O ports with optional interrupts. Each can run RS 232 at up to 19,200 BAUD, as can our VI/O board.
- VI/O—has two serial ports; two 8-bit parallel output and two 8-bit parallel input ports plus 8 individually controllable command lines and 16 levels of vectored interrupts.
- FDC II—can DMA up to a full track into 16 Megabytes of memory. Optionally generates interrupts and handles up to four 8" floppies.
- MPU-8000 — available with the non-segmented Z-8002†, which directly addresses 64K, or the segmented Z-8001†, which can directly address 8 Megabytes.

Extended systems options...



Interfacing disk drives is not a trivial matter, so when your objectives and resources dictate you spend your energy elsewhere, use our resources to perform the service for you. We can add our disk drive package to any Z-80 or Z-8000 configuration we provide ... again, fully assembled and tested and covered under one warranty.

Or our complete Pascal Development System.

We use it for our own hardware and software development. It includes either table-top mainframe, two 8" floppy disks, 128K RAM, CP/M#, and Intersystems Pascal/Z™ compiler and Cache BIOS™.

THIS SYSTEM IS FAST! Why? Because our ultra-fast Cache BIOS automatically buffers whole tracks, eliminating most disk accesses. This delivers up to three times the throughput of any other floppy-based system we know and is equal to many small hard disk systems.

The system is versatile, too. SET program allows you to change many BIOS parameters and specify control characters to enable special features such as diagnostic output to trace program execution. It can also provide remote I/O to link your system to almost any other computer, large or small.

And it's reliable. The Cache BIOS System runs continuous memory tests when idle, and verifies with a Read after Write and Read after Read.

And the system also includes our Pascal/Z, a true native compiler producing ROMable and Re-entrant code. It features a minimum of extensions chosen for the development of your scientific and business applications. And it's compatible with our native code Pascal for Z-8000, providing a graceful upward path to 16 bit applications. So what you write now is right later.

One choice you won't have to make...

We don't believe you should ever have to sacrifice good technical support to find a good product. We'll back you to the hilt with services like free technical consultation, board-swapping, diagnostic packages, and documentation that gives you all you need to integrate, operate and maintain your system ... right down to schematics of the boards.

Your solution should be clear.

Whether you're integrating for scientific, governmental or commercial applications, Intersystems can provide a Delta for your Epsilon.

Talk to us today.

Ithaca Intersystems Inc.,
Dept. B
1650 Hanshaw Road,
P.O. Box 91
Ithaca, NY 14850

Phone
(607) 257-0190

InterSystems™
Ithaca Intersystems Inc.

Micros for bigger ideas.

Circle 180 on inquiry card.

#Registered trademark of Digital Research

™Trademark of Ithaca Intersystems, Inc.

ment" on page 90) spoke about the efficiency of the language at the NCC. For example, suppose a user is running a complex program that churns away for nearly an hour—then a bug appears in the output routine. All is not lost. Since the Smalltalk-80 language is "modeless" (a concept Tesler discusses in his article), the user can debug the output routine and continue with the main routine without having to start from the beginning. This is only one of the advantages of the Smalltalk-80 system.

Where to Start

The order in which you read the Smalltalk-80 articles in this issue makes a difference. The first stopping point should be Adele Goldberg's article "Introducing the Smalltalk-80 System" on page 14, in which she provides a guided tour of the issue. I also recommend Dave Robson's "Object-Oriented Software Systems" on page 74 as a good overview of the Smalltalk-80 philosophy. The glossary on page 48 will be helpful as you begin to absorb the rather extensive (and sometimes overwhelming) vocabulary used to describe the language. I found that, once the terms become familiar, the concepts begin to make elegant sense.

When Can I Buy It?

There are currently no personal computer implementations of the Smalltalk-80 language. Because of this, I'm sure we'll be criticized by some for introducing the language too early and frustrating our readers. Nevertheless, I feel that the time to begin exposing people to object-oriented language is *now*. Only by challenging and enticing the personal computer community can we stimulate the industry to create the machines we all dream of.

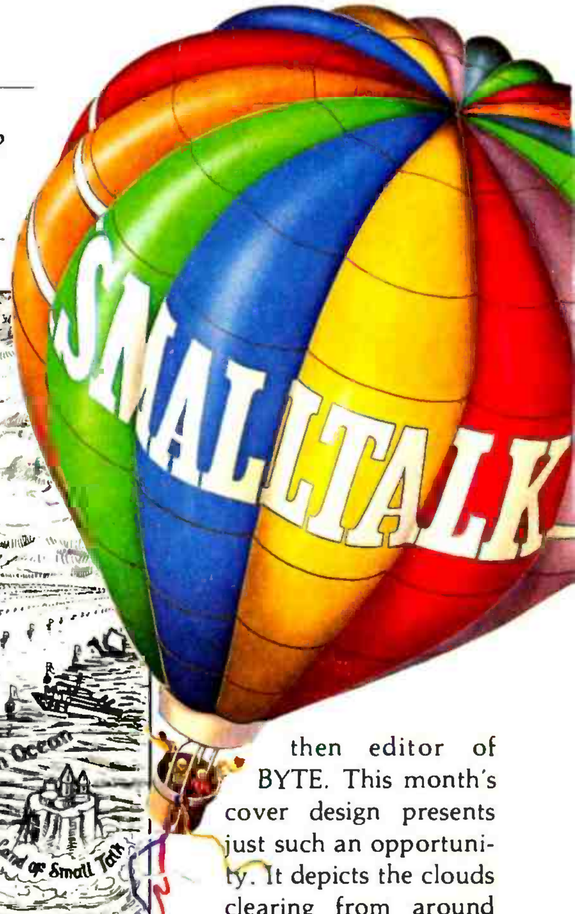
As far as future hardware hopes are concerned, it is interesting to note that four of the speakers at the recent NCC Smalltalk-80 symposium were from Digital Equipment Corporation, Apple Computer Company, Tektronix, and Hewlett-Packard. All four research representatives were quick to point out that their companies are not necessarily working on Smalltalk products, but are rather exploring the language's potential. Despite the disclaimers, though, I would be very surprised if we do not see a computer with the Smalltalk-80 system built in sometime in the next few years—perhaps sooner. I hope this issue brings that dream closer.■

Acknowledgments

I wish to express my appreciation to Adele Goldberg and Dave Robson at Xerox PARC for their invaluable help in preparing this special issue—and especially to Adele for coordinating the many authors who contributed their expertise. I'd also like to thank Gregg Williams for his editorial skills in preparing this issue . . . . CM

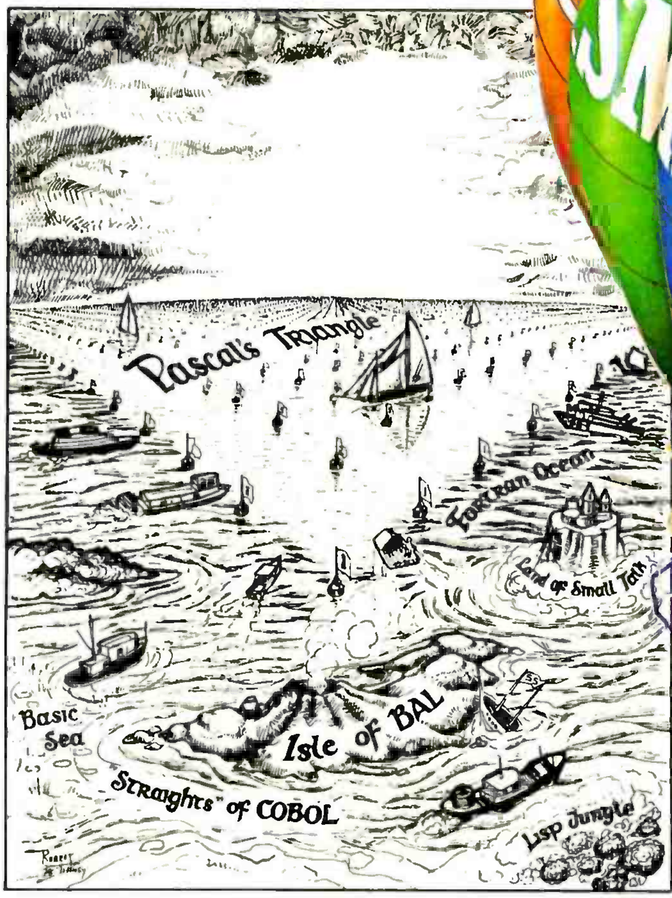
Introducing the Smalltalk-80 System

Adele Goldberg
Manager, Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304



It is rare when one can indulge in one's prejudices with relative impunity, poking a bit of good humored fun to make a point.

With this statement, Carl Helmers opened his remarks in the "About the Cover" section of the August 1978 issue of BYTE. The issue was a special on the language Pascal, so Helmers took the opportunity to present Pascal's triangle as drawn by artist Robert Tinney. The primary allegory of the cover was the inversion of the Bermuda Triangle myth to show smooth waters within the area labeled "Pascal's Triangle." In explaining the allegory, Helmers guided the traveler through the FORTRAN Ocean, the BASIC Sea, around the Isle of BAL, and up to the Land of Smalltalk.



Traveling upward (in the picture) through heavy seas we come to the pinnacle, a snow white island rising like an ivory tower out of the surrounding shark infested waters. Here we find the fantastic kingdom of Smalltalk, where great and magical things happen. But alas . . . the craggy aloofness of the kingdom of Smalltalk keeps it out of the mainstream of things.

It is rare when one can indulge in one's fantasies to respond to so pointed a remark as that provided by the then editor of BYTE. This month's cover design presents just such an opportunity. It depicts the clouds clearing from around the kingdom of Smalltalk, and, with banners streaming, the Smalltalk system is taking flight into the mainstream of the computer programming community. This cover was also executed by Robert Tinney, to the delight of the Learning Research Group (LRG) of the Xerox Palo Alto Research Center. LRG is the group that has designed, implemented, and evaluated several generations of Smalltalk over the past ten years.

The balloon on the cover symbolizes the Smalltalk-80 system that is being released this year for more general access. The release is in the form of publications and a file containing the Smalltalk-80 programming system. Twelve articles describing the system appear in this issue of BYTE. Through such publication, LRG's research will become generally accessible, dispelling the clouds.

Smalltalk is the name LRG assigned to the software

TRS-80* COMPUTING EDITION

©1981 Percom Data Co., Inc. **The Percom Peripheral** 35 cents

Percom's DOUBLER II™ tolerates wide variations in media, drives

GARLAND, TEXAS — May 22, 1981 — Harold Mauch, president of Percom Data Company, announced here today that an improved version of the Company's innovative DOUBLER™ adapter, a double-density plug-in module for TRS-80* Model I computers, is now available.

Reflecting design refinements based on both theoretical analyses and field testing, the DOUBLER II™, so named, permits even greater tolerance in variations among media and drives than the previous design.

Like the original DOUBLER, the DOUBLER II plugs into the drive controller IC socket of a TRS-80 Model I Expansion Interface and permits a user to run either single- or double-density diskettes on a Model I.

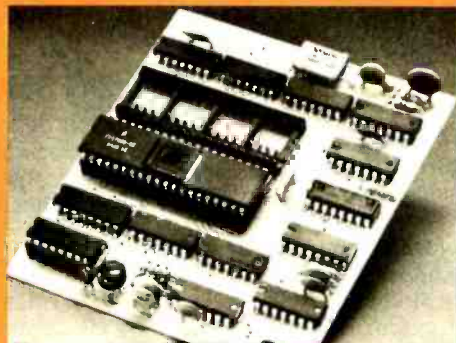
With a DOUBLER II installed, over four times more formatted data — as much as 364 Kbytes — can be stored on one side of a five-inch diskette than can be stored using a standard Tandy Model I drive system.

Moreover, a DOUBLER II equips a Model I with the hardware required to run Model III diskettes.

(*Ed. Note*: See "OS-80™: Bridging the TRS-80* software compatibility gap" elsewhere on this page.)

The critical clock-data separation circuitry of the DOUBLER II is a proprietary design called a ROM-programmed digital phase-lock loop data separator.

According to Mauch, this design is more tolerant of differences from diskette to diskette and drive to drive, and also provides immunity to performance degradation caused by circuit component aging.



Percom DOUBLER II

Mauch said "A DOUBLER II will operate just as reliably two years after it is installed as it will two days after installation."

The digital phase-lock loop also eliminates the need for trimmer adjustments typical of analog phase-lock loop circuits.

"You plug in a Percom DOUBLER II and then forget it," he said.

The DOUBLER II also features a refined Write Precompensation circuit that more effectively minimizes the phenomena of bit- and peak-shifting, a reliability-impairing characteristic of magnetic data recording.

The DOUBLER II, which is fully software compatible with the previous DOUBLER, is supplied with DBLDOS™, a TRSDOS*-compatible disk operating system.

The DOUBLER II sells for $2~~[illegible]~~5, including the DBLDOS diskette. NOW $169.95!

Owners of original DOUBLERs may purchase a DOUBLER II upgrade kit, without the disk controller IC, for $30.00. Proof of purchase of an original DOUBLER is required, and each DOUBLER owner may purchase only one DOUBLER II at the $30.00 price.

The Percom DOUBLER II is available from authorized Percom retailers, or may be ordered direct from the factory. The factory toll-free order number is 1-800-527-1592.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 306 on inquiry card.

All that glitters is not gold

OS-80™ Bridging the TRS-80* software compatibility gap

Compatibility between TRS-80* Model I diskettes and the new Model III is about as genuine as a gold-plated lead Krugerrand.

True, Model I TRSDOS* diskettes can be *read* on a Model III. But first they must be converted and re-recorded for Model III operation.

And you *cannot write* to a Model I TRSDOS* diskette. Not with a Model III. You cannot add a file. Delete a file. Or in any way modify a Model I TRSDOS diskette with a Model III computer.

Furthermore, your converted TRSDOS diskettes cannot be converted *back* for Model I operation.

TRSDOS is a one-way street. And there's no retreating. A point to consider before switching the company's payroll to your new Model III.

Real software compatibility should allow the *direct, immediate* interchangeability of Model I and Model III diskettes. No read-only limitations, no conversion/re-recording steps and no chance to be left high and dry with Model III diskettes that can't be run on a Model I.

What's the answer? The answer is Percom's OS-80™ family of TRS-80 disk operating systems.

OS-80 programs allow *direct, immediate* interchangeability of Model I and Model III diskettes.

You can run Model I single-density diskettes on a Model III; install Percom's plug-in DOUBLER™ adapter in your Model I, and you can run double-density Model III diskettes on a Model I.

There's no conversion, no re-recording.

Slip an OS-80 diskette out of your Model I and insert it directly in a Model III.

And vice-versa.

Just have the correct OS-80 disk operating system — OS-80, OS-80D or OS-80/III — in each computer.

Moreover, with OS-80 systems, you can add, delete, and update files. You can read *and write* diskettes regardless of the system of origin.

OS-80 is the original Percom TRS-80 DOS for BASIC programmers.

Even OS-80 utilities are written in BASIC.

OS-80 is the Percom system about which a user wrote, in Creative Computing magazine, ". . . the best $30.00 you will ever spend."†

Requiring only seven Kbytes of memory, OS-80 disk operating systems reside completely in RAM. There's no need to dedicate a drive exclusively for a system diskette.

And, unlike TRSDOS, you *can* work at the track sector level, defining and controlling data formats — in BASIC — to create simple or complex data structures that execute more quickly than TRSDOS files.

The Percom OS-80 DOS supports single-density operation of the Model I computer — price is $29.95; the OS-80D supports double-density operation of Model I computers equipped with a DOUBLER or DOUBLER II; and, OS-80/III — for the Model III of course — supports both single- and double-density operation. OS-80D and OS-80/III each sell for $49.95.

Circuit misapplication causes diskette read, format problems.

High resolution key to reliable data separation

GARLAND, TEXAS — The Percom SEPARATOR™ does very well for the Radio Shack TRS-80* Model I computer what the Tandy disk controller does poorly at best: *reliably* separates clock and data signals during disk-read operations.

Unreliable data-clock separation causes format verification failures and repeated read retries.

CRC ERROR–TRACK LOCKED OUT

The problem is most severe on high-number (high-density) inner file tracks.

As reported earlier, the clock-data separation problem was traced by Percom to misapplication of the internal separator of the 1771 drive controller IC used in the Model I.

The Percom Separator substitutes a *high-resolution* digital data separator circuit, one which operates at 16 megahertz, for the low-resolution one-megahertz circuit of the Tandy design.

Separator circuits that operate at lower frequencies — for example, two- or four-megahertz — were found by Percom to provide only marginally improved performance over the original Tandy circuit.

The Percom solution is a simple adapter that plugs into the drive controller of the Expansion Interface (EI).

Not a kit — some vendors supply an untested separator kit of resistors, ICs and other paraphernalia that may be installed by modifying the computer — the Percom SEPARATOR is a fully assembled, fully tested plug-in module.

Installation involves merely plugging the SEPARATOR into the Model I EI disk controller chip socket, and plugging the controller chip into a socket on the SEPARATOR.

The SEPARATOR, which sells for only $29.95, may be purchased from authorized Percom retailers or ordered directly from the factory. The factory toll-free order number is 1-800-527-1592.

Ed. note: Opening the TRS-80 Expansion Interface may void the Tandy limited 90-day warranty. Circle 307 on inquiry card.

PRICES AND SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE. PRICES DO NOT INCLUDE HANDLING AND SHIPPING.

PERCOM DATA COMPANY, INC. 211 N. Kirby Street Garland, Texas 75042 (214) 272-3421

™Trademark of Percom Data Company, Inc. *TRS-80 and TRSDOS are trademarks of Tandy Corporation which has no relationship to Percom Data Company. †Creative Computing Magazine, June, 1980, page 26.

TWELVE STRONG HEATH/ZENITH YOUR

Pick a strong partner

A computer purchase is the beginning of a long term partnership between you and the people you buy from. Your ongoing need for software and accessories requires a partner who will stand by you with a growing line of products. And nowhere will you find a more complete line of hardware, software and accessories than at your Heathkit Electronic Center. Here are twelve strong reasons to make Heath/Zenith your partner.

1. The All-In-One Computer

The heart of the Heath/Zenith line is the stand-alone *89 Computer.* It's a complete system with built-in 5¼-inch floppy disk drive, professional keyboard and keypad, smart video terminal, two Z80 microprocessors, and two RS-232C serial I/O ports. It comes with 16K RAM, expandable to 64K.

2. Peripherals

These include the popular *Heath/Zenith 19 Smart Video Terminal*, loaded with professional features. And the *14 Line Printer*, priced as low as $495. Other printer brands are on display, including high-speed, typewriter-quality printers.

3. Software

Word processing, includes reliable, easy-to-use Zenith Electronic Typing and powerful, full-featured WORDSTAR.

Small Business Programs, feature General Ledger and Inventory Control.

HUG, Heath Users' Group, offers members a library of over 500 low-cost programs for home, work or play.

4. Programming Languages

For your own custom programs, Microsoft languages are available in BASIC (compiler and interpreter), FORTRAN and COBOL.

5. Operating Systems

Three versatile systems give you the capability to perform your specific tasks.

CP/M by Digital Research makes your system compatible with thousands of popular CP/M programs.

UCSD P-System with Pascal is a complete program development and execution environment.

HDOS, Heath Disk Operating System gives you a sophisticated, flexible environment for program construction, storage and editing.

6. Utility Software

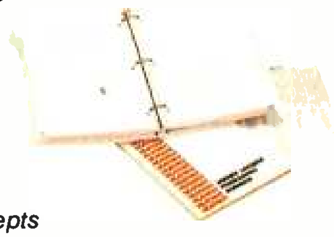
Expand the performance range of your computer with a broad selection of utility tools, including the best of *Digital Research* and the complete line of innovative *Softstuff* products.

7. Disk Systems

The 8-inch Heath/Zenith 47 Dual Disk System adds over 2 megabytes of storage to your 89 Computer. Diskettes are standard IBM 3740 format, double-sided, double-density.

The 5¼-inch 87 Dual Disk System adds 200K bytes of storage to your 89. Both disk systems feature read/write protection and easy plug-in adaptability.

8. Self-Study Courses



Learn at your own pace with *Programming Courses* that teach you to write and run your own programs in Assembly, BASIC, Pascal or COBOL.

A course on *Computer Concepts for Small Business* gives you the understanding to evaluate the ways a computer can benefit your business.

Personal Computing is a complete introduction to the fundamentals for the novice. Every Heathkit/Zenith course is professionally designed for easy, step-by-step learning.

All Heath/Zenith Computer Products are available completely assembled and tested for commercial use. Or in easy-to-build, money-saving kits.

REASONS TO MAKE COMPUTER PARTNER

9. Expansion Options

Communicate with the outside world through a *Three-port EIA RS-232C Serial Interface.*

Expand RAM to 64K with easy-to-install *expansion chips.*

10. Accessories

Your Heathkit Electronic Center has the latest in modems, black-and-white and color video monitors, computer furniture and a full line of supplies, accessories, books and parts.

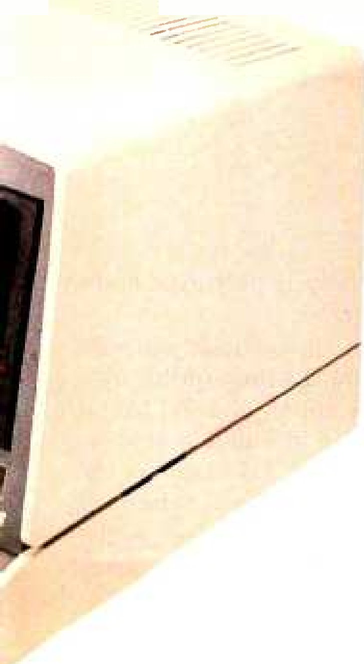
11. Service

No one stands by you like Heath/Zenith. We help you get your system up and running smoothly. Service is available from trained technicians, over the phone or at one of 56 Heathkit Electronic Centers.

12. Value

Your money buys you more because Heath/Zenith prices are among the industry's most competitive. Make your own comparison and find out how much you can save.

Complete, integrated computer hardware and software, designed to serve you and to grow with you – that's what to look for in a strong partner. And with Heath/Zenith you get it all under one roof.



All at your Heathkit Electronic Center

Pick the store nearest you from the list at right. And stop in today for a demonstration of the Heath/Zenith 89 Computer System. If you can't get to a store, send $1.00 for the latest Heathkit® Catalog and the new Zenith Data Systems Catalog of assembled commercial computers. Write to Heath Co., Dept. 334-804, Benton Harbor, MI 49022.

Visit Your Heathkit Electronic Center*

where Heath/Zenith Products are displayed, sold and serviced.

PHOENIX, AZ
2727 W. Indian School Rd.
602-279-6247

ANAHEIM, CA
330 E. Ball Rd.
714-776-9420

CAMPBELL, CA
2350 S. Bascom Ave.
408-377-8920

EL CERRITO, CA
6000 Potrero Ave.
415-236-8870

LA MESA, CA
8363 Center Dr.
714-461-0110

LOS ANGELES, CA
2309 S. Flower St.
213-749-0261

POMONA, CA
1555 N. Orange Grove Ave.
714-623-3543

REDWOOD CITY, CA
2001 Middlefield Rd.
415-365-8155

SACRAMENTO, CA
1860 Fulton Ave.
916-486-1575

WOODLAND HILLS, CA
22504 Ventura Blvd.
213-883-0531

DENVER, CO
5940 W. 38th Ave.
303-422-3408

AVON, CT
395 W. Main St. (Rt. 44)
203-678-0323

HIALEAH, FL
4705 W. 16th Ave.
305-823-2280

PLANTATION, FL
7173 W. Broward Blvd.
305-791-7300

TAMPA, FL
4019 W. Hillsborough Ave.
813-886-2541

ATLANTA, GA
5285 Roswell Rd.
404-252-4341

CHICAGO, IL
3462-66 W. Devon Ave.
312-583-3920

DOWNERS GROVE, IL
224 Ogden Ave.
312-852-1304

INDIANAPOLIS, IN
2112 E. 62nd St.
317-257-4321

MISSION, KS
5960 Lamar Ave.
913-362-4486

LOUISVILLE, KY
12401 Shelbyville Rd.
502-245-7811

KENNER, LA
1900 Veterans Memorial Hwy.
504-467-6321

BALTIMORE, MD
1713 E. Joppa Rd.
301-661-4446

ROCKVILLE, MD
5542 Nicholson Lane
301-881-5420

PEABODY, MA
242 Andover St.
617-531-9330

WELLESLEY, MA
165 Worcester Ave.
617-237-1510

DETROIT, MI
18645 W. Eight Mile Rd.
313-535-6480

E. DETROIT, MI
18149 E. Eight Mile Rd.
313-772-0416

HOPKINS, MN
101 Shady Oak Rd.
612-938-6371

ST. PAUL, MN
1645 White Bear Ave.
612-778-1211

BRIDGETON, MO
3794 McKelvey Rd.
314-291-1850

OMAHA, NE
9207 Maple St.
402-391-2071

ASBURY PARK, NJ
1013 State Hwy. 35
201-775-1231

FAIR LAWN, NJ
35-07 Broadway (Rt. 4)
201-791-6935

AMHERST, NY
3476 Sheridan Dr.
716-835-3090

JERICHO, L.I. NY
15 Jericho Turnpike
516-334-8181

ROCHESTER, NY
937 Jefferson Rd.
716-424-2560

N. WHITE PLAINS, NY
7 Reservoir Rd.
914-761-7690

CLEVELAND, OH
28100 Chagrin Blvd.
216-292-7553

COLUMBUS, OH
2500 Morse Rd.
614-475-7200

TOLEDO, OH
48 S. Byrne Rd.
419-537-1887

WOODLAWN, OH
10133 Springfield Pike
513-771-8850

OKLAHOMA CITY, OK
2727 Northwest Expressway
405-848-7593

FRAZER, PA
630 Lancaster Pike (Rt. 30)
215-647-5555

PHILADELPHIA, PA
6318 Roosevelt Blvd.
215-288-0180

PITTSBURGH, PA
3482 Wm. Penn Hwy.
412-824-3564

WARWICK, RI
558 Greenwich Ave.
401-738-5150

DALLAS, TX
2715 Ross Ave.
214-826-4053

HOUSTON, TX
1704 W. Loop N.
713-869-5263

SAN ANTONIO, TX
7111 Blanco Road
512-341-8876

MIDVALE, UT
58 East 7200 South
801-566-4626

ALEXANDRIA, VA
6201 Richmond Hwy.
703-765-5515

VIRGINIA BEACH, VA
1055 Independence Blvd.
804-460-0997

SEATTLE, WA
505 8th Ave. N.
206-682-2172

TUKWILA, WA
15439 53rd Ave. S.
206-246-5358

MILWAUKEE, WI
5215 W. Fond du Lac
414-873-8250

*Units of Veritechnology Electronics Corporation in the U.S.

Prices and specifications subject to change without notice.

HEATH/ZENITH

Your strong partner

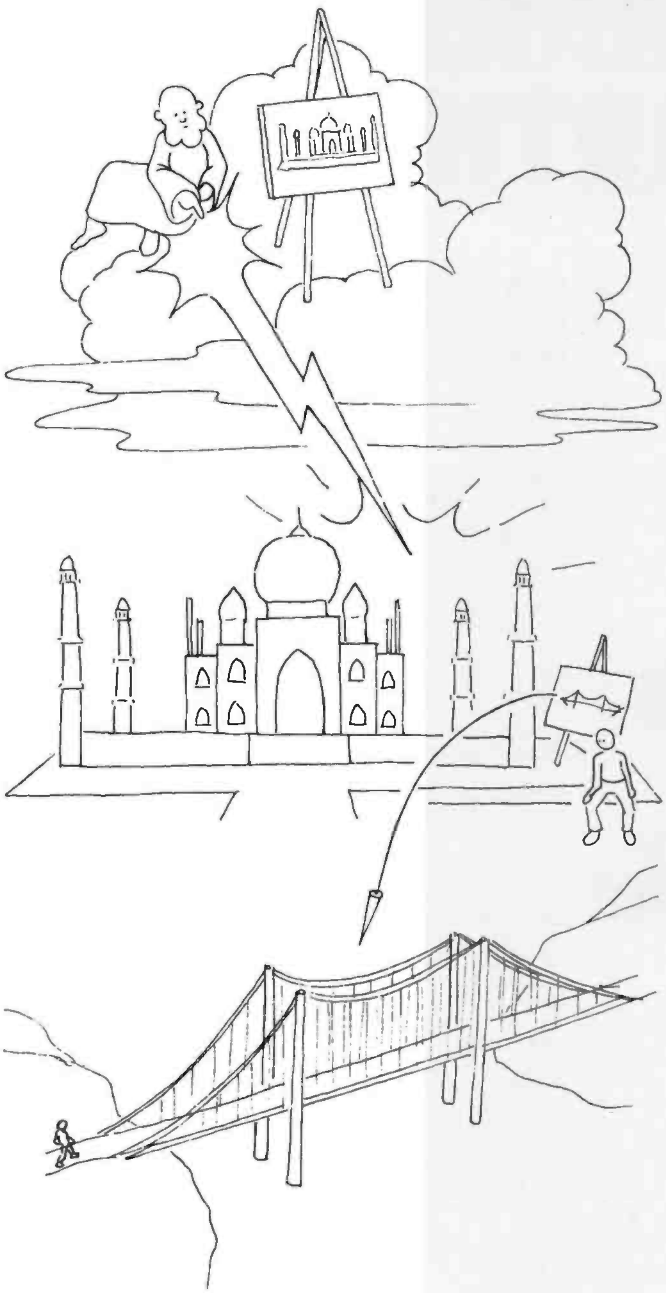


Figure 1

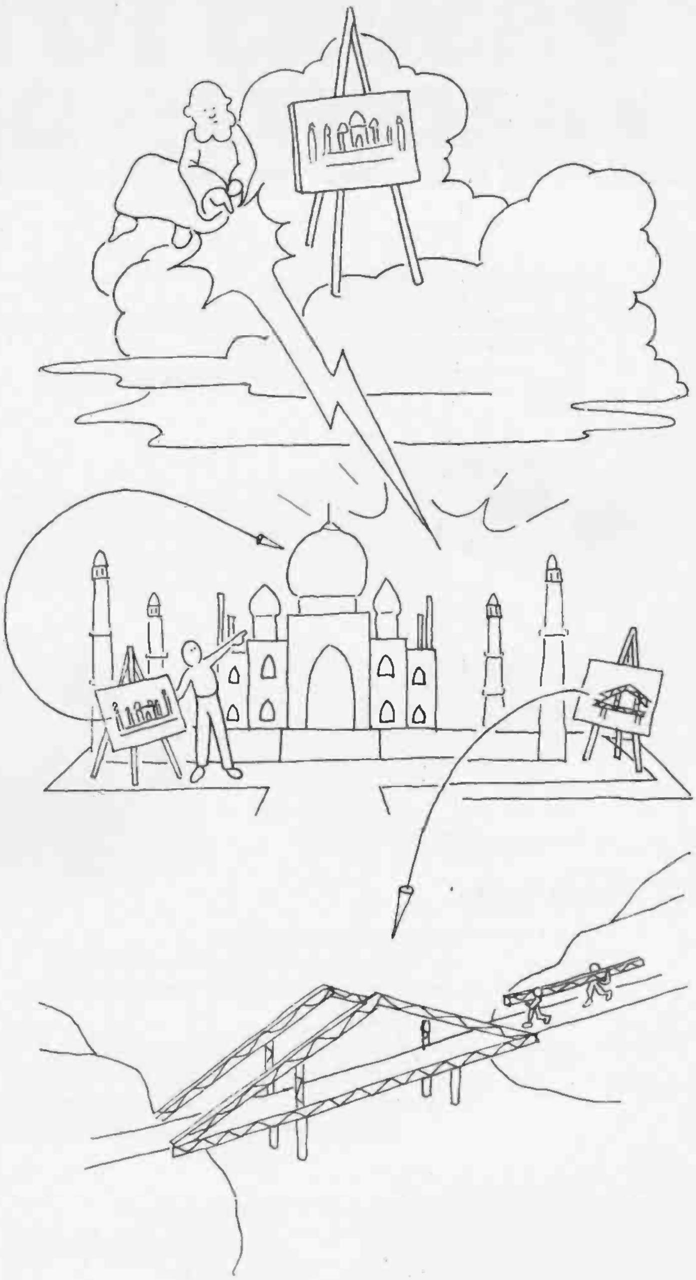


Figure 2

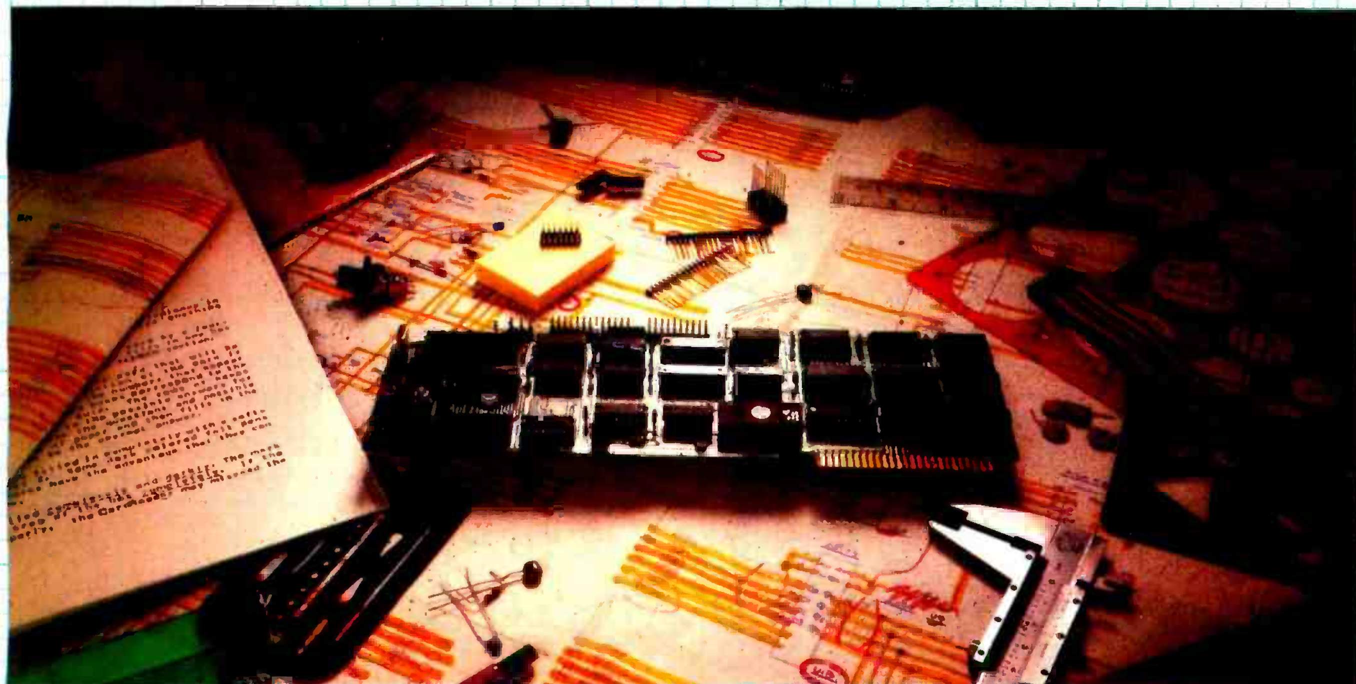
part of Alan Kay's personal computing vision, the Dynabook. The vision is a hand-held, high-performance computer with a high-resolution display, input and output devices supporting visual and audio communication paths, and network connections to shared information resources. LRG's goal is to support an individual's ability to use the Dynabook creatively. This requires an understanding of the interactions among language, knowledge, and communication. To this end, LRG does research on the design and implementation of programming languages, programming systems, data bases, virtual memories, and user interfaces.

The ivory tower on the island of Smalltalk is an exciting, creative place in which to work on these ideas. A sense of LRG's long-range goals is aptly portrayed in the illustrations designed by Ted Kaehler.

In figure 1, we see a view of the conventional software development environment: a wizard sitting on his own computational cloud creating his notion of a Taj Mahal in which programmers can indulge in building applications for nonprogramming users. The Taj Mahal represents a complete programming environment, which includes the tools for developing programs as well as the language in which the programs are written. The users must walk whatever bridge the programmer builds.

A goal in the design of the Smalltalk system was to create the Taj Mahal so that programmers can modify it by building *application kits*, which are specialized exten-

Mountain Computer put it all together for you.



The CPS MultiFunction Card

Three cards in one! The Mountain Computer CPS MultiFunction Card provides all the capabilities of a serial interface, parallel output interface and real-time clock/calendar—all on one card—occupying only one slot in your Apple II®. Serial and Parallel output may be used simultaneously from CPS. CPS is configured from a set-up program on diskette which sets the parameters (such as baud rate, etc.) for all functions contained on the card and is stored in CMOS RAM on the card. Once you have configured your card, you need never set it up again. You may also change parameters from the keyboard with control commands. All function set-ups stored on-board are battery powered for up to two years. "Phantom slot" capability permits assigning each of the functions of CPS to different slots in your Apple without the card actually being in those slots! For example, insert CPS in slot #4 and set it up so that is simulates a parallel interface in slot #1 and a clock in slot #7 and leave the serial port assigned to slot #4. CPS's on-board intelligence lets it function in a wide variety of configurations, thereby providing software compatibility with most existing programs. "We've put it all together for you"—for these reasons and many more! *Drop by your Apple dealer and see for yourself how our CPS MultiFunction Card can expand the capabilities of your Apple and save you a great deal of money as well!*

Calendar/Clock
- One second to 99 years
- Battery backed-up (2 years)
- Two AA standard alkaline batteries for back-up (provided)
- Compatible with MCI Apple Clock™ time access programs

Parallel Output
- Features auto-line feed, Apple tabbing, line length, delay after carriage return, lower to upper case conversion
- Centronics standard—reconfigurable to other standards
- Status bit handshaking

Serial Interface
- Features auto-line feed, transparent terminal mode, Apple tabbing, line length, delay after carriage return, local echo of output characters, simultaneous serial/parallel output, lower to upper case conversion, discarding of extraneous LFs from serial input
- Uses the powerful 2651 serial PCI chip
- 16 selectable internal baud rates—50 to 19.2Kbaud
- Half/Full duplex terminal operation
- I/O interface conforms to RS-232C
- Asynchronous/Synchronous operation

Special Introductory Price

$239

Mountain Computer
INCORPORATED

300 El Pueblo Scotts Valley, CA 95066
(408) 438-6650 TWX: 910 598-4504

Circle 255 on inquiry card.

™Apple Clock was the trademark of Mountain Computer Inc.

®Apple and Apple II are registered trademarks of Apple Computer Inc.

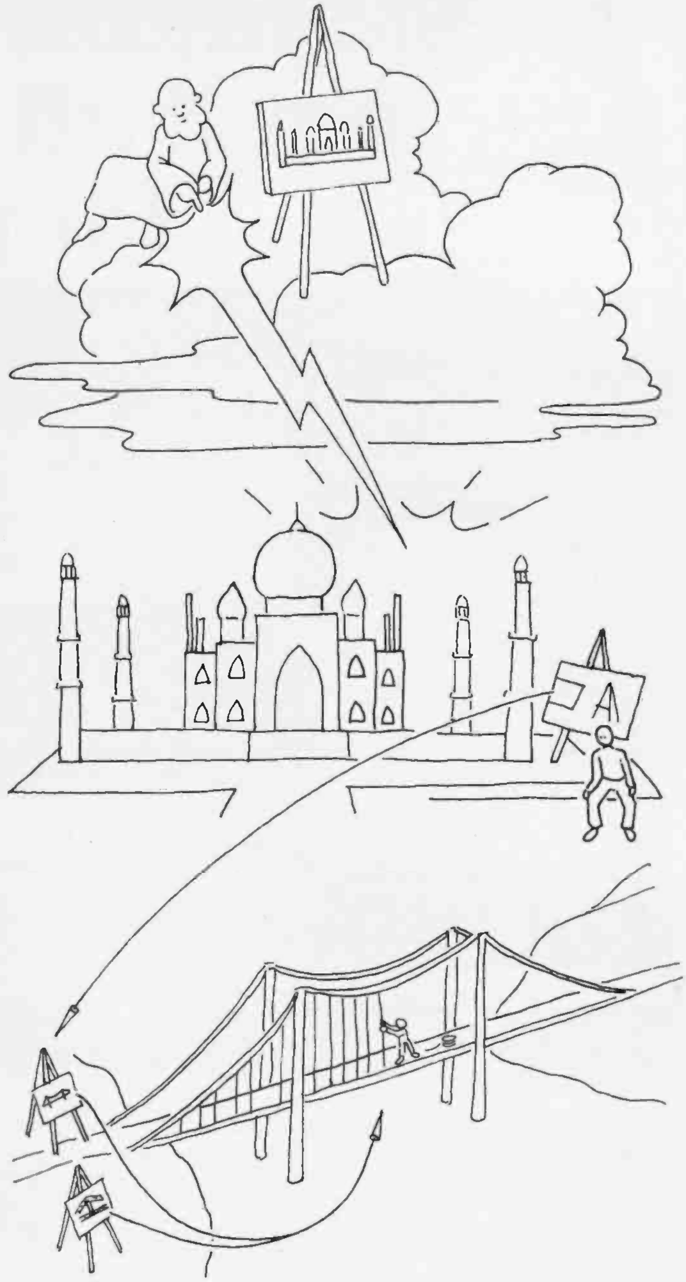
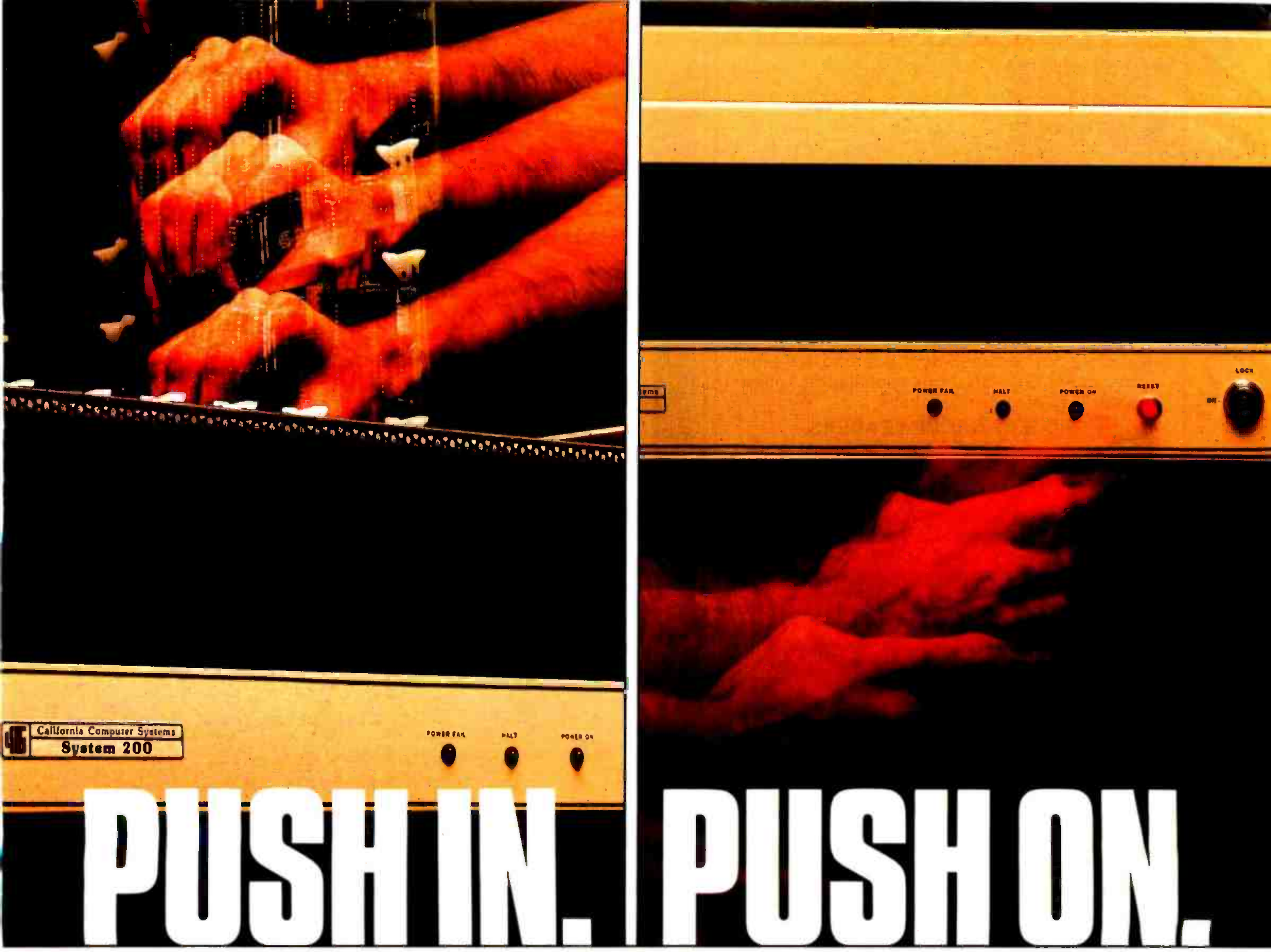


Figure 3

sions and/or subsets of the system whose parts can be used by a nonprogrammer to build a customized version of the application. Applications that can be created from a kit are related in a fundamental way: the programmer may, for example, create it for building bridges, but it is the user who pieces together the parts to create a customized bridge (see figure 2).

One of LRG's current research goals is to provide system parts to aid the programmer in creating kits. Although Smalltalk itself is conceptually sufficient for this task, it needs better support to help the programmer piece together the graphical display and the control for an interactive user interface. This is the "kit maker," as shown in figure 3.



CCS. MAKING MINIS OUT OF MICROS.

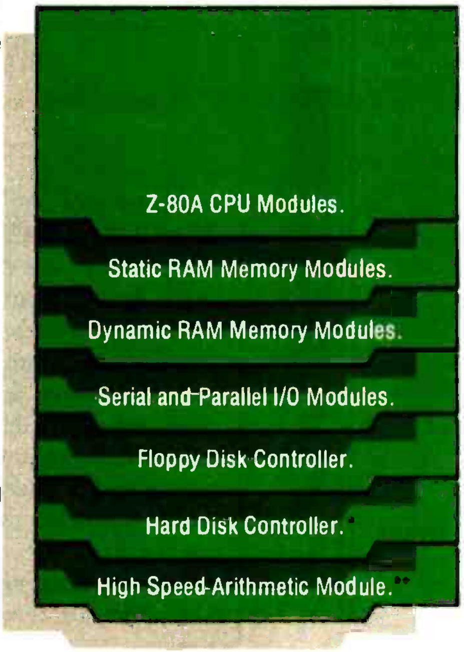
Here's the CCS line of board-level computers for system builders on the move. **Push in** the CCS board. And **push on** with your application. CCS board-level systems go together easily, come up quickly, and run reliably, with a proven return rate of less than 1%.

CCS board-level computers offer systems builders the optimal combination of low development cost, low manufacturing cost, and high reliability from proven, tested modules.

A headstart on reliability. CCS modules are designed to industrial performance standards, manufactured to industrial quality standards, fully burned in and tested. You spend more time and energy on your application when you rely on CCS modules instead of reinventing (and rebuilding) standard computer functions.

A full selection of S-100 board-level computers. Whether you want to add capability to another S-100 based system, or build a system from scratch, chances are you'll find solutions for all your system needs in the CCS product line. CCS manufactures a comprehensive selection, so you can tailor a system to your needs with a minimum of components. You buy exactly what you need. But you can easily expand later.

We'd like to tell you more about the CCS line of board-level computers, OEM systems, and computer systems. There's a lot more to tell. Send in the coupon for more information, contact your local computer dealer, or call.



* Available Quarter 2, 1981.
** For use with CCS System Models 200, 300, 400.

○ Please have a sales representative call me.
○ Please send more information on CCS Board-Level Computer Modules.

Name ______________________
Company ______________________
Address ______________________
City/State/Zip ______________________
Phone ( ) ______________________

California Computer Systems
250 Caribbean Drive
Sunnyvale, California 94086
(408) 734-5811

Circle 46 on inquiry card.

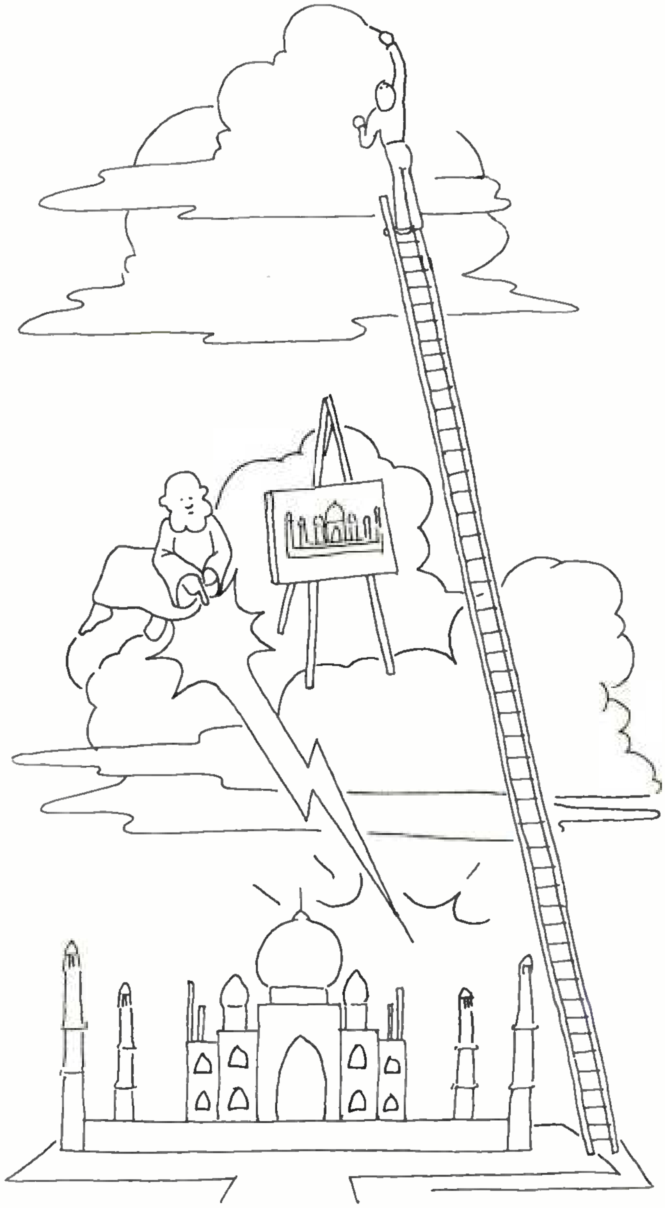


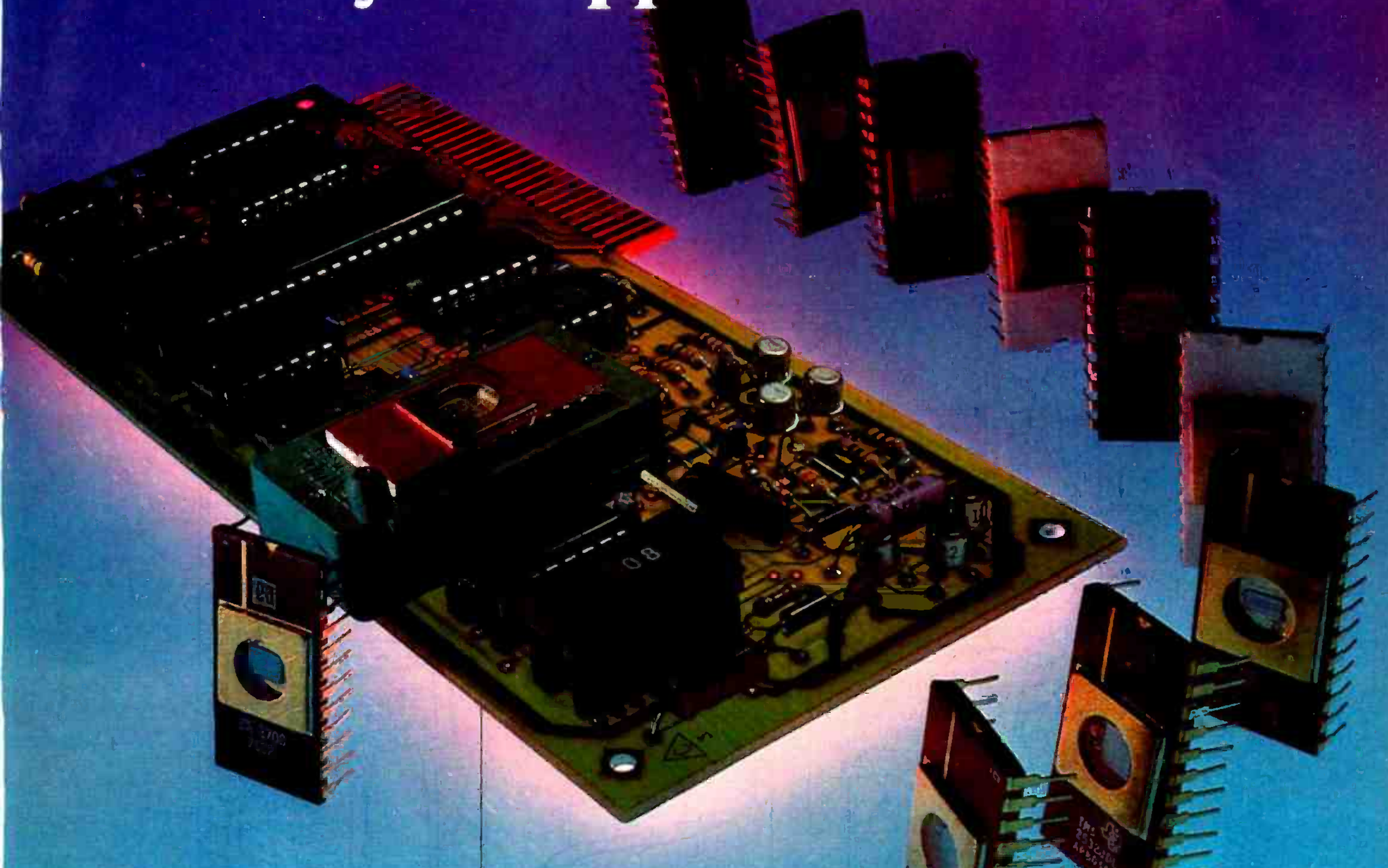
Figure 4

As part of the Dynabook vision, the system should help the programmer build a personal computational cloud (see figure 4). Two research projects, ThingLab by Alan Borning and PIE by Ira Goldstein and Danny Bobrow, took advantage of Smalltalk's support for creating new metaphors.

We are often asked: "What makes Smalltalk different from other languages?" The articles in this issue attempt to answer that question. Look for an emphasis on interactive graphics, on modular development of programs, and on integrated approaches to accessing program development tools. Also, look for the distinction between a programming language and a programming system, and consider the difference in providing a system in which the user can feel individual mastery over complexity. Although each article can be read independently of the

Text continued on page 26

Take a look at our EPROM blaster for your Apple™ or TRS-80.™



Apparat announces the most versatile EPROM burner available today for your TRS-80 model I and III or Apple computer . . . the Apparat PROM Blasting system (A.P.B.). Most EPROM burners will program only one type of EPROM. The A.P.B. system will program all commonly used 24 pin EPROMs by using special personality modules that adapt the unit to the EPROM. The following EPROMs are programmable: 2704, 2708, 2716, (3-volt) & (5-volt), 2732, 2508, 2516 and 2532.

The versatility and power of the A.P.B. system means you're getting a PROM burning package with extensive capabilities. The price, $149.00, insures you're getting the most cost-effective PROM burner on the market today.

With a unique combination of personality modules and sophisticated software, A.P.B. will perform many operations impossible with conventional PROM burners. Here's a brief list of some of A.P.B.'s capabilities:

- Verify ROM is erased
- Read ROM
- Copy ROM
- Copy between different ROM types
- Program ROM
- Partial programming and copies
- Verify programming
- Read or save ROM data on disk or cassette (Apple only)
- Program directly from computer memory
- Examine and/or modify working memory
- Preset working memory

The A.P.B. system is the most flexible PROM burner available. The A.P.B. system package consists of an interface card that plugs directly into an expansion slot*, a complete set of personality modules, software on disk and a detailed instruction manual. The software will run under NEWDOS/80, or TRSDOS™ for the TRS-80, and APPLE DOS™ or APEX for the Apple.

If you're looking for a powerful, versatile and cost efficient EPROM burner, call APPARAT today. Dealer inquiries welcome.

(303) 741-1778

*TRS-80 version requires the TRS-80 bus extender (Cat. # 1-025) or a separate user provided power supply and cable.

TRS-80, and Apple are trademarks of Tandy Corp. and Apple Computer.

VISA | master charge

Apparat, Inc.

4401 So. Tamarac Parkway, Denver, CO 80237 (303) 741-1778

"ON GOING SUPPORT FOR MICROCOMPUTERS"

Circle 21 on inquiry card.

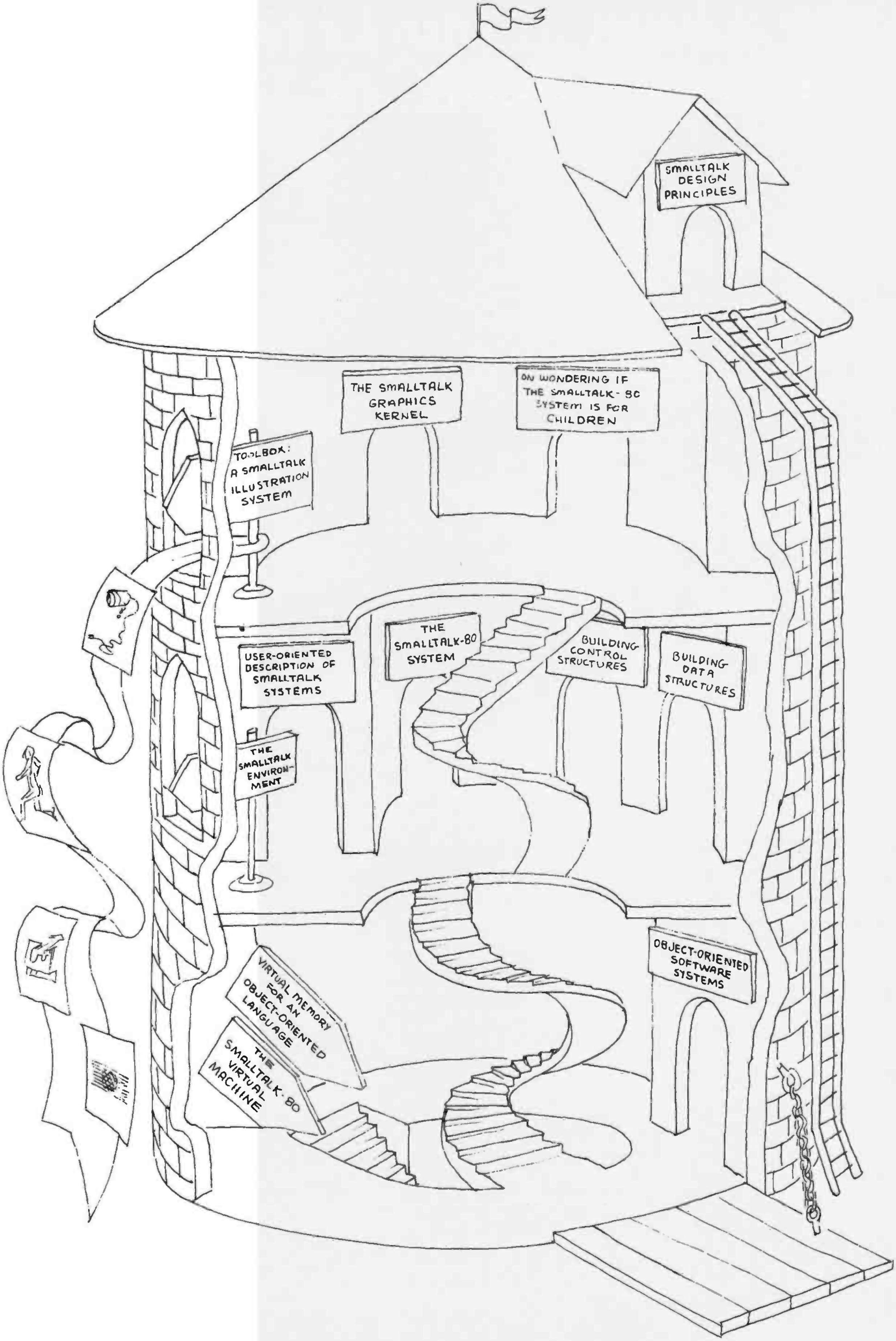

SMALLTALK DESIGN PRINCIPLES
THE SMALLTALK GRAPHICS KERNEL
ON WONDERING IF THE SMALLTALK-80 SYSTEM IS FOR CHILDREN
TOOLBOX: A SMALLTALK ILLUSTRATION SYSTEM
USER-ORIENTED DESCRIPTION OF SMALLTALK SYSTEMS
THE SMALLTALK-80 SYSTEM
BUILDING CONTROL STRUCTURES
BUILDING DATA STRUCTURES
THE SMALLTALK ENVIRONMENT
OBJECT-ORIENTED SOFTWARE SYSTEMS
VIRTUAL MEMORY FOR AN OBJECT-ORIENTED LANGUAGE
THE SMALLTALK-80 VIRTUAL MACHINE

Figure 5

MICRO-SCI SQUEEZES MORE OUT OF YOUR COMPUTER, NOT YOUR POCKET

If you own an Apple II,* or plan to buy one, consider this:

The Disk II* subsystem made for your Apple II provides only 35 tracks of storage. But Micro-Sci subsystems made for your Apple II provide up to 70 tracks, without reduced versatility or compatibility.

MORE CAPACITY FOR LESS MONEY

Our A40 system features 40 tracks, whereas our A70 provides 70 tracks and exactly twice the byte capacity of Disk II.

With either Micro-Sci system, you pay a lot less per byte. And with the A40, you could even end up paying considerably less per drive.

COMPATIBILITY TO SPARE

Micro-Sci has achieved this extra storage while maintaining compatibility with your existing Apple formated diskettes.

Our subsystems operate with DOS 3.2 and 3.3, Pascal, and the Z80 SoftCard.

VERSATILITY PLUS

You can even mix Apple Disk II's, A40's and A70's on the same computer. Micro-Sci's controller supports one or two A40's, one or two A70's or one of each.

Single or dual A40 drive subsystems give you more capacity (20,000 to 40,000 bytes) than Disk II drives, for less money.

Micro-Sci's A40/A70 subsystem combines the diskette level compatibility and interchangeability of the A40 with the superior storage capacity of the A70.

Dual A70's provide over half-a-megabyte of storage, at 5¼" floppy prices!

No matter which Micro-Sci subsystem you choose, you'll have more capacity, compatibility and versatility for your computer — and more money in your pocket. Contact us today for more information and the name of your nearest Micro-Sci Dealer.

* "Disk II" is a registered trademark of Apple Computer, Inc., Cupertino, CA

** "SoftCard is a registered trademark of Micro-Soft Consumer Products.

μ-SCI

MICRO-SCI

17742 Irvine Boulevard, Suite 205, Tustin, California 92680 / Phone: 714/731-9461 / Telex: 910-346-6739

MICRO-SCI IS A DIVISION OF STANDUN CONTROLS, INC.

Text continued from page 22:

others, knowledge of the Smalltalk-80 system and its design philosophy is a prerequisite to understanding many of them. The map in figure 5 is presented to help the reader find a course through this hitherto uncharted ivory tower.

You can begin at the drawbridge by reading Dave Robson's introduction to object-oriented programming (page 74) and then proceed by reading the description of the Smalltalk-80 language (page 36). The two examples of programming in Smalltalk-80 are likely next steps: one, by Jim Althoff, tells you how to build data structures (page 230); the other, by Peter Deutsch, describes how to build control structures (page 322). Or, you can follow a hallway to the user interface window and read Larry Tesler's description of the Smalltalk programming environment (page 90). Trygve Reenskaug offers further perspectives on providing a programming interface to a Smalltalk system (page 147).

At any time, you can take the side stairs to read Dan Ingalls' presentation of the design principles behind Smalltalk (page 286). Those readers who are interested in implementation details can head for the cellar and read Glenn Krasner's article on the Smalltalk virtual machine (page 300), or Ted Kaehler's article on a Smalltalk virtual memory (page 378).

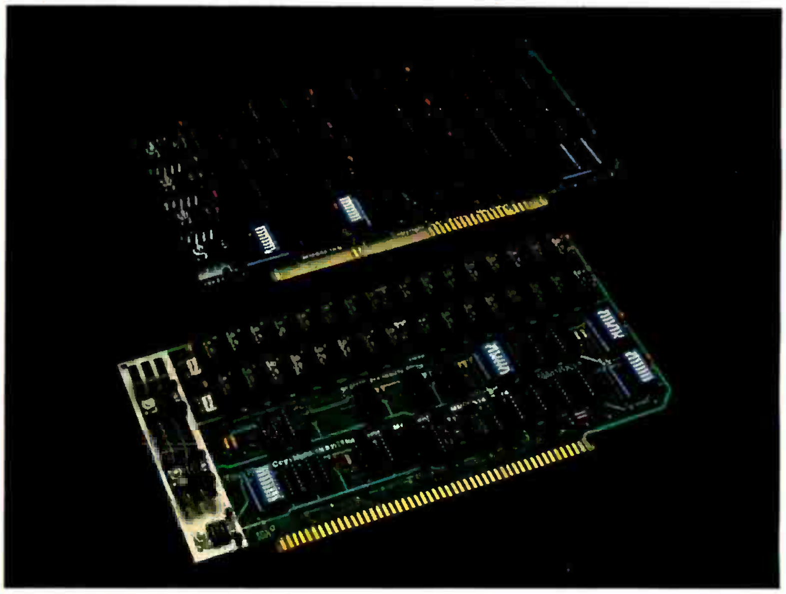
The walls of the tower are covered with visual images that will please any graphics enthusiast. Many were created by the ToolBox painting component of Smalltalk, as described in Bill Bowman and Bob Flegal's article (page 369). Greater detail about the Smalltalk graphics kernel is provided by Dan Ingalls (page 168).

Ivory towers are often associated with educational enterprises. So it is not surprising that field studies of the various versions of Smalltalk have been carried out mostly in educational settings; elementary, junior, and senior high school students as well as university students have helped us test our ideas. Joan Ross and I provide some of the history in an article exploring whether the Smalltalk-80 system is for children (page 348).

Many people have helped to build our ivory tower, to surround it with protective clouds, and then to blow some of the clouds away. All the people, past and present, of the Xerox Palo Alto Research Center contributed a brick or two. George Pake, vice president of Corporate Research, assembled the bricklayers. We especially herald the person who is responsible for laying the foundation, Alan Kay, and current members of LRG not named as article scribes: Peggy Asprey, Alan Borning, Laura Gould, Bruce Horn, Neil Jacobstein, Kim McCall, Diana Merry, Steve Putz, and Steve Weyer. Special thanks to Bert Sutherland who did the "preflight check."■

Getting "STATIC" from our competition?. . if so, you're paying too much!

Try Ours $179



64K Static $895
assembled

16K Static $179
assembled

• STATIC RAMS • FULLY ASSEMBLED • FULLY TESTED • BURNED-IN • FULLY SOCKETED • INCREDIBLE VERSATILITY • BANK SELECTABLE • EXTENDED ADDRESSING • DELIVERY FROM STOCK • SAVE HUNDREDS OF DOLLARS • INTRODUCTORY PRICE - ORDER TODAY

The Memory Merchant Story

Why hasn't memory come down in price like it should? Here's what is being done for you.

High Performance and Low Price 16K Static Board

You want the most cost-effective, high performance memory boards that technology will allow. With that in mind we commissioned one of the top memory designers in the country. We told him to design the board with the user in mind. It had to sell for less than $200. It had to run cool and have low-power consumption. It had to have both *extended addressing capabilities and bank select capabilities at no additional cost.* You had to be able to de-select 1K blocks so the memory could accommodate memory-mapped video displays or controller cards. The board had to be fast so a user could run his processor at full speed. Finally, the board had to be reliable and easy to install. He came up with all this and more. Here's a high performance, *fully assembled, tested and burned-in,* guaranteed 16K board that we are *introducing for only $179.* Runs on any S-100 8080, 4 MHz Z-80, or 5 MHz 8085 system.

The Most Advanced 64K Static Board

The end user wants State-of-the Art when he buys a 64K board. So we had our super designer put together the 64K board of the future with tomorrow's high speed processors in mind. This board had to work with all S-100 systems, with current processors and future (up to 8 MHz) processors. It had to be ultra-low power. It had to be designed so the advanced user could *populate the board with programmed EPROMs* for special applications. This board, too, had to have *both bank select and extended addressing at no extra cost.* The board was also designed to be used as a 32K or 48K board and we are selling it that way, too. Put in additional chips when you want to increase the capacity!

OEM and dealer inquiries invited.

16K Ram, Model MM16K14 Specifications:

- Four independent 4K×8 byte segments
- One 4K segment equipped with 1K windows
- Compatible with both existing bank select type hardware and IEEE 696/S100 extended address protocol
- Operation guaranteed to 4 MHz with Z-80 and to 5 MHz with 8085 processors
- Low power consumption, typically 1.3 amps
- Uses low power 300 ns 2114 (1K×4)

64K Ram, Model MM65K16S Specifications:

- Operation guaranteed to 8 MHz
- Compatible with both existing bank select type hardware and IEEE 696 extended address protocol
- Fully loaded board (64K) draws 400ma. while max. current is 550 ma.
- Four independently addressable 16K submodules on one board organized as 2 pair of independent 32K banks or as 1 64K extended address page. Each 32K bank responds independently to phantom. Bank select logic is compatible with either Cromemco Cromix* or standard bank select software.
- 2716 (5V) EPROM compatibility: Programmed 2716 EPROMs may replace any or all of the Ram components on the board.
- New 16K (2K×8) Static Rams which combine extreme low power (40ma. ON; 5ma. OFF) with high speed (200ns max. access time).
- Also available partially populated to 48K or 32K.

*Cromix is a trademark of Cromemco.

Circle 215 on inquiry card.

No Risk Free Trial

After you purchase one of our boards you may return it (intact) for any reason within 15 days after shipment and receive a full refund.

Free Six Months Memory Insurance

We will replace any board purchased from Memory Merchant that becomes defective through normal use for up to six months.

Yes! Please send me the items listed below. I understand that if I'm not fully satisfied with the product, I can get a full refund within 15 days after shipment. (Send check, money order, or use your credit card.) Note to credit card buyers: For extra fast service phone (415) 483-1008

QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
	64K	$895.00	
	48K	749.00	
	32K	569.00	
	16K	179.00	
	SHIPPING & HANDLING $5.00/Board		
California Residents Add 6% Tax		TOTAL	

SEND TO:
MEMORY MERCHANT (B1)
14666 Doolittle Dr.
San Leandro, CA 94577
(NO C.O.D.'s)

☐ CHECK
☐ MONEY ORDER
☐ VISA
*☐ MASTERCHARGE
(Must also have ICA#)

CARD NO. ____________ EXP. DATE ____________

* ICA NO. ____________ SIGNATURE ____________

NAME ____________

ADDRESS ____________
Street City State Zip

Prices, terms, specifications subject to change without notice.

14666 DOOLITTLE DR.
SAN LEANDRO,
CA 94577
(415) 483-1008

Memory Merchant™

ANNOUNCING

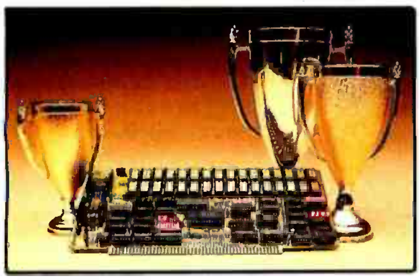
A Major Breakthrough

The SYSTEM 2800

The System 2800 is the next logical step in the continuing line of innovative products from the Systems Group.

Unbeatable S-100 Memory Boards

First was the development of the DMB6400 series of S-100 Memory boards featuring the innovative Bank Select switching technique. This enables users to software select up to four totally independent memory banks per board.



The 2nd Generation

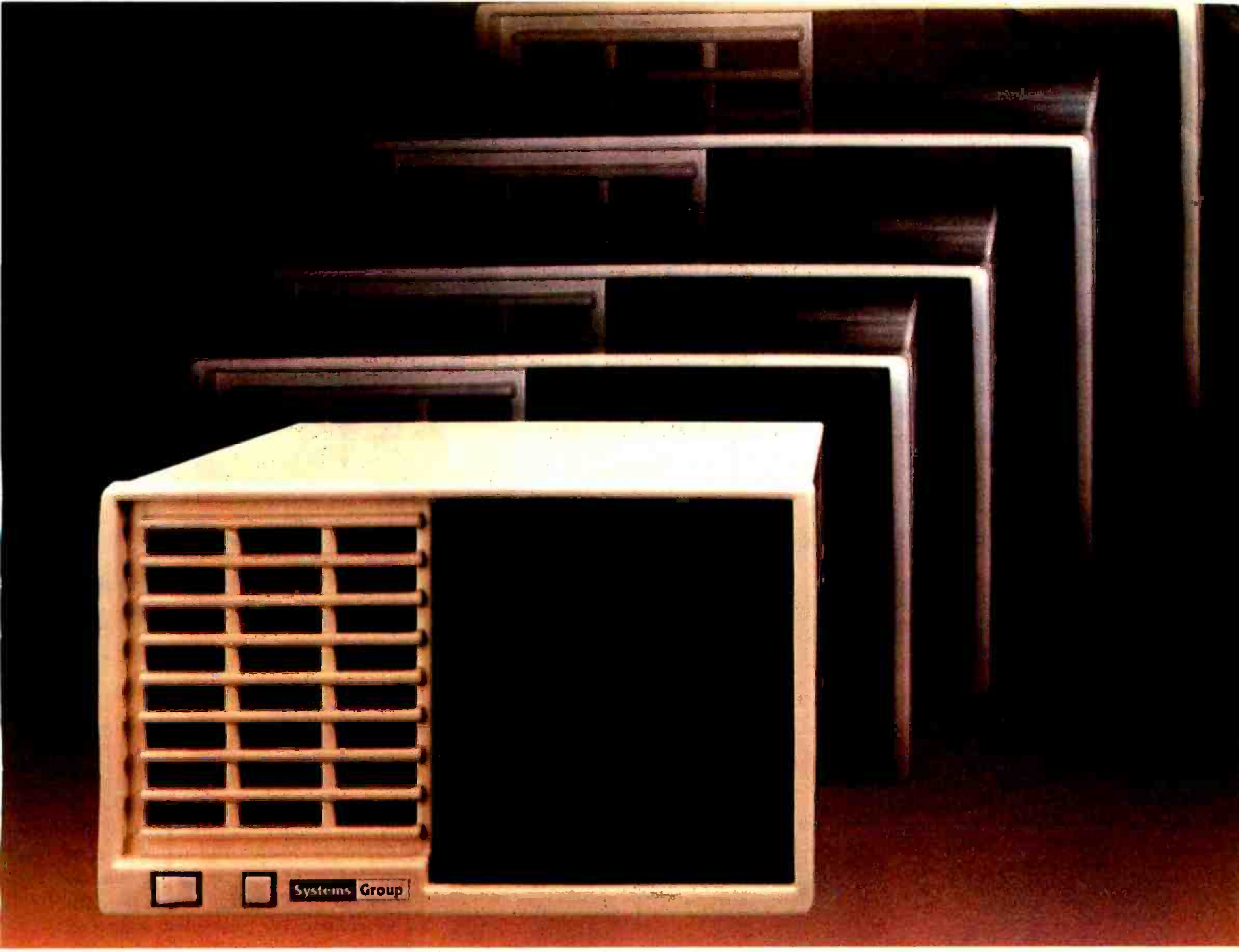
Then came the 2nd Generation of IEEE S-100 COMPATIBLE Z80 PROCESSORS, FLOPPY DISK CONTROLLERS and SERIAL I/O BOARDS. Each has been designed for single user, multi-user or network operating systems such as CP/M®, MP/M™, CP/Net™ and OASIS™.

The Next Logical Step ...

We challenged our design team to create an innovative yet competitive system utilizing our existing line of field proven, dependable S-100 boards. The result: a highly reliable, quality built, state of the art microcomputer that gives you the cost/performance edge you need to be a leader in your field.

The System 2800 comes with a choice of operating systems: CP/M with an enhanced CBIOS for single user systems and either MP/M or OASIS for multi-user, multi-tasking systems. MP/M is available with either a standard or

CP/M MP/M and CP/Net are trademarks of Digital Research
OASIS is a trademark of Phase One Systems



enhanced XIOS. The CP/M based System 2800 provides improved diagnostic reporting capability and increased sector sizes of 1024 bytes yielding disk performance throughput increases up to 400% over standard unblocked systems.

The enhanced multi-user, multi-tasking MP/M based System 2800 provides the same advanced features as CP/M. In addition, this interrupt driven implementation can offer performance throughput increases up to 2000% thru extensive disk buffering for applications requiring a large number of disk accesses.

Also available is the OASIS operating system with ISAM files, automatic record locking and multiple-user print spooling.

All operating systems are available in either floppy or hard disk configurations. The disk drive selection includes single or double sided, double density 8-inch floppies with up to 2.52 megabytes of formatted storage per system, expandable to 5.04 megabytes, and an 8-inch 10 megabyte winchester hard disk.

Cost Effective Reliability

Dealers, OEM's and System Integrators share many common needs. Not the least of these is dependable products. That's why we back our System 2800 with our established reputation for high quality products, superior support, prompt and courteous service, and a one-year warranty.

Take the next logical step. See your nearest computer dealer, or contact us for the complete story on our S-100 family of board products and enhanced systems.

Systems Group

A Division of MEASUREMENT systems & controls incorporated

1601 Orangewood Ave.
Orange, Calif. USA 92668
(714) 633-4460 TWX/TELEX: 678 401 TAB IRIN

For International Sales Inquiries contact: SIGMA INTERNATIONAL, INC., P.O. Box 1118, Scottsdale, AZ 85252 USA (602) 994-3435 / Telex 165 745 Sigma

Circle 213 on inquiry card.

Letters

Advertisements, Etc

An advertisement in the May 1981 BYTE could cause readers to mistakenly conclude that certain products of Computer Corporation of America are available through Computers, Etc.

Computer Corporation of America's products and services are available only through the Computer Corporation of America. Additionally, the name "Computer Corporation of America" is the exclusive property of Computer Corporation of America, a corporation organized under the laws of the Commonwealth of Massachusetts.

Thank you, BYTE, for this opportunity to eliminate any confusion concerning the use of our name or availability of our products and services.

Joseph Jarzembowski
General Counsel
Computer Corporation of America
575 Technology Sq
Cambridge MA 02139

Noise from the Past

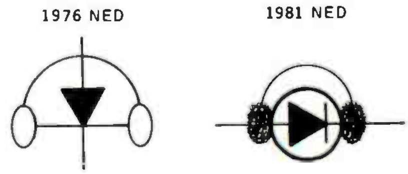
I was pleased to see BYTE's ongoing reporting of new semiconductor devices with April's "What's New?" mention of LOUD Electronics's 3N120DB NED (noise-emitting diode).

BYTE seems to be in error, however, when it says that the device is a "new development in indiscreet electronics." As I remember, BYTE reported the development of an earlier version of this device five years ago, in 1976. At that time, the device was only available in high-voltage versions and had a much shorter lifetime than the current component has.

In the 1976, BYTE said:

> *When connected across a +1000 V supply, it makes a loud noise (once). The NED was discovered by Igor Pravaganda, whom, you'll recall, worked many years trying to filter AC with polarized electrolytic capacitors. He'll always be remembered as the father of the confetti generator.*

At that time, the schematic diagram of the device was also slightly different. I assume the drawing of the NED has been standardized to the current version in the past five years.



While I am pleased to learn of the continued development of this device, I do feel that, in the future, BYTE should be more careful in reporting of "new" semiconductors.

David J Lindbergh
49 Beechmont St
Worcester MA 01609

We have been following the development of the NED (which appeared for the first time on page 41 of the February 1976 BYTE) very closely. Also at that time, we reported on the invention of two other devices: the Shiftless Register and the Fuzz-Locked Loop. We believe that these three devices will form the basis for data-communications systems in the future. Watch upcoming issues for a report on the Fast-Fourier Stepdown Transformer. . . . CPF

April's Foolers

The hasty printing of data concerning our Black-Hole Diode is not only an invasion of our corporate security, but is not in the national interest. (See the April 1981 BYTE, page 363.)

Our device, which is covered by US patents and is classified by the National Security Council as "Top Secret," should not be pandered about in a general-circulation magazine for all to see, especially when those not friendly to our nation may learn details of this device.

Furthermore, how BYTE learned of the existence of our device is unknown to us, but be advised that stricter security has been imposed to forestall any further lapses.

Be also advised that the company BYTE lists as being responsible for creating the

PALANTIR™

The next generation of business software

WHAT'S IN A NAME?

We've changed the name of our product line. Originally, we called our products "Phoenix" because we saw the phoenix as an appropriate symbol of quality. Unfortunately, a lot of *other* companies chose Phoenix as well, and there was some concern that the market place would become confused.

Our new name, *PALANTIR*™ (pronounced *pal'anteer*), is not a new name for us since it's our corporate name. It comes from J.R.R. Tolkien's *The Lord of the Rings* and describes a black crystal ball, a "seeing stone", used to see things at a distance.

Whatever the name on the package, the software in the package hasn't changed. It is still the highest quality business software you can buy for your microcomputer.

WORD PROCESSING

We know word processing. A year-and-a-half ago the owners of *Designer Software*™ wrote a well-known word processor for another company. In the last 18 months we've learned about other features you want in a word processing package. *PALANTIR*™ Word Processing reflects our experience. It is more powerful than other word processing packages you can buy and can compete, feature for feature, with expensive dedicated word processors.

Many people have remarked that the user's manual we wrote earlier was the best ever for microcomputer software. Even so, we felt that we could have made it more accessible to the non-technical user. With *PALANTIR*™ Word Processing we have a separate Training Manual with beginning, intermediate and advanced levels. By allowing you to work at your own level, we have made the learning process easier and less intimidating.

ACCOUNTING

All five *PALANTIR*™ general accounting packages (General Ledger, Accounts Receivable and Payable, Payroll and Inventory) were designed by CPA's based on similar packages from mini and mainframe computers. The programs are COBOL with an integral assembly-language data base. They are integrated to allow automated posting to the General Ledger. An internal screen handler permits full-screen data entry for speed and ease of use. Although we made cosmetic enhancements prior to distribution, the basic programs have been user-tested for at least eighteen months.

PALANTIR™ Accounting also includes a growing number of specific application packages. We have completed or scheduled for completion Fixed Assets, Tenant Processing, Mail Management, Financial Projections and Time/Billing. Each package stands alone, but many also work in conjunction with other *PALANTIR*™ packages. For example, Mail Management will work very well by itself, but we also designed it to fit in easily with the merging capabilities of Word Processing.

With all *PALANTIR*™ Accounting we have given special attention to documentation. Not being content to describe which buttons to push, we have taken the time to explain the accounting principles behind the programs and how each package *helps* to automate your office.

Designer Software™
HOUSTON

If you want to know what PALANTIR™ *Word Processing and accounting can do for your business, call, write, telex or use The Source to request more information.*

3400 Montrose Blvd • Suite 718 • Houston, Texas 77006
(713) 520-8221 • Telex 790510 • Source TCU671

Black-Hole Device, Spatial Regression Ltd, will shortly receive summons from our legal department.

Any repetition or further disregard for national security regarding this device or its uses in particle-beam research will bring about swift and *final* action.

J W Kelty
Chief Executive Officer
Code-7 Electronics
POB 1505
Modesto CA 95353

Each year, the BYTE staff enjoys slipping a few joke items into the April issue for our readers to find; some are subtle, some are outrageous. Response to this year's foolishness was greater than in any year past. In case you missed it, look for

"Lost Dutchman's Bug" (photo), page 302
"Black-Hole Diode" (new product), page 363
"Noise-Emitting Diode" (new product), page 364
"Slightly Used Cray-1" (unclassified ad), page 414

So you see, there's no need for "swift and final action" (gulp!)—we were just kidding! By the way, where should we return the sample device that was included with your letter? . . . CPF

Unpublished Apple Logo

With some hesitation, I'm writing this letter to inform BYTE readers of an unfortunate situation concerning the distribution of the MIT Apple Logo programming language. I've been writing Apple Logo at the Logo laboratory for the last two years as an undergraduate project. I've labored under the understanding that Apple Logo was to be placed in the public domain or licensed to software-development companies or dealers for distribution. However, for the past eight months, MIT has withheld the language from the public.

I would like to explain why. The original intent of my project was to implement a small subset of the Logo interpreter on the Apple computer. The final product actually evolved into a full-scale implementation, with features surpassing the Texas Instruments (TI) version, which also was developed at the Logo laboratory. When TI heard about this and the Apple Logo project, it reacted angrily; it fears that a Logo for the Apple would adversely affect sales of its Logo system. In fact, TI may be quite justified in its fears, for there are many people who think that Apple Logo is superior to TI Logo as an educational tool. It's rumored that Texas Instruments is depending on TI Logo to redeem the TI-99/4 home computer, which is not selling as well as expected.

Texas Instruments is a very generous friend of MIT, and some people here are embarrassed about a situation that might threaten one of its sales programs. So, in an effort to appease its corporate friend, MIT has been stalling the distribution of Apple Logo. There was a version ready for distribution at the end of last year with many improvements over the version reviewed in the June BYTE (see "Logo for Personal Computers," page 36), and since then it has been expanded and improved. But I'm extremely frustrated that MIT chooses to avoid angering Texas Instruments by compromising the efforts of one of its undergraduate students. This frustration is compounded by the fact that I feel, as do many here at the lab, that the TI-99/4 has many serious deficiencies and that the public will be cheated if forced to buy it because it is the only machine on which Logo is available.

Apple Logo is one of the finest programs that can be used on the Apple, and I would like to see it widely distributed as early as possible. Two years of my efforts went into it, as well as those of several others, and it's sad that MIT does not recognize the injustice that it is doing to myself, the Logo laboratory, and the many Apple users who would benefit from Apple Logo. If TI is afraid that its sales will be hurt, then it should fix the deficiencies in its machine and stop trying to suppress this program. I urge BYTE readers to write the Office of the Provost at MIT and request that Apple Logo be made public or licensed for distribution without delay. Thank you.

Stephen Hain
MIT Logo Laboratory
545 Technology Sq
Cambridge MA 02139

Love's Labors Lost

Whilst enjoying very much the Shakespearean research endeavours of Andrew Kalnik, it is obvious that he has missed the point. (See "Micro-Shakespeare," April 1980 BYTE, page 104 and "MicroShakespeare Revisited," April

The guy on the left doesn't stand a chance.

The guy on the left has two file folders, a news magazine, and a sandwich.

The guy on the right has the OSBORNE 1®, a fully functional computer system in a portable package the size of a briefcase. Also in the case are the equivalent of over 1600 typed pages, stored on floppy diskettes.

The owner of the OSBORNE 1 is going to get more work done—and *better* work done—in less time, and with less effort.

Unfold it, plug it in, and go to work like you've never worked before. . . .

Go to work with WORDSTAR® word processing, so your correspondence, reports, and memos take less time to produce, and say more of what you wanted to say. And with MAILMERGE®—the mailing system that turns out personalized mass mailings in the time you'd spend on a rough draft.

Go to work with SUPERCALC®, the electronic spreadsheet package that handles complex projections, financial planning, statistics, and "what if" questions instantly. For the more technically minded, SUPERCALC will process scientific data and calculate results.

Go to work with powerful BASIC language tools—the CBASIC-2® business BASIC, or the Microsoft BASIC® interpreter.

That's standard equipment.

Options include about a thousand different software packages from a host of vendors designed to run on the CP/M® computer system.

Go to work at the office, at home, or in the field.

Or anywhere. Optional battery packs and telephone transmission couplers mean you need never work without the capabilities of the OSBORNE 1. That's good, because you won't want to work again without it.

All for $1795. It's inevitable.

The OSBORNE 1 is the productivity machine that's changing the way people work. Put simply, the machine delivers a significant productivity edge—day in and day out—to virtually anyone who deals with words or numbers. Or both.

Since the entire system is only $1795, it won't be too long before the guy on the left has an OSBORNE 1 of his own. The same probably goes for the person reading this ad. In fact, we think it's inevitable.

The OSBORNE 1 Includes a Z80A®CPU, 64K bytes of RAM memory, two 100 kilobyte floppy disk drives, a business keyboard, built-in monitor, IEEE 488 and RS232 interfaces for printers and other things that get connected to computers, plus CP/M, CBASIC-2, Microsoft BASIC, WORDSTAR, and SUPERCALC. The system is available from computer retailers nationally.

$1795. It's inevitable.

OSBORNE

COMPUTER CORPORATION

26500 Corporate Avenue Hayward, California 94545
Phone (415) 887-8080 TWX (910) 383-2021

1981 BYTE, page 98.)

Careful scrutiny of the works of the Bard of Programmers reveals that some discarded program segments have become garbled into the text, probably as the result of bad file merges.

Take, for example, the statement

If it were done when 'tis done then 'twere well it were done quickly

or, parsing

IF I(T) WERE D(ONE) WHEN 'T IS D(ONE) THEN 'T WERE W(L) I(T) WERE D(ONE) QUICKLY

which, written as we understand it, and using X for ', gives

```
IF I(T)  = D(1)
   WHILE T(X) = D(1)
      T(X) = W(L)
     I(T) = D(1)
          QUICKLY
```

The WEND statement is missing, but it may be that QUICKLY denotes a machine-code subroutine that could have some terminating function. (Mistress Quickly is a comical character in *The Merry Wives of Windsor*—an example, perhaps, of a subroutine label being confused with a file name?)

Further research has revealed, hidden in the depths of the surviving listings, an incomplete command syntax of a lost high-level language.

Typical examples of this are

Lost Language	Modern Parlance
Armour	Chain
Billet	Log
Breach	Input
Burden	Load
Count	Cont
Curtail	Edit
Espy	Peek
Fellow	Cos
Folio	Print
Hail	Call
Inquisition	Exam
Buffet	Poke
Missives	Data
Near	Close
Peasant	Common
Scotch	Erase
Scribe	Write
Set	Put
Tally	List
Unbesmirch	Clear

There are some commands still in use today: GOTO, END, EXIT, ERROR, RESTORE, RUN are typical, whilst the use of functions such as SIN, HEX, DIM, and FIX show the arithmetical properties of the language. It can safely be assumed that commands such as READ and AUTO were not generally implemented at this time.

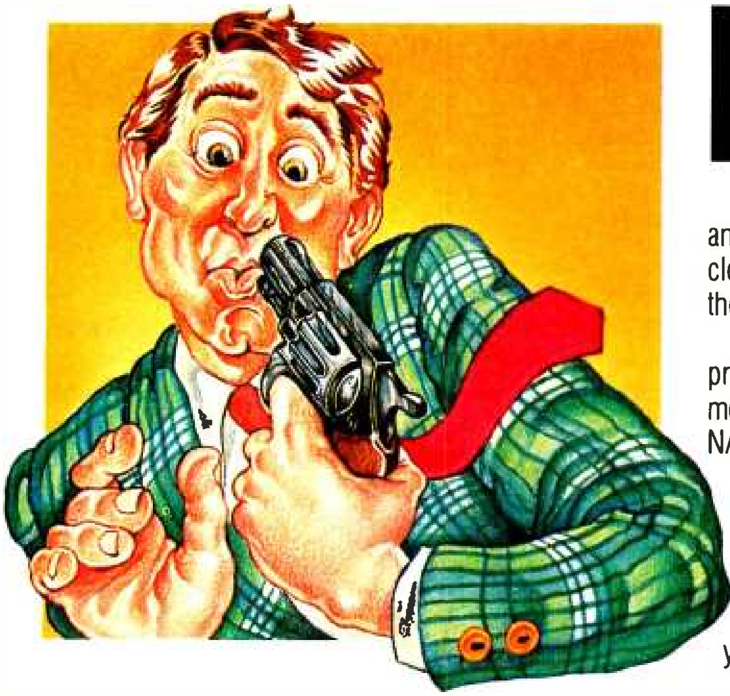
Research continues, but so far it looks as if Sir Francis Drake made the first recorded visit to Silicon Valley, during which, presumably, the natives acquired the principles of his on-board navigational computer.

Ross Henderson
Systems Manager
Digital Devices Ltd
134 London Rd
Southborough, Kent,
TN4 0PL, England

It is obvious that, despite improvements in hardware, some aspects of programming never change—Shakespeare, in his time, may have suffered the "slings and arrows of outrageous fortune" just as modern programmers do. What personal-computer user has not, after seeing an advertisement for software, purchased same from The *Software* Merchant *of*

Letters continued on page 282

STOP STEALING FROM YOUR OWN BUSINESS



Here's the white collar crime of 1981: Let your people labor away for hours at jobs a properly trained computer can do in seconds.

You pay for all those wasted hours.

And you're **missing opportunities**, because the hours could be spent on new, productive, profitable projects.

We can help you.

If you have a CP/M®-based microcomputer, SSG's Business Productivity Packages will scoop up all those hours you're losing and give you back more productivity, more time, more information, and more success.

ANALYST. $250. An information storage and retrieval (data base) system that will replace piles of files with information you can USE.

MAGIC WORKSHEET. $250. SSG's answer to the world's demand for electronic spreadsheet calculation and "what-if" capabilities on CP/M systems. (Available quarter two 1981.)

NAD Name and Address. $100. A mailing and addressing system to do all the typing and clerical work on lists—from ten names to ten thousand.

LETTERIGHT. $200. A correspondence processing package that speeds letter writing AND merges your letters with names selected from your NAD list.

It takes very few hours at today's salary levels to repay the cost of any of these systems. They'll do you far better than that. SSG's Productivity Software Packages will contribute immediately to the growth and success of your business.

Please act now. **Tear out this page.** This coupon or a phone call will get you immediate relief from the white collar crime of 1981. We'll send you complete information. Or better still, answer your questions **immediately**.

Time's a-wasting.
That's a crime.

☐ Please rush me information on the SSG Business Productivity Packages for CP/M-based computers.

☐ Please call me right away.

Name ______________________
Company ______________________
Address ______________________
City State Zip ______________________
Telephone (   ) ______________________

CP/M is a registered trademark of Digital Research. NAD, Magic Worksheet are trademarks of SSG.

Structured Systems Group INCORPORATED

5204 Claremont, Oakland, California 94618 (415) 547 1567

Circle 362 on inquiry card.

The Smalltalk-80 System

The Xerox Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

The Smalltalk-80 system represents the current state of the object-oriented point of view as it has been reduced to practice by the Xerox Learning Research Group. The Smalltalk-80 system is composed of objects that interact only by sending and receiving messages. The programmer implements a system by describing messages to be sent and describing what happens when messages are received.

The Smalltalk-80 system is the latest in a series of programming environments that have applied the object-oriented point of view more and more uniformly to the design and production of software systems. The fundamental ideas of objects, messages, and classes came from SIMULA. (See reference 1.) SIMULA allows users to create object-oriented systems, but uses the standard data/procedure-oriented ALGOL language to provide numbers, booleans, basic data structures, and control structures. The Flex system, the Smalltalk-72, Smalltalk-74, and Smalltalk-76 (see references 5, 2, and 4, respectively) systems extended the object-oriented point of view to an increasing number of the elements of a programming environment. For example, in Smalltalk-72, arithmetic, list structures, and control structures were represented as objects and messages, but classes were not. In Smalltalk-74, class descriptions as objects were introduced. The Smalltalk-76 system added the capability to express relationships between classes, and extended the object-oriented point of view to the programmer's interface.

This article presents the central semantic features and most of the syntactic features of the Smalltalk-80 system. It was prepared by Dave Robson and Adele Goldberg as scribes for the group effort of designing and implementing the system. Two forthcoming books (see reference 3) provide the full specification of the Smalltalk-80 system; in particular, the books describe the implementation of the interpreter and storage manager, and the graphical user interface.

Sending Messages—Expressions

Messages are described by *expressions*, which are sequences of characters that conform to the syntax of the Smalltalk-80 programming language. A message-sending expression describes the *receiver*, *selector*, and *arguments* of the message. When an expression is *evaluated*, the message it describes is transmitted to its receiver. Here are several examples of expressions describing a message to an object. (Note: color has been added to help identify the receivers, selectors, and arguments in the following examples.)

1. frame center
2. origin + offset
3. frame moveTo: newLocation
4. list at: index put: element

Key: Receiver; Selector; Argument

Each expression begins with a description of the receiver of the message. The receivers in these examples are described by *variable names:* frame, origin, frame, and list, respectively. Generally, at least one space must separate the parts of an expression.

Messages without arguments are called *unary messages*. A unary message consists of a single identifier called a unary selector. The first example is a unary message whose selector is center.

A *binary message* has a single argument and a selector that is one of a set of special single or double characters called *binary selectors*. For example, the common arithmetic symbols (+, −, *, and /) are binary selectors; some comparison operations are represented as double characters (eg: == for equivalence, ~= for not equal). The second example is a binary message whose argument is offset.

A *keyword message* has one or more arguments and a selector that is made up of a series of *keywords*, one preceding each argument. A keyword is an identifier with a trailing colon. The third example is a single-argument keyword message whose selector is moveTo: and whose argument is newLocation. The fourth example is a two-argument keyword message whose selector is made up of the keywords at: and put: and whose arguments are index and element. To talk about the selector of a multiple-argument keyword message, the keywords are concatenated. So, the selector of the fourth example is at:put:.

The message receivers and arguments in the examples are described by variable names. In addition, they can also be described with *literals*. The two most common kinds of literals are integers and strings. An *integer literal* is a sequence of digits that may be preceded by a minus sign (eg: 0, 1, 156, −3, or 13772). A *string literal* is a sequence of characters between single quotes (eg: 'hi', 'John', or 'the Smalltalk-80 system'). A binary message with an integer literal as its receiver is

```
45 + count
```

A keyword message with a string literal as its argument is

```
printer display: 'Monthly Payroll'
```

When a message is sent, it invokes a method determined by the class of the receiver. The invoked method will always return a result (an object). The result of a message can be used as a receiver or argument for another message. An example of a unary message describing the receiver of another unary message is

```
window frame center
```

Unary messages are parsed left to right. The first message in this example is the unary selector frame sent to the object named window. The unary message center is then sent to the result of the expression window frame (ie: the object returned from window's response to frame).

Binary messages are also parsed left to right. An example of a binary message describing the receiver of another binary message is

```
index + offset * 2
```

The result of sending the binary message + offset to the object named index is the receiver for the binary message *2. All binary selectors have the same precedence; only the order in which they are written matters. Parentheses can be used to change the order of evaluation. A message within parentheses is sent before any messages outside the parentheses. If the previous example were written

```
index + (offset * 2)
```

the result of the binary message * 2 to offset would be used as the argument of a binary message with receiver index and selector + .

Unary messages take precedence over binary messages. If unary messages and binary messages appear together, the unary messages will be sent first. In the example

```
frame center + window offset − index
```

the result of the unary message center to frame is the receiver of the binary message whose selector is + and whose argument is the result of the unary message offset to window. The result of the + message is, in turn, the receiver of the binary message − index. Parentheses can be used to explicitly show the order of evaluation, eg: ((frame center) + (window offset)) − index. Parentheses can also be used to alter the order of evaluation. In the example

```
(center + offset) x
```

the binary message + offset would be sent before the unary message x.

Whenever keywords appear in an unparenthesized message, they compose a single selector. The example

```
window showText: 'Title' inFont: helvetica
  indented: 15
```

is a single message whose selector is showText:inFont:indented:. Because of this concatenation, there is no left-to-right parsing rule for keyword messages. If a keyword message is to be used as a receiver or argument of another keyword message, it must be parenthesized. The expression

```
frame scale: (factor max: 5)
```

describes two keyword messages. The result of the expression factor max: 5 is the argument for the scale: message to frame.

Binary messages take precedence over keyword messages. When unary, binary, and keyword messages appear in the same expression without parentheses, the unary messages are sent first, the binary messages next, and the keyword messages last. The example

```
bigFrame height: smallFrame height * 2
```

is evaluated as if it were parenthesized as follows:

```
bigFrame height: ((smallFrame height) * 2)
```

A *cascaded message expression* describes a sequence of messages to be sent to the same object. A simple message expression is a description of the receiver (ie: a variable name, literal, or expression) followed by a message (ie: a unary selector, a binary selector and argument, or a set of keywords and arguments). A cascaded message expres-

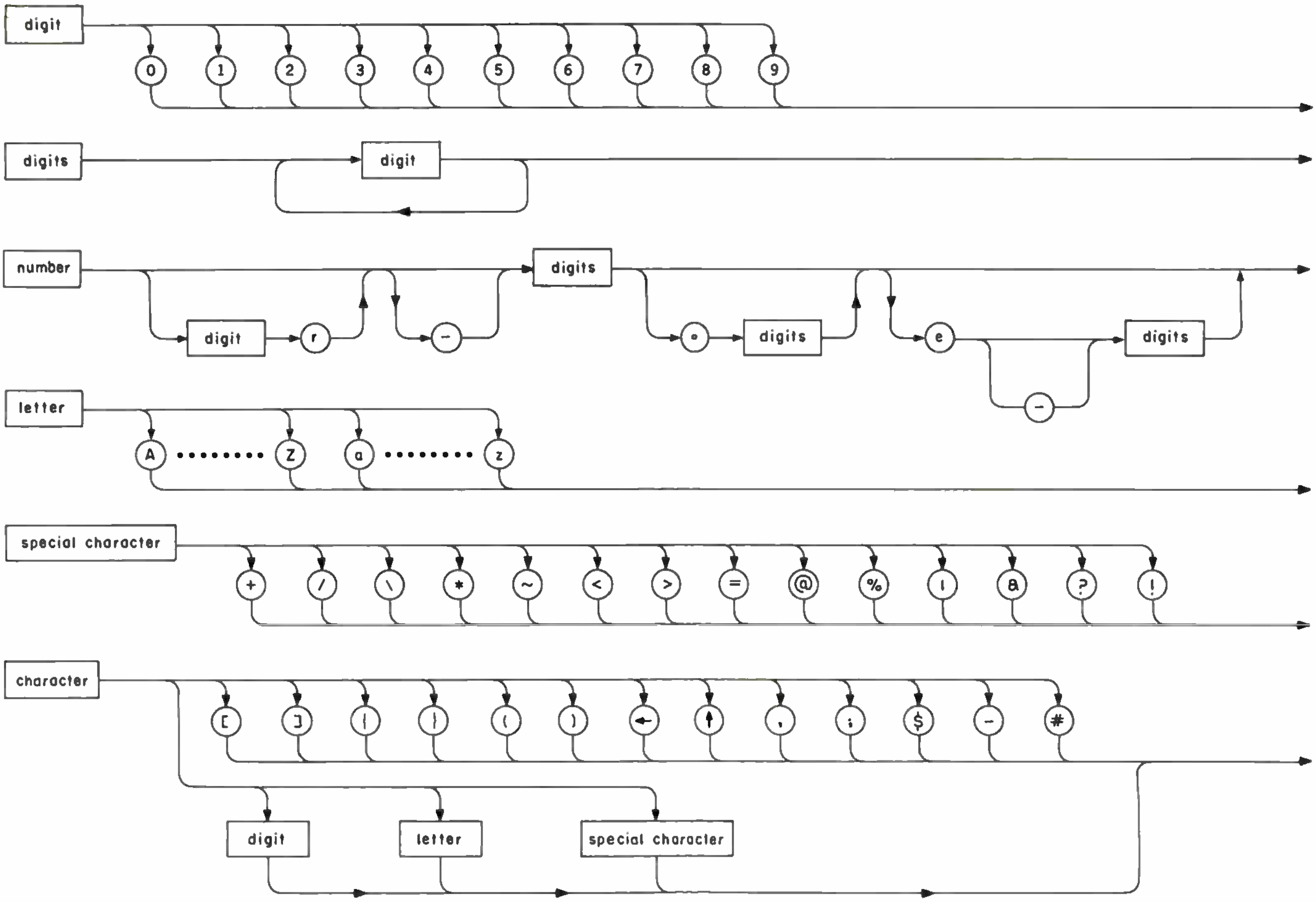


Figure 1: *Syntax diagrams for the Smalltalk-80 language.*

sion is a single description of a receiver followed by several messages separated by semicolons. For example, in the expression

```
printer newLine; print: reportTitle; space;
  print: Date today.
```

four messages are sent to the object named printer. The selectors of the four messages are newLine, print:, space, and print:. In the expression

```
window frame center: pointer location;
  width: border + contents; clear
```

three messages are sent to the object returned from the frame message to window. The selectors of the three messages are center:, width:, and clear. Without cascading, this would have been three expressions

```
window frame center: pointer location.
window frame width: border + contents.
window frame clear
```

Assigning Variables

The value of a variable can be used as the receiver or argument of a message by including its name in an expression. The value of a variable can be changed with an *assignment expression*. An assignment expression consists of a variable name followed by a left arrow (←) followed by the description of an object. When an assignment expression is evaluated, the variable named to the left of the arrow assumes the value of the object described to the right of the arrow. The new value can be described by a variable name, a literal, or a message-sending expression. Examples of assignments are

```
center ← origin
index ← 0
index ← index + 1
index ← index + 1 max: limit
```

In the last example, the message + 1 is sent to the value of the variable index, the message max: limit is sent to the result of the + 1 message, and the result of the max: limit message becomes the new value of the variable index.

A number of variables can be assigned in the same expression by including several variable names with left arrows. The expression

```
start ← index ← 0
```

makes the value of both start and index be 0.

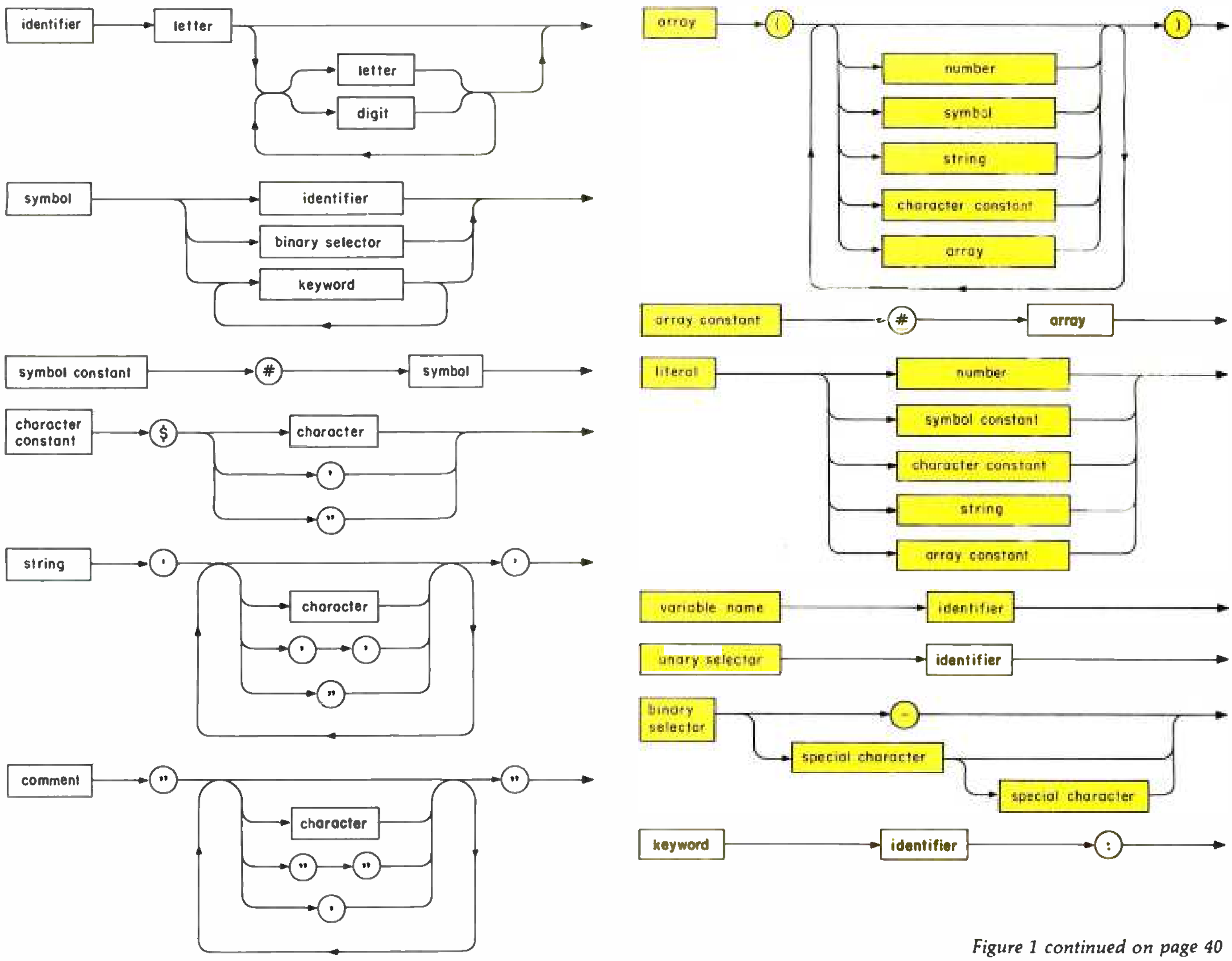


Figure 1 continued on page 40

The syntax table in figure 1 is a diagram for parsing well-formed Smalltalk-80 expressions. This table does not specify how *spaces* are treated. Spaces must not appear between digits and characters that make up a single token, nor within the specification of a number. Spaces must appear

- between a sequence of identifiers used as variables or unary selectors
- between the elements of an array in an array constant
- on either side of a keyword in a keyword expression

Spaces may optionally be included between any other elements in an expression. A carriage return or tab has the same syntactic function as a space.

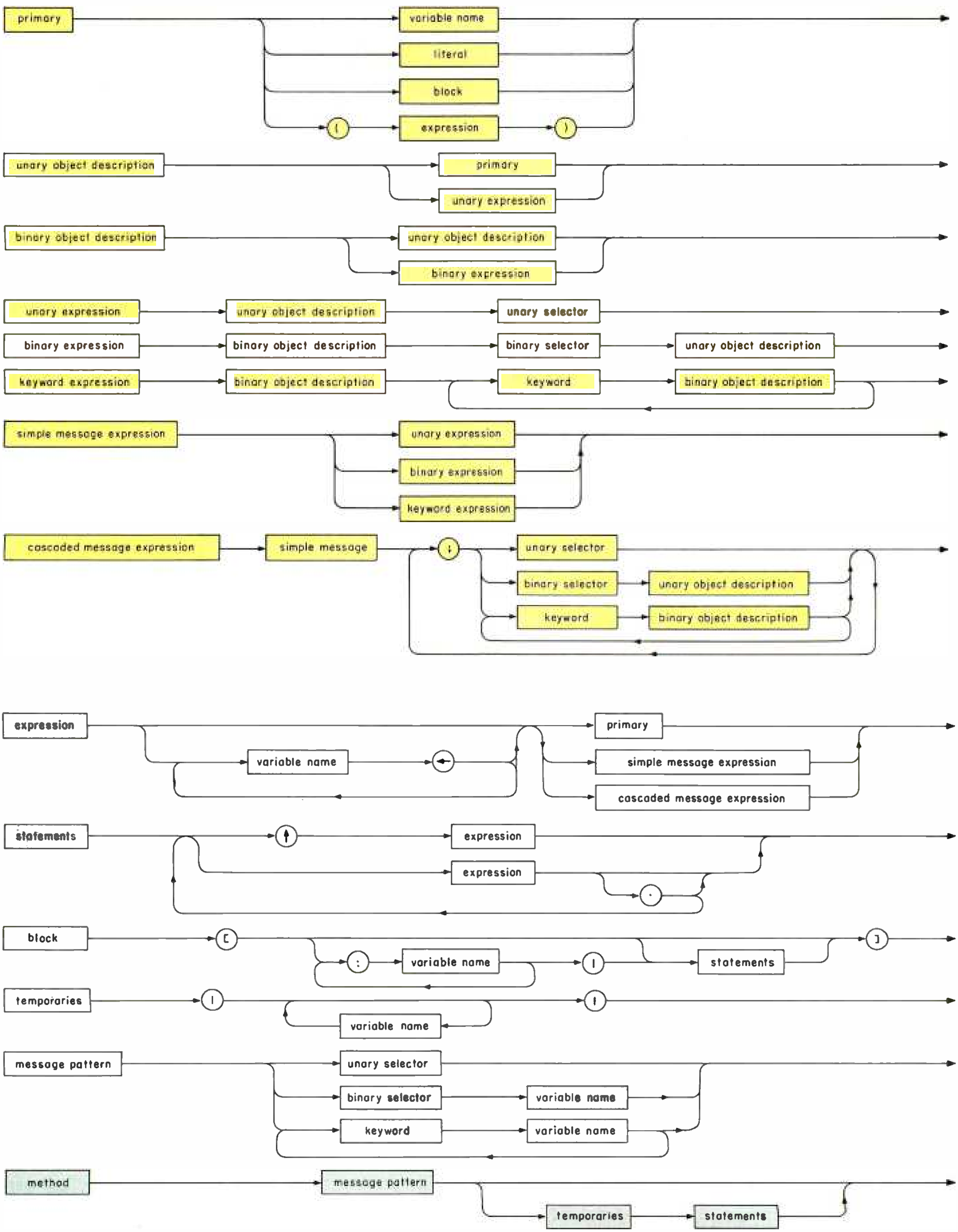
Receiving Messages—Classes

A *class* describes a set of objects called its *instances*. Each instance has a set of *instance variables*. The class provides a set of names that are used to refer to these variables. A class also provides a set of *methods* that describe what happens when its instances receive messages. A method describes a sequence of actions to be taken when a message with a particular selector is received by an instance of a particular class. These actions consist of sending other messages, assigning variables, and returning a value to the original message.

To create a new application, modify an existing application, or to modify the Smalltalk-80 system itself, a programmer creates and modifies classes that describe objects. The most profitable way to manipulate a class is with an interactive system. Much of the development of the Smalltalk-80 system has been the creation of appropriate software-development tools. (See Larry Tesler's article "The Smalltalk Environment," on page 90.) Unfortunately, to describe a system on paper, a noninteractive linear mode of presentation is needed. To this end, a *basic class template* is provided as a simple textual representation of a class. The basic class template in table 1 shows the name of the class, the names of the instance variables, and the set of methods used for responding to messages.

In table 1, the italicized elements will be replaced by the specific identifiers or methods appropriate to the

Figure 1 continued:



class name	*identifier*
instance variable names	*identifier* *identifier* *identifier*
methods	
method	
method	
method	

Table 1: *The basic class template.*

class. Names of classes begin with an uppercase letter, and names of variables begin with a lowercase letter. As an example, figure 2 shows the basic template form of a class named Point whose instances represent points in a two-dimensional coordinate system. Each instance has an instance variable named x that represents its horizontal coordinate and an instance variable named y that represents its vertical coordinate. Each instance can respond to messages that initialize its two instance variables, request the value of either variable, and perform simple arithmetic. The details of methods (in particular, the use of '|', '.' and '↑') are the subject of our next discussion.

Methods

A method has three parts:

- a *message pattern*
- some *temporary variable names*
- some expressions

The three parts of a method are separated by vertical bars (|). The message pattern consists of a selector and names for the arguments. The expressions are separated by periods (.) and the last one may be preceded by an up arrow (↑). In the method for selector + in figure 2, the message pattern is + aPoint, the temporary variable names are sumX and sumY, and there are three expressions, the last one preceded by an ↑.

Line breaks have no significance in methods; formatting is used only for purposes of aesthetics. The vertical bars and periods are delimiters of significance.

As stated earlier, each message pattern contains a selector. When a message is received by an instance, the method whose message pattern contains the same selector will be executed. For example, suppose that offset were an

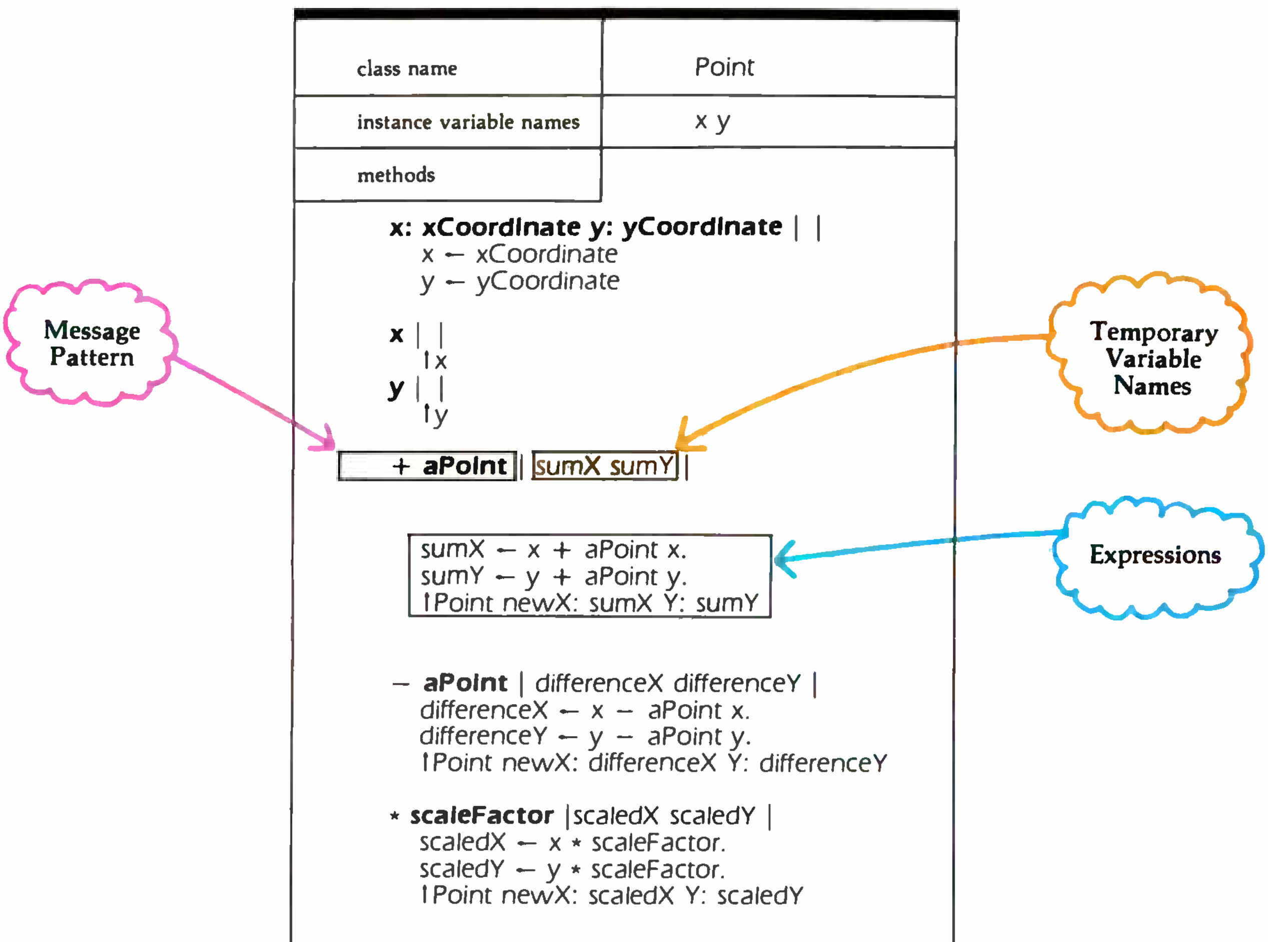


Figure 2: *Illustrated class template for the class* Point.

class name	DepositRecord
superclass	Object
instance variable names	date amount
methods	

```
of: depositAmount on: depositDate | |

    date ← depositDate.
    amount ← depositAmount

amount | |
    ↑ amount

balanceChange | |
    ↑ amount
```

Table 2: *Class template for class* DepositRecord.

class name	CheckRecord
superclass	DepositRecord
instance variable names	number
methods	

```
number: checkNumber for: checkAmount on:
  checkDate | |
    number ← checkNumber.
    date ← checkDate.
    amount ← checkAmount

of: anAmount on: aDate | |
    self error:
      'Check records are initialized with
    number:for:on:'

balanceChange | | ↑ 0 − amount
```

Table 3: *Class template for class* CheckRecord.

instance of Point in the expression

offset + frame center

The method whose message pattern is + aPoint would be executed in response. For selectors that take arguments, the message pattern also contains *argument names* wherever arguments would appear in a message. When a method is invoked by a message, the argument names in the method are used to refer to the actual arguments of that message. In the above example, aPoint would refer to the result of frame center.

class name	*identifier*		
superclass	*identifier*		
instance variable names	*identifier*	*identifier*	*identifier*
class variable names	*identifier*	*identifier*	*identifier*
class messages and methods			
method			
method			
method			
instance messages and methods			
method			
method			
method			

Table 4: *The full class template.*

Following the message pattern, a method can contain some *temporary variable names* between vertical bars. When a method is executed, a set of variables is created that can be accessed by the temporary variable names. These temporary variables exist only while the method is in the process of execution.

Following the second vertical bar, a method contains a sequence of expressions separated by periods. When a method is executed, these expressions are evaluated sequentially.

So, there are three steps in receiving a message, corresponding to the three parts of the method. Smalltalk will

1. *Find* the method whose message pattern has the same selector as the message and *create* a set of variables for the argument values.
2. *Create* a set of temporary variables corresponding to the names between the vertical bars.
3. *Evaluate* the expressions in the method sequentially.

Six kinds of variables can be used in a method's expressions:

- the instance variables of the receiver
- the pseudo-variable self
- the message arguments
- temporary variables
- class variables
- global variables

The instance variables are named in the message receiver's class. In the example, x and y refer to the values of the instance variables of offset.

There is an important *pseudo-variable* available in every method, which is named self. self refers to the receiver of the message that invoked the method. It is called a pseudo-variable because its value can be accessed like a variable, but its value cannot be changed using an assignment expression. In the example, self refers to the same object as offset during the execution of the method associated with +.

Arguments and temporary variables are similar, in that the names for both are declared in the method itself and they both exist only during the method's execution. However, unlike arguments, temporary variables are not automatically initialized. The values of temporary variables can be changed with an assignment expression.

Class variables are shared by all instances and the class itself. Names for the class variables are shown in the full class template in an entry called "class variable names" (see table 4). Although they are variables and their values can be changed, they are typically treated as constants, initialized when the class is created, and then simply used by the instances. For example, if the class of floating-point numbers wanted to provide trigonometric functions, it might want to define a variable called pi to be used in any of its methods.

Global variables are shared by all objects. A global dictionary, called Smalltalk, holds the names and values of these variables. The classes in the system, for example, are the values of global variables whose names are the class names. With the exception of variables used to reference system resources, few global variables exist in the Smalltalk-80 system. Programming style that depends on user-defined globals is generally discouraged.

If the last expression in a method is preceded by an ↑, the message that invoked the method takes on the value of this expression. If an ↑ does not precede the last expression, the value of the message is simply the receiver of the message. For example, the x:y: message to a Point (see figure 2) behaves as if it had been written

```
x: xCoordinate y: yCoordinate | |
    x ← xCoordinate.
    y ← yCoordinate.
    ↑ self
```

Methods can contain comments anywhere. A *comment* is a sequence of characters delimited by double quotes. Two consecutive double quotes are used to embed a double quote within a comment. The methods in class Point were purposely written in a verbose style to provide examples. The messages for + could have been written

```
+ aPoint | |
    ↑ Point newX: x + aPoint x Y: y + aPoint y
```

The basic class template presents only the most important attributes of a class. The complete description of a class is provided by the *full class template*, described in the next section.

Inheritance

The basic template allows a class to be described independently of other classes. It ignores inheritance among classes. The full class template, however, takes inheritance into account. (See table 4.) With it, a class can be described as a modification of another class called its *superclass*. All classes that modify a particular class are called its *subclasses*. A subclass inherits the instance variable names and methods of its superclass. A subclass can also add instance variable names and methods to those it inherits. The instance variable names added by the subclass must differ from the instance variable names of the superclass. The subclass can *override* a method in the superclass by adding a message with the same selector. Instances of the subclass will execute the method found in the subclass rather than the method inherited from the superclass.

To assemble the complete description of a class, it is necessary to look at its superclass, its superclass's superclass, and so on, until a class with no superclass is encountered. There is only one such class in the system (ie: without a superclass), and its class name is Object. All classes ultimately inherit methods from Object. Object has no instance variables. The set of classes linked through the superclass relation is called a *superclass chain*. The full class template has an entry called "superclass" that specifies the initial link on the class's superclass chain.

As an example, we might describe a class, DepositRecord, whose instances are records of bank account deposits. Each instance has two instance variables representing the date and amount of the deposit. The class template is shown in table 2.

class name	CheckRecord
superclass	DepositRecord
instance variable names	number
class messages and methods	

```
number: checkNumber for: checkAmount on:
  checkDate | |
   ↑ self new number: checkNumber
              for: checkAmount
              on: checkDate
```

instance messages and methods

```
number: checkNumber for: checkAmount on:
  checkDate | |
   super of: checkAmount on: checkDate.
   number ← checkNumber

of: anAmount on: aDate | |
   self error: 'Check records are initialized with
     number:for:on:'
balanceChange | | ↑ 0 − amount
```

Table 5: *Full class template for class* CheckRecord.

A class, CheckRecord, whose instances are records of *checks written* on an account is a subclass of DepositRecord; this new class adds an instance variable that represents the check number. The class template is shown in table 3.

An instance of CheckRecord has three instance variables. It inherits the amount message, adds the number:for:on: message, and overrides the balanceChange and of:on: messages. The of:on: method contains a single expression in which the message error: 'Check records are initialized with number:for:on:' is sent to the pseudo-variable self. The method for error: is found in the superclass of DepositRecord, which is the class Object; the response is to stop execution and to display the string literal argument to the user.

An additional pseudo-variable available in a method's expressions is super. It allows a subclass to access the methods in its superclass that have been overridden in the subclass description. The use of super as the receiver of a message has the same effect as the use of self, except that the search for the appropriate message starts in the superclass, not the class, of the receiver.

For example, the method associated with number:for:on in CheckRecord might have been defined as

```
number: checkNumber for: checkAmount on:
checkDate | |
    super of: checkAmount on: checkDate.
    number ← checkNumber
```

class name	Point
superclass	Object
instance variable names	x y
class variable names	pi
class messages and methods	

```
  instance creation
  newX: xValue Y: yValue | |
     ↑ self new x: xValue
                y: yValue
  newRadius: radius Angle: angle | |
     ↑ self new x: radius * angle sin
                y: radius * angle cos

  class initialization
  setPI | | pi ← 3.14159
```

instance messages and methods

```
  accessing
  x: xCoordinate y: yCoordinate | |
     x ← xCoordinate.
     y ← yCoordinate
  x | | ↑x
  y | | ↑y
  radius | | ↑((x * x) + (y * y)) squareRoot
  angle | | ↑(x/y) arctan

  arithmetic
  + aPoint | | ↑Point newX: x + aPoint x
                           Y: y + aPoint y
  − aPoint | | ↑Point newX: x − aPoint x
                           Y: y − aPoint y
  * scaleFactor | | ↑Point newX: x * scaleFactor
                                Y: y * scaleFactor
  circleArea | r |
     r ← self radius.
     ↑ pi * r * r
```

Table 6: *Full class template for class* Point.

Metaclasses

Since a class is an object, there is a different class that describes it. A class that describes a class is called a *metaclass*. Thus, a class has its own instance variables that represent the description of its instances; it responds to messages that provide for the initialization and modification of this description. In particular, a class responds to a message that creates a new instance. The unary message new creates a new instance whose instance variables are uninitialized. The object nil indicates an uninitialized value.

The classes in the system might all be instances of the same class. However, each class typically uses a slightly different message protocol to create initialized instances. For example, the last expression in the method associated with + in class Point (see figure 2) was

```
Point newX: sumX Y: sumY
```

newX:Y: is a message to Point, asking it to create a new instance with sumX and sumY as the values of the new instance's instance variables. The newX:Y: message would not mean anything to another class, such as DepositRecord or CheckRecord. So, these three classes can't be instances of the same class. All classes have a lot in common, so their classes are all subclasses of the same class. This class is named Class. The subclasses of Class are called *metaclasses*.

The newX:Y: message in Point's metaclass might be implemented as

```
newX: xValue Y: yValue | |
    ↑ self new x: xValue y: yValue
```

The new message was inherited by Point's metaclass from Class. One reason for having metaclasses is to have a special set of methods for each class, primarily messages for initializing class variables and new instances. These methods are displayed in the full class-template form shown in table 4; they are distinguished from the methods for messages to the instances of the class. The two categories are "class messages and methods" and "instance messages and methods," respectively. Methods in the category "class messages and methods" are associated with the metaclass; those in "instance messages and methods" are associated with the class.

If there are no class variables for the class, the "class variable name" entry is omitted. So, CheckRecord might be described as shown in table 5.

It is often desirable to create subcategories within the categories "class messages and methods" and "instance messages and methods." Moreover, the order in which the categories or subcategories are listed is of no significance. (The notion of categories is simply a pretty printing" technique; it has no semantic significance.)

Returning to the example of class Point, if the instance methods of class Point include subcategories *accessing* and *arithmetic*, the template for Point might appear as shown in table 6.

When the class Point is defined, the expression

```
Point setPi
```

should be evaluated in order to set the value of the single class variable.

A Point might be created and given a name by evaluating the expression

```
testPoint ← Point newX: 420 Y: 26
```

The new Point, testPoint, can then be sent the message circleArea:

```
testPoint circleArea
```

or used in a more complex expression:

```
(testPoint * 2) circleArea
```

Primitive Routines

The response to some messages in the system may be performed by a *primitive routine* (written in the implementation language of the machine) rather than by evaluating the expressions in a method. The methods for these messages indicate the presence of such a primitive routine by including <primitive> before the first expression in the method. A major use of primitive methods is to interact with the machine's input/output devices.

An example of a primitive method is the new message to classes, which returns a new instance of the receiver.

```
new | | <primitive>
```

This particular primitive routine always produces a result. If there are situations in which a primitive routine cannot produce a result, the method will also contain some expressions. If the primitive routine is successful in responding to the message, it will return a value and the expressions in the method will not be evaluated. If the primitive routine encounters difficulty, the expressions will be evaluated as though the primitive routine had not been specified.

Another example of a message with a primitive response is a message with the selector + sent to a SmallInteger

```
+ aNumber | | <primitive>
    self error: 'SmallInteger addition has failed'
```

One reason this primitive might fail to produce a result is that the argument is not a SmallInteger. In the example, this would produce an error report. In the actual Smalltalk-80 system, an attempt is made to check and see if the argument were another kind of number for which a result could be produced.

Indexed Instance Variables

An object's instance variables are usually given names by its class. The names are used in methods of the class to refer to the values of the instance variables. Some objects also have a set of instance variables that have no names and can only be accessed by messages. The instance variables are referred to by an integral *index*. Indexable objects are used to implement the classes in the system that represent collections of other objects, such as arrays and strings.

The messages to access indexed instance variables have

class name	Array
superclass	IndexedCollection
indexable instance variables	
class messages and methods	

```
instance creation
with: anElement | |
    ↑(self new: 1) at: 1 put: anElement
with: firstElement with: secondElement
    | anArray |
    anArray ← self new: 2.
    anArray at: 1 put: firstElement.
    anArray at: 2 put: secondElement.
    ↑anArray
```

instance messages and methods

```
accessing
at: anInteger | |
    <primitive>
    self error: 'index out of range'

at: anInteger put: anElement | |
    <primitive>
    self error: 'index out of range'

funny stuff
embed | |
    ↑Array with: self
```

Table 7: *Full class template for class* Array.

selectors at: and at:put:. For example

```
list at: 1
```

returns the first indexed instance variable of list. The example

```
list at: 4 put: element
```

stores element as the value of the fourth indexed instance variable of list. The at: and at:put: messages invoke primitive routines to load or store the value of the indicated variable. The legal indices run from one to the number of indexable variables in the instance. The at: and at:put: messages are defined in class Object and, therefore, can be understood by all objects; however, only certain classes will create instances with indexable instance variables. These classes will have an additional line in the class template indicating that the instances contain *indexable instance variables*. As an example, we show a part of the template for class Array in table 7.

Each instance of a class that allows indexable instance variables may have a different number of them; such instances are created using the new: message to a class, whose argument tells the number of indexable variables. The number of indexable instance variables an instance has can be found by sending it the message size. A class whose instances have indexable instance variables can also have named instance variables. All instances of any class will have the same number of named instance variables.

Control Structures and Blocks

The two control structures in the Smalltalk-80 system described so far are

- the sequential execution of expressions in a method
- the sending of messages that invoke other methods that eventually return values

All other control structures are based on objects called *blocks*. Like a method, a block is a sequence of expressions, the last of which can be preceded by an up arrow (↑). The expressions are delimited by periods; they may be preceded by one or more identifiers with leading colons. These identifiers are the *block arguments*. Block arguments are separated from expressions by a vertical bar.

Whenever square brackets are encountered in a method, a block is created. Evaluation of the expressions inside the square brackets is deferred until the block is sent the message value or a message whose selector is a concatenation of one or more occurrences of the keyword value:. Control structures are implemented as messages with receivers or arguments that are blocks. The methods for carrying out these control-structure messages involve sending the blocks patterns of value messages.

In the Smalltalk-80 system, there are two types of primitive control messages: conditional selection of blocks, ifTrue:ifFalse:, and conditional iteration of blocks, whileTrue: and whileFalse:.

The representation of conditions in the Smalltalk-80 system uses distinguished boolean objects named false and true. The first type of primitive control message provides for conditional selection of a block to be executed. This is similar to the IF . . . THEN . . . ELSE of ALGOL-like languages. The expression

```
queue isEmpty ifTrue: [index ← 0]
              ifFalse: [index ← queue next]
```

evaluates the expressions in the first block if the receiver is true and evaluates the expressions in the second block if the receiver is false. Two other forms of conditional selection provide only one alternative

```
queue isEmpty ifTrue: [index ← 0].
queue isEmpty ifFalse: [index ← queue next].
```

When ifTrue: is sent to false, it returns immediately without executing the block. When ifFalse: is sent to true, the block is not executed.

The second type of primitive control message repeatedly evaluates the expressions in a block as long as some condition holds. This is similar to the WHILE and UNTIL statements in ALGOL-like languages. This type of control message is a message to a block; the receiver, the block, evaluates the expressions it contains and determines whether or not to continue on the basis of the value of the last expression. The first form of this control message has selector whileTrue:. The method for whileTrue: repeatedly executes the argument block as long as the receiver's value is true. For example,

```
[index < = limit] whileTrue: [self process: list at: index.
                              index ← index + 1]
```

The binary message < = is understood by objects representing magnitudes. The value returned is the result of comparing whether the receiver is less than or equal to (< =) the argument.

The second conditional iteration message has selector whileFalse:. The method for whileFalse: repeatedly executes the argument block as long as the receiver's value is false. For example,

```
[queue isEmpty] whileFalse: [self process: queue next]
```

The messages whileTrue and whileFalse to a block provide a shorthand notation for messages of the form whileTrue: aBlock and whileFalse: aBlock, if the argument aBlock is an empty block.

Block arguments allow one or more of the variables inside the block to be given new values each time the block is executed. Instead of sending the block the message value, messages with selectors value: or value:value:, and so on, are sent to the block. The arguments of the value: messages are assigned to the block arguments (in order) before the block expressions are evaluated.

As an example, classes with indexed instance variables could implement a message with selector do: that takes a block as an argument and executes it once for every indexed variable. The block has a single block argument; the value of the appropriate indexed variable is passed to it for each execution. An example of the use of such a message is

```
list do: [ :element | self process: element]
```

The message might be implemented as

```
do: aBlock | index |
   index ← 1.
   [index < = self size] whileTrue:
         [aBlock value: (self at: index).
          index ← index + 1]
```

Similar control messages can be implemented for any class. As an example, a simple repetition could be provided by a timesRepeat: aBlock message to instances of class Integer

```
timesRepeat: aBlock | index |
   index ← 1.
   [index < = self] whileTrue:
         [aBlock value.
          index ← index + 1]
```

Examples of implementing other control messages are given in L Peter Deutsch's article "Building Control Structures in the Smalltalk-80 System," on page 322.

The Smalltalk-80 System: Basic Classes

The Smalltalk-80 *language* provides a uniform syntax for retrieving objects, sending messages, and defining classes. The Smalltalk-80 *system* is a complete programming environment that includes many actual classes and instances. In support of the uniform syntax, this system includes class descriptions for Object, Class, Message, CompiledMethod, and Context, whose subclasses are BlockContext and MethodContext. Multiple independent processes are provided by classes ProcessorScheduler, Process, and Semaphore. The special object nil is the only instance of class UndefinedObject. These classes comprise the *kernel* Smalltalk-80 system.

The system also includes class descriptions to support basic data structures; these are numerical and collection classes. The class Number specifies the protocol appropriate for all numerical objects. Its subclasses provide specific representations of numbers. The subclasses are Float, Fraction, and Integer. For a variety of reasons, there are both SmallIntegers and LargeIntegers; of these, there are LargePositiveIntegers and LargeNegativeIntegers.

Class Collection specifies protocol appropriate to objects representing collections of objects. These include Bag, Set, OrderedCollection, LinkedList, MappedCollection, SortedCollection, and IndexedCollection. The latter provides protocol for objects with indexable instance variables. It has subclasses String and Array. Elements of a string are instances of class Character; bytes are stored in instances of ByteArray. A subclass of String is Symbol; a subclass of Set is Dictionary (a set of Associations).

Interval is a subclass of Collection with elements representing an arithmetic progression. Intervals can be created by sending the message to: or to:by: to Integer. So, the expressions 1 to: 5 by: 1 and 1 to: 5 each create a new Interval representing 1, 2, 3, 4, 5. As a Collection, Interval responds to the enumeration message do:. For example, in

```
(1 to: 5) do: [:index | anArray at: index put: index * 2]
```

the block argument index takes on successive values 1, 2, 3, 4, 5.

For programmer convenience, an Integer also responds to the messages to:do: and to:by:do:, allowing the parentheses in interval enumeration expressions to be omitted.

The ability to stream over indexed or ordered collections is provided by a hierarchy based on class Stream, including ReadStream, WriteStream, and ReadAndWriteStream. A file system, local or remote, is then implementable as a subclass of these kinds of Streams.

Since instances of the system classes described above are used in the implementation of all applications, an understanding of their message protocol is as necessary to understanding an implementation as an understanding of the language syntax. These system classes are fully described in the forthcoming Smalltalk books.

In addition to the basic data-structure classes, the Smalltalk-80 system includes class descriptions to support interactive graphics (forms and images and image editors, text and text editors), networking, standard files, and hard-copy printing. A complete Smalltalk-80 system contains about sixty class definitions, not including a variety of windows or views, menus, scrollbars, and the metaclasses. Many of these are discussed in companion articles in this issue. (See Daniel H H Ingalls's "The Design Principles Behind Smalltalk," page 286, and Larry Tesler's "The Smalltalk Environment," page 90.)

The important thing to note is that each of these class descriptions is implemented in the Smalltalk-80 language itself. Each can be examined and modified by the programmer. Some of the class descriptions contain methods that reference primitive methods; only these methods are implemented in the machine language of the implementation machine. It is a fundamental part of the philosophy of the system design that the programmer have such complete access. In this way, system designers, such as members of the Xerox Learning Research Group, are able to build the next Smalltalk in the complete context of Smalltalk itself. ■

References

1. Birtwistle, Graham; Ole-Johan Dahl; Bjorn Myhrhaug; and Kristen Nygaard. *Simula Begin*. Philadelphia: Auerbach, 1973.
2. Goldberg, Adele and Alan Kay, editors. *Smalltalk-72 Instructional Manual*. Xerox PARC technical report, March 1976 (out of print).
3. Goldberg, Adele; David Robson; and Daniel H H Ingalls. *Smalltalk-80: The Language and Its Implementation* and *Smalltalk-80: The Interactive Programming Environment*, 1981 (books forthcoming).
4. Ingalls, Daniel H H. "The Smalltalk-76 Programming System: Design and Implementation." In *Proceedings of the Principles of Programming Languages Symposium*, January 1978.
5. Kay, Alan. *The Reactive Engine*. Ph.D. Thesis, University of Utah, September, 1969 (University Microfilms).

Glossary

Editor's Note: *This glossary provides concise definitions for many of the keywords and concepts related to Smalltalk-80. These definitions will be most useful if you first read the introductory Smalltalk articles. . . .* **GW**

General Terminology

object	*a package of information and descriptions of its manipulation*
message	*a specification of one of an object's manipulations*
method	*a procedure-like entity; the description of a sequence of actions to be taken when a message is received by an object*
class	*a description of one or more similar objects*
instance	*an object described by a particular class*
method dictionary	*a set of associations between message selectors and methods; included in each class description*
metaclass	*a class whose (single) instance is itself a class*
subclass	*a class that is created by sharing the description of another class, often modifying some aspects of that description*

Syntax Terminology

message receiver	*the object to be manipulated, according to a message*
message sender	*the object requesting a manipulation*
message selector	*a symbolic name that describes a desired manipulation of an object*
message argument	*one of the objects specified in a message that provides information needed so that a message receiver can be manipulated appropriately*
unary message	*a message without arguments*
binary message	*a message with a single argument and a selector that is one of a set of special single or double characters*
keyword message	*a message that has one or more arguments and a selector made up of a series of identifiers with trailing colons, one preceding each argument*
block	*a literal method; an object representing a sequence of actions to be taken at a later time, upon receiving an "evaluation" message (such as one with selector* value *or* value:*)*

Semantics

instance variable	*a variable that is information used to distinguish an instance from other instances of the same class*
class variable	*a variable shared by all instances of a class and the class itself*
named variable	*an instance variable that is given a name in the class of the instance; the name is used in methods of the class*
indexed variable	*an instance variable with no name, accessed by message only; referred to by an integer (an index)*
global or pool variable	*a variable shared by instances of several classes; a system example is* Smalltalk, *a dictionary that includes references to all the defined classes*
temporary variable	*a variable that exists only while the method in which it is declared is in the process of execution*
pseudo-variable	*a variable available in every method without special declaration, but whose value cannot be changed using an assignment. System examples are* self, super *and* thisContext.
nil	*a special object, the only instance of class* UndefinedObject

Implementation Terminology

field	*the memory space in which the value of an object's variable is stored*
bytecode	*a machine instruction for the virtual machine*
object pointer	*a reference to an object*
reference count	*of an object, is the number of objects that point to it (ie: that contain its object pointer)*

Build a Z8-Based Control Computer with BASIC, Part 2

Steve Ciarcia
POB 582
Glastonbury CT 06033

The Z8-BASIC Microcomputer system described in this two-part article is unlike any computer presently available for dedicated control applications. Based on a single-chip Zilog Z8 microcomputer with an onboard tiny-BASIC interpreter, this unit offers an extraordinary amount of power in a very small package. It is no longer necessary to use expensive program-development systems. Computer control can now be applied to many areas where it was not previously cost-effective.

The Z8-BASIC Microcomputer is intended for use as an intelligent controller, easy to program and inexpensive enough to dedicate to specific control tasks. It can also serve as a low-cost tiny-BASIC computer for general interest. Technical specifications for the unit are shown in the "At a Glance" box on page 52.

Last month I described the design of the Z8-BASIC Microcomputer hardware and the architectures of the Z8671 microcomputer component and Z6132 32 K-bit Quasi-Static Memory. This month I'd like to continue the description of the tiny-BASIC interpreter, discuss how the BASIC program is stored in memory, and demonstrate a few simple applications.

Process-Control BASIC

The BASIC interpreter contained in ROM (read-only memory) within the Z8671 is officially called the Zilog BASIC/Debug monitor. It is essentially a 2 K-byte integer BASIC which has been optimized for speed and flexibility in process-control applications.

There are 15 keywords: GOTO, GO@, USR, GOSUB, IF...THEN, INPUT, IN, LET, LIST, NEW, REM, RUN, RETURN, STOP, PRINT (and PRINT HEX). Twenty-six numeric variables (A through Z) are supported; and numbers can be ex-

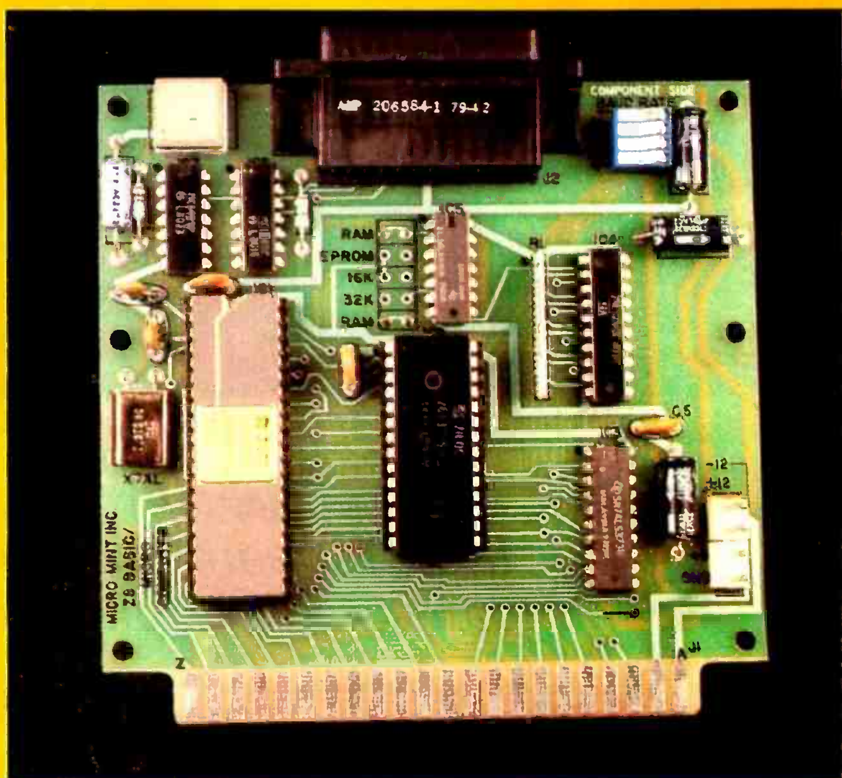


Photo 1: *Z8-BASIC Microcomputer. With the two "RAM" jumpers installed, it is configured to operate programs residing in the Z6132 Quasi-Static Memory. A four-position DIP (dual-inline pin) switch (at upper right) sets the serial data rate for communication with a user terminal connected to the DB-25S RS-232C connector on the top center. The reset button is on the top left.*

NEVER UNDER$OLD.

Thats right. If you can find a lower price in this magazine WE WILL BEAT IT! Period.*

S-100 HARDWARE

SO SYSTEMS	
Versa Floppy I kit	$259
Versa Floppy II kit	$349
ExpandoRam II kit	$249
ITHICA INTERSYSTEMS	$CALL
ALTOS	$CALL
NORTHSTAR	$CALL

SUPPLIES

Verbatim Datalife Diskettes	
MD525-01,10,16	$26.50
FD34-9000	$30.00
FD34-8000	$44.00
Avery Tabulables	
5,000 3½ X 15/16	$18.75
3,000 3½ X 15/16	$14.25
1,000 3½ X 15/16	$8.15
UARCO Paper (prices are FOB S.P.)	
9½ X 11, 15 or 18 Lb.	$25.95
14 7/8 X 11, 15 or 18 Lb.	$35.00

SOFTWARE

Microsoft Basic-80	$299
Microsoft Basic Compiler	$319
Microsoft Fortran-80	$399
Magic Wand	$275
Apple Visicalc	$113
Pickles and Trout CP/M®	$175

APPLE HARDWARE

Microsoft Z-80 Softcard	$259
Microsoft Ramcard	$170
SSM AIO A&T	$165
SYMTEC Apple Light Pen	$219
MOUNTAIN HARDWARE:	
Super Talker	$270
ROMWRITER	$157
INTROL/X-10	$180
ROMPLUS +	$162
MUSICSYSTEM	$499
Apple Clock	$252
Lobo Drive	$CALL
Videx 80 x 24	$299
Andromeda	$170
M & R Sup-R-Term	$299
Enhancer	$100
NEC Green Monitor	$240
Sanyo Green Monitor	$240
D.C. Hayes Micromodem	$299

CALIFORNIA COMPUTER SYSTEMS
See our full page ad in this magazine.

PRINTERS

EPSON MX-80	CALL
MX-80 Graphics ROM	CALL
NEW EPSON MX-80 TF	CALL
Okidata Microline 80	$415
Okidata Microline 82	$625
Okidata Microline 83	$899
IDS Paper Tiger 460G	$1050
Anadex DP-9000,1	$1195
Anadex DP-9500,1	$1295
Centronics 737	$689
NEC Spinwriter	$CALL
NEC w/ Sellum Option	$CALL
C. Itoh Starwriter 25 cps	$1440
C. Itoh Starwriter 45 cps	$1770
Diablo 630	$2195
Malibu 165	$1995
Malibu 200	$CALL
MPI 88G	$495

TRS-80 HARDWARE

TRS-80's	$CALL
Micropolis 77 track	$399
Percom Doubler	$199
Percom Separator	$27
Orchestra 80	$79

ALPHA BYTE STORES

5115 Douglas Fir Road • Suite B • Calabasas, CA 91302

*Include $2.00 shipping and handling on all orders. Visa and Master Card accepted. Never undersold offer applies only to items currently deliverable from other retail vendors at advertised price. All never undersold offers good as supply lasts. Please add $2.00 for all COD orders. Please call for items not listed. We gladly answer any questions on all of our hardware, software, and supply needs. Quanitity discounts available. School purchase orders accepted. Please remember to figure competitors shipping and handling charges when arriving at never undersold price.

(213) 883-8594

pressed in either decimal or hexadecimal format. BASIC/Debug can directly address the Z8's internal registers and all external memory. Byte references, which use the "@" character followed by an address, may be used to modify a single register in the processor, an I/O port, or a memory location. For example, @4096 specifies decimal memory location 4096, and @%F6 specifies the port-2 mode-control register at decimal location 246. (The percent symbol indicates that the characters following it are to be interpreted as a hexadecimal numeral.) To place the value 45 in memory location 4096, the command is simply, @4096=45 (or @%1000=%2D).

Command abbreviations are standard with most tiny-BASIC interpreters, but this interpreter allows some extremes if you want to limit program space. For example:

IF 1>X THEN GOTO 1000
    can be abbreviated
IF 1>X 1000

PRINT"THE VALUE IS ";S
    can be abbreviated
"THE VALUE IS ";S

IF X=Y THEN IF Y=Z
THEN PRINT "X=Z"
    can be abbreviated
IF X=Y IF Y=Z "X=Z"

One important difference between most versions of BASIC and Zilog's BASIC/Debug is that the latter allows variables to contain statement numbers for branching, and variable storage is not cleared before a program is run. Statements such as GOSUB X or GOTO A*E−Z are valid. It is also possible to pass values from one program to another. These variations serve to extend the capabilities of BASIC/Debug.

In my opinion, the main feature that separates this BASIC from others is the extent of documentation supplied with the Z8671. Frequently, a computer user will ask me how he can obtain the source-code listing for the BASIC interpreter he is using. Most often, I have to reply that it is not available. Software manufacturers that have invested many man-years

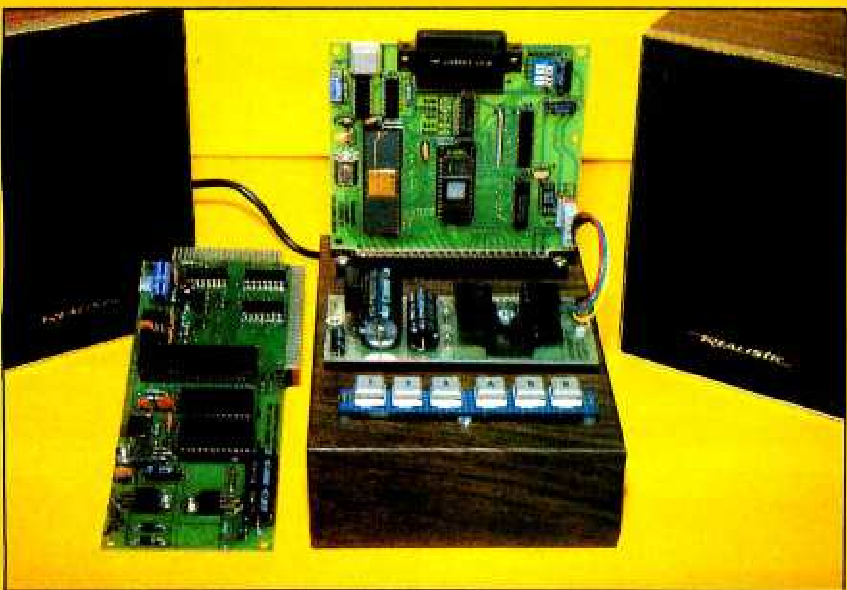


Photo 2: *The Z8/Micromouth demonstrator. A Z8-BASIC Microcomputer is configured to run a ROM-resident program that exercises the Micromouth speech synthesizer presented in the June Circuit Cellar article. A Micromouth board similar to that shown on the left is mounted inside the enclosure. Six pushbutton switches, connected to a parallel input port on the Z8 board, select various speech-demonstration sequences. The Micromouth board is driven from a second parallel port on the Z8 board.*

At a Glance

Name
Z8-BASIC Microcomputer

Processor
Zilog Z8-family Z8671 8-bit microcomputer with programmable (read/write) memory, read-only memory, and I/O in a single package. The Z8671 includes a 2 K-byte tiny-BASIC/Debug resident interpreter in ROM, 144 internal 8-bit registers, and 32 I/O lines. System uses 7.3728 MHz crystal to establish clock rate. Two internal and four external interrupts.

Memory
Uses Z6132 4 K-byte Quasi-Static Memory (pin-compatible with 2716 and 2732 EPROMs); 2 K-byte ROM in Z8671. Memory externally expandable to 62 K bytes of program memory and 62 K bytes of data memory.

Input/Output
Serial port: RS-232C-compatible and switch-selectable to 110, 150, 300, 1200, 2400, 4800, and 9600 bps.
Parallel I/O: two parallel ports; one dedicated to input, the other bit-programmable as input or output; programmable interrupt and handshaking lines; LSTTL-compatible.
External I/O: 16-bit address and 8-bit bidirectional data bus brought out to expansion connector.

BASIC Keywords
GOTO, GO@, USR, GOSUB, IF...THEN, INPUT, LET, LIST, NEW, REM, RETURN, RUN, STOP, IN, PRINT, PRINT HEX. Integer arithmetic/logic operators: +, −, /, *, and AND; BASIC can call machine-language subroutines for increased execution speed; allows complete memory and register interrogation and modification.

Power-Supply Requirements
+5 V ±5% at 250 mA
+12 V ±10% at 30 mA
−12 V ±10% at 30 mA
(The 12 V supplies are required only for RS-232C operation.)

Dimensions and Connections
4- by 4½-inch board; dual 22-pin (0.156-inch) edge connector. 25-pin RS-232C female D-subminiature (DB-25S) connector; 4-pole DIP-switch data-rate selector.

Operating Conditions
Temperature: 0 to 50°C (32 to 122°F)
Humidity: 10 to 90% relative humidity (noncondensing)

in a BASIC interpreter are not easily persuaded to give away its secrets.

In most cases, however, a user merely wants to know the location of the GOSUB...RETURN address stack or the format and location of stored program variables. While the source code for BASIC/Debug is also not available (because the object code is mask-programmed into the ROM, you couldn't change it anyway), the locations of all variables, pointers, stacks, etc, are fixed, and their storage formats are defined and described in detail. The 60-page BASIC/Debug user's manual contains this information and is included in the 200 pages of documentation supplied with the Z8-BASIC Microcomputer board. (The documentation is also available separately.)

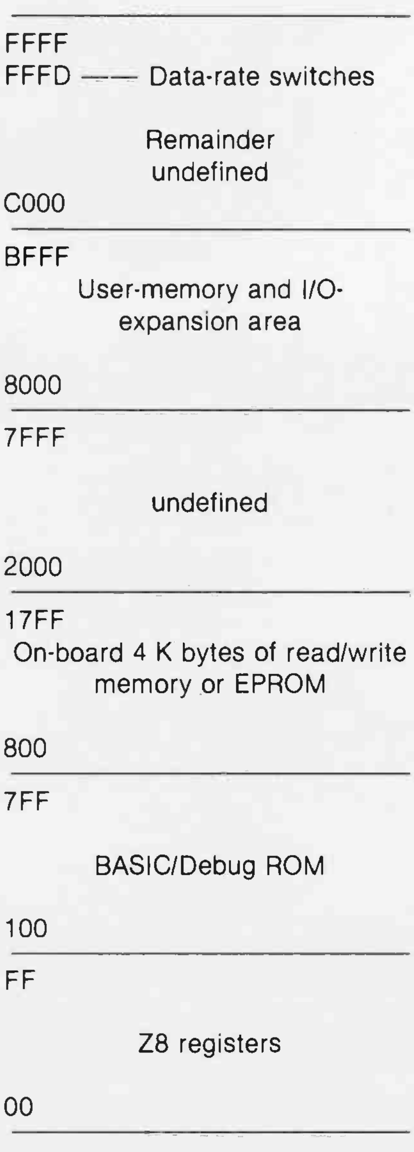


Figure 1: *A simplified hexadecimal memory map of the Z8-BASIC Microcomputer.*

Memory Allocation

Z8-family microcomputers distinguish between four kinds of memory: internal registers, internal ROM, external ROM, and external read/write memory. (A slightly different distinction can also be made between program memory and data memory, but in this project this distinction is unnecessary.) The register file resides in memory-address space in hexadecimal locations 0 through FF (decimal 0 through 255). The 144 registers include four I/O- (input/output) port registers, 124 general-purpose registers, and 16 status and control registers. (No registers are implemented in hexadecimal addresses 80 through EF [decimal addresses 128 through 239]).

The 2 K-byte ROM on the Z8671 chip contains the BASIC/Debug interpreter, residing in address space from address 0 to hexadecimal 7FF (decimal 0 to 2047). External memory starts at hexadecimal address 800 (decimal 2048). A memory map of the Z8-BASIC Microcomputer system is shown in figure 1.

When the system is first turned on, BASIC/Debug determines how much external read/write memory is available, initializes memory pointers, and checks for the existence of an auto-start-up program. In a system with external read/write memory, the top page is used for the line buffer, program-variable storage, and the GOSUB...RETURN address stack. Program execution begins at hexadecimal location 800 (decimal 2048).

When BASIC/Debug finds no external read/write memory, the internal registers are used to store the variables, line buffer, and GOSUB...RETURN stack. This limits the depth of the stack and the number of variables that can be used simultaneously, but the restriction is not too severe in most control applications. In a system without external memory, automatic program execution begins at hexadecimal location 1020 (decimal 4128).

In a system that uses an external 2 K-byte EPROM (type 2716), wrap-around addressing occurs, because the state of the twelfth address line on the address bus (A11) is ignored. (A 4 K-byte type-2732 EPROM device does use A11.) A 2716 EPROM device inserted in the Z6132's memory socket will read from the same memory cells in response to accesses to both logical hexadecimal addresses 800 and 1000. Similarly, hexadecimal addresses 820 and 1020 will be treated as equivalent by the 2716 EPROM. Therefore, when a 2 K-byte 2716 EPROM is being used, the auto-start address, normally operating at hexadecimal 1020, will begin execution of any program beginning at hexadecimal location 820. For the purposes of this discussion, you may assume that programs stored in EPROM use type-2716 devices and that references to hexadecimal address 820 also apply to hexadecimal address 1020.

Listing 1: *Simple illustration of BASIC program storage in the Z8-BASIC Microcomputer.*

```
          100      P    R    I    N    T         "    T
800   00   64   50   52   49   4E   54   20   22   54
      E    S    T    "
80A   45   53   54   22   00   FF   FF
```

Listing 2: *A multiple-line illustration of BASIC program storage.*

```
          100 A=5
          200 B=6
          3005 "A*B=";A*B

          100       A    =    5         200       B    =
800   00   64   41   3D   35   00   00   C8   42   3D
      6        3005       "    A    *    B    =    "
80A   36   00   0B   BD   22   41   2A   42   3D   22
      ;    A    *    B
814   3B   41   2A   42   00   FF   FF
```

Program Storage

The program-storage format for BASIC/Debug programs is the same in both types of memory. Each BASIC statement begins with a line number and ends with a delimiter. If you were to connect a video terminal or teletypewriter to the RS-232C serial port and type the following line:

100 PRINT "TEST"

it would be stored in memory beginning at hexadecimal location 800 as shown in listing 1.

The first 2 bytes of any BASIC statement contain the binary equivalent of the line number (100 decimal equals 64 hexadecimal). Next are bytes containing the ASCII (American Standard Code for Information Interchange) values of characters in the statement, followed by a delimiter byte (containing 00) which indicates the end of the line. The last statement in the program (in this case the only one) is followed by 2 bytes containing the hexadecimal value FFFF, which designates line number 65535.

The multiple-line program in listing 2 further illustrates this storage format.

One final example of this is illustrated in listing 3 on page 58. Here is a program written to examine itself. Essentially, it is a memory-dump routine which lists the contents of memory in hexadecimal. As shown, the 15-line program takes 355 bytes and occupies hexadecimal locations 800 through 963 (decimal 2048 through 2499). I have dumped the first and last lines of the program to further demonstrate the storage technique.

I have a reason for explaining the internal program format. One of the useful features of this computer is its ability to function with programs residing solely in EPROM. However,

NO MORE WAITING.

CIS COBOL™ software with FORMS-2™ for Apple II® computers is here. Now. From Micro Focus.

Apple II users . . . the wait is over. And your patience has paid off. Now you can create serious business programs with the world's most popular professional programming language—COBOL. And, run them on the industry standard operating system—CP/M™.

COBOL—the only standard language designed exclusively for business programming.

COBOL gives you programs that are easy to write, easy to read, easy to maintain and easy to learn.

A complete program in 20 minutes.

FORMS-2, a COBOL source-code generator, lets you begin with a blank screen . . . and end with a fully-operational program. FORMS-2 generates standard COBOL code. You can use it as is. Or build on it to create even more sophisticated programs.

Business computer compatibility.

CIS COBOL on Apple II is standard COBOL. (ANSI X3.23-1974) With it, you have the broadest applications flexibility available today. And the most reliable.

Powerful file handling.

You can grow with CIS COBOL. It provides you with all the power of ANSI COBOL file handling. Underlying B-tree technology takes care of large ISAM files . . . fast.

Circle 189 on inquiry card.

Quick, convenient program development.

With CIS COBOL and FORMS-2, you have your very own low-cost tools that allow you to get work done faster and less expensively than ever before. Features include interactive debug, fast compile-and-go, interactive screen creation and dynamic loading of modules.

GSA approved.

CIS COBOL is certified on Apple II by the General Services Administration. Which means it's been tested, re-tested and tested again . . . all under the most demanding conditions. No wonder it's been chosen for use by over 25 of the world's leading computer manufacturers.

See your Apple dealer for a demonstration.

Don't wait any longer. Get all the details about CIS COBOL and FORMS-2 today. For further information, visit your nearest Apple dealer. Or call us at (408) 248-3982 for a FREE fact-filled brochure.

CIS COBOL and FORMS-2 are trademarks of Micro Focus, Inc. Apple II is a registered trademark of Apple Computer Inc. CP/M is a trademark of Digital Research.

MICRO FOCUS™
The COBOL Company

Micro Focus, Inc.
1601 Civic Center Dr., Santa Clara, CA 95050
Tel: (408) 248-3982
Telex: 171135 MISSION SNTA

Micro Focus LTD.
58 Acacia Rd., London N.W. 8, ENGLAND
Tel: (01) 722-8843/4/5/6/7
Telex: 28536 MICROF G

the EPROMs must be programmed externally. While I will explain how to serially transmit the contents of the program memory to an EPROM programmer, some of you may have only a manual EPROM programmer or one with no communication facility. But if you are willing to spend the time, it is easy to print out the contents of memory and manually load the program into an EPROM device.

Dedicated-Controller Use

The Z8-BASIC Microcomputer can be easily set up for use in intelligent control applications. After being tested and debugged using a terminal, the control program can be written into an EPROM. When power is applied to the microcomputer, execution of the program will begin automatically.

The first application I had for the unit was as a demonstration driver for the Micromouth speech-processor board I presented two months ago in the June issue of BYTE. (See "Build a Low-Cost Speech-Synthesizer Interface," in the June 1981 BYTE, page 46, for a description of this project, which uses National Semiconductor's Digitalker chip set.) It's hard to discuss a synthesized-speech interface without demonstrating it, and I didn't want to carry around my big computer system to control the Micromouth board during the demonstration. Instead, I quickly programmed a Z8-BASIC Microcomputer to perform that task. While I was at it, I set it up to demonstrate itself as well.

The result (see photo 2 on page 52) has three basic functional components. On top of the box is a Z8-BASIC Microcomputer (hereinafter called the "Z8 board") with a 2716 EPROM installed in the memory integrated-circuit socket, the Z8-board power supply (the wall-plug transformer module is out of view), and six pushbutton switches. Inside the box is a prototype version of the Micromouth speech-processor board (a final-version Micromouth board is shown on the left).

The Micromouth board is jumper-programmed for parallel-port operation (8 parallel bits of data and a data-ready strobe signal) and connected to I/O port 2 on the Z8 board. The Micromouth BUSY line and the six pushbuttons are attached to 7 input bits of the Z8 board's input port mapped into memory-address space at hexadecimal address FFFD (decimal 65533).

The most significant 3 bits of port FFFD are normally reserved for the data-rate-selector switches, but with no serial communication required, the data rate is immaterial and the switches are left in the open position. This makes the 8 bits of port FFFD, which are brought out to the edge

Listing 3: *A program (listing 3a) that examines itself by dumping the contents of memory in printed hexadecimal form. Listing 3b shows the first and last lines of the program as dumped during execution.*

(3a)

```
100 PRINT"ENTER START ADDRESS FOR HEX DUMP ";:INPUT X
102 PRINT"THE LIST IS HOW MANY BYTES LONG ";:INPUT C
103 PRINT:PRINT
105 B=X+8 :A=X+C
107 PRINT"ADDRESS                DATA":PRINT
110 PRINT HEX (X);"       ";
120 GOSUB 300
130 X=X+1
140 IF X=B THEN GOTO 180
150 GOTO 120
180 IF X>=A THEN 250
200 PRINT:PRINT:B=X+8:GOTO 110
250 PRINT:STOP
300 PRINT HEX (@X);: PRINT"  ";
310 RETURN
:
```

(3b)

```
:RUN
ENTER START ADDRESS FOR HEX DUMP ? 2048
THE LIST IS HOW MANY BYTES LONG ? 30
```

ADDRESS	DATA							
	100		P	R	I	N	T	"
800	0	64	50	52	49	4E	54	22
	E	N	T	E	R	sp	S	T
808	45	4E	54	45	52	20	53	54
	A	R	T	sp	A	D	D	R
810	41	52	54	20	41	44	44	52
	E	S	S	sp	F	O	R	sp
818	45	53	53	20	46	4F	52	20

:
:

```
:RUN
ENTER START ADDRESS FOR HEX DUMP ? 2360
THE LIST IS HOW MANY BYTES LONG ? 45
```

ADDRESS	DATA							
	O	P		300		P	R	I
938	4F	50	0	1	2C	50	52	49
	N	T	sp	H	E	X	sp	(
940	4E	54	20	48	45	58	20	28
	@	X	)	;	:	sp	P	R
948	40	58	29	3B	3A	20	50	52
	I	N	T	"	sp	sp	"	;
950	49	4E	54	22	20	20	22	3B
		310		R	E	T	U	R
958	0	1	36	52	45	54	55	52
	N		65535					
960	4E	0	FF	FF	0	0	0	0

connector, available for external inputs. In this case, pressing one of the six pushbuttons selects one of six canned speech sequences.

Coherent sentences are created by properly timing the transmission of word codes to the speech-processor board. This requires nothing more than a single handshaking arrangement and a table-lookup routine (but try it without a computer sometime). The program is shown in listing 4a.

The first thing to do is to configure the port-2 and port-3 mode-control registers (hexadecimal F6 and F7, or decimal 246 and 247). Port 2 is bit-programmable. For instance, to configure it for 4 bits input and 4 bits output, you would load F0 into register F6 (246). In this case, I wanted it configured as 8 output bits, so I typed in the BASIC/Debug command @246=0 (set decimal location 246 to 0).

The data-ready strobe is produced using one of the options on the Z8's port 3. A Z8 microcomputer has data-available and input-ready handshaking on each of its 4 ports. To set the proper handshaking protocol and use port 2 as I have described, a code of hexadecimal 71 (decimal 113) is placed into the port-2 mode-control register. The BASIC/Debug command is @247= 113. The RDY2 and DAV2 lines on the Z8671 are connected together to produce the data-available strobe signal.

Lines 1000 through 1030 in listing 4a have nothing to do with demonstrating the Micromouth board. They form a memory-dump routine that illustrates how the program is stored in memory. You notice from the memory dump of listing 4b that the first byte of the program, as stored in the ROM, begins at hexadecimal location 820 (actually at 1020, you remember) rather than 800 as usual. This is to help automatic start-up. The program could actually begin anyplace, but you would have to change the program-pointer registers (registers 8 and 9) to reflect the new address. The 32 bytes between 800 and 820 are reserved for vectored addresses to optional user-supplied I/O drivers and interrupt routines.

Programming the EPROM

The first EPROM-based program I ran on the Z8-BASIC Microcomputer was manually loaded. I simply

Listing 4: *A program (listing 4a) that demonstrates the functions of the Micromouth speech synthesizer, operating from a type-2716 EPROM. The simple I/O-address decoding of the Z8 board allows use of the round-figure address of 65000. The program uses a table of vocabulary pointers that has been previously stored in the EPROM by hand. Listing 4b shows a dump of the memory region occupied by the program, proving that storage of the BASIC source code starts at hexadecimal location 820.*

(4a)

```
100 @246=0:@247=113
110 X=@65000 :A=%1400
120 IF X=254 THEN @2=0
130 IF X=253 THEN GOTO 500
140 IF X=251 THEN A=A+32 :GOTO 500
150 IF X=247 THEN A=A+64 :GOTO 500
160 IF X=239 THEN A=A+96 :GOTO 500
170 IF X=223 THEN A=A+128 :GOTO 500
180 IF X=222 THEN N=0 :GOTO  300
200 GOTO 110
300 @2=N :N=N+1 :IF N=143 THEN 110
310 IF @65000<129 THEN 310
320 GOTO 300
500 @2=@A :A=A+1
510 IF @65000<129 THEN 510
520 IF @A=255 THEN GOTO 110
530 GOTO 500
1000 Q=2048
1005 W=0
1010 PRINT HEX(@Q),:Q=Q+1
1015 W=W+1 :IF W=8 THEN PRINT" ":GOTO 1005
1020 IF Q=4095 THEN STOP
1030 GOTO 1010
:
```

(4b)

```
:goto 1000
FF      FF      FF      FF      FF      FF      FF      FF
FF      FF      FF      FF      FF      FF      FF      FF
FF      FF      FF      FF      FF      FF      FF      FF
FF      FF      FF      FF      FF      FF      FF      FF
0       64      40      32      34      36      3D      30
3A      40      32      34      37      3D      31      31
33      0       0       6E      58      3D      40      36
35      30      30      30      20      3A      41      3D
25      31      34      30      30      0       0       78
49      46      20      58      3D      32      35      34
20      54      48      45      4E      20
0! AT 1015
:
```

The System/48 is the outstanding office automation computing system for the 80's   it's so productive we call it MAGIC©. Look at these features:

- One to eight interactive users per node
- Data management system
- Report generator
- Query processor
- Screen format generator
- Automatic interface code generator
- Up to ½ Mbytes of user memory
- Winchester disk with 18-million bytes (formatted capacity)
- 15-minute mean-time-to-repair
- Built-in protection from line-voltage spikes, noise, and brownouts

And, it features MAGIC©, the Operating System that gets things done faster than you can say abracadabra because of its multi-keyed Indexed-Sequential Access Method and flexible file-organization. MAGIC© also offers high security, with password protection. MAGIC© supports global or local printers for as many users as desired.

MAGIC© also includes DataMagic II — TEI's red-hot database manager. DataMagic II has even more tricks up its sleeve — like automatic or manual record-lock protection and automatic transaction backout to protect the database. And it runs application software written for CP/M 2.X.

Take a MAGIC© leap into the future!

Arrange to attend one of our regularly scheduled System/48 workshops (RSVP).

OEM and Dealer Inquiries Invited

TEi INC | System/48®

5075 S. LOOP EAST, HOUSTON, TX. 77033
(713) 738-2300 TWX. 910-881-3639

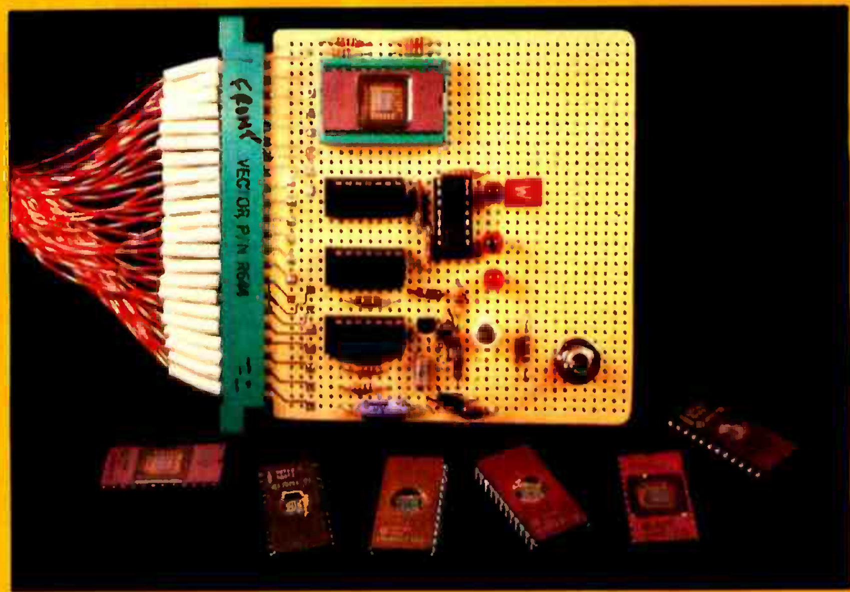


Photo 3: *Type-2716 EPROM programmer, adapted from "Program Your Next EROM in BASIC" (March 1978 BYTE, page 84). The circuit, which is driven through parallel ports, programs a 2716 in about 2½ minutes and is controlled by a BASIC program.*

printed out the contents of the Z6132 memory using the program of listing 3 and entered the values by hand into the EPROM programmer. This is fine once or twice, but you certainly wouldn't want to make a habit of it. Fortunately, there are better alternatives if you have the equipment.

Many EPROM programmers are peripheral devices on larger computer systems. In such cases, it is possible to take advantage of the systems' capabilities by downloading the Z8 program directly to the programmer.

The programmer shown in photo 3 is a revised version of the unit I described in a previous article, "Program Your Next EROM in BASIC" (March 1978 BYTE, page 84). It was designed for type-2708 EPROMs, but I have since modified it to program 2716s instead. All I had to do was lengthen the programming pulse to 50 ms and redefine the connections to four pins on the EPROM socket. It still is controlled by a BASIC program and takes less than 2½ minutes to program a type-2716 EPROM device. Refer to the original article for the basic design.

Normally, the LIST function or memory-dump routine cannot be used to transmit data to the EPROM programmer because the listing is filled with extraneous spaces and carriage returns. It is necessary to write a program that transmits the contents of memory without the extra characters required for display formatting. The only data received by the EPROM programmer should be the object code to load into the EPROM.

In writing this program we can take advantage of the Z8's capability of executing machine-language programs directly through the USR and GO@ commands. The serial-input and serial-output subroutines in the BASIC/Debug ROM can be executed independently using these commands. The serial-input driver starts at hexadecimal location 54, and the serial-output driver starts at hexadecimal location 61. Transmitting a single character is simply done by the BASIC statement

```
GO@ %61,C
```

where C contains the value to be transmitted. A serial character can be received by

```
C=USR (%54)
```

TRS-80*
Model I
Model III
Products that set Precedents.
COUGAR
OMIKRON™
Word Processing
MAPPER CP/M Adaptor
CBASIC II*** CP/M** AND
THE BEST WORD PROCESSOR
$1000.00 VALUE ONLY $299
UNPRECEDENTED SAVINGS
are available on selected CP/M programs through COUGAR, Omikron's official users group.
PHOENIX
TRADEMARKS:
*TRS-80/Radio Shack/Tandy Corp.
**CP/M/Digital Research
***CBASIC II/Compiler Systems
****PHOENIX/Palantir Inc.
OMIKRON
1127 Hearst St.
Berkeley, CA 94702
(415) 845-8018

Listing 5: *BASIC statements that print out the entire contents of the 4 K bytes of user memory, for use with a communicating EPROM programmer.*

```
1000 X=%800 :REM BEGINNING OF
     USER MEMORY
1010 GO@ %61,@X :REM TRANSMIT
     CONTENTS OF LOCATION X
1020 X=X+1 :IF X=%1801 THEN
     STOP
1030 GOTO 1010
```

Listing 6: *A simple BASIC program segment to demonstrate the concept of the "black box" method of modifying data being transmitted through the Z8-BASIC Microcomputer.*

```
100 @246=0:@247=113 :REM SET PORT
    2 TO BE OUTPUT
110 @2=X :REM X EQUALS THE DATA
    TO BE TRANSMITTED
```

where the variable C returns the value of the received data.

To dump the entire contents of the Z6132 memory to the programmer, the statements in listing 5 should be included at the end of your program.

Execution begins when you type GOTO 1000 as an immediate-mode command and ends when all 4 K bytes have been dumped. The transmission rate (110 to 9600 bps) is that selected on the data-rate-selector switches.

Conceivably, this technique could also be used to create a cassette-storage capability for the Z8 board. In theory, a 3- or 4-line BASIC program can be entered in high memory (you can set the pointer to put the program there) to read in serial data and load it in lower memory. Changing the program pointer back to hexadecimal 800 allows the newly loaded program to be executed. Since the Z8-BASIC Microcomputer already has a serial I/O port, any FSK (frequency-shift keyed) modem and cassette-tape recorder can be used for cassette data storage.

I/O for Data Acquisition

Data acquisition for process control is the most likely application for the Z8-BASIC Microcomputer. Low-

Customizable

The Unique Difference that Sets VEDIT Apart in Full Screen Editors

Total user customizability is a predominate reason that over a thousand users find VEDIT the easiest to use full screen editor. It makes VEDIT the only editing package which allows you to determine your own keyboard layout and use the cursor and special function keys on any terminal having them. And only VEDIT fully supports all of the newly available terminals. It may come as a surprise to you, that with any other editor or word processor, you will have to memorize obscure control characters or multi-character sequences, while your terminal's extra keys and editing functions go unused. The customization extends to setting the default tab positions, scrolling methods and much more. It's almost like designing your own editor for your system, applications and preferences. And all of this is easily done with the setup program which requires no programming knowledge or 'patches', but simply prompts you to press a key or enter a parameter.

Unequaled Hardware Support

The CRT version supports all terminals by allowing you to select during setup which terminal VEDIT will run on. Features such as line insert and delete, reverse scroll, status line and reverse video are used on 'smart' terminals. All screen sizes are supported, including large ones such as the 60 X 80 format on the Ann Arbor Ambassador terminal. Special function keys on terminals such as the Heath H19, Televideo 920C and IBM 3101, and keyboards producing 8 bit codes are all supported. The memory mapped version is extremely flexible and supports bank select and hardware cursors such as on the SSM VB3. With this level of customizability and hardware support, you will feel for the first time that the software was optimally designed for your system.

Fully Compatible Replacement for Ed

Since VEDIT creates and edits standard text files of up to one diskette in length, it serves as a replacement for the CP/M standard editor ED. Of course, you benefit from the fastest and easiest to use 'What you see is what you get' type full screen editing available, fast disk access and an editor which takes up only 12K of your valuable memory space. With VEDIT you will never again need or want to use the slow and tedious ED.

Special Features

VEDIT is more than just a full screen editing replacement for ED, it gives you many new editing capabilities, such as a scratchpad buffer for moving and rearranging sections of text, complete file handling on multiple drives and iteration macros. Amoung its special features you will find automatic indenting for use with structured programming languages such as Pascal and PL/I, and other special facilities for Assembler and COBOL. A real time saver is the ability to insert a specified line range of another file anywhere in the text. Unlike most software, VEDIT will even tolerate your mistakes. For example, one key will 'Undo' the changes you mistakenly made to a screen line, and the disk write error recovery lets you delete files or insert another disk should you run out of disk space.

Ordering

Many dealers carry VEDIT, or you may contact us for fast delivery. Specify the CRT version, your video board or microcomputer, the 8080, Z80 or 8086 code version, and disk format required.

VEDIT for 8080 or Z80: Disk and manual $130
VEDIT for CP/M-86: Disk and manual . *(NEW)* $185
Manual: Price refunded with software purchase $15

VISA or MASTERCARD Welcomed

CP/M and MP/M are registered trademarks of Digital Research. Inc. Apple II is a registered trademark of Apple Computer. Inc. SoftCard is a trademark of Microsoft. TRS-80 is a trademark of Tandy Corp.

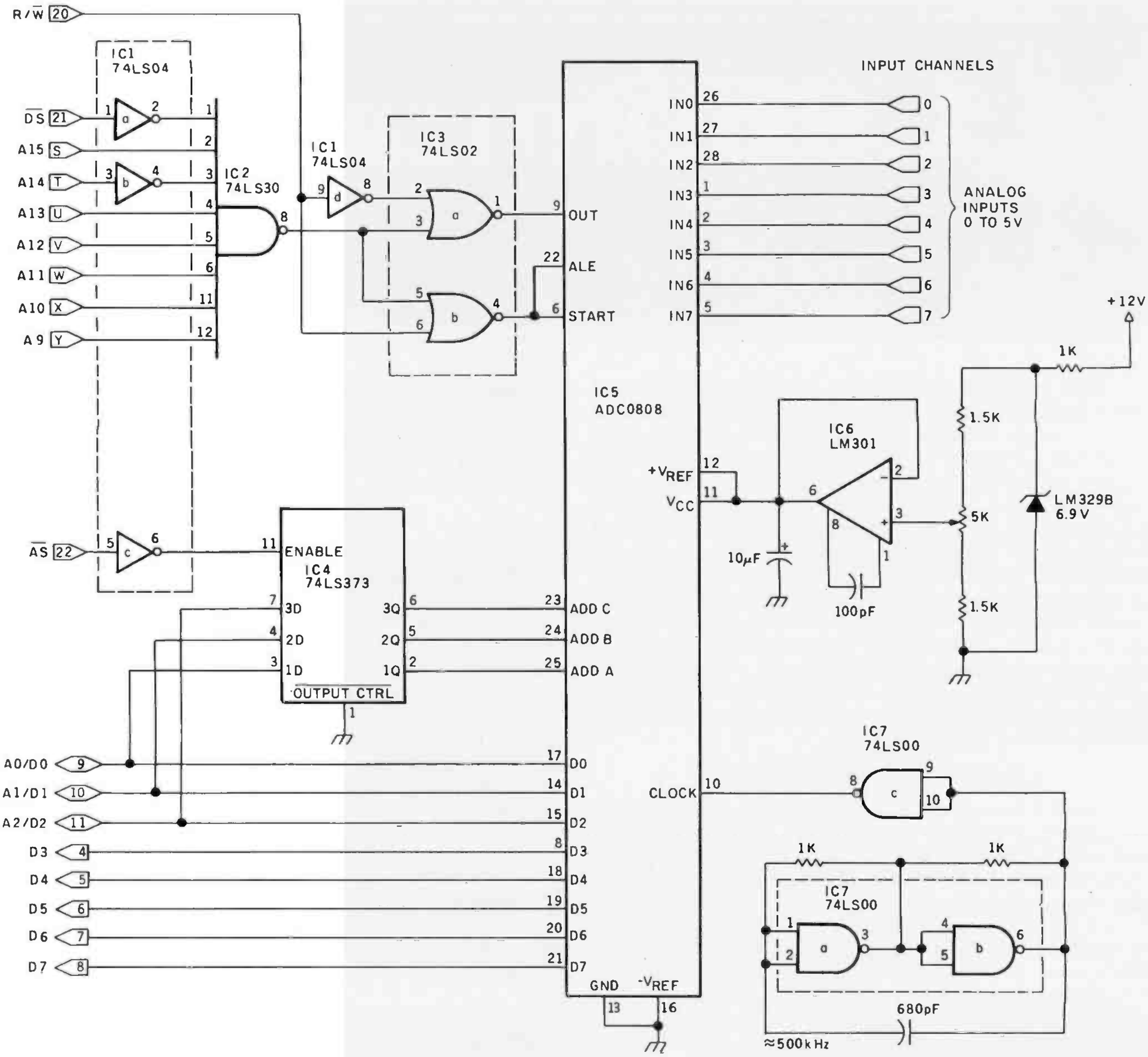
• North Star • Cromemco • Heath H8/H89 • SuperBrain • Apple II Softcard • TRS-80 Model II & Model I
Most other CP/M Systems with CRT or Memory Mapped Displays • MP/M • CP/M-86

VEDIT
CP/M
CUSTOMIZABLE
FULL SCREEN EDITOR

CompuView Products Inc.

618 Louise, Ann Arbor, Michigan 48103 • Telephone (313) 996-1299

Circle 85 on inquiry card.

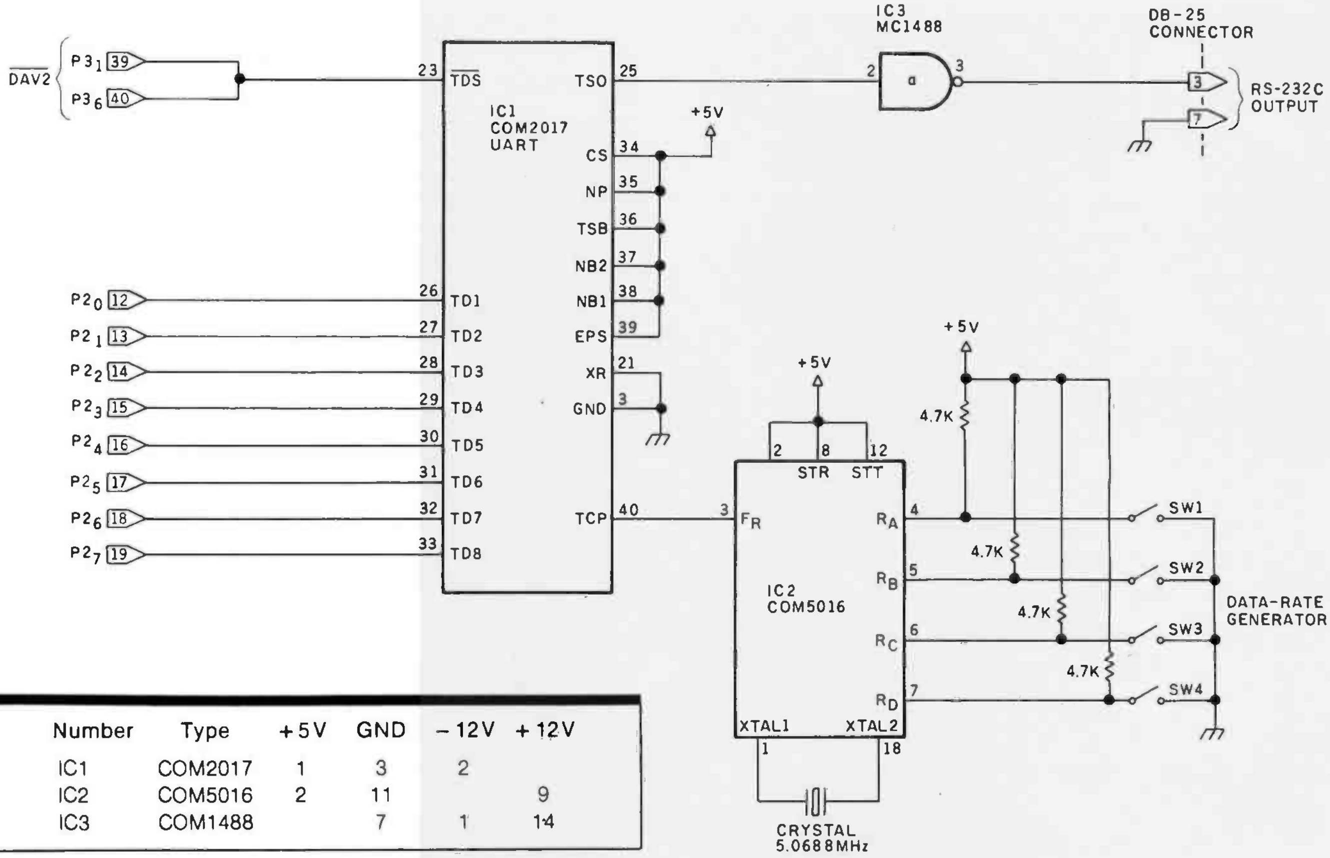


Number	Type	+5V	GND	+12V
IC1	74LS04	14	7	
IC2	74LS30	14	7	
IC3	74LS02	14	7	
IC4	74LS373	20	10	
IC5	ADC0808	see schematic diagram		
IC6	LM301		4	7
IC7	74LS00	14	7	

Figure 2: *Schematic diagram of an A/D converter. This 8-bit, eight-channel unit has a unipolar input range of 0 to +5 V, with the eight output channels addressed as I/O ports mapped into memory-address space at hexadecimal addresses BF00 through BF07.*

cost distributed control is practical, substituting for central control performed by a large computer system. Analog and digital sensors can be read by a Z8-BASIC Microcomputer, which then can digest the data and reduce the amount of information (experiment results or control parameters) stored or transmitted to a central point. Control decisions can be made by the Z8-BASIC Microcomputer at the process locality.

The Z8 board can be used for analog data acquisition, perhaps using an A/D (analog-to-digital) converter such as that shown in figure 2. This 8-bit, eight-channel A/D converter has a unipolar input range of 0 to +5 V (although the A/D integrated circuit can be wired for bipolar operation), with the eight output channels addressed as I/O ports mapped into memory-address space at hexadecimal addresses BF00 through BF07 (decimal 48896 through 48903). When the Z8671 performs an output operation to the channel address, the channel is initialized for acquiring data, while data is read from the channel when the Z8671 performs



Number	Type	+5V	GND	−12V	+12V
IC1	COM2017	1	3	2	
IC2	COM5016	2	11		9
IC3	COM1488		7	1	14

Figure 3: *Schematic diagram of an RS-232C serial output port for the "black box" communication application of the Z8-BASIC Microcomputer. The Z8671 must be configured by software to provide the proper signals: one such signal, DAV2, is derived from two bits of I/O port 3 on the Z8671. The pin numbers shown in the schematic diagram for $P3_1$ and $P3_6$ are pins on the Z8671 device itself, not pins or sections on the card-edge connector, as are $P2_0$ through $P2_7$.*

an input operation on the channel's address.

Intelligent Communication

Another possible use for the Z8-BASIC Microcomputer is as an intelligent "black box" for performing predetermined modification on data being transmitted over a serial communication line. The black box has two DB-25 RS-232C connectors, one for receiving data and the other for retransmitting it. The intelligence of the Z8-BASIC Microcomputer, acting as the black box, can perform practically any type of filtering, condensing, or translating of the data going through.

Perhaps you have an application where continuous raw data is transmitted, but you would rather just keep a running average or flag deviations from preset limits at the central monitoring point rather than contend with everything. The Z8 board can be programmed to digest all the raw data coming down the line and pass

NEW!
"WORDSTAR™ goes APPLE!!"

It's amazing! It's colossal! Awesome Apple at last joins forces with world-famous WordStar. And together they easily conquer the most beastly word processing! If you're an Apple owner, this is one double feature you won't want to miss!

WordStar, after all, is the most powerful and versatile word processing software ever developed for microcomputers. And now it's available for Apple—thanks to the SoftCard from Microsoft, a Z-80-based circuit card that converts Apple to CP/M. And thanks to a new edition of WordStar formatted especially for Apple.

You'll be glad to know our Apple edition contains all the features that have made WordStar the top banana in word processing:

What you see is what you get. With WordStar the screen shows exactly what will get printed—including all format variables like page breaks, justification, and hyphenation. As soon as you type a change, it's onscreen.

User friendly? Our menus give you so much help that most of the time you can leave your manual sitting on the shelf. Choose from four levels of help according to the job and your own experience.

WordStar has more talent than you may ever need. Its flexibility is simply awesome. From text typing to the most complex word processing you can imagine—WordStar lets you sail through it all with ease and efficiency.

In fact, WordStar is so powerful and so friendly, we challenge comparison—feature for feature—against dedicated word processing systems costing thousands more than a WordStar-based system.

So, if you love your Apple but wish it could do more, that's where we come in. First, with WordStar. And next—since we don't monkey around when it comes to software—with Apple editions of our whole software family, all designed to work together:

SpellStar™, a new WordStar option, will find your spelling and typing mistakes for you. **MailMerge**™, another WordStar option, makes it easy to combine files to produce personalized form letters. **SuperSort**™ takes on the biggest sorting, merging, and selecting jobs. And **DataStar**™ handles data entry, retrieval, and update with tremendous power and precision.

Innovative excellence—that's what has made WordStar such a smash among micro users. And that's what you'll find in MicroPro's entire family of business software—now available in Apple editions.

Want more information about our Apple software? Clip the coupon. Or, if you've really gone ape by now, just phone us for the name of your nearest dealer.

Available in 40 & 80 column screen versions; and 13 & 16 sector media.

CP/M is a registered trademark of Digital Research.
Apple Computer is a registered trademark of Apple Computer, Inc.

Circle 230 on inquiry card.

MicroPro™
INTERNATIONAL CORPORATION

1299 Fourth Street
San Rafael, California 94901
(415) 457-8990

Telex 340-388

YES,
I've gone ape!
Please rush me information on MicroPro's family of business software solutions, and the name of my local MicroPro dealer.

Name ______________
Title ______________
Company ______________
Address ______________
City ______________ State ______ Zip ______

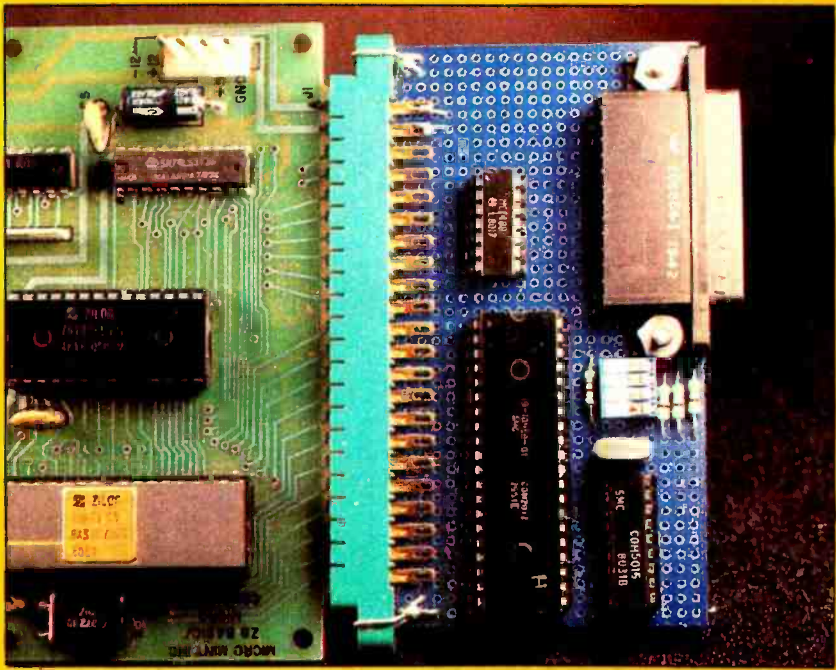


Photo 4: *A three-integrated-circuit hardwired serial output port for the Z8-BASIC Microcomputer. Connected to port 2, any program data sent to register 2 will be transmitted serially at the data rate selected on the four-position DIP switch (between 50 to 19200 bps). The Z8 board, configured with two serial ports, is used to process raw data moving through it. Data is received on one side, digested, and retransmitted in some more meaningful form from the other port. Such a configuration could also be used to connect two peripheral devices that have radically different data rates.*

on only what's pertinent.

Another such black-box application is to use the Z8 board as a printer buffer. Photo 4 shows the interface hardware of one specific application, which I used to attach a high-speed computer to a very slow printer. The host computer transmitted data to the Z8 board at 4800 bps. Since the receiving serial port used had to be bidirectional to handshake with the host computer, I added another serial output to the Z8 board for transmitting characters to the printer. Only three integrated circuits were required to add a serial output port. A schematic diagram is shown in figure 3 on page 67. The UART (universal asynchronous receiver/transmitter, shown as IC1) is driven directly from port 2 on the Z8 board (port 2 could also be used to directly drive a parallel-interface printer), and IC2 supplies the clock signal for the desired data rate. Of course, the UART could have been attached to the data and address buses directly, but this was easier.

Transmitting a character out of this serial port requires setting the port-2 and port-3 mode-control registers as before. After that, any character sent to port 2 will be serially transmitted. The minimum program to perform this is shown in listing 6 on page 64. This circuit can also be used for downloading programs to the EPROM programmer.

In Conclusion

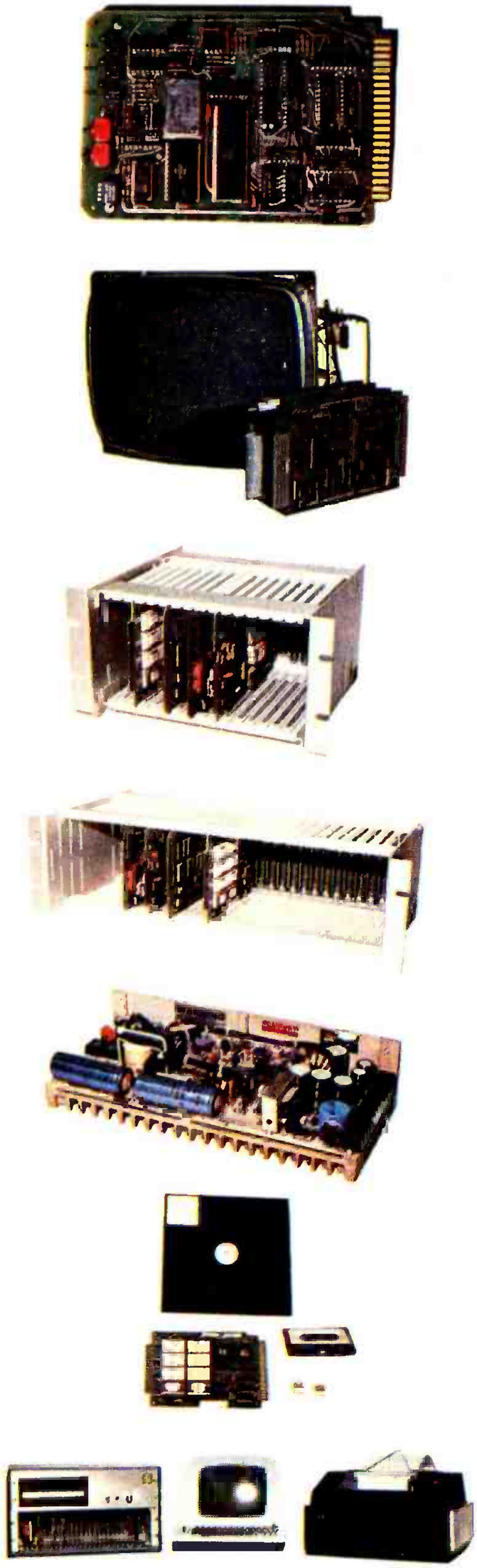
It is impossible to describe the full potential of the Z8-BASIC Microcomputer in so few pages. For this reason, considerable effort has been taken to fully document its characteristics. I have merely tried to given an introduction here.

I intend to use the Z8-BASIC Microcomputer in future projects. I am interested in any applications you might have, so let me know about them, and we can gain experience together.

We know just how good G&L Microcomputers are.

Because we use them in our own PC's and CNC's.

And now we can fill all your needs with reliable industrial grade modules.



GL 868 MODULES

- CPU-FPA PROCESSOR
- RAM-CMOS-EPROM
- ANALOG MODULES
- VIDEO MODULES
- SERVO MODULES

NESTS-POWER SUPPLIES

- HALF NEST
- FULL NEST
- MASTER RACK
- POWER SUPPLIES

PERIPHERALS

SOFTWARE PACKAGES

DEVELOPMENT SYSTEMS

RELIABILITY

- 130°F AMBIENT RATED
- 95% RELATIVE HUMIDITY
- PRE-TESTED CHIPS WITH 125°C, 168 HOUR BURN-IN
- MODULE BURN-IN AND TEST AT 130°F FOR 40 HOURS

GET THE FACTS

Ask for the fact-packed GL868 booklet.
Giddings & Lewis Electronics Co.,
P.O. Box 1658, 666 S. Military Road,
Fond du Lac, WI 54935, U.S.A. Telephone
(414) 921-9400.

Electronics Division

Giddings & Lewis

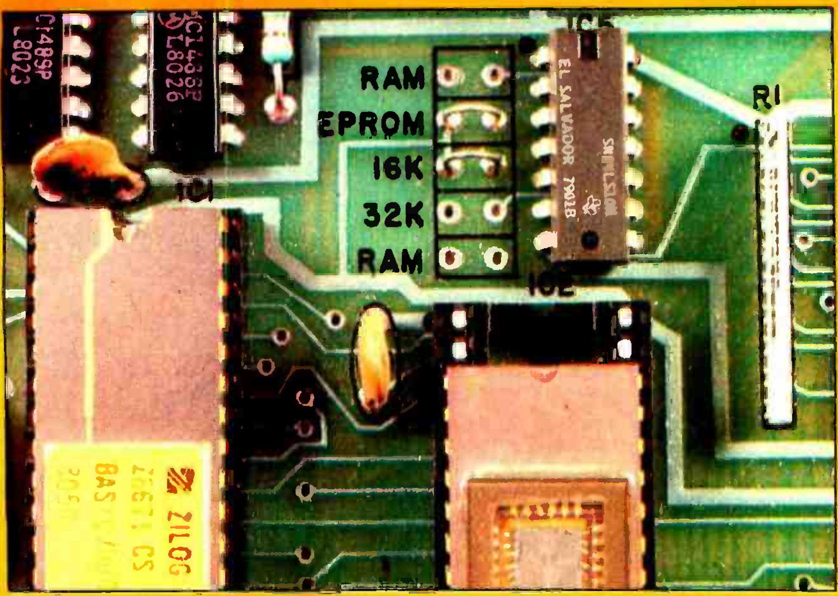


Photo 5: *When the Z8-BASIC Microcomputer is used with a ROM-resident program, the two jumpers used with the Z6132 are removed, and the EPROM jumper is installed instead. When using a type-2716 16 K-bit (2 K-byte) EPROM device, the "16 K" jumper is installed. If a type-2732 32 K-bit (4 K-byte) EPROM is used instead, the "32 K" jumper is installed. The EPROM is inserted in the lower 24 pins of the 28-pin Z6132 socket (IC2) as shown.*

Next Month: *Build a phonetic voice synthesizer based on the Votrax SC-01 synthesizer chip.* ■

Special thanks to Steve Walters and Peter Brown of Zilog Inc for their aid in producing these articles.

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for the articles he presents each month. These articles are available in reprint books from BYTE Books, 70 Main St, Peterborough NH 03458.* Ciarcia's Circuit Cellar *covers articles appearing in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *presents articles from December 1978 through June 1980.*

To receive a complete list of Ciarcia Circuit Cellar kits available from The Micro-Mint, circle 100 on the inquiry card.

The following items are available postpaid in the United States from:
The MicroMint Inc
917 Midway
Woodmere NY 11598
Telephone:
(800) 645-3479 (for orders)
(516) 374-6793 (for technical information)

Z8-BASIC Microcomputer
(Documentation includes:
Z8 Technical Manual
Z8 Product Specification
Z6132 Product Specification
BASIC/Debug Manual
Z8-BASIC Microcomputer Construction/Operator's Manual)
Assembled and tested....$170
Kit....$140

Z8-BASIC Microcomputer power supply
(Size: 2⅛ by 4½ inches)
Provides: +5 V, 300 mA
+12 V, 50 mA
−12 V, 50 mA
Assembled and tested....$35

These prices are in effect until September 15, 1981; call for prices after that date.

All printed-circuit boards are solder-masked and silk-screened. The documentation supplied with the Z8 board includes approximately 200 pages of materials. It is available separately for $25. This charge will be credited toward any subsequent purchase of the Z8 board.

Please include $2 for shipping and handling. New York residents please include 7% sales tax.

Object-Oriented Software Systems

David Robson
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

This article describes a general class of tools for manipulating information called object-oriented software systems. It defines a series of terms, including software system *and* object-oriented. *The description is greatly influenced by a series of object-oriented programming environments developed in the last ten years by the Learning Research Group of Xerox's Palo Alto Research Center, the latest being the Smalltalk-80 system. The article describes object-oriented software systems in general, instead of the Smalltalk-80 system in particular, in order to focus attention on the fundamental property that sets the Smalltalk-80 system apart from most other programming environments. The words "object-oriented" mean different things to different people. Although the definition given in this article may exclude systems that should rightfully be called object-oriented, it is a useful abstraction of the idea behind many software systems.*

Many people who have no idea how a computer works find the idea of object-oriented systems quite natural. In contrast, many people who have experience with computers initially think there is something strange about object-oriented systems. (I don't mean to imply that computer-naive users can create complex systems in an object-oriented environment more easily than experienced programmers can. Creating complex systems involves many techniques more familiar to the programmer than the novice, regardless of whether or not an object-oriented environment is used. But the basic idea about how to create a software system in an object-oriented fashion comes more naturally to those without a preconception about the nature of software systems.) I had had some programming experience when I first encountered an object-oriented system and the idea certainly seemed strange to me. I am assuming that most of you also have some experience with software systems and their creation. So instead of introducing the object-oriented point of view as if it were completely natural, I'll try to explain what makes it seem strange compared to the point of view found in other programming systems.

Software Systems

A software system is a tool for manipulating information. For the purposes of this article, I'm using a very broad definition of information.

> **Information:** *A representation or description of something.*

There are many types of information that describe different things in different ways. One of the great insights in computer science was the fact that information can (among other things) describe the manipulation of information. This type of information is called *software*.

> **Software:** *Information describing the manipulation of information.*

Software has the interesting recursive property of describing how to manipulate things like itself. Software is used to describe a particular type of information-manipulation tool called a *software system*.

> **Software system:** *An information-manipulation tool in which the manipulation is described by software.*

A distinction is made in information-manipulation tools between *hardware* systems and *software* systems. A hardware system is a physical device like a typewriter, pen, copier, or television set. The type of manipulation performed by a hardware system is built in and can only be changed by physical modification. The type of manipulation performed by a software system is not built in—it is determined by information, which can be manipulated.

The virtue of software systems is that the mechanism developed for manipulating information can be used to manipulate the mechanism itself. Software systems that actually manipulate other software systems are called *programming environments*.

> **Programming environment:** *A software system that manipulates software systems. An environment for the design, production, and use of software systems.*

"Our goal at The Denver Software Company is to translate the advances in high technology—symbolized by the Space Shuttle triumph—into practical, problem-solving microcomputer programs for small business and home use."

Wally Schirra

Microcomputers Are The Door To The Future.

We Have The Key.

Finally, there's an accounting package available for most microcomputers—from the least expensive to the top-of-the-line—that works the moment the machine is switched on. Language, programs, everything needed for accurate bookkeeping is built into the software, eliminating the need for programming skills or expensive equipment add-ons.

The FINANCIAL PARTNER™ is a comprehensive financial package that takes the headache out of bookkeeping. With general ledger, cash receipts, accounts payable, and check-printing capability, this system also provides standard financial reports. In addition, the FINANCIAL PARTNER™ comes with a detailed user's manual containing basic bookkeeping instruction. By automatically sorting and posting accounts, the FINANCIAL PARTNER™ saves you valuable time and is a complete guide to money management for your home or very small business. At $175, it's worth its weight in gold.

Also from The Denver Software Company:

The PASCAL TUTOR™, a computer assisted course in UCSD Pascal*. This complete software package uses the microcomputer to teach this powerful new programming language. $125 for this fast, easy way to learn versatile UCSD Pascal*.

The PASCAL PROGRAMMER™ a software breakthrough for those knowledgeable about UCSD Pascal*. Pre-tested modules drastically shorten the time spent coding, testing, and debugging programs—by as much as 70%. For $125, save money as well as time.

*UCSD Pascal is a trademark of the Regents of the University of California.

Products available from your local dealer.

THE DENVER SOFTWARE COMPANY ™

MANUFACTURERS OF MICROCOMPUTER SOFTWARE

[illegible]100 E. Jewell Ave., Suite 13 • [illegible]012
Dealer inquiries welcome: 303 321-[illegible]

Thus, a programming environment is also recursive: it *is* what it manipulates. The fact that software systems can be manipulated is both good news and bad news. Since a text editor is a software system, it is not "cast in concrete" and you can change it to conform to your style of interacting with text more closely than it does now (using a programming environment). However, you also may reduce it to the proverbial "pile of bits" (not a text editor at all).

Data/Procedure-Oriented Software

The traditional view of software systems is that they are composed of a collection of *data* that represents some information and a set of *procedures* that manipulates the data.

> **Data:** *The information manipulated by software.*
>
> **Procedure:** *A unit of software.*

Things happen in the system by invoking a procedure and giving it some data to manipulate.

As an example of a software system, consider a system for managing windows that occupy rectangular areas on a display screen. The windows contain text and have titles. They can be moved around the screen, sometimes overlapping each other. (The details of this system are not important. Its main purpose is to point out the differences between the structure of a data/procedure system and an object-oriented system.)

A window-management system implemented as a data/procedure system would include data representing the location, size, text contents, and title of each window on the screen. It would also include procedures that move a window, create a window, tell whether a window overlaps another window, replace the text or title of a window, and perform other manipulations of windows on a display. To move a window, a programmer would call the procedure that moves windows and pass to it the data representing the window and its new location.

A problem with the data/procedure point of view is that data and procedures are treated as if they were independent when, in fact, they are not. All procedures make assumptions about the form of the data they manipulate. The procedure to move a window should be presented with data representing a window to be moved and its new location. If the procedure were presented with data representing the text contents of a window, the system would behave strangely.

In a properly functioning system, the appropriate choice of procedure and data is always made. However, in an improperly functioning system (eg: one in the process of being developed or encountering an untested situation), the data being manipulated by a procedure may be of an entirely different form from that expected. Even in a properly functioning system, the choice of the appropriate procedure and data must always be made by the programmer.

These two problems have been addressed in the context of the data/procedure point of view by adding several features to programming systems. Data typing has been added to languages to let the programmer know that the appropriate choice of data has been made for a particular procedure. In a typed system, the programmer is notified when a procedure call is written using the wrong type of data. Variant records allow the system to choose the appropriate procedure and data in some situations.

Object-Oriented Software

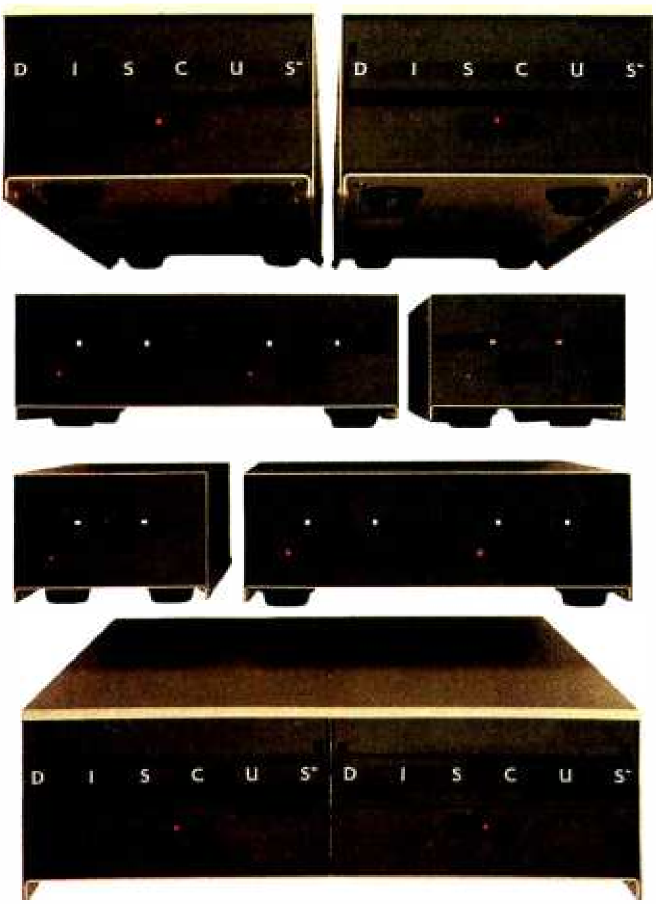
Instead of two types of entity that represent information and its manipulation independently, an object-oriented system has a single type of entity, the *object*, that represents both. Like pieces of data, objects can be manipulated. However, like procedures, objects describe manipulation as well. Information is manipulated by sending a *message* to the object representing the information.

> **Object:** *A package of information* and *descriptions of its manipulation.*
>
> **Message:** *A specification of one of an object's manipulations.*

When an object receives a message, it determines how

MORROW DESIGNS

Cost effective answers to floppy disk problems.



DMA answers. Standard, accumulator transfer floppy disk controllers can stall your microcomputer system's CPU for as long as 160 milliseconds. Just to access and transfer a sector of data to main memory. If CPU processing speed and system performance are critical, you need something better. That's where Morrow Designs' new intelligent Disk Jockey DMA™ controller comes in. This new breed of perpherial handles both 5¼" and 8" drives and can read almost any format in existence. Speed? Your CPU runs at full tilt while the DMA controller seeks and gathers a sector of data. How? Information transfers to and from main memory occur as "cycle steals" from the system bus. And the missing memory cycles are transparent to the CPU totalling only two milliseconds instead of the usual 80.

Build a buffer. Give the Disk Jockey DMA a little extra memory and your system's performance gets even better. The extra storage is used as a track buffer. So, whenever a sector on a new track is read, the track buffer is automatically filled with the other sectors on the track. The result? Additional data on the track is immediately available. Without the 80 millisecond rotational latency normally encountered. And similar efficiencies occur with disk writes. Sectors in the track buffer are conditionally written on the disk only if a new track is accessed. And only one revolution of the disk is required.

Now, prices.* All systems listed are supplied with a floppy disk drive, Disk Jockey Direct Memory Access Controller, CP/M** 2.2 operating system, power supply, fan, cables, cabinet and Microsoft 5.2 BASIC.

Even lower prices. Morrow Designs' floppy disk systems with Disk Jockey™ 2D controllers offer the same high quality at even lower prices. Now without memory mapping!

Fast answers. See Morrow Designs' family of cost effective floppy disk systems at your computer dealer. For a somewhat more leisurely answer, circle the reader service number below. For immediate answers, phone us at (415) 524-2101.

LOOK TO MORROW FOR ANSWERS.

5¼ Inch Systems (formatted data)

400,000 Bytes (1) Dual Sided 48 TPI Drive	$1110
800,000 Bytes (2) Dual Sided 48 TPI Drive	$1899
800,000 Bytes (1) Dual Sided 96 TPI Drive	$1499
1,600,000 Bytes (2) Dual Sided 96 TPI Drive	$2599

OEM pricing available

8 Inch Systems (formatted data)

500,000 Bytes (1) Single Sided Drive	$1199
1,000,000 Bytes (2) Single Sided Drive	$1975
1,000,000 Bytes (1) Dual Sided Drive	$1595
2,200,000 Bytes (2) Dual Sided Drive	$2675

OEM pricing available

*Prices subject to change without notice.
Disk Jockey DMA and Disk Jockey 2D are trademarks of Morrow Designs
**CP/M is a trademark of Digital Research.

MORROW DESIGNS
5221 Central Avenue, Richmond, CA 94804
(415) 524-2101

Circle 252 on Inquiry card.

to manipulate itself. The object to be manipulated is called the *receiver* of the message. A message includes a symbolic name that describes the type of manipulation desired. This name is called the message *selector*. The crucial feature of messages is that the selector is only a *name* for the desired manipulation; it describes *what* the programmer wants to happen, not *how* it should happen. The message receiver contains the description of how the actual manipulation should be performed. The programmer of an object-oriented system sends a message to invoke a manipulation, instead of calling a procedure. A message names the manipulation; a procedure describes the details of the manipulation.

Of course, procedures have names as well, and their names are used in procedure calls. However, there is only one procedure for a name, so a procedure name specifies the exact procedure to be called and exactly what should happen. A message, however, may be interpreted in different ways by different receivers. So, a message does not determine exactly what will happen; the receiver of the message does.

If the earlier example of the window-management system were implemented as an object-oriented system, it would contain a set of objects representing windows. Each object would describe a window on the screen. Each object would also describe the manipulations of the window it represents—for example, how to move it, how to determine whether it overlaps another window, or how to display it. Each of these manipulations would correspond to a selector of a message. The selectors could include move, overlap, display, delete, width, or height. (In this article, an alternate typeface is used for words that refer to specific elements in example systems.)

In addition to a selector, a message may contain other objects that take part in the manipulation. These are called the message *arguments*. For example, to move a

window, the programmer might send the object representing the window a message with the selector move. The message would also contain an argument representing the new location. Since this is an object-oriented system, the selector and argument are objects: the selector representing a symbolic name and the argument representing a location or point.

The description of a single type of manipulation of an object's information (the response to a single type of message) is a procedure-like entity called a *method*. A method, like a procedure, is the description of a sequence of actions to be performed by a processor. However, unlike a procedure, a method cannot directly call another method. Instead, it must send a message. *The important thing is that methods cannot be separated from objects.* When a message is sent, the receiver determines the method to execute on the basis of the message selector. A different kind of window could be added to the system with a different representation and different methods to respond to the messages move, overlap, display, delete, width, and height. Places where messages are sent to windows do not have to be changed in order to refer to the new kind of window; whichever window receives the message will use the method appropriate to its representation.

Objects look different from the outside than they do from the inside. By the outside of an object, I mean what it looks like to other objects with which it interacts (eg: what rectangles look like to other rectangles or to windows). From the outside, you can only ask an object to do something (send it a message). By the inside of an object, I mean what it looks like to the programmer implementing its behavior. From the inside, you can tell an object how to do something (in a method). For example, a window can respond to messages having the selectors move, overlap, display, delete, width, or height.

I'll probably come down the hall to see you.

"I like to tell anyone who has done a good job that I know it and appreciate it. As far as I'm concerned, being the President doesn't mean a big office with a closed door. It's not private dining rooms and splendid isolation.

"You see, I know success at ITT DCD is its people. Our most important asset is our people; the computers, the facilities–whatever else we have or buy–nothing works right without the right people. And when you find them you have to challenge them, then reward them when they meet the challenges.

"People work for recognition. OK, I know what you're going to say. It's the money they're after and the praise is only icing on the cake. But believe me, you can't buy loyalty. You can pay people for their talent... but you can't buy them.

"I really appreciate a special effort. And if you do something innovative, notable, different–I'm going to get up, go and see you, tell you what I feel. We've put millions into independent research this year, because we believe you should back original thought. As far as I'm concerned, today's bright idea is tomorrow's profit. You can't get any simpler than that! Corporate success is a collective success, and it's my job to build a better team.

"For me it was alway ITT. It was my first significant exposure to industry. I guess I'm a good example of the fact that staying can work for you. From a Project Engineer to President in 14 years. Yes, you're looking for a long term commitment and what it can do for you.

"And it looks like I'm here to stay–who would leave a life like this. I've got a wonderful house in Morris County, NJ. There I am, just 1 hour from Broadway, and I still have wild deer wandering across my lawn. A great place to bring up children-that wonderful mix of rural fantasy and Big Apple culture.

"Success? You could call it that. But success is setting a goal and reaching it. Satisfaction is finding yourself exactly where you want to be."

If you want to align your career with a company that looks for ideas and backs them all the way to reality, consider ITT DCD. We have openings for degreed engineering/scientific professionals at all levels of experience in the following areas:

COMMAND & CONTROL COMMUNICATIONS
MESSAGE / CIRCUIT SWITCHING
VOICE / SIGNAL PROCESSING

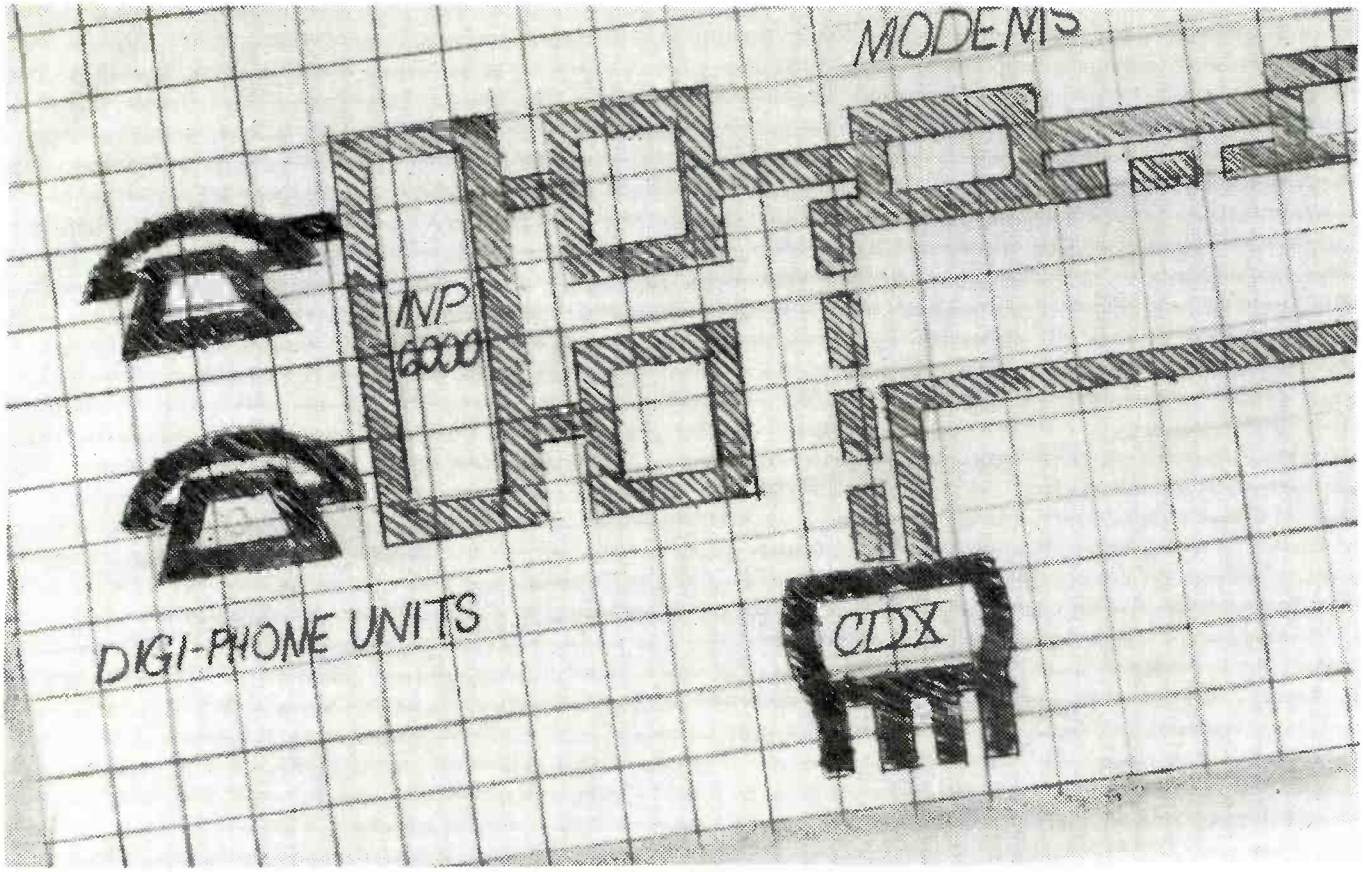
- **Hardware Systems Design**
- **Software Systems Design**
- **Systems Analysis • Programming**

ITT DCD offers excellent salaries and a comprehensive benefits package that would be difficult to duplicate. Beyond medical, dental and life, we offer a superior system of educational support which encourages acquisition of credits and advanced degrees on our time at our expense. Relocation is another area of extraordinary effort on ITT DCD's part. We ease your move by coordinating all phases through our in-house relocation specialist. Please call or send resume to our Director of Professional Placement.

Where engineers never stop learning

ITT DEFENSE COMMUNICATIONS DIVISION

An equal opportunity employer M/F   (800) 526-6292,(201) 284-2551   492 River Road, Nutley, New Jersey 07110



Our Systems Speak for Themselves.

At Codex, we produce high-speed state-of-the-art data communications equipment. And our systems are known as the best in the industry.

If you know where the future in electronics is, those facts should speak for themselves.

Being the leader in data communications means we're part of one of the fastest-growing fields today. Our clients are Fortune 1000 firms. And we're shaping tomorrow's information networks to make them more efficient, and more productive.

What's in it for you? Just this. That kind of growth means you can go places with us. We promote extensively from within. And we make a conscious effort to enable our people to do more—technically and professionally—than they ever thought possible.

Our technology helps the world communicate. Maybe it's saying something to you.

Codex offers competitive salaries and a comprehensive benefits package including dental insurance and profit sharing.

codex

A Subsidiary of MOTOROLA INC.

An Equal Opportunity/Affirmative Action Employer M/F

Interested candidates should forward a resume including salary history, in confidence, to J.T. Dombrowski, CODEX CORPORATION, 20 Cabot Boulevard, Mansfield, MA 02048.

Senior Systems Engineer

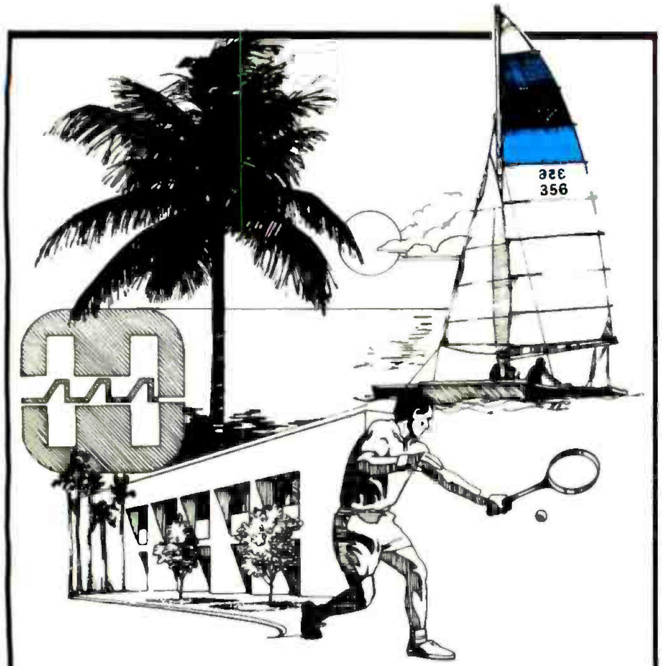
Will be responsible for the design of custom software interfaces, product enhancements and product support for data communications systems. Requires a BS or MS in electrical engineering or computer science and a minimum of 4 years software design with some exposure to telecommunications and Assembly language programming.

Senior Software Engineer

Responsibility will be for the definition and implementation of operating systems in multi-microprocessor environment for data communications systems. Requires a BS or MS in Computer Science or a related field and a minimum of 4 years of software development including implementation of operating systems software. Will utilize the knowledge of a variety of operating systems approaches in real-time multiprocessing environment e.g. UNIX.

Senior Hardware Engineer

This position involves designing hardware to customer specifications for data communications systems. A BSEE is required plus a minimum of 4 years experience in digital design of microprocessor-based systems. Knowledge of data communication systems and some analog experience is a plus.



UNABASHED SUCCESS AND WE'RE READY TO SHARE IT!

We've entered a crowded market and pushed the competition aside. Today, HARRIS COMPUTER SYSTEMS DIVISION is growing at a compound annual rate of nearly 30%. This expansion will continue to accelerate as emphasis on CAD/CAM, energy and systems create a greater demand for the Harris super mini-computer.

Now we're developing improved architecture, even greater performance and an expanded range of applications. These developments will lead to opportunity for the skilled SOFTWARE or HARDWARE ENGINEER looking for a place to step out of the crowd. If you have a BSCS or BSEE, 3-5 years of experience and a great deal of promise, let's talk about unabashed success!

A high salary, great benefits and fine working environment are only part of what awaits you when you join Florida's largest industrial employer. We're offering you a way of life in the sunny, income tax free state where off hours can be spent at almost every conceivable form of recreation and relaxing. But find out why high performance on the job can lead to better performance all around. For details, call Jan Kelley, toll free, at 1-800-327-4986 or send your resume including salary history to: **HARRIS COMPUTER SYSTEMS DIVISION,** 2101 West Cypress Creek Road, Ft. Lauderdale, Florida 33309.

HARRIS
COMMUNICATION AND INFORMATION PROCESSING

An Equal Opportunity Employer M/F

THE TIME IS NOW. THE COMPANY IS DRC.

At DRC you'll find an environment that encourages personal growth through high visibility, project mobility and technical recognition, both internally and through direct customer contact. You'll be part of a small team of highly skilled technical professionals performing Systems Analysis and Engineering Studies for DOD program managers. With the increased emphasis on Defense Systems, the time is now to grow with a leader in the industry.

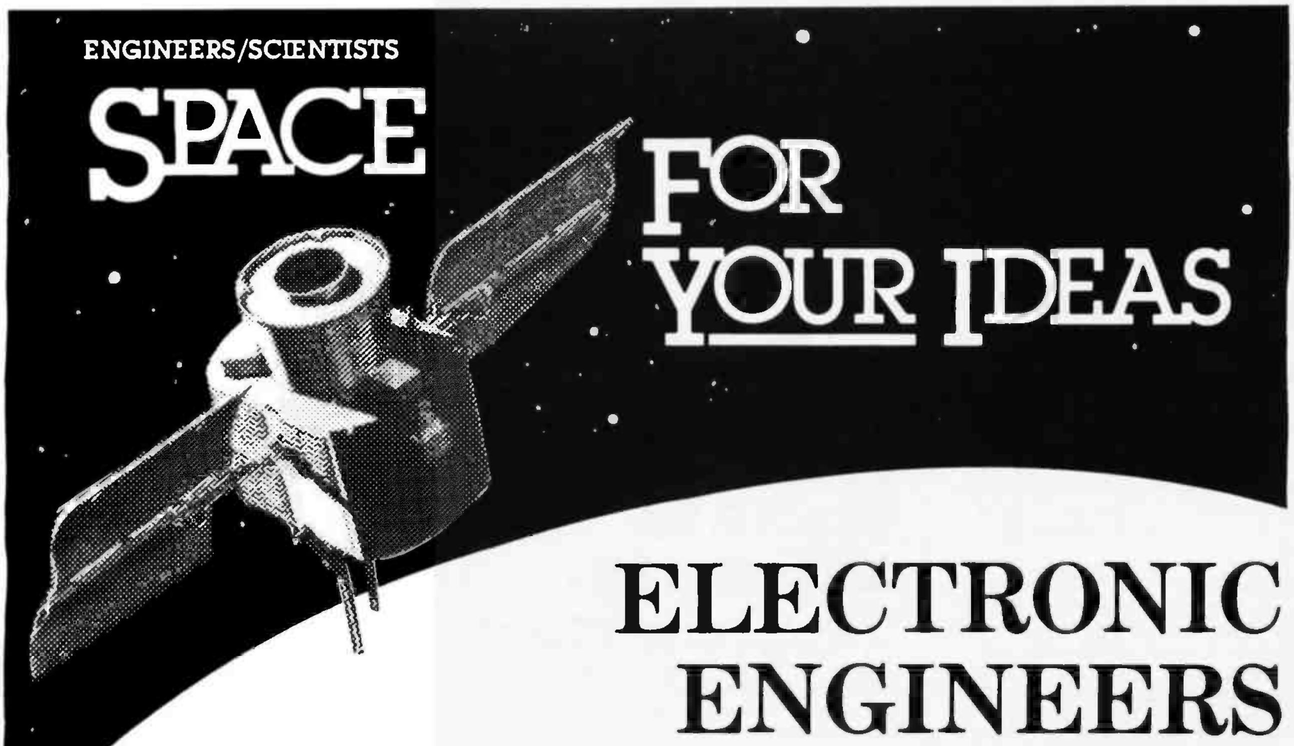
We are specifically interested in people with a BSEE, MS preferred, with 5 to 10 plus years systems level experience in these topical areas.

- Automatic Test Equipment for use on military avionic systems
- Military Aircraft Displays and Instruments
- Fire Control Systems and Airborne Computers
- State-of-the-art Radar and ECM Systems
- IMU Component Reliability Analysis
- Military Digital Computers and associated Automatic Test Equipment
- Inertial Component Test
- Creative Design (Analog/Digital) of laboratory test equipment
- F-16 Avionics Intermediate Shop Management—Management Information Systems
- Signal Processing for Electronic Warfare, ECM, ECCM
- Life Cycle Cost Analysis
- Operations Research for airborne and ground based electronic systems
- Logistics Support Analysis for weapons systems applications

To learn more about these exciting opportunities, please forward your resume, including salary information, to Don Shanley, Dept. MH6 Dynamics Research Corporation, 60 Concord Street, Wilmington, MA 01887.

An equal opportunity employer, M/F.

DRC **DYNAMICS RESEARCH CORPORATION**



ELECTRONIC ENGINEERS

If you're the kind of engineer who enjoys the challenge of new technological problems, investigate the professional positions available with **The Aerospace Corporation**. We seek scientists and engineers with Ph.D or M.S. in EE or Physics with background in one of these areas:

Laser Communication Engineer

Perform analysis, design and development of laser communications systems for a variety of space programs, as well as other applications. In addition to a background in communications systems, you should be knowledgeable in the various laser transmitter technologies including solid state and gas, as well as laser receiver and optical components.

RF Systems Design

Antenna design studies, RF link calculations for communications satellites, propagation studies to determine link margins. A broad RF background, and the ability to perform systems trade analysis for terrestrial communications networks involving large antenna and microwave subsystems are desirable.

Communications Systems Analysis

Statistical analysis of communications systems. The ability to perform coding systems studies, link calculations for communications satellites, modulation and spread spectrum studies and systems trade analysis for communications networks is desirable.

Optical and Electro-Optical Systems Analysis

Analysis and laboratory evaluation of optical and electro-optical components and systems such as CCD imaging and signal processing devices, lasers, laser modulators, fiber and integrated optics, and coherent optical processing. Image analysis, diffraction effects, optical systems design and specifications.

Space Power Systems

Analysis of the design, processing, assembly and testing of solar cells and arrays, procurement and testing of batteries, and electrical integration of solar arrays and batteries into power systems.

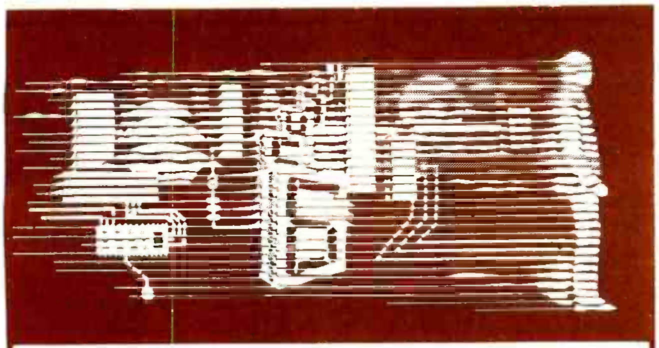
For a more rewarding career please forward your resume to:

The Aerospace Corporation
Professional Placement Dept. KK
2350 E. El Segundo Blvd.
El Segundo, CA 90245

The Aerospace Corporation

Where There's Space For Your Ideas

An Affirmative Action Employer • U.S. Citizenship Required



DON'T WAIT FOR TOMORROW...

CREATE IT.

When creative ideas are needed for new and unprecedented software systems, the people to see are at SofTech. We take new techniques and old approaches and combine them to find the best possible solution to any given problem.

At SofTech, you will have the opportunity to apply your abilities to exciting, real-world problems in such diverse areas as:

- Language design and compiler development
- Communications
- Software engineering facilities
- Data base systems
- Requirements analysis
- Signal processing applications
- Operating systems and executives
- Computer-aided design and computer-aided manufacturing.
- Sale and enhancement of microprocessor software products — sole world-wide distributor of the UCSD p-System.

If you have the talent and vision to add to our international reputation for excellence in the development and application of new systems and software technology, your best position is waiting at SofTech.

We offer opportunities for professional growth inherent in a 300 person environment, coupled with excellent starting salaries and outstanding benefits. Please send your resume and salary requirements to Judith M. Forsythe, Dept. 525, SofTech, Inc., 460 Totten Pond Road, Waltham, MA 02154; or call toll-free 1-800-225-8854.

an affirmative action/equal opportunity employer

SOFTECH

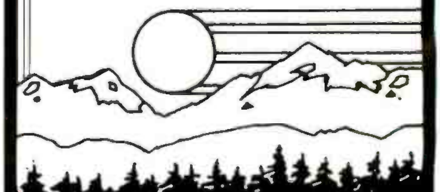
THE SOFTWARE TECHNOLOGY COMPANY

Move Up To STC . . . And COLORADO!

Storage Technology Corporation is the world's largest manufacturer of high performance tape and disk storage equipment and a major producer of high speed line printers. A Fortune 500 company, we're located at the base of the magnificent Rocky Mountains and just minutes away from Denver. We offer you exciting career opportunities and the kinds of challenges that stimulate the most innovative of minds. Our current openings for qualified professionals include:

Manufacturing Engineering Managers
•
Development Engineers
•
Mechanical Engineers
•
Test Engineers
•
Power Systems Engineers
•
Software Test Engineers
•
Test Design Engineers
•
VLSI Design Engineers
•
Senior Systems Programmers
•
Quality Engineers
•
Senior Product Specialist
•
Marketing Product Line Planner

If you like to see your ideas impact the industry, we'd like to hear from you. We provide an excellent compensation package that includes health, dental and life insurance benefits, stock purchase plan, competitive relocation assistance and more. For consideration, please send your detailed resume in absolute confidence to STORAGE TECHNOLOGY CORPORATION, Dept. MID, 2270 South 88th St., MD #29, Louisville, CO 80027. We are an equal opportunity employer.



STC STORAGE TECHNOLOGY CORPORATION

Share in the excitement of our outstanding achievements. Be part of Honeywell's Small Systems and Terminals Division (SS&TD) at our Billerica facility. And gain satisfying rewards in an environment governed by no less than excellence.

Since 1969, Billerica has been one of Honeywell's foremost engineering organizations with a history of significant technical accomplishments.

As headquarters for SS&TD, Billerica continues in this vein. Most recently, with the acclaimed introduction of Honeywell's DPS-6 family of small computers...and the WP-6 word processing system, just the first of many advanced products to be announced for Honeywell's new office automation line.

Throughout the coming year, and in years to come, our Billerica operation will continue to advance Honeywell's state of the art. Our engineers will continuously strive to find innovative answers in the field of LSI and VLSI, Terminals, Design Automation, Office Automation, Networking and Communications, Distributed Data Processing and more.

Join us in our quest for excellence. In computer technologies. In communications technologies. And in each and every thing we do.

Honeywell
Small Systems and Terminals Division
300 Concord Road
Billerica, MA 01821

An Equal Opportunity Employer M/F/H

Positions are available at most levels in:

Terminals Software Development
Product Planning & Specification
Product Test
Programming & Systems Analysis
New Terminal Products Development
CAD/CAM Design
Systems Design
Custom Software Development
Terminals Hardware Development
Firmware & Maintainability Systems Engineering
Analog Design
Custom Terminals Hardware Engineering
Mechanical Design & Engineering Support
Design Automation
Semiconductor Design
VLSI & LSI Design
Disk Controller Design
Components & Materials Engineering
Maintainability & Systems Design
Hardware & Systems Test
Peripheral Subsystem Design
Hardware & Software Technical Writers & Editors

To investigate the above positions, please forward your resume to Don B. Batsford.

25 years in Computers 25 years in Massachusetts

Honeywell

People. Our Competitive Edge

The Landlord™

Apartment Management Software

Keeping track of apartment availabilities, rent payments, security deposits, leases, and other administrative functions consumes a great deal of time and attention for apartment owners and managers. You and your staff probably spend countless hours dealing with the paperwork necessary to manage your property.

With the Landlord™ apartment management software and an Apple II* computer, file cabinets full of paperwork and the frustrations of cumbersome bookkeeping procedures can be eliminated. The clerical work for your apartments can be accomplished with greater accuracy in a fraction of the time you presently spend. The Landlord™ will keep up-to-date files on apartments and residents as well as detailed records of property income and expenses.

You'll be able to enter, change, or delete information by following the simple English instructions that appear on the screen of the Apple II*. The Landlord™ will automatically organize and store your data and make it available for your review at any time. With the Landlord™, your resident manager can instantly determine where apartment vacancies exist and when additional units will become available for rental. The Landlord™ also keeps track of resident payments, letting you see at a glance who is behind on rent or other payments. Property and tax analysis reports are printed automatically each month and allow you to monitor the profitability of your apartments.

The Landlord™ apartment management software and the necessary Apple II* equipment are available for less than the cost of a new sub-compact car. If you own or manage an apartment property with no more than 400 units, visit your nearest computer dealer for a demonstration.

BY881

Please return this coupon for more information about the Landlord™ and the name of the dealer nearest you.

Name ______________________

Company ______________________

Address ______________________

City/State ______________ Zip ________

MIN MICROCOMPUTER SOFTWARE, INC.
5835-A Peachtree Corners East
Norcross, Ga. 30092

*Apple II is a registered trademark of Apple Computer, Inc.
The Landlord is a trademark of MIN Microcomputer Software, Inc.

Circle 251 on inquiry card.

However, nothing is known outside the window about how it responds to these messages. (It is known that a window will move when asked to, but it is not known how it accomplishes the move.)

The set of messages an object can respond to is called its *protocol*. The external view of an object is nothing more than its protocol; the internal view of an object is something like a data/procedure system. An object has a set of variables that refers to other objects. These are called its *private variables*. It also has a set of methods that describes what to do when a message is received. The values of the private variables play the role of data and the methods play the role of procedures. This distinction between data and procedures is strictly localized to the inside of the object.

Methods, like other procedures, must know about the form of the data they directly manipulate. Part of the data a method can manipulate are the values of its object's private variables. For example, we might imagine three ways that a window represents its location and size (internally). The private variables might contain:

- four numbers representing the *x* and *y* location of the center, the width, and the height
- two points representing opposite corners of the window
- a single rectangle whose location and size are the same as the window's

The method that moves a window (the response to messages with the selector move) assumes that a particular representation is used. If the representation were changed, the method would also have to be changed. Only the methods in the object whose representation changed need be changed. All other methods must manipulate the window by sending it messages.

A message must be sent to an object to find out anything about it (ie: our concept of manipulation includes inquiring about information, as well as changing information). This is needed because we don't want the form of an object's inside known outside of it. The response to a message may return a value. For example, a window's response to the message width returns an object that represents its width on the display (a number). The method for determining what to return depends on the form of the window's private variables. If they are represented as the first alternative listed above (four numbers), the response would simply return the value of the appropriate private variable. If the second alternative is used (two points), the method would have to determine the width from the *x* coordinates of the two corners. If the third alternative is used (one rectangle), the width message would simply be passed on to the rectangle and the rectangle's response would become the window's response.

Classes and Instances

Most object-oriented systems make a distinction between the description of an object and the object itself. Many similar objects can be described by the same general description. The description of an object is called a *class* since the class can describe a whole set of related objects. Each object described by a class is called an *instance* of that class.

> **Class:** *A description of one or more similar objects.*
>
> **Instance:** *An object described by a particular class.*

Every object is an instance of a class. The class describes all the similarities of its instances. Each instance contains the information that distinguishes it from the other instances. This information is a subset of its private variables called *instance variables*. All instances of a class have the same *number* of instance variables. The *values* of the instance variables are different from instance to instance. An object's software (ie: the methods that describe its response to messages) is found in its class. All instances of a class use the same method to respond to a particular type of message (ie: a message with a particular selector). The difference in response by two different instances is a result of their different instance variables. The methods in a class use a set of names to refer to the set of instance variables. When a message is sent, those names in the invoked method refer to the instance variables of the message receiver. Some of an object's private

SuperSoft's Gallery of CP/M Masterworks

Programming Languages	Disk/Manual Only
"C"	$200/20
FORTH	$200/25
FORTRAN IV	$250/25
RATFOR	$100/NA
BASIC	$200/25
'TINY' PASCAL	$ 85/10
System Maintenance	
Diagnostics II	$100/15
Diagnostics I	$ 75/15
DISK DOCTOR	$100/15
Utilities	
Utility Pack #1	$ 60/NA
Utility Pack #2	$ 60/NA
Text Processing	
TFS	$ 85/15
Super-M-List	$ 75/10
Software Security	
Encode/Decode II	$100/20
Encode/Decode I	$ 50/20
Intercommunications	
TERM	$150/15
TERM II	$200/15
Entertainment	
ANALIZA	$ 35/NA
NEMESIS	$ 40/NA
Dungeon Master (For use with Nemesis)	$ 35/NA
Miscellaneous	
Z8000 Cross-Assembler	$500/25
"C" Cross-Compiler (Z8000 Target)	$500/25

TERM

A Complete Networking/Intercommunications Package

TERM allows the CP/M user to communicate with other CP/M based systems or with remote timesharing computers. TERM supports file transfers between both timesharing systems and between CP/M systems.

TERM equals or exceeds comparable programs in power and flexibility, but costs less, delivers more and *source code* is provided on discette!

With TERM you can send and receive ASCII, HEX and COM files. You also have a conversational mode, and a timesharing terminal emulator. Below is a partial list of features:

- Engage/disengage printer
- terminal emulator
- auto error checking with re-try
- conversational mode
- send files
- receive files

requires 32K CP/M and a minimal knowledge of assembly language programming.

TERM is supplied with source and user manual: $150.00
Manual only: $15.00

TERM

Many programs include SuperSoft's online "HELP" system!

SUPERDISKS FOR SALE!

SuperSoft Has Great Prices on Blank Discettes

SuperSoft sought out and found a discette that met our high standards. In the software distribution business we needed a discette that was reliable, sturdy, durable, and inexpensive. We wanted no data errors on any discette that we shipped.

- **Guaranteed**
- **Data density in excess of 3200 b.p.i.**
- **Approved by Shugart, Persci, Qume, Remex, others**
- **Operating temperature: 50–120 degrees Fahrenheit**

Discette type	price per box
Single Sided Single Density:	
Soft sectored IBM compatible 8"*	$30.00
10 hard sectors 5¼"*	$30.00
16 hard sectors 5¼"*	$30.00
Single Sided Double Density:	
Soft sectored IBM compatible 8"*	$35.00
10 hard sector 5¼"*	$35.00
16 hard sector 5¼"*	$35.00

*Add $15.00 for Double Sided Discettes
Illinois residents add 5%
Add $1.00 shipping per box

All SUPERDISKS are sold only in lots of 10. Each comes with jackets and box. All orders must be pre-paid or C.O.D. Generally we ship from stock, with arrival times running about 8-10 days

For complete information on these and all other SuperSoft products, please write for our free catalogue.

All software can be supplied on the following media:
CP/M formats . . . 8" sft sectored, 5" Northstar, 5" Micropolis Mod II, Vector MZ, Superbrain DD/QD, Apple II+

VISA · master charge

All Orders and General Information:
SUPERSOFT ASSOCIATES
P.O. BOX 1628
CHAMPAIGN, IL 61820
(217) 359-2112
Technical Hot Line: (217) 359-2691
(answered only when technician is available)

*CP/M REGISTERED TRADEMARK DIGITAL RESEARCH
SSS FORTRAN is the copyright of Small Systems Services, Urbana, Illinois

24 hour express service available!

SuperSoft

First in Software Technology

Prices subject to change without notice

EXCITING DISCOUNTS

apple® II

16K computer

DISK with CONTROLLER
NEW DOS 3.3 $529
without . . . $445
Nearly Everything
for Apple

$1045

APPLE II 48K
$1095

WE WILL MEET OR BEAT ANY ADVERTISED PRICES ON MOST ITEMS IF MERCHANDISE IN STOCK

APPLE SOFTWARE

Adventure by Microsoft	27
ABM by Muse	22
Alien Rain by Broderbund	22
Applebug Debugger	29
Apple PIE	129
Apple Pilot	129
Apple Plot System	59
Applepost Mailing List System	44
Applesoft Cassette Demos	29
Apple Game Paddles	26
Applesoft Utility Programs	29
Applewriter Word Processor	65
Ascii Express	65
Asteroid Field by Cabalier	19
Autostart ROM Pkg.	59
Controller Bus. Pkg.	514
Cosmos Mission/Space Invaders	24
CCA Data Mgmt.	84
3-D Animation Pack	55
Data Factory by Microlab	129
Desktop Plan II	169
DB Master by Stoneware	209
DOS Tool Kit	65
DOS 3.3 Upgrade	49
Dow Jones Portfolio Evaluator	45
Forth II by Softape	45
Fortran for Language Sys.	159
Galaxian by Broderbund	23
Hi Res Football	33
Head-on	25
Integer Basic Cassette Demos	29
Pascal Language System	459
Peachtree Bus. Pkgs.	CALL
Personal Filing System	84
Phantoms Five	39
Raster Blaster by Budge Co.	24
Sargon II Chess Game disk	32
Single Disk Copy Routines	35
Space Game Album by B. Budges	39
Space Eggs	25
Star Cruiser	24
Stellar Trek	23
Sub-Logic FS-1 Flt. Sim. disk	34
Supertext II by Muse	129
3-D Graphics Tool by B. Budges	39
Tranquility Base	24
Trilogy by Bill Budge	24
Visicalc II	169
Visilist	CALL
Wizard and the Princess	32
Zork	34

LARGE SELECTION OF SOFTWARE IN STOCK — CALL FOR FREE BROCHURE —

APPLE COMPUTER INTERFACE CARDS

ALS Smartterm	324
Apple Clock/Calendar Card by Mtn. Comp.	225
Applesoft II Firmware Cd.	149
CCS Asynchronous 7710A	145
CCS Parallel Print Cd. 7720A	155
Centronics Interface Cd.	179
Comm. Cd. & DB25 Cable	179
CPS Multifunction by Mtn. Comp.	259
Expansion Chassis by Mtn. Comp.	649
HiSpeed Serial Int. Cd.	155
Integer Basic Firmware Cd.	149
ROMPLUS (keyboard filter extra)	135
Serial Interface Card	139
SSM AIO Serial/Parallel I/O Assembled & Tested	189

ACCESSORIES

A/D D/A Board by Mtn. Comp.	319
Andromeda 16k Ramcard	179
Arith. Processor 7811 A or B	339
COPYROM by Mtn. Comp.	51
Dan Paymar L.C. Kit 1 or 2	55
Extender Board	27
GPIB by CCS model 7490A	259
Graphics Input Tablet	649
Hayes Micromodem'	319
Introl X-10 Remote Control Sys.	239
K & D Joystick for the Apple	47
Keyboard Filter ROM chip	49
M & R Sup-R-Term 80 column board	319
Music System by Mtn. Comp.	479
Programmable Timer CCS 7440A	159
Prototyping Hobby Card	22
ROMWRITER by Mtn. Comp.	149
SuperTalker Speech Synthesizer	239
Symtec Light Pen	214
Versa-Writer Digitizer Drawing System	209
Videx Keyboard Enhancer	115
Videx Videoterm	319
Z-80 Soft Card Microsoft	295

MEMBER CHAMBER OF COMMERCE

CALL 1-800-854-2833
PHONE ORDERS
MON. - SAT. 8 to 6 P.S.T.

Circle 76 on inquiry card.

AUTHORIZED APPLE SALES & SERVICE

COMPUTER SPECIALTIES

DIV. OF COMPUTER METRICS INC.

variables are shared by all other instances of its class. These variables are called *class variables* and are part of the class.

The programmer developing a new system creates the classes that describe the objects that make up the system. The programmer of the window-management system would create a class that contained methods corresponding to the message selectors move, display, delete, width, and height. This class would also include the names of the instance variables referred to in those methods. These names might be frame, text, and title, where:

> frame is a rectangle defining the area on the screen,
> text is the string of characters displayed in the window, and
> title is the string of characters representing the window's name

The classes representing rectangles and strings of characters are included in most systems, so they don't need to be defined.

In a system that is uniformly object-oriented, a class is an object itself. A class serves several purposes. In a running system, it provides the description of how objects behave in response to messages. The processor running an object-oriented system looks at the receiver's class when a message is sent to determine the appropriate method to execute. For this use of classes, it is not necessary that they be represented as objects since the processor does not interact with them through messages (preventing a nasty recursion). In a system under development, a class provides an interface for the programmer to interact with the definition of objects. For this use of classes, it is extremely useful for them to be objects, so they can be manipulated in the same way as all other descriptions. Classes also are the source of new objects in a running system. Here again, it is useful for the class to be an object, so object creation can be accomplished with a simple message. For example, the message new might be sent to a class to create a new instance.

Inheritance

Another mechanism used for implicit sharing in object-oriented systems is called *inheritance*. One object inherits the attributes of another object, changing any attributes that distinguish the two. Some object-oriented systems provide for inheritance between all objects, but most provide it only between classes. A class may be modified to create another class. In such a relationship, the first class is called the *superclass* and the second is called the *subclass*. A subclass inherits everything about its superclass. The following modifications can be made to a subclass:

- adding instance variables
- providing new methods for some of the messages understood by the superclass
- providing methods for new messages (messages not understood by the superclass)
- adding class variables

As an example, the window-management system might contain windows that have a minimum size. These would be instances of a subclass of the ordinary class of windows that added an instance variable to represent the minimum size and provided a new method for the message that changes a window's size.

Conclusion

The realization that information can describe the manipulation of information is largely responsible for the great utility of computers today. However, that discovery is also partially responsible for the failure of computers to reach the utility of some predictions made in earlier times. On the one hand, it can be seen as a unification between the manipulator and the manipulated. However, in practice, it has been seen as a distinction between software and the information it manipulates. For small systems, this distinction is harmless. But for large systems, the distinction becomes a major source of complexity. The object-oriented point of view is a way to reduce the complexity of large systems without placing additional overhead on the construction of small systems. ■


ALTOS
PREMIUM VALUE
COMPUTER · SYSTEMS
PRODUCED IN THE HEART OF SILICON VALLEY, CALIFORNIA U.S.A.

BUMPER CROP

8-inch Winchester Multi-User Systems. Now In Volume-$8,500.

Altos is delivering the cream of the crop with their new 8-inch multi-user Winchester disk systems. They're freshly packed with the quality features you expect from Altos, and at a price you expect from Altos, too—just $8,500.

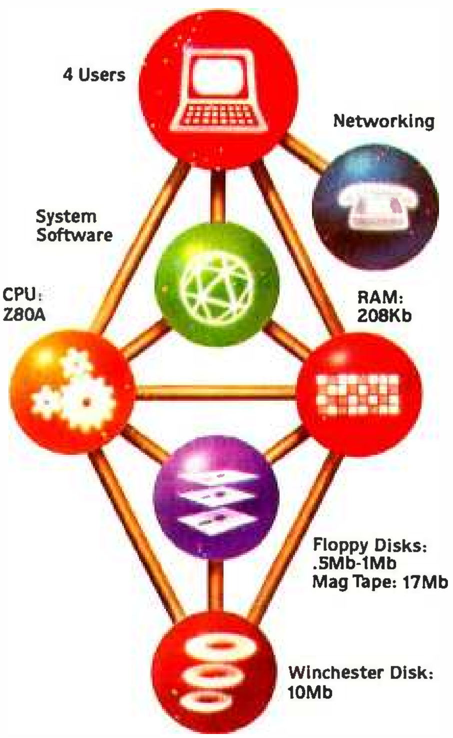
Pick from two fully integrated systems, each packaged in our new compact, stylish cabinet suitable for either rack mount or table top applications. You get 10 MBytes of reliable on-line storage in our 8-inch Winchester drives. Then for system back-up storage, you can select from either 8-inch, single or double-sided floppy drives (ACS8000-10 and -10D) or a ¼-inch magnetic tape drive (ACS8000-10/MTU). And for powerful performance, all of these Z80A*based systems come complete with 208K of RAM and 6 programmable serial ports, ready to support four users.

Here's the most bountiful selection of systems and capacities in the field from the company that knows how to deliver quality systems in the volumes that OEMs need to stay competitive.

And Altos supports these systems with a broad software selection including the three industry standard operating systems—CP/M, multi-user MP/M** and OASIS†. These operating systems support seven high level programming languages: BASIC, FORTRAN, COBOL, PASCAL, APL, PL/1 and C. Also available are comprehensive communications packages: ASYNC—Altos-to-Altos, BISYNC—Altos-to-mainframe and full networking with CP/NET. All are designed to run on a high speed 800 Kilobaud networking channel—standard with every system.

The ACS8000-10 Winchester systems join our growing family of field-proven products. In just three years, more than 8,000 systems have been shipped to an OEM customer-base.

Get to market fast. Harvest your 8-inch Winchester system direct from the heart of Silicon Valley. Call or write today for specific product information and OEM pricing. Altos Computer Systems. 2360 Bering Drive, San Jose, CA 95131, (408) 946-6700, Telex 171562 ALTOS SNJ.



SYSTEMS PICTURED:

ACS8000-10 (10Mb HD + 1 floppy)	$ 8,500
ACS8000-10/MTU (10Mb HD + DEI Mag Tape)	$10,990

Packed with Fresh Ideas

ALTOS COMPUTER SYSTEMS

*Z80A is a registered trademark of Zilog, Inc.
**CP/M and MP/M are registered trademarks of Digital Research, Inc
†OASIS is a registered trademark of Phase One Systems, Inc.
‡datapro is a registered trademark of Datapro Research Corp.

Circle 15 on inquiry card.

The Smalltalk Environment

Larry Tesler
Apple Computer Inc
10260 Bandley Dr
Cupertino CA 95014

As I write this article, I am wearing a T-shirt (photo 1) given to me by a friend. Emblazoned across the chest is the loud plea:

DON'T
MODE
ME IN

Surrounding the caption is a ring of barbed wire that symbolizes the trapped feeling I often experience when my computer is "in a mode."

In small print around the shirt are the names of some modes I have known and deplored since the early 1960s when I came out of the darkness of punched cards into the dawn of interactive terminals. My rogues' gallery of inhuman factors includes command modes like INSERT, REPLACE, DELETE, and SEARCH, as well as that inescapable prompt, "FILE NAME?" The color of the silk screen is, appropriately enough, very blue.

My friend gave me the shirt to make fun of a near-fanatical campaign I have waged for several years, a campaign to eliminate modes from the face of the earth—or at least from the face of my computer's display screen. It started in 1973 when I began work at the Xerox Palo Alto Research Center (PARC) on the design of interactive systems to be used by office workers for document preparation. My observations of secretaries learning to use the text editors of that era soon convinced me that my beloved computers were, in fact, unfriendly monsters, and that their sharpest fangs were the ever-present modes. The most common question asked by new users,

Photo 1: *The "DON'T MODE ME IN" T-shirt.*

at least as often as "How do I do this?," was "How do I get out of this mode?" Other researchers have also condemned the prevalence of modes in interactive systems for novice users (reference 1).

Novices are not the only victims of modes. Experts often type commands used in one mode when they are in another, leading to undesired and distressing consequences. In many systems, typing the letter "D" can have meanings as diverse as "replace the selected character by D," "insert a D before the selected character," or "delete the selected character." How many times have you heard or said, "Oops, I was in the wrong mode"?

Preemption

Even when you remember what mode you are in, you can still fall into a trap. If you are running a data-plotting program, the only commands you can use are the ones provided in that program. You can't use any of the useful capabilities of your computer that the author of the program didn't consider, such as obtaining a list of the files on the disk. On the other hand, if you're using a program that lets you list files, you probably can't use the text editor to change their names. Also, if you are using a text editor, you probably can't plot a graph from the numbers that appear in the document.

If you stop any program and start another, data displayed by the first program is probably erased from the screen and irretrievably lost from view. In general, "running a program" in most systems puts you into a mode where the facilities of other programs are unavailable to you. Dan Swinehart calls this the *dilemma of preemption* (reference 2).

Many systems feature hierarchies of modes. A portion of a typical mode hierarchy is shown in figure 1. If you are in the editor and want to copy text from a file, you issue the *copy-from* command and it gives the prompt "from what file?" You then type a file name. What if you can't remember the spelling? No problem. Leave *from-what-file* mode, leave *copy-from* mode, *save* the edited text, *exit* from the editor to the executive, call up *file management* from the executive, issue the *list-files* command, look for the name you want (Hey, that went by too fast. Sorry, you can't scroll backwards in that mode.), *terminate* the list command, *exit* from file management to the executive, reenter the *editor*, issue the *copy-from* command, and when it prompts you with "from-what-file?," simply type the name (you haven't

TO ORDER CALL (212) 687-5000

The COMPUTER FACTORY®

SUPERBRAIN™

INTERTEC DATA SYSTEMS
64K ONLY
$2995

More than an intelligent terminal, the SuperBrain outperforms many other systems costing three to five times as much. Endowed with a hefty amount of available software (BASIC, FORTRAN, COBOL), the SuperBrain is ready to take on your toughest assignment. You name it! General Ledger, Accounts Receivable, Payroll, Inventory or Word Processing. ..the SuperBrain handles all of them with ease.

FEATURES INCLUDE:
• 2 dual-density minifloppies with 360K bytes of disk storage • A CP/M Disk Operating System with a high-powered text editor, assembler and debugger.

Model QD
720K Bytes disk storage and 64K RAM
$3495

SUPER BRAIN HARD DISKS

10 Megabyte List $4995	16 Fixed-16 Removable
$4495	**$9995**

NEW 96K

80 Column Commodore CBM
Basic 4.0 Operating System

- 80 column by 25 line display
- 12" CRT
- New screen editor
- Split screen processing
- Super fast string handling
- 15 additional basic commands
- Supports relative record processing

Model 8032
32K memory
$1495

NEW! *Model 8096*
$1795

8050 DUAL DISK $1795
1 million bytes on-line storage and DOS 2.0 operating system
NEW 2031 SINGLE DISK $695

Commodore Computer

These low cost Commodore PET Business Computers have virtually unlimited business capabilities. Accounts Receivable, Inventory Records, Payroll, and other accounting functions.

PET 16N & 32N COMPUTERS
- Full size keyboard
- 16 or 32,000 Bytes Memory
- Level III Operating System
- Full Screen Editor
- Upper lower case & 64 graphic characters

$995

PET DUAL FLOPPY DISK
- Stores 360,000 Bytes on-line
- Microprocessor controlled
- Uses single or dual sided floppies

$1295

HI-SPEED PRINTER
- 150 characters per second • Up to 4 copies 8" wide
- Microprocessor Controlled • Prints All Graphics • Full Formatting Capability

$795

apple

NEW CORVUS 5 MEG ONLY $3750

APPLE II PLUS *Call for price*

A complete self-contained computer system with APPLESOFT floating point BASIC in ROM, full ASCII keyboard in a light weight molded carrying case.

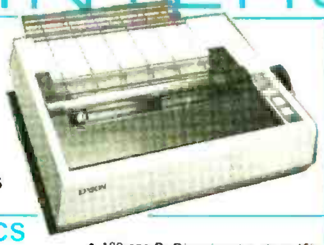
Features Include:
• auto-start ROM • Hi-Res graphics and 15 color video output.
• Expandable to 48K.

Supertalker	$279	Micromodem	$379
Disk	645	Superterm (24 x 80)	395
Add-on Disk	525	Speechlab	229
Pascal Card	495	Communication Card	225
Business Software	625	Modem	200
Monitor	159	Graphics Printer	595
Printer Card	180	Graphics Tablet	795

apple /// IS FINALLY HERE 128K RAM!!

FOR BEST DELIVERY AND SUPPORT SEE IT AT THE COMPUTER FACTORY

PRINTERS



EPSON
MX-70
MX-80
MX-80FT
MX-100FT
Call for Prices

Qume®
NEW SPRINT 9
Only $ 2295
• 45 cps

CENTRONICS
700-9
$1195

• 180 cps Bi-Directional • Up to 15" Paper Width • 9 x 9 Matrix
• Upper/Lower Case
• Tractor Feed
• RS-232
Serial Interface

MONITORS

SANYO 12" GREEN	$325
BMC 12" GREEN	295
LEEDEX 13" COLOR	449
ZENITH 13" COLOR	395
LEEDEX 12" GREEN	179

704
$ 1695
• 60 cps • Up to 15" paper width • Tractor Feed • Parallel Interface for Apple & TRS-80 • 2 channel vertical forms! • Top of Form!
737 Parallel $895

ANDERSON JACOBSON

841 I/O Terminal Ideal for word processing and small businesses.
- ASCII Code
- 15 CPS Printout
- High Quality Selectric Printing
- Reliable heavy duty mechanism
- Completely Refurbished by A.J.
- Delivered FREE to nearest service center

Serial
$895

HAZELTINE ESPIRIT

NEW!

- 24 x 80
- Green Screen
- 7 x 11 Matrix
- Full Format Editing Controls
- Bi-Directional Aux-Port

INCREDIBLY ONLY **$695**

DEALER INQUIRIES INVITED ON DIABLO, CENTRONICS, SUPERBRAIN

DIABLO
630 Special $2495
On Site Warranty List $2755

VISA master charge

Min. Credit Card Order $75
N.Y. residents add 8% sales tax
• Same day shipment on prepaid and credit card orders

NEW STORES
Grand Opening Specials

LONG ISLAND, NY 1301 Franklin Ave., Garden City, Opposite Saks (516) 248-6700
FOREST HILLS, NY 100-17 Queens Blvd. At 67th Road (212) 896-0700
YONKERS, NY 2361 Central Ave., Opposite Caldors (914) 793-1300

TO ORDER CALL (212) 687-5000

Open Mon-Fri. 10-6 Sat. 11-5

The COMPUTER FACTORY®
485 Lexington Ave., New York, NY 10017 (46th St. Lobby)
Foreign order desk — Telex 640055

forgotten it, have you?).

You don't have to be a user-sympathizer to join the campaign against modes. The most coldhearted programmer is a victim as well. Say you have programmed a new video game for your personal computer and have encountered a bug. An obscure error message appears on the screen mixed in with spacecraft and alien forms. To see the latest version of the program on the screen, you have to wipe out the very evidence you need to solve the problem. Why? Because the system forces you to choose between edit mode and execute mode. You can't have both.

Enter the Integrated Environment

Soon after I began battling the mode monster, I became associated with Alan Kay, who had just founded the Learning Research Group (LRG) at the Xerox PARC. Kay shared my disdain for modes and had devised a user-interface paradigm (reference 3) that eliminated one kind of mode, the kind causing the preemption dilemma. The paradigm he advocated was called "overlapping windows."

Most people who have used computer displays are familiar with windows. They are rectangular divisions of the screen, each displaying a different information set. In some windowing systems, you can have several tasks in progress, each represented in a different window, and can switch freely between tasks by switching between windows.

The trouble with most windowing systems is that the windows compete with each other for screen space—if you make one window bigger, another window gets smaller. Kay's idea was to allow the windows to overlap. The screen is portrayed as the surface of a desk, and the windows as overlapping sheets of paper (photo 2). Partly covered sheets peek out from behind sheets that obscure them. With the aid of a pointing device that moves a cursor around the screen, you can move the cursor over a partly covered sheet and press a button on the pointing device to uncover that sheet.

The advantages of the overlapping-window paradigm are:

- the displays associated with several user tasks can be viewed simultaneously
- switching between tasks is done with the press of a button
- no information is lost switching between tasks
- screen space is used economically

Of course, windows are, in a sense, modes in sheep's clothing. They are more friendly than modes because you can't slip into a window unknowingly when you are not looking at the screen, and because you can get in and out of any window at any time you choose by the push of a button.

Kay saw his paradigm as the basis for what he called an "integrated environment." When you have an integrated environment, the distinction between operating system and application fades. Every capability of your personal computer is always available to you to apply to any information you want. With minimal effort, you can move among such diverse activities as debugging programs, editing prose, drawing pictures, playing music, and running simulations. Information generated by one activity can be fed to other activities, either by direct user interaction or under program control.

When Kay invented the Smalltalk language in 1972, he designed it with the ability to support an integrated en-

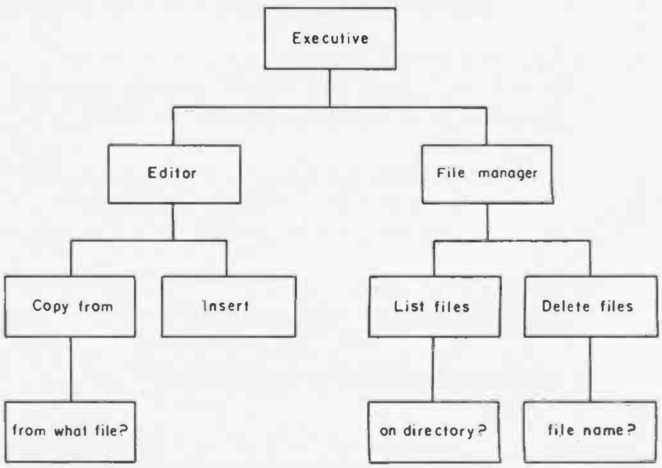


Figure 1: *A portion of a typical mode hierarchy.*

vironment. The implementations of Smalltalk produced by Dan Ingalls and the other members of the Learning Research Group have achieved ever-increasing integration. The file system, process-management system, graphics capability, and compiler are implemented almost entirely in Smalltalk. They are accessible from any program, as well as by direct user interaction.

In recent years, the idea of an integrated environment has spread outside the Learning Research Group and even to non-Smalltalk systems. The window-per-program paradigm is now commonplace, and many system designers have adopted the overlapping-sheet model of the screen.

In summary, the term *environment* is used to refer to everything in a computer that a person can directly access and utilize in a unified and coordinated manner. In an *integrated environment*, a person can interweave activities without losing accumulated information and without giving up capabilities.

Strengths of Smalltalk

Before delving further into the *nature* of the Smalltalk environment, we should first discuss its *purpose*.

Many general-purpose programming languages are more suitable for certain jobs than others. BASIC is easy to learn and is ideal for small dialogue-oriented programs. FORTRAN is well suited to numerical applications. COBOL is tailored to business data processing. Pascal is good for teaching structured programming. LISP is wonderful for processing symbolic information. APL excels at manipulating vectors and matrices. C is great for systems programming. SIMULA shines at discrete simulations. FORTH lets people quickly develop efficient modular programs on very small computers.

All these languages have been used for numerous purposes in addition to those mentioned. You can write almost any program better in a language you know well than in one you know poorly. But if languages are compared from a viewpoint broader than that of a narrow expert, each language stands out above the others when used for the purpose for which it was designed.

Although Smalltalk has been used for many different applications, it excels at a certain style of software development on a certain type of machine. The machine that best matches Smalltalk's strengths is a personal computer with a high-resolution display, a keyboard, and a pointing device such as a *mouse* or graphics tablet (photo 3a). A cursor on the screen tracks mouse movements on the table so you can point to objects on the screen. The mouse (reference 4) has one or more buttons on its top side (photo 3b). One button is used as a *selection button*. If there are more buttons, they are normally used as *menu buttons*.

If the machine has a high-performance disk drive, you can use a virtual-memory version of Smalltalk and have as little as 80 K bytes of main memory, not counting display-refresh memory. Otherwise, you should have at least 256 K bytes of memory. This much memory is required because the whole integrated environment lives in one address space. It includes not only the usual run-time language support, but window-oriented graphics, the

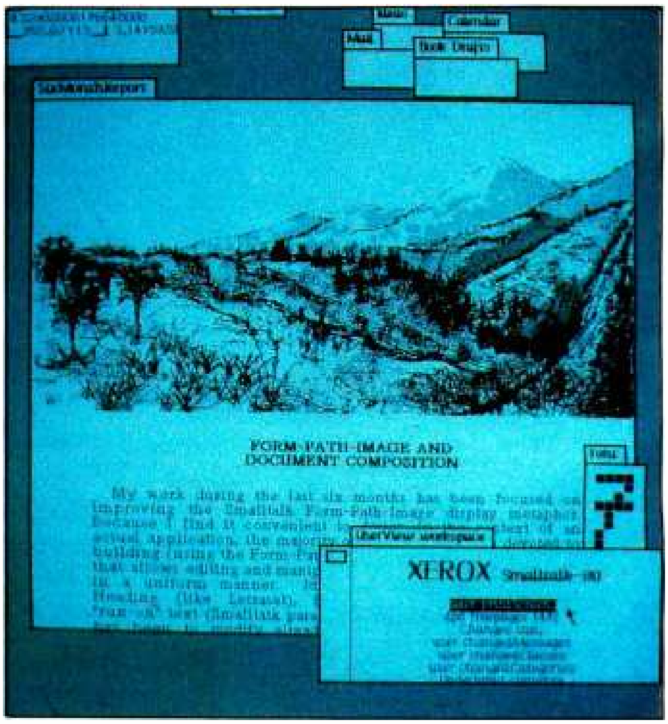


Photo 2: *A typical Smalltalk display. The various "windows" look and behave like overlapping sheets of paper.*

editor, the compiler, and other software-development aids. The programs you write tend to be small because they can build on existing facilities; no system facilities are hidden from the user. Users of LISP and FORTH will be familiar with this idea.

Smalltalk supports its preferred hardware by incorporating software packages that provide:

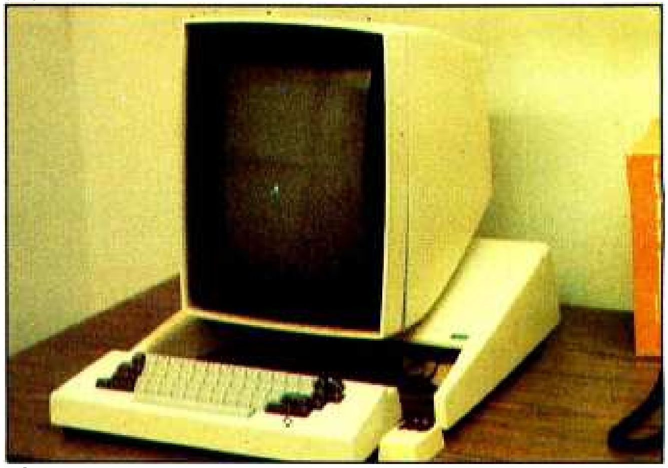
- output to the user through overlapping windows
- input from a keyboard, a pointing device, and menus
- uniform treatment of textual, graphical, symbolic, and numeric information

These interactive facilities are utilized heavily by the built-in programming aids and are available to all user-written applications.

The style of software development to which Smalltalk is oriented is *exploratory*. In exploratory development, it should be fast to create and test prototypes, and it should be easy to change them without costly repercussions. Smalltalk is helpful because:

- The language is more concise than most, so less time is spent at the keyboard.

(3a)



(3b)

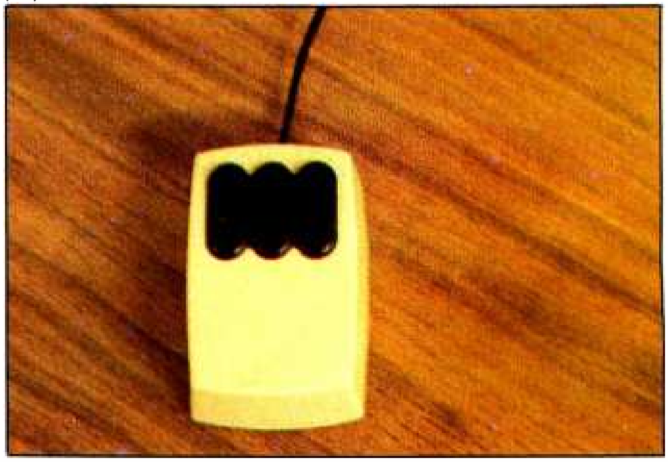


Photo 3: *A typical Smalltalk system (photo 3a) and a close-up of the "mouse" (photo 3b), a device that allows you to move an on-screen cursor and select certain options.*

COMPUTER WAREHOUSE

CALL TOLL FREE 1-800-528-1054

International Dealer & Personal Inquiries Invited, Prices May Vary. Tlx (0) 668382 (MCB)

ATARI

Special 32K 800 System	
800 w/32K. recorder star raiders. joysticks	$860
Above w/48K	$925
800 (32K)	$744
810 Disk Drive	$440
825 Printer	$575
850 Interface	$155
410 Recorder	$70
830 Modem	$140
16K Memory	$ 75
32K Memory	$150

DISK DRIVES

Lobo	
Apple 1st Drive	$490
Apple 2nd Drive	$410

MODEMS

Novation	
CAT	$155
D-CAT	$155
AppleCat II	Call
Auto Cat	Call

VIDEO TERMINALS

Adds	
Viewpoint	Call
Soroc	
IQ 120	Call
IQ 130	Call
IQ 135	Call
IQ 140	Call
Televideo	
912 C	$699
920 C	$749
950	Call
Zenith - Z - 19	Call

PRINTERS

C.Itoh	
Starwriter	$1380
Datasouth	
DS180	$1299
Diablo	Call
Epson	
MX-80	Call
MX-80 F/T	Call
MX-100	Call
Fric.Feed Opt. for MX-80	$ 50
NEC	Call
Okidata	
Microline 80	$399
Microline 82	$515
Microline 83	$755
Qume	Call
Qantex	
Serial	$1198
Parallel	$1160
Texas Instruments	
810 Basic	$1480
810 Loaded	$1739

COMPUTERS

Altos	Call
Northstar	Call
Zenith	
Z-89 48K	Call

SOFTWARE

CBASIC	Call
CP/M	Call
MP/M for NorthStar	Call

DISKETTES

Scotch		
5¼-0, 10, 16 Sector	(Qty 100)	$250
8"-0, 32 Sector	(Qty 100)	$260

MONITORS

Sanyo - 9" Monitor	$165

We Buy and Sell Used Equipment

Experienced Equipment

Diablo, NEC, Qume	Call
Centronics 779	$450
Hazeltine 1420	$600
Atari 820 printer	$250
Soroc IQ 120	$475
TI 810 Basic	$1100

COMPUTER WAREHOUSE

2222 E. Indian School Rd. Phoenix, Arizona 85016
(602) 954-6109 1-800-528-1054
Store Hours: Tues.- Friday 10-5 MST Saturday 10-4 MST

MasterCard VISA

Personal checks will delay shipping two weeks. Prices & availability subject to change without notice

Prices reflect 3% cash discount. Product shipped in factory cartons with manufactures warranty. Add 2%, a minimum of $5, for shipping and handling.

- The text editor is simple, modeless, and requires a minimum of keystrokes.
- The user can move among programming, compiling, testing, and debugging activities with the push of a button.
- Any desired information about the program or its execution is accessible in seconds with minimal effort.
- The compiler can translate and relink a single change into the environment in a few seconds, so the time usually wasted waiting for recompilation after a small program modification is avoided.
- Smalltalk programs grow gracefully. In most environments, a system gets more difficult to change as it grows. If you add 2 megabytes of virtual memory to the Smalltalk environment, you can fill the second megabyte with useful capabilities as fast as you can fill the first.
- The class structure of the language prevents objects from making too many assumptions about the internal behavior of other objects (see David Robson's article, "Object-Oriented Software Systems," on page 74 of this issue). The programmer can augment or change the methods used in one part of a program without having to reprogram other parts.

The Anatomy of a Window

Over the years, members of the Learning Research Group have embellished Kay's original window concept. Let us look at a Smalltalk window in more detail (figure 2).

The window is shown as a *framed* rectangular area with a *title tab* attached to its top edge. The program associated with the window must confine its output to the framed area.

Every window has a *window menu* (photo 4a). The window menu includes commands to reframe the window in a new size and location, to close the window, to print the contents of the window on a hard-copy device, and to retrieve windows hidden under it.

A window is tiled by one or more *panes*, each with its own *pane menu* (photo 4b). The pane menu includes commands appropriate to the contents of that pane. In

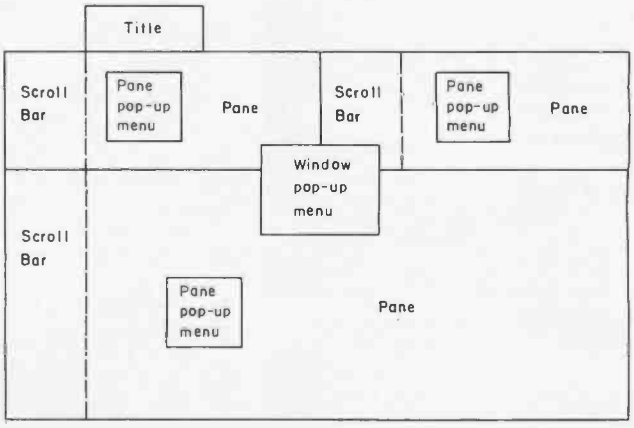


Figure 2: *Anatomy of a window.*

MDBS...
true data base management for small systems!

Harvey M. Weiss, an independent software reviewer, has this to say about our system:

"MDBS is truly a data base management system..., not a file management system."

"MDBS... offers the data manipulation, query, and report-writer capabilities of a DBMS found on much larger and more complex computer systems."

"MDBS has come to the rescue with...products whose ability to reduce development time and implement processes not available elsewhere make them invaluable to integrators and developers of μc-based systems."

For the complete Weiss review, see "Downscaling DBMS to the Microworld," *Mini-Micro Systems*, April, 1981, pp. 187-195.

Check these advanced features for yourself:

Flexible, powerful data structuring capabilities: network and hierarchical data structures, including many-to-many relationships (not available elsewhere).

Genuine data base management capabilities: far surpasses file management in data independence, automatic maintenance of relationships, and complete lack of data redundancy.

English-like, nonprocedural query language interface: ad hoc queries result in the automatic generation of desired reports, tables, files, and relations.

Host language interfaces, including various BASICS, COBOLS, PASCALS, FORTRAN, PL/I, C, and several assemblers.

Extensive built-in data access security (256 levels).

Automatic transaction logging and data base recovery.

Dynamic data base restructuring.

Plus many other advanced data base management features.

Is MDBS right for your system?

MDBS is written in Z-80, 6502, 8080 and 8086 machine language and run under CP/M (and similar derivatives) with CBASIC2, PL/1, PASCAL Z, PASCAL M, PASCAL MT+, BDS C, CIS COBOL, and Microsoft COBOL, FORTRAN, or BASIC; under North Star DOS and North Star BASIC; under TRSDOS or NEWDOS with TRS DISK BASIC; with Apple DOS and Applesoft BASIC; and with 86-DOS.

MDBS requires only 18K to 20K bytes for the Z-80 version, 22K for the 8080, and 30K for the 6502.

MDBS is independent of the types and sizes of disk drives.

To learn more

- For free literature about serious data base management on a microcomputer, please fill out and mail the coupon.
- For a practical introduction to true data base management for small computers, please send $20 (Indiana residents, add 80¢ tax) for PRIMER/GUIDE manuals.
- For a comprehensive DOCUMENTATION PACKAGE consisting of THE PRIMER plus user manuals covering the MDBS, QRS, RTL, and DRS, please forward $60 (+ $2.40 Ind. tax).

Setting standards of excellence for data base software...worldwide.

Micro Data Base Systems, inc.
Box 248
Lafayette, Indiana 47902
317-448-1616/TWX 810-342-1881

Dealer/distributor/OEM inquiries invited.

YES, please send me more information on the remarkably flexible MDBS Data Base System.

Name ______________ Title ______
(Please print)

Company ______________

Address ______________

City ______________ (State) ______ (Zip) ______

Phone ______________

MAIL TO: Micro Data Base Systems, Inc.
P.O. Box 248-Y
Lafayette, IN 47902

Circle 225 on inquiry card.

addition, a pane has a *scroll bar* on its left side used to scroll the contents of the pane when more information exists than fits in the frame at one time.

Although you can see many windows and panes at once, you can interact with only one pane at a time. That pane and its window are said to be awake or *active*. To awaken a different pane of the same window, move the cursor over the new pane (photo 4c). To awaken a different window, move the cursor over the new window and press the *selection button* on the pointing device (photo 4d). When a window wakes up, its title tab and all its panes are displayed, and it is no longer covered up by other windows.

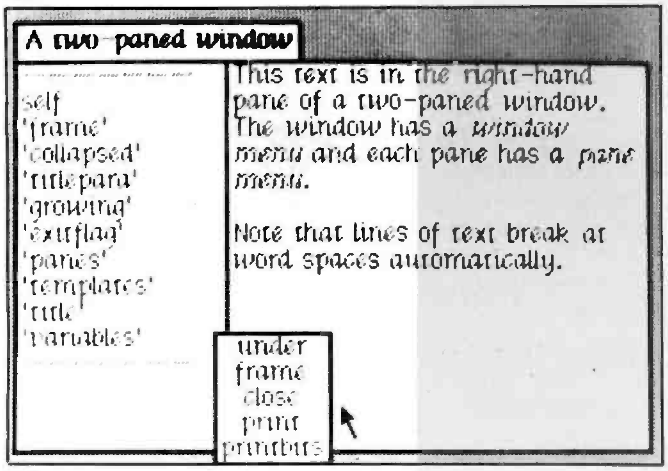
The scroll bar of the active pane is called the *active scroll bar*. Its menu and the menu of its window are called the *active menus*. In order to reduce screen clutter and maximize utilization of precious screen space, no inactive scroll bars or menus are displayed. On machines that use a pointing device with three buttons, some versions of Smalltalk even hide the active menus until one of two *menu buttons* is pressed, at which time the associated menu *pops up* and stays up until the button is released. If the button is released when the cursor is over a command in the menu, that command is executed (photo 4e).

Modeless Editing

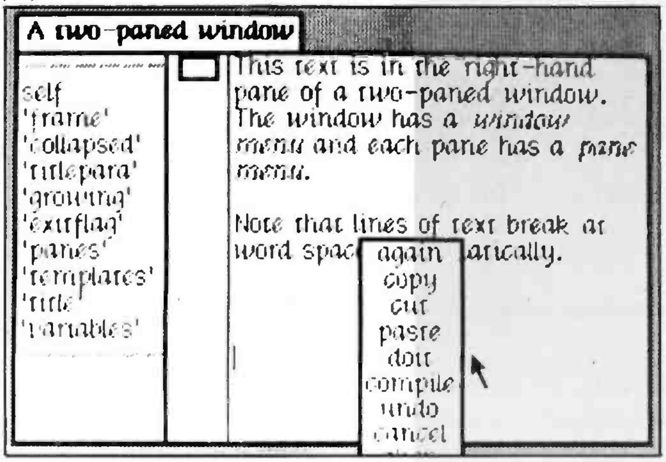
The overlapping-window paradigm helps eliminate preemption. It can also reduce the need for certain prompts and their associated modes. For example, you never have to type the name of a procedure you want to examine. At worst, you point to its name in a list; at best, the desired procedure is already in a window on the screen, and you activate that window.

Unfortunately, overlapping windows do not eliminate command modes like "insert" and "replace" by themselves. Between 1973 and 1975, I worked at PARC with various collaborators, including Dan Swinehart and Timothy Mott, to banish command modes from interac-

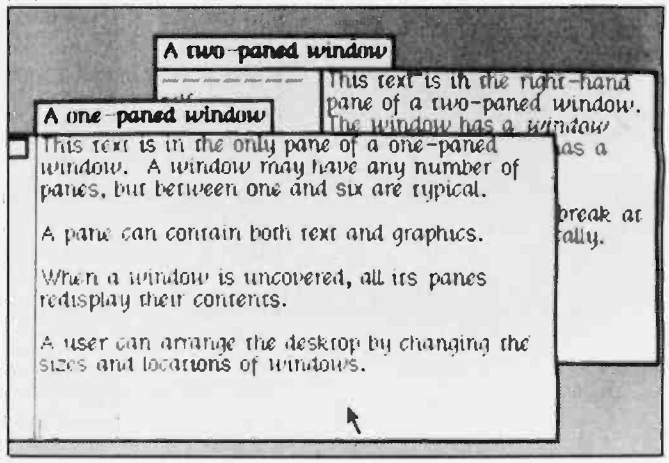
(4a)



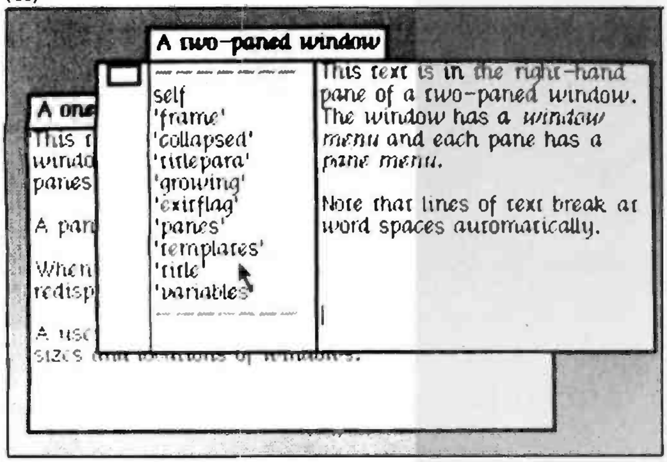
(4b)



(4d)



(4c)



(4e)

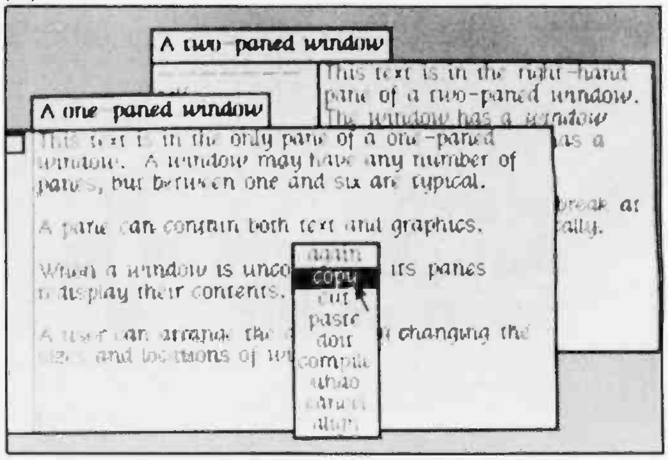


Photo 4: *Windows and their behavior.*

Circle 165 on inquiry card. →

54 dB. Put up or shut up.

The Gauntlet Is Down

Can any dot matrix computer printer match the INFOSCRIBE 1000? Its sound level in normal, continuous operation is only 54 dBA. By independent sound laboratory test.*

That's right, 54 dBA. Like a group office where paper shuffling and throat clearing are making most of the noise.

As far as we're concerned, INFOSCRIBE 1000 is the quietest serial matrix impact printer on the market.

Compare with the typical matrix printer that can sound like a blender full of ball bearings, and you have the Number One reason why your next printer will be an INFOSCRIBE 1000

Even printers advertised at 56dB are a **full 2 dB higher** than ours. (Remember, every 3 dB up doubles the noise.)

A New Generation Printer

If INFOSCRIBE 1000's purr were its only benefit, you should still buy it for the sanity of your office staff. But it happens that INFOSCRIBE 1000 is also the most feature-packed, the most beautiful, and the most economical printer in its class.

Graphics Galore

INFOSCRIBE 1000 doesn't print characters only. Under software control it produces charts, diagrams, graphs, signs, anything within a vertical and horizontal resolution of 70 dots per inch. Now we're talking about a capability that can enhance management presentations, sales reports, even technical documents.

Format Flexibility

INFOSCRIBE 1000 can produce data processing quality characters at 10, 12, or 16.5 characters per inch, or correspondence quality characters at 10. You also get subscripts and superscripts in any selected pitch, double-wide printing, true lower case descenders, and true underlining.

In addition to two different character sets stored in the printer, a third character set can be downloaded from the host computer. This offers a total of 288 different characters that can be selected on a character-by-character basis.

Gratifying Throughput

There's more to INFOSCRIBE 1000's speed than a nominal 180 characters per second. High-speed paper movement with vertical and horizontal tabbing, plus bidirectional printing with logic seeking in both directions gets a lot of work out of the machine. And that's equivalent to having a faster computer.

Unmatched Elegance

It's almost unfair that INFOSCRIBE 1000 is also the industry's best looking matrix printer. Slim, sleek, graceful, it makes those machines with the visible viscera look like remnants of early experimental days at Menlo Park. INFOSCRIBE 1000 is completely enclosed, sealing dirt out while sealing noise in. Its controls use membrane switches, so not even knobs or buttons break its sculptured exterior.

Demand the INFOSCRIBE 1000

Is there a single reason why you should have any printer but the INFOSCRIBE 1000? At $1,825 in singletons (substantially less in OEM quantities), INFOSCRIBE 1000 becomes mandatory for your system.

Insist on it from your system specialists. And if you are buying a first-time computer, no matter what make, ask for the printer that is setting a new standard: INFOSCRIBE 1000.

Get full details from your nearest Infoscribe distributor/representative. Or talk to your computer dealer. If he doesn't handle Infoscribe yet, he will.

**Contact Infoscribe for an abstract of the independent testing laboratory report.*

INFOSCRIBE™

QUIETLY AUTHORITATIVE

Corporate Headquarters and Factory: Infoscribe, Inc., 2720 S. Croddy Way, Santa Ana, California 92704. Distributor/Representatives: CA, HI (714) 964-4722 or (415) 948-8961; CO, UT, WY (303) 371-4140 or (801) 292-8145; WA, OR, MT, IO, AK (206) 455-4922; IA, IL, IN, WI (312) 298-4830 or (414) 351-6123; TX, OK, AR, LA (214) 661-9633, (713) 681-0200, (918) 252-9646 or (512) 454-3579; MA, VT, ME, CT, RI, NH (617) 729-5770, (413) 737-6624 or (203) 624-7800; MN, ND, SD (612) 922-7011; DC, VA, MD (301) 424-1416; NY (315) 699-2651, (716) 223-4490; France 334-30-20; United Kingdom (063-33) 69162; Australia (61-2) 29-3753.

Overseas Distributor Inquiries Welcome

tive systems. Despite initial skepticism, nearly all users of our prototypes grew to appreciate the absence of modes. The following techniques were devised by us to eliminate modes from text editing. They are analogous to the techniques used to keep Polish-notation calculators relatively mode-free. Similar techniques can be applied to page layout, graphics creation, and other interactive tasks.

Selection precedes command:

- Every command is executed immediately when you issue it. You are not asked to confirm it. You can issue an *undo* command to reverse the effects of the last issued command. Although the main purpose of "undo" is to compensate for the lack of command confirmation, it can also be used to change your mind after issuing a command.
- For a command like "close the active window" that requires no additional parameters, you simply issue the command.
- For a command like "delete text" that requires one parameter, you first select the parameter using the pointing device and then issue the command. Until you issue the command, you can change your mind and make a different selection, or even choose a different command.
- For a command like "send electronic mail" that requires several parameters (recipient, subject, content), you first fill the parameters into a form using modeless text editing and then issue the command. You are not in a mode while filling out the form. If you want to copy something into the form from another place, you can. If you want to do something else instead, just do it; you may even return to the form later and finish filling it out.

Typing text always replaces the selected characters:

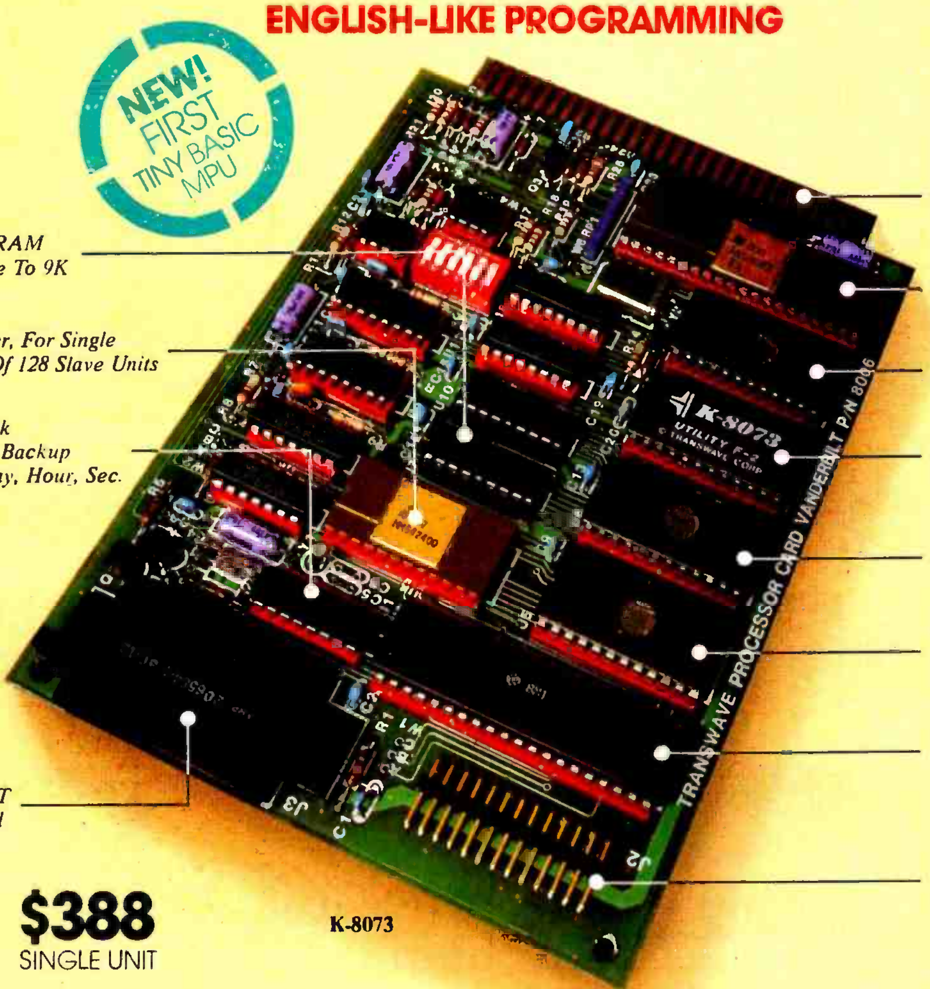
- Pressing a text key on the keyboard never issues a command. It always replaces the current selection by the typed character and automatically selects the gap following that character.
- To replace a passage of text, first select it (photo 5a) and then type the replacement. The first keystroke deletes the original text (photo 5b).
- To insert between characters, you first select the gap between those characters (photo 6a) and then type the insertion (photo 6b). Essentially, you are replacing nothing with something.
- The destructive backspace function always deletes the character preceding the selection, even if that character was there before the selection was made.
- The "undo" command (photos 6c and 6d) can be used to reverse the effects of all your typing and backspacing since you last made a selection with the pointing device.

Thus, the usual insert, append, and replace modes are folded into one mode—replace mode—and one mode is no mode at all.

Tiny BASIC MICROCOMPUTER K-8073

The Engineer's Product Development Board Level Computer

LOW COST
POWERFUL/VERSATILE
ENGLISH-LIKE PROGRAMMING



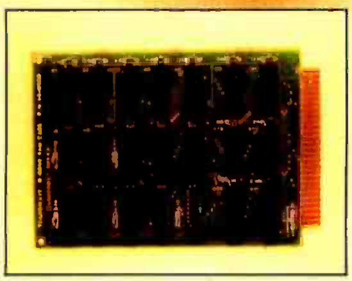
$388
SINGLE UNIT

K-8073

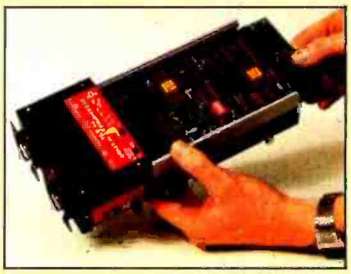
THIS IS AN ENGINEER'S COMPUTER. Simply attach a CRT, connect 5 volts, and you have yourself one each powerful, versatile microcomputer that YOU can program.

If you're fed-up with board level computers that require expensive development systems plus the skills of an Assembly language programmer, then you need the K-8073. With an on-chip microinterpreter and the extra control devices we designed into the board, you can do your own programming in the most simple English-like language available—Tiny BASIC. Sophisticated application designs can be implemented in hours instead of days or weeks because you have eliminated expensive and time consuming hardware and software costs.

IN ADDITION TO ALL THIS, the K-8073 offers advantages unheard of in other board level computers. Among these are an on-board EPROM Programmer, A Real Time Clock, Autostart, 1K Byte local RAM for variables, 8K Byte EPROM, ART/RC and PPI W/24 line I/0.



8K Byte RAM $232.00



Development Station $195.00

THE K-8073 IS FOR OEM'S AS WELL AS END USERS.
Whether you manufacture Industrial Process Control, Environmental or Test/Measurement systems, or simply for your own use, you can count on top quality performance. The K-8073 comes complete with all socketed devices including the powerful F-2 Utilities Firmware and a Hardware/Software manual.

In Industry, Education, or New Product Development, the K-8073 provides you with State-of-the-Art technology for microprocessor efficiency and ease. With a full line of support products, the TransWave line takes care of your every need at the most reasonable prices.

To order your K-8073 or for further information, write or call TRANSWAVE CORPORATION, Cedar Valley Building, Vanderbilt, PA 15486, **(412) 628-6370.**

TRANSWAVE
COMPUTER DIVISION OF UTSC

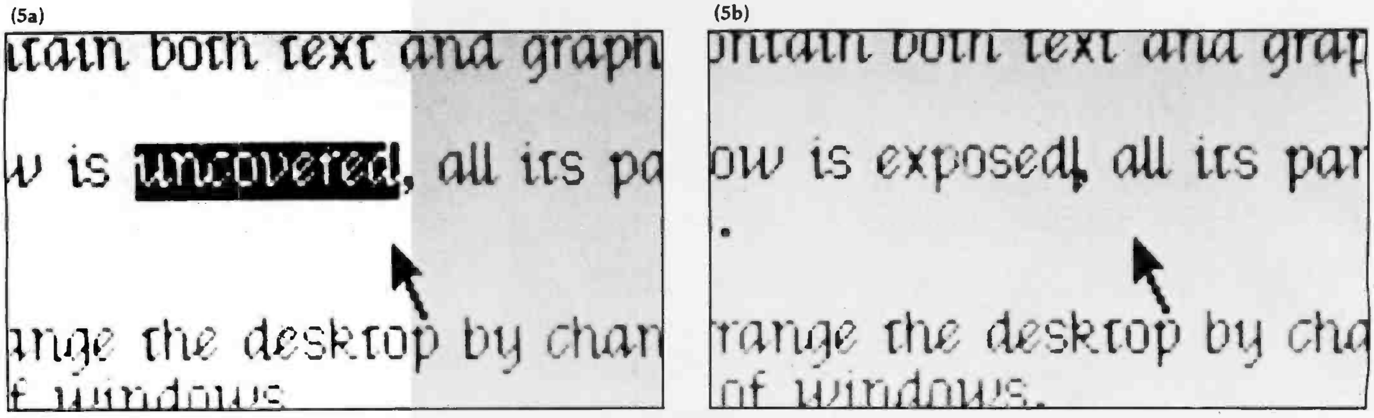


Photo 5: *Replacing text in Smalltalk.*

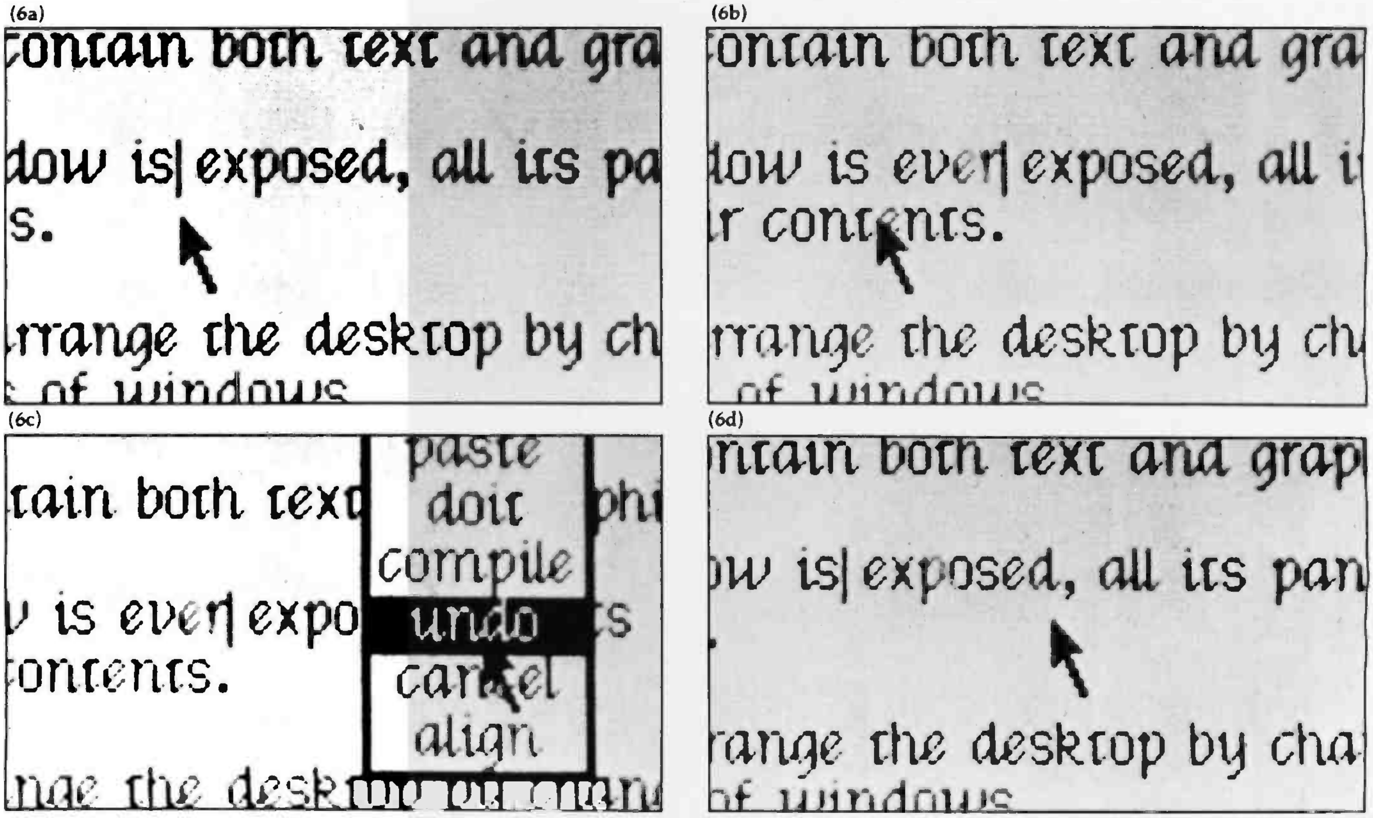


Photo 6: *Inserting text in Smalltalk.*

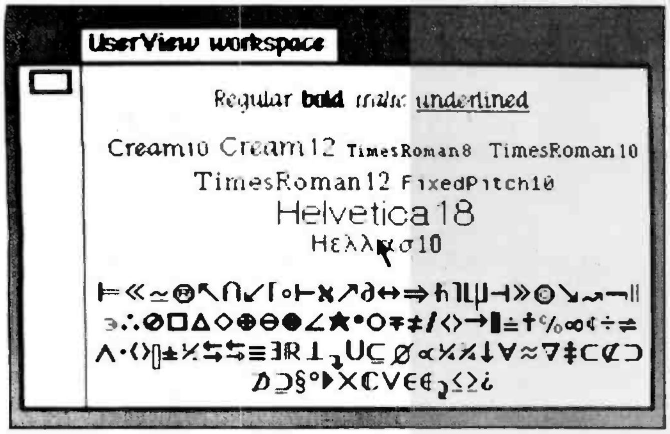


Photo 7: *Multiple typefaces can be used in any window.*

The "shift lock" key and analogous commands like "bold shift" and "underline shift" cause modes for the interpretation of subsequently typed characters. However, shifts are familiar to people and are relatively harmless. The worst they do is change a "d" to a "D," "**d**," or "<u>d</u>"—never to a Delete command.

The bit-map display can show boldface characters, as well as italics, underlining, and a variety of styles and sizes of printer's type (photo 7). Thus, as you enter text in bold shift, the screen shows what the text will look like when it is printed. A command like bold shift can also be applied to existing text to change it to boldface.

In 1976, Dan Ingalls devised a user interface for Smalltalk that incorporated most of the mode-avoidance techniques discussed earlier. Consequently, it is rare in

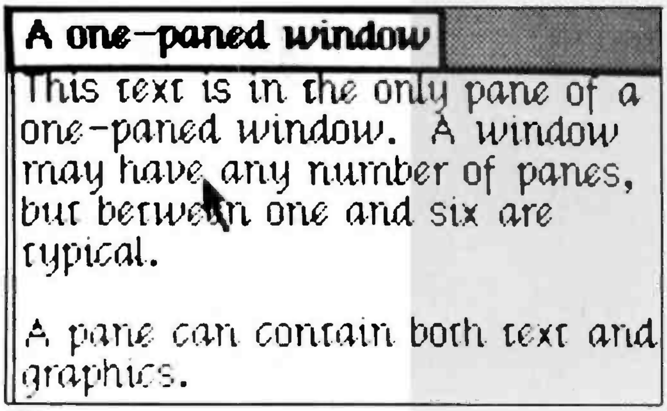
the present Smalltalk environment to encounter a mode.

Making a Selection

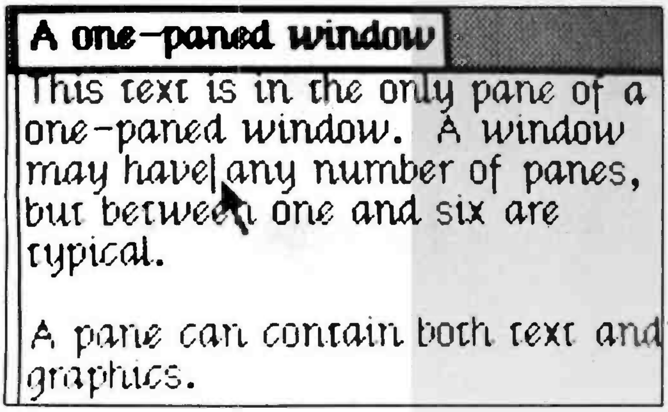
In the Smalltalk-76 user interface, text is selected using the pointing device and a single button. First, the cursor is moved to one end of the passage to be selected (photo 8a). The selection button is pressed and held down while the cursor is moved to the other end of the passage. This operation is called "draw-through," though it is not necessary to traverse intermediate characters en route to the destination. When the cursor reaches the other end of the passage, the button is released. The selected passage is then shown in inverse video (photo 8d).

The feedback given to the user during selection is as follows. When the button is depressed, a vertical bar appears in the nearest intercharacter gap (photo 8b). (At the

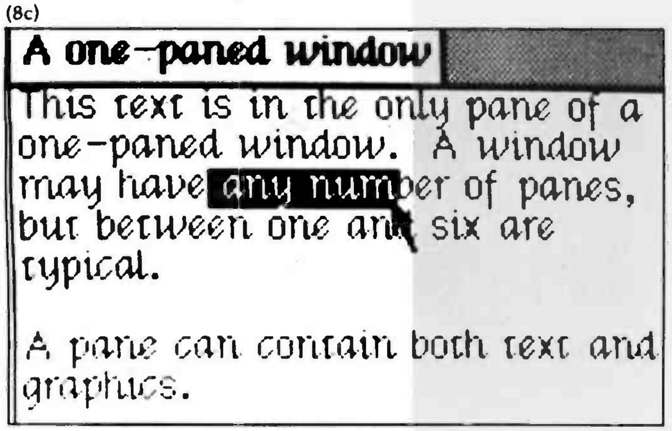
(8a)



(8b)



(8c)



left end of a line of text, the bar appears to the left of the first character. At the right end of a line, the bar appears to the left of the final space character.)

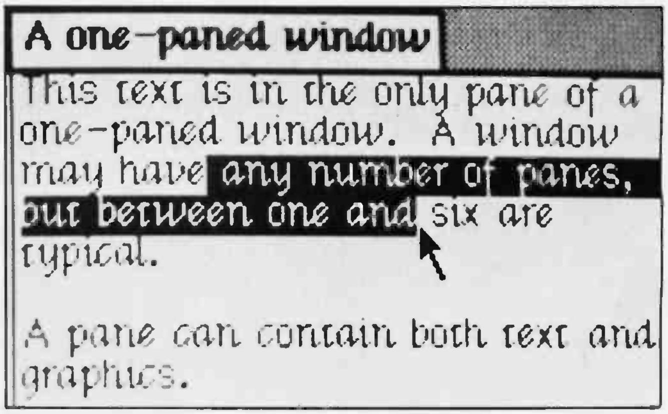
If the button is released without moving the cursor, the bar remains, indicating that a zero-width selection has been made. This method—clicking once between characters—is the one to use before you insert new text.

If the button is held down while the cursor is moved, the system supplies continuous feedback by highlighting in inverse video all characters between the initial bar and the gap nearest to the cursor (photo 8c). When the button is released, the selected characters remain highlighted (photo 8d). This method—drawing through a passage—is the one to use before you copy, move, delete, or replace text, or before you change it to boldface or otherwise alter its appearance.

Clicking the button twice with the cursor in the same spot within a word selects that whole word and highlights it (photo 8e). This special mechanism is provided because it is very common to select a word. Informal experiments lead us to believe that double clicking is much easier than drawing through a word for beginners and experts alike. It is also faster. It takes the average user about 2.6 seconds to select a word anywhere on the screen using draw-through, but it takes only 1.5 seconds using the double click (reference 5).

There is only one selection in the active pane. It is called the *active selection*.

(8d)



(8e)

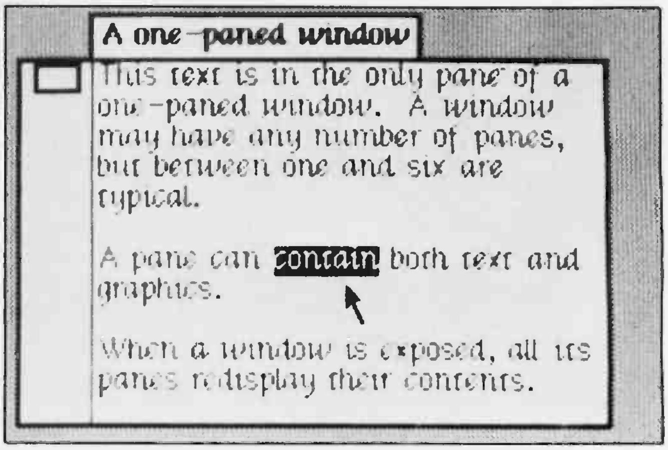


Photo 8: *Selecting text using the mouse and the cursor.*

OMNI

THE NEW

FLIP/FLOPPY™ DISK

with twice the byte

OMNI is pleased to bring you a **reversible** 5¼" mini diskette...the FLIP/FLOPPY DISK. Now you can record on both sides for twice the storage capacity of a single sided disk. And you'll be able to do it far more economically, too!

Each OMNI FLIP/FLOPPY DISK incorporates all of the quality features you'd expect from the very best single sided disk.

- Two recording surfaces
- Two sets of WRITE ENABLE notches
- Two index holes
- Reinforced Hub Rings
- Certified error-free operation at more than twice the error threshold of disk drives
- Over 12 million rated passes without disk related errors or significant wear, for extra long life operation
- Compatible with most 5¼" disk drives including APPLE, TRS-80, PET, OHIO SCIENTIFIC, and many more.

OMNI Resources
4 Oak Pond Avenue • Millbury, MA 01527 • 617-799-0197

Call TOLL-FREE: **In Mass. 1-800-252-8770**
Nationwide 1-800-343-7620

INTRODUCTORY OFFER

Order the OMNI FLIP/FLOPPY DISK at this special introductory price:

Five Pack...$21.00
Equivalent to ten single-sided disks.

Ten Pack....$40.00
Equivalent to twenty single-sided disks.

OFFER EXPIRES OCTOBER 15, 1981

Please send me the following OMNI FLIP/FLOPPY DISK(s)

________ Five Packs(s) @ $21.00 each =	$	________
________ Ten Pack(s) @ $40.00 each =	$	________
Shipping and handling	$	1.50
Massachusetts residents add 5% sales tax	$	________
TOTAL	$	________

☐ Check made payable to OMNI RESOURCES ☐ C.O.D.
☐ Mastercard
Account Number _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
☐ VISA/BankAmericard
Account Number _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _
Credit Card Expiration Date _ _ / _ _

Name ________________
Address ________________
City ________________
State ________________ Zip ________
Phone Number ( ) ________________
Authorized Signature ________________

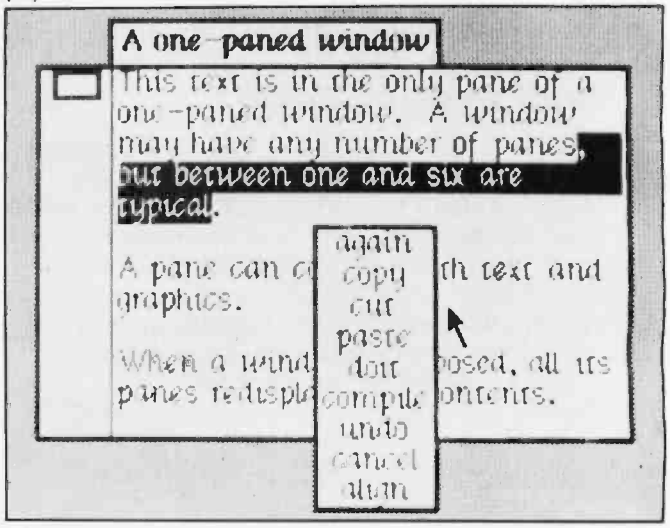
(Please allow approximately three weeks for delivery)
Money back guarantee if not completely satisfied

Circle 279 on inquiry card.

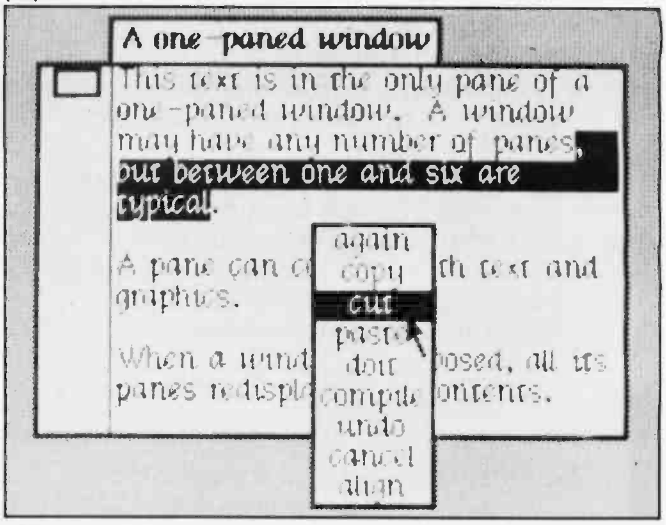
Issuing a Command

When you issue a command in Smalltalk, you are sending a message to an object. There are two ways to send a message from Ingalls's user interface. You can send certain commonly sent messages to the active pane or window by choosing them from menus; you can send any message to any object by direct execution of a Smalltalk statement.

(9a)



(9b)



(9c)

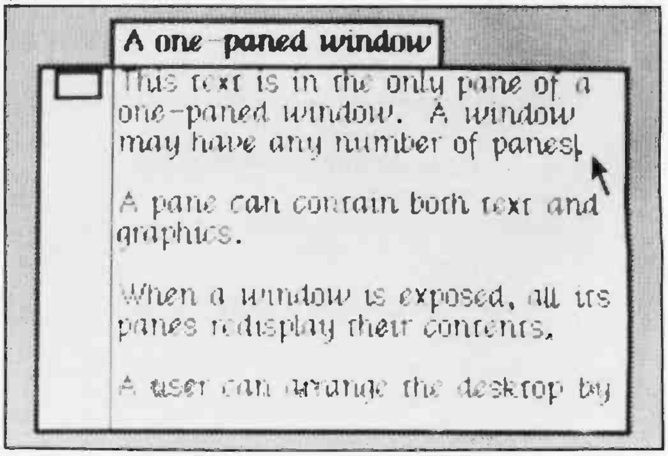


Photo 9: *"Cutting" text in Smalltalk.*

Turn your Apple into the world's most versatile personal computer.

The SoftCard™ Solution. SoftCard turns your Apple into two computers. A Z-80 and a 6502. By adding a Z-80 microprocessor and CP/M to your Apple, SoftCard turns your Apple into a CP/M based machine. That means you can access the single largest body of microcomputer software in existence. Two computers in one. And, the advantages of both.

Plug and go. The SoftCard system starts with a Z-80 based circuit card. Just plug it into any slot (except 0) of your Apple. No modifications required. SoftCard supports most of your Apple peripherals, and, in 6502-mode, your Apple is still your Apple.

CP/M for your Apple. You get CP/M on disk with the SoftCard package. It's a powerful and simple-to-use operating system. It supports more software than any other microcomputer operating system. And that's the key to the versatility of the SoftCard/Apple.

BASIC included. A powerful tool, BASIC-80 is included in the SoftCard package. Running under CP/M, ANSI Standard BASIC-80 is the most powerful microcomputer BASIC available. It includes extensive disk I/O statements, error trapping, integer variables, 16-digit precision, extensive EDIT commands and string functions, high and low-res Apple graphics, PRINT USING, CHAIN and COMMON, plus many additional commands. And, it's a BASIC you can compile with Microsoft's BASIC Compiler.

More languages. With SoftCard and CP/M, you can add Microsoft's ANSI Standard COBOL, and FORTRAN, or Basic Compiler and Assembly Language Development System. All, more powerful tools for your Apple.

Seeing is believing. See the SoftCard in operation at your Microsoft or Apple dealer. We think you'll agree that the SoftCard turns your Apple into the world's most versatile personal computer.

Complete information? It's at your dealer's now. Or, we'll send it to you and include a dealer list. Write us. Call us. Or, circle the reader service card number below.

SoftCard is a trademark of Microsoft. Apple II and Apple II Plus are registered trademarks of Apple Computer. Z-80 is a registered trademark of Zilog, Inc. CP/M is a registered trademark of Digital Research, Inc.

MICROSOFT
CONSUMER PRODUCTS

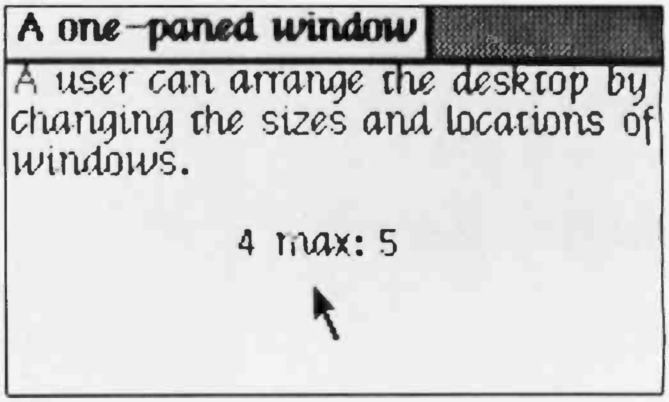
Microsoft Consumer Products, 400 108th Ave. N.E., Bellevue, WA 98004. (206) 454-1315

Circle 240 on inquiry card.

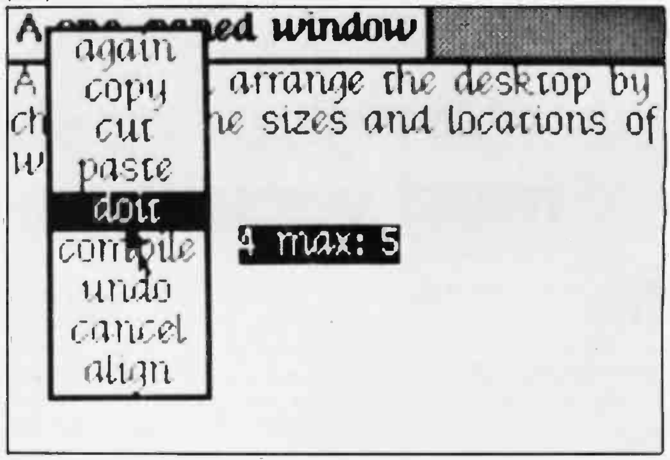
Smalltalk-76 provides pop-up menus for the most commonly used commands, like "cut," which deletes the selected text. To issue the "cut" command, you pop up the active-pane menu with one of the menu buttons on the mouse (photo 9a), keep that button down while moving the cursor to the command name (photo 9b), and then release the button (photo 9c). A command in the pane menu can have only one parameter, the active selection. A command in the window menu can have no parameters.

To issue a command that is not available in a menu, you select any place you can insert text, and type the whole command as a statement in the Smalltalk language (photo 10a). Then you select that statement and issue the

(10a)



(10b)



(10c)

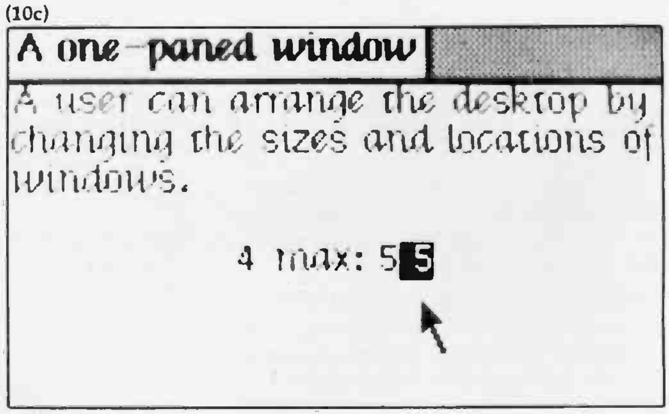
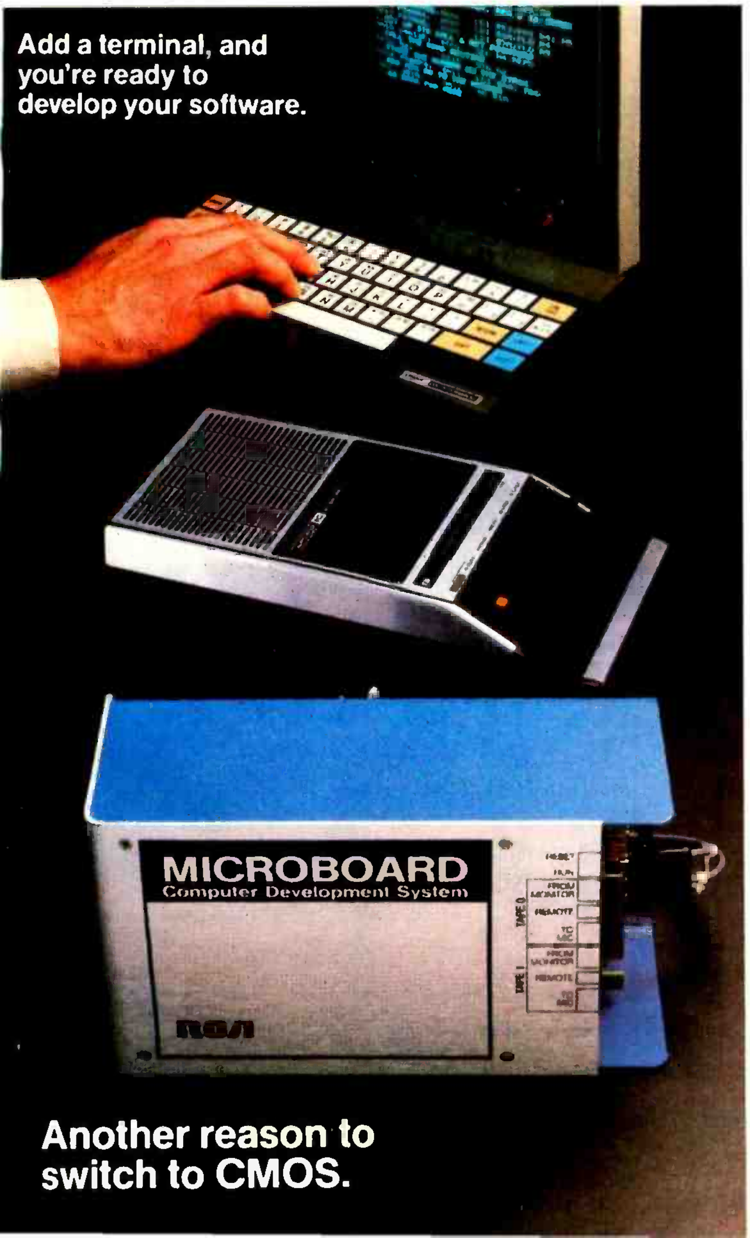
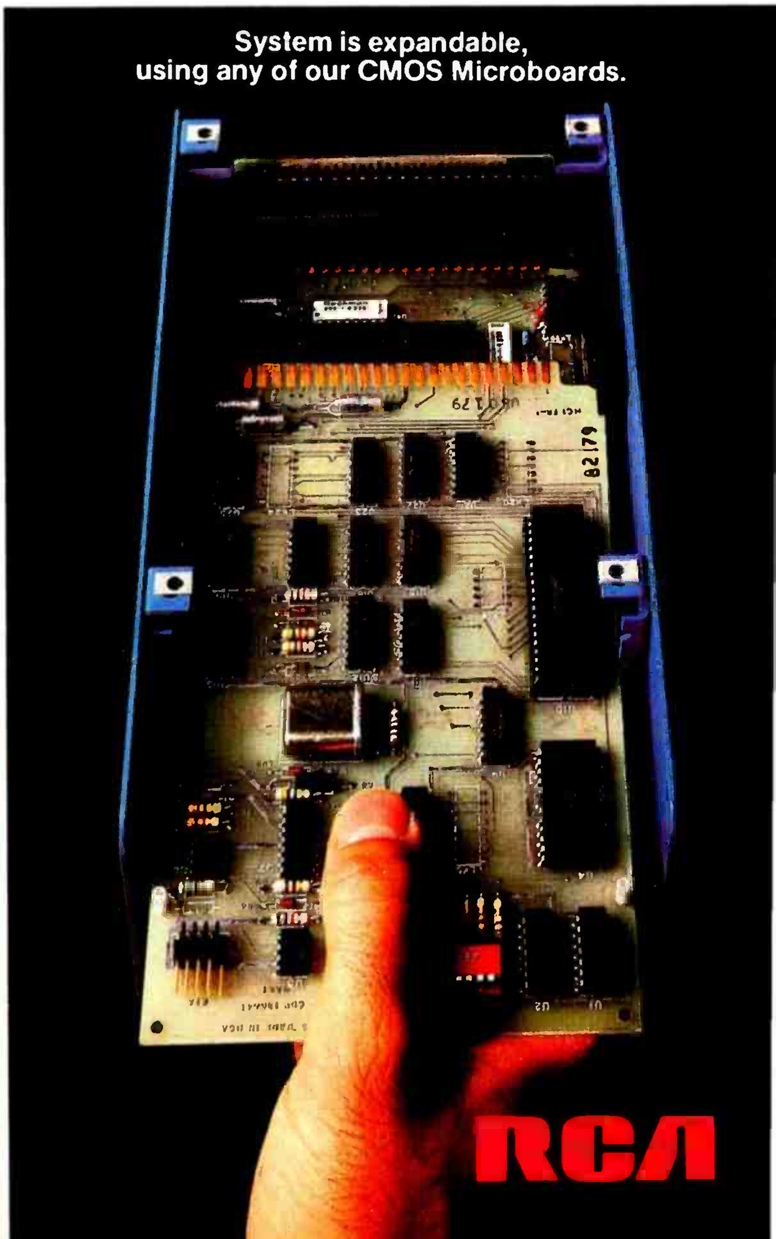


Photo 10: *Executing text using the "doit" message.*



Add a terminal, and you're ready to develop your software.
MICROBOARD
Computer Development System
RCA
Another reason to switch to CMOS.



System is expandable, using any of our CMOS Microboards.
RCA

single-parameter command "do it" (photo 10b) to obtain the result (photo 10c). The "do it" command provides immediate execution of any Smalltalk statement or group of statements. This method of command issuance uses the previous method: you are sending the message *doit* to the pane, with the Smalltalk statement as its parameter.

It is standard practice to keep a "work-space" window around the screen in which to type your nonmenu commands. When you want to reissue a nonmenu command issued earlier, simply select the command in the work-space window and "do it." You may, of course, edit some of the parameters of the old command before you select it and "do it." In a sense, you are filling out a form when you edit parameters of an immediate statement.

Unfortunately, the common commands "move text from here to there" and "copy text from here to there" cannot be issued by a single menu command because they require two parameters, the source selection and the destination selection. Sometimes, they even involve messages to more than one pane, the source pane and the destination pane. In a modeless system, a move or copy command is done in two steps:

• A move is done by *cut and paste*. First, you select the source text and issue the "cut" command (photo 11a). The "cut" command deletes the selected text (photo 11b), but leaves it in a special place where it can be retrieved by "paste." Then you select the destination and issue the "paste" command (photo 11c) to complete the move (photo 11d).

• A copy is done by *copy and paste*, which is completely analogous to cut and paste, but does not delete the original text.

Remember the "copy-from-file" example (the one where you had to go in and out of many layers of modes)? In the Smalltalk-76 user interface, you can accomplish this with six pushed buttons, no mode exits, and no typing: (1) activate the source window that displays the file you are copying from; (2) select the desired text; (3) issue the "copy" command in the menu; (4) activate the destination window; (5) select the destination point, and (6) issue the "paste" command in the menu. The job requires little more effort than copying within the same document. If the window is not already

(11a) (11b) (11c) (11d)

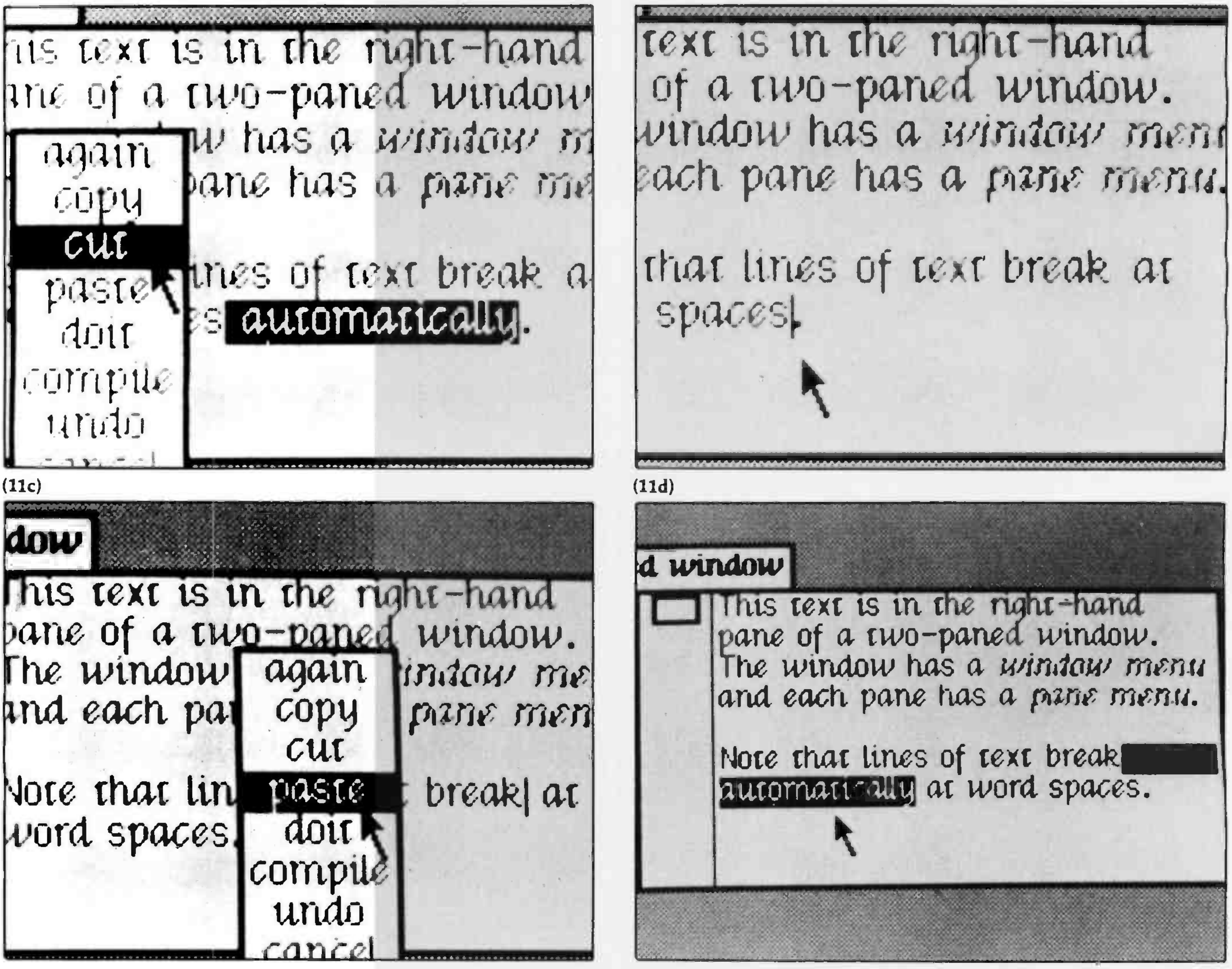
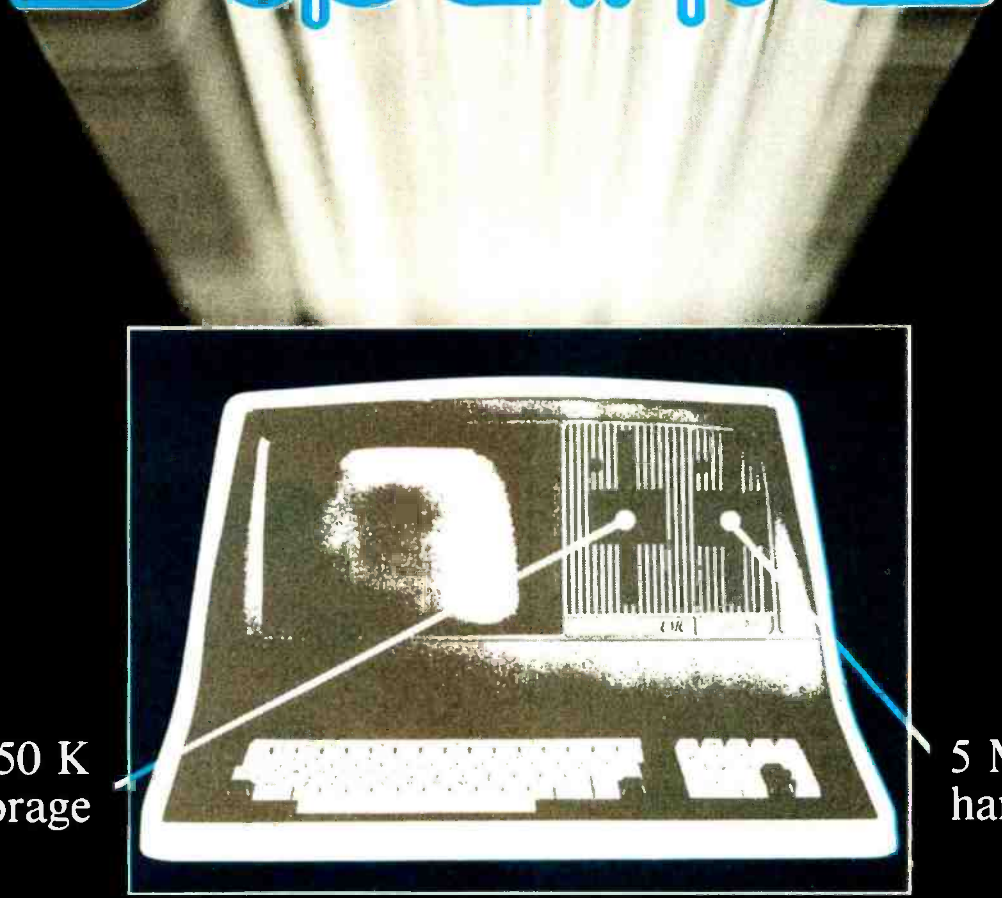


Photo 11: *Moving text in Smalltalk.*

The perfect marriage of Superbrain™ and Winchester.™

SUPERFIVE™



Finally, a price-performance breakthrough for mass storage in a one-piece, handsomely styled desk-top computer.

SUPERFIVE™

A product of CMC International

- 5¼" Micro-Winchester™ 5 Mbyte (formatted) hard disk
- 700K or 350K floppy disk back up
- Dual Z-80 processors with 64K RAM
- Dual RS232 ports
- Complete and ready to run with CP/M™ 2.2
- Also available 10 Mbyte hard disk, 5 MB removable
- 10 Mbyte hard disk SuperTen™

DEALER & OEM INQUIRIES INVITED
Telephone (206) 453-9777

CMC INTERNATIONAL

A Division of Computer Marketing Corporation
11058 Main, Suite 125, Bellevue, WA 98004

Circle 56 on inquiry card.

on the screen and you can't remember the file name, you can go to another window and scroll through a list of files without having to exit any modes, invoke any programs, save any edits, lose sight of the destination file, or lose any time.

The Smalltalk-76 text-editing facilities not only relieve you of the burden of modes, they also require very few keystrokes and are easy to learn.

Software-Development Aids

One of my summer projects in 1977 was to increase the speed and friendliness of the Smalltalk software-development environment by adding *inspect windows*, *browse windows*, and *notify windows* to the user interface. These and other enhancements made by the Learning Research Group are described below. In recent months, the team has further enhanced the Smalltalk-80 environment. Although it conforms to the same principles as before, its details are different from what is described in this article.

Inspecting Data Structures

Suppose someone has given you a Smalltalk program to implement a "regular polygon" class (table 1) and you want to learn more about it. It would be helpful to see an actual instance of a regular polygon.

If the variable triangle refers to a regular polygon, you type the following statement into your work-space window:

```
triangle inspect
```

and then issue the "do it" command in the pane menu (photo 12a). In a few seconds, a two-paned "inspect window" appears on the screen. Its title tab tells you the class of the inspected object, in this case, RegularPolygon. The window is divided into two panes. The left or *variable pane* lists the parts of a regular polygon, sides, center, radius, and plotter. The right or *value pane* is blank.

You point to the word sides in the variable pane and click the selection button on the mouse. The word sides is highlighted, and in the value pane, the value of the variable sides appears (photo 12b), in this case, 3. You point to the word center and click. In the value pane appears the value of center (photo 12c), in this case, the point 526@302. The value pane is *dependent* on the variable pane because its contents are determined by what you select in the variable pane. The arrow in figure 3 symbolizes this dependency.

Let's inspect the value of center. In the variable pane, where center is selected, pop up the pane menu and issue

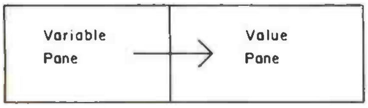


Figure 3: *Principal dependencies among panes of an inspect window.*

Orange Micro

"THE COMPUTER PRINTER SPECIALISTS"

UP TO 25% DISCOUNTS! — SAME DAY SHIPMENT!

NEW CENTRONICS 739 (RADIO SHACK LINE PRINTER IV)

With Graphics and Word Processing Print Quality

• 18 x 9 dot matrix; suitable for word processing • Underlining • proportional spacing • right margin justification • serif typeface • 80/100 CPS • 9½" Pin Feed/Friction feed • Reverse Platen • 80/132 columns • Top of form

CENTRONICS 739-1 (Parallel)................(List $995) $ Call
CENTRONICS 739-3 (Serial)................(List $1045) $ Call

VISTA — C. ITOH

Daisy Wheel Letter Quality

• 25 CPS (Optional 45 CPS) • Typewriter quality • Centronics parallel • RS 232 Serial (Optional) • Proportional spacing • Bidirectional • Programmable VFU • Self test • Diablo compatible • Friction feed (Optional tractors) • 136 printable columns. • Manufactured by C. ITOH.

VISTA V300 (C. ITOH)....................(List $1895) $ Call

ANADEX

Dot Graphics, Wide Carriage

• 11 x 9 dot matrix; lower case descenders • Dot resolution graphics • Bi-directional, logic seeking • Up to 200 CPS • RS 232 Serial & Parallel • Forms control • X-ON/X-OFF • Up to 6 part copy.

ANADEX 9501............................(List $1650) $1350

ANACOM

Low Cost, High Speed, Wide Carriage

• 9 x 9 dot matrix • Lower case descenders • Wide carriage • Adjustable tractors to 16" • 150 CPS, Bidirectional, Logic Seeking

ANACOM 150..........................(List $1350) $ Call

MALIBU 165

The Small Business Printer; Letter Quality & Speed.

• 10 x 9 dot matrix • Letter quality print; Lower case descenders • High speed; 165 CPS, Bidirectional, Logic seeking • Wide carriage • Vertical forms control • User programmable character set • Dot Resolution Graphics.

AXIOM

Dot Graphics, Low Price

• Dot addressable graphics • 70 CPS • 12 characters per inch • 80 columns • adjustable tractors • 3 part copies • Manufactured by Sieko • Parallel, RS232 serial, IEEE-488 interfaces available.

AXIOM GP-80M..........................(List $399) $349

NEC SPINWRITER

High Speed Letter Quality

• 55 CPS • Typewriter quality • Bidirectional • Plotting • proportional spacing.

5510-5 RO, Serial, w/tractors................(List $2995) $2650
5530-5 RO, Parallel, w/tractors................(List $2970) $2625

TELEVIDEO CRT'S

AT DISCOUNT PRICES!

TVI 912C
TVI 920C
TVI 950

Please Call Toll Free
Prices are too low to advertise

QUANTITY PRICING AVAILABLE

IDS PAPER TIGERS

Dot Resolution Graphics, quality print, speed

• 7 wire printhead (445); 9 wire printhead (460) with lower case descenders • Over 150 CPS • bi-directional, logic seeking (460) • 8 character sizes; 80-132 columns • Adjustable tractors • High-resolution dot graphics • Proportional spacing & text justification (460).

IDS 445G 7 wire printhead, graphics...........(List $895) $ 750
IDS 460G 9 wire printhead, graphics...........(List $1394) $1150
IDS 560G 9 wire, wide carriage, graphics......(List $1794) $1590

PRINTERS

MALIBU 165 wide carriage, graphics, letter quality..(List $2495) $ 1975
QUME 5/45 typewriter quality..................(List $2905) $ 2559

INTERFACE EQUIPMENT

CCS APPLE PARALLEL Interface & cable.................$ 150
ORANGE INTERFACE for Apple II
parallel interface board & cable.....................$ 110
MICROTRONICS Atari parallel interface....................$ 69
ATARI 850 Interface module, serial/parallel................$ 199
TRS-80 CABLES to keyboard or Exp. interface................$ Call
NOVATION D-CAT direct connect modem....................$ Call

CALL FOR FREE CATALOG

(800) 854-8275

CA, AK, HI (714) 630-3322

At Orange Micro, we try to fit the right printer to your application. Call our printer specialists for free consultation.

TELEPHONE ORDERS: Mon.-Fri. 8:30 - 5:00
The Orange Micro Printer Store (Retail):
Mon.-Fri. 10:00 - 6:00, Sat. til 4:00

Phone orders WELCOME; same day shipment. Free use of VISA & MASTERCARD. Personal checks require 2 weeks to clear. Manufacturer's warranty included on all equipment. Prices subject to revision.

Orange Micro, Inc.
3150 E. La Palma, Suite I
Anaheim, CA 92806

Circle 283 on inquiry card.

The following template contains a description of a regular polygon with the following attributes:

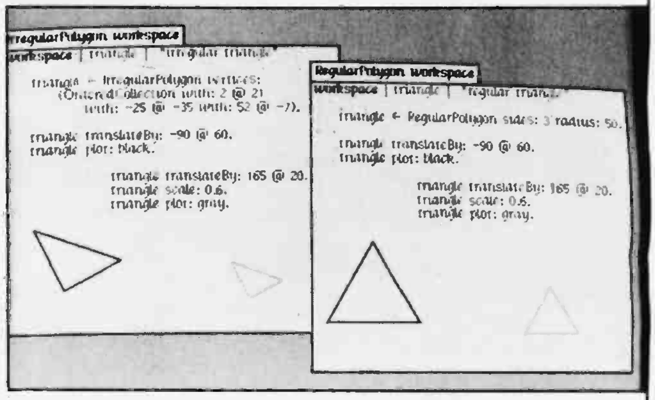
sides	Number of sides (3 for a triangle, 5 for a pentagon, etc.).
center	If the regular polygon were inscribed in a circle, this would be its center point.
radius	If the regular polygon were inscribed in a circle, this would be its radius.
plotter	A pen that can draw an image of the polygon on the screen or on paper.

The following expressions provide an example of creating and using an instance of RegularPolygon.

```
triangle ← RegularPolygon sides: 3 radius: 50.

triangle translateBy: -90 @ 60.
triangle plot: black.

triangle translateBy: 165 @ 20.
triangle scale: 0.6.
triangle plot: gray.          "where gray denotes an ink color"
```



class name	RegularPolygon
superclass	Object
instance variable names	sides center radius plotter
class messages and methods	

initialization

sides: s radius: r | |

"Create an instance of RegularPolygon whose center is located at the center of the currently active window on the display screen. Screen is a global variable that refers to the hardware display screen."

↑ self new sides: s radius: r center: (Screen activeWindow frame center)

instance messages and methods

initialization

sides: s radius: r center: c | |

"Initialize all attributes. Class Pen is provided in the system as one way of side effecting the display screen."

```
sides ← s.
center ← c.
radius ← r.
plotter ← Pen width: 2
```

analysis

center | | — "Answer the center coordinate of the polygon."

↑center

sides | | — "Answer the polygon's number of sides."

↑sides

display

plot: ink | | — "Draw an image of the polygon using the specified ink color."

```
plotter penup.                             "lift the pen to disable drawing"
plotter goto: self center.                 "position the pen at the center"
plotter up.                                "face the top of the screen"
plotter go: radius.                        "position at a corner"
plotter turn: 180 - (self cornerAngle/2).  "turn to face along a side"
plotter color: ink.                        "select the ink color"
plotter pendn.                             "lower the pen to enable drawing"
1 to: sides do:                            "for each side of the polygon:"
   [:i | plotter go: self sideLength.      "plot that side"
      plotter turn: 180-self cornerAngle]  "turn to face along the next side"
```

transformation

scale: factor | |

"Scale the polygon radius by the specified factor."

radius ← radius * factor

translateBy: deltaXY | |

"Change the polygon's location by the specified amount (a Point)"

center ← center + deltaXY

private instance methods

cornerAngle | | "Answer the interior angle of any vertex, in degrees."

↑180 - (360 / sides)

sideLength | | "Answer the length of any one of the equal sides."

↑2 * radius * (self cornerAngle /2) degreesToRadians cos

Table 1: *Description and class template for class* RegularPolygon.

Take Your Cue From Vista . . .

When it comes to Apples, take your cue from Vista's A800 Eight-Inch Floppy Disk Controller. The A800 offers a cost-efficient approach to software compatible disk memory expansion for your Apple II® computer. The A800 Controller enables Apple II users to access up to five megabytes of online storage through conventional disk operating (DOS) commands.

The Control and DMA Logic provides high speed (1 microsecond per byte) transfer of data from the disk drive directly to the Apple II memory without processor intervention. Plus, the Phase-Locked Loop Data Separator provides the ultimate in data reliability.

It's a Sure Shot.

AND THERE'S MORE.

The controller is compatible with the most popular disk operating systems for the Apple II computer. It also interfaces to all Shugart/ANSI Standard Eight-Inch Floppy Disk Drives. The A800 provides complete IBM format compatibility in both single and double-density modes.

THE HOT SHOT AT A COOL PRICE.

The A800 is reasonably priced at $595. A price you can't beat when you compare its quality and performance.

CALL YOUR SHOTS.

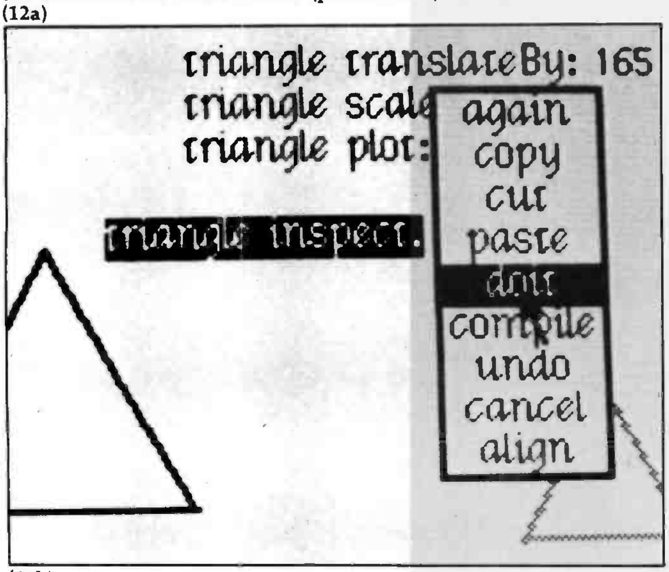
Vista offers you a complete line of peripheral equipment to maximize the capabilities of your Apple system including: High capacity Mini-floppy Disk Drives, the Vista Music Machine 9 and the Vista Model 150 Type Ahead Buffer. In addition, Vista offers a line of advanced components fully compatible with the TRS-80* and S-100 based computers.

Vista Computer Company
1317 E. Edinger Avenue
Santa Ana, CA 92705
(714) 953-0523

Call Toll Free 800-854-8017

the "inspect" command (photo 12d). On the screen appears another inspect window showing that center is an instance of class Point (photo 12e). You can now examine that point's variables, x and y, reactivate the original inspect window, close either or both windows, or work in any other window. You are not in a mode.

(12a)



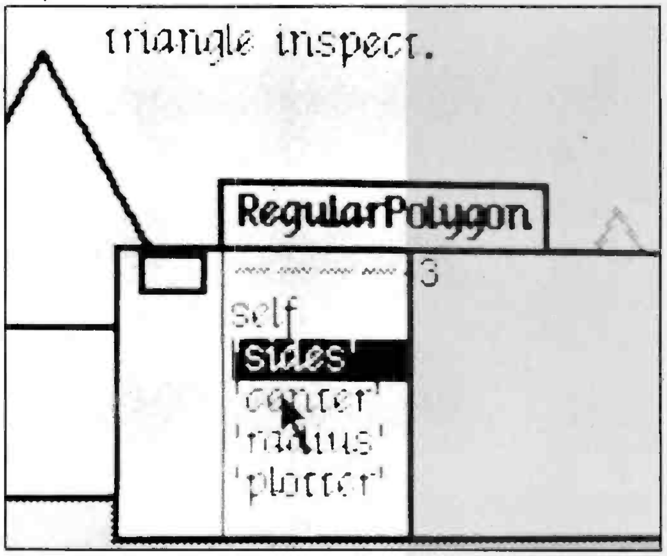
Browsing Through Existing Definitions

Now that you have inspected a sample regular polygon, you might want to find out what methods have been defined in its class. One way to do this is to activate a window called a "browse window" or "browser." Most Smalltalk programmers leave a browser or two on the screen at all times with the work-space window.

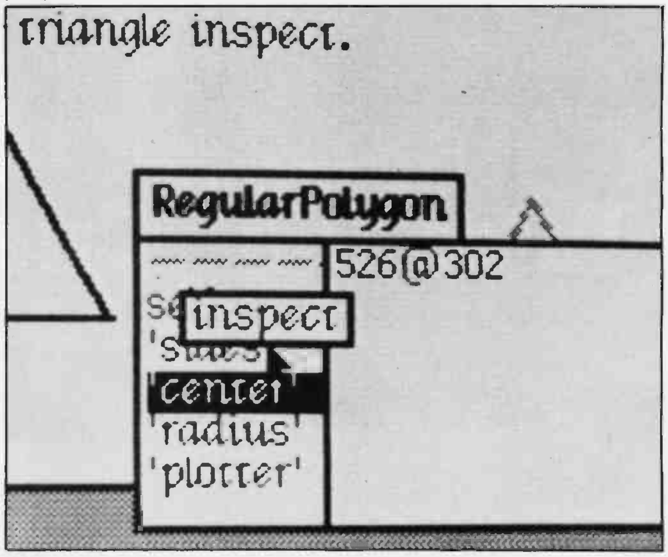
The title tab of the browser (photo 13a) says "Classes" because the standard browser lets you examine and change the definitions of all Smalltalk classes—classes supplied by the system, as well as classes supplied by yourself. It is easy to create a more restricted browser that protects the system from ill-conceived modification. But on a personal computer, you are just going to hurt yourself.

The browser has five panes. The principal dependen-

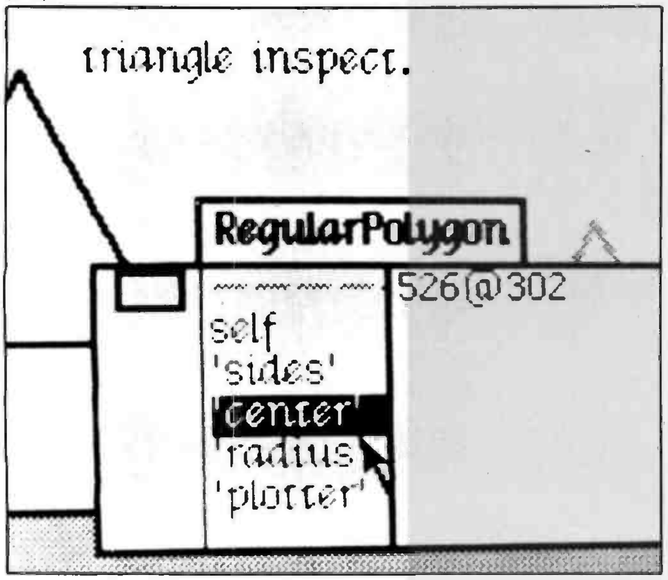
(12b)



(12d)



(12c)



(12e)

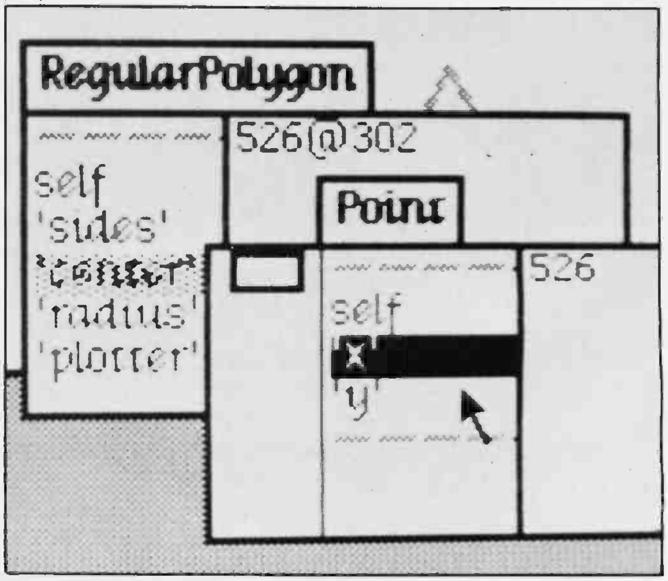


Photo 12: *Inspecting data structures in Smalltalk.*

"Together we're working to better serve mankind."

"Speaking on behalf of Vector computers, I'm pleased to announce that TRW Customer Service Division will provide a nationwide, nine-month on-site service warranty that you, the end-user, will receive absolutely free.*

"I'd also like to add that this is a unique program. It's actually the first time a microcomputer has had this kind of comprehensive nationwide on-site service – especially from a company of experts like TRW.

"Now you have even more security when you buy a Vector. In addition to increasing your personal productivity, helping you make faster decisions, and improving your business, we offer a network that will service us right in your office if we ever need it. At no expense to you.

"Right now, you can get quick, dependable service in Los Angeles, New York City, Denver, Dallas, Chicago, San Francisco, Northern New Jersey, Philadelphia, Atlanta, and Boston. With more cities on the way.

For more information and your nearest Dealer, call us at 800-423-5857. In California, call 800-382-3367. Or write to us at 31364 Via Colinas, Westlake Village, CA 91362.

"TRW and Vector. Now that we're helping each other, there's no telling how much we can accomplish for you."

VECTOR
Vector Graphic Inc.

COMPUTERS FOR THE ADVANCEMENT OF SOCIETY.

Circle 393 on inquiry card.

*Within 50 mile radius of a TRW service center.

cies between panes are symbolized by arrows in figure 4. The top row has four panes called the *class-category pane*, *class pane*, *method-category pane*, and *method pane*. The large lower pane is called the *editing pane*. (After you have used the system for a few minutes, the significance of each pane becomes apparent, and it is not necessary to memorize their technical names.)

In photo 13a, the browser shows a method definition in the editing pane. You can tell that the method is class RegularPolygon's version of scale: because RegularPolygon is highlighted in the class pane and scale: is highlighted in the method pane.

The method-category pane lists several groups of methods within class RegularPolygon: **initialization, analysis, display, transformation, testing,** and **private** methods. You can tell that scale: is a **transformation** message in class RegularPolygon because that category is highlighted.

The class-category pane lists several groups of classes, including **numbers, files,** and **graphical objects**. You can tell that class RegularPolygon is in the **graphical objects** group because that category is highlighted.

Suppose you want to look at a different method, translateBy:. Click its name in the method pane and its definition is immediately displayed in that pane's dependent, the editing pane (photo 13b). If the method you want to see is in the method category **analysis**, first click that category name. Immediately after you do that, its dependent, the method pane, lists the methods in that category. Now you can click the name of the desired method (photo 13c).

If you want to know things about the class as a whole, like its superclass and field names, click "Class Definition" in the method-category pane and the definition appears in the editing pane (photo 13d).

Suppose you want to look at a different class, say IrregularPolygon. Click its name in the class pane and its method categories are immediately displayed in the next pane (photo 13e). If the class you want to see is in the class category **windows**, first click that category name. Immediately after you do that, the class pane lists the classes in that category. Now you can click the name of

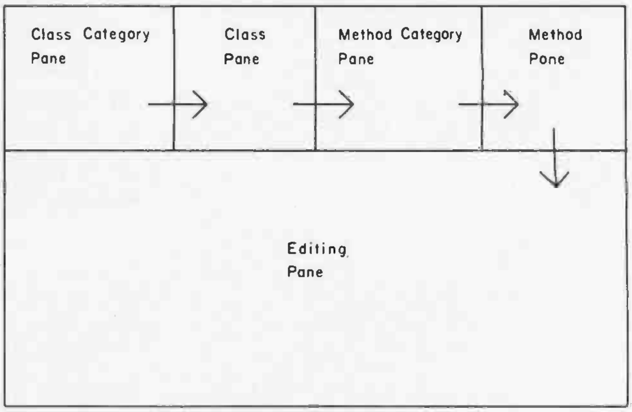


Figure 4: *Principal dependencies among panes of a browse window.*

IF YOU CAN RECOGNIZE VALUE

YOU CAN SAVE

$500[00]

TRS-80®
MOD III*

FIRST . . .
We lowered the prices of the Model III from $2499* to

$1998

*We have taken the basic 16K Model III expanded the memory to 48K and added our MTI Double Density, Dual Disk Drive system. System is fully compatible with Radio Shack DOS and peripherals.

MOD III/EXPANDED

Same as above but has double storage capacity (708K storage). Your choice of 2 dual headed 40 track drives or 2 single headed 80 track disk drives. Includes Microsystems DOS plus 3.3.

$2499

MOD III/280

Our largest MOD III, approximately 1.5 mega bytes of storage, utilizes 2 dual headed 80 track, double density disk drives. Complete with manuals and professional operating system, Microsystems DOS plus 3.3 (40 & 80 track capability).

$2799

MTI has a complete line of COMPUTER add ons:

INTERNAL DISK KIT 40 OR 80 TRACK

Drive Kit #1 from $699
Drive Kit #2 from $279

EXTERNAL DISK KIT 40 OR 80 TRACK

Drive Kit #3 from $379
Drive Kit #4 from $359

TRS DOS & Manual $21.95
DOS PLUS from $99

MTI MOD III SALES, PARTS & SERVICE CENTERS - INDEPENDENT DEALERS

ARIZONA .... (602) 839-0546
SAN JOSE .... (408) 427-0836
MIDWEST .... (618) 345-5068
NEW YORK .... (212) 728-5252
CALL NORTH TIER .. (701) 594-5674
SAN DIEGO .... (714) 281-0285
TEXAS .... (214) 247-6679
GEORGIA .... (404) 449-8982

MICROCOMPUTER TECHNOLOGY INC.

3304 W. MACARTHUR, SANTA ANA, CA 92704
• (714) 979-9923 • TELEX 6780401 TABIRIN •

• TRS-80 IS A REG. TRADEMARK OF TANDY CORP. *Uses MTI Memory Disk Drives & Components

PRICES F.O.B. SANTA ANA

Circle 234 on inquiry card.

the desired class (photo 13f).

Categorization is used at both the class and method level to help the programmer organize his or her program and to provide fewer choices in each pane. If a list is longer than what can fit in a pane, it can be scrolled by pressing a mouse button with the cursor in the scroll bar.

If you just want to browse around reading class and method definitions, you can do so by lazily clicking the selection button with the cursor over each name, never touching the keyboard. That is why the window is called a browser. Browsers are further discussed in references 6 and 7.

Astute readers may have noticed that the class template (see "The Smalltalk-80 System" by the Learning Research Group on page 36 of this issue) presents the methods of a class apart from the methods of its instances, while the browser does not. This discrepancy stems from differences between the Smalltalk-80 and Smalltalk-76 languages.

Revising Definitions

If you are looking at a method definition or class definition in the editing pane, you can revise it using the standard text-editing facilities (select, type, cut, paste, copy).

If you like, you can copy information into the definition from other windows—including other browse windows—because you are not in any mode while browsing. You can even interrupt your editing to run another program, list your disk files, draw a picture, or do whatever you like. You can later reactivate the browser and continue editing.

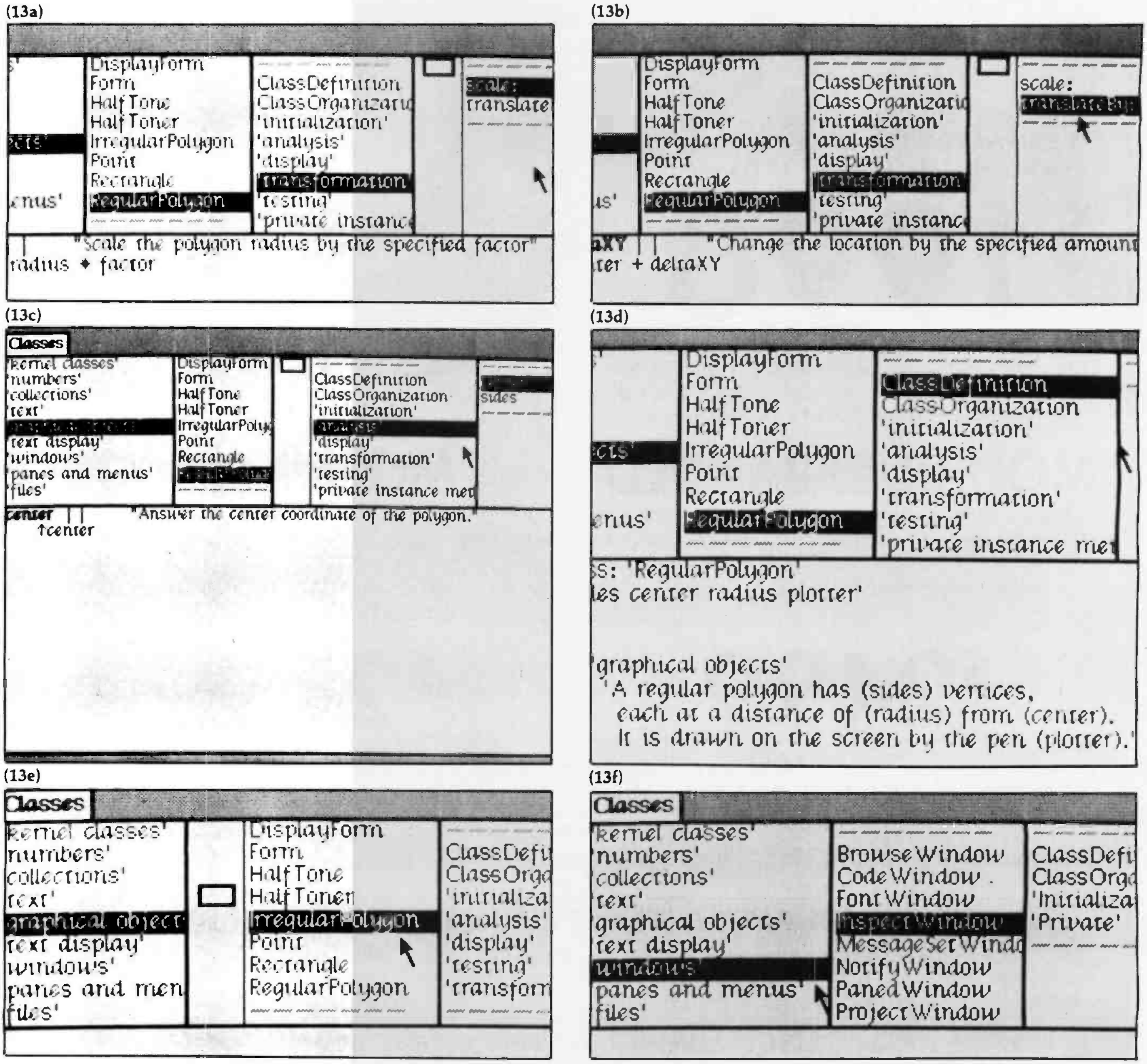


Photo 13: *Browsing through existing definitions in Smalltalk.*

The following template contains a description of an irregular polygon with the following attributes:

vertices	An OrderedCollection of Points.
plotter	A pen that can draw an image of the polygon on the screen or on paper.

The following expressions provide an example of creating and using an instance of IrregularPolygon.

```
triangle ← IrregularPolygon vertices:
                (OrderedCollection with: 2 @ 21
                                   with: -25 @ -35
                                   with: 52 @ -7).
triangle translateBy: -90 @ 60.
triangle plot: black.

triangle translateBy: 165 @ 20.
triangle scale: 0.6.
triangle plot: gray.  "where gray denotes an ink color"
```

class name	IrregularPolygon
superclass	Object
instance variable names	vertices plotter

class messages and methods

```
initialization
   vertices: aCollection | |
    "Create an instance of IrregularPolygon whose center is located at the center of the currently active window on the display screen.
    Screen is a global variable that refers to the hardware display screen."
    ↑ self new vertices: aCollection center: (Screen activeWindow frame center)
```

instance messages and methods

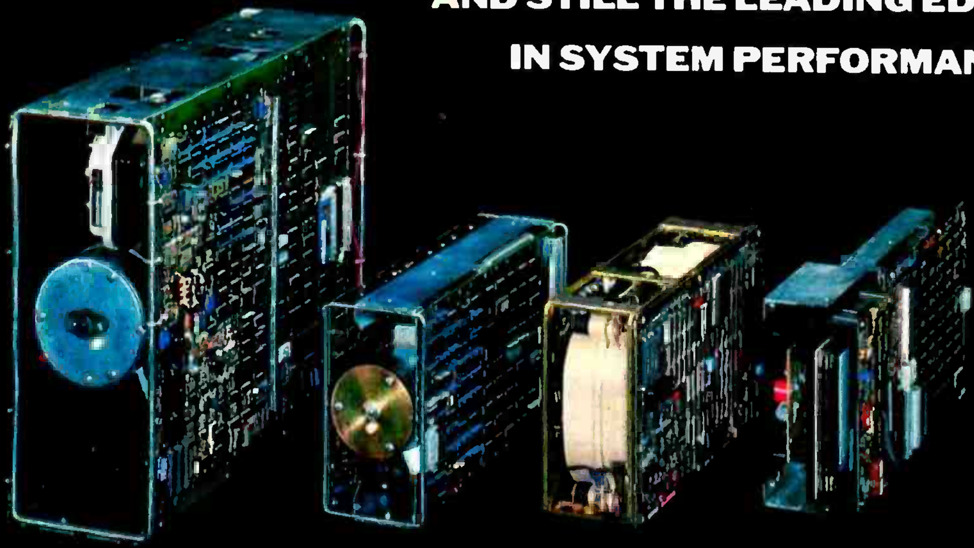
```
initialization
   vertices: aCollection center: c | |
    "Initialize all attributes. Class Pen is provided in the system as one way of side effecting the display screen."
    vertices ← aCollection.
    plotter ← Pen width: 2.
    self translateBy: c - self center
analysis
   center | sum |                              "Answer the center coordinate of the polygon."
    sum ← 0@0.
    vertices do: [ :pt | sum ← sum + pt].
    ↑sum / self sides
   sides | |                                   "Answer the polygon's number of sides."
    ↑vertices size
display
   plot: ink | |                               "Draw an image of the polygon using the specified ink color."
    plotter penup.                             "lift the pen to disable drawing"
    plotter goto: vertices last.               "position the pen at one vertex"
    plotter color: ink.                        "select the ink color"
    plotter pendn.                             "lower the pen to enable drawing"
    vertices do:                               "for each vertex"
       [:pt | plotter goto: pt]                "draw a straight line to it"
transformation
   scale: factor | center |
    "Scale the polygon by the specified factor."
    center ← self center.                      "the center of expansion"
    vertices ← vertices collect:               "generate new vertex list from old list"
       [ :pt | (pt - center)*factor + center]
   translateBy: deltaXY | |
    "Change the polygon's location by the specified amount (a Point)."
    vertices ← vertices collect: [:vertex | vertex + deltaXY]
```

Table 2: *Description and class template for class* IrregularPolygon.

Circle 4 on inquiry card. →

THE HARD EDGE

AND STILL THE LEADING EDGE . . .
IN SYSTEM PERFORMANCE



ADES

Hard Disk and Streaming Tape

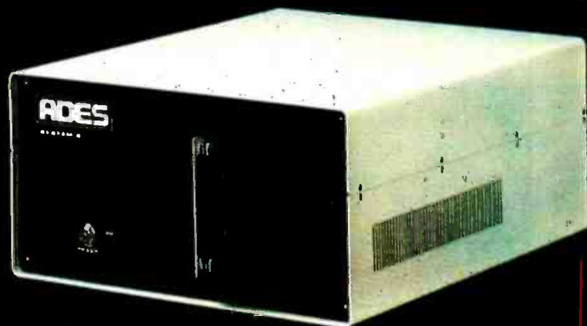
reliability and versatility that can't be beat

OEM CONTROLLERS

- Multibus
- General Purpose
- S100

S33

S10



SYSTEM 8

- 31 or 62 MByte formatted
- 10.5 or 32 MByte formatted
- Lowest cost/MByte from any manufacturer
- CP/M* compatible "drop in" BIOS
- Single S100 card controller
- Fully expandable up to four drives, 8" or 14"
- Reliable high performance Priam Winchester Disks
- Immediate delivery

- 8" Winchester 10 or 32 MByte formatted
- Integrated streaming cartridge backup
- Streaming backup at 5 MB/min
- Selective file backup under CP/M
- Versatile parallel I/O or DMA interface

ADES

ADAPTIVE DATA & ENERGY SYSTEMS
2627 Pomona Boulevard • Pomona, CA 91768
Phone: (714) 594-5858

*CP/M is a trademark of Digital Research Corp.

When you are done editing, pop up the active-pane menu and issue the "compile" command (photo 14a). Compilation takes a few seconds or less because it is *incremental*—that is, you can compile one method at a time. The compiler reports a syntax error to you by inserting a message at the point where the error was detected and automatically selecting that error message (photo 14b). You can then cut out or overtype the message, make the correction, and immediately reissue the "compile" command.

If you start to revise a definition and change your mind about it, you can pop up the pane menu and issue the

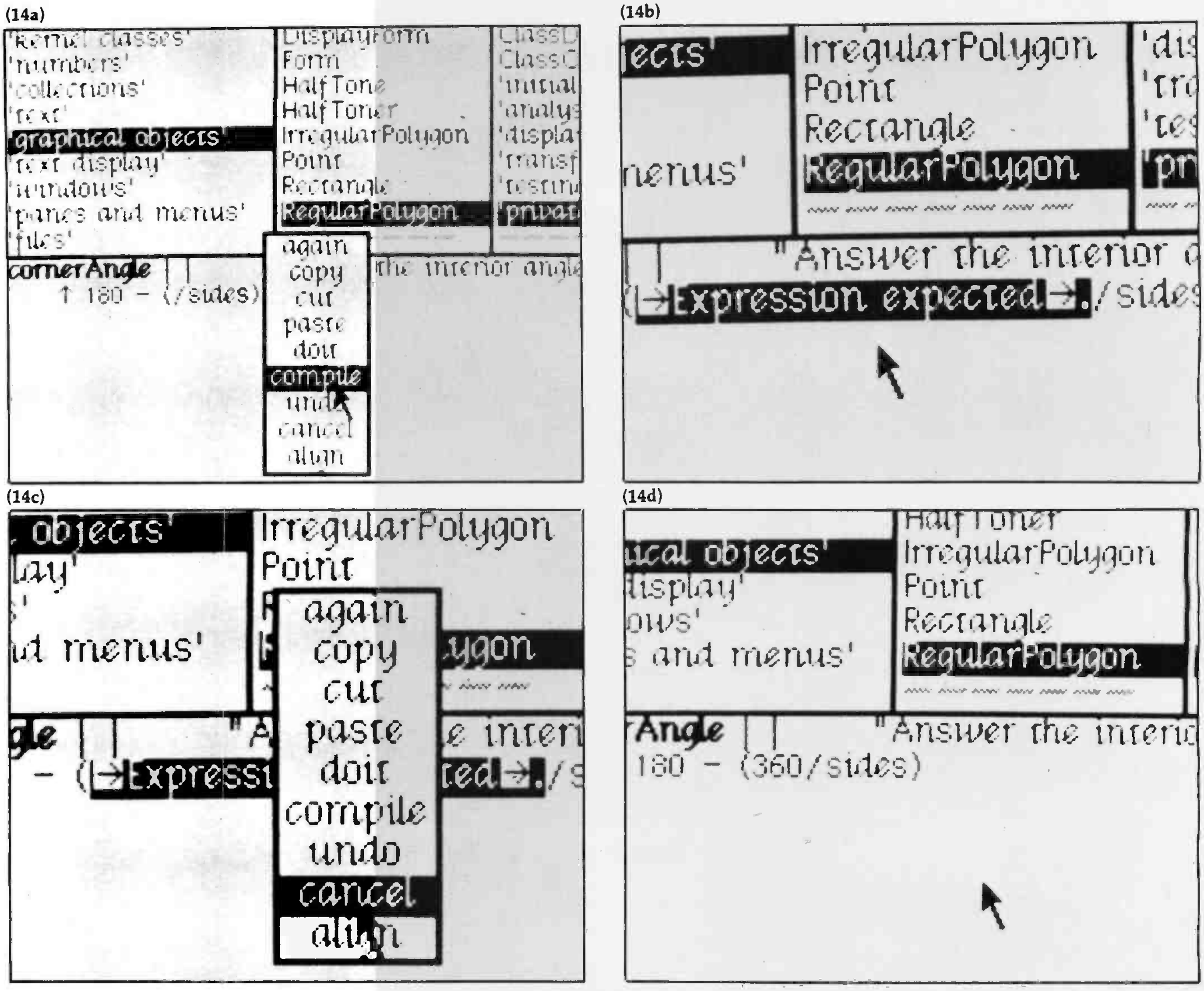


Photo 14: *Options during method compilation.*

 Circle 145 on inquiry card.

MULTIUSER

COMPUTER ON S-100 BUS DESIGNED TO SATISFY A WIDE VARIETY OF APPLICATIONS.

STANDARD FEATURES INCLUDE: CP/M 2.2 OPERATING SYSTEM, 64K EXPANDABLE, BANKSELECTABLE MEMORY, 4MHZ Z80A CPU WITH 4 SERIAL AND 3 PARALLEL PORTS, RELIABLE 8" FLOPPY DISK DRIVES IN A STURDY ALL METAL CABINET.

$4900

MP/M OPTIONAL.

ZOBEX®

P.O.BOX 1847 SAN DIEGO, CA. 92112
7343-J RONSON RD, SAN DIEGO, CA. 92111
(714) 571-6971

We're #1 to the world.

For two good reasons.

More people fly on Pan Am from America to places overseas than on any other airline.

Because Pan Am provides more of what demanding travelers demand.

Comfort and convenience.

For example, take comfort. To the Pan Am passenger, that may mean the unabashed luxury of First Class. With its spacious cabin and Sleeperette seats. (A Pan Am first, we might add.)

Or comfort could be Clipper® Class. Our separate section especially for business travelers. In Clipper Class, no one sits in the middle. No matter where in the world one is flying.

Sleeperette service® and Clipper Class are available on most of our widebodies. And we've got more widebodies than any other airline.

But offering more widebodies is just the beginning of our convenience story. For another chapter, consider this:

Pan Am can take passengers from more of the U.S. to more of the world than any other airline. From 25 U.S. cities to 47 cities around the world.

All with one ticket. One baggage check-in. On one airline.

If all this isn't reason enough to get you to fly us, we've got more coming. More ways to make your trip even more comfortable. Even more convenient.

Because at Pan Am, we intend to keep on giving you reasons for making us your number one choice.

Say hello to Pan Am.

United States
Detroit
Ft. Lauderdale / Hollywood
Fort Myers
Honolulu
Houston
Jacksonville
Las Vegas
Los Angeles
Melbourne
Miami
Mobile
Newark
New Orleans
New York
Norfolk
Orlando
Pensacola
Phoenix
San Diego
San Francisco
Sarasota / Bradenton
Seattle / Tacoma
Tampa / St. Pete
Washington, D.C.
West Palm Beach

Caribbean
San Juan

Central and South America
Buenos Aires
Caracas
Guatemala City
Maracaibo
Mexico City
Montevideo
Panama City
Rio de Janeiro
San José
Santiago de Chile*
São Paulo

Europe
Berlin
Frankfurt
Hamburg
London
Munich
Nuremberg
Paris
Rome
Stuttgart
Warsaw

The Middle East and Africa
Abidjan
Accra
Ankara
Bahrain
Dakar
Dhahran
Istanbul
Lagos
Monrovia
Nairobi

The Far East and Pacific
Auckland
Bangkok
Beijing (Peking)
Bombay
Delhi
Guam
Hong Kong
Karachi
Manila
Melbourne
Osaka
Shanghai
Singapore
Sydney
Tokyo

*Subject to government approval

"cancel" command (photo 14c). The "cancel" command *redisplays* the last successfully compiled version of the method (photo 14d). If you cancel by accident, just issue the "undo" command to return the revised version.

Adding New *Definitions*

To add a new method definition, select a method category. In the editing pane, a *template* appears for defining a new method (photo 15a). The template reminds you of the required syntax of a method.

Use standard editing facilities to supply the message pattern, variable list, and body of the method. When the definition is ready, issue the "compile" command (photo 15b).

Once compilation succeeds, the selector of the new method is automatically added to the alphabetized list in the method pane, and the message pattern is automatically changed to boldface in the editing pane (photo 15c).

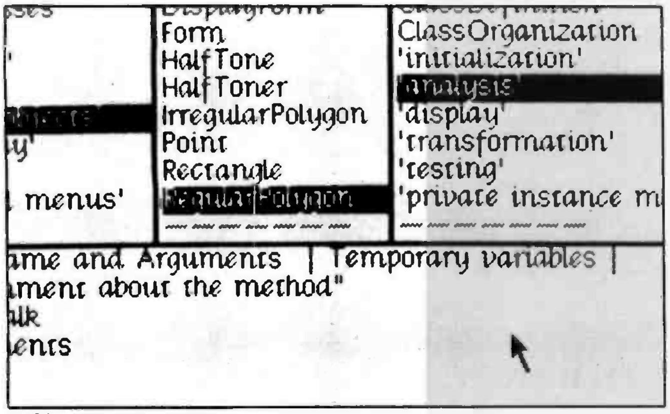
A new class definition is added in an analogous manner. Start by selecting a class category (photo 15d), then fill in a template for defining a new class and compile it (photo 15e). New categories can be added and old categories can be renamed and reorganized.

Program Testing

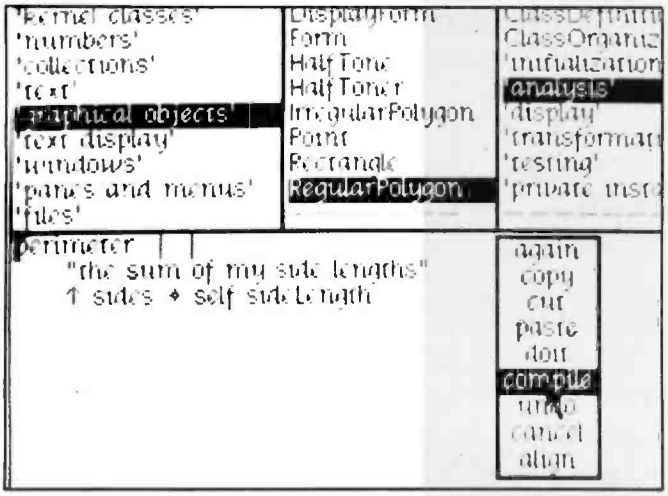
Let us purposely add a bug to a method and see how it can be tracked down and fixed.

Browse to the method cornerAngle in class RegularPolygon, cut out the characters "180 —" (photo 16a), and recompile it. In the RegularPolygon work-space window, select the test program and issue the "do it" command (photo 16b). Instead of the desired triangle, an open three-sided figure is drawn because of the bug introduced into the angle calculation.

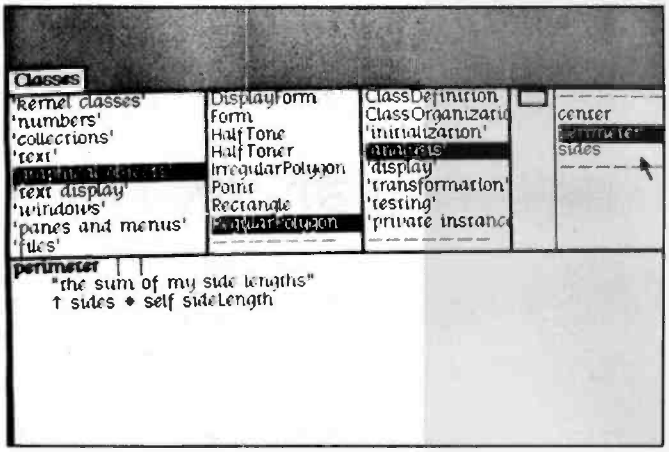
(15a)



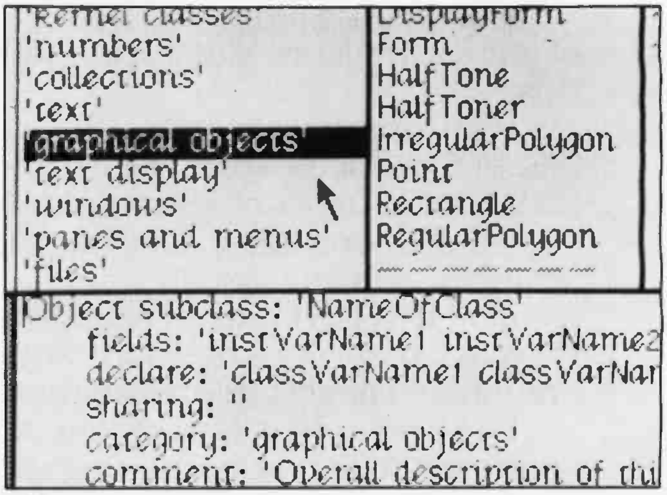
(15b)



(15c)



(15d)



(15e)

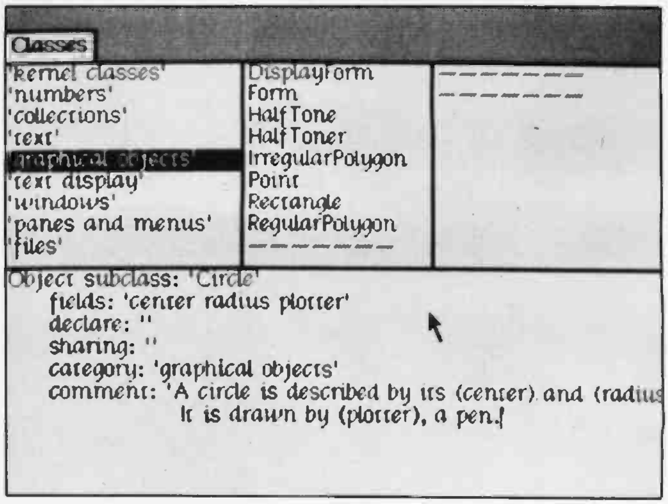


Photo 15: *Adding new definitions in Smalltalk.*

C ~~or~~ AND Pascal

Efficiency ~~or~~ AND Portability

Flexibility ~~or~~ AND Strong Typing

Now you don't have to compromise!

Whitesmiths Ltd. now offers portable language development systems for four families of computers. Approximately one thousand installations use our software.

We support complete versions of both C and Pascal, as compilers and cross-compilers. You get C automatically when you license Pascal, and you get native support with each cross-compiler. Test the software on your VAX before burning PROMs for your 68000 or 8080.

Whitesmiths Ltd. offers a variety of licensing arrangements, the simplest being a binary license for use on a single CPU. The full source code is available with internal documentation. Maintenance, training and sublicensing rights may also be obtained.

Call or write for more information.

Source Operating Systems	Target Machines			
	8080/Z80	LSI-11/PDP-11	VAX-11	M68000
8080/Z80 CP/M	C: $750 Pascal: $950	*	*	*
LSI-11/PDP-11: Idris, Unix, RT11, RSX-11/M, RSTS/E, IAS	C: $1350 Pascal: $1550	C: $750 Pascal: $950	*	C: $1350 Pascal: $1550
VAX-11 Unix/V32 VMS	C: $1350 Pascal: $1550	*	C: $750 Pascal: $950	C: $1350 Pascal: $1550
M68000 VERSAdos	*	*	*	C: $750 Pascal: $950

Idris is a trademark of Whitesmiths, Ltd. ■ Unix is a trademark of Bell Laboratories ■ CP/M is a trademark of Digital Research Company ■ VMS, RSX-11/M, RSTS/E, LSI-11, VAX, are trademarks of Digital Equipment Corporation ■ VERSAdos is a trademark of Motorola Corporation

*Special Order

Protect your software investment.

Whitesmiths, Ltd.

P.O. Box 1132 Ansonia Station New York, N.Y. 10023 (212) 799-1200 Telex 645 592

Distributors:

Australia	Japan	United Kingdom
Fawnray Pty Ltd.	Advance Industries	Real Time Systems
Brighton-Le-Sands	Chiyoda-ku, Tokyo	Newcastle upon Tyne
522 5574	03-258-0839	0632 733131

Breakpoints

To track down the bug, let us set a breakpoint in the method cornerAngle. Using standard editing facilities, add the statement:

self notify: 'about to calculate angle'.

before the return statement (photo 16c). Now rerun the test case. When the computer encounters the breakpoint, a new window appears in midscreen. It is called a "notify window" (photo 16d). The title tab of the notify window says "about to calculate angle".

The notify window has one pane, the *stack pane*. It shows RegularPolygon>>cornerAngle (ie: the class and method in which the breakpoint was encountered). The pop-up menu of that pane offers several commands, including "stack" and "proceed" (photo 16e).

The "proceed" command closes the notify window and continues execution from the breakpoint. If we issue a "proceed" in our example, the same breakpoint will be encountered again immediately because the cornerAngle method is used several times during the execution of the test program.

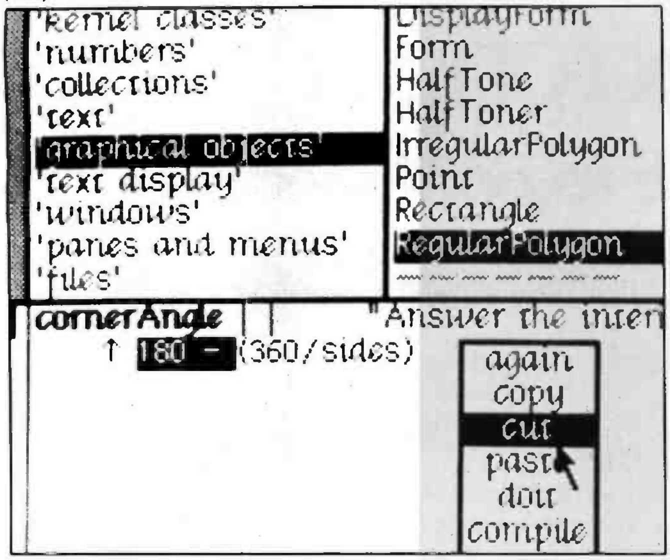
What a Notify Window Can Display

The "stack" command expands the contents of the pane to include messages that have been sent, but have not yet received replies (photo 17a). It reveals that the sender of the message cornerAngle was RegularPolygon>>plot:.

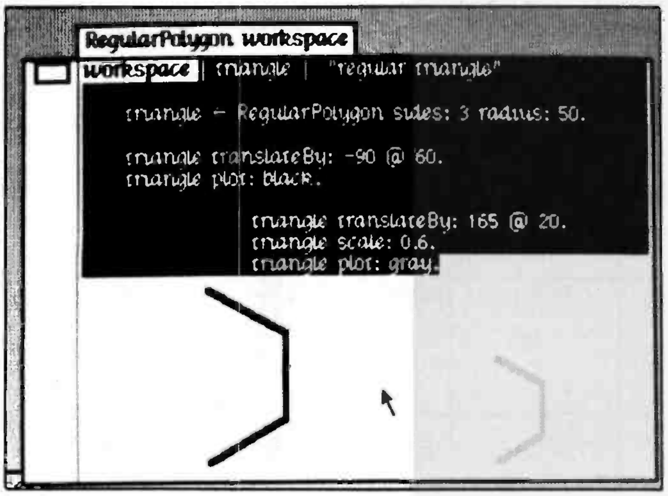
The pop-up menu of the notify window offers the usual repertoire, including the "close" and "frame" commands (photo 17b). If "close" were issued, the notify window would disappear from the screen and execution of the

Text continued on page 138

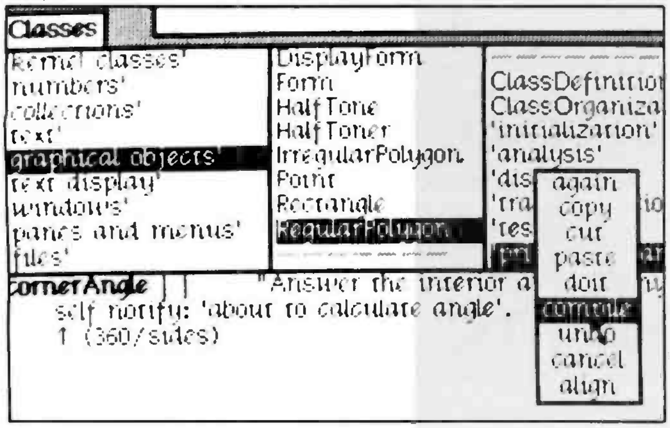
(16a)



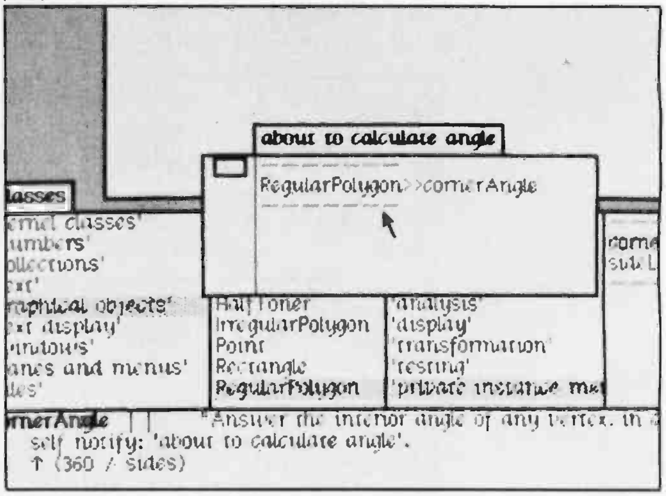
(16b)



(16c)



(16d)



(16e)

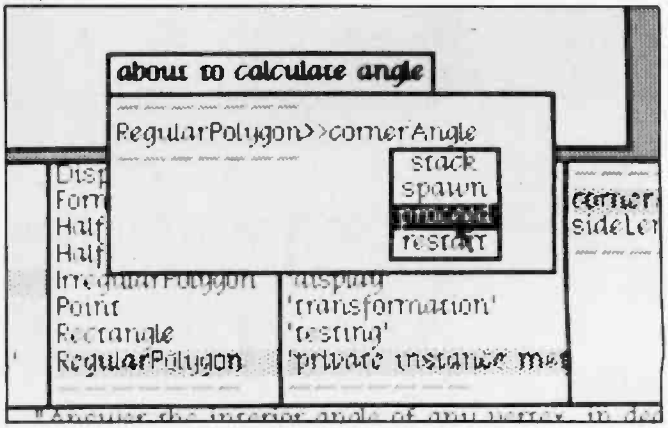
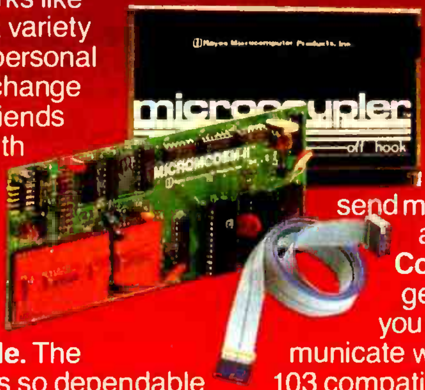


Photo 16: *Creating a faulty method for purposes of illustration.*

With the Hayes direct-connect Micromodem II,™ your Apple II can communicate by phone with the outside world. You can access information networks like The Source for a variety of business and personal applications, exchange programs with friends anywhere in North America, and even use your Apple II when you're away from your home or office.



Dependable. The Micromodem II is so dependable it comes with a *two-year* limited warranty. That's another reason why it's the largest selling direct-connect modem for Apple II computers.

Programmable. Automatic dialing and answering? Of course! We include programs on disk that dial phone numbers for you, send messages while you're away, and much more!

Complete. You get everything you need to communicate with other Bell 103 compatible modems at 110 or 300 baud. The serial interface is built-in, and we even include our FCC-approved Microcoupler™ that plugs directly into any modular telephone jack in the U.S. – you don't even need the phone!

S-100, too. The Hayes Micromodem 100 gives S-100 microcomputers all the advantages of our Micromodem II!

Put the outside world *inside* your computer with a data communications system from Hayes. Available at computer stores nationwide – call or write for the location nearest you. And don't settle for anything less than Hayes.

Hayes

The Hayes Micromodem II opens up your Apple II† to the outside world.

Hayes Microcomputer Products Inc. 5835 Peachtree Corners East, Norcross, Georgia 30092 (404) 449-8791

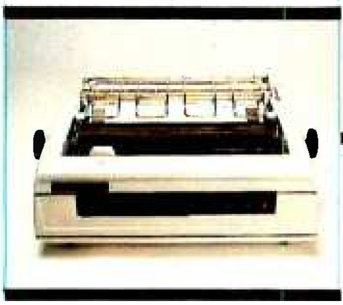
PRINTERS

EPSON MX-80
Now in stock!
The MX-80 dot matrix printer. Unequalled Epson reliability. Has all the features of the MX-70 plus more power and extra functions. **CALL US**

C-ITOH STARWRITER: LETTER QUALITY PRINTING FOR UNDER $2000!/This daisywheel printer gives high quality at a low price. 25 cps. Parallel and serial interfaces available. **CALL**

NEC SPINWRITER FROM THE FIRST NAME IN LETTER QUALITY PRINTERS/Compumart offers beautiful print quality with NEC Spinwriter Terminals. We carry all models from RO THRU KSR WITH NUMERIC KEYPAD—5510-5530. All versions give unsurpassed hard copy output! **CALL FOR PRICES**

NEW INTEGRAL DATA'S 560 PRINTER/All the exciting features of the 400 series plus 14 1/2" paper capacity. 132 col. graphics printer.
IDS 445. Priced lower than the 440 and equipped with a better print head. With & w/o graphics.
IDS 460. Features include correspondence quality printing, high resolution graphics. **CALL FOR PRICES**



CENTRONICS PRINTERS
3 SERIAL MODEL 737
The closest thing to letter quality print for under $1000.
List $1045 **SPECIAL $795.**
737-1 Parallel Interface
List $995 **SALE PRICE $695.**
PLUS EXCITING REBATE OFFER ON CENTRONICS PRINTERS.

OMNI 810 PRINTER FROM TEXAS INSTRUMENTS **CALL US**
The 820 RO PACKAGE includes machine mounted paper tray and cable. A compressed print option and device forms control are standard features.
THE 820 KSR PACKAGE includes fully ASCII Keyboard plus all of the features of the RO. **CALL FOR PRICES**

MONITORS TERMINALS

CLEARANCE ZENITH COLOR VIDEO MONITOR **$349.**

SUPER SELLING TERMINALS FROM LEAR SIGLER/We have the following Lear Siegler terminals in stock at prices too low to print! Call for quotes.
ADM-3A/Industry's favorite dumb terminal for some very smart reasons/
ADM-3A + NEW from Lear Siegler. CALL!
IT IS HERE! It is the new Intermediate Terminal from Lear Siegler. **CALL FOR DETAILS**

SANYO MONITORS AT LOW COMPUMART PRICES/Sanyo's new line of CRT data display monitors are designed for the display of alphanumeric or graphic data.

9" SANYO B/W	**$169.**
12" SANYO B/W	**CALL**
12" SANYO W/ GREEN SCREEN	**CALL**
13" SANYO COLOR	**CALL**

NEC COLOR MONITOR/RECEIVER HIGH RESOLUTION/
Composite video using BNC connectors, 8-Pin connector for VCR/VTR video loop In/Out and television reception. **CALL US!**

Visit our giant
ANN ARBOR STORE
1250 North Main Street
Ann Arbor, Michigan

FREE CATALOGS

MICRO
Our complete line of microcomputers, accessories and peripherals.

DEC LSI-11
Systems configured and integrated with other manufacturers compatibles.

Send for them!

CALCULATORS MISC

HP-41C CALCULATORS
MEMORY MODULES for storing programs of up to 2000 lines of program memory.
"EXTRA SMART" CARD READER. Records programs and data back onto blank magcards.
THE PRINTER. Upper and lower case. High resolution plotting. Portable thermal operation.
APPLICATION MODULES
CALL FOR PRICES ON ALL

NEW SUPER 41-CV SYSTEMS with Quad RAMS built-in. Maximum memory on-board leaves slots open for Application Pacs and peripherals.
+ CARD READER
+ CARD READER + PRINTER
QUAD RAMS equivalent to four Memory Modules all packed into one. **CALL ON ALL**

MATROX PRODUCTS/Compumart stocks the complete line. **CALL ON SPECS**

DEC LSI-11/Compumart now offers the entire product line
CALL FOR PRICES AND DELIVERY

NOVATION CAT ACOUSTIC MODEM Answer Originate. **CALL**

NEW! D-CAT Direct Connect Modem from Novation. **CALL**

NEW! GILTRONIX RS 232 SWITCH/
The ultimate in flexibility. You can connect three peripherals to one computer or three computers to one peripheral. Switches the eight most important RS 232 signals. **CALL ON PRICE**

DYSAN DISKETTES/Single side, single density. Hard or Soft Sector **$5. ea.**
MEMOREX 3401's/5 1/4" disks **$3.25.**
/with hub ring for Apple **$3.50.**
MEMORY INTEGRATED CIRCUITS/
Call for quantity discounts when ordering over 50 units. **CALL**
MOTOROLA 4116 (200 Nanosecond Plastic) **$4.50**

SYSTEMS SOFTWARE

RM EXPANSION ACCESSORIES FOR AIM—
CALL SPECS AND PRICES

APPLE III IS IN STOCK/Apple III Information Analyst Package—128K Apple III, Black and White Monitor 12", and information analyst software. **CALL**

TOP SOFTWARE PACKAGES FROM COMPUMART

VISICALC/FOR APPLE/FOR HP/FOR COMMODORE/FOR ATARI

SOFTWARE FROM APPLE/Apple Plot (the perfect graphic complement for Visicalc/Dow Jones News & Quotes/Apple Fortron/Apple Writer/Pascal Language System/Controller Business System **CALL**

PERSONAL SOFTWARE/Visidex/VisiTrend/VisiPlot/VisiTerm **CALL**
MUSE/Super Text **CALL**

MOUNTAIN COMPUTER/
Expansion accessories for Apple/Super Talker/The Music System/ROM plus board with Keyboard filter/ROM Writer/Clock Calendar/AtoD and DtoA Converter/Clock for Apple/CPS Multifunction Board **CALL**

VIDEX/Video Term (80 col. x 24 line, 7x9 Matrix plug in compatible board for Apple II) w/wo graphics EPROM/SSM Serial & Parallel, Apple Interface/ABT's Numeric Key Plan/California Microcomputer Keyboard **CALL**

NEW!
VIC 20 PERSONAL COMPUTER FROM COMMODORE
$299.

IMPORTANT ORDERING INFORMATION
CALL: 800 343-5504. In Massachusetts (617) 491-2700, phones open from 8:30 a.m. to 7:00 p.m. Mon-Fri. 11:00 a.m. to 4:00 p.m. Sat.
PO's: Accepted from Dun & Bradstreet rated companies—shipment contingent upon receipts of signed purchase order.
SALE PRICES. Valid for month of magazine date only—all prices subject to change without notice. Our Ann Arbor retail store is open 11:00 a.m. to 7:00 p.m. Tues-Fri. 10:00 a.m. to 5:00 p.m. on Saturdays.

SYSTEMS APPLE II STARTER

$1895.

SAVE OVER $200 ON OUR BEST SELLING APPLE SYSTEM/ System includes a 48K Apple II, Apple Disk, DOS 3.3 and Controller and a Sup R MOD RF Modulator.
List $2209.

EXCLUSIVE FOR THE APPLE: Magic Wand, Videx, Z-80 softcard (Requires 48K Apple and disk).
COMPLETE SYSTEM $925.

APPLE ACCESSORIES

CHOOSE FROM: Silentype Printer w/x face/Light Pen/Easy Writer (80 col. need a Videx)/Clock for Apple.

FROM MICROSOFT: 16K RAM Board/FORTRAN.

FROM COMPUTER STATION: Hi-Res Dump for 460 Printer.

OUR APPLE INVENTORY IS COMPLETE. WE'VE GOT IT ALL— CALL US FOR PRICES

SYSTEMS COMMODORE WORD PRO

$4695.

CRISP LETTER QUALITY OUTPUT UNSURPASSED EASE OF OPERATION

This Compumart/Commodore system includes a **COMMODORE 8032 32K CPU**, a **4040 DUAL DISK**, a **C-ITOH PRINTER** and x/face and **WORDCRAFT 80** (all cables included).
List $5385.

CALL FOR DETAILS AND LOW PRICES

A COMPLETE SYSTEM: includes a **DUAL DISK DRIVE/TRACTOR PRINTER** and an **80 COLUMN 32K CPU**. No interfaces needed. Cables included. List $3685.
COMPUMART $3335.

SAVE $200 ON COMMODORE ACCESSORIES WITH PURCHASE OF A 32K PET—SAVE $100 WITH A 16K PET.

CHOOSE FROM: Visicalc/Word Pro 4/Wordcraft 80/ Ozz the Information Wizzard/ Dow Jones Portfolio Mgmt System/ Assembler Development Package.

SYSTEMS HP 83 BASIC

$4249.

This Basic System from Hewlett-Packard includes **HP-83/ROM DRAWER/MASS STORAGE ROM/ 5¼" SINGLE MASTER FLEXIBLE DISK DRIVE/HP-1B INTERFACE MODULE/2 METER HP-1B CABLE.**

SAVE $400 ON HP-85 SERIES ACCESSORIES WITH THE PURCHASE OF AN HP-85.

CHOOSE FROM: PERIPHERALS; Disk Drives to Graphics Plotters ENHANCEMENTS; Basic Training/ General Statistics/Financial Decision/Math/Linear Programming ($95 EA.) ACCESSORIES; Enhancement ROM's/ ROM drawer/Overhead Transparency Kit SUPPLIES; Plotter Pens/Tape Cartridges INTERFACE MODULES; HP-1B Interconnect Cables/Serial (RS-232C) Interface Module.

WE CARRY EVERY PERIPHERAL MADE FOR THE HP-85. CALL US FOR PRICES

SYSTEMS AIM 65 STARTER

$795.

FROM ROCKWELL
Our **AIM** Starter System for Educational & Laboratory use includes **4K AIM/BASIC & ROM/ASSEMBLER & ROM/POWER SUPPLY EG1 ENCLOSURE/CRAIG TAPE RECORDER.**

ACCESSORIES FOR AIM STARTER: PL 65 High Level Language/Paper for the Aim (roll)/Rockwell's 4 slot Motherboard/
CALL

WE ALSO CARRY RM EXPANSION ACCESSORIES FOR THE AIM-65. CALL FOR SPECS AND PRICES

800-343-5504

IN MASS CALL 617-491-2700

Systems Customized

COMPUMART

65 Bent Street, Dept 108
PO Box 568, Cambridge, MA 02139

From THE LEADER...

We just might be the largest independent small systems dealer in the country. Here's why:

COMPUMART has been serving the computer needs of industry since 1971.

We stock, for immediate shipment, only those products from the finest micro-computer manufacturers.

And any product, except software, can be returned within 10 days for a full refund—even if you just change your mind. We also honor all manufacturers' warranties. Our expert technicians will service any product we sell

Call us for more information on products, product configuration and service. Our phones are open Monday thru Friday, 8:30 a.m. to 7:00 p.m. and Saturday 11:00 a.m. to 4:00 p.m.

We have a staff of highly knowledgeable sales people waiting to hear from you, and to help. Because service is what we're all about.

Circle 62 on inquiry card.

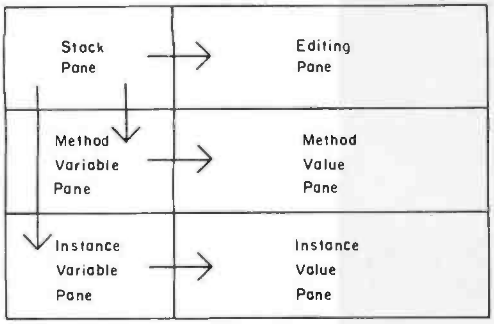


Figure 5: *Principal dependencies among panes of a notify window.*

Text continued from page 134:
program under test would be aborted. Let us issue the "frame" command instead. The notify window grows larger and acquires a total of six panes (photo 17c). Their interdependencies are diagrammed in figure 5.

The upper left pane is the stack pane retained from before. The upper right pane is an editing pane. If you select RegularPolygon >> plot: in the stack pane, its method definition appears in the editing pane. You can scroll through the definition and even edit it there and recompile as in the browser.

The middle two panes are the "context variable" and "context value" panes. They are analogous to the two panes of an inspect window, but, in this case, the variables you can examine are the arguments and local variables of the method selected in the stack pane. Click ink in the variable pane to see its value in the value pane.

The bottom two panes are the "instance variable" and "instance value" panes. They also are analogous to the panes of an inspect window. They let you examine the instance variables of the receiver of the message selected in the stack pane. Click center to see its value appear in the value pane.

You can type statements into the value panes and execute them using "do it" (photo 17d). They will be executed in the context of the method selected in the stack pane—that is, they may refer to arguments and local variables of the method and to instance variables.

Debugging

You could step through the execution of the method in the editing pane. You would select one statement at a time in the editing pane and issue the "do it" command. To close in on the planted bug, we can evaluate self cornerAngle, an expression on the last line of the method. Select that expression and issue the "do it" command (photo 18a). The answer, 120, appears to the right of the question (photo 18b). Since the interior angle of a regular

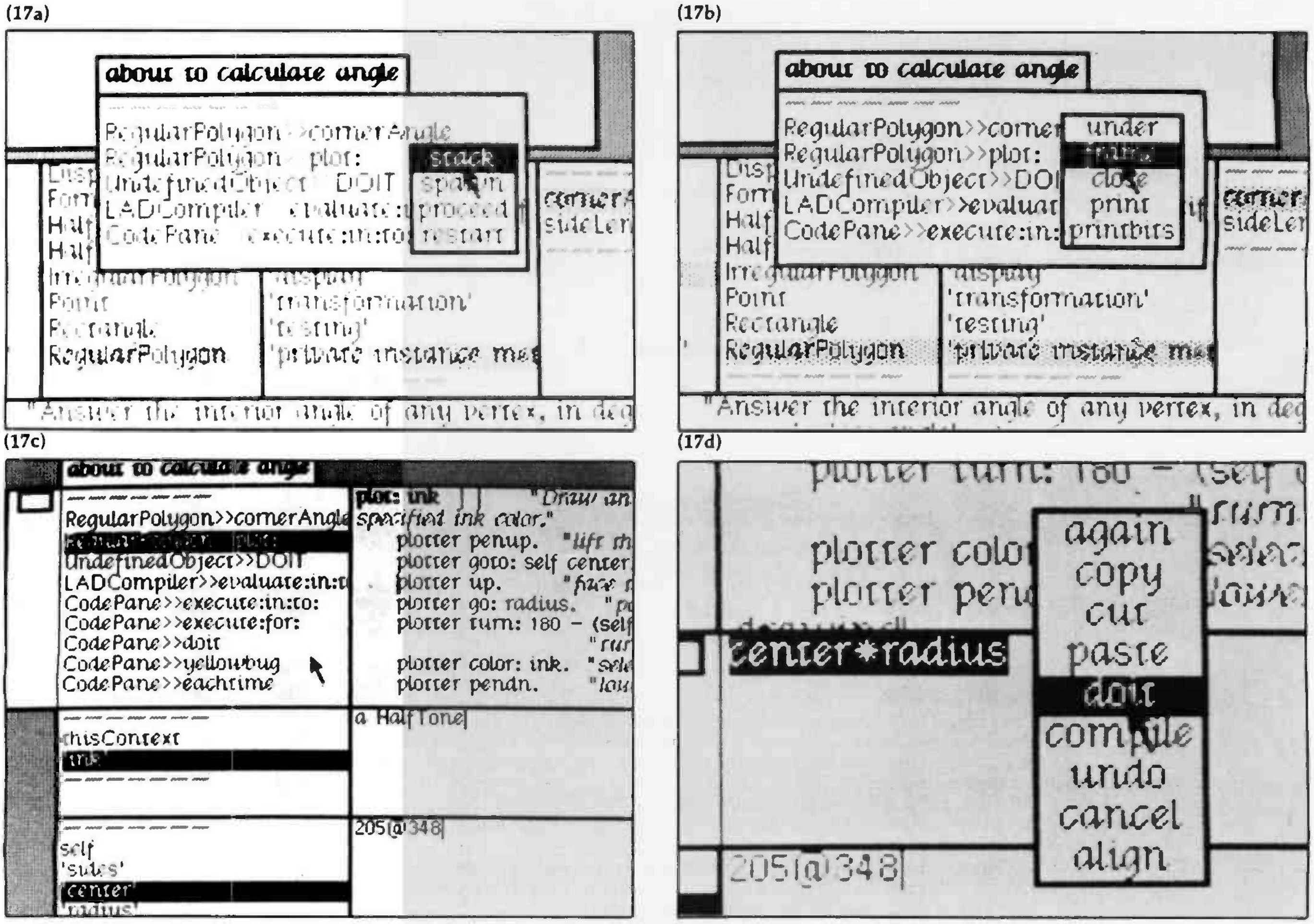
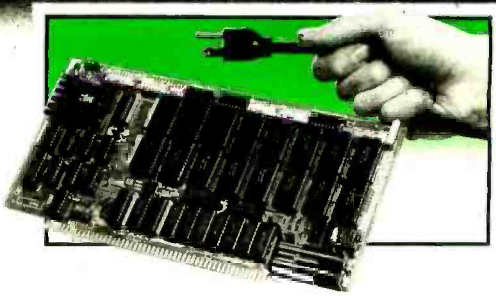


Photo 17: *Use of the "notify" window.*

MEMORY

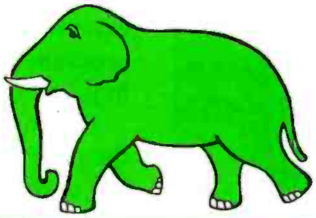
Blackout!

A PROBLEM FOR YOUR PRESENT RAM?



Don't Curse the darkness. Get our non-volatile memory and watch elephants turn green with envy!

Are you looking for a reliable non-volatile memory on a rugged industrial-standard IEEE-696 S-100 card? Your search is over. Our CMOS memory modules have a battery backup that is guaranteed to keep programs and data intact for a year. We didn't sacrifice performance for non-volatility in the design of our CMEM module, so you get all the card you're looking for . . . we even supply the battery.



- ☐ 32K on a single board, 8 or 16-bit cpu compatible.
- ☐ Switch selectable addressing on 4K boundaries.
- ☐ Extended memory addressing through 24-bit lines.
- ☐ 250 nanosec access time, no wait states required.
- ☐ Runs at 4 MHz for both 8 and 16-bit S-100 systems.
- ☐ Programs developed & stored w/out disks or tapes.
- ☐ Power fail interrupts.
- ☐ Software programmable write-protect window.
- ☐ 8K bytes-$695, 16K bytes-$895, 32K bytes-$1095.

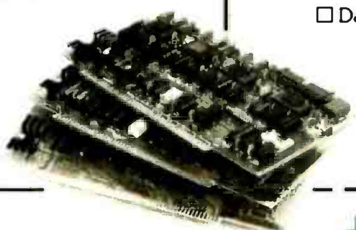
The DUAL 77 Data Acquisition and Control System is a turnkey system built to industrial standards and it comes ready to perform. As with all our systems and modules, our computer was designed with the wicked environment of the real world in mind. BASIC language makes programming easy and the built-in interface simplifies access to hundreds of sensors. The enormous expandability of the system allows its growth to meet your increasing needs, even if you enjoy learning new languages. The DUAL 77 is economical; $9995 or higher with options.

DUAL SYSTEMS CONTROL CORPORATION
1825 Eastshore Highway, Berkeley, CA 94710
Phone (415) 549-3854 or (415) 549-3890

A/D CONVERTER

This S-100 based module is designed to withstand the rugged environment of the laboratory or in industry for general use in converting analog signals to digital information.

- ☐ 32-channel single-ended, 16-channel differential.
- ☐ 12-bit resolution and accuracy.
- ☐ 30-microsecond conversion time.
- ☐ Instrumentation amplifier on board.
- ☐ BASIC program for use provided.
- ☐ $695 or $785 w/1-1000 gain transducer amplifier.



NON-STOP CLOCK

Now you can keep time even with the main power off. Our industrial level clock module utilizes a backup battery circuit for a full year.

- ☐ Day, date, hours, minutes and seconds.
- ☐ Features new LSI CMOS chip.
- ☐ Vectored interrupt capability.
- ☐ Dip switch selectable port address.
- ☐ Simple BASIC or Assembly language program.
- ☐ Precision quartz crystal clock. ☐ $250

D/A CONVERTER

The AOM-12 analog output module is an industrial level digital-to-analog (D/A) converter which converts digital commands from the computer into analog voltages.

- ☐ 12-bit ±½ L.S.B accuracy over full 0-70°C temperature range.
- ☐ Voltage outputs of 0-10 volts, ±5 volts, or ±10 volts.
- ☐ Short circuit protection on all voltage outputs.
- ☐ Switch-programmable port base address for multiple boards.
- ☐ $575

Dual Systems Control Corporation
Department B, 1825 Eastshore Highway
Berkeley, CA 94710 • (415) 549-3854

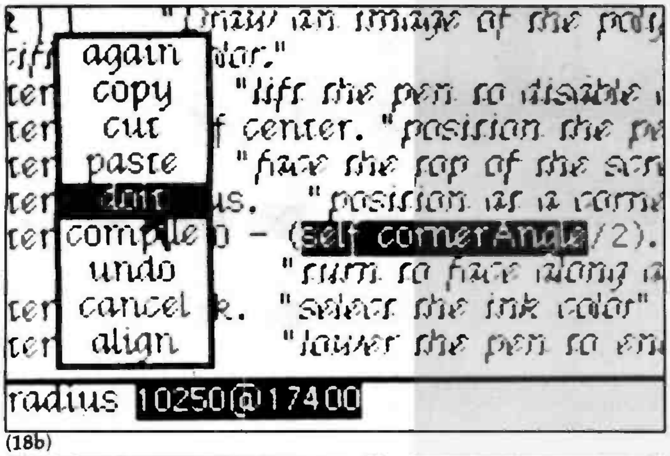
☐ Please send your brochure with complete details on modules.
☐ Please provide information on the DUAL 77 System.

Name ____________ Title ____________
Company ____________
Street ____________
City ____________ State ______ Zip ______

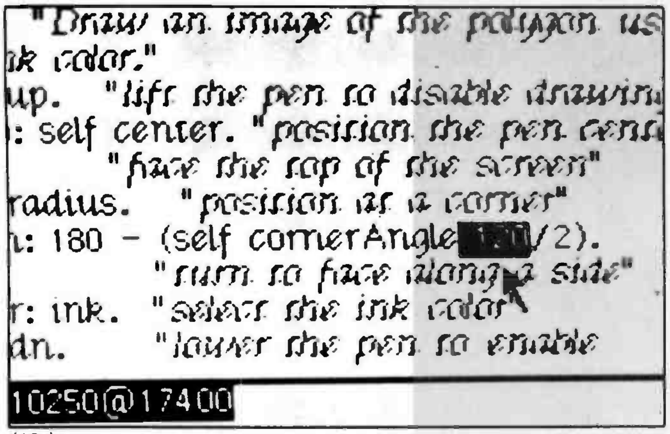
DEALER AND OEM INQUIRIES INVITED

Circle 122 on inquiry card.

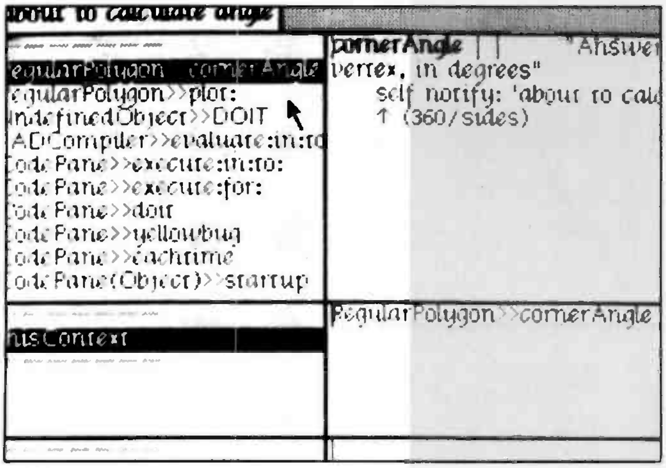
(18a)



(18b)



(18c)



(18d)

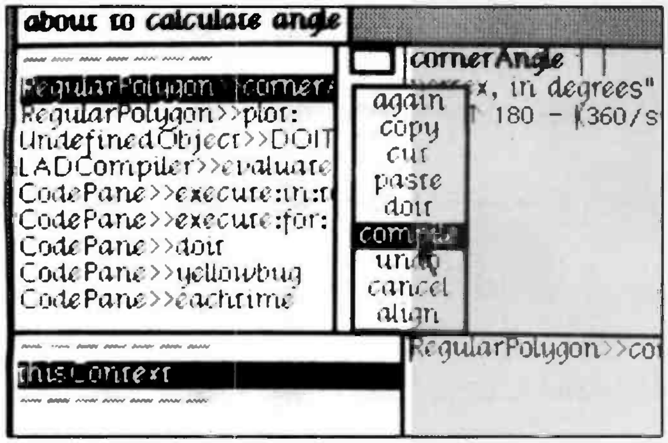


Photo 18: *Debugging a faulty method.*

triangle is 60 degrees, we have found the planted bug.

Now select RegularPolygon>>cornerAngle in the stack pane. Its method definition, including the breakpoint we set, appears in the editing pane (photo 18c). Use standard editing to remove the breakpoint, correct the error, and recompile the editing pane (photo 18d).

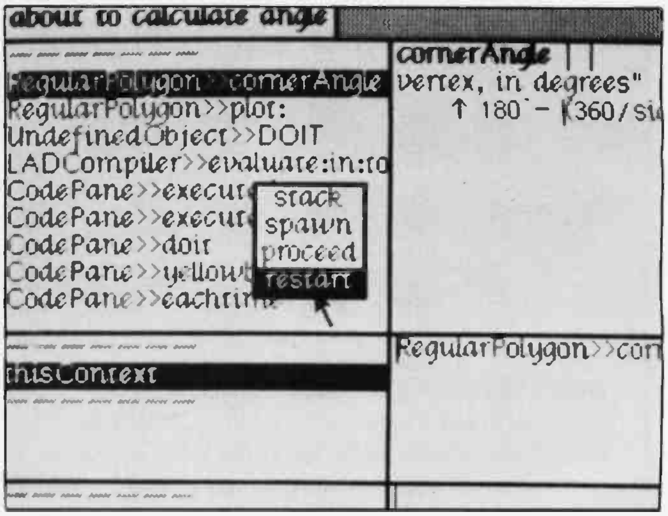
You can randomly access any level in the stack by clicking it in the stack pane.

Resumption

After recompiling a method, you can resume execution from the beginning of any method on the stack using the "restart" command in the stack-pane menu (photo 19a). This lets the test proceed (photo 19b) without having to start over from the work-space window. Resumption of execution after a correction is a handy capability when a program that has been running well encounters a minor bug.

The entire stack of the process under test was saved in the notify window. When a notify window appears, the rest of the system is not preempted. You are not required to deal with the notify window when it appears. You can

(19a)



(19b)

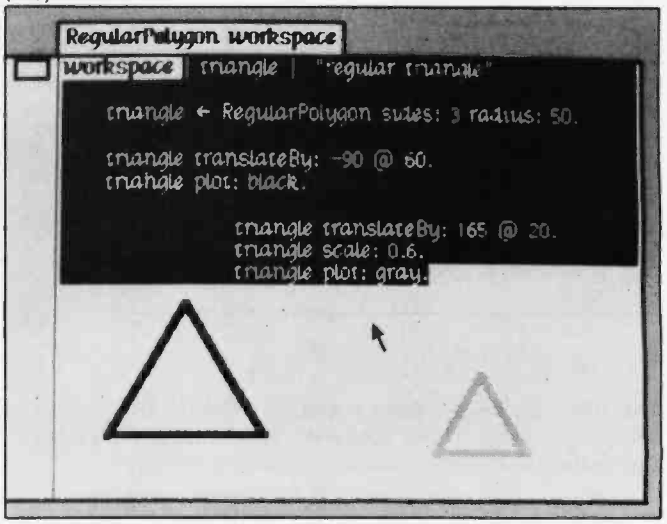


Photo 19: *Compilation of a faulty method can be continued without restarting, once the error has been corrected.*

New Products From Orange Micro

Mix APPLES and ORANGES?

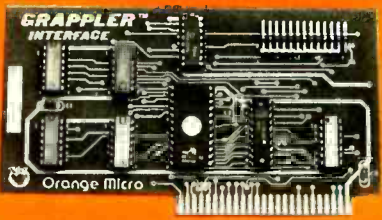
. . . And you get GRAPHICS!

NEW

THE GRAPPLER™ Apple Interface and Cable

FROM ORANGE MICRO

The Grappler™ Interface is the first universal parallel interface card to provide on-board firmware for Apple high resolution dot graphics. No longer does the user need to load clumsy software routines to dump screen graphic – it's all in a chip. Actually, it's our E-PROM, and there are versions to accommodate the Anadex, Epson MX80 & MX70, IDS Paper Tigers, Centronics 739, and future graphics printers. The Grappler™ accepts 18 software commands including Hi-Res inverse, 90° rotation, double size, and much more.



GRAPPLER INTERFACE FEATURES

TEXT FEATURES:
Printer Bell on/off
High Bit on/off
Left Margin
Right Margin
Var. Line Length
Var. Page Length (skip over perf.)
Video on/off
Alternate Command Chars.
Text Screen Dump

HI-RES GRAPHICS FEATURES:
Print Hi-Res Page 1 or 2
Print Inverse
Rotate Picture 90°
Single/Double Size
Variable Left Margin
Chart Recorder Mode

$165.00 Includes Cable

Dealer/Distributor Inquiries Invited

NEW

MX80/MX70 FRICTION FEED

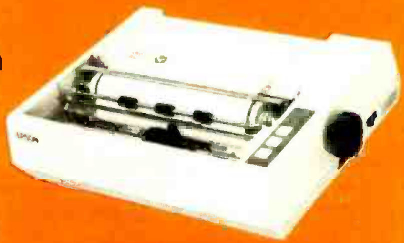
FROM ORANGE MICRO

HERE AT LAST! A friction feed kit for your EPSON MX80/70. The kit allows the user to convert his Epson printer to a friction feed and pin feed mechanism.

The friction feed will accept single sheets of your letterhead, or multiple copy forms such as invoices with up to 4 part carbon copies.

The pin feed replaces the adjustable sprocket mechanism. It allows use of 9½" wide continuous fanfold paper which is an industry standard size.

No drilling required. Installation takes about 15 minutes. All parts are included with easy to follow instructions.



$75.00

Dealer/Distributor Inquiries Invited

CALL FOR FREE CATALOG

(800) 854-8275

CA, AK, HI (714) 630-3322

RETAIL PRINTER STORES:
3150 E. La Palma, #I, Anaheim, CA.
13604 Ventura Bl., Sherman Oaks, CA.
Store Hours: M-F 10-6 Sat. 10-4

Phone orders WELCOME; same day shipment. Free use of VISA & MASTERCARD. Personal checks require 2 weeks to clear. Manufacturer's warranty included on all equipment. Prices subject to revision.

Orange Micro, Inc.
3150 E. La Palma, Suite I
Anaheim, CA 92806

work in other windows and come back to it later, cause other notify windows to be created, or work a little in the notify window and then do something else. There are no modes.

Error Notifications

Error messages are no different from breakpoints, except that if they are supposed to be "unrecoverable" they are programmed as:

```
self error: 'error whatever'.
```

If the user "proceeds" out of the notify window after an error, the process under test is terminated.

The most frequently encountered Smalltalk error is "Message not understood." It occurs when a method is sent to an object and neither that object's class nor any of its superclasses defines a method to receive that message. Let us edit the method sideLength (photo 20a) to send the message cosine instead of cos. After recompiling that method (photo 20b) and reexecuting the test program, a notify window appears (photo 20c) to announce that class Real and its superclasses do not define cosine.

In most programming systems, equivalent error conditions such as "undeclared procedure" and "wrong number of arguments" are issued at compile time. Smalltalk cannot detect these conditions until run time because variables are not declared as to type. At run time, the object sent the message cosine could be an instance of a class that did define a method of that name.

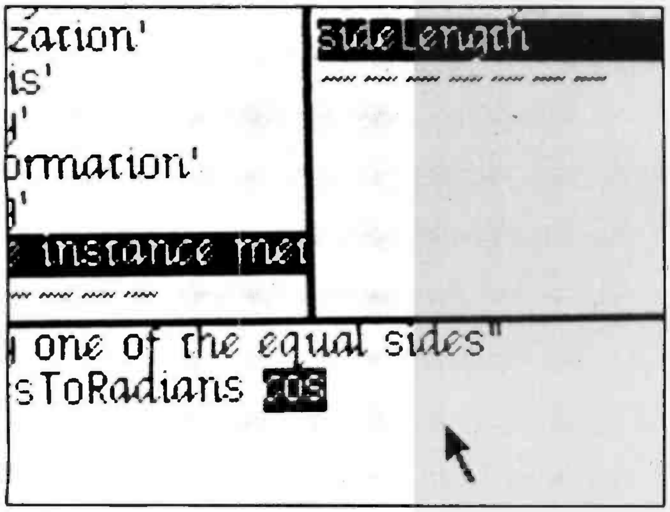
Type Checking

When we program in languages like Pascal, we depend on type checking to catch procedure-call errors early in the software-development process. In return, we have to take extra time maintaining type declarations, and we lose the very powerful ability to define "generic" or "polymorphic" procedures with the same name but with parameters of varying types.

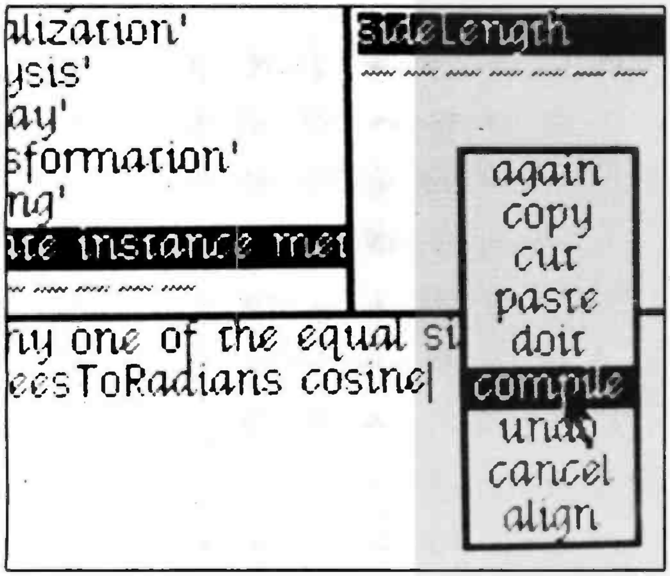
Type checking is important in most systems for four reasons, none of which is very important in Smalltalk:

- Without type checking, a program in most languages can "crash" in mysterious ways at run time. Even with type checking, most programming systems can crash due to uninitialized variables, dangling references, etc. Languages with this feature are sometimes called "unsafe." Examples of unsafe languages are Pascal, PL/1, and C. Examples of fairly safe languages are BASIC and LISP. Smalltalk is a safe language. It cannot be wiped out by normal programming. In particular, it never crashes when there are "type mismatches." It just reports a "Message not understood" error and helps the programmer quickly find and fix the problem through the notify window.
- In most systems, the edit-compile-debug cycle is so tedious that early error detection is indispensable. In Smalltalk, type errors are found early in testing, along with value-range errors and other bugs.
- Type declarations help to document programs. This is true, but well-chosen variable names and pertinent comments provide more specific information than do type declarations. A poor documenter can convey as little information in a strongly typed program as in an untyped program.

(20a)



(20b)



(20c)

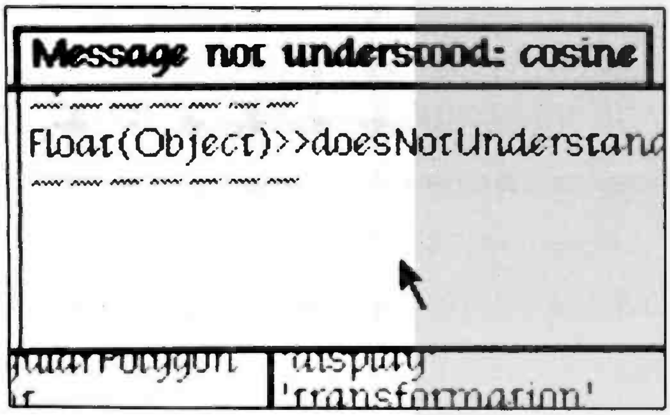
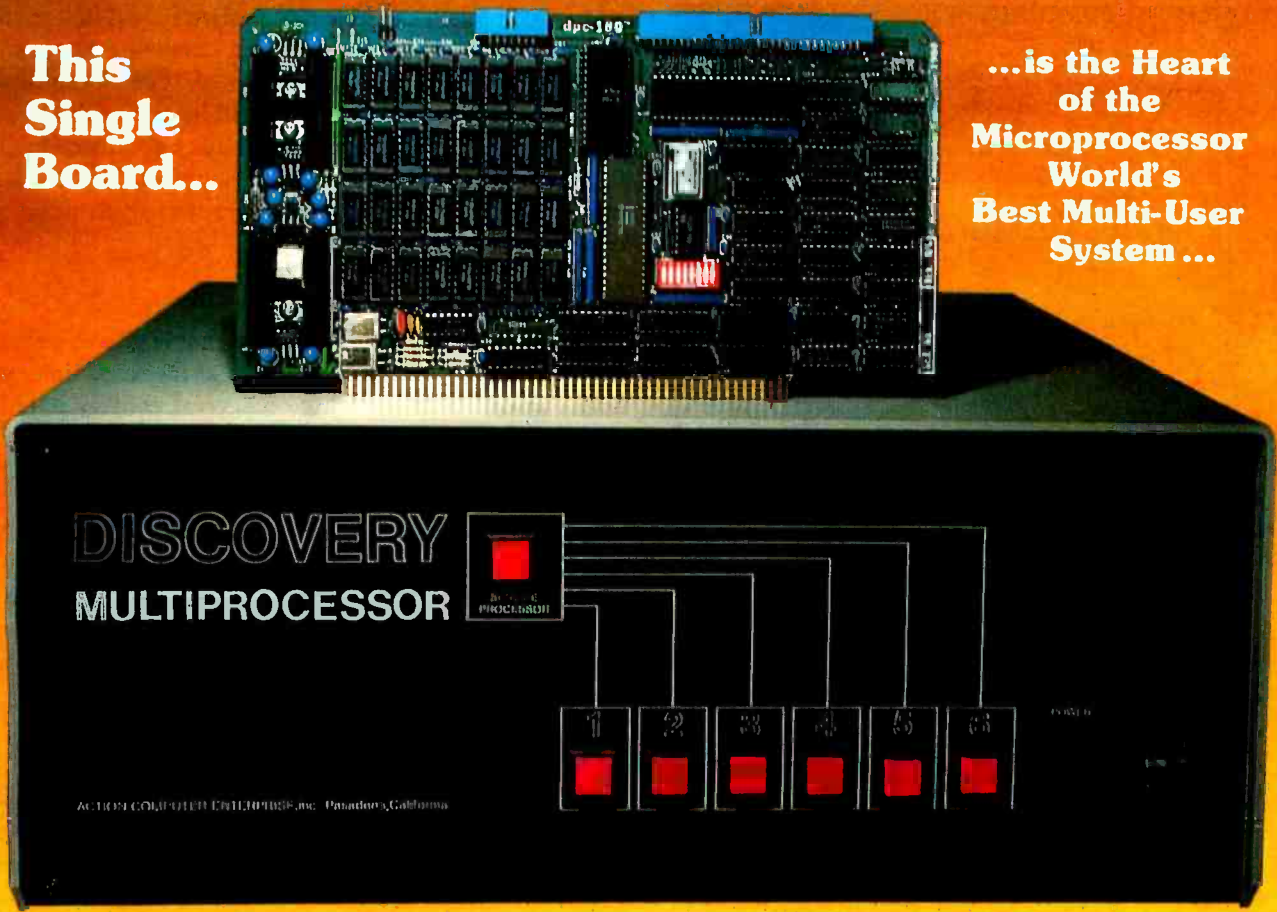


Photo 20: *Displaying an error in a faulty method.*

This Single Board...

...is the Heart of the Microprocessor World's Best Multi-User System...



THE DISCOVERY MULTIPROCESSOR

The dedicated power of this complete single board computer is provided to each user, making the DISCOVERY MULTIPROCESSOR unique among multi-user systems. With the power and expandability of distributed processing ● With the economy of shared peripherals ● With the flexibility of shared and public files ● And all of this with full CP/M* and S-100 compatibility.

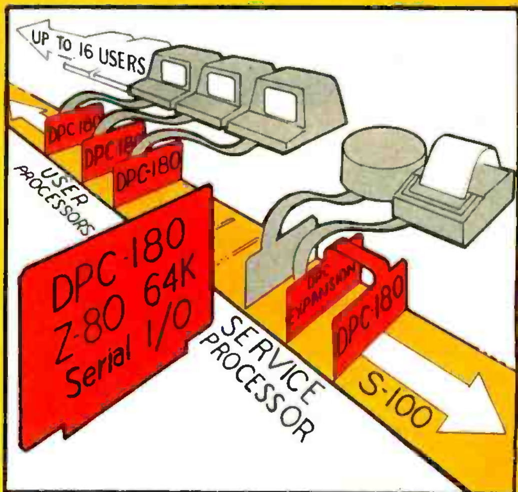
Multiprocessing Software

Our Distributed Processing Operating System, **dpc/os**©, resides in the Service Processor, establishing a CP/M environment for each user and managing access to the shared system resources. Multiuser facilities are provided for print spooling, for interprocessor communication and for private, public and shared-update files. Several processors can be employed concurrently by a single user via the enhanced batch submit facilities. And with **DISCOVERY** all CP/M compatible programs will execute without modification, thus protecting your software investment.

Multiprocessing Hardware

The ACE 64K Distributed Processing Single Board Computer, the **dpc-180**™ gives the **DISCOVERY** MULTIPROCESSOR its own unique architecture. One DPC is dedicated to each user providing exclusive use of the onboard Z-80, 64K ram and serial I/O. Access to the shared resources is provided by an expanded DPC used as a Service Processor. Additional users can be added at any time by simply inserting additional DPC's, into the standard S-100 bus — up to a total of sixteen user processors in a single chassis!

*CP/M is a registered TM of Digital Research, Inc.



The ACE **DISCOVERY MULTIPROCESSOR** dedicates a complete 64K Z-80 Distributed Processing single board Computer, the **dpc-180**™ to each user. An expanded DPC coordinates all of the system activities.

Multiuser mainframes with 192K ram start at under $6000. The 64K **dpc-180**™ is priced at $1395. Immediate delivery. A complete line of standard peripherals including a 26M byte hard disk subsystem can be supplied on request. Dealer and OEM inquiries are invited.

DISCOVERY has been proven in installations throughout the World. If you need the Power of Multiprocessing... it's time you discovered us!

Action Computer Enterprise, Inc.
The Multiprocessing Company
55 West Del Mar Boulevard, Pasadena, California 91105 USA ● Cable ACEPAS Pasadena ● (213) 793-2440

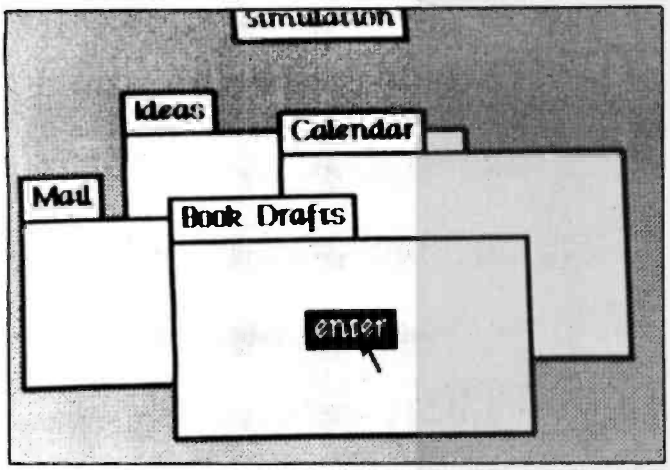
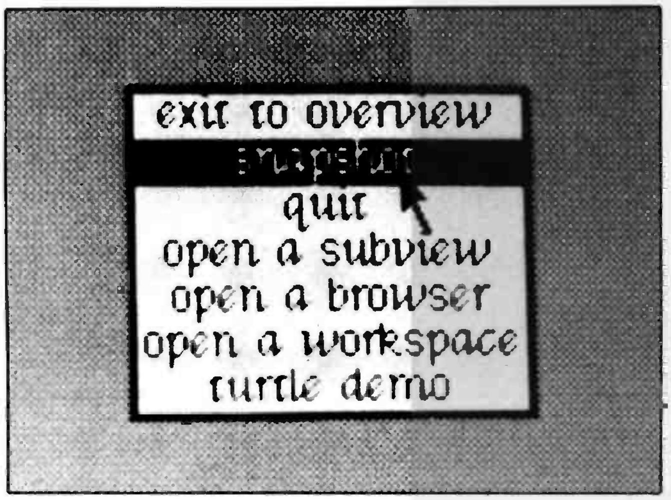


Photo 21: *Project windows in Smalltalk. Each window, when selected, makes available all the windows associated with that project.*

(22a)



(22b)

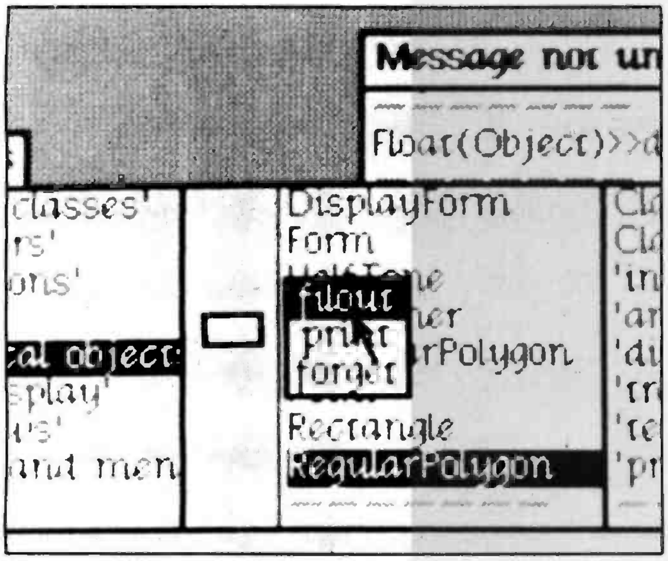


Photo 22: *Recording results in Smalltalk. The current state of the Smalltalk system can be saved with "snapshot." Smalltalk code can be saved to a text file by using "filout" and restored by using "filin."*

•Most compilers can generate more efficient object code if types are declared. Existing implementations of Smalltalk cannot take advantage of type declarations. We expect that future versions will have that ability. At that time, type declarations may be added to the language. They probably will be supplied by the system rather than the user, using a program-analysis technique called "type inference."

Project Windows

Although overlapping windows enable you to keep the state of several tasks on the screen at the same time, you may sometimes be working on several entirely different *projects*, each involving several tasks. Smalltalk lets you have a different "desk top" for each project. On each desk top are windows for the tasks involved in that project. To help you travel from one desk top to another, a desk top can have one or more *project windows* that show you other available desk tops and let you switch to one of them (photo 21).

Saving Programs

In unintegrated systems, you create a program using standard text-editing facilities. Then, using standard utility programs, you can obtain a program listing on paper, back up the program on other media, and transmit the program to other people. In an integrated system, equivalent capabilities must be provided within the system itself. Some of the program-saving capabilities of Smalltalk are described briefly below.

One important facility is the *snapshot* (photo 22a). The entire state of the Smalltalk environment—including class and method definitions, data objects, suspended processes, windows on the screen, and project desk tops—can be momentarily frozen and saved on secondary storage. The snapshot can be restored later and resumed. People familiar with the *sysout* in InterLISP or the *workspace* concept in APL will understand the benefit of this facility.

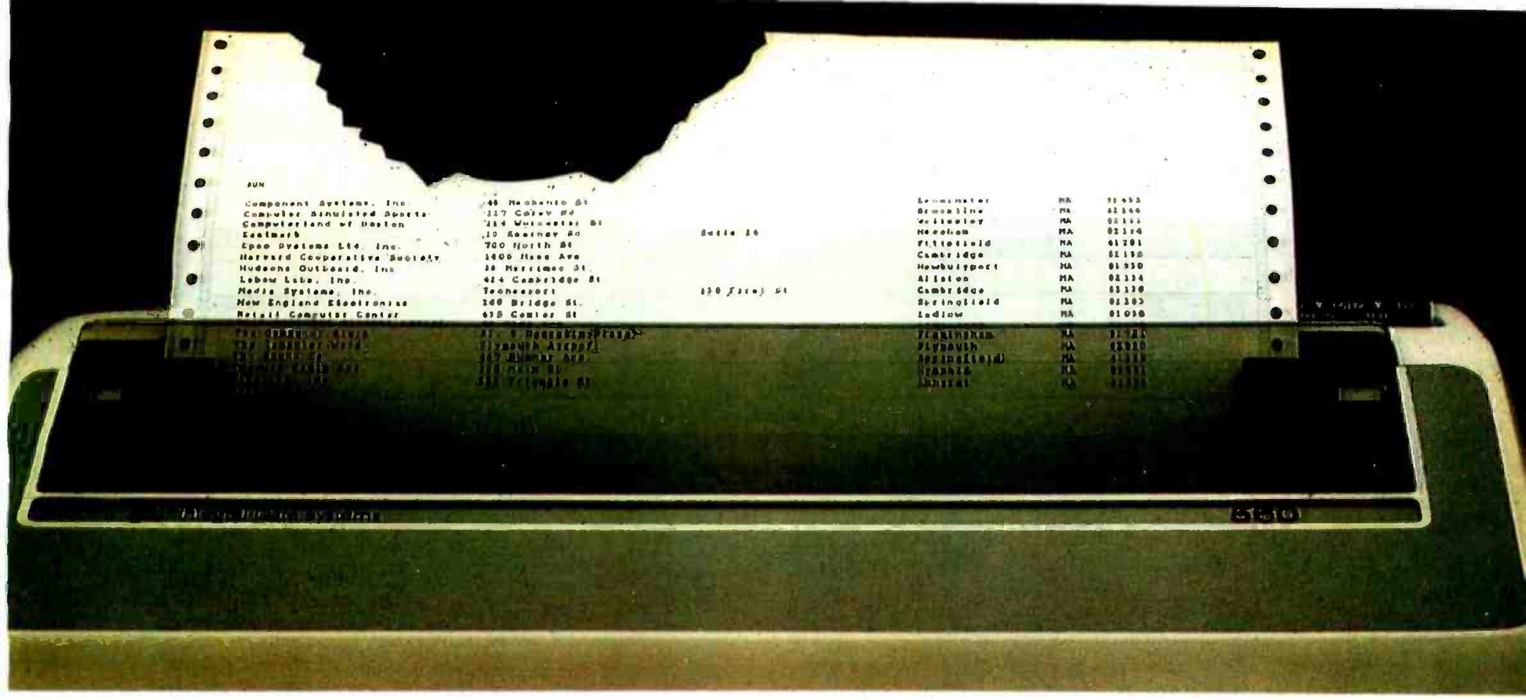
Another facility allows definitions of one or more methods or classes to be listed on a printer. A related facility is *filin/filout*. The *filout* message (photo 22b) writes an ASCII representation of one or more definitions onto a conventional text file. The definitions can then be transfused into another Smalltalk environment by using the *filin* message in that environment.

Often, during a programming session, the user changes a number of method definitions that are scattered throughout many classes and cannot recall which ones were changed. The *changes* facility automatically keeps a record of what definitions changed in each project, and makes it easy for the user to *filout* those definitions at the end of the session.

Implementation of the Environment

Because Smalltalk is an integrated environment, all the facilities described in this article are implemented in the

Text continued on page 147



Meet the Tiger with a bigger bite.

Introducing the remarkable 132-column Paper Tiger™ 560. The first full-width matrix printer to give you fully formed characters for a low $1695.*

The new 560 features a staggered nine-wire ballistic type print head that overlaps dots in both horizontal and vertical planes. It bi-directionally prints up to 150 dense, text quality characters per second.

The 560 also features a reliable cartridge ribbon that lasts up to four times as long

```
presents a breakthrough in matrix printin
ering the user excellent print quality wit
ce of a matrix printer.  Employing a uniq
red column" head manufactured by Integr
 creates high quality printouts by overla
```

Paper Tiger 560 Print Sample

as spool and cassette ribbons, separate heavy-duty stepper motors to drive the print head and advance the paper, plus true tractor feed.

And famous Paper Tiger performance comes with every new 560. Like fixed or proportionately spaced text, programmable tabbing and business forms control, automatic text justification, print formats to 220 columns, parallel and serial interfaces, self-diagnostics, and more. All inside the most compact printer of its kind.

Need more stripes? Dotplot,™ our high-resolution raster graphics package, is standard on every 560.

For data processing, word processing and small business applications, this is your Tiger. The business-sized Paper Tiger™ 560.

It's a Tiger you can count on.

Call TOLL FREE 800-258-1386 (In New Hampshire, Alaska and Hawaii, call 603-673-9100.) Or write: Integral Data Systems, Inc., Milford, NH 03055.

Paper Tiger 560

Integral Data Systems, Inc.

Circle 172 on Inquiry card.

*Suggested U.S. retail price.

Text continued from page 144:
high-level language, including modeless editing, windows, the compiler, and the notify mechanism. This was possible because Smalltalk represents everything, including the dynamic state of its own processes, as objects that remember their own state and that can be sent messages by other objects. Using the browser, you can examine and (carefully) change the definitions of the software-development aids.

In the implementation of Smalltalk-76, classes InspectWindow, BrowseWindow, and NotifyWindow are all tiny subclasses of class PanedWindow, which defines their common behavior. Similarly, classes StackPane, VariablePane, ValuePane, and so on, are all tiny subclasses of class ListPane. The superclass defines common behavior such as scrolling and selecting entries.

If someone shows you a system claimed to be "Smalltalk," find out whether the software-development aids exist and whether they are programmed as class definitions in the high-level language. If not, the system is not bona fide.

Conclusions

The Smalltalk programming environment is *reactive*. That is, the user tells it what to do and it reacts, instead of the other way around. To enable the user to switch between tasks, the state of the tasks is preserved in instantly accessible windows that overlap on desk tops. To give the user the maximum freedom of choice at every moment, modes rarely occur in the user interface. The result of this organization is that tasks, including software-development tasks, can be accomplished with greater speed and less frustration than is usually encountered in computer systems. ■

References

1. Sneeringer, J. "User-Interface Design for Text Editing: A Case Study." *Software—Practice and Experience 8*, pages 543 thru 557, 1978.
2. Swinehart, D C (thesis). "Copilot: A Multiple Process Approach to Interactive Programming Systems." *Stanford Artificial Intelligence Laboratory Memo AIM-230*, Stanford University, July 1974.
3. Kay, A and A Goldberg. "Personal Dynamic Media." *Computer*, March 1977 (originally published as *Xerox PARC Technical Report SSL-76-1*, March 1976, out of print).
4. English, W, D Engelbart, and M Berman. "Display-Selection Techniques for Text Manipulation." *IEEE Transactions on Human Factors in Electronics*, volume 8, number 1, pages 21 thru 31, 1977.
5. Card, S, T Moran, and A Newell. "The Keystroke-Level Model for User Performance Time with Interactive Systems." *Communications of the ACM*, volume 23, number 7, July 1980.
6. Goldberg, A and D Robson. "A Metaphor for User-Interface Design." *Proceedings of the Twelfth Hawaii International Conference on System Sciences*, volume 6, number 1, pages 148 thru 157, 1979.
7. Borning, A. "ThingLab—A Constraint-Oriented Simulation Laboratory." To appear in *ACM Transactions on Programming Languages and Systems* (originally published as *Stanford Computer Science Report STAN-CS-79-746* and *Xerox PARC Technical Report SSL-79-3*, July 1979, out of print).

← Circle 38 on inquiry card.

User-Oriented Descriptions of Smalltalk Systems

Trygve M H Reenskaug
Central Institute for Industrial Research
Blindern, Oslo 3
Norway

For many people, the workings of a computer remain a mystery. Just exactly what the computer does and how it does it is locked within the code of a computer language. The computer and the user understand two completely different languages. It is well known that only a few systems are designed and written so that they can be understood by the user. More than twenty years of experience has shown that a bad system design can never be hidden from the user, even by a masterfully devised user interface. A quality system, therefore, must be based on sound design that can be described in terms with which the user is familiar.

The Smalltalk system has been designed to handle a great variety of problems and solutions. It, therefore, provides the greatest possible flexibility for writing any kind of system a programmer may desire. While this flexibility is essential for experimenting, there is the potential for disastrous results if restrictions are not put on the system structures that are available to the application programmer.

This article shows how the basic metaphors of Smalltalk can be used to describe complex systems. Since this magazine is not yet distributed in a form readable by Smalltalk, we have to restrict ourselves to traditional written documentation. (Let it be a challenge to Smalltalk experimenters to convert this presentation into a graphic and dynamic one.)

The Smalltalk system user will most likely employ his system to organize the large amount of information that will be available to him,

More than twenty years of experience has shown us that a bad system design can never be hidden from the user, even by a masterfully devised user interface.

such as reference materials in the form of market information, news services, and weather forecasts. Some data, such as travel information and bank transactions, may flow both to and from the owner. Other information, such as personal notes or material that is not yet ready for distribution, can remain private.

An individual's total information needs are very large and complex. His Smalltalk system, therefore, is also likely to be large and complex. The challenge to the Smalltalk experimenter is to find ways to structure systems so the user will not only understand how to use them, but also get an intuitive feel for their inner workings. In this way, the user can really be the master and the systems his faithful slaves.

An important part of any system is the software that controls the user's interaction with the information. Mastering the software is crucial to handling the information. With Smalltalk, software is just a special kind of information and is treated as any other information within the total system. It is available to the user in the usual manner.

A traditional way of describing software is through written documentation. Smalltalk provides more dynamic interfaces through the use of two-dimensional graphics and animation on the computer screen. Devising such interfaces is probably the greatest challenge in personal computing today, and it provides a rich field of endeavor for the interested experimenter.

System Descriptions

We can describe any application system in three different ways: *how it is used, its system structure,* and *its implementation*:

- *How it is used*—This is the least satisfactory type of description. The user operates the system through rote command sequences such as: *switch on the machine, type your password, hit button A, listen to your system saluting you by playing "Hail to the Chief."* Since 80% of all user manuals for electronic data processing systems are of this kind, we will not discuss them further here.

This level of understanding has been likened to walking around in a strange city following directions such as: "Go outside, turn right, walk straight ahead for four blocks, turn left . . . . " It is easy to get lost under such circumstances.

• *System structure*—With this type of description, the user has an intuition about the kinds of building blocks that make up the system, how they behave, and how they interact to form the complete system. We show that the basic Smalltalk metaphors of *objects* and *messages* are well suited to function as building blocks. The metaphors are simple and easy to understand; yet they permit construction of immensely powerful systems.

A basic system will have several thousand objects, and typical applications would contain many more.

Any Smalltalk system contains a large number of objects. A basic system will have several thousand objects, and typical applications would contain many more. The common software engineering device of *layering* becomes essential in making the whole thing manageable. In the description of a layer, essential function on that level is highlighted and inconsequential detail is relegated to lower levels. There is one absolute requirement of these simplified descriptions appearing on the different layers: *what is shown should be correct and complete as far as it goes.* This means that the structure of the description has to be a pure tree structure: the function of each module has to be limited to that module with *no hidden side effects upon the other modules.*

This level of understanding corresponds to the user having a street map of the system. He knows the major landmarks and the most important streets. This gives the user an intuition about the total structure and permits him tc find his way anywhere. It is almost impossible to get totally lost under these circumstances.

• *Implementation*—Descriptions at this level of understanding explain to the user how each individual object is built so that it behaves in the manner prescribed on the system structure level. Here he will find the third basic metaphor of Smalltalk, the *method.* A method is similar to a subroutine in other languages; it prescribes the actions to be taken by an object when it receives a message.

On all layers but the lowest, the behavior of an object is fairly complex, and we can think of it as composed of a number of *sub-objects* that are used to implement it. The purpose of the method is to enlist the aid of the sub-objects to implement the desired behavior. The user thus finds that the typical object is structured in much the same manner as his total system, and it consists of a number of sub-objects that send messages to each other. The description tool is recursive in that the same tool is used on all levels. This recursion description is probably the most powerful feature of Smalltalk. Once the user masters the few very general concepts, he can learn more and more about his system by simply using these concepts to dig deeper and deeper into the system layers. In addition, the user can modify and expand the system on any level by collecting new components out of the building blocks provided by the next level below it.

The user at this level now has an intuition of the overall layout of the city. He also has sub-maps of all the details and he knows how to read them. Depending on his personality, he may use these maps only when absolutely necessary, or he may use them to explore unknown territory. In contrast to the tourist, the Smalltalk user can even make modifications and new extensions to the city. The tools are there. The user decides if, when, and how he wants to use them.

Example of a System Description

The problem: Consider a small manufacturing company that has two

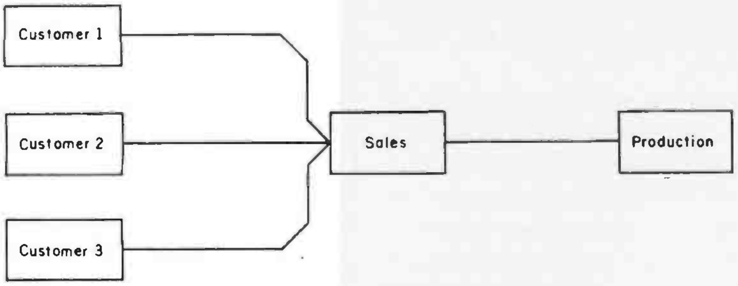


Figure 1: *A job-shop manufacturing company with its customers.*

departments: sales and production. The responsibility of the sales department is to find customers for any product the company can make, to contact the production department to find out when the product can be delivered, and to sign a contract with the customer. The responsibility of the production department is to manufacture each product as cheaply as possible at a specified level of quality and to have it finished on the promised date. When the production department has manufactured the product, it is dispatched to the customer through the sales department.

The system: A natural way to map this into a Smalltalk system would be to represent each department as an object. The function of the Sales object would be to keep track of the state of each sale in the following sequence:

1. Fill in and send proposals
2. Reserve the necessary resources in production for the product
3. Send contracts and packing notes to the customer

The function of the Production object would be to:

1. Keep track of commitments
2. Schedule the manufacture of products
3. Help keep the product quality
4. Control the manufacturing process to get the products completed on time

It also seems reasonable to include a third kind of object in our system: Customer objects. The purpose of these objects would be to act as a receptacle for the messages being passed from the company to the customer and from the customer to the company. The various objects with a set of reasonable communication channels is shown in figure 1.

The overall processing of an order: The Smalltalk system would be programmed to reflect everything of importance that takes place during the processing of an order and to support its user on every step. The process that takes place inside the Smalltalk system would, therefore, closely resemble the actual processing of an order. Let us assume the following real-life process, which is depicted in figure 2. A customer submits an intention to buy, a request for offer, to the company. The sales department books resources from the production department and returns an offer with the cost and delivery date to the customer. The customer answers with a purchase order. This is transcribed and passed from sales to production as a requisition. The product is manufactured in production, and a ready-note is sent to sales, which arranges for transport and sends packing notes to the customer.

In the Smalltalk system, the Sales object would help the user of the system in corresponding with the customer, in keeping track of progress, and in sending the required forms to the production department. The Production object would help the user in the planning and control of the manufacturing process.

In order to highlight the principles, we have made this a very simple system. The reader will have no difficulty in expanding it, for example, by adding an object for the accounting department that takes care of bill-

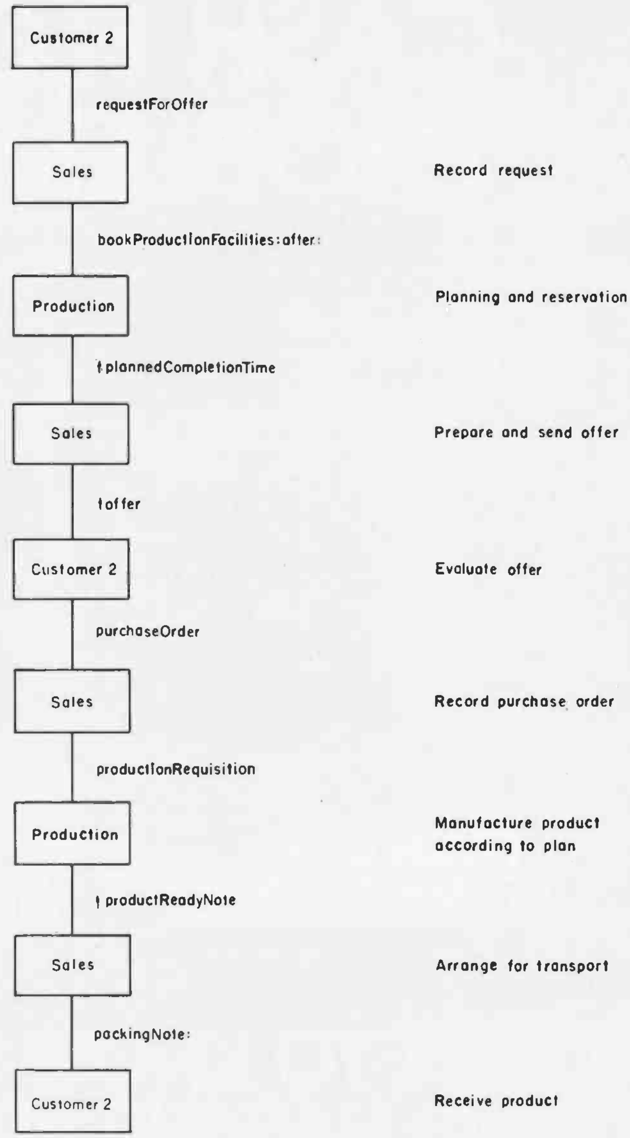


Figure 2: *The processing of an order. The Smalltalk system supports this processing through interaction with its owner in real-time.*

ing, an object for the warehouse that may or may not have the required product in stock, and so on. Also, figure 2 could probably be better documented on a Smalltalk computer by animating figure 1.

An Implementation Description

Let us inspect the Production object of figure 1 and see how it processes the message bookProductionFacilities: after:. When this message is received by the Production object, it consults its message dictionary to find the corresponding method. If the products were simple and the workshop small, the object could contain the current production plan directly and the method could go something like that shown in listing 1.

One of the instance variables of the Production object is the table productDuration which contains the time it takes to manufacture various products. Looking at this table, we find the duration for a product. In this simple example, there is only one resource, and we find the first available time slot for the product by sending self the message findFreePeriod: after:. This corresponds to calling a local subroutine in other systems. We then reserve the resource for our product in that period. (These two steps could have been combined into one, but the separation gives us more flexibility in varying the planning algorithm if we wish to do so later.)

TRANSFER YOUR DATA INTO

HARDCACHE™

THE HARDCACHE SUBSYSTEM:

- 30 Megabytes (Formatted) Winchester Disk
  Average access time 48 milliseconds
- Cartridge tape drive provides:
  Complete backup in under 10 minutes
  File save/reload
  Software distribution
- S-100 Bus Intelligent Interface Card
  DMA or programmed I/O data transfer
  Disk throughput optimizer
  Bootstrap ROM - switch selectable
  Time of day clock - battery powered
- Compatible with
  CROMEMCO
  VECTOR GRAPHICS
  NORTH STAR and other
  S-100 based computer systems
- Installs on any CP/M or
  MP/M system*

*CP/M and MP/M are registered trademarks of Digital Research.

EXECUTIVE SYSTEMS, INC.
15300 Ventura Boulevard
Sherman Oaks, California 91403
(213) 990-3457

Listing 1: *Smalltalk method for the message* bookProductionFacilities:after:.

```
bookProductionFacilities: productType after: earliestStartTime
    "Reserves production facilities for a new product of given type as soon as possible after the
      specified earliest starting time. Returns the planned completion time for the product."
  | duration plannedStartTime |
  duration ← productDuration at: productType.
  plannedStartTime ← self findFreePeriod: duration after: earliestStartTime.
  self reservePeriod: duration from: plannedStartTime.
  ↑ (plannedStartTime + duration)
```

Listing 2: *Alternate Smalltalk method for the message* bookProductionFacilities:after:.

```
bookProductionFacilities: productType after: earliestStartTime
    "Reserves production facilities for a new product of given type as soon as possible after the
      specified earliest starting time. Returns the planned completion time for the product."
  | productIdentification |
  productIdentification ← jobManager defineProduct: productType.
  jobManager schedule: productIdentification after: earliestStartTime.
  ↑ (jobManager plannedCompletionTime: productIdentification).
```

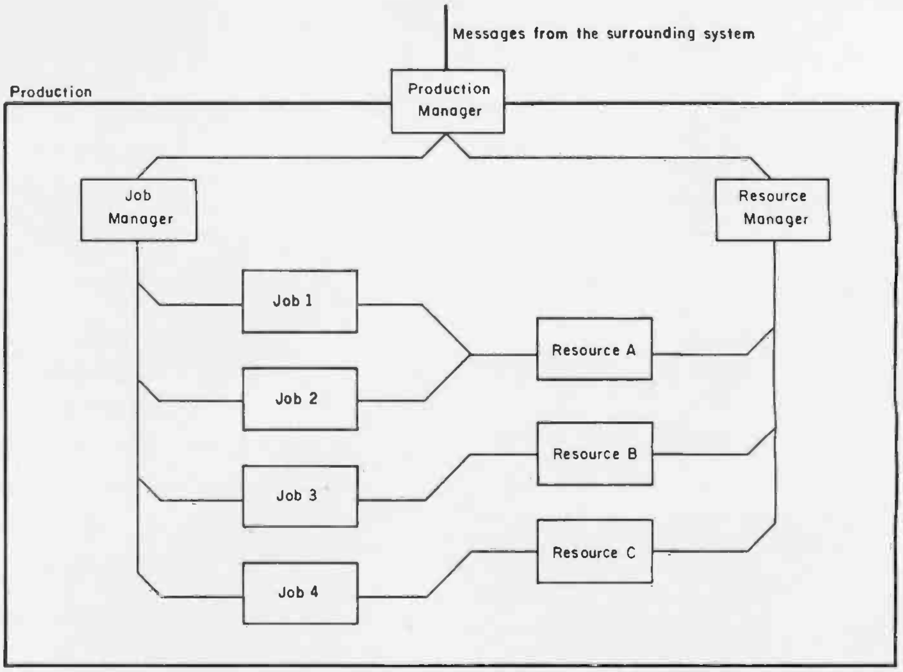


Figure 3: *The internals of the Production object.*

The planned completion time is returned to the sender, in this case the Sales object.

Lower-Level System Description

If the user wants more advanced aids for production control, the Production object would call upon the services of a subsystem of interconnected objects. A possible subsystem is shown in figure 3.

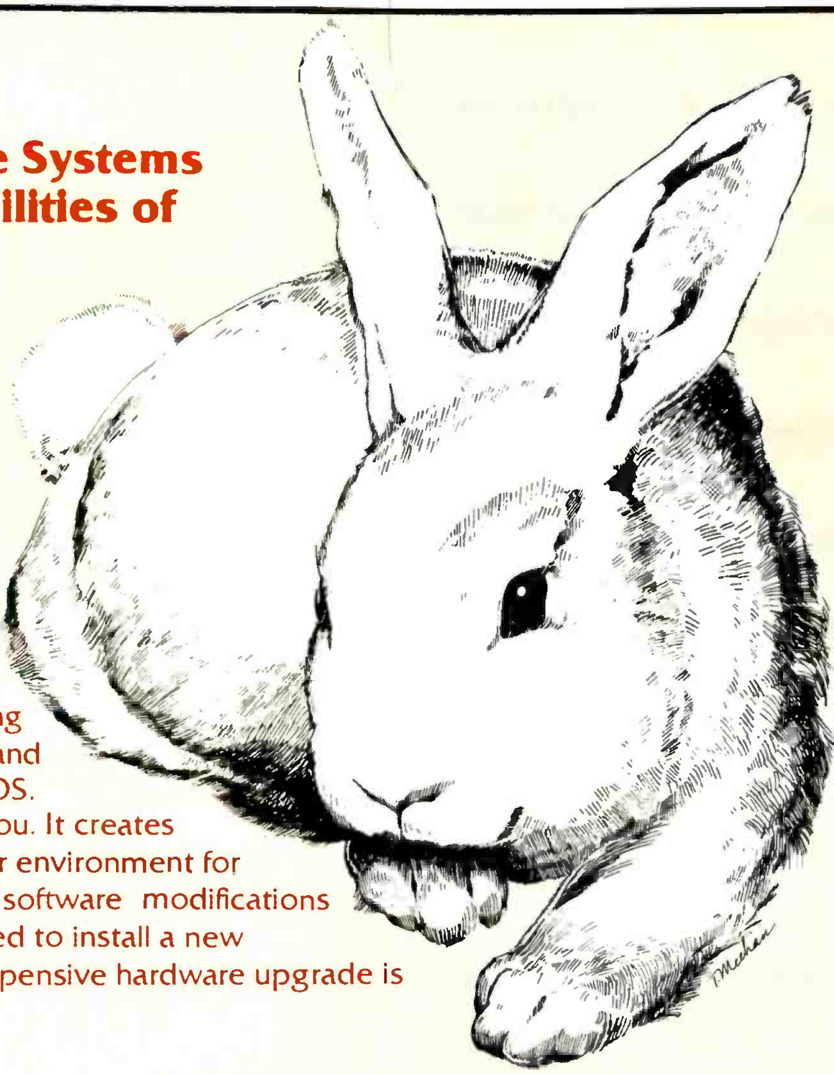
The entrance to the internals of the Production objects is through a Production Manager object; it is connected to a Job Manager object and a Resource Manager object.

The manufacturing of a product is split into a number of jobs. The available production facilities (people and machines) are split into a number of resources. Each job is to be performed by a single resource. A natural way to map this into a Smalltalk system is to represent each job by a Job object and each resource by a Resource object.

In this scheme, each Job object ensures that the job is performed by its

Wild Hare Software Systems Multiply the Capabilities of Data General's

RDOS
INFOS®
ICOS
DOS



Wild Hare gives Data General users a choice when upgrading to a multi-user environment and eliminates the need to use AOS. Wild Hare makes it easy for you. It creates a true multi-lingual, multi-user environment for your current system. No user software modifications are necessary. There is no need to install a new operating system. And, no expensive hardware upgrade is required.

Features

- Each user is totally independent of all other users.
- Each user may run all standard Data General software.
- Each user may independently edit, compile, execute and debug programs written in any language supported by RDOS, INFOS®, ICOS and DOS.
- Standard languages supported include: Fortran IV, Fortran V, COBOL, ALGOL, RPG, DG/L™, BASIC, PASCAL, MAC, etc.
- All NOVA's® and ECLIPSE's® are supported.
- Wild Hare guarantees its software systems on a money back basis.

Wild Hare's Software Gives Data General Users A Choice!

WILD HARE COMPUTER SYSTEMS INC.

P.O. Box 3581, Boulder, Colorado 80307
(303)·494·0221

NOVA· ECLIPSE· and INFOS· are registered trademarks of Data General Corporation.

Circle 401 on Inquiry card.

resource within the available time. Similarly, each Resource object ensures that its resource is used in an efficient manner, that there is sufficient time available for preventive maintenance, and that there are no unacceptable overloads. The method in the Production object that handles the *bookProductionFacilities:after:* message could now be written as shown in listing 2.

One of the instance variables of the Production Manager object is a pointer to the Job Manager object. By using that pointer as a communication channel, the Production Manager object passes most of the work on to the Job Manager object. First, the Job Manager is asked to define the new product. The Job Manager creates the Job objects (see figure 3), links them to the proper Resource objects, and returns an identification that is to be used for future references to the product. The Job Manager is then asked to schedule the product for manufacturing as soon as possible after the given date. Finally, the Job Manager is asked when the product will be completed, and this value is returned to the outside world (in this case, to the Sales object). The planning process in the Production subsystem that is shown in figure 4 is controlled by this method.

Definition of New Objects

The first task of the Job Manager object is to define the new object. It receives message *defineProduct:* when this is to be done. The corresponding method could be something like that shown in listing 3. We are referencing two instance variables of the Job Manager object in this method: *productDescriptions* and *productionManager*. *productDescriptions* is an ordered collection with one member for each product type. Each of these members contains a sequence of small objects with the class, duration, and resource type for each of the jobs that go into the manufacture of such a product. *productionManager* contains a pointer to the Production Manager object. The result of the product creation is put into a third instance variable, the *productDic-*

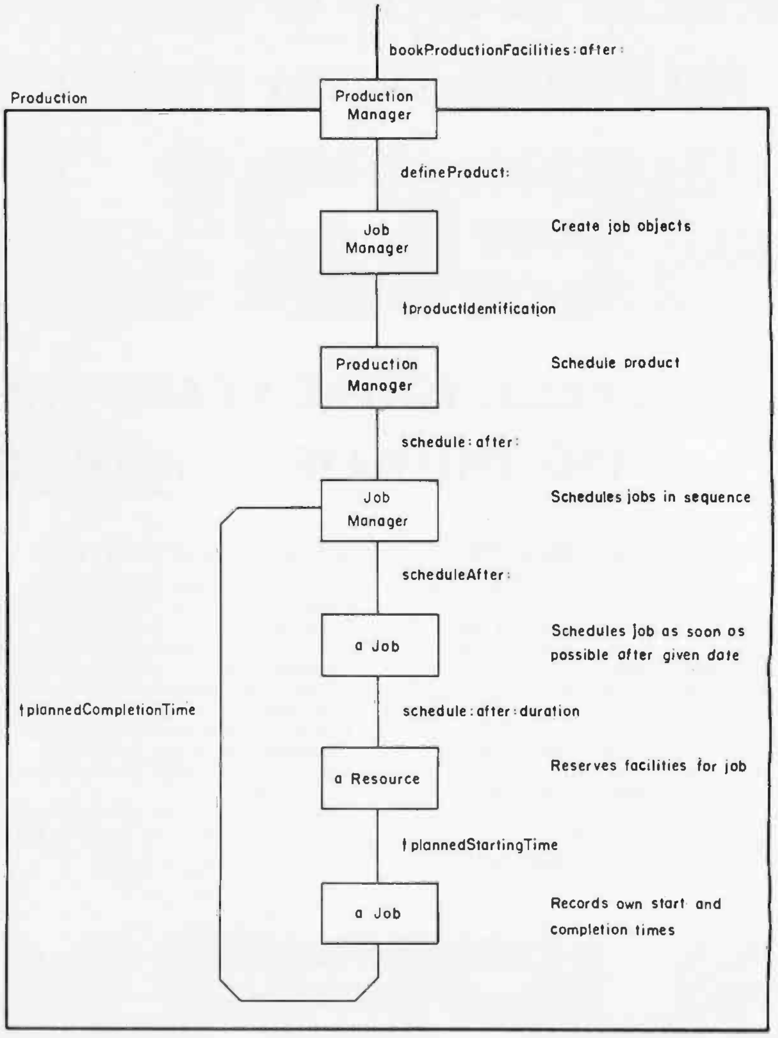


Figure 4: *A simple planning algorithm implemented in a Smalltalk system.*

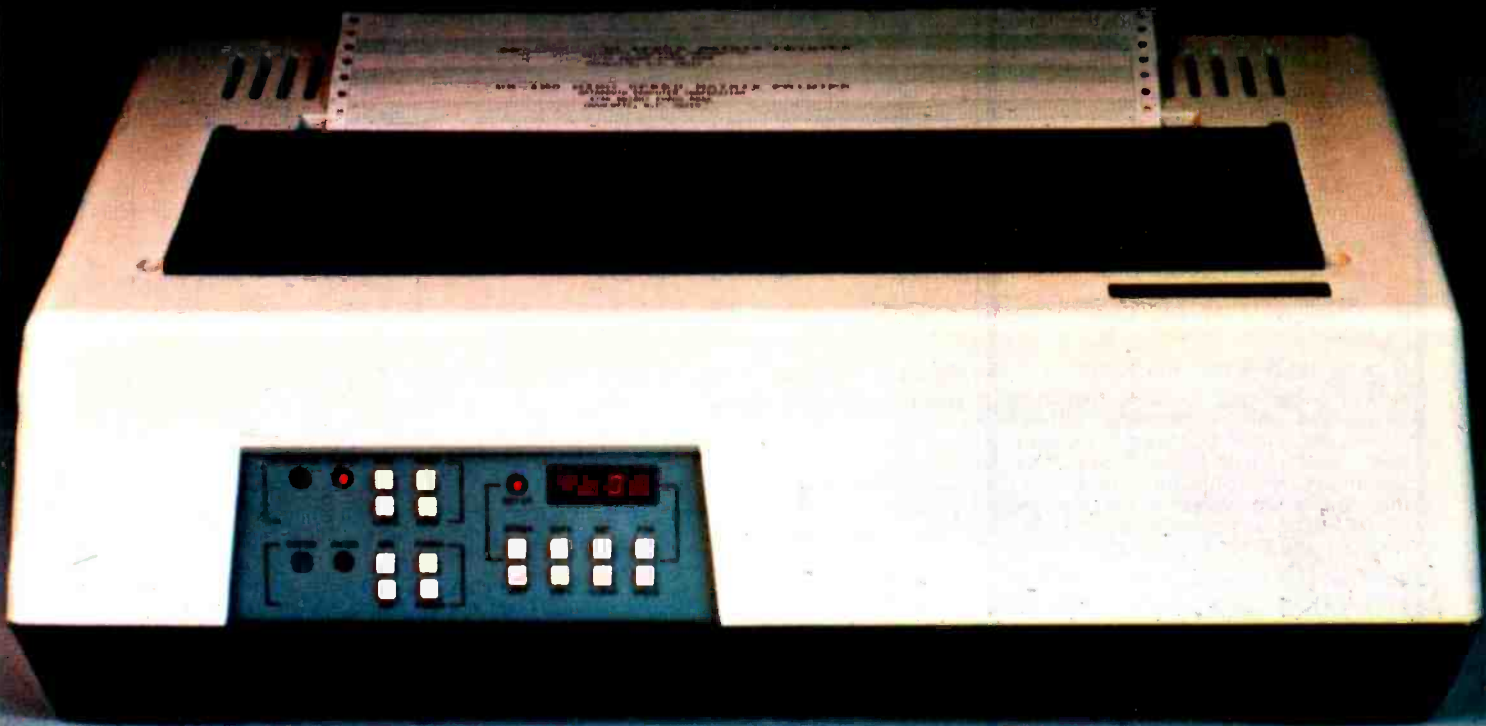
Listing 3: *Smalltalk method for the message* defineProduct:.

```
defineProduct: productType
  "To create a new product of given type. The corresponding Job objects are created and linked to
  their resource objects."
  | productIdentification jobDescriptions job jobList resourceObject |
  productIdentification ← self nextProductIdentification.
  jobDescriptions ← productDescriptions at: productType.
  jobList ← jobDescriptions collect:
      [ :description |
      job ← (description class) new.
      job duration: (description duration).
      resourceObject ← productionManager getResource: (description
      resourceType).
      job resource: resourceObject].
  productDictionary at: productIdentification put: jobList.
  ↑ productIdentification.
```

tionary. In this dictionary, each key is a product identification; the corresponding entry is the sequence of job objects for that product.

The first line of code gets a new, unique identification for the new product. Next, the list of job descriptions is retrieved from the productSpecification collection. We then build the sequence of Job objects by going systematically through the job descriptions. For each description, we create a new Job object of the given class, feed it its duration, and let it

datasouth announces...
THE TOTAL PRINTER PACKAGE!



With so many matrix printers on the market today, it may seem tough to find exactly the right one for your application. Some models may offer the speed you need, others the communications flexibility and still others the forms handling capability. But no printer offers all the features you need...until now.

The DS180 matrix printer provides the total package of performance features and reliability required for applications such as CRT slave copy, remote terminal networks and small to mid-range systems. Not a "hobby-grade" printer, the DS180 is a real workhorse designed to handle your most demanding printer requirements. And pricing on the DS180 is hundreds of dollars below competitive units.

High Speed Printing—Bidirectional, logic-seeking printing at 180 cps offers throughput of over 200 lpm on average text. A 9-wire printhead life-tested at 650 million characters generates a 9x7 matrix with true lower case descenders and underlining.

Non-volatile Format Retention—a unique programming keypad featuring a non-volatile memory allows the user to configure the DS180 for virtually any application. Top of form, horizontal and vertical tabs, perforation skipover, communications parameters and many other features may be programmed and stored from the keypad.When your system is powered down, the format is retained in memory. The DS180 even remembers the line where you stopped printing. There is no need to reset the top of form, margins, baud rate, etc....it's all stored in the memory. If you need to reconfigure for another application, simply load a new format into the memory.

Communications Versatility—The DS180 offers three interfaces including RS232, current loop and 8-bit parallel. Baud rates from 110-9600 may be selected. A 1K buffer and X-on, X-off handshaking ensure optimum throughput.

Forms Handling Flexibility—Adjustable tractors accommodate forms from 3"-15". The adjustable head can print 6-part forms crisply and clearly making the DS180 ideal for printing multipart invoices and shipping documents. Forms can be fed from the front or the bottom.

If you would like more information on how the DS180's low-cost total printer package can fill your application, give us a call at Datasouth. The DS180 is available for 30-day delivery from our sales/service distributors throughout the U.S.

datasouth
computer corporation

4740 Dwight Evans Road • Charlotte, North Carolina 28210 • 704/523-8500

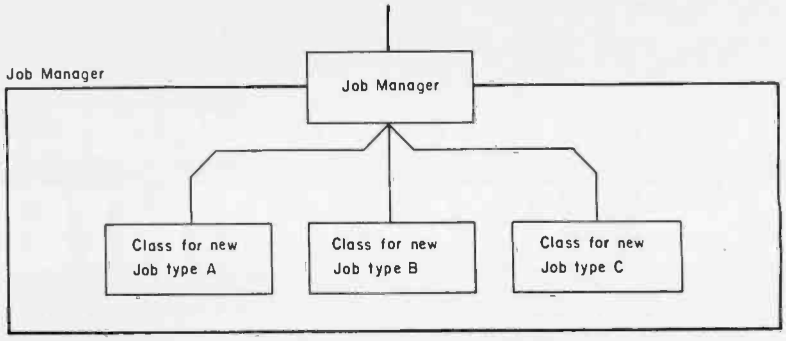


Figure 5: *Sub-objects in the Job Manager actually create the new Job objects.*

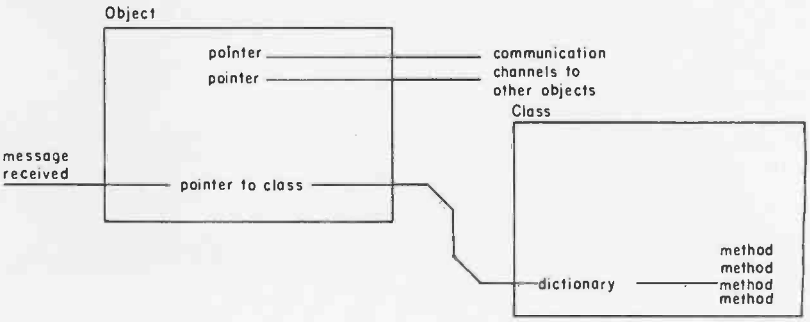


Figure 6: *All objects contain a pointer to a Class object that contains their message dictionary and methods.*

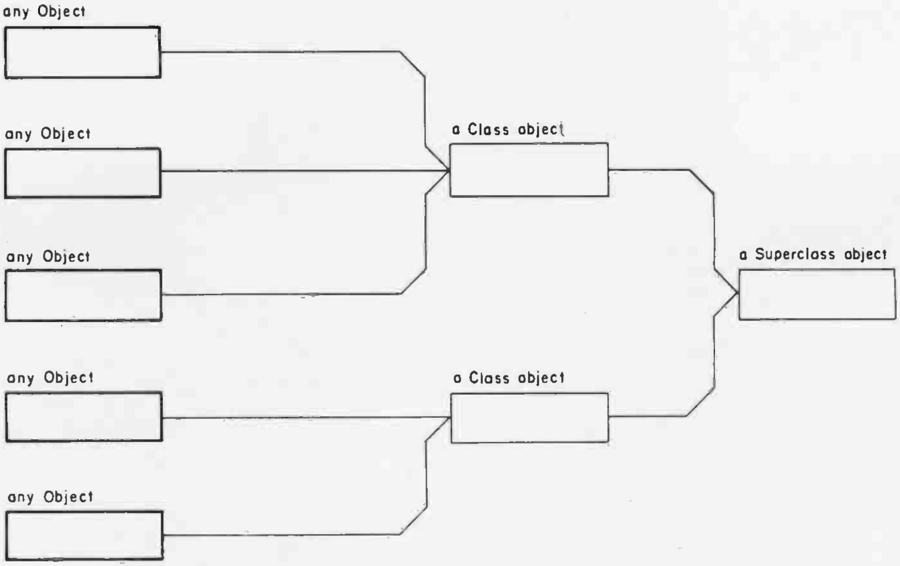


Figure 7: *The superclass-subclass chains of pointers. The user does not meet them unless he wants to become a real Smalltalk expert.*

connect itself to its Resource object. From figure 3, we see that there is no direct connection between the Job Manager object and the resources. We therefore have to go via the Production Manager object to get the pointer to the Resource object that we give to the new Job object.

We finally insert the new list of jobs into the productDictionary in the Production Manager object and return the product identification.

The Job Manager is built so that Job objects may belong to several different classes. The different Job objects created would all understand the

The One Printer Solution for the Two Printer Problem.

HIGH SPEED DATA PROCESSING

The new Dual-Mode 200 brings speed and uncompromising print quality to business and professional applications.

Financial statements, inventory reports, labels and more are printed at data processing speeds from 165 cps to 250 cps.

Fully adjustable tractors and a friction feed platen provide precise forms handling for pinfeed and single sheet paper.

Complete "Dot Control" graphics is standard with resolution to 120 x 144 dots per inch.

Interfacing is easy with both E.I.A. RS-232C serial and an ASCII parallel port.

LETTER QUALITY WORD PROCESSING

The Dual-Mode 200 also features letter perfect print you will be proud to use for business letters and reports. Letter Mode speeds range from 42 cps to 60 cps.

The standard Titan 10 pitch font is complemented by an array of optional fonts including Elite 12 pitch, italics, proportionally spaced, OCR-A, scientific and foreign character sets.

Up to 12 font selections may be stored in the printer and interchanged while printing.

The Dual-Mode 200 accepts standard daisywheel print commands for word processing system compatibility.

It's the perfect solution for the two printer problem.

The Dual-Mode 200 Printer for the one printer office.

Call or write today for complete specifications

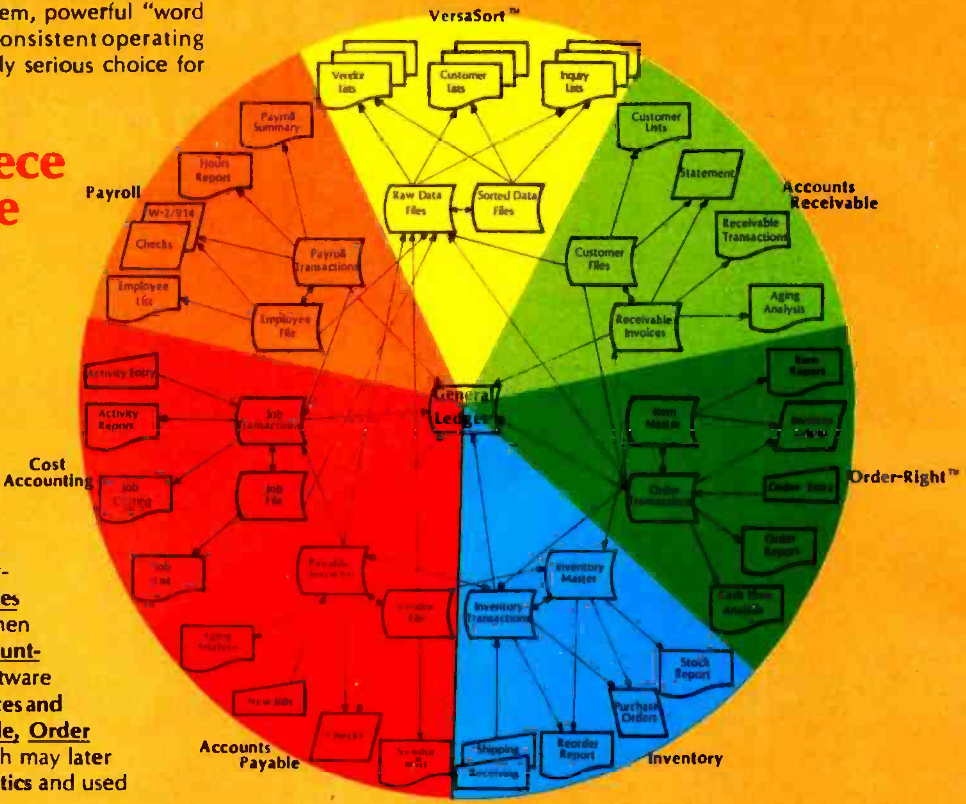
2301 Townsgate Road, Westlake Village, CA 91361, (805) 496-1990

malibu
Electronics Corporation

a subsidiary of Datametrics Corporation

DOTS DO IT BETTER™

Thousands of SoftwareHows™ users agree — SoftwareHows products set a new standard of excellence for solution-oriented software. Instant installation for your system, powerful "word processing-like" editing facilities and consistent operating features make this SolutionWare™ the only serious choice for your needs.



Why settle for a piece when you can have the whole pie?!

At last! An integrated system of business software ideal for you!

How often have you purchased software only to be **disappointed by its features** or frustrated by the **inability of the different programs to work together?** Are you tired of entering the same data into your Purchase Ordering System when a part is ordered, into Inventory when it arrives, Payables when it's invoiced and General Ledger when it's paid for? Can you easily link your Accounting Data Base with your word processing software to create **personalized letters, reports, notices and announcements?*** Does your Point of Sale, Order Entry software also save a **keyed file** which may later be **Sorted** for over **60 customer characteristics** and used to generate **personalized sales literature?**

If you don't like your answers to these questions, **your accounting software is costing you money!**

The Data Base Integration™ System from SoftwareHows™ does **all this and much more!** This newest software product offers the perfect blend of **performance, price and flexibility. Every single transaction** feeds your **master records.** This common data base approach organizes all your business information so that every module is **fully interactive.** The result of this vast and easy to use data base is unique. You'll be amazed at how much better **you'll understand the operation and cash flow of your business!** And better understanding means **better planning** — and **higher profits for you!**

The Data Base Integration System is built around the basic four accounting tools: General Ledger provides those all important **balance sheets** and **income statements,** Accounts Receivable and Payable take care of **invoice control** in a jiffy, while Payroll with Cost Accounting does **your payroll** and provides **cost effectiveness data.** All packages fully interact and are self-checking. The amazing Order-Right™ **order entry system** and MicroDaSys Inventory, give you one of the most complete **sales management and material requirements systems available.** Output is processed with lightning speed and meticulous accuracy: invoices, shipping labels, charge slips and COD tags. Orders **automatically** interact with Inventory and Receivables. If your **stock is too low,** Inventory recommends the **best source of supply** and **approximate prices** to pay. Upon authorization, a **purchase order** is generated. The receiving department verifies receipt and the invoice is transferred to Accounts Payable.

The Data Base Integration Business System is $2500. And that's for all seven packages! Now there's a deal too good to pass up! It includes over 1500 pages of user documentation, and a supply of computer forms. With our unique DBI Installation Program, getting the complete package up and running on your system is a **breeze.** Best of all, complete CBASIC source code is included with every CBASIC package. Current disk formats include 8" soft-sectored, 5" hard- and soft-sectored.

Call or Write for the SolutionWare™ to meet your software needs — today!

☐ Ask your dealer why our business software is the best!

☐ A Complete 200 page Overview of all SoftwareHows SolutionWare is yours for just $75, refundable with purchase.

SOFTWARE HOWS™ a division of MicroDaSys

PO Box 36275 Los Angeles, CA 90036
(213)731-0876 TWX:910-321-2378

same message protocols, but they would differ in their implementation. For example, a job might be: *wait for 24 hours while a resin glue is curing*. This does not need any resources, and the planning of such a job would be very simple—wait 24 hours. Another kind of job, such as pouring concrete, should not span a weekend, since joining old and new concrete could give weak spots in the product.

As is the case with Job objects, we often find that several objects share the same message protocols and process the messages with the same methods. Their only difference is that they appear in different places in the total system and that their instance variables point to different objects (their states are different). Such objects are created by the same class object and are said to belong to the same class.

The Smalltalk user should be able to "open up" the application object on the screen to see its component parts and to find out how they work together.

It would be very inefficient if each object of a class stored a replica of the message dictionary and all methods, and it would be extremely tiresome if we actually had to program each object by itself. We, therefore, use the concept of layering to let each and every object enlist the services of its class object in order to decode an incoming message and to select the proper method to process it. This mechanism is illustrated in figure 6. As in so many other parts of Smalltalk, we find a recursive argument.

Many classes are very similar; they differ only in the handling of a few messages. The different kinds of Job objects are a case in point. It seems reasonable to let a class object enlist the services of a superclass object whenever it is called upon to execute methods it shares with other classes.

← Circle 351 on inquiry card.

consumer computers mail order

This is just a sample of our everyday low prices.

APPLE II PLUS

16K
for only
$1025

48K
for only
$1129

Apple Disk II Drive w/controller **$519**
Disk II Drive, Add-On **$439**
Silentype Printer **$349**
Hayes Micromodem II **$299**
Epson MX-80 w/apple card **$599**

Videx
Videoterm
$269

FREE!

1982 Catalog

In order to keep our phone lines clear for your orders, please mail this coupon to receive a free catalog

NAME ____________________

ADDRESS ____________________

CITY __________ STATE ______ ZIP ______

Microsoft
Z-80
Softcard
$269

TOLL FREE ORDER LINE **800-854-6654**

in California or outside the continental U.S. **(714) 698-8088**

See pages 474-475 for more discount prices and order information.

Circle 89 on inquiry card.

ANNOUNCING A NEW ERA OF LOWER PRICES

We're in the business of saving you money.

Let's Face It. When you order anything through the mails you never really know who you are dealing with. We at Consumer Computers realize this every time we talk to you or receive a letter from you. We do our darndest to see that you not only get the information and help you need to intelligently place your order, but also that the price we give you is the best you can get anywhere.

We've been around. Consumer Computers has been actively serving people's computer needs in the San Diego area for 5 years now. We will still be here tomorrow, and the next day, too. So when you deal with Consumer Computers, you can rest assured that you're dealing with people that are thoroughly familiar with the business of selling computers. We pledge to see that any order placed with us is handled with the utmost efficiency and care, from the time the order is placed until it arrives at your doorstep. And if you have a problem, we think you will find that the expertise of our Service Department is unmatched for the quality of their work, and the speed that they have your equipment back into your hands where it belongs.

That's our promise. That's Consumer Computers.

consumer computers ***mail order***

See our advertisement on previous page

Many classes will then share the same superclass; we get a tree-shaped class structure as shown in figure 7. Note that the purpose of this structure is convenience in programming and efficiency in implementation; it belongs on the lowest levels of the system hierarchy and is not part of the structure of the application system.

Future Experiments

When personal computing becomes sufficiently entertaining and interesting to become a widespread tool, the new user of a Smalltalk system is likely to begin by using its ready-made application systems for writing and illustrating documents, for designing aircraft wings, for doing homework, for searching through old court decisions, for composing music, or whatever. After a while, he may become curious as to how his system works. He should then be able to "open up" the application object on the screen to see its component parts and to find out how they work together. He could, for example, see something like figure 1 together with his usual user interface. By exercising the application commands, the computing process could be illustrated on the system diagram. Using Smalltalk to document itself in this manner should make it possible to make some novel and extremely powerful system description tools.

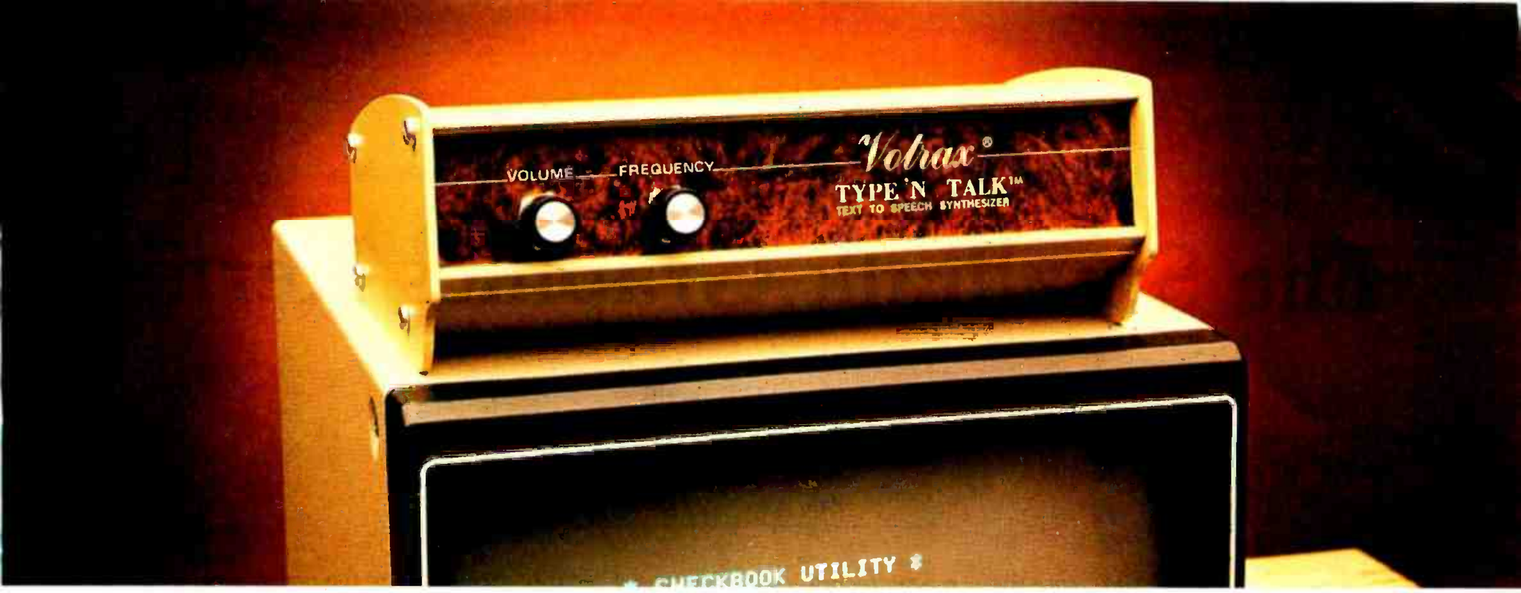
The next thing the user might want to do is to build new systems similar to the one he has been using. A *kit* of graphical building blocks would let the user compose a new system by editing the system diagram on the screen. While the Trip system (as described in reference 2) is not a proper kit, it could be a good source of ideas to the experimenter on building such systems.

Finally, the expert user would want to make his own kits. Even here, it is important that he sees only what he needs and that all unimportant details are suppressed. Since what is important in one context might be unimportant in another, and vice versa, the concepts of *filters* (see reference 1) will be an essential ingredient for the experimenter when he develops tools for these expert users.

Much experimenting needs to be done before we learn how to make systems that are self-documenting on any level and that provide a smooth and stumble-free transition from one level to the next. It is hoped that the availability of Smalltalk will lead to great activity in this field, to the benefit of all future computer users. ■

References

1. Goldberg, Adele and David Robson. "A Metaphor for User Interface Design." *Proceedings of the University of Hawaii Systems Science Symposium*, January 1979, Honolulu.
2. Gould, Laura and William Finzer. "A Study of TRIP: A Computer System for Animating Time-Rate-Distance Problems." *Proceedings of the IFIP World Conference on Computers in Education (WCCE-81)*, Lausanne, Switzerland, July 1981.
3. Ingalls, Daniel H H. "The Smalltalk-76 Programming System. Design and Implementation." *Conference Record of the Fifth Annual ACM Symposium on Principles of Programming Languages*, Tucson, Arizona, January 1978.



TYPE-'N-TALK™ IS T.N.T.

The exciting text-to-speech synthesizer that has every computer talking.

- **Unlimited vocabulary**
- **Built-in text-to-speech algorithm**
- **70 to 100 bits-per-second speech synthesizer**

Type-'N-Talk,™ an important technological advance from Votrax, enables your computer to talk to you simply and clearly — with an unlimited vocabulary. You can enjoy the many features of Type-'N-Talk,™ the new text-to-speech synthesizer, for just $375.00.

You operate Type-'N-Talk™ by simply typing English text and a talk command. Your typewritten words are automatically translated into electronic speech by the system's microprocessor-based text-to-speech algorithm.

The endless uses of speech synthesis.

Type-'N-Talk™ adds a whole new world of speaking roles to your computer. You can program verbal reminders to prompt you through a complex routine and make your computer announce events. In teaching, the computer with Type-'N-Talk™ can actually tell students when they're right or wrong — even praise a correct answer. And of course, Type-'N-Talk™ is great fun for computer games. Your games come to life with spoken threats of danger, reminders, and praise. Now all computers can speak. Make yours one of the first.

Text-to-speech is easy.

English text is automatically translated into electronically synthesized speech with Type-'N-Talk.™ ASCII code from your computer's keyboard is fed to Type-'N-Talk™ through an RS 232C interface to generate synthesized speech.

Just enter English text and hear the verbal response (electronic speech) through your audio loud speaker. For example: simply type the ASCII characters representing "h-e-l-l-o" to generate the spoken word "hello."

TYPE-'N-TALK™ has its own memory.

Type-'N-Talk™ has its own built-in microprocessor and a 750 character buffer to hold the words you've typed. Even the smallest computer can execute programs and speak simultaneously. Type-'N-Talk™ doesn't have to use your host computer's memory, or tie it up with time-consuming text translation.

Data switching capability allows for ONLINE usage.

Place Type-'N-Talk™ between a computer or modem and a terminal. Type-'N-Talk™ can speak all data sent to the terminal while online with a computer. Information randomly accessed from a data base can be verbalized. Using the Type-'N-Talk™ data switching capability, the unit can be "de-selected" while data is sent to the terminal and vice-versa — permitting speech and visual data to be independently sent on a single data channel.

Selectable features make interfacing versatile.

Type-'N-Talk™ can be interfaced in several ways using special control characters. Connect it directly to a computer's serial interface. Then a terminal, line printer, or additional Type-'N-Talk™ units can be connected to the first Type-'N-Talk,™ eliminating the need for additional RS-232C ports on your computer.

Using unit assignment codes, multiple Type-'N-Talk™ units can be daisy-chained. Unit addressing codes allow independent control of Type-'N-Talk™ units and your printer.

Look what you get for $375.00. TYPE-'N-TALK™ comes with:

- Text-to-speech algorithm
- A one-watt audio amplifier
- SC-01 speech synthesizer chip (data rate: 70 to 100 bits per second)
- 750 character buffer
- Data switching capability
- Selectable data modes for versatile interfacing
- Baud rate (75-9600)
- Data echo of ASCII characters
- Phoneme access modes
- RS 232C interface
- Complete programming and installation instructions

The Votrax Type-'N-Talk™ is one of the easiest-to-program speech synthesizers on the market. It uses the least amount of memory and it gives you the most flexible vocabulary available anywhere.

Order now. Toll free.

Call the toll-free number below to order or request additional information. MasterCard or Visa accepted. Charge to your credit card or send a check for $375.00 plus $4.00 delivery. Add 4% sales tax in Michigan.

1-800-521-1350.

Dealer Inquiries Invited

Votrax

Circle 398 on inquiry card.

Distributed by Vodex
A Votrax Company — Dept. RT
500 Stephenson Highway, Troy, MI 48084
(313) 588-0341

Type-'N-Talk™ is covered by a limited warranty. Write Votrax for a free copy.

The Smalltalk Graphics Kernel

Daniel H H Ingalls
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

Graphics are essential to the quality of an interactive programming system and to the interactive applications that go along with such a system. Qualitatively, people think with images, and any system that is incapable of manipulating images is incapable of augmenting such thought. Quantitatively, a person can visually absorb information equivalent to millions of characters a second, while the normal rate for reading text is less than 100 characters a second.

For the graphical interaction cycle to be complete, a computer system must provide a channel for input in the visual domain as well. While the projection of images from the realm of thought into the space of electronic information seems an impossible task, a well-designed pointing device can effectively harness the computer's graphical output capability to express graphical input from the user. Given such a pointing device, the process of selecting from graphical objects, such as text displayed on the screen, is natural and rapid. By tracking the pointer with a program that simulates a pen or paintbrush, the visual input channel can be extended to include line drawing and freehand sketches.

The purpose of graphics in the Smalltalk system is to support the *reactive principle*:

Any object accessible to the user should be able to present itself in a meaningful way for observation and manipulation.

Meaningful presentation of any object in the system demands maximum control over the display medium, and many technologies fall short in this respect. One approach that provides the necessary flexibility is to allow the brightness of every discernible point in the displayed image to be independently controlled. The simplest implementation of this approach is a contiguous block of storage in which the setting of each *bit* (1 or 0) is *mapped* into dark or light illumination of the corresponding picture element, or *pixel*, when displaying or combining with other images. The block of storage is thus referred to as a *bitmap*, and this type of display is called a *bitmap display*. The simplest form of bitmap allows only two brightness levels, white and black. The Smalltalk-80 graphics system is built around this model.

Photo 1: *An example of a Smalltalk-80 video display. Note the multiple windows, the combinations of text and graphics, and the pointer in the window marked "UserView workspace."*

Photo 1 shows a typical view of the Smalltalk-80 system, and it illustrates the wide range of graphical idiom implied by the reactive principle. Rectangular areas of arbitrary size are filled with white, black, and various halftone patterns. Text, in various typefaces, is placed on the screen from stored images of the individual characters. Halftone shades are "brushed" by the user to create freehand paintings. Moreover, although not shown on the printed page, images on the display may be moved or sequenced in time to provide animation.

Graphical Storage—Forms

Simple images are represented by instances of class Form. A Form has height and width and a bitmap that indicates the white and black regions of the particular image being represented. Consider, for example, the arrow-shaped Form that appears in the lower-right window of the screen image in photo 1. The internal representation of this Form is depicted in figure 1. Its height is 16, its width is 8, and its appearance is described by the pattern of ones and zeros (shown as light and dark squares) in its bitmap. The height and width of the Form serve to impose the

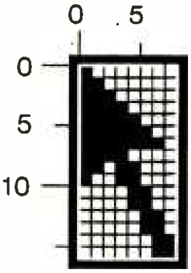
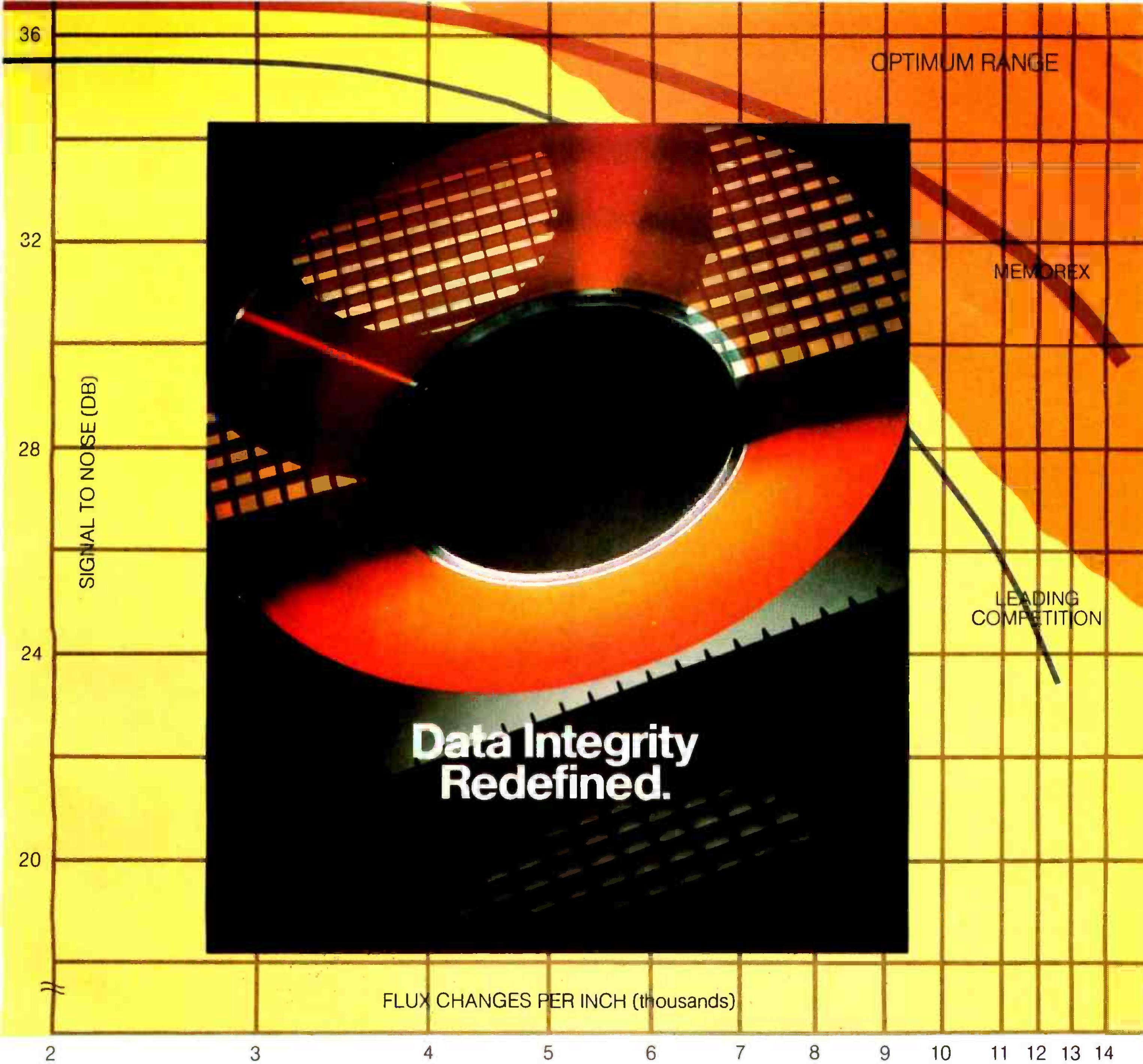


Figure 1: *A simple* Form *representing the cursor in photo 1.*



The new Memorex® M Formula magnetic coating has been widely accepted by major OEM drive manufacturers. Now M Formula is redefining performance and reliability standards for removable rigid disc products on all existing and new generation drives as well. M Formula, containing our exclusive Hi/Oxide™ formulation, offers the highest signal to noise ratio—up to 30 dB at 10,000 flux changes per inch—of any rigid media in the industry. With higher performance margins and protection against random errors, you're assured greater data integrity.

Our revolutionary Hi/Oxide coating provides higher coercivity, which allows stronger and more consistent magnetic properties. Hi/Oxide coating also forms a uniformly smooth, hard surface that sets new standards for durability.

It all adds up to virtually trouble-free data handling. But most importantly, the new M Formula helps ensure the highest levels of data integrity in disc packs or cartridges.

To help you compare and evaluate rigid media, send for a free copy of the booklet, "Critical Factors in Purchasing Rigid Media." Write to Debi Garringer, Memorex Rigid Media and Components Division, 1125 Memorex Drive, Santa Clara, CA 95052 or call (800) 538-8028; in California (408) 987-2064.

MEMOREX

For twenty years, the expression of excellence.

Circle 214 on inquiry card.

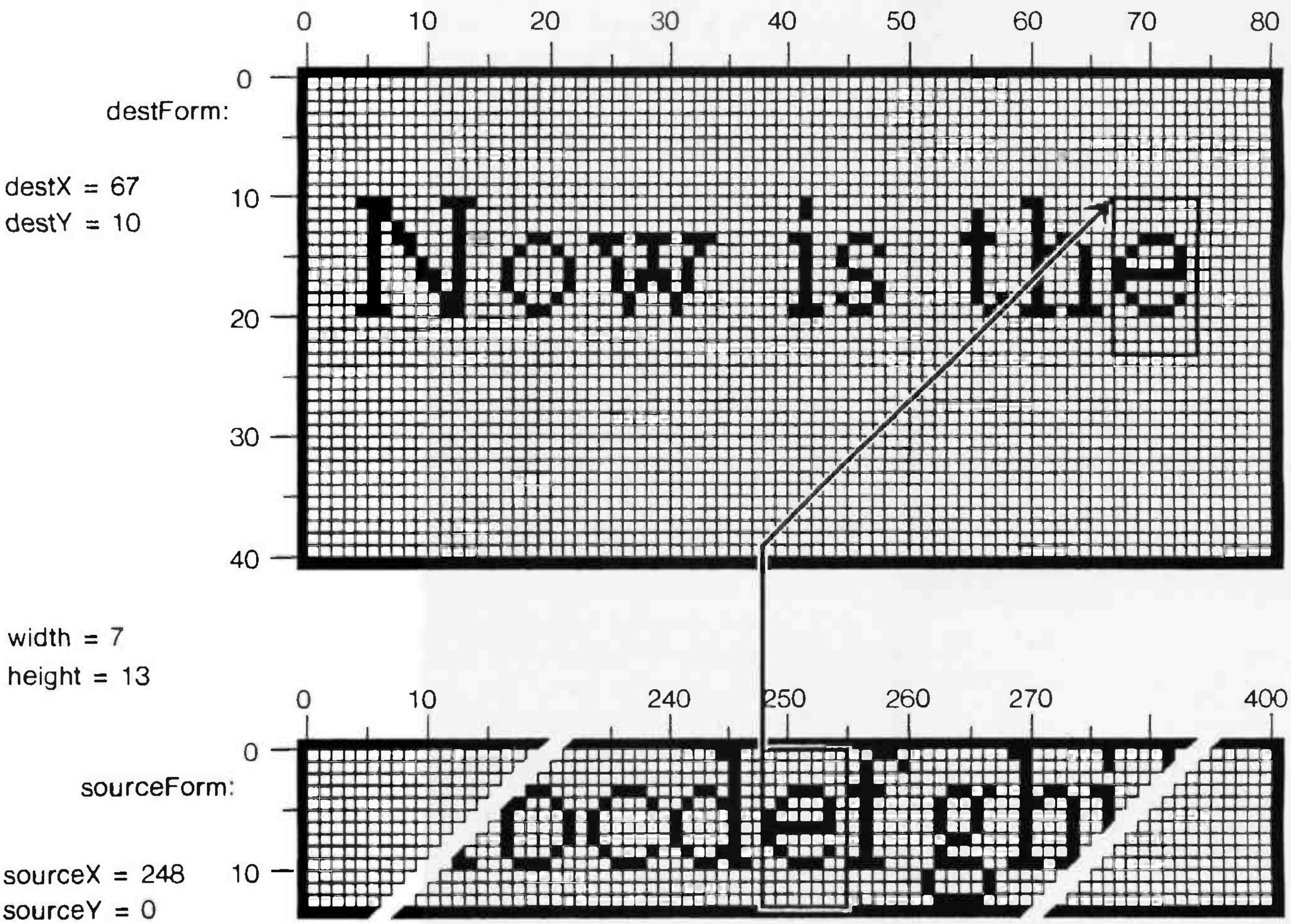


Figure 2: *Copying a character of text from a source* Form *(bottom) to a destination* Form *(top).*

appropriate two-dimensional ordering on the otherwise unstructured data in the bitmap. We will return to the representation of Forms in more detail later in this article.

A complex image can be represented in either of two ways: by a very large Form, or by a structure that includes many Forms and rules for combining and repeating them in order to produce the desired image. The freehand drawing in the center of photo 1 is an example of the former, and the text below it is an example of the latter.

The large unstructured Form has an additional use of great importance: it can be presented to the display hardware as a buffer in memory of the actual data to be shown on the display terminal. We refer to the Form which is so used as the displayForm. Since the interface to the hardware is through a Form, there is no difference between combining images internally and displaying them on the screen. Animation can be done simply in this manner: one Form serves as the displayForm while the next image to be displayed is prepared in a second Form. As each image is completed, the two Forms exchange roles, causing the new image to be displayed and making the Form with the old image available for building the next image in sequence.

Graphical Manipulation—BitBlt

To support a wide range of graphical presentation, we have specified a kernel operation on Forms that we call *BitBlt*. All text and graphic objects in Smalltalk are displayed and modified using this single graphical primitive. The author wrote the original design in October 1975 with the advice and support of Diana Merry. After five years' experience, we have felt the need for only minor changes, and these improvements are largely due to Bob Flegal and Bill Bowman. The remainder of this article describes the current BitBlt primitive in detail—its specification, examples of its use, and, finally, the details of its implementation.

One of the first computers on which a Smalltalk system was implemented had an instruction called BLT for *block transfer* of 16-bit words. The name BitBlt derives from the generalization of data transfer to arbitrary bit locations, or pixels. BitBlt is intentionally a very general operation, although most applications of it are graphically simple, such as "move this rectangle of pixels from here to there."

A specific application of BitBlt is governed by a list of parameters that includes:

- destForm—a Form into which pixels will be stored by BitBlt
- sourceForm—a Form from which pixels may be copied
- halftoneForm—a Form containing a spatial halftone pattern
- combinationRule—an Integer specifying the rule for combining corresponding pixels of the sourceForm and destForm
- destX, destY, width, height—Integers specifying the rectangular subregion to be filled in the destination
- clipX, clipY, clipWidth, clipHeight—Integers specifying a rectangular boundary that further restricts the affected region of the destination
- sourceX, sourceY—Integers specifying the location (top left) of the subregion to be copied from the source

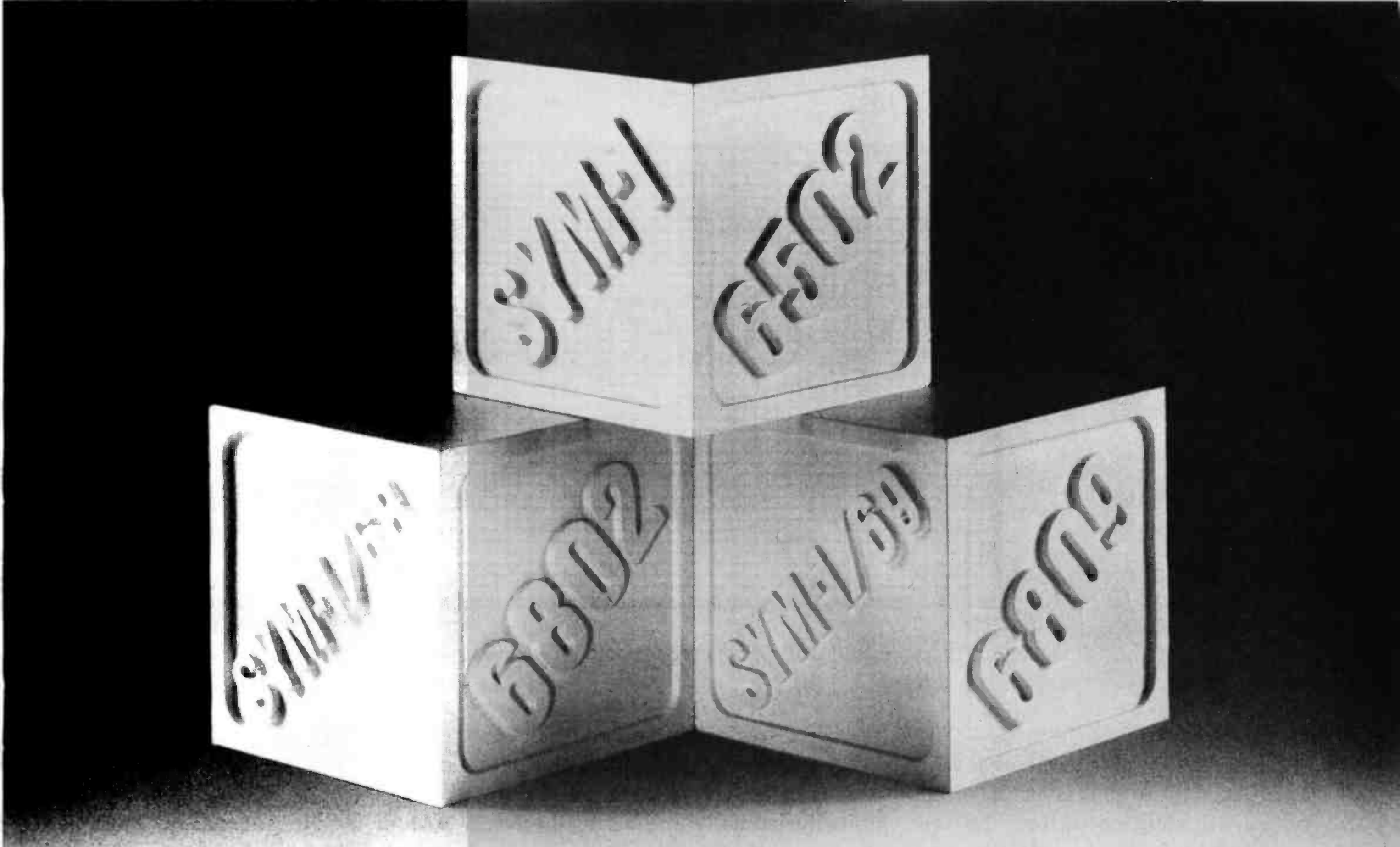
In the remainder of this section, we examine the effect of each of these parameters in greater detail.

Source and Destination Forms

Figure 2 illustrates the process of copying a character of text into a region on the display. This operation will serve to illustrate most of the characteristics of BitBlt. The copy operation involves two Forms, a source and a destination. The source in this example is a *font* containing a set of character glyphs depicted in some uniform style and scale and packed together horizontally. Pixels are copied out of the source (the font) and stored into the destination (the display). The width and height of the transfer correspond to the character size. The source *x* and *y* coordinates give the character's location in the font, and the destination coordinates specify the position on the display where its copy will appear.

Clipping Rectangle

In its specification, BitBlt includes a rectangle that limits the region of the destination that can be affected by its operation, independent of the other destination parameters. We call this rectangle the *clipping rectangle*. Often it is desirable to display a partial *window* onto larger scenes, and the clipping rectangle ensures that all picture elements fall inside the bounds of the window. By its inclusion in the BitBlt primitive, the clipping function can be done efficiently and in one place, rather than being replicated in all application programs. Figure 3 illustrates the result of imposing a clipping rectangle on the example of figure 2. Pixels that would have been placed outside the clipping rectangle (the left edge of the "N" and half of the word "the") have not been transferred. If other characters had fallen above or below this rectangle, they would have been clipped similarly.



'Universatility.' It's as easy as 1. 2. 3.

'Universatility' can be found in three versions of Synertek Systems' SYM single board computer — the versatile, universal evaluation board.

Over 20,000 SYM-1 boards have been used for learning about and evaluating 6502 microprocessors for specific applications. OEM SYM boards are used in hundreds of products.

Now Synertek Systems presents the new SYM-1/68 for 6802 microprocessors, and the SYM-1/69 for 6809 microprocessors. These boards are designed to reliably perform the same functions as the SYM-1 board for these popular microprocessors. Each SYM board is complete and ready-to-use with its own version of the 4K byte ROM SUPERMON monitor firmware.

Modification kits are also available to quickly and easily convert existing SYM-1 boards to SYM-1/68 or SYM-1/69 microcomputers.

Build on your microprocessor knowledge with the 'universatility' of SYM microcomputer boards from Synertek Systems.

Every SYM-1, SYM-1/68, and SYM-1/69 single board computer features:

- 28 double-function keypad with audio response
- 4K byte ROM resident SUPERMON with over 30 standard monitor functions and expandable for individual requirements
- Up to 24K bytes of available program memory
- Expansion to 4K bytes of on-board static RAM
- Expansion to 71 Input/Output lines
- Single +5V power supply required
- Standard interfaces for audio cassette with remote control, 185 bytes/second cassette format, TTY and RS-232-C, system expansion bus, four I/O buffers, and oscilloscope single-line display

Synertek Systems

P.O. Box 552 Santa Clara, CA 95052
Telephone: (408) 988-5689
TWX: 910-338-0135

Dealer inquiries invited.

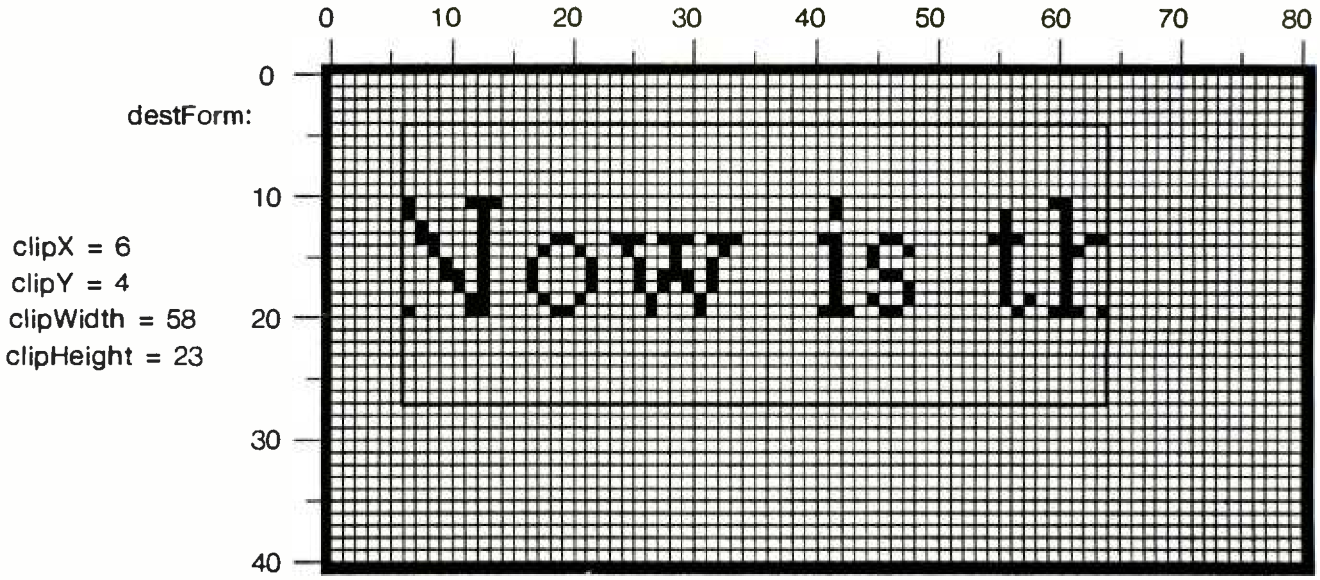


Figure 3: *An example of using a clipping window on the illustration in figure 2.*

Halftone Form

It is often desirable to fill areas with a regular pattern that gives the effect of gray shading or texture. To this end, BitBlt provides for reference to a third Form (halftoneForm) containing the desired pattern. This Form is restricted to a height and width of 16. When halftoning is specified, this pattern is effectively repeated every 16 units horizontally and vertically over the entire destination. There are four "modes" of supplying pixels from the source and halftone controlled by eliding (supplying nil for) sourceForm or halftoneForm:

- *Mode 0*—No source, no halftone (supplies solid black)
- *Mode 1*—Halftone only (supplies halftone pattern)

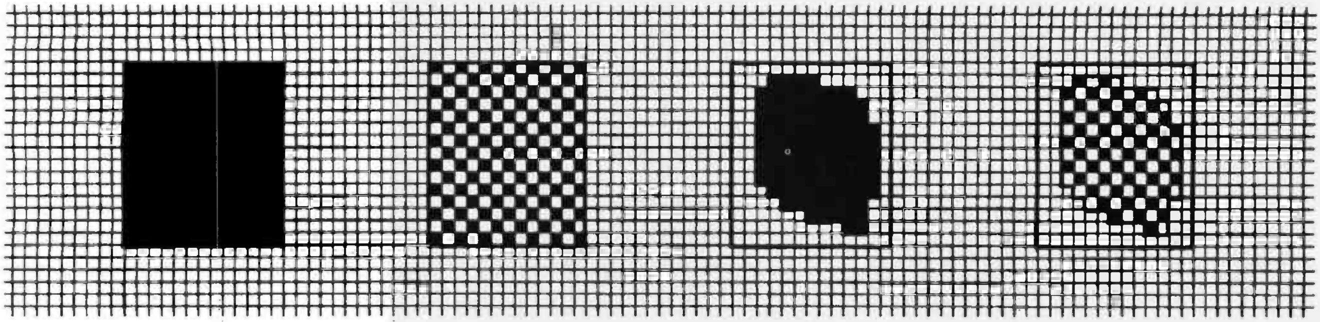


Figure 4: *BitBlt's four possible source modes.*

- *Mode 2*—Source only (supplies source pixels)
- *Mode 3*—Source AND halftone (supplies source bits masked by halftone pattern)

Figure 4 illustrates the effect of these four modes with the same source and destination and a regular gray halftone.

Combination Rule

The examples above have all stored their results directly into the destination. There are actually many possible rules for combining each source element S with the corresponding destination element D to produce the new destination element D′. Such a rule must specify a white or black result for each of the four cases of source being white or black and destination being white or black.

Figure 5 shows a box with four cells corresponding to the four cases encountered when combining source (S) and destination (D). For instance, the cell numbered 2 corresponds to the case where the source was black and the destination was white. By appropriately filling the four cells with white or black, the box can be made to depict any combination rule (there are sixteen possible rules altogether). The numbers in the four cells relate the rule as depicted to the integer value that selects that rule. For instance, to specify that the result

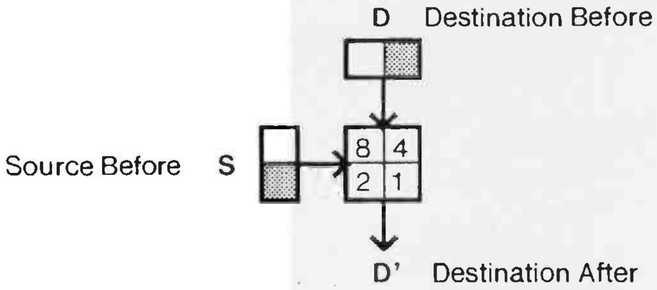


Figure 5: *A BitBlt combination diagram. This diagram, when filled in, specifies the effects of a given combination (or "rule") on all combinations of dark and light source and destination cells. Each combination is given a number equal to the sum of the cells that are darkened. See figure 6 for examples.*

The MicroFrame® is **Pure Power** for computing. It is the industry standard for high quality, reliable S-100 mainframes.

TEI manufactures each MicroFrame® with great care. They deliver pure regulated power at the proper level, improving the reliability of your computer. Typically, the output voltages remain virtually constant, even when the power line voltage varies widely. The MicroFrame® will never notice a brown-out . . . and it provides 100 db noise rejection, protecting your computer from power line voltage spikes and noise. Complies with I-EEE S-100.

The combination of the lowest noise bus, a regulated power system and a rugged chassis produces a MicroFrame® without equal.

Distributor and OEM Inquiries Invited

For more information, call Rick Barnes at (713) 738-2300

TEi INC | MicroFrame®

5075 S. LOOP EAST, HOUSTON, TX. 77033
(713)738-2300 TWX. 910-881-3639

Circle 381 on inquiry card.

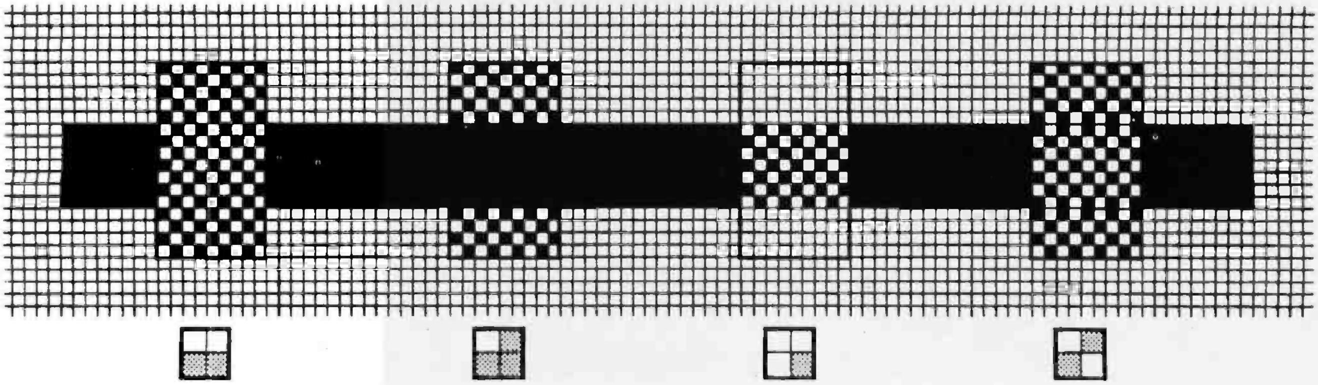


Figure 6: *Four common combination rules.*

should be black wherever the source or destination (or both) was black, we would blacken the cells numbered 4, 2, and 1. The associated integer for specifying that rule is the sum of the blackened cell numbers, or 4 + 2 + 1 = 7.

Figure 6 illustrates four common combination rules graphically. Each is described by a combination diagram, its integer rule number, and the actual logical function being applied. The earlier case of ORing can be seen in left center of the figure. This case is often described as painting "under" the destination because existing black areas remain black.

Smalltalk Access to BitBlt

In this section, we present the Smalltalk interface to BitBlt and take a detailed look at the application of BitBlt to text display and line drawing. In preparation, you will need some additional context, which we present here before describing class BitBlt.

Besides class Form, two additional classes are used extensively in working with stored images, Point and Rectangle. Points contain x and y coordinate values and are used for referring to pixel locations relative to the top left corner of a Form (or other point of reference). By convention, x increases to the right and y down, consistent with the layout of text on a page and the direction of TV scanning. A Rectangle contains two Points: origin, which specifies the top left corner, and corner, which indicates the bottom right corner of the region described. Class Point provides protocol for access to the coordinates and for various useful operations such as translation and scaling. Class Rectangle provides protocol for access to all the coordinates involved and other operations such as intersection with other rectangles. It may be useful to note the parallel between classes Point, Rectangle, Form and classes Number, Interval, IndexedCollection. Numbers index Collections and Points index Forms. Intervals select subCollections, and Rectangles select subForms.

Figure 7 shows the complete representation of the Form shown in figure 1. The width and height are stored as Integers. The actual pixels are stored in a separate instance of class Bitmap. Bitmaps have almost no protocol, since their sole purpose is to provide storage for Forms. They also have no intrinsic dimensionality, apart from that projected by their own Form, although the figure retains this structure for clarity. It can be seen that space has been provided in the Bitmap for a width of 16; this is a manifestation of the hardware organization of storage and processing into 16-bit *words*. Bitmaps are allocated with an integral number of words for each row of pixels. The integral constraint on row size facilitates movement from one row to the next during the operation of BitBlt and during scanning of the display screen by the hardware. While this division of memory into words is significant at the primitive level, it is encapsulated in such a way that none of the higher-level graphical components in the system need consider word size.

Class BitBlt

The most basic interface to BitBlt is through a class of the same name. Each instance of BitBlt contains the parameters necessary to specify a BitBlt operation. The BitBlt protocol includes messages for initializing the parameters and one message, copyBits, that causes the primitive operation to take place. The class template for BitBlt is given in table 1.

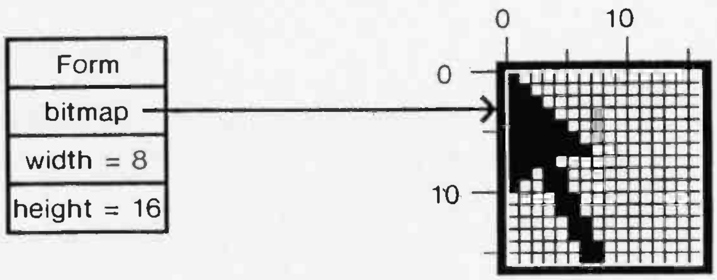


Figure 7: *The complete representation of figure 1.*

class name	BitBlt
superclass	Object
instance variable names	destForm sourceForm halftoneForm combinationRule destX destY width height clipX clipY clipWidth clipHeight sourceX sourceY
instance messages and methods	

setup

```
destForm: form1 sourceForm: form2 halftoneForm: form3 rule:
   rule destRectangle: destRectangle clipRectangle: clipRectangle
   sourceOrigin: sourceOrigin | |

    destForm ← form1.
    sourceForm ← form2.
    halftoneForm ← form3.
    combinationRule ← rule.

    destX ← destRectangle minX.
    destY ← destRectangle minY.
    width ← destRectangle width.
    height ← destRectangle height.

    clipX ← clipRectangle minX.
    clipY ← clipRectangle minY.
    clipWidth ← clipRectangle width.
    clipHeight ← clipRectangle height.

    sourceForm == nil ifFalse:
       [sourceX ← sourceOrigin x.
       sourceY ← sourceOrigin y].

    self copyBits
```

operations

```
copyBits | | < primitive >
```

Table 1: *Class template for class* BitBlt.

The state held in an instance of BitBlt allows multiple operations in a related context to be performed without the need to repeat all the setup. For example, when displaying a scene in a display window, the destination Form and clipping rectangle will not change from one operation to the next. This situation occurs frequently in the graphics kernel, as demonstrated in the following section.

Image Synthesis of Text

Much of the graphics in the Smalltalk system consists of text and lines. These high-level entities are synthesized by repeated invocation of BitBlt. In this section and the next, we examine these two important applications more closely.

One of the advantages derived from BitBlt is the ability to store fonts compactly and to display them using various combination rules. The compact storage arises from the possibility of packing characters horizontally one next to another (as shown in figure 2), since BitBlt can extract the relevant bits if supplied with a table of left x coordinates of all the characters. This is called a *strike* format, from the typographical term meaning a contiguous display of all the characters in a font.

The scanning and display of text is performed in the Smalltalk-80 system by a subclass of BitBlt. This subclass inherits all the normal state, with destForm indicating the Form in which text is to be displayed and sourceForm indicating a Form containing all the character glyphs side by side (as in figure 2). In addition, this subclass defines further state information, including:

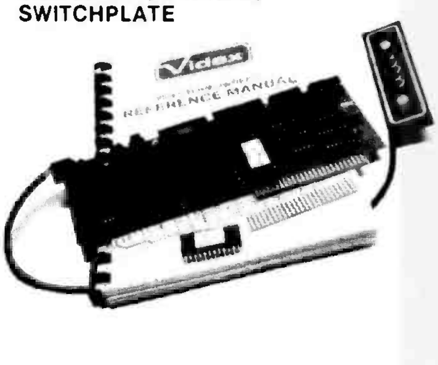
- text—a String of Characters to be displayed
- textPos—an Integer giving the current position in text

The Text Solution for APPLE II®

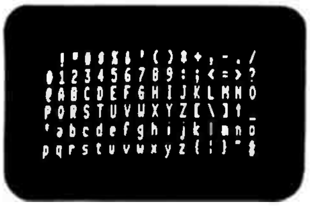
Now APPLE II® Owners Can Solve Text Problems With VIDEOTERM 80 Column by 24 Line Video Display Utilizing 7 X 9 Dot Character Matrix

Perhaps the most annoying shortcoming of the Apple II® is its limitation of displaying only 40 columns by 24 lines of text, all in uppercase. At last, Apple II® owners have a reliable, trouble-free answer to their text display problem. VIDEOTERM generates a full 80 columns by 24 lines of text, in upper and lower case. Twice the number of characters as the standard Apple II® display. And by utilizing a 7 by 9 character matrix, lower case letters have true descenders. But this is only the start.

VIDEOTERM, MANUAL, SWITCHPLATE



7X12 MATRIX
18X80 OPTIONAL



7X9 MATRIX
24X80 STANDARD

VIDEOTERM

BASICs VIDEOTERM lists BASIC programs, both Integer and Applesoft, using the entire 80 columns. Without splitting keywords. Full editing capabilities are offered using the ESCape key sequences for cursor movement. With provision for stop/start text scrolling utilizing the standard Control-S entry. And simultaneous on-screen display of text being printed.

Pascal Installation of VIDEOTERM in slot 3 provides Pascal immediate control of the display since Pascal recognizes the board as a standard video display terminal and treats it as such. No changes are needed to Pascal's MISC.INFO or GOTOXY files, although customization directions are provided. All cursor control characters are identical to standard Pascal defaults.

Other Boards The new Microsoft Softcard* is supported. So is the popular D. C. Hayes Micromodem II*, utilizing customized PROM firmware available from VIDEX. The powerful EasyWriter* Professional Word Processing System and other word processors are now compatible with VIDEOTERM. Or use the Mountain Hardware ROMWriter* (or other PROM programmer) to generate your own custom character sets. Naturally, VIDEOTERM conforms to all Apple OEM guidelines, assurance that you will have no conflicts with current or future Apple II* expansion boards.

Advanced Hardware Design VIDEOTERM's on-board asynchronous crystal clock ensures flicker-free character display. Only the size of the Pascal Language card, VIDEOTERM utilizes CMOS and low power consumption ICs, ensuring cool, reliable operation. All ICs are fully socketed for easy maintenance. Add to that 2K of on-board RAM, 50 or 60 Hz operation, and provision of power and input connectors for a light pen. Problems are designed out, not in.

Available Options The entire display may be altered to inverse video, displaying black characters on a white field. PROMs containing alternate character sets and graphic symbols are available from Videx. A switchplate option allows you to use the same video monitor for either the VIDEOTERM or the standard Apple II* display, instantly changing displays by flipping a single toggle switch. The switchplate assembly inserts into one of the rear cut-outs in the Apple II* case so that the toggle switch is readily accessible. And the Videx KEYBOARD ENHANCER can be installed, allowing upper and lower case character entry directly from your Apple II* keyboard.

Firmware 1K of on-board ROM firmware controls all operation of the VIDEOTERM. No machine language patches are needed for normal VIDEOTERM use.

Firmware Version 2.0

Characters Options	7 x 9 matrix 7 x 12 matrix option; Alternate user definable character set option; Inverse video option.	Display	24 x 80 (full descenders) 18 x 80 (7 x 12 matrix with full descenders)

Want to know more? Contact your local Apple dealer today for a demonstration. VIDEOTERM is available through your local dealer or direct from Videx in Corvallis, Oregon. Or send for the VIDEOTERM Owners Reference Manual and deduct the amount if you decide to purchase. Upgrade your Apple II* to full terminal capabilities for half the cost of a terminal. VIDEOTERM. At last.

Apple II* is a trademark of Apple Computer Inc.
ROMWriter* is a trademark of Mountain Hardware Inc.
Micromodem II* is a trademark of D. C. Hayes Associates Inc.
Softcard* is a trademark of Microsoft
EasyWriter* is a trademark of Information Unlimited Software Inc.

PRICE:
- VIDEOTERM includes manual $345
- SWITCHPLATE ..... $ 19
- MANUAL refund with purchase ..... $ 19
- 7 x 12 CHARACTER SET ..... $ 39
- MICROMODEM FIRMWARE ..... $ 25

APPLE II® OWNERS!

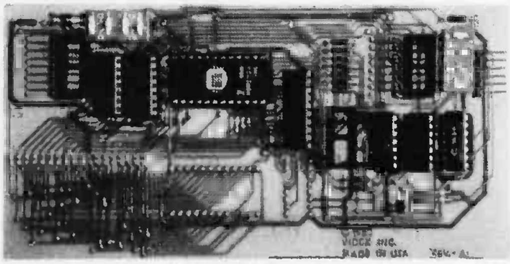
introducing the
KEYBOARD & DISPLAY ENHANCER

- *PUT THE SHIFT AND SHIFT LOCK BACK WHERE IT BELONGS*
- *SEE REAL UPPER AND lower CASE ON THE SCREEN*
- *ACCESS ALL YOUR KEYBOARD ASCII CHARACTERS*

Videx has the perfect companion for your word processor software: the **KEYBOARD AND DISPLAY ENHANCER**. Install the enhancer in your APPLE II and be typing in lower case just like a typewriter. If you want an upper case character, use the SHIFT key or the CTRL key for shift lock. Not only that, but you see upper and lower case on the screen as you type. Perfectly compatible with Apple Writer and other word processors like, for example, Super-Text.

If you want to program in BASIC, just put it back into the alpha lock mode; and you have the original keyboard back with a few improvements. Now you can enter those elusive 9 characters directly from the keyboard, or require the Control key to be pressed with the RESET to prevent accidental resets.

KEYBOARD AND DISPLAY ENHANCER is recommended for use with all revisions of the APPLE II. It includes 6 ICs, and EPROM and dip-switches mounted on a PC board, and a jumper cable. Easy installation, meaning no soldering or cutting traces. Alternate default modes are dip-switch selectable. You can even remap the keyboard, selecting an alternate character set, for custom applications.



PRICE
- KDE-700 (REV. 7 or greater) ..... $129.
- KDE-000 (REV. 6 or less) ..... $129.

Apple II® is a trademark of Apple Computer, Inc.

VIDEX
897 N.W. Grant Avenue
Corvallis, Oregon 97330
Phone (503) 758-0521

Listing 1: *The* scanWord: *method scans or prints text.*

```
scanWord: endRun
  | charIndex |
  < primitive >   "May be implemented internally for speed"
  [charIndex > endRun] whileTrue:
     [charIndex ← text at: textPos.                          "pick character"
     (exceptions at: charIndex) > 0                          "check exceptions"
        ifTrue: [↑ exceptions at: charIndex].
     sourceX ← xTable at: charIndex.                         "left x of character in font"
     width ← (xTable at: charIndex + 1) − sourceX.           "up to left of next char"
     printing ifTrue: [self copyBits].                       "print the character"
     destX ← destX + width.                                  "advance by width of character"
     destX > stopX ifTrue: [↑ stopXCode].                    "passed right boundary"
     textPos ← textPos + 1].                                 "advance to next character"
  textPos ← textPos − 1.
  ↑ endRunCode
```

- xTable—an Array of Integers giving the left *x* location of each character in sourceForm
- stopX—an Integer that sets a right boundary past which the inner loop should stop scanning
- exceptions—an Array of Integers that, if non-zero, indicate that the corresponding characters must be specially handled

Once an instance has been initialized with a given font and text location, the scanWord: loop given in listing 1 will scan or print text until some horizontal position (stopX) is passed, a special character (determined from exceptions) is found, or the end of this range of text (endRun) is reached.

The check on exceptions handles many possibilities in one operation. The space character may have to be handled exceptionally in the case of text that is padded to achieve a flush right margin. Tabs usually require a computation or table check to determine their width. Carriage return is also identified in the check for exceptions. Character codes beyond the range given in the font are detected similarly and are usually handled by showing an exceptional character, such as a little lightning bolt, so that they can be seen and corrected. The printing flag can be set false to allow the same code to *measure* a line (break at a word boundary) or to find where the cursor points. While this provision may seem over-general, two benefits (besides compactness) are derived from that generality. First, if one makes a change to the basic scanning algorithm, the parallel functions of measuring, printing, and cursor tracking are sure to be synchronized. Second, if a primitive implementation is provided for the loop, it exerts a threefold leverage on the system performance. The scanWord: loop is designed to be amenable to such primitive implementation; that is, the interpreter may intercept it and execute primitive code instead of the Smalltalk code shown. In this way, much of the setup overhead for copyBits can be avoided at each character, and an entire word or more can be displayed

State-of-the-art hardware demands state-of-the-art software

Operating Systems & Support Software from Technical Systems Consultants

To perform to its fullest capabilities, your hardware demands software designed to meet the specialized requirements of today's microprocessors. State-of-the-art software from Technical Systems Consultants keeps pace with the rapid advancements in computer technology so your hardware can live up to its full potential. Our complete line of state-of-the-art software includes:

The UniFLEX™ Operating System
UniFLEX, a true multi-user, multi-tasking system for the 6809 and 68000 microprocessors, supports such features as:

- hierarchical file systems
- device independent I/O
- four Gigabyte disk capacities
- full file protection
- inter-task communication via pipes
- I/O redirection
- task swapping
- full random access files
- comprehensive shell command language

UniFLEX, structured for large-scale microprocessor systems, will not run with minimal systems and thus has avoided design compromise. (Off-the-shelf versions and OEM licenses are available.)

The FLEX™ Operating System
FLEX, a powerful, easy-to-use operating system designed for the 6800 and 6809 microprocessors, includes:

- dynamic filespace allocation
- random files
- batch job entry
- automatic space compression
- English error messages
- user environment control
- disk resident commands
- flexible device I/O
- printer spooling

Plus, FLEX can accommodate hard disks as well as floppies. The System is available off-the-shelf for a variety of systems and in a field-adaptable version. (OEM licenses available.)

FLEX and UniFLEX are trademarks of Technical Systems Consultants, Inc.

Support Software
Technical Systems Consultants offers a full line of state-of-the-art support software compatible to FLEX and UniFLEX, some of which are:

- native C and Pascal compilers for advanced programming
- extended BASIC for business and educational applications
- text editing and processing software
- sort/merge package for business applications
- variety of absolute and relocatable assemblers
- debug and diagnostic packages

... and more. Write or call today for our brochures describing our complete product line.

technical systems consultants, inc.

Box 2570, 1208 Kent Avenue
West Lafayette, Indiana 47906
(317) 463-2502 Telex 27-6143

Sculpture by Joann Chaney

Listing 2: *The* drawLoopX:Y: *method draws lines.*

```
drawLoopX: xDelta Y: yDelta
  | dx dy px py p i |
  < primitive >
  dx ← xDelta sign.
  dy ← yDelta sign.
  px ← yDelta abs.
  py ← xDelta abs.
  self copyBits.                "first point"

  py > px
    ifTrue:                     "more horizontal"
      [p ← py/ /2.
      1 to: py do:
        [:i | destx ← destx + dx.
        (p ← p − px) < 0 ifTrue: [desty ← desty + dy. p ← p + py].
        self copyBits]]
    ifFalse:                    "more vertical"
      [p ← px/ /2.
      1 to: px do:
        [:i | desty ← desty + dy.
        (p ← p − py)<0 ifTrue: [destx ← destx + dx. p ← p + px].
        self copyBits]]
```

Listing 3: *Methods for image magnification. @ is a shorthand message that returns a new* Point *whose x-value is the receiver (on the left) and whose y-value is the argument (on the right).* Points *respond to the + and * messages by distributing them over each of the coordinates.*

```
magnify: rect by: scale spacing: spacing
  | wideForm bigForm |                          "First expand horizontally"
  wideForm ← Form extent: (rect width * scale x) @ rect height.
  wideForm spread: rect from: self by: scale x
    spacing: spacing x direction: 1 @ 0.
  bigForm ← Form extent: rect extent * scale.   "Then expand vertically"
  bigForm spread: wideForm asRectangle from: wideForm by: scale y
    spacing: spacing y direction: 0 @ 1.
  ↑ bigForm

spread: rect from: sourceForm by: scale spacing: spacing
 direction: dir
  | slice sourcePt |
  slice ← Rectangle origin: 0 @ 0 extent: dir transpose * self extent + dir.
  sourcePt ← rect origin.      "transpose returns a Point with swapped coordinates"
  1 to: (rect extent dot: dir) do:      "dot product selects direction of stretch"
    [:i |      "slice up the original image"
    self copy: slice from: sourcePt in: sourceForm rule: STORing.
    sourcePt ← sourcePt + dir. slice moveby: dir * scale].
  1 to: scale − spacing − 1 do:
    [:i |      "smear out the slices, leave some space"
    self copyAllTo: 1 @ 0 in: self rule: ORing]
```

directly. Conversely, the Smalltalk text and graphics system requires implementation of only the one primitive operation to provide full functionality.

Line Drawings, Image Synthesis

The same design principle applies in the support for drawing lines. By using BitBlt, one algorithm can draw lines of varying widths, different halftone "color," and any combination rule. To draw a line, an instance of BitBlt is initialized with the appropriate destination Form and clipping window, and with a source that can be any Form to be applied as a pen shape along the line. Starting from the stored destX and destY, the line-drawing loop, drawLoopX:Y: (listing 2), accepts *x* and *y* delta values and *x* and *y* step values as necessary, calling copyBits at each point along the line. The method used

THE BACKBONE OF YOUR SYSTEM

The Heath/Zenith 19 Smart Video Terminal gives you all the important professional features, all for under $700.* You get the flexibility you need for high-speed data entry, editing, inquiry and transaction processing. It's designed to be the backbone of your system with heavy-duty features that withstand the rigors of daily use.

Standard RS-232C interfacing makes the 19 compatible with DEC VT-52 and most computer systems. And with the 19, you get the friendly advice and expert service that makes Heath/Zenith a strong partner for you.

Pick the store nearest you from the list on page 00. And stop in today for a demonstration of the Heath/Zenith 19 Smart Video Terminal. If you can't get to a store, send $1.00 for the latest Heathkit® Catalog and the new Zenith Data Systems Catalog of assembled commercial computers. Write Heath Co., Dept. 334-806, Benton Harbor, MI 49022.

HEATH/ZENITH

Your strong partner

*In kit form, F.O.B. Benton Harbor, MI. Also available completely assembled at $995. Prices and specifications are subject to change without notice.

CP-202B

is the Bresenham plotting algorithm (*IBM Systems Journal*, Volume 4, Number 1, 1965). It chooses a principal direction and maintains a variable, p. When p's sign changes, it is time to move in the minor direction as well. This procedure is another natural unit to be implemented as a primitive, since the computation is trivial and the setup in copyBits is almost all constant from one invocation to the next.

Image Processing

We have seen how BitBlt can copy shapes and, in the foregoing examples, how repeated invocation can synthesize more complex images such as text and lines. BitBlt is also useful in the manipulation of existing images. For example, text can be made to look bold by ORing over itself, shifted right by one pixel. Just as complex images can be built from simple ones, complex processing can be achieved by repeated application of simple operations. Here, we present three examples of such structural manipulation: magnification, rotation, and the game of Life. These examples were devised by the author in collaboration with Ted Kaehler.

As we shall see in the next two sections, many applications of BitBlt are very simple, such as filling a Form with white, or copying all of one Form to some location in another. Smalltalk provides for such casual use of BitBlt through a wide range of simple messages to class Form, such as:

```
someForm fillAll: white.
someForm copyAllTo:
    destLocation in: destForm.
```

We will not list all such messages here. In the examples that follow, the reader should be able to infer the meaning from the message names and the accompanying explanations.

Magnification

It is often useful to magnify an image for closer scrutiny and especially to allow convenient alteration of stored Forms. Photo 1 shows this function providing user control over the font used for display of text.

Listing 4: *The* rotate *method. This method rotates an image of size* 2^n *by* 2^n *one quarter-turn clockwise.*

```
rotate | mask temp quad |
   temp ← Form extent: self extent.
   mask ← Form extent: self extent.          "set up the first mask"
   mask copy: mask asRectangle halftone: white rule: STORing.
   mask copy: mask asRectangle/2 halftone: black rule: STORing.
   quad ← self width/2. "the size of a quadrant"
   [quad > = 1] whileTrueDo:
     [  "First exchange left and right halves"
      mask copyAllTo: 0 @ 0 in: temp rule: STORing.
      mask copyAllTo: 0 @ quad in: temp rule: ORing.
      self copyAllTo: 0 @ 0 in: temp rule: ANDing.
      temp copyAllTo: 0 @ 0 in: self rule: XORing.
      temp copyAllFrom: quad @ 0 in: self rule: XORing.
      self copyAllTo: (0 – quad) @ 0 in: self rule: ORing.
      temp copyAllTo: quad @ 0 in: self rule: XORing.
        "Then flip the diagonals"
      self copyAllTo: 0 @ 0 in: temp rule: STORing.
      temp copyAllFrom: quad @ quad in: self rule XORing.
      mask copyAllTo: 0 @ 0 in: temp rule: ANDing.
      temp copyAllTo: 0 @ 0 in: self rule: XORing.
      temp copyAllTo: quad @ quad in: self rule: XORing.
        "Compute the next fine mask"
      mask copyAllFrom: (quad/2) @ (quad/2) in: mask rule: ANDing.
      mask copyAllTo: quad @ 0 in: mask rule: ORing.
      mask copyAllTo: 0 @ quad in: mask rule: ORing.
      quad ← quad/2]
```

The character for "7" has been presented magnified nine times. Using a pointing device, the user has blackened some cells to provide a European style "7," and the result can be seen in both the upper-left and lower-right windows on the screen.

A simple way to magnify a stored Form would be to copy it to a larger Form, making a big dot for every little dot in the original. For a height *h* and width *w*, this would take $h \times w$ operations. The algorithm presented in listing 3 (as two messages to class Form) uses only a few more than $h + w$ operations.

The magnification proceeds in two steps. First, it slices up the image into vertical strips in wideForm separated by a space equal to the magnification factor. These are then smeared, using the ORing function, over the intervening area to achieve the horizontal magnification. The process is then repeated from wideForm into bigForm, with horizontal slices separated and smeared in the vertical direction, achieving the desired magnification. Figure 8 illustrates the progress of the above algorithm in producing the magnified "7" shown in photo 1.

Rotation

Another useful operation on images is rotation by a multiple of 90 degrees. Rotation is often thought to be a fundamentally different operation from translation, and this point of view would dismiss the possibility of using BitBlt to rotate an image. However, the reader must consent that the first transformation shown in figure 9 is a step toward rotating the image shown: all that remains is to rotate the insides of the four cells that have been permuted. The remainder of the figure shows each of these cells being further subdivided, its cells being similarly permuted, and so on. Eventually each cell being considered contains only a single pixel. At this point, no further subdivision is required, and the image has been faithfully rotated!

Each transformation shown in figure 9 would appear to require successively greater amounts of computation, with the last one requiring several times more than $h \times w$ operations. The tricky aspect of the algorithm below is to permute the subparts of every subdivided cell at once, thus performing the entire rotation in a constant times $log_2(h)$ operations. The parallel permutation of many cells is accomplished with the aid of two auxiliary Forms. The first, mask, carries a mask that selects the upper left quadrant of every cell; the second, temp, is used for temporary storage. A series of BitBlt operations exchanges the right and left halves of every cell, and then another series ex-

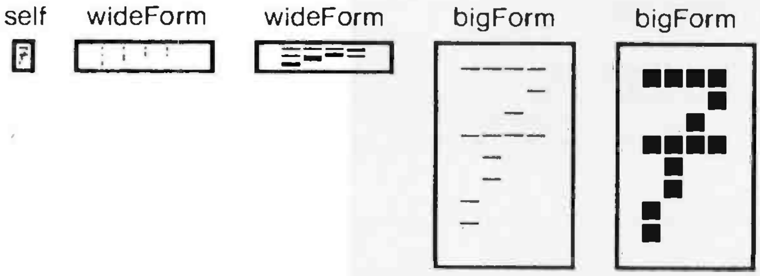


Figure 8: *Magnification with BitBlt. See the text for more details.*

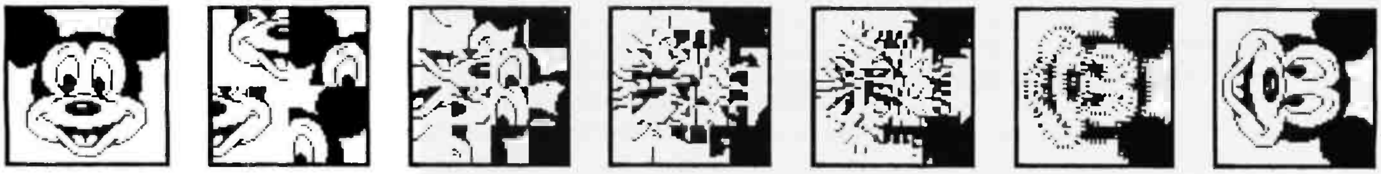
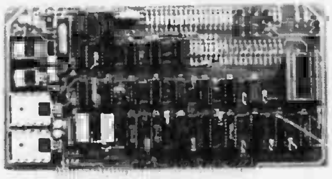


Figure 9: *Image rotation with BitBlt. See the text for more details.*

PUT YOUR SYSTEM ON THE FOREFRONT OF TECHNOLOGY

PROM BLASTER

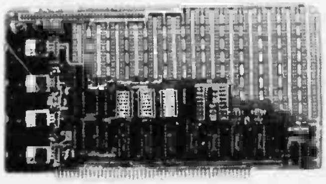


PROGRAMS MOST FAMILIES OF EPROMS!

- Accepts 1K/2K/4K or 8K EPROMS
- Extended Device Option
- Phantom Slave Option
- All Programming Characteristics Software Controlled
- Accepts Single or 3 Supply Parts
- Device Address Switch Selectable

Kit Price $199.95

KLUGE CARD

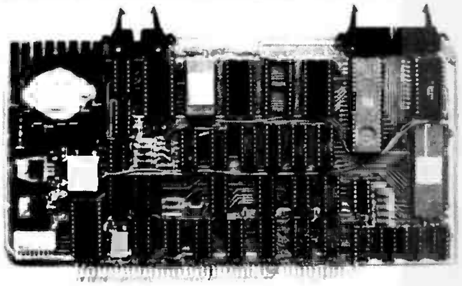


SIMPLIFY YOUR PROJECTS WITH A PROTOTYPE BREADBOARD WITH EXTRAS

- 4 On-Board Pwr. Supplies up to 3 of which can be +5, or ±5, ±12
- Switch Selectable Memory or Device Address
- On-Board Address/Device Decoding
- Bi-Directional Data Bus Buffering
- On-Board Wait States

Bare Board $39.95

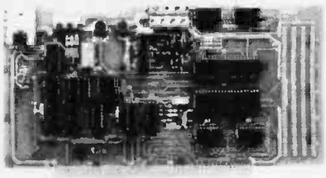
6809 SINGLE BOARD COMPUTER



- 2K ROM
- 4K/8K/16K RAM
- 20 Parallel I/O Lines
- RS 232 Interface
- Baud Rates from 110 to 9600
- All Memory/I.O. Relocatable on 4K Boundaries
- 8080 I/O Instructions Memory Mapped (Gives 256 I/O Ports)
- Complete Documentation
- ADSMON Monitor Includes User Callable Functions, Autopatch and more

Kit Price $299.95 (Includes Software)

NOISEMAKER



- Two On-Board Audio Amplifiers for Stereo Sound Effects
- Uses the GIAY 3-8910
- Six Tone Generators
- Two Envelope Generators
- Two Noise Sources
- Four 8-Bit I/O Ports
- Up to Two Wait States

ALL SOUND EFFECTS ARE SOFTWARE CONTROLLED FOR AN ENDLESS VARIETY!
KIT $84.95

MOTHER BOARDS

THREE S-100 MOTHER BOARDS AVAILABLE;

- 3 Slots for Stand-Alone Applications
- 9 Slots for Small Systems
- 18 Slots for Full Size Systems
- Active Termination (9 & 18 Slot Boards Only)
- Extensive Ground Shield
- Breadboard Area

(Write for complete information)

The products shown here are just an example of the quality products and service **Ackerman Digital Systems** offers. **ADS** is an engineering company dedicated to providing the micro computer industry with solid quality products to meet a variety of needs.

All **ADS** products adhere to the **I.E.E.E. 696/S-100 Bus** standard, a bus noted for its widespread acceptance and versatility.

For catalog containing complete hardware and software information, write Ackerman Digital Systems, Inc., 110 N. York Rd., Elmhurst, IL 60126. TEL 312-530-8992

ACKERMAN DIGITAL SYSTEMS, INC.

Circle 3 on Inquiry card.

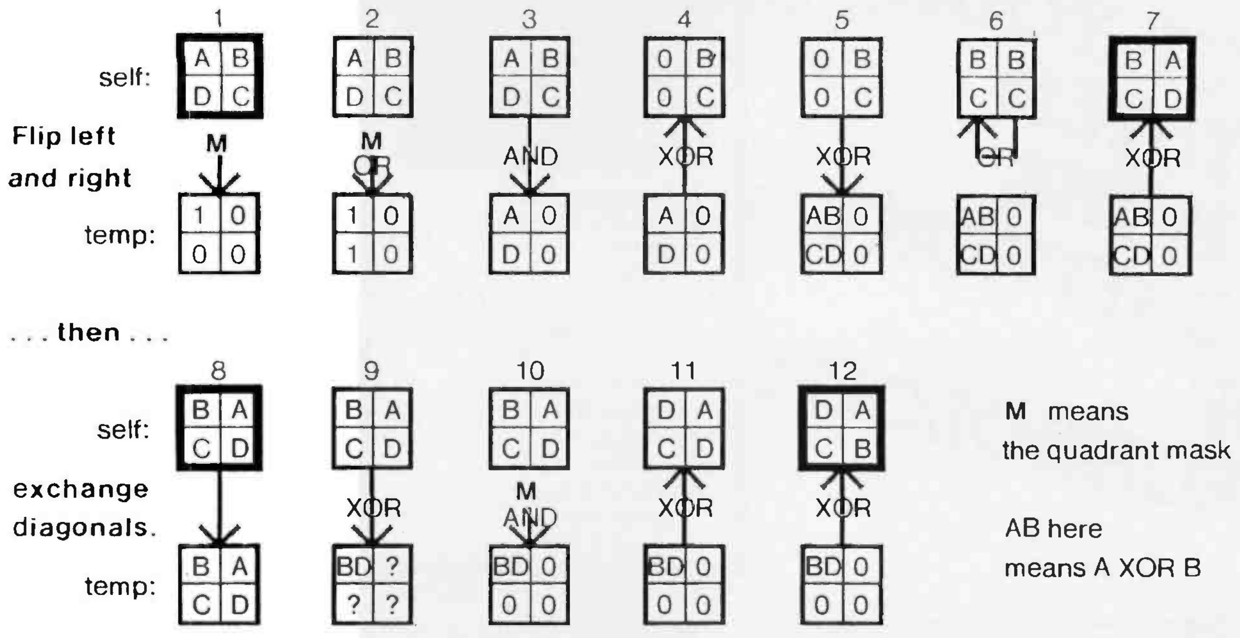


Figure 10: *Permuting four quadrants of a cell.*

changes the diagonal quadrants, achieving the desired permutation. The complete method for rotation is given in listing 4.

Figure 10 traces the state of temp and self after successive operations. The offsets of each operation are not shown, though they are given in the program listing. After twelve operations, the desired permutation has been achieved. At this point, the mask evolves to a finer grain, and the process is repeated for more, smaller cells. Figure 11 shows the evolution of the mask from the first to the second stage of refinement. The reader will note that the algorithm presented here for rotation is applicable only to square forms whose size is a power of two. The extension of this technique to arbitrary rectangles is more involved and is left as an exercise for the reader. A somewhat simpler exercise is to apply the above technique to horizontal and vertical reflections about the center of a rectangle.

The Game of Life

John Conway's game of Life is probably well known to readers of BYTE. It is a fairly simple rule for successive populations of a bitmap. The rule involves the neighbor count for each cell—how many of the eight adjacent cells are occupied? Each cell will be occupied in the next generation if it has exactly three neighbors, or if it was occupied and has exactly two neighbors. This is explained as follows: three neighboring organisms can give birth in an empty cell, and an existing organism will die of exposure with less than two neighbors or from overpopulation with more than three neighbors. Since BitBlt cannot add, it would seem to be of no use in this application. However, BitBlt's combination rules do include the rules for partial sum (XOR) and carry (AND). With some ingenuity and a fair amount of extra storage, the next generation of any size of bitmap can be computed using a *constant* number of BitBlt operations.

Listing 5 gives the method for nextLifeGeneration. As shown in figure 12, the number of neighbors is represented using three image planes for the 1s bit, 2s bit, and 4s bit of the neighbor count in binary. The 8s bit can be ignored, since there are no survivors in that case, which is equivalent to zero (the result of ignoring the 8s bit). This Smalltalk method is somewhat wasteful, as it performs the full carry propagation for each new neighbor, even though nothing will propagate into the 4-plane until at least the fourth neighbor. Some readers may enjoy improving upon this algorithm.

Many other image-processing tasks can be performed with BitBlt. The author has built a complete optical character-recognition system for Sanskrit text using the various combination rules and an operation that counts the number of black bits in any rectangle (how would you do it?).

Bitmap processing is ideally suited to VLSI (very large scale integration) implementation. Readers who are interested in this direction should check the proceedings of the Design Automation Conference, June 1981, for "Parallel Bitmap Processor," by Tom Blank, Mark Stefik, and Willem vanCleemput.

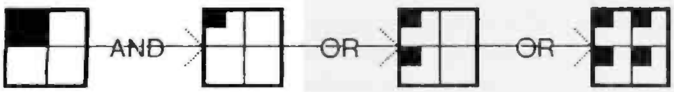


Figure 11: *Refinement of the quadrant mask.*

Efficiency Considerations

Our original specification for BitBlt has been published elsewhere


YOUR SOFTWARE STRATEGY FOR THE 80's
New Compiler and Support Team Brings Products to Market Faster and Easier
If your company's in the big game of small business systems, you'll want to know more about Compiler Systems' support team and its new CB80.
Everyone's talking about the ultimate microcomputer winners and how software will be the driving force in the market. Enter the new CB80 BASIC compiler.
CB80 is derived from the industry's standard CBASIC™ and designed for 8-bit micros supporting CP/M®, MP/M™ and CP/NET™. It retains all of the characteristics that made CBASIC widely used in business applications, while providing substantial improvements in speed and performance.
And advanced CSI design provides CB80 with enhancements for multi-user support further expanding your marketing opportunities.
CSI's support team will assist in your development and marketing efforts — plus special assistance via a technical hotline for users.
CB80 is sold throughout the U.S. and overseas by a network of distributors. Call today (213) 355-4211 for ordering information or write for technical details.
CB80 CSi
Compiler Systems, Inc., 37 N. Auburn Ave., P.O. Box 145, Sierra Madre, California 91024, (213) 355-1063
CP/M®, MP/M™ and CP/NET™ are trademarks of Digital Research
CB80™

Listing 5: *The* nextLifeGeneration *method. This method calculates the next Life generation given the BitBlt bitmap of the current generation. See figure 12.*

```
nextLifeGeneration | nbr1 nbr2 nbr4 carry2 carry4 |
  nbr1 ← Form new extent: self extent + (2 @ 2).     "temp areas larger by 1"
  nbr2 ← Form new extent: self extent + (2 @ 2).     "bit all around"
  nbr4 ← Form new extent: self extent + (2 @ 2).
  carry2 ← Form new extent: self extent + (2 @ 2).
  carry4 ← Form new extent: self extent + (2 @ 2).
  (1 @ 1) eightNeighbors do:
    [:delta | "delta equals a different neighbor-offset each time through this loop"
    carry2 copyAllFrom: 0 @ 0 in: nbr1 rule: STORing.
    carry2 copyAllFrom: delta in: self rule: ANDing.      "carry into 2"
    nbr1 copyAllFrom: delta in: self rule: XORing.        "sum 1"
    nbr2 copyAllTo: 0 @ 0 in: carry4 rule: STORing.
    carry2 copyAllTo: 0 @ 0 in: carry4 rule: ANDing.      "carry into 4"
    carry2 copyAllTo: 0 @ 0 in: nbr2 rule: XORing.        "sum 2"
    carry4 copyAllTo: 0 @ 0 in: nbr4 rule: XORing].       "sum 4"
  nbr2 copyAllTo: 1 @ 1 in: self rule: ANDing. "perform logic to determine the survivors"
  nbr2 copyAllTo: 0 @ 0 in: nbr1 rule: ANDing.   "(2s AND self) OR (2s AND 1s))"
  nbr1 copyAllTo: 1 @ 1 in: self rule: ORing.    "...all AND (NOT 4s)"
  nbr4 copyAllTo: 0 @ 0 in: self rule: NOTANDing       "store next generation"
                                                        "over self"
```

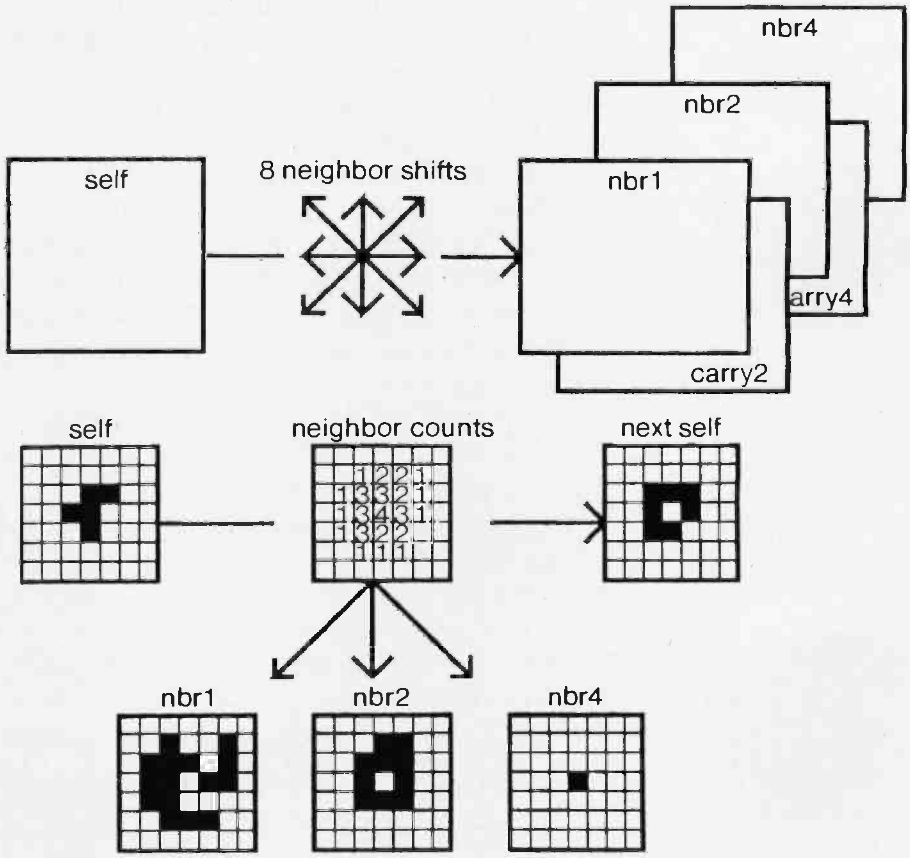
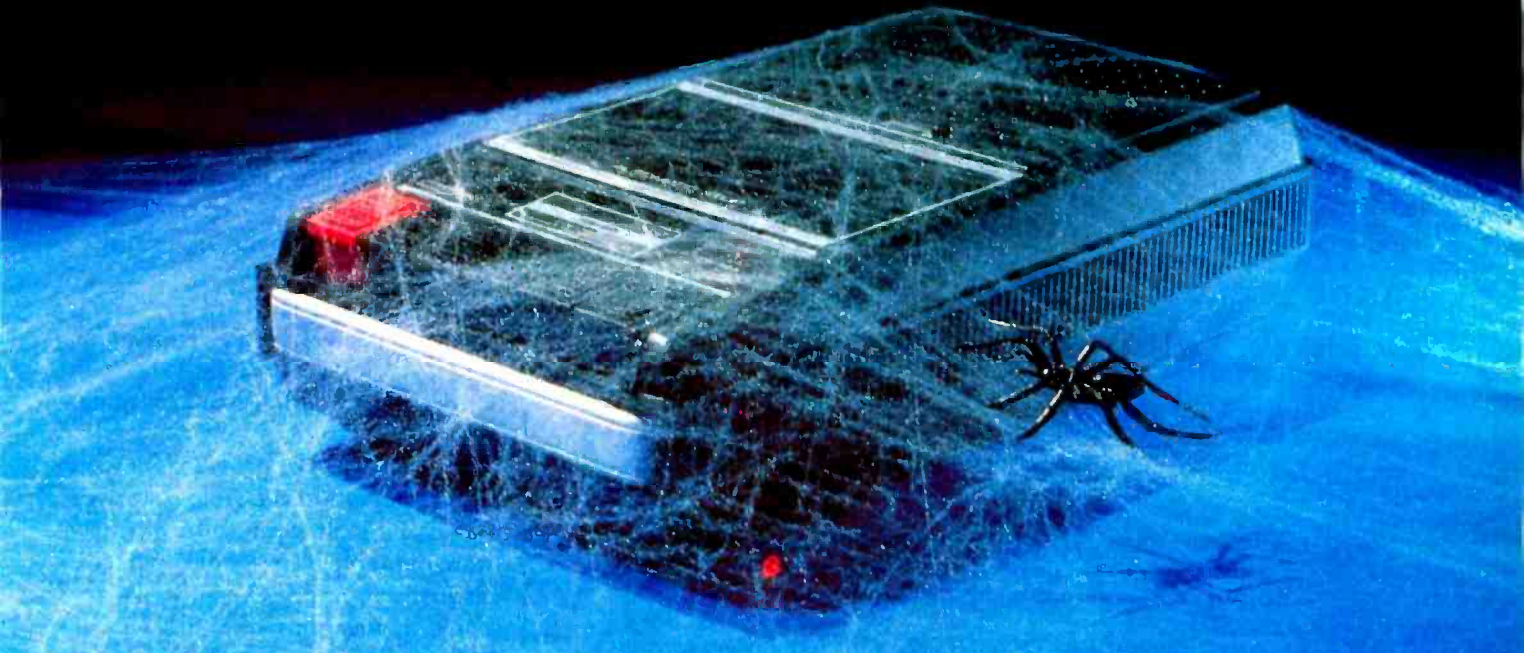


Figure 12: *Counting neighbors in the game of Life.*

(Newman and Sproull, *Principles of Interactive Computer Graphics*, 2nd edition, McGraw-Hill, 1979) under the name *RasterOp*. The implementation described in that reference can easily be extended to include the full set of combinations, and the addition of clipping is also straightforward. Here, we add a few notes on efficiency gathered from experience.

BitBlt is so central to the user interface that any improvement in its performance has considerable effect on the interactive quality of the system

TIRED OF WAITING?



Frustrating isn't it! No matter how much you speed up your program it still seems to take forever to save data onto a cassette. Wouldn't it be great if someone could design a mass storage system with the speed of a disk, but at half the cost? *Exatron* did, the *Exatron Stringy Floppy (ESF)*.

Totally self-contained, the ESF is an extremely fast, reliable, and economical alternative to cassette or disk storage of programs or data. All of the ESF's operations are under the computer's control, with no buttons, switches, knobs or levers to adjust or forget.

The ESF uses a miniature tape cartridge, about the size of a business card, called a wafer. The transport mechanism uses a direct drive motor with only one moving part. Designed to read and write digital data only, the ESF suffers from none of the drawbacks of cassettes - without the expense of disks.

Several versions of the ESF are available, for the *TRS-80, Apple, PET, OSI* and an *RS 232* unit. Even the slowest of the units is 15 times faster than a cassette, and all are as reliable as disk drives - in fact a lot of users say they are *more* reliable!

excellence in electronics

exatron

To get further information about the ESF give Exatron a *call* on their Hot Line *800-538 8559* (inside California 408-737 7111).

If you can't wait any longer then take advantage of their 30 day money-back guarantee, you've nothing to lose but time!

181 Commercial Street
Sunnyvale, CA 94086

TRS-80, Apple and PET are trademarks of Tandy, Apple and Commodore respectively.

as a whole. In normal use of the Smalltalk-80 system, most calls on BitBlt are either in the extreme microscopic or macroscopic range. Let us examine these more closely.

In the macroscopic range, the width of transfer spans many words. The inner loop across a horizontal scan line gets executed many times, and the operations requested tend to be simple moves or constant stores. Examples of these are:

- Clearing a line of text to white
- Clearing an entire window to white
- Scrolling a block of text up or down

It is fortuitous that most processors provide a fast means for block moves and stores, and these can be made to serve the applications above. Suppose we structure the horizontal loop of BitBlt as the following sequence:

1. Move left partial word
2. Move many whole words (or none)
3. Move right partial word (or none)

Special cases can be provided for item 2 if the operation is a simple store or if it is a simple copy with no skew (horizontal bit offset) from source to destination. In this way, most macroscopic applications of BitBlt can be made fast, even on processors of modest power.

The microscopic range of BitBlt is characterized by a zero count for the inner loop in item 2, so that the work on each scanline involves, at most, two words. Both overall setup and vertical loop overhead can be considerably reduced for this case. Because characters tend to be less than a word wide and lines tend to be less than a word thick, nearly all text and line drawing fall into this category. A convenient way to provide such efficiency is to write a special case of BitBlt that assumes the microscopic parameters, but goes to the general BitBlt whenever these are not met. Because of the statistics (many small operations and a few very large ones), it does not hurt to pay the penalty of a false assumption on infrequent calls. ■

FMS-80 Organizes Your Organization

FMS-80, a data base management system, offers the user a quick and easy way to organize and efficiently manipulate data so sound decisions can be made on facts displayed.

FMS-80*** is the most powerful stand alone DBM program available to the microcomputer industry.

Completely menu driven and written in assembly language it offers these features:

- **User definable**
  File Definitions
  Screen Displays
  Reports (with math and field break analysis)
  Selection Criteria (on any or all fields)
  Menus (that applications programs can be selected from)
- Instantaneous data query on indexed records.
- Mathematical manipulation of numeric data fields using the report generator or the programming language EFM (Extended File Maintenance)
- Easy to use video "how to" training tapes are available.
- Manipulation of up to 19 different data files (using EFM) at one time and displaying this information on the screen, generating reports, generating other data files or on-line updating of input files that already exist
- FMS-80 is able to call other programs like subroutines in EFM
- FMS-80 is able to read data files that other programs have generated
- No restrictions to record size other than available RAM memory space
- Operates under CP/M,* MP/M* or CDOS**

FMS-80 allows the flexibility to quickly create programs that allow data to be entered in a form that a secretary recognizes and generates reports that the manager requires.

If you're continuously asked to do applications programs and don't have time to do it in BASIC, consider FMS-80. For additional information contact

Systems Plus,
3975 East Bayshore,
Palo Alto, CA
94303. Phone
415/969/7047

Systems Plus

***TM of DJR Associates
**TM of Cromemco, Sunnyvale, CA
*TM of Digital Research, Pacific Grove, CA

BYTE's Bits

Apple Displaces Organ at Wedding

The organ at St Bartholomew Church, Cincinnati, Ohio, stood idle at the wedding of Curt Brookbank and Libby Nieman, but the traditional wedding music of Wagner and Mendelssohn sounded as if an organist were hard at work. The organist was an Apple II. Ms Nieman, a buyer in the calculator department of the 21st Century Computer store in Cincinnati, decided on computerized wedding music after playing some computerized Christmas carols. The Apple II computer was equipped with ALF and Mountain music boards.

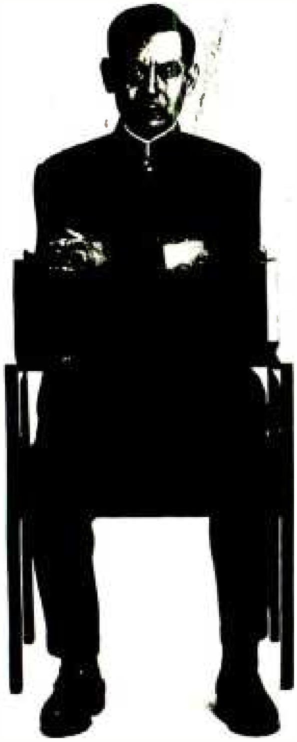
Old Altairs Never Die . . .

Five years ago, a computer built by students at Venice (California) High School began operation. Today that computer, and a duplicate built one semester later, are still operating. The computers, Altair 8800s, were built from kits for about $2000 each, which at the time was about a fourth of what an equivalent commercial computer would have cost. The school's principal at the time, Arnold Miller, agreed to buy the computer kits not only for the saving in cost but also for the educational value to the students who would build them and those who would use them.

The computers, running eight hours almost every day, have served hundreds of students in computer programming classes and in math classes. But the most enthusiastic users are those students who crowd the computer room before and after school and at other times to play computer games.

The student-built computers have been very reliable. They have never had a serious malfunction, requiring only the replacement of two integrated-circuit memory chips. The biggest maintenance problems have been mechanical, primarily the keyboards, which have taken a tremendous amount of pounding over their approximately 8000 hours of operation. It is estimated that total maintenance costs over five years for both Altairs have been less than $50.

It is estimated that each Altair represents an expenditure of $3000 including initial cost and additions and improvements over the five-year period. This yields a student-hour cost of less than one-half dollar.■



“我不知道你是谁
"I don't know who you are
我不知道你的公司
I don't know your company
我不知道你的公司的产品
I don't know your company's product
我不知道你的公司代表什么
I don't know what your company stands for
我不知道你的公司有那些顾客
I don't know your company's customers
我不知道你的公司办得怎样
I don't know your company's record
我不知道你的公司的声誉如何——
I don't know your company's reputation
那么，你到底要什么给中国？”
Now -- what was it you wanted to sell us?"

McGraw-Hill helps you do business in the People's Republic of China.

You know how advertising in McGraw-Hill magazines helps your company contact prospects, arouse interest in products, overcome sales resistance, and create preference when you're selling to businesses here in America.

But you may not know that McGraw-Hill's *American Industrial Report* can do the very same things to help you sell to your toughest prospects in the People's Republic of China. And you also may not know that *American Industrial Report*, as the first U.S. technical magazine accepted into modern China, has more than five years of experience and marketing expertise.

During the early 1980's, the People's Republic of China will spend an estimated $30 billion-plus for foreign technology and capital goods. By 1985, they'll be buying a projected total of $12-15 billion worth from companies in the United States.

Obviously, the People's Republic of China is an important new market for American manufacturers.

But it's one thing to identify an important new market. And quite another to successfully capture a share of it.

Selling industrial products in the P.R.C. involves the same problems as selling them in the U.S.

Plus the problems of a different language and culture. And a different political, economic and foreign trade system.

There are almost 1 billion Chinese. McGraw-Hill's American Industrial Report reaches the .1% you need to do business with.

Every month, *American Industrial Report* reaches 35,000 end-users, engineers, managers, Foreign Trade Corporation and ministry officials. With an estimated pass-along of 50 readers per copy, that gives you exposure to 1 million Chinese – the .1% of the population who, as key decision-makers, are your key prospects.

American Industrial Report also helps you reach them in their own language. With free translation of your advertising copy into modern Chinese characters – the kind used in technical journals in the P.R.C., not Hong Kong or Singapore. We also give you free, expert advice on how to avoid the kind of political and cultural errors that could alienate or confuse the very people you're trying to sell to.

A free guide to selling in the P.R.C. and to the magazine that helps you do it.

American Industrial Report would like to share what it's learned over more than five years of serving end-users in the People's Republic of China – and serving American advertisers who want to sell to them.

We've put it all into a free 84-page guidebook, which you can get by writing *American Industrial Report*, 1221 Avenue of the Americas, New York, New York 10020. Or calling Robert Christie at 212-997-6730.

Write or call for your copy today.

Now that the People's Republic of China has opened the door, see how *American Industrial Report* can help you get a foot in it.

McGraw-Hill Magazines

Circle 417 on inquiry card. Circle 155 on inquiry card. →

Hayes Stack™

Microcomputer Component Systems

At Hayes, we don't believe in second best. Or planned obsolescence. We believe in taking the state of the art to the limit. Our new Smartmodem, for example, is the most sophisticated 300-baud originate/answer modem you can buy. And yet, it is perhaps the easiest-to-use modem ever.

RS-232C Compatible. Smartmodem lets any RS-232C compatible computer or terminal communicate by phone with other computers and time-sharing systems located *anywhere in North America*. You get full and half-duplex operation with both Touch-Tone* *and* pulse dialing.

Auto-Answer/Dial/Repeat. Smartmodem can answer the phone, dial a number, receive and transmit data, and then hang up the phone—automatically! If desired, Smartmodem will even repeat the last command. You can depend on Smartmodem for completely unattended operation.

Completely Programmable. Smartmodem can be controlled using *any* programming language. Over 30 different commands can be written into your programs or entered directly from your keyboard.

Smartmodem also includes several switch-selectable features that let you tailor performance to your exact needs. You can "set it and forget it" for the ultimate in convenience.

Built-in Audio Monitor. Thanks to an internal speaker, you can actually listen to your connection being made. You'll know immediately if the line is busy or if you reached a wrong number—*and you don't even need a phone!*

Status at a Glance. Seven LED's indicate Smartmodem's current operating mode: auto-answer, carrier detect, off hook, receive data, send data, terminal ready and modem ready. You're never left in the dark!

Direct-Connect Design. Smartmodem is FCC registered for direct connection to any modular phone jack—there's no acoustic coupler to cause signal loss and distortion.

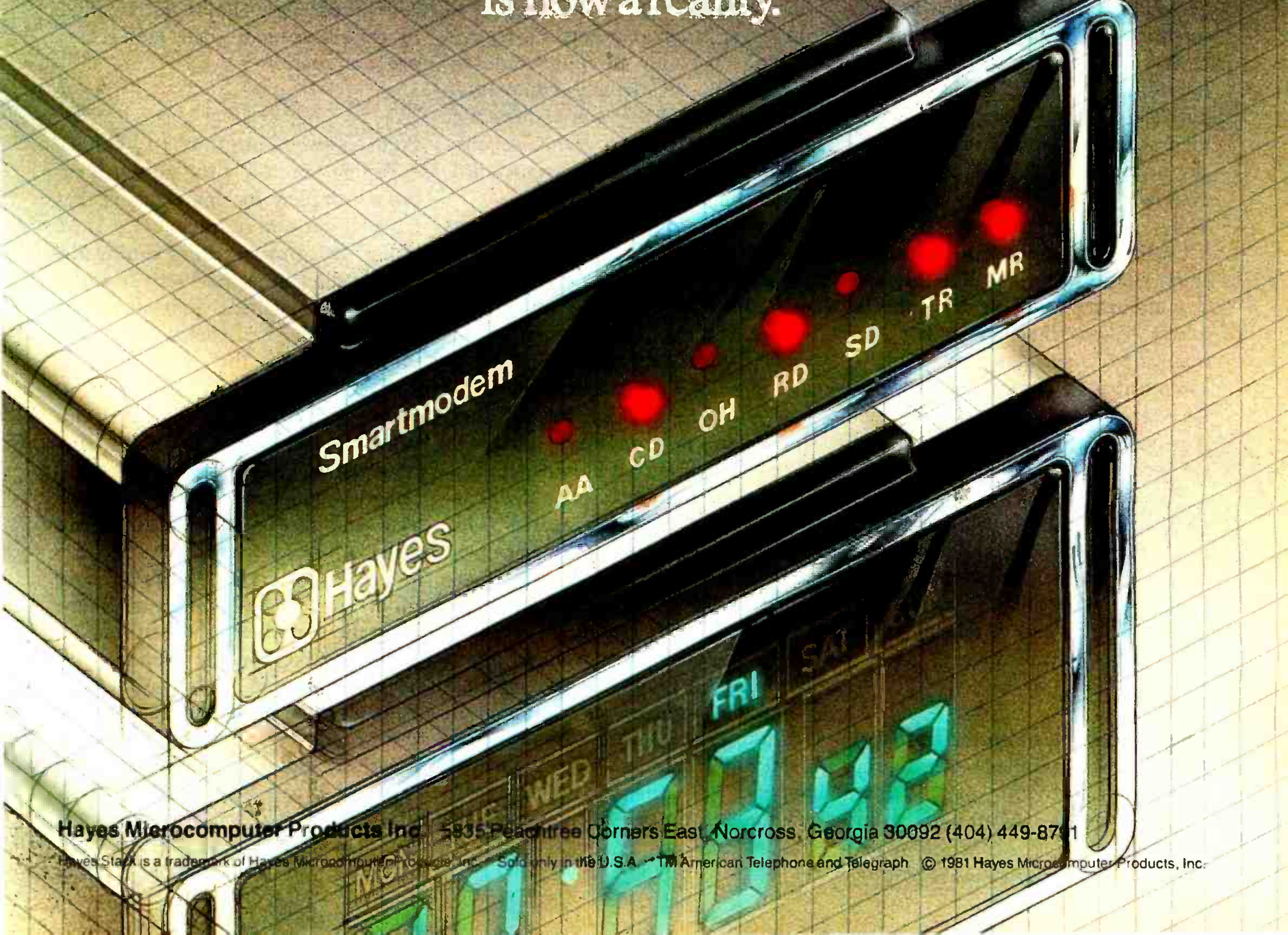
Smartmodem, Smart Buy. Professional quality features. Versatile performance. A full two-year limited warranty. A suggested retail price of only $279.

What more could you want? Perhaps the matching Hayes Stack Chronograph, an RS-232C compatible calendar/clock system.

Check out the Smartmodem wherever fine computer products are sold. And don't settle for anything less than Hayes.

Hayes

Smartmodem.
The ultimate concept in modems is now a reality.



Hayes Microcomputer Products Inc. 5835 Peachtree Corners East, Norcross, Georgia 30092 (404) 449-8791

Illustration by Jonathan Graves

The Japanese Computer Invasion

Stan Miastkowski, Technical Editor

Whenever computer-industry people get together these days the conversation inevitably turns to the so-called "Japanese Computer Invasion." From conversations I've overheard, it sometimes seems that there is an invasion fleet of Japanese ships off the West Coast, waiting to establish a beachhead in Silicon Valley.

Cutting through the paranoia, rumors, and just plain false information about the Japanese computer industry is a time-consuming and frustrating undertaking. It is further complicated by the intense secrecy of the Japanese, who, unlike their American counterparts, *never* talk off the record.

This article focuses on the Japanese companies who are (or soon will be) marketing personal computers in the United States. Make no mistake: Japanese computers *are* coming—with long-term implications for the American marketplace.

The Japanese Computer Industry

Contrary to popular belief, there is no such thing as "Japan Incorporated." Although many Americans view Japanese industry as one huge conglomerate working to take over foreign markets, the truth is that the Japanese computer industry is a group of fiercely competitive companies. It is that competition that fuels a rich variety of high-quality Japanese consumer electronic products.

Another strong reason for the quality of Japanese products is that in Japan a worker generally stays with one company throughout his or her working life. Unlike American industry, where labor and management are often at odds, Japanese workers feel a strong loyalty toward their employers, who pay them back with virtually guaranteed lifetime employment and carefully listen to their suggestions and complaints. This cooperation between management and labor produces a climate where each worker feels personally responsible for product quality.

Finally, one of the strongest points working in favor of the Japanese computer industry is that almost without exception the companies are vertically integrated—they control all aspects of the product, from manufacturing the silicon integrated circuits to marketing the products. This integration allows the Japanese to closely control costs and ensure product quality.

Fujitsu—the Company to Watch

Fujitsu Limited is the largest computer company in Japan, taking that coveted position by racking up $1.55 billion in computer sales during the year ending in April 1980. It edged past the Japanese subsidiary of IBM—which had sales of $1.54 billion during the same period. Although the margin was small, it gave the Japanese an important psychological boost—it was the first time that a Japanese computer company was number one in Japan. In the year ending this past April, Fujitsu pulled ahead even further.

Unlike the other Japanese conglomerates that have entered the computer market, Fujitsu's main business is computers. Although involved in a number of related fields, Fujitsu's interests do not seem to lie in the broad-ranging diversification of most of the other Japanese giants.

It would be a mistake not to think that Fujitsu is serious about the

68K

WHY SETTLE FOR A 68000 BASED microCOMPUTER WHEN YOU CAN HAVE OUR 68K™ MINICOMPUTER ?

FEATURES:

- 8 MHz 68000 CPU
- Virtual memory to 4 billion bytes
- 6809 peripheral processor
- Multi-user/multi-tasking memory management
- Each RAM board accomodates 2 megabytes
- High-speed DMA for universal hard disk interface
- 6 RS-232 and 4 8-bit I/O ports standard
- Dual 8" quad-density floppys
- Extensive error checking and recovery

☆ Attend the 68K SEMINAR:

our experts will field your 68K questions and discuss:

- 68000 architecture
- 68K MiniFrame™ architecture
- 68K hardware interface
- MiniFrame programming
- $85 registration fee includes all-day seminar, lunch, and take-home documentation
- in Los Angeles

Please call or write for 68K MiniFrame information and the complete 1981 seminar schedule.

from MicroDaSys

Dept. 5B, P.O.Box 36051
Los Angeles, CA. 90036
(213)731-0876

detach coupon and mail ASAP

YES. Enroll me in your 68K all-day seminar.

circle day you can attend: July 23 24 25 / Aug 27 28 29 / Sept 24 25 26

name:

address:

tel.# home: work:

Enclose $85 registration fee

MicroDaSys seminar 68K

worldwide computer market. It owns 27.6% of Amdahl—the California-based manufacturer of IBM-compatible mainframe computers. It is also making strong inroads into the European market with its business ties to the West German electronics company Siemens. In contrast to other Japanese computer makers, who spend 5 to 6% of their sales on research and development, Fujitsu consistently sinks 10 to 12% of its sales into R & D. The company has come a long way since the early 1960s, when it approached IBM about a joint venture to design and build computers for the Japanese market. At that time IBM flatly turned them down.

The TRW/Fujitsu Connection

It's obvious that the United States will be the next target for Fujitsu. Early on, the company realized that it would have to have strong ties to US companies in order to compete in our market. One of the main reasons for this is that Fujitsu is an intensely *Japanese* company. Fujitsu's president rarely meets with foreigners and has broken off discussions in the past because of alleged breaches of Japan's strict business protocols.

The purchase of a partial interest in Amdahl was one of its first steps in the United States designed to create competition in the large-systems business. Fujitsu has also set up a marketing-service organization for its line of Winchester-technology hard-disk drives designed for small and medium systems. In fact, a low-cost 5¼-inch Winchester disk designed expressly for personal computers is expected to be available by the time you read this.

Last year, Fujitsu signed an agreement with another California-based company, TRW. Fujitsu agreed to supply computers, with TRW providing software development and support as well as a nationwide sales and service network.

The power of the TRW/Fujitsu connection cannot be overemphasized. TRW/Fujitsu Vice-President Garret Fitzgibbons told me the company plans a complete line of computers and peripherals aimed squarely at the personal and small-business markets. Late last year, the company displayed a prototype of a computer that was recently introduced. The Facom 9450, tentatively priced at $8000-plus, is an extremely powerful system with a custom-designed 16-bit microprocessor. Included in the price are an 80-column video display, two 5¼-inch floppy-disk drives, and a letter-quality printer.

The most revolutionary result of the TRW/Fujitsu connection is in its final development stage. Tentatively named the Bubcom 80, it is a machine that uses *bubble memory*, a technology that American companies have been reluctant to implement. (Bubble memory stores information in nonvolatile magnetic bubbles.)

The Bubcom 80 uses 32 K-byte memory cartridges; 128 K-byte cartridges are scheduled to be introduced in 1982. The computer is based around a Z80 microprocessor and comes with 64 K bytes of standard programmable memory. The Bubcom 80 runs CP/M and comes complete with an updated version of Microsoft BASIC.

Recently introduced in Japan, the Bubcom 80 sells for the equivalent of about $1200 with one bubble memory cartridge. Extra cartridges are about $130.

But that's not all from the people at Fujitsu/TRW. Their real personal computer blockbuster, soon to be introduced in the United States, is the Micro-8. This machine uses twin Motorola 6809 microprocessors to greatly increase speed, and the package includes full-color graphics. The Micro-8 has Microsoft's Extended Color BASIC (now available in the TRS-80 Color Computer) and will sell for about $1000.

In addition, a plug-in Z80 card will convert the Micro-8 into a CP/M machine. Also available are UCSD Pascal and the 32 K-byte bubble memory cartridges that will be standard in the Bubcom 80.

Early in March, a high-end

Text continued on page 206

T/Maker II:™ it not only does more than VisiCalc,™ it does it on your computer.

VisiCalc is a fine aid for the computation of numerical problems. But it does have two major limitations: it is available only for a small number of systems, and its use is limited strictly to numbers, not words. To overcome these substantial limitations, Lifeboat Associates introduces T/Maker II.

Unlike VisiCalc, T/Maker II is designed to run on most small business computers with CP/M® or similar operating systems and a video terminal with cursor addressing capabilities. And soon there will be T/Maker II versions available for UNIX,™ RT-11™ and other systems.

Works with words as well as numbers. Like VisiCalc, T/Maker II reduces the manual tasks involved in computing and calculating financial documents. But since most business problems and reports involve words as well as numbers, T/Maker II also functions as a full-screen text editor for word processing.

T/Maker II is the most advanced aid for the analysis and presentation of numerical data and text material. In a matter of minutes, an entire document—including all edited text, all figures and all calculations—can be created, reviewed on your screen and reported in printed form.

T/Maker II turns your small business computer into a powerful, sophisticated and convenient tool. A tool that will save you money, time and energy, and eliminate the need for costly time-sharing.

With T/Maker II you can easily perform an unlimited number of analytical and reporting tasks which integrate numerical and text processing. You'll find T/Maker II perfect for such things as:

- Financial Statements
- Statistics
- Profitability Reports
- Revenue and Expense Analyses
- Portfolio Evaluations
- Price Lists
- Rate Structures
- Expense Accounts
- Cash Flow Projections
- Checking Account Reconciliations

. . . and much, much more.

Easy to learn and use. You don't have to be a programmer to operate T/Maker II. Just follow T/Maker II's easily understood and ordered instructions, set up your data in rows and columns, define the relationships and T/Maker II will do the rest: it will perform the computations and formatting necessary to prepare your document. When you're finished you can analyze your report on your screen or store it on a diskette. Or, you can have the report printed with presentation quality.

And when any changes have to be made, simply enter the new figure or relationship and tell T/Maker II to adjust and recalculate all the new results.

Editing capabilities. As a full-screen editor for word processing, T/Maker II handles text up to 255 characters wide. It includes features like text formatting and justification, centered titles, a text buffer for block moves and repeated inserts, global search and replace commands for printing your letters, reports and documents. Wide documents are supported by horizontal scrolling.

Low cost. The cost of T/Maker II is only $275 plus shipping and handling. Dollars well spent once you consider all the time, energy and money it can save. T/Maker II is brought to you exclusively and supported completely by Lifeboat Associates, world's largest computer software publisher. For more information send us the coupon below.

Mail coupon to: Lifeboat Associates, 2005
1651 Third Ave., NY, NY 10028. Or call (212) 860-0300.

☐ Please send me more information on T/Maker II.
☐ Please send me a free Lifeboat Catalog featuring over 200 programs, including integrated accounting and professional practice systems, office tools for bookkeepers and secretaries and sophisticated tools for programmers.

Name________
Title________
Company________
Street________
City________
State________ Zip________

T/Maker II is a trademark of P. Roizen. CP/M is a trademark of Digital Research, Inc. VisiCalc is a trademark of PersonalSoftware, Inc. UNIX is a trademark of Bell Laboratories. RT-11 is a trademark of Digital Equipment Corp.

As an example of what T/Maker II can do, see the chart below. The operator entered only the data shown in boldface. T/Maker II calculated and reported all the other values.

	— Actual —			Growth		Total	— Projected —		
	1978	1979	1980	Rate	Average	(000's)	1981	1982	1985
Item A	**42,323**	51,891	**65,123**	24.04	53,112	159.34	80,782	100,206	191,262
Item B	**45,671**	**46,128**	**49,088**	3.67	46,962	140.89	50,891	52,761	58,791
Total	87,994	98,019	114,211	13.93	100,075	300.22	131,673	152,966	250,053
% Item	48.10	52.94	57.02	8.88	52.69	158.1	61.35	65.51	76.49
% Item	51.90	47.06	42.98	-9.00	47.31	141.9	38.65	34.49	23.51
Total	100.00	100.00	100.00	—	100.00	300.0	100.00	100.00	100.00

LIFEBOAT WORLOWIDE offers you the world's largest library of software. Contact your nearest dealer or Lifeboat:

Lifeboat Associates
1651 Third Ave.
New York, N.Y. 10028
Tel: (212) 860-0300
Telex: 640693 (LBSOFT NYK)
TWX: 710-581-2524

Lifeboat Inc.
OK Bldg., 5F
1-2-8, Shiba-Daimon
Minato-ku, Tokyo, 105 Japan
Tel: 03-437-3901
Telex: 2422723 (ASRTYOJ)

Lifeboat Associates, Ltd.
PO Box 125
London WC2H 9LU, England
Tel: 01-836-9028
Telex: 893709 (LBSOFTG)

Lifeboat Associates GmbH
PO Box 168, Aegeristrasse 35
CH 6340 Baar, Switzerland
Tel: 042-31-2931
Telex: 865265 (MICO CH)

Intersoft GmbH
Schlossgartenweg 5
D-8045 Ismaning, W. Germany
Tel: 089-966-444
Telex: 5213643 (ISOFD)

Lifeboat Associates, SARL
10, Grande Rue Charles de Gaulle
92600 Asnieres, France
Tel: 1-733-08-04
Telex: 250303 (PUBLIC X PARIS)

Lifeboat Associates
Software with full support

Circle 197 on inquiry card.

BUSINESS and UTILITIES

SPELLGUARD™ (CP/M only) — Price: $269.95 Disk

SPELLGUARD is a revolutionary new product which increases the value of your current word processing system (WORDSTAR, MAGIC WAND, ELECTRIC PENCIL, TEXTED EDITOR II and others). Written entirely in assembly language, SPELLGUARD™ rapidly assists the user in eliminating spelling and typographical errors by comparing each word of the text against a dictionary (expandable) of over 20,000 of the most common English words. Words appearing in the text but not found in the dictionary are "flagged" for easy identification and correction. Most administrative staff familiar with word processing equipment will be able to use SPELLGUARD™ in only a few minutes.

MAIL LIST 2.2 (Apple, Atari and North Star diskette only) — Price: $34.95

This program is unmatched in its ability to store a maximum number of addresses on one diskette (minimum of 1100 per diskette, more than 2200 for "double density" systems!). Its many features include alphabetic and zip code sorting, label printing, merging of files and a unique keyword seeking routine which retrieves entries by a virtually limitless selection of user defined codes. Mail List 2.2 will even find and delete duplicate entries. A very valuable program!

FORM LETTER SYSTEM (FLS) (Apple and North Star diskette only) — Price: $21.95

Use FLS to create and edit form letters and address lists. Form letters are produced by automatically inserting each address into a predetermined portion of your letter. FLS is completely compatible with MAIL LIST 2.2, which may be used to manage your address files.

FLS and MAIL LIST 2.2 are available as a combined package for $49.95.

SORTIT (North Star only) — Price: $29.95 Diskette

SORTIT is a general purpose sort program written in 8080 assembly language. This program will sort sequential data files generated by NORTH STAR BASIC. Primary and optional secondary keys may be numeric or one to nine character strings. SORTIT is easily used with files generated by DYNACOMP's MAIL LIST program and is very versatile in its capabilities for all other BASIC data file sorting.

PERSONAL FINANCE SYSTEM (Atari and North Star only) — Price: $34.95 Diskette

PFS is a single diskette, menu-oriented system composed of ten different programs. Besides recording your expenses and tax deductible items, PFS will sort and summarize expenses by payee, and display information on expenditures by any of 26 user defined codes by month or by payee. PFS will even produce monthly bar graphs of your expenses by category! This powerful package requires only one disk drive, minimal memory (24K Atari, 32K North Star) and will store up to 600 records per disk (and over 1000 records per disk by making a few simple changes to the programs). You can record checks plus cash expenses so that you can finally see where your money goes and eliminate guesswork and tedious hand calculations.

FAMILY BUDGET (Apple only) — Price: $34.95 Diskette

The FAMILY BUDGET is a very convenient financial record-keeping program. You will be able to keep track of cash and credit expenditures as well as income on a daily basis. You can record tax deductible items and charitable donations. The FAMILY BUDGET also provides a continuous record of all credit transactions. You can make daily cash and charge entries to any of 21 different expense accounts as well as to 5 payroll and tax accounts. Data is easily retrieved giving the user complete control over an otherwise complicated (and unorganized!) subject.

THE COMMUNICATOR (Atari only) — Price: $49.95 Diskette

This software package contains a menu-driven collection of programs for facilitating efficient two-way communications through a full duplex modem (required for use). In one mode of operation you may connect to a data service (e.g., The SOURCE or MicroNet) and quickly load data such as stock quotations onto your diskette for later viewing. This greatly reduces "connect time" and thus the service charge. You may also record the complete contents of a communications session. Additionally, programs written in BASIC, FORTRAN, etc. may be built off-line using the support text editor and later "uploaded" to another computer, making the Atari a *very* smart terminal. Even Atari BASIC programs may be uploaded. Further, a command file may be built off-line and used later as controlling input for a time-share system. That is, you can set up your sequence of time-share commands and programs, and the Atari will transmit them as needed: batch processing. All this adds up to saving both connect time and your time.

DYNACOMP also supplies THE COMMUNICATOR with an Atari 830 modem for a combined price of $219.95. The modem is available separately for $189.95.

TEXT EDITOR II (CP/M) — Price: $29.95 Diskette/$33.45 Disk

This is the second release version of DYNACOMP's popular TEXT EDITOR I and contains many new features. With TEXT EDITOR II you may build text files in chunks and assemble them for later display. Blocks of text may be appended, inserted or deleted. Files may be saved on disk/diskette in right justified/centered format to be later printed by either TEXT EDITOR II or the CP/M ED facility. Futher, ASCII CP/M files (including BASIC and assembly language programs) may be read by the editor and processed. In fact, text files can be built using ED and later formatted using TEXT EDITOR II. All in all, TEXT EDITOR II is an inexpensive, easy to use, but very flexible editing system.

DFILE (North Star only) — Price: $19.95

This handy program allows North Star users to maintain a specialized data base of all files and programs in the stack of disks which invariably accumulates. DFILE is easy to set up and use. It will organize your disks to provide efficient locating of the desired file or program.

FINDIT (North Star only) — Price: $19.95

This is a three-in-one program which maintains information accessible by keywords of three types: Personal (eg: last name), Commercial (eg: plumbers) and Reference (eg: magazine articles, record albums, etc). In addition to keyword searches, there are birthday, anniversary and appointment searches for the personal records and appointment searches for the commercial records. Reference records are accessed by a single keyword or by cross-referencing two or three keywords.

GRAFIX (TRS-80 only) — Price: $14.95 Cassette/$18.95 Diskette

This unique program allows you to easily create graphics directly from the keyboard. You "draw" your figure using the program's extensive cursor controls. Once the figure is made, it is automatically appended to your BASIC program as a string variable. Draw a "happy face", call it H$ and then print it from your program using PRINT H$! This is a very easy way to create and save graphics.

EDUCATION

HODGE PODGE (Apple only, 48K Applesoft or Integer BASIC) — Price: $19.95 Cassette/$23.95 Diskette

Let HODGE PODGE be your child's baby sitter. Pressing any key on your Apple will result in a different and intriguing "happening" related to the letter or number of the chosen key. The program's graphics, color and sound are a delight for children from ages 1½ to 9. HODGE PODGE is a non-intimidating teaching device which brings a new dimension to the use of computers in education.

TEACHER'S PET I (Available for all computers) — Price: $11.95 Cassette/$15.95 Diskette

This is the first of DYNACOMP's educational packages. Primarily intended for pre-school to grade 3, TEACHER'S PET provides the young student with counting practice, letter-word recognition and three levels of math skill exercises.

MORSE CODE TRAINER (TRS-80 only) — Price: $12.95 Cassette/$16.95 Diskette

MORSE CODE TRAINER is designed to develop and improve your speed and accuracy in deciphering Morse Code. As such, MCT is an ideal software package for FCC test practice. The code sound is obtained through the earphone jack of any standard cassette recorder. You may choose the pitch of the tones as well as the word rate. Also, various modes of operation are available including number, punctuation and alphabet tests, as well as the keying of your own message. A very effective way to learn code!

MISCELLANEOUS

CRYSTALS (Atari only) — Price: $ 9.95 Cassette/$13.95 Diskette

A unique algorithm randomly produces fascinating graphics displays accompanied with tones which vary as the patterns are built. No two patterns are the same, and the combined effect of the sound and graphics are mesmerizing. CRYSTALS has been used in local stores to demonstrate the sound and color features of the Atari.

NORTH STAR SOFTWARE EXCHANGE (NSSE) LIBRARY

DYNACOMP now distributes the 23 volume NSSE library. These diskettes each contain many programs and offer an outstanding value for the purchase price. They should be part of every North Star user's collection. Call or write DYNACOMP for details regarding the contents of the NSSE collection.

Price: $9.95 each/$7.95 each (4 or more)
The complete collection may be purchased for $149.95

AVAILABILITY

DYNACOMP software is supplied with complete documentation containing clear explanations and examples. Unless otherwise specified, all programs will run within 16K program memory space (ATARI requires 24K). Except where noted, programs are available on ATARI, PET, TRS-80 (Level II) and Apple (Applesoft) cassette and diskette as well as North Star single density (double density compatible) diskette. Additionally, most programs can be obtained on standard (IBM format) 8" CP/M floppy disks for systems running under MBASIC.

STATISTICS and ENGINEERING

DIGITAL FILTER (Available for all computers) — Price: $29.95 Cassette/$33.95 Diskette

DIGITAL FILTER is a comprehensive data processing program which permits the user to design his own filter function or choose from a menu of filter forms. The filter forms are subsequently converted into non-recursive convolution coefficients which permit rapid data processing. In the explicit design mode the shape of the frequency transfer function is specified by directly entering points along the desired filter curve. In the menu mode, ideal low pass, high pass and bandpass filters may be approximated to varying degrees according to the number of points used in the calculation. These filters may optionally also be smoothed with a Hanning function. In addition, multi-stage Butterworth filters may be selected. Features of DIGITAL FILTER include plotting of the data before and after filtering, as well as display of the chosen filter functions. Also included are convenient data storage, retrieval and editing procedures.

DATA SMOOTHER (Not available for Atari) — Price: $14.95 Cassette/$18.95 Diskette

This special data smoothing program may be used to rapidly derive useful information from noisy business and engineering data which are equally spaced. The software features choice in degree and range of fit, as well as smoothed first and second derivative calculation. Also included is automatic plotting of the input data and smoothed results.

FOURIER ANALYZER (Available for all computers) — Price: $16.95 Cassette/$20.95 Diskette

Use this program to examine the frequency spectra of limited duration signals. The program features automatic scaling and plotting of the input data and results. Practical applications include the analysis of complicated patterns in such fields as electronics, communications and business.

TFA (Transfer Function Analyzer) — Price: $19.95 Cassette/$23.95 Diskette

This is a special software package which may be used to evaluate the transfer functions of systems such as hi-fi amplifiers and filters by examining their response to pulsed inputs. TFA is a major modification of FOURIER ANALYZER and contains an engineering-oriented decibel versus log-frequency plot as well as data editing features. Whereas FOURIER ANALYZER is designed for educational and scientific use, TFA is an engineering tool. Available for all computers.

HARMONIC ANALYZER (Available for all computers) — Price: $24.95 Cassette/$28.95 Diskette

HARMONIC ANALYZER was designed for the spectrum analysis of repetitive waveforms. Features include data file generation, editing and storage/retrieval as well as data and spectrum plotting. One particularly unique facility is that the input data need not be equally spaced or in order. The original data is sorted and a cubic spline interpolation is used to create the data file required by the FFT algorithm.

FOURIER ANALYZER, TFA and HARMONIC ANALYZER may be purchased together for a combined price of $49.95 (three cassettes) and $59.95 (three diskettes).

REGRESSION I (Available for all computers) — Price: $19.95 Cassette/$23.95 Diskette

REGRESSION I is a unique and exceptionally versatile one-dimensional least squares "polynomial" curve fitting program. Features include very high accuracy, an automatic degree determination option; an extensive internal library of fitting functions; data editing; automatic data and curve plotting; a statistical analysis (eg: standard deviation, correlation coefficient, etc.) and much more. In addition, new fits may be tried without reentering the data. REGRESSION I is certainly the cornerstone program in any data analysis software library.

REGRESSION II (PARAFIT) (Available for all computers) — Price: $19.95 Cassette/$23.95 Diskette

PARAFIT is designed to handle those cases in which the parameters are imbedded (possibly nonlinearly) in the fitting function. The user simply inserts the functional form, including the parameters (A(1), A(2), etc.) as one or more BASIC statement lines. Data and results may be manipulated and plotted as with REGRESSION I. Use REGRESSION I for polynomial fitting, and PARAFIT for those complicated functions.

MULTILINEAR REGRESSION (MLR) (Available for all computers) — Price: $24.95 Cassette/$28.95 Diskette

MLR is a professional software package for analyzing data sets containing two or more linearly independent variables. Besides performing the basic regression calculation, this program also provides easy to use data entry, storage, retrieval and editing functions. In addition, the user may interrogate the solution by supplying values for the independent variables. The number of variables and data size is limited only by the available memory.

REGRESSION I, II and MULTILINEAR REGRESSION may be purchased together for $51.95 (three cassettes) or $63.95 (three diskettes).

ANOVA (Available for all computers) — Price: $39.95 Cassette/$43.95 Diskette

In the past the ANOVA (analysis of variance) procedure has been limited to the large mainframe computers. Now DYNACOMP has brought the power of this method to small systems. For those conversant with ANOVA, the DYNACOMP software package includes the 1-way, 2-way and N-way procedures. Also provided are the Yates 2^{K-P} factorial designs. For those unfamiliar with ANOVA, do not worry. The accompanying documentation was written in a tutorial fashion (by a professor in the subject) and serves as an excellent introduction to the subject. Accompanying ANOVA is a support program for building the data base. Included are several convenient features including data editing, deleting and appending.

BASIC SCIENTIFIC SUBROUTINES, Volume I (Not available for Atari)

DYNACOMP is the exclusive distributor for the software keyed to the popular text *BASIC Scientific Subroutines, Volume I* by F. Ruckdeschel (see the BYTE/McGraw-Hill advertisement in BYTE magazine, January 1981). These subroutines have been assembled according to chapter. Included with each collection is a menu program which selects and demonstrates each subroutine.

Collection #1: Chapters 2 and 3: Data and function plotting, complex variables
Collection #2: Chapter 4: Matrix and vector operations
Collection #3: Chapters 5 and 6: Random number generators, series approximations
Price per collection: $14.95 Cassette/$18.95 Diskette

All three collections are available for $39.95 (three cassettes) and $49.95 (three diskettes).
Because the text is a vital part of the documentation, *BASIC Scientific Subroutines, Volume I* is available from DYNACOMP for $19.95 plus 75¢ postage and handling.

ROOTS (Available for all computers) — Price $10.95 Cassette/$14.95 Diskette

In a nutshell, ROOTS simultaneously determines all the zeroes of a polynomial having real coefficients. There is no limit on the degree of the polynomial, and because the procedure is iterative, the accuracy is generally very good. No initial guesses are required as input, and the calculated roots are substituted back into the polynomial and the residuals displayed.

ACTIVE CIRCUIT ANALYSIS (ACAP) (48K Apple only) — Price: $25.95/$29.95 Diskette

ACAP is the analog circuit designer's answer to LOGIC SIMULATOR. With ACAP you may analyze the response of an active or passive component circuit (e.g., a transistor amplifier, band pass filter, etc.). The circuit may be probed at equal steps in frequency, and the resulting complex (i.e., real and imaginary) voltages at each component juncture examined. By plotting the magnitude of these voltages, the frequency response of a filter or amplifier may be completely determined with respect to both amplitude and phase. In addition, ACAP prints a statistical analysis of the range of voltage responses which result from tolerance variations in the components.

ACAP is easy to learn and use. Simply describe the circuit in terms of the elements and their placement, and execute. Circuit descriptions may be saved onto cassette or diskette to be recalled at a later time for execution or editing. ACAP should be part of every circuit designer's program library.

LOGIC SIMULATOR (Apple only; 48K RAM) — Price: $24.95 Cassette/$28.95 Diskette

With LOGIC SIMULATOR you may easily test your complicated digital logic design with respect to given set of inputs to determine how well the circuit will operate. The elements which may be simulated include multiple input AND, OR, NOR, EXOR, EXNOR and NAND gates, as well as inverters, J-K and D flip-flops, and one-shots. The response of the system is available every clock cycle. Inputs may be clocked in with varying clock cycle lengths/displacements and delays may be introduced to probe for glitches and race conditions. At the user's option, a timing diagram for any given set of nodes may be plotted using HIRES graphics. Save your breadboarding until the circuit is checked by LOGIC SIMULATOR.

LOGIC DESIGNER (North Star and CP/M only) — Price: $34.95 Diskette

LOGIC DESIGNER is an exceptional Computer Aided Design (CAD) program. With it you may convert a large and complicated digitial truth table (the functional specification) into an optimized Boolean logic equation. This equation may then be *easily* converted into a circuit design using either NAND or AND/OR gates. Operationally, LOGIC DESIGNER is composed of a BASIC program which calls in a machine language routine to reduce execution time. Example: For a 7 variable by 127 line table, the processing time is only two minutes. LOGIC DESIGNER is clearly a fast and powerful tool for building digital circuitry.

ORDERING INFORMATION

All orders are processed and shipped within 48 hours. Please enclose payment with order and include the appropriate computer information. If paying by VISA or Master Card, include all numbers on card.

Shipping and Handling Charges
Within North America: Add $1.50
Outside North America: Add 10% (Air Mail)

Delivery
All orders (excluding books) are sent First Class.

Quantity Discounts
Deduct 10% when ordering 3 or more programs. Dealer discount schedules are available upon request.

8" CP/M Disks
Add $2.50 to the listed diskette price for each 8" floppy disk (IBM soft sectored CP/M format). Programs run under Microsoft MBASIC or BASIC-80.

5¼" CP/M Disks
All software available on 8" CP/M disks is also available on 5¼" disks, North Star format.

Ask for DYNACOMP programs at your local software dealer. Write for detailed descriptions of these and other programs from DYNACOMP.

DYNACOMP, Inc.
1427 Monroe Avenue
Rochester, New York 14618
24 hour order phone: (716)586-7579 recording
Office phone (9AM-5PM EST): (716)442-8960

VISA — MasterCard

New York State residents please add 7% NYS sales tax.

Circle 125 on inquiry card.

Text continued from page 202:
business microcomputer was announced by TRW/Fujitsu. The TFC-8500 system starts at $25,000 and goes upward to $200,000. In addition, the company will market a line of point-of-sale computer cash registers/terminals. This market is very competitive at the present time.

It's obvious that there is a large amount of activity going on behind the scenes at both TRW and Fujitsu—two companies to watch carefully.

Sharp Electronics

Although not in the multibillion-dollar league of many of the companies we're discussing here, Sharp is one of the most well known in the United States. Its wide-ranging line of calculators and other consumer electronics products is sold by approximately 1400 dealers in the States. Consequently, the company has a great deal of marketing experience here as well as an extremely strong sales and service network.

Over the past few years, Sharp's calculator products have become more and more sophisticated; therefore, it's not surprising that its first personal computer resembled a calculator. It's interesting that instead of marketing the product itself, Sharp sold initial marketing rights to the company with one of the largest sales and service networks in the world—Radio Shack.

The Sharp PC-1211 Pocket Computer became the TRS-80 Pocket Computer, introduced in August 1980 by Radio Shack. By using the immense marketing power of Radio Shack, Sharp was "testing the waters." A source at Sharp told me the company had doubts about how the product would be received.

To say the reception was good is an understatement. Sales of the TRS-80 Pocket Computer during its first six months were estimated at 40,000 units—four times the Radio Shack sales projections. The company initially purchased approximately 10,000 units, creating supply problems shortly after introduction.

Radio Shack's exclusive marketing rights to the PC-1211 ran out in March 1981. Sharp has started marketing the Pocket Computer with the addition of a printer although Radio Shack will also offer a printer in the near future.

Some observers of the personal computer market feel pocket computers are only a novelty—a fad that will soon pass. However, a number of companies seem committed to their development. Although presently limited in utility, pocket computers will be a major factor in the popularization of personal computers.

In the meantime, Sharp has aimed squarely at the small-business market with the recent introduction of the YX-3200. The system is being sold by 720 Sharp dealers and will retail in the $6000 range. The powerful Z80-based system includes a 12-inch green-phosphor display (80-characters) and two 5¼-inch quad-density floppy-disk drives. Also included in the price is an Epson MX-80 printer (manufactured by a Japanese subsidiary of Seiko). An interesting sidelight is that the YX-3200 was designed in the United States—by American engineers.

The marketing of the YX-3200 system will also be an experiment. Sharp has projected sales of 5000 systems by April 1982. It will be virtually the first computer system to be sold by persons who are *not* computer dealers. The majority of Sharp salesmen chosen to sell the system are office equipment dealers. As the small-business market continues to grow, we are likely to see more and more personal computer systems sold in this way.

In the realm of the truly personal computer, the MZ-80 is perhaps the most interesting part of the Sharp line. Not currently available in the United States, it is one of the largest-selling personal computers in Europe and Japan. The MZ-80 retails for approximately $900 with a calculator-style keyboard (not unlike the early PET), $1200 with a standard keyboard. It's an attractive machine

Text continued on page 212

AVAILABLE FALL 1981

DIGITAL HARMONY
by John Whitney

A new synthesis of sight and sound

Digital Harmony lays the foundation for the whole new field of audio-visual art made possible by microcomputers. John Whitney, a pioneer of the special effects technology used in STAR WARS and 2001: A SPACE ODYSSEY, explains the special union of computer graphics and music. His computer-generated visual art graphically depicts the laws of harmonic motion common to all music.

Digital Harmony includes a complete description of Whitney's computer, peripherals, and film techniques. Colorful illustrations are included, as well as the program listings that generated them. The descriptions are sufficient for anyone to begin to explore this new territory as a composer and computer experimenter - transforming the small computer into an ideal instrument for creating compositions in aural and visual art.

John Whitney is on the Faculty in the Department of Art at the University of California, Los Angeles.

ISBN 0-07-070015-X
240 pages
hardcover
over 50 color photographs

$21.95

INVERSIONS: A Catalogue of Calligraphic Cartwheels
by Scott Kim
Foreword by Douglas Hofstader
Backword by Jef Raskin

Surprising symmetries in design and letterforms

Illusion . . . calligraphy . . . visual magic - Scott Kim's new book, Inversions, delights the eye and enchants the mind. Filled with intriguing designs, words that read the same right-side up and upside down, words within words, and unexpected symmetries, these compositions create a fresh way to look at the alphabet. The text includes the visual principles of symmetry, lettering, and problem solving that are basic to these images. The author also draws parallels to related exercises in perception in such diverse areas as art, music, word play, and mathematics. Scott Kim's original inversion designs first appeared in *Omni* magazine, inspiring an overwhelming reader response. An irresistable challenge, invertible writing appeals to everyone who loves beauty in mathematics and design.

Scott Kim is a doctoral student in Computer Science at Stanford University and is a concert pianist and composer.

ISBN 0-07-034546-5
128 pages
softcover
over 50 illustrations
available summer 1981

$8.95

BRAINS, BEHAVIOR, AND ROBOTICS
by James S. Albus

Robotics design and applications

This computer-oriented guide explores how the brain functions primarily as a computer device for generating and controlling behavior. The author assesses behavior as a product of three hierarchies of computing modules:

- memory modules
- behavior-generating modules
- sensory-processing modules

A section on artificial intelligence ties this hierarchical model to vital computer science techniques such as planning, problem-solving, machine vision, natural language understanding and knowledge representation. A closing section on robotics discusses the design considerations in constructing a robot control system fashioned after this model of the brain, and explores the current and potential use of robots in our environment.

Dr. James S. Albus is Project Manager with the National Bureau of Standards.

ISBN 0-07-000975-9
400 pages
hardcover
180 illustrations

$15.95

THE BRAINS OF MEN AND MACHINES
by Ernest W. Kent

Human models for computer design

When the "Brains of Men and Machines" series of articles first appeared in BYTE magazine, the response was immediate and enthusiastic. Now Ernest W. Kent has expanded his ideas about the brain into a full-length book. As researchers begin to unravel the mysteries of the brain's chemical, electrical, and synaptic circuitry, their findings are becoming immediately applicable to advances in robotic behavior and computer design. The Brains of Men and Machines "dissects" the brain to provide new insights into computer design and artificial intelligence.

It is one of the rare books that transcends disciplinary boundaries. In it the ever-increasing relationship between man and machine is freshly examined - a relationship, Professor Kent concludes, that is today being reexamined in the light of man's own neurological self-image.

Dr. Ernest W. Kent is a Professor of Physiological Psychology and Psychopharmacology at the University of Illinois at the Chicago Circle Campus.

ISBN 0-07-034123-0
304 pages
hardcover
illustrated

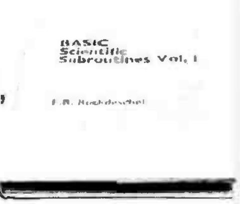
$15.95

The BYTE BOOK Collection . . . .

Circle 40 on inquiry card.

BASIC SCIENTIFIC SUBROUTINES, VOLUMES 1 AND 2

by Fred Ruckdeschel



Valuable programs for professional and hobbyist

Designed for the engineer, scientist, experimenter, and student, this series presents a complete scientific subroutine package in BASIC.

- Volume 1 covers plotting, complex variables, vector and matrix operation, random number generation, and series approximations.
- Volume 2 continues with least-squares approximation, special polynomial functions, approximating techniques, optimization, roots of functions, interpolation, differentiation, integration, and digital filtering.

These volumes feature routines written in both standard Microsoft and North Star BASIC, extensive appendices, and subroutine cross-referenes.

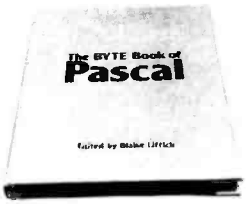
Dr. Fred Ruckdeschel is a Principal Scientist with Dynacomp, Inc.

VOLUME 1
ISBN 0-07-054201-5
336 pages
hardcover
illustrated

$19.95

VOLUME 2
ISBN 0-07-054202-3
384 pages hardcover
illustrated
available Fall 1981

$23.95



THE BYTE BOOK OF PASCAL

Blaise W. Liffick, Editor

A powerful, structured language

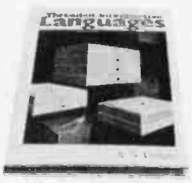
Based on articles, language forums, and letters from BYTE magazine, this work is a valuable software resource. Pascal continues to be popular as a structured programming language. Written for both potential and established users, this book introduces the Pascal language and examines its merits and possible implementations. Featured are two versions of a Pascal compiler, one written in BASIC and the other in 8080 assembly language; a p-code interpreter written in both Pascal and 8080 assembly language; a chess-playing program; and an APL interpreter.

ISBN 0-07-037823-1
334 pages
hardcover

$25.00

THREADED INTERPRETIVE LANGUAGES

by Ronald Loeliger



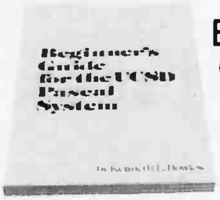
How to implement FORTH on your Z80

Threaded languages (such as FORTH) are compact, giving the speed of assembly language with the programming ease of BASIC. They combine features found in no other programming languages. This book develops an interactive, extensible language with specific routines for the Zilog Z80 microprocessor. With the core interpreter, assembler, and data type defining words covered in the text, it is possible to design and implement programs for almost any application and equivalent routines for different processors.

Ron Loeliger is a Senior Analyst with Intermetrics, Inc.

ISBN 0-07-038360-X
272 pages
hardcover
illustrated

$18.95



BEGINNER'S GUIDE FOR THE UCSD PASCAL SYSTEM

by Kenneth L. Bowles

The most popular Pascal version explained by its creator

Written by the originator of UCSD Pascal System, this informative book is an orientation guide to the UCSD Pascal System. For the novice, this book steps through the System, bringing the user to a sophisticated level of expertise. Once familiar with the System, the reader will find the guide an invaluable reference tool for creating advanced applications. The package offers programs which may be run without alteration on:

- DEC PDP-11 or General Automation minicomputers
- Western Digital Microengines
- 8080, 8085, Z80, 6502, 6800, 9900 or AM-100 based microcomputers (including the popular Apple II and Radio Shack TRS-80 microcomputers)

Dr. Kenneth L. Bowles is Director of the Institute for Information Systems, University of California, San Diego.

ISBN 0-07-006745-7
204 pages
softcover

$11.95

YOU JUST BOUGHT A PERSONAL *WHAT?*

by Thomas Dwyer and Margot Critchfield

A Structured Approach to Creative Programming

Intended for both the novice programmer and the experienced computer enthusiast, this book presents practical ideas for personal computer use at home or at work.

Its approach is especially suitable for educational purposes. Written by the leading contributors of computer education material, this book is an entertaining and resourceful tool. There are over 60 ready-to-use programs written in Microsoft and Level II BASIC for the TRS-80 in the areas of educational games, financial record keeping, business transactions, disk-based files, and word processing.

Dr. Thomas Dwyer is a Professor of Computer Science at the University of Pittsburgh.

Margot Critchfield is a doctoral student in Foundations in Education at the University of Pittsburgh.

ISBN 0-07-018492-5
343 pages
softcover
78 illustrations

$11.95

BEYOND GAMES: SYSTEM SOFTWARE FOR YOUR 6502 PERSONAL COMPUTER

by Kenneth Skier

Creating programs for the Apple, Atari, Challenger and PET computers

At last, a complete programming guidebook for owners of personal computers utilizing the 6502 microprocessor. A self-contained course in structures programming and top-down design, this book presents a powerful set of tools for building an extended monitor, disassembler, hexadecimal dump routine, and text editor programs. Programs are thoroughly explained, with clear instructions for modifications.

Kenneth Skier is a Systems Programmer for Wang Laboratories, Inc., and a Lecturer at MIT.

ISBN 0-07-057860-5
440 pages
softcover
illustrated

$14.95

stimulating, provocative, problem-solving

Circle 41 on inquiry card.

CIARCIA'S CIRCUIT CELLAR
by Steve Ciarcia

Practical uses for home computers

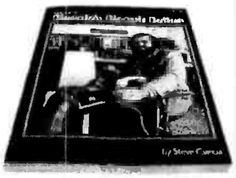
Imaginative and practical, Ciarcia's Circuit Cellar details a variety of microcomputer projects. A collection of the best articles from the popular series in BYTE magazine, this volume includes
- D/A conversion
- Programming EPROMS
- AC remote-controlled appliances
- digitized speech
- touch input video display

Complete instructions are given on how to construct each project. With amusing anecdotes and an easy-going style, Ciarcia presents his material in such a manner that even a neophyte need not be afraid of it.

ISBN 0-07-010960-5
125 pages
softcover
color photographs and diagrams

$8.00

CIARCIA'S CIRCUIT CELLAR, *VOLUME II*
by Steve Ciarcia



More practical uses for home computers

Composed of popular articles from BYTE magazine, this volume tells how microcomputers can be uniquely interfaced to our environment. Projects include
- building a computer controlled home-security system
- computerizing appliances
- transmitting digital information over a beam of light
- building the Intel 8086 microprocessor system design kit
- input-output expansion for the TRS-80

ISBN 0-07-010963-X
224 pages
softcover
photographs and diagrams

$12.95

MICRO-COMPUTER STRUCTURES
by Henry D'Angelo

Digital Electronics, Logic Design, and Computer Architecture

Today, there is an increasing demand for computer users who are not only well-versed in software, but who can also maintain, modify, and design their own hardware systems.

This text introduces computer users with little or no background in digital hardware to the basic computer structures used in microcomputer design and microcomputer interfacing. Helpful examples and end-of-chapter exercises further illustrate the various concepts presented, and a detailed bibliography provides additional reading opportunities. As a resource and textbook, it will assist
- programmers and systems analysts
- engineers and scientists
- managers
- students

Detailed Instructor's Manual also available.

Dr. Henry D'Angelo is the Associate Dean of the College of Engineering and Professor of Manufacturing Engineering at Boston University.

ISBN 0-07-015294-2
288 pages
hardcover
314 illustrations
available spring 1981

$18.95

Instructor's Manual
ISBN 0-07-015298-5
softcover

$8.95

BYTE Books' reputation is based on providing technically accurate, useful, and timely information. Established on the same principle as *BYTE* magazine, BYTE Book's evolved in response to the rapidly expanding audience of home and business computer users. Computer professionals and enthusiastic newcomers need to keep pace with this unabated growth. This selection of BYTE books can expand your library of knowledge and expertise.

TO ORDER, CALL TOLL FREE 800-258-5420, OR FILL OUT YOUR CHOICES IN THIS COUPON and return it with check, money order, or charge card number to:

BYTE BOOKS
70 Main Street
Peterborough,
New Hampshire 03458

BUILD YOUR OWN Z80 COMPUTER
by Steve Ciarcia

Every step spelled out for do-it-yourself buffs

For the engineer, computer technician, student, and anyone interested in building a computer rather than buying one, this practical guide shows how to build a working computer based on the Zilog Z80 microprocessor. Each computer subsystem is fully explained and supported by proven design and testing information. The description focuses on a basic single-board microcomputer containing
- easy expansion to include a video terminal
- a 1 K-byte operating system
- serial and parallel ports
- hexadecimal display
- audio cassette mass storage

Readers can modify the system to meet personal needs.

Steve Ciarcia is a Computer Consultant, Electrical Engineer, and author of "Ask Byte" and "Ciarcia's Circuit Cellar" columns in BYTE magazine.

ISBN 0-07-010962-1
330 pages
softcover
available summer 1981

$15.95

BYTE BOOKS
70 Main Street
Peterborough, New Hampshire 03458

Name ____________

Address ____________

City ________ State ________ Zip ________

- Check enclosed in the amount of ________
- Bill Visa. Card Number ________
- Bill Master Charge. Card Number ________
- Expiration Date ________

Include 75c per book to cover postage and handling.

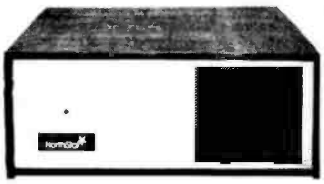
TITLE	PRICE	QUANTITY	AMOUNT
		SHIPPING	
		TOTAL	

order now . . . !

Circle 42 on inquiry card.

LOWEST PRICE - BEST QUALITY

NORTH STAR



North Star Horizon 2

2-5¼ Disk Drives
32K Double Den
Factory assem. & tested
Factory guaranteed
List $3695

only **$2697**

POWERFUL NORTH STAR BASIC FREE
SUPERB FOR BUSINESS & SCIENCE

FACTORY ASSEMBLED & TESTED	LIST	ONLY
HORIZON-2-64K-DOUBLE DEN	$4195	$3062
HORIZON-2-32K-QUAD DENSITY	$3995	$2916
HORIZON-2-64K-QUAD	$4495	$3281
HORIZON RAM ASSM 16K = $279		32K = $479
HORIZON RAM ASSM 48K = $679		64K = $879
HORIZON DISK DRIVE SALE		
DOUB DEN	SAVE!	$ 445
NORTH STAR HARD DISK 18 Mb	$5375	$3923
NORTH STAR TIME SHARING MULTI-USER		CALL

SUPERBRAIN

ZENITH

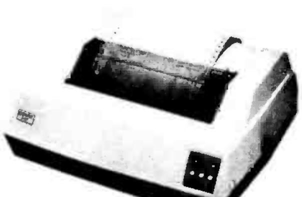
SUPERBRAIN QD 64K
List $3995 only $2995

Z-89 48K
List $2895 only $2299

TERMINALS Z-19 $725

INTERTUBE III only $725

DYNABYTE COMPUTER—SAVE—PHONE
EPSON MX-80—PHONE
ANADEX 9501 $1349
NEC PRINTER $2639
TRACTOR, THIMBLE, RIBBON



DIP-81 $395
TEC LETTER QUAL $1599

InterSystems

ITHACA INTERSYSTEMS 2A

Z-80A CPU 4 MHz
64K Dynamic RAM
Front panel
V I/O—with interrupts
FDCII Disk Controller
20 slot motherboard

CALL FOR PRICE—
TOO LOW TO ADVERTISE!

PASCAL/Z + THE FASTEST PASCAL $375
Z-8000 & CACHE BIOS—POWERFUL—PHONE
8086 16 BIT CPU & SUPPORT CARD SEATTLE $695
CALIFORNIA COMPUTER 2210A ONLY $1795

MORROW 8" DISK

DISCUS 2D + CP/M® 600K ONLY $929
DISCUS 2 + 2 + CP/M® 1.2 MEGA B. $1240
ADD DRIVES 2D = $650 2 + 2 = $975
2D-DUAL + CP/M® ONLY $1540
FREE MBASIC FROM MORROW!!

MORROW HARD DISK
26,000,000 BYTES!!
LIST $4995 ONLY $3919
CP/M® IS INCLUDED!

SAVE ON MEMORY AND PROGRAMS

SYSTEMS MEMORY 64K A & T 4mHz	$590
SYSTEM MEMORY 64K BANK SELECT	$740
ITHACA MEMORY 8/16-bit 64K	$845
SEATTLE MEMORY 8/16 BIT 16K	$249
SSM KITS Z-80 CPU	$221
VIDEO BRD V83 4Mhz	$412
ANADEX PRINTER DP-9500-1	$1349
CAT NOVATION MODEM	$169
ECONORAM 2A 8K ASSM	$179
NSSE 1-22 & P01 TERRIFIC PROGRAMS	ONLY $10. EACH
NORTHWORD $329 MAILMAN $246	
INFOMAN	$411
WORD STAR	$315
SPECTRUM	$269
COMPUPRO	SAVE
EZ-CODER Translates English to BASIC	$71
ECOSOFT FULL ACCOUNTING PKG	$355
BOX OF DISKETTES	$29
SECRETARY WORD PROCESSOR The Best!	$99
GOFAST NORTH STAR BASIC OPTIMIZER—FAST	$71
Which Computers are BEST? BROCHURE	FREE
North Star Documentation refundable w/HRZ	$35

TARBELL COMPUTER-PHONE
AMERICAN SQUARE COMPUTERS BEATS ADV. PRICES

American square Computers

919-889-4577 KIVETT DR. JAMESTOWN N.C. 27282 919-883-1105

® CP/M is a registered trademark of Digital Research, Inc.

Circle 18 on inquiry card.

Text continued from page 206:
designed with the consumer in mind. The keyboard, 10-inch black-and-white display, and a cassette recorder are all contained in a single compact package. The MZ-80 is based around a Z80 microprocessor and includes 16 K bytes of programmable memory, Microsoft-compatible BASIC, a real-time clock, and sound/music capabilities. Dual 5¼-inch floppy-disk drives as well as a variety of printers are also being sold by Sharp in Europe and Japan, making the MZ-80 a powerful low-end business machine.

Sharp officials deny there are any plans afoot to market the MZ-80 in the United States. My personal feeling is that it will make its appearance here soon. The existing Sharp dealers network is the ideal place to market a machine such as this—designed for the *consumer*.

Hitachi

Hitachi is yet another of the multibillion-dollar Japanese giants. 1980 sales of $13.4 billion make it the fifth largest company in Japan. Long known for high-quality inexpensive consumer electronics equipment (sold under a variety of names in the United States), Hitachi seemed to be one of the first to plan a marketing strategy to crack the US personal computer market. The problem is that, until recently, it never became serious about the plan.

Hitachi was one of the first Japanese companies to build a personal computer. The HD46800 was announced in June 1978 and was a true *home* computer designed for environmental control, menu and financial planning, as well as burglar and fire alarm interfacing. But it was too much, too soon. The US personal computer market was then only beginning to develop with the introduction of the first Radio Shack TRS-80 models.

Another major problem with Hitachi is the lack of a marketing organization in the United States. There seems to be little movement in the direction of developing one. Lately, the company appears to be concentrating on large computers to compete in the IBM mainframe market. Hitachi recently introduced the AS-9000 computer with features far and above IBM's largest computer at a comparable price. But the lack of a US organization has hurt. The AS-9000 is being sold in the United States by National Advanced Systems—a company with a large amount of small computer experience. Although the AS-9000 is receiving a very favorable response, service is already a major problem. Recently, Lockheed Dialog installed an AS-9000 in its well-known database system. It was learned recently that a strange bug caused the entire system to crash at random intervals. Servicing the AS-9000 required that engineers be brought in from Japan, an extremely expensive proposition for Hitachi.

Even with the lack of a US organization, it seems certain that Hitachi will begin a major drive to in-

if He'd used select™ it wouldn't have taken seven days

Learn SELECT* in just 90 minutes. A whole new word processing software concept that kicks the coded key habit and frees you from complicated instruction manuals. *SELECT* is fast. *SELECT* is logical. With single key mnemonics, you'll use dozens of commands that instantly access the rich capabilities of this system. There's nothing like it.

Simply hit "C" and you'll be ready to Create a document.
Key "I" and you'll be in the Insert mode.
Key "M" and Move entire blocks of text . . . and key dozens more.

That's all there is to it. You'll get all that word processing software promises . , . plus a few surprises.

SELECT with SUPERSPELL.* The only microcomputer software with an integrated spelling dictionary. To proof your text all you do, of course, is to key "S". *SUPERSPELL* with its 10,000 word dictionary scans your text at computer speed then displays and corrects all your typing errors. You can increase *SUPERSPELL*'s word power and customize the dictionary by adding new words, one at a time. Ask to see it today at your local dealer.

SELECT with SUPERSPELL . . . just a little byte more.™

SELECT will run on any machine that uses CP/M or MP/M** or its derivatives. It needs 40K of RAM and two disk drives. Special version now available for Radio Shack Mod II*** and Apple II****

* SELECT and SUPERSPELL are trademarks of Select Information Systems Inc.
** CP/M and MP/M are trademarks of Digital Research
*** A trademark of Tandy Corp.
**** A trademark of Apple Computer Inc.

select INFORMATION SYSTEMS™ 919 Sir Francis Drake Boulevard · Kentfield, California 94904 · (415) 459-4003

Circle 344 on inquiry card.

troduce its personal computers here. The Hitachi BASIC Master Level III is now being sold in Japan and will probably soon be test-marketed in the United States. Based on a Motorola 6809 microprocessor, the unit has Microsoft BASIC, 80-column text display, and high-resolution graphics with six colors available. The US price is expected to be in the $1500 range. A special color monitor for ultra-high-resolution graphics is $900.

Hitachi seems to be making a slow but steady penetration into the personal computer market. Although it probably won't be a strong force in the US for a few years, Hitachi's heavy R & D expenditures and quality-at-low-cost reputation make it a strong long-term prospect for major US sales.

NEC

Nippon Electric Company is poised for a major move into the US computer market in *both* the personal and small-business markets.

NEC's trump card is the PC-8001, the largest-selling personal computer in Japan (some 3000 to 4000 units are sold monthly). The details of the PC-8001 were covered in an article in the January 1981 BYTE (page 72). It was first shown at the 1980 NCC (National Computer Conference). In January 1981, it was featured at the winter Consumer Electronics Show. NEC's Consumer Electronics Division, based in Elk Grove Village, Illinois, is now marketing it in the US through major personal computer dealers. The base price is $1295 with 32 K bytes of programmable memory. (A little-known fact about the PC-8001 is that it was jointly developed by NEC and an Arlington Heights, Ohio, company called Just Another Computer Company.)

The major strength of the PC-8001 is that it has something for everyone: dazzling color graphics for the consumer as well as strong computation power and a full line of peripherals for business people.

The key to the unit's success will be its marketing. The NEC name is not well known in the United States and,

at present, no large-scale organization exists to support it. However, NEC's marketing manager says the company will have a number of computer distributors and retail outlets in the near future.

NEC is also aiming at the higher end of the small-business market with the Astra system, which is expected to be available soon. NEC Information Systems (Lexington, Massachusetts) is marketing the system, with prices starting at $11,000.

Casio

Relatively small (by Japanese standards) Casio is well known for its extensive line of calculators (many sold under different brand names). Casio has had its ups and downs over the past few years and developed a personal computer about three years ago. Although some were sold in Japan, the product was ahead of its time.

Casio is about to make a major bid for the US personal and small-business computer market with the imminent introduction of the FX-9000P.

The FX-9000P has a unique design with a built-in green phosphor 5-inch monitor (similar to the Hewlett-Packard HP-83 and HP-85). One of the most interesting features is the set of plug-in modules for programmable memory expansion, peripheral interface, and software in read-only memory. In addition, the unit will be one of the first to partially use CMOS memory (which doesn't lose data when the power is turned off). As CMOS prices continue to fall, more companies will incorporate this new technology in their computer designs.

The big question mark about the FX-9000P is the price. Although company officials were more than happy to talk about its capabilities, the price is something they refused to even hint at. The unit seems to be aimed at more specialized uses than personal computers made by others. It will probably be marketed for scientific as well as small-business uses—aggressive pricing, however, will make it attractive for lower-end uses. The best guess is that it will sell in the $1200 to $1800 range.

Mitsubishi

Another of the giant Japanese conglomerates, Mitsubishi, builds everything from small consumer applicances to jet planes. The company is one of the few that doesn't (at the moment) seem to be interested in the personal computer market, but its large mainframe systems make it the fifth largest computer company in Japan.

Mitsubishi does have a US subsidiary which is working to market a high-end small-business computer. Melcom systems is expected to market the Melcom Model 18 soon. The system is already being sold in Japan with prices starting at $18,000.

Rumors about a Mitsubishi personal computer are nonexistent, but the fact that it is developing a computer marketing network portends things to come.

Seiko

Best known for its line of watches, Seikosha Limited has been rumored for some time to be developing a low-end portable personal computer. Since 1979, the company has been selling a personal computer in Japan (with very limited success). The Seikosha 8500 uses two Intel 8085 microprocessors, has a 12-inch video display, and comes with two 5¼-inch floppy-disk drives. Chances are slim that this product will ever arrive on the American market.

The hottest rumor, circulating for some time now, is that Seiko's low-end personal computer would have a "designer" look created by Pierre Cardin. At the winter Consumer Electronics Show, Seiko displayed a number of products designed by Cardin. Conversations with Seiko personnel brought out the fact that "other products" are under development and will soon be appearing here.

Perhaps the biggest argument for an eventual Seiko push into the US personal computer market is the success of Seiko's Epson subsidiary. Epson printers are rapidly becoming more and more popular in the United States, with a sales and service organization that is building rapidly—an organization that could

H&E COMPUTRONICS INC.

• EVERYTHING FOR YOUR TRS-80* • ATARI* • APPLE* • PET* •

*TRS-80 is a trademark of the Radio Shack Division of Tandy Corp. - *ATARI is a trademark of Atari Inc. - *Apple is a trademark of Apple Corp. - *Pet is a trademark of Commodore

NEW

★ All orders processed within 24-Hours
★ 30-Day money back guarantee on all Software

BUSINESS PAC 100

100 Ready-To-Run Business Programs

(ON CASSETTE OR DISKETTE).....Includes 110 Page Users Manual.....5 Cassettes (Or Diskettes)
Inventory Control.....Payroll.....Bookkeeping System.....Stock Calculations.....
Checkbook Maintenance.....Accounts Receivable.....Accounts Payable.....

BUSINESS 100 PROGRAM LIST

NAME	DESCRIPTION
1 RULE78	Interest Apportionment by Rule of the 78's
2 ANNU1	Annuity computation program
3 DATE	Time between dates
4 DAYYEAR	Day of year a particular date falls on
5 LEASEINT	Interest rate on lease
6 BREAKEVN	Breakeven analysis
7 DEPRSL	Straightline depreciation
8 DEPRSY	Sum of the digits depreciation
9 DEPRDB	Declining balance depreciation
10 DEPRDDB	Double declining balance depreciation
11 TAXDEP	Cash flow vs. depreciation tables
12 CHECK2	Prints NEBS checks along with daily register
13 CHECKBK1	Checkbook maintenance program
14 MORTGAGE/A	Mortgage amortization table
15 MULTMON	Computes time needed for money to double, triple, etc.
16 SALVAGE	Determines salvage value of an investment
17 RRVARIN	Rate of return on investment with variable inflows
18 RRCONST	Rate of return on investment with constant inflows
19 EFFECT	Effective interest rate of a loan
20 FVAL	Future value of an investment (compound interest)
21 PVAL	Present value of a future amount
22 LOANPAY	Amount of payment on a loan
23 REGWITH	Equal withdrawals from investment to leave 0 over
24 SIMPDISK	Simple discount analysis
25 DATEVAL	Equivalent & nonequivalent dated values for oblig.
26 ANNUDEF	Present value of deferred annuities
27 MARKUP	% Markup analysis for items
28 SINKFUND	Sinking fund amortization program
29 BONDVAL	Value of a bond
30 DEPLETE	Depletion analysis
31 BLACKSH	Black Scholes options analysis
32 STOCVAL1	Expected return on stock via discounts dividends
33 WARVAL	Value of a warrant
34 BONDVAL2	Value of a bond
35 EPSEST	Estimate of future earnings per share for company
36 BETAALPH	Computes alpha and beta variables for stock
37 SHARPE1	Portfolio selection model-i.e. what stocks to hold
38 OPTWRITE	Option writing computations
39 RTVAL	Value of a right
40 EXPVAL	Expected value analysis
41 BAYES	Bayesian decisions
42 VALPRINF	Value of perfect information
43 VALADINF	Value of additional information
44 UTILITY	Derives utility function
45 SIMPLEX	Linear programming solution by simplex method
46 TRANS	Transportation method for linear programming
47 EOQ	Economic order quantity inventory model
48 QUEUE1	Single server queueing (waiting line) model
49 CVP	Cost-volume-profit analysis
50 CONDPROF	Conditional profit tables
51 OPTLOSS	Opportunity loss tables
52 FQUOQ	Fixed quantity economic order quantity model
53 FQEOWSH	As above but with shortages permitted
54 FQEOQPB	As above but with quantity price breaks
55 QUEUECB	Cost-benefit waiting line analysis
56 NCFANAL	Net cash-flow analysis for simple investment
57 PROFIND	Profitability index of a project
58 CAP1	Cap. Asset Pr. Model analysis of project
59 WACC	Weighted average cost of capital
60 COMPBAL	True rate on loan with compensating bal. required
61 DISCBAL	True rate on discounted loan
62 MERGANAL	Merger analysis computations
63 FINRAT	Financial ratios for a firm
64 NPV	Net present value of project
65 PRINDLAS	Laspeyres price index
66 PRINDPA	Paasche price index
67 SEASIND	Constructs seasonal quantity indices for company
68 TIMETR	Time series analysis linear trend
69 TIMEMOV	Time series analysis moving average trend
70 FUPRINF	Future price estimation with inflation
71 MAILPAC	Mailing list system
72 LETWRT	Letter writing system-links with MAILPAC
73 SORT3	Sorts list of names
74 LABEL1	Shipping label maker
75 LABEL2	Name label maker
76 BUSBUD	DOME business bookkeeping system
77 TIMECLCK	Computes weeks total hours from timeclock info.
78 ACCTPAY	In memory accounts payable system-storage permitted
79 INVOICE	Generate invoice on screen and print on printer
80 INVENT2	In memory inventory control system
81 TELDIR	Computerized telephone directory
82 TIMUSAN	Time use analysis
83 ASSIGN	Use of assignment algorithm for optimal job assign.
84 ACCTREC	In memory accounts receivable system-storage ok
85 TERMSPAY	Compares 3 methods of repayment of loans
86 PAYNET	Computes gross pay required for given net
87 SELLPR	Computes selling price for given after tax amount
88 ARBCOMP	Arbitrage computations
89 DEPRSF	Sinking fund depreciation
90 UPSZONE	Finds UPS zones from zip code
91 ENVELOPE	Types envelope including return address
92 AUTOEXP	Automobile expense analysis
93 INSFILE	Insurance policy file
94 PAYROLL2	In memory payroll system
95 DILANAL	Dilution analysis
96 LOANAFFD	Loan amount a borrower can afford
97 RENTPRCH	Purchase price for rental property
98 SALELEAS	Sale-leaseback analysis
99 RRCONVBD	Investor's rate of return on convertable bond
100 PORTVAL9	Stock market portfolio storage-valuation program

Circle 150 on inquiry card.

☐ **CASSETTE VERSION** $99.95
☐ **DISKETTE VERSION** $99.95
☐ **TRS-80* MODEL II VERSION** $149.95

ADD $3.00 FOR SHIPPING IN UPS AREAS
ADD $4.00 FOR C.O.D. OR NON-UPS AREAS
ADD $5.00 OUTSIDE U.S.A, CANADA & MEXICO

NEW TOLL-FREE ORDER LINE (OUTSIDE OF N.Y. STATE)
(800) 431-2818

H&E COMPUTRONICS INC.
MATHEMATICAL APPLICATIONS SERVICE™
50 N. PASCACK ROAD
SPRING VALLEY, NEW YORK 10977

24 HOUR ORDER LINE
(914) 425-1535

easily handle personal computers.

Matsushita

Matsushita is one of the largest manufacturers and marketers of consumer electronics products in the world, with 1980 sales of $13.7 billion. In the United States, the company is best known for the Quasar, Panasonic, and Technics brands. Its US marketing organization and expertise are formidable.

Apparently, the company's first thought about entering the US personal computer market was to approach it in a very different way—namely, the Panasonic and Quasar hand-held computer, introduced officially at the winter Consumer Electronics Show. (See BYTE January 1981, page 34.)

Persistent rumors exist in the industry that Matsushita is having second thoughts about the hand-held computer in its present form. Release dates have already been pushed up a few months, lending credence to the rumor that the product will undergo a major redesign. Meanwhile, there are reports that the company is hard at work on a full-sized personal computer in the $1000 range.

IBM obviously respects the resources of Matsushita in the small computer field; Matsushita officials recently admitted they were approached by IBM to build a personal computer for the US giant. Sources at both companies say nothing came of the meeting, but, in fact, Matsushita and IBM having been working for some time on a joint project to produce a series of personal computers bearing the IBM logo. Code-named "Go," the project now seems to have been suspended. (See the editorial in last month's BYTE.)

Sord

Although virtually unknown in the United States, this small company based in Tokyo is planning a major push into the US market. Sord designed and markets the M100 computer in both Europe and Japan. Some 1800 units were reportedly shipped to Europe in 1980. They are evidently being sold under another name because dealers contacted in the United Kingdom had never heard of them.

Most Japanese companies are secretive, but Sord stands out as one of the most tight-lipped. I was consistently unable to contact company officials and letters went unanswered. Consequently, details of the M100 are not available.

There are, however, persistent rumors that the company will appear suddenly in the US with a strong product, marketed well.

Other Companies

A number of other Japanese companies are working on personal and small-business computers designed for the United States market. In most of the following cases, little if any details are available.

Sony recently admitted it is designing a personal computer which will either interface with or be designed around its recently introduced TypeCorder portable typewriter (which fits in a briefcase and stores text on miniature tape cassettes). Sony has what is probably the most formidable marketing/service organization of any Japanese company in the United States. More importantly, the Sony name is synonymous with high quality and innovative technology.

Expect the introduction of a Sony personal computer within a year. It will probably be unlike any other product now on the market and will use Sony's new 3-inch disks. Reported problems with quality control on the disks may, however, delay the process. When the unit does appear, it will certainly give both US and other Japanese computer makers a run for their money.

OKI is expanding its US marketing and service network and quietly showed its OKI IF800 at the winter Consumer Electronics Show. The OKI IF800 is now being sold in Japan (for approximately $8000) and is a strong seller for small-business applications.

Toshiba is working on small computers but doesn't seem to be interested in either the US or Japanese

WHY BUY FROM THE BEST?

NEECO

Service... Support... Software...

MULTI-CLUSTER

For Commodore Systems. allows 3 CPU's (Expandable to 8) to access a single Commodore Disk.

MULTI-CLUSTER (3 CPU's)	$ 795
Each Additional CPU (up to 8)	$ 199

commodore

16K B (16K RAM-40 Column) - Lim. Qty	$ 995
32K B (32K RAM-40 Clm.) - Lim. Qty	$1295
4016 (16K RAM 4.0 Basic-40 Clm.)	$ 995
4032 (32K RAM 4.0 Basic-40 Clm.)	$1295
8032 (32K RAM 4.0 Basic-80 Clm.)	$1495
8050 Dual Disk (1 Meg Storage)	$1795
4040 Dual Disk (343K Storage)	$1295
8010 IEEE Modem	$ 280
C2N Cassette Drive	$ 95
CBM - IEEE Interface Cable	$ 40
IEEE - IEEE Interface Cable	$ 50
VIC 20 Home/Personal Computer	$ 295

ALTOS

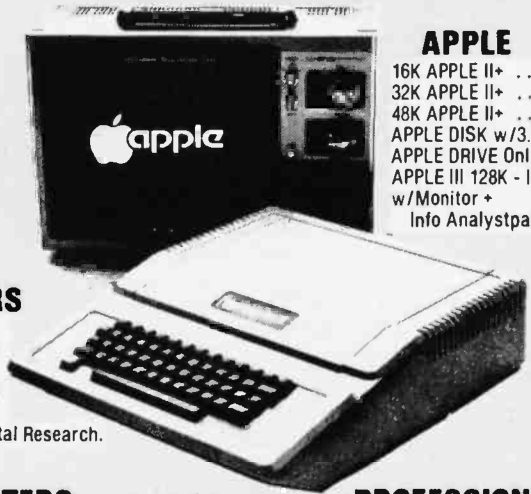
ACS 8000-2 64K 1M	$ 4500
ACS 8000-15 64K 1M	$ 5990
ACS 8000-6 208K 14.5M	$10490
ACS 8000-7 208K 29.0M	$11690
ACS 8000-10 208K 10M	$ 8500
ACS 8000-10/MTU	$10990

EPSON PRINTERS

MX-80 PRINTER	$ 645
MX-80 FT	$ 745
MX-100	$ 945
MX-70	$ 459
INTERFACE CARDS	
8141 (RS-232)	$ 75
8150 (2K Buffered RS-232)	$ 150
8161 (IEEE 488)	$ 55
8131 (Apple Card)	$ 85
8230 (Apple Card)	$ 25
8220 (TRS-80 Cable)	$ 35

NEC SPINWRITER PRINTERS

5530 (Parallel)	$3055
5510 (Serial)	$3055
5520 (KSR-Serial)	$3415
Tractor Option	$ 225



APPLE

16K APPLE II+	$1330
32K APPLE II+	$1430
48K APPLE II+	$1530
APPLE DISK w/3.3 DOS	$ 650
APPLE DRIVE Only	$ 490
APPLE III 128K - In Stock! w/Monitor + Info Analystpak	$4740

DIABLO 630 PRINTER

DIABLO 630 - Serial - RS-232	$2710
Tractor Option	$ 250

AMDEK MONITORS

Video 100 12" B+W	$ 179
Video 300 12" Green	$ 249
Color I 13" Low Res	$ 449
Color II 13" High Res	$ 999

INTERTEC COMPUTERS

64K Superbrain (360 Disk Storage), CP/M™	$3495
64K QD Superbrain (700K Disk Storage), CP/M™	$3995

*CP/M is a registered trademark of Digital Research.

ATARI COMPUTERS

Atari 400 (16K RAM)	$ 399
Atari 800 (32K RAM) - good thru 8/31	$1080
Atari 410 RECORDER	$ 89.95
Atari 810 DISK DRIVE	$ 599.95

NEECO carries all available ATARI Software and Peripherals.

PROFESSIONAL SOFTWARE

WordPro 1 8K	$ 29.95
WordPro 3 (40 Clm.) 16K	$ 199.95
WordPro 3+	$ 295
WordPro 4 (80 Clm.) 32K	$ 375
WordPro 4+	$ 450

JUST A SAMPLE OF THE MANY PRODUCTS WE CARRY. CALL US FOR OUR NEW 60-PAGE CATALOG.
WE WILL MATCH ANY ADVERTISED PRICE ON PRODUCTS LISTED UNDER SIMILAR "IN STOCK" CONDITIONS.

NEECO
679 HIGHLAND AVE.
NEEDHAM, MA 02194

(617) 449-1760
Telex: 951021

MON-FRI 9:00 - 5:00

MasterCharge and VISA Accepted

Circle 268 on inquiry card.

personal and/or small-business market at this time. The only small computer product it is currently offering is a one-board uncased machine with BASIC and a keyboard that's mainly designed for development work.

AI Electronics Corporation and *Logic Systems International* are two small companies, based in Tokyo, which seem to be quietly working behind the scenes. Both ship about 2000 personal computers a year to Europe—where they are packaged and sold under different names. In the Japanese tradition of secrecy, details on their products are unavailable; however, watch for the names, possibly in conjunction with US companies. Rumors persist that both companies have had major discussions with US companies regarding the marketing of their personal computers in the United States.

Finally, *Sanyo* has exhibited some personal computer prototypes at Japanese trade shows, but seems to have put the project on a back burner for the time being.

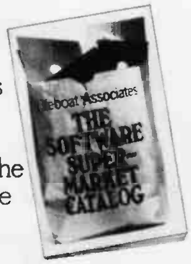
Summary

The Japanese personal computers are impressive machines at highly competitive prices. However, the outlook for American computer manufacturers is not entirely grim. There is little if any chance that the influx of Japanese products into our market will have anywhere near the same effect Japanese automobiles and steel have had on those US markets. The American computer industry is far from being the mature and top-heavy group that the auto and steel industries are. The United States developed the computer and that development continues to move forward at a dizzying pace.

In fact, the influx of Japanese personal computers is likely to further spur the domestic computer makers. Their highly experienced marketing and product-development groups are poised to give the Japanese products a run for their money. The bottom line seems to be that the "Japanese Computer Invasion" will result in better products and lower prices for consumers. ■

If you can't find the right program in our new catalog, it probably hasn't been written.

As the world's largest publisher of professional software for microcomputers, Lifeboat Associates offers the largest selection of state-of-the-art programs. And our new catalog has more to offer than ever. We also add the crucial dimension of after-sales service and full support to everything we sell. Order your free catalog today.



For a free catalog, mail coupon to Lifeboat Associates, 1651 Third Avenue, New York, NY 10028.
Or call (212) 860-0300. Telex 640693 (LBSOFT NYK)

CB881

Name________ Title________
Company________
Street________
City________ State________ Zip________

Our catalog contains full descriptions and specifications of the following:

DISK OPERATING SYSTEMS

CP/M CONFIGURED FOR:
APPLE II
DATAPOINT 1550/2150
ICOM MICRO DISK
ICOM 3712
ICOM 3812
ICOM 4511/PERTEC D3000
INTEL MDS
MICROPOLIS FLOPPY DISK
MITS/ALTAIR
MOSTEK MDX
NORTH STAR
OSI C3
OSI C3B
OSI C3C Prime
TRS-80 MODEL II
MP/M FOR INTEL MDS

HARD DISK INTEGRATION MODULES

CORVUS WITH APPLE II SOFTCARD
CORVUS WITH S100 AND TRS-80 MODEL II
ICOM 4511/PERTEC D3000
KONAN PLUS CDC PHOENIX
XCOMP SM/S PLUS CDC PHOENIX
XCOMP DFC10 FOR PERTEC D3000

SYSTEMS TOOLS

BUG AND uBUG, DESPOOL, DISILOG, DISTEL, EDIT, EDIT-80, FILETRAN, IBM/CPM, MAC, MACRO-80, PASM, PLINK, PMATE, RAID, RECLAIM, SID, TRS-80 MODEL II CP/M CUSTOMIZATION, UNLOCK, WORD-MASTER, XASM-18, XASM-48, XASM-65, XASM-68, XMACRO-86, ZDT, Z80 DEVELOPMENT PACKAGE, ZSID

TELECOMMUNICATIONS

BSTAM, BSTMS

LANGUAGES

ALGOL-80, APL/V80, BASIC-80 (COMPILER), BASIC-80 (INTERPRETER), BDS C COMPILER, CBASIC-2, CIS COBOL, COBOL-80, FORTRAN-80, JRT PASCAL, muLISP, muSIMP, NEVADA COBOL, PASCAL/M, PASCAL/MT, PASCAL/MT+, PASCAL/Z, PL/I-80, S-BASIC, TINY C, TINY-C TWO, W'SMITHS C COMPILER, XYBASIC

LANGUAGE AND APPLICATIONS TOOLS

BASIC UTILITY DISK, DATASTAR, FABS, FORMS 1 FOR CIS COBOL, FORMS 2 FOR CIS COBOL, MAGSAM III, MAGSAM IV, MDBS.DRS, MDBS.RTL, M/SORT FOR COBOL-80, PEARL, PSORT, QSORT, STRING BIT, STRING/80, SUPER-SORT, ULTRASORT II

WORD PROCESSING SYSTEMS AND AIDS

MAGIC WAND, LETTERIGHT, MICROSPELL, SPELLGUARD, TEX, TEXTWRITER III, WORDSTAR, WORDINDEX

DATA MANAGEMENT PACKAGES

CONDOR, HDBS, MDBS, MDBS.DRS

GENERAL PURPOSE APPLICATIONS

CBS, SELECTOR III-C2, SELECTOR IV

MAIL LIST APPLICATIONS

MAILING ADDRESS (PTREE)
MAILMERGE FOR WORDSTAR
NAD
POSTMASTER

BUSINESS APPLICATIONS

ACCOUNTS PAYABLE (PTREE)
ACCOUNTS PAYABLE (SSG)
ACCOUNTS RECEIVABLE (PTREE)
ACCOUNTS RECEIVABLE (SSG)
GENERAL LEDGER II (CPAIDS)
GENERAL LEDGER (PTREE)
GENERAL LEDGER (SSG)
GLECTOR FOR SELECTOR III-C2
INVENTORY (PTREE)
INVENTORY (SSG)
PAYROLL (PTREE)
PAYROLL (SSG)

NUMERICAL PROBLEM-SOLVING TOOLS

ANALYST, FPL, muMATH, STATPAK, T/MAKER

OTHER SPECIALIZED APPLICATIONS

DATEBOOK
ESQ-1
PAS-3 DENTAL
PAS-3 MEDICAL
PROPERTY MANAGEMENT (PTREE)

BOOKS AND PERIODICALS

APL—AN INTERACTIVE APPROACH
ACCOUNTS PAYABLE & ACCOUNTS RECEIVABLE-CBASIC
8080/Z80 ASSEMBLY LANGUAGE
THE CP/M HANDBOOK
THE C PROGRAMMING LANGUAGE
CRASH COURSE IN MICROCOMPUTERS
FIFTY BASIC EXERCISES
GENERAL LEDGER-CBASIC
INTRODUCTION TO PASCAL
LIFELINES
THE PASCAL HANDBOOK
PASCAL USER MANUAL AND REPORT
PAYROLL WITH COST ACCOUNTING-CBASIC
STRUCTURED MICROPROCESSOR PROGRAMMING
USING CP/M-A SELF-TEACHING GUIDE

ACCESSORIES

DC 300 DATA CARTRIDGE
HEAD CLEANING DISKETTE
FLIPPY DISK KIT
FLOPPY SAVER

Program names and computer names are generally trademarks or service marks of the author or manufacturing company.

All software products have specific requirements for hardware and additional associated software (e.g. operating system or language).

All products are subject to terms and conditions of sale.

Prices and specifications are subject to change without notice.

All Lifeboat software requires CP/M unless otherwise stated.

ORDERING INFORMATION. COMPUTERS SUPPORTED INCLUDE:

ADDS Multivision	RT
AVL Eagle	RB
Altair 8800	B1
Altos	A1
Apple CP/M 13 Sector	RG
Apple CP/M 16 Sector	RR
BASF System 7100	RD
Blackhawk Micropolis Mod II	Q2
CDS Versatile 3B	Q1
CDS Versatile 4	Q2
Columbia Data Products	A1
COMPAL-80	Q2
CSSN Backup	T1
Cromenco System 3	A1
Cromenco System 2 SDSS	R6
Cromenco System 2 DDSS	RX
Cromenco System 2 DDDS	RY
Datapoint 1550/2150 Single Sided	AA
Datapoint 1550/2150 Double Sided	AB
Delta Systems	A1
Digi-Log Microterm II	RD
Digital Microsystems	A1
Durango F-85	RL
Dynabyte DB8/2	R1
Dynabyte DB8/4	A1
Exidy Sorcerer + Lifeboat CP/M	Q2
Exidy Sorcerer + Exidy CP/M	RW
Heath H8 + H17/H27 disk	P4
Heath H89 + Lifeboat CP/M	P4
Heath H89 + Magnolia CP/M	P7
Heath H89 + Heath CP/M	P7
Helios II	B2
ICOM 2411 Micro Floppy	R3
ICOM 3712	A1
ICOM 3812	A1
ICOM 4511 5440 Cartridge CP/M 1.4	D1
ICOM 4511 5440 Cartridge CP/M 2.2	D2
IMS 5000	RA
IMS 8000	A1
IMSAI VDP-40	R4
IMSAI VDP-42	R4
IMSAI VDP-44	R5
IMSAI VDP-80	A1
ISC Intecolor 8063/8360/8963	A1
Intertec Superbrain DDS 0.1	R7
Intertec Superbrain DOS 0.5	RJ
Intertec Superbrain DOS 3.x	RK
Intertec Superbrain QD	RS
Kontron PSI-80	RF
MITS 3200-3202	B1
MSD 5.25 in	RC
Meca Delta-1 5.25 in.	P6
Micromation	A1
Micropolis Mod I	Q1
Micropolis Mod II	Q2
Morrow Discus	A1
Mostek	A1
NEC PC-8001	RV
North Star Single Density	P1
North Star Double Density	P2
North Star Quad Density	P3
Nylac Micropolis Mod II	Q2
Ohio Scientific C3	A3
OKI IF-800	RZ
Onyx C8001	T2
Pertec PCC 2000	A1
Processor Technology Helios II	B2
Quay 500	RO
Quay 520	RP
RAIR Single Density	R9
RAIR Double Density	RE
Research Machines 5.25 in.	RH
Research Machines 8 in.	A1
SD Systems 5.25 In.	R3
SD Systems 8 In.	A1
Sanco 7000 5.25 in.	RO
Spacebyte	A1
TEI 5.25 in.	R3
TEI 8 In.	A1
TIP	T3
TRS-80 Model I STANDARD	R2
TRS-80 Model I + FEC Freedom	RN
TRS-80 Model I + Micromation	A4
TRS-80 Model I + Omikron 5.25 In.	RM
TRS-80 Model I + Omikron 8 in.	A1
TRS-80 Model I + Shuffleboard 8 in.	A1
TRS-80 Model II	A1
TRS-80 Model III	RU
Vector MZ	Q2
Vector System 2800	A1
Vector System B	Q2
Vector VIP	Q2
Vista V-80 5.25 in. Single Density	R8
Vista V200 5.25 in. Double Density	P6
Zenith Z89 + Zenith CP/M	P7
Zenith Z89 + Lifeboat CP/M	P4
Zenith Z89 + Magnolia CP/M	P7

SS = single sided   SD = single density
DD = double sided   DD = double density

The list of available formats is subject to change without notice. In case of uncertainty, call to confirm the format code for any particular equipment.

LIFEBOAT WORLDWIDE

Lifeboat Inc.
3-23-8 Nishi-shinbashi
Minato-ku, Tokyo, 105 Japan
Tel: 03-437-3901
Telex: 2422723 (ASRTYOJ)

Lifeboat Associates, Ltd.
PO Box 125
London WC2H 9LU, England
Tel: 01-836-9028
Telex: 893709 (LBSOFTG)

Lifeboat Associates GmbH
PO Box 168, Aegeristrasse 35
CH 6340 Baar, Switzerland
Tel: 042-31-2931
Telex: 865265 (MICO CH)

Intersoft GmbH
Schlossgartenweg 5
D-8045 Ismaning, W. Germany
Tel: 089-966-444
Telex: 5213643 (ISOFD)

Lifeboat Associates, SARL
10, Grande Rue Charles de Gaulle
92600 Asnieres, France
Tel: 1-733-08-04
Telex: 250303 (PUBLIC X PARIS)

Lifeboat Associates
Software with full support.

Circle 409 on inquiry card.

Buying new software is the pits, isn't it?

You read an ad and it sounds terrific, so you ask around, then buy the manual.

So far, so good—so you spring several hundred dollars for the package.

And it does exactly what they said. But to get exactly what <u>you</u> want, you're going to have to change the way you run your business. Or go through so much hassle that you're not sure it's worth it.

So you grit your teeth and suffer, or put it on a shelf to gather dust.

Sounds familiar, doesn't it?

But there is at least one known exception: an exceptional DBMS called dBASE II.

For database fans, an offer you shouldn't refuse.

dBASE II is the only high-performance <u>relational</u> Database Management System for micros. And it's the only DBMS that can help you get the DBMS that's right for you, no matter which DBMS you may want. Here's how:

If you have a 48k micro with CP/M, send us its model number and the size of your drives along with $700 (CP/M 86 version soon—call if you can't wait).

We'll send you a copy of dBASE II that you can run on your system, solving your problems your way, for 30 days. Then just send everything back and we'll return your money, no questions asked.

During that 30 days, you can find out how much a real database management system can do for you. How it will affect your operations. Exactly what you want done. And precisely how you want to do it.

Then even if you go for some other system, you'll be an informed buyer.

And it never hurts to know what you're doing.

IBM just caught up. So can you.

With dBASE II, you'll get the same kind of system for your micro that IBM introduced a few months ago for their mainframes.

It's a <u>relational</u> DBMS, and that makes it different from any other micro system you've ever seen.

In a relational database, the data is organized as simple tables, with records as the rows and the data fields as the columns, much like your data is organized now. Data relations are logical, so that you can zero in on the specific information you want without knowing a thing about the pre-defined sets, pointers or other cumbersome structures of hierarchal and network DBMS's.

And unlike file management systems, dBASE II gives you program and data independence. You can change your database structure without re-entering your data and without reprogramming, or change some or all of your programs without touching your database. And the same database can be used for any number of different applications.

dBASE II is a stand-alone applications development system.

You don't need an extra support language, because dBASE II comes with its own Applications Development Language (ADL). With ADL, you can use simple English-like statements to manipulate your data, or use built-in structured constructs to prepare sophisticated applications packages. It's simple and easy to use, yet extremely powerful.

You create a new database and start using it in a minute or less. Just type CREATE, then respond to system prompts to name the file and define the fields. Now enter the data.

Add data to an existing database instantly, whether your file has 10 records or 10,000 records, by typing APPEND, then entering the information.

UPDATE, MODIFY, JOIN and REPLACE whole databases or individual records and characters.

Add or delete fields in your database structure without re-entering all your data.

And with dBASE II, it's easy to get information out once you've put the data in.

Do automatic calculations on fields, records and databases with a few keystrokes.

Organize months' worth of data in minutes with REPORT (printing optional), and get your reports today instead of tomorrow. Use the built-in SORT, with single or multiple keys. Or INDEX your data, then FIND it in seconds, even with floppies.

You can use dBASE II interactively or store a sequence of commands to automate your accounting, billing, mailing lists or whatever data you have to manage.

You'll wonder how you managed without it.

dBASE II is the most powerful, easiest to use DBMS you can get for a micro.

And instead of poring over the manual, you can run it hands-on, in-house to see exactly what it can do for you. Try it.

What have you got to lose? We even provide the label so you can send it back.

Ashton-Tate, 3600 Wilshire Blvd., Suite 1510, Los Angeles, CA 90010. (213) 666-4409.

Ashton-Tate

BYTELINES

News and Speculation About Personal Computing

Conducted by Sol Libes

Small-Computer Confrontation: The battle lines are being drawn between small-computer suppliers and long-established, large-computer companies. Expect the first skirmishes next year. On one side are the microcomputer manufacturers led by Tandy Corporation, Apple Computer Inc, and Commodore Business Machines. On the other, there's IBM, DEC (Digital Equipment Corporation), HP (Hewlett-Packard), Xerox, and Data General. What is at stake is a market estimated at 300,000 units (not including sales to home users) that should exceed $1 billion in sales in 1982.

Here's what's happening: the small-computer makers are introducing larger systems, while the large-computer makers are bringing out smaller systems. The small-computer makers are expanding and strengthening their marketing and distribution channels, while the large, established companies are crowding into the retail area with their own stores and the same outlets that the small-computer makers have been using. Therefore, both groups will soon be competing in the same price/performance areas.

A third factor that should become a significant presence in the market next year is the Japanese. They are expected to concentrate on the small-business market, at this time.

The key to success will be product marketing and distribution, rather than technology—ask IBM. While other manufacturers always seem to have a technological edge, IBM supplies a total marketing program—sales, service, and support.

The Radio Shack division of the Tandy Corporation is expected to hold its own because of its firmly entrenched chain of stores. Presently, Radio Shack has 138 computer stores, 200 company-owned stores, and about 7000 franchises. However, the competition is spreading. Both DEC and IBM have more than two dozen stores in operation. Xerox, with fifteen stores, hopes to have twice that number within the coming year, while HP is expected to open several of its own. HP already sells through independent retailers, and DEC and IBM are expected to go this route along with their own retail outlets.

Status Report: 5-Inch Winchester Disks: Disk manufacturers are rushing into the 5-inch Winchester market with drives providing up to 13 megabytes of storage (unformatted) in the volume of a standard 5-inch floppy-disk drive. The early entrants into the market are Seagate Technology and Tandon Magnetics; both started shipping samples late last year. Other companies with 5-inch hard-disk products in the making are Shugart, Internation Memories, Irwin International, Olivetti, New World Computer, BASF, Computer Memories, and Rotating Memory Systems. Most companies are forwarding samples to OEMs (original equipment manufacturers) and expect to be in limited production by year's end.

Capacities range from 2 to 13 megabytes, unformatted. Prices, per megabyte, range from $90 to $450 in 100-unit quantities (drive only), which compares favorably with 8-inch Winchesters, which currently cost $50 to $400 per megabyte in similar quantities. Although no standard interface has been developed, a number of manufacturers are providing Seagate-compatible interfaces.

Floppy- And Winchester-Drive Capacities Increasing: Iomega, Ogden, Utah, is expected to introduce a 10-megabyte 8-inch floppy-disk drive. It's rumored that Iomega plans to push this up to 100 megabytes. Persi is gearing up to produce a 6.4-megabyte dual 8-inch drive that fits in the same space as a Shugart 850 8-inch drive.

Seagate Technology has a new version of its 5-inch Winchester drive with capacities of 12.76 megabytes unformatted and 10 megabytes formatted. The 3M company has decided to enter the Winchester-drive market after making the media for years. It plans to introduce 10-, 20- and 60-megabyte 8-inch Winchesters.

New 8080/Z80 DOSes: There are three new disk operating systems (DOSes) for Intel's 8080 and Zilog's Z80 microprocessors. MuSys Corporation, Tustin, California, has introduced MuDOS, a CP/M-compatible DOS that provides a management system for handling multiuser access to the disk. MuDOS runs only on Z80-based systems and, MuSys claims, is six times faster than Digital Research's CP/M. The price will be in the $300 to $750 range depending on configuration.

Vortex Technology, Culver City, California, will introduce MARC, a UNIX-like DOS for 8080 and Z80 systems. Designed by Leor Zolman (the creator of the BDS C compiler) and Ed Ziemba, it initially boots under CP/M and has the UNIX-like, tree-structured file system replete with users, groups, protections, and the like. It also has a shell-type command interpreter, shell files (pipes), user-customization modes, and utilities. Vortex expects the system to provide for the transparent running of most existing CP/M programs as well as programs written for MARC. Projected price is $175, and for another $75, you can have either the BDS C or the MINCE editor.

InfoSoft, Westport, Connecticut, is introducing MULTI/os for 8080 and Z80 systems. MULTI/os will support up to sixteen users, with a shared data base of 975 megabytes and multiple disk controllers. Like the others, it also maintains CP/M compatibility.

Ada And Little Ada Released: Telesoftware has finally released its Ada com-

THE MAROT EXECUTIVE MENU

THE COMPUTER SOLUTION FOR NON-COMPUTER PEOPLE

Now Marot brings you another delicious first: a menu-driven information system so simple even a CEO can use it.

A single key-stroke takes you directly to the required application:

DATA BASE MANAGER (CONTROL™): a combined program generator that works with standard English query. That means it talks your language. So there's no need to learn a computer language or write a program to be a successful user.

WORD PROCESSOR (MAGIC WAND™): a powerful word processor that allows full screen creation and editing of files. It also produces true proportional spacing, microjustification and kerning. In addition, documentation can be fully examined at the CRT prior to printing.

ACCOUNTING: consists of several complete business packages either in standard ANSI '74 COBOL or OASIS™ BASIC, including accounts receivable and payable, general ledger, payroll, order entry and inventory. Financial modeling and job costing are also available.

MAILING LIST (POSTMAN™): delivers up to 65,000 entries in zip and name order and is completely interactive with MAGIC WAND.

SCHEDULER: maintains a complete office diary with ability to compare schedules.

Although the Marot Menu appears simplistic, it also incorporates OASIS with user logons, accounting histories and password protection. Languages available include JCL (EXECUTIVE), BASIC, PASCAL, COBOL and FORTRAN.

As a result, the Marot Executive Menu is a tasty pleasure for the higher-ups and the higher-techs.

A la carte extra

OPSCAN SERVICE™: available exclusively from Marot. Send us your well-printed or typed files. We'll read them directly into MAGIC WAND at a speed that would take 20 typists to match. The cost is less than conventional typing and the turn-around is never more than 5 days.

CONTROL and OASIS are trademarks of Phase One Systems Inc.
POSTMAN is a trademark of Marot Systems Inc.
OPSCAN SERVICE is a trademark of Marot Systems Inc.
MAGIC WAND is a trademark of Retail Sciences Inc.

MAROT SYSTEMS INC.
310 Madison Avenue, Suite 408, New York, N.Y. 10017
(212) 661-8550 TWX: 710-581-2477

I'd like to order more information on
☐ MAROT MENU ☐ OPSCAN SERVICES.

I am a ☐ computer consultant
☐ computer dealer ☐ computer user ☐ CEO

Name ____________________

Title ____________________

Address ____________________

City/State/Zip ____________________

Circle 207 on inquiry card.

piler. This is the first implementation of Ada on a microcomputer. The first release is for a 16-bit Motorola 68000 machine and provides *most* of the features called for in the Department of Defense Ada standard. Telesoftware hopes to add the missing features in the future. A single-user license is $2000.

For $50, you can obtain a "Little Ada" compiler and interpreter for 8080/Z80-based systems that executes the primary Ada functions. With it, you can get a feel for what Ada is all about. While the compiler is furnished in object-code form, the L-machine run-time interpreter is furnished in source-code form. For more information, contact Ralph Kenyon, 145-103 S Budding Ave, Virginia Beach VA 23452.

TEC To Make TRS-80s In Japan: Tokyo Electric Company (TEC) will manufacture and sell the TRS-80 Model I in Japan through a new agreement with Tandy Corporation. TEC will also market the TRS-80 Models II and III, and the Color units. Tandy stopped the manufacture and sale of the Model I in the US because it did not comply with the FCC (Federal Communications Commission) RF (radio frequency) radiation requirements. TEC is a division of Toshiba, which manufactures its own personal computer.

AT&T And Publishers Clash Over Electronic Information Test: Newspaper publishers in Texas have gone to court to prevent AT&T (American Telephone and Telegraph) from testing its "Electronic Information Service" (EIS). The publishers contend that AT&T is creating a monopoly whereby subscribers would not be properly served. AT&T counters that EIS will be a service from a new company with separate assets. However, the publishers feel that this is a juggling act and a violation of a 1956 Justice Department ruling that stopped AT&T from providing data-processing services of any kind.

The test was to be conducted in Austin, Texas. It was intended to be the prelude to a nationwide information-processing service that would bring yellow-page listings and advertising into the home through television sets.

Software Broadcast Via Radio: Radio Netherlands will experimentally broadcast a short computer program this September tenth. The program will be aired in three different formats (TRS-80, Apple II, and PET). Listeners will be able to record the FM broadcast onto a cassette tape and then play it back into their computer systems. The broadcast will be heard in Australia, Europe, Africa, and North America. For information on frequencies and times, write to Computer Experiment, Media Network, Radio Netherlands, POB 222, 1200 JG Hilversum, Holland.

IEEE-696/S-100 Standard Out Of Committee: After three years, the IEEE (Institute of Electrical and Electronics Engineers) 696/S-100 Bus Standard Committee has submitted a finished standard to the IEEE's computer-standard adoption committee. The standard is now complete and formal adoption is expected early in 1982.

Random News Bits: Sinclair will replace the ZX80 with the ZX81. The ZX81 contains only four integrated circuits in place of the ZX80's twenty-two. The price will drop significantly. . . . Apple Computer has signed a lease for a 160,000-square-foot plant in Carrolton, Texas. Apple plans to add 700,000 square feet of manufacturing space during the next twelve months. Tandy will open a fourth TRS-80 plant in San Antonio, Texas, adding 400,000 square feet of manufacturing space. . . . Zenith reported that its Heath division had sales of $104 million last year. Zenith's total sales were $1.186 billion, with color television sales of $774 million leading the way. . . . Integrated-circuit makers are sharply reducing prices on EEPROMs (electrically erasable, programmable read-only memories). Prices currently average $115 for 1 K by 8-bit devices and $67 for the 512 by 8-bit variety, in 100-unit lots. The parts boast a 500 ns access time and 10-year data retention. . . . Intel's profits for the first quarter of 1981 were down 91.3%. The decline is attributed to the falling price of memory devices. As a result, Intel plans to cut capital spending by $30 million. . . . Pick & Associates, developer of the Microdata Disk Operating System, is working with Intel on the disk operating system for the 32-bit iAPX-432 microprocessor. It's currently running on Hewlett-Packard, ADDS, Honeywell, ECSC, and Microdata minicomputer systems. Pick is also working on a Motorola 68000 implementation. . . . Intel has reduced the price of the 8085 microprocessor to $4 in large quantities and to under $5 in 100-unit lots. Intel wants to compete with other suppliers of the same part (NEC, Toshiba, Mitsubishi, and Siemens) and outrun competition from Zilog's Z80 microprocessor.

Random Rumors: IBM is rumored readying two under-$1000 personal-computer systems at its Raleigh, North Carolina, facility. One system attaches to the telephone line and serves as a home-information system (bank-at-home, teleshopping, etc). The other is a very-small-business system aimed at the professional market (lawyers, doctors, etc). Neither system will be as versatile as a stand-alone product because IBM does not want to hurt its regular systems sales. Also, IBM is said to be developing an under-$5000 small-business system aimed at competing with the Apple II, TRS-80, and PET. . . . DEC reportedly has working prototypes of its Tiny-11, which blends into one integrated circuit the current four-device set of the LSI-11/2. Industry pundits say it works with standard memory and I/O (input/output) devices. . . . Zilog is rumored developing a 32-bit microprocessor for introduction by mid or late 1982. . . . Later this year, you can expect a removable 1-megabyte bubble-memory cassette from Intel. Fujitsu introduced 8 K- and 32 K-byte bubble cassettes last year. Plan on National Semiconductor to introduce an 8 K-byte bubble cassette and cassette unit with controller in the $2000 to $3000 range. . . . **Rumors from all over:** Expect an under-$2000 small-business computer from Sony to include a Z80, 64 K bytes of programmable memory, video display, 1.2 megabytes of floppy-disk storage, and a printer port. . . . Vector Graphic,

R&D COMPUTER SYSTEMS

Data Acquisition & Control Systems

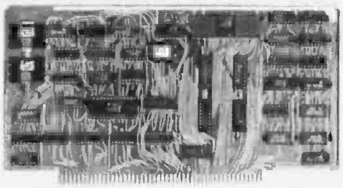
16 to 256 ch.; Programmable gain; Voltage or current output;
12, 14, or 16 bit; 30 to 125 KHz; Stepping motor control

8086 16 Bit Micro Systems

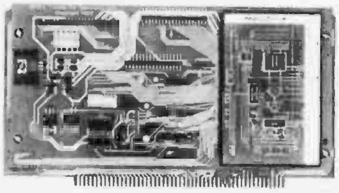
31 MByte Winchester Drives
256 KByte Memory Boards
8086 Software

Real Time Video Digitization Systems

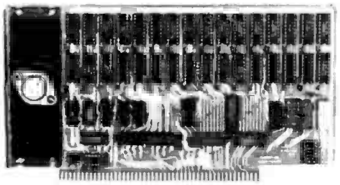
S-100 Boards



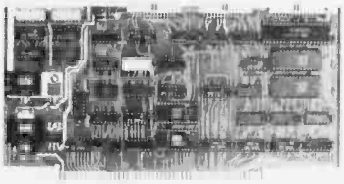
8086 CPU with Vectored Interrupts



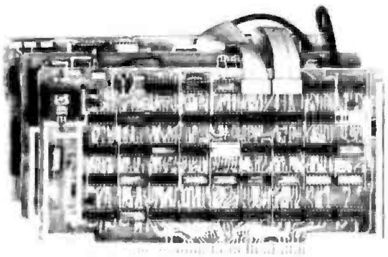
Analog to Digital Converter and Timer/Counter
16 channels expandable to 256
12, 14, or 16 bit accuracy
30,40,100,or 125 KHz
Programmable Gain



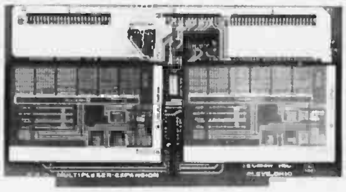
16 Kilobyte Static RAM
8 and 16 bit transfer



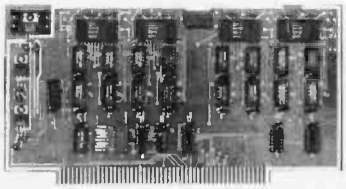
PROM and I/O
2 RS 232 - PIO
CP/M-86 ROM Boot



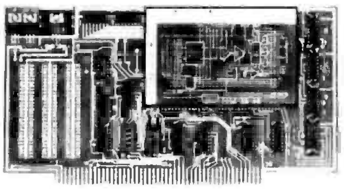
Real Time Video Digitizer and Display



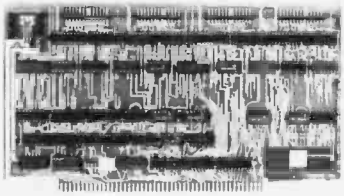
Expansion Multiplexer



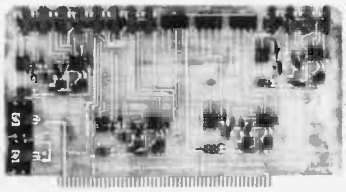
Digital to Analog Converter
4 channels - 12 bit accuracy
3 microsecond conversion rate



Analog to Digital Converter
16 channels - 12 bit accuracy
30 KHz Conversion rate

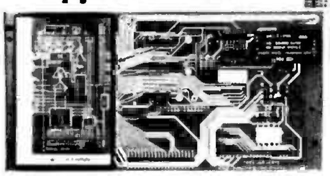


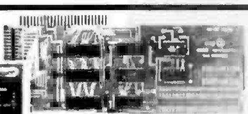
4 PIO and Timer/Counter



Digital to Analog Companion
4-20 mA output - Filters

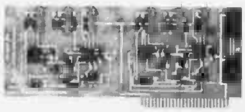
Apple Boards

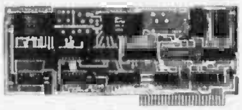




Analog to Digital Converter
16 channels
12, 14, or 16 bit accuracy
30, 40, 100, or 125 KHz

Digital to Analog Companion
4-20 mA output - Filters





Digital to Analog Converter
2 channels - 12 bit accuracy
3 microsecond conversion rate
1 parallel output port

TECMAR INC.

23600 Mercantile Rd. • Cleveland, OH 44122

TECMAR, INC.
(216) 464-7410

Circle 379 on inquiry card.

boasting sales in the $30 million range, will go public with a stock offering this summer. It is also developing a Z8000-based system. . . . Cromemco is working on an IBM-compatible tape-drive unit to serve as a backup for hard disks. It's also working on a 68000-based S-100 microprocessor card. . . . Godbout Electronics, which recently introduced a 128 K-byte S-100 programmable memory card, is now ready to unveil a 256 K-byte version. . . . Sperry Univac may be the first customer for Intel's new 32-bit microprocessor. . . .

Apology: I must apologize to MicroDaSys, Los Angeles, California. In the March 1981 "BYTELINES" (see page 242), I gave credit to another company for having the first 16-bit system using the new Motorola 68000 microprocessor. MicroDaSys was actually first, advertising its 68000 system in the September 1980 BYTE.

The MicroDaSys "68 K MiniFrame" contains a 68000, 6809 memory manager (for true virtual-memory operation), 512 K bytes or 2 megabytes of programmable memory, disk controller, memory parity, and ten I/O ports. The system operates at 8 MHz and, the company claims, is faster than the DEC PDP-11/45.

Personal Computer With 768 K Bytes Of Memory: Southwest Technical Products (SwTPC) will release a new 6809-based personal computer that can address up to 768 K bytes of memory. Also slated to be introduced are hard-disk systems of 32 and 300 megabytes that are chainable—the maximum number has not been determined. Lastly, SwTPC will market a 32-terminal I/O (input/output) board for the system. The system will run the TSC (Technical Systems Consultants) Uniflex operating system supporting 32 users.

SwTPC has come a long way from its first personal computer, which had 4 K bytes of memory, audio-cassette storage, and a 2 K-byte BASIC interpreter.

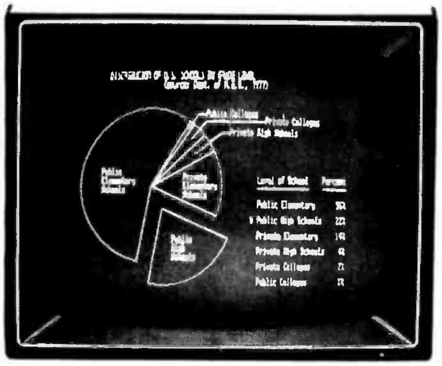
Intel Seeks Injunction: Intel is seeking an injunction against Seeq Inc, Milipitas, California. The suit seeks to temporarily bar Seeq from making devices similar to Intel's 2864, a 64 K-bit EEPROM (electrically erasable, programmable read-only memory) that may be marketed later this year. Seeq was started by four former Intel staffers who had worked in Intel's special-products division while the 2864 was being developed. Seeq intends to develop nonvolatile memory devices.

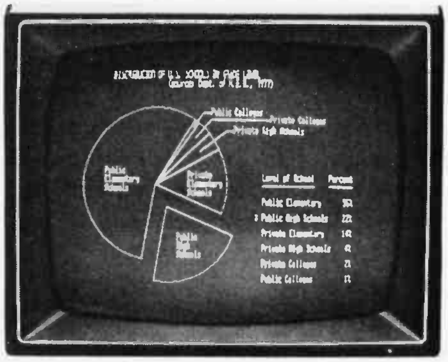
MAIL: I receive a large number of letters each month as a result of this column. If you write to me and wish a response, please include a self-addressed, stamped envelope.

Sol Libes
POB 1192
Mountainside NJ 07081

Teach your little Apple big-time electronic mail.

New York——————————Los Angeles





For the first time, you can move just about anything in your Apple II™ computer to any other Apple,™ anywhere in the world. Micro-Courier™ allows you to electronically mail charts, graphs, correspondence, VisiCalc® reports and entire programs. You spend far less time on the phone. And, in a matter of moments, you transmit material the Post Office takes days to deliver.

Unlike traditional electronic mail, Micro-Courier doesn't require expensive central computers or special phone lines. Using standard lines, you benefit in two important ways. First, you communicate outside your company, not just within it. And second, you realize tremendous savings on late-night rates. Micro-Courier takes advantage of them automatically, without anyone in attendance.

What's more, Micro-Courier will exchange data with time-sharing systems and larger computers. Even if you don't own an Apple, Micro-Courier is the best reason in years to go out and get one. Call our toll-free number today. And make your little Apple heard 'round the world.

MICROCOM

We make little computers talk big.

Call 800-547-5995, ext. 188, toll-free, for the Micro-Courier-Apple dealer nearest you.

Microcom, Inc., 89 State Street, Boston, MA 02109. (617) 367-6362

Circle 224 on inquiry card.

Building Data Structures in the Smalltalk-80 System

James C Althoff Jr
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

Most programmers are exposed to the concept of data structures very early in their programming experience. A course in data structures is an integral part of most computer science curricula, and there are many excellent and widely used texts on the subject (see references 1, 2, and 4). The data structures covered in these texts generally include the linear list, stack, queue, tree, and graph.

In this article, we will define and implement some of the simplest structures, including the linear list, stack, and queue. Our approach will be to describe each data structure informally, and then to show a Smalltalk-80 class definition that closely matches this informal description. We will see that it is possible, using the class construct, to create programming structures that clearly mirror the entities being implemented. However, in order to demonstrate how to build these data structures from scratch, we will not make use of any of the advanced data structure classes that already exist in the Smalltalk-80 system.

We will make extensive use of the Smalltalk-80 subclass mechanism in the class definitions we introduce. We will use subclassing to facilitate the construction of different implementations of the same entity. In addition, we will see how the subclass mechanism enables us to define two or more related classes in such a way that the common parts of their definition can be shared.

Notation

In order to understand the program examples presented in this article, the reader should have some familiarity with the Smalltalk-80 programming language. For an introduction to the language and a fuller discussion of subclasses, see "The Smalltalk-80 System," on page 36. In addition, a text box on page 240 of this article contains a brief description of some of the messages that we will use in the examples.

The advantage of the sequential list is that it is easy to access and replace an arbitrary item in the list.

For each data structure that we describe, we will give a corresponding Smalltalk-80 class definition. Each class definition will be presented in the form of a template that shows the instance variables, messages, and other information associated with the class. (A complete description of the template can be found in the article mentioned above.)

The messages defined in the template are partitioned into two main groups. The first comprises the class messages. These are messages that are sent to the class itself (which is, in actuality, an object). For our purposes, these will be a set of creation messages that can be sent to the class in order to create a new, initialized instance of the class. The second group consists of a set of messages that can be sent to instances of the class. These will be divided into two more groups. The first is a collection of external messages that represent the interface between an instance of the class and clients (ie: other objects in the system) of that instance. The second is a set of internal messages used in methods that are defined in the class or a subclass but are not intended for wider use. Note that the distinction between internal and external messages is made for conceptual clarity. The Smalltalk-80 programming language does not have a mechanism for controlling message usage.

An example of a class definition is given in table 1. This template defines a class whose name is Card. An instance of class Card can be used to represent a card in a game program. Class Card has instance variables named suit, rank, and faceUp. A new instance is created by sending class Card the creation message suit:rank:. For example:

```
|aCard|
aCard ← Card suit: 'heart' rank: 7.
```

creates a new instance of Card that represents the seven of hearts. In the method for suit:rank:, the message new creates an uninitialized instance. The internal message setSuit:setRank: sets the suit and rank fields and initializes the new instance to be "face down." Given an instance of class Card, we can determine its suit, rank, and orientation, and change the latter using the external messages specified in the class definition. Because we do not want to be able to change the suit and rank of an instance once it has been created, we do not include a message for doing this operation in the set of external messages.

The methods shown here demonstrate a convention we will use in subsequent examples. All of the names that we use for parameters and local variables will be formed by taking the name of a class and preceding it with an indefinite article. For example, the two parameters to the message setSuit:setRank: are named aString and anInteger. Such a name indicates what kind of object is expected as the value of the parameter or local variable to which the name refers. Smalltalk-80 has no type-checking; this is only a convention to help make the examples more understandable.

We will now examine a number of elementary data structures and their implementation with Smalltalk-80 classes. In the informal description of each data structure, we will include a list of operations that are meaningful for that structure. We will then show a corresponding class definition whose external messages match the listed operations. The details of the implementation of the data structure will be hidden in the class definition. We will see how this process enables us to define different classes that reflect different implementations of the same basic data structure.

The Linear List

The first data structure we will examine is the *linear list*. A linear list is a sequence of data items that have, essentially, a one-dimensional relationship to one another (see figure 1). That is to say, given an object in the sequence, we can find the object that precedes or follows it. For example, if we have a program that deals with a game of cards, we might represent

class name	Card
superclass	Object
instance variable names	suit rank faceUp
class messages and methods	

```
suit: aString rank: anInteger | aCard |
    aCard ← self new. aCard setSuit: aString setRank: anInteger.
    ↑ aCard.
```

instance messages and methods

```
external
suit | | ↑ suit.
rank | | ↑ rank.
turnFaceUp | | faceUp ← true.
turnFaceDown | | faceUp ← false.
turnOver | | faceUp ← faceUp not.
isFaceUp | | ↑ faceUp.
isFaceDown | | ↑ faceUp not.

internal
setSuit: aString setRank: anInteger | |
    suit ← aString. rank ← anInteger. self turnFaceDown.
```

Table 1: *Class template for class* Card.

SUPERBRAIN® * & COMPUSTAR™ * USERS' GROUP

JOIN SUPER ★ STAR INTERNATIONAL FOR THE REGULAR YEARLY MEMBERSHIP FEE AND RECEIVE A FREE DISKETTE WITH THE FOLLOWING PROGRAMS:

- ★ "RECOVER", it allows you to recover an erased program.
- ★ "AUTO LOAD", it enables you to load and run a program automatically.
- ★ "RETURN", it gets you back into a crashed program from CP/M[1].
- ★ the game "OTHELLO".

Since our first ad in March 1981, we have been contacted from as far away as South America, Europe, Australia, and Indonesia. Super ★ Star International is becoming a world-wide family whose members will enjoy the benefits of a wide range of hardware and software developments.

Our full color, monthly magazine will print a free program in every issue—programs like an appointment calendar and personal finance record keeping. You'll also find technical information, tips for beginners, special business uses, equipment reviews, and the Intertec Story—the people, ideas, and machines behind your computer.

WE GIVE YOU VALUE! Purchase just one commercial program and you will save more than the price of our membership fee. Rent a car or stay in a hotel offered in our discount program and save even more, not to mention insurance discounts, a market place for your personal software, and a shoulder to lean on if something isn't working quite right.

Super ★ Star International—with savings, service, and efficiency—we're here to win your heart.

WE NOW OFFER A WIDE RANGE OF PRODUCTS

A few may still be under development at the date of this issue.

SOFTWARE

- ★ DIAGNOSTICS—for the CPU, Memory, Disk Drives and more
- ★ WORD PROCESSING—WordStar[2], MailMerge[2], WordMaster[2], Magic Wand[3]
- ★ LANGUAGES—COBOL, FORTRAN, Pascal, FORTH, BASCOM Compiler[4]
- ★ UTILITIES—Assemblers, Disassemblers, Monitor
- ★ GAMES—Chess, Adventure, Star Trek, Analiza[5], and more
- ★ BUSINESS—Real Estate Acquisition Package; Systems Plus[6], Peachtree[7], and other Accounting Packages; Plus the most powerful, easy to use business package, which automatically updates all information at the point of entry; SuperSort[5], DataStar[2], dBASE II[8], FMS-80[6]

HARDWARE

- ★ S-100 Adaptor
- ★ External Controls
- ★ Add-on Disk Storage

ENHANCEMENTS

- ★ Upgrades for ALL SuperBrains
- ★ SuperDOS (Fantastic!)
- ★ Add-on character sets-including graphics
- ★ MTT Upgrade for the Intertube

SUPER ★ STAR™

INTERNATIONAL CORPORATION

P. O. Box 33675, Northglenn, CO 80233 ★ (303) 526-1050

Dealers are invited to contact us concerning a special dealer program.

VISA master charge

Charge membership by phone

* REGISTERED TRADEMARKS OF INTERTEC DATA SYSTEMS 1 REGISTERED TRADEMARKS OF DIGITAL RESEARCH 2 REGISTERED TRADEMARKS OF MICROPRO INTERNATIONAL 3 REGISTERED TRADEMARKS OF SMALL BUSINESS APPLICATIONS 4 REGISTERED TRADEMARKS OF MICROSOFT 5 REGISTERED TRADEMARKS OF SUPERSOFT 6 REGISTERED TRADEMARKS OF SYSTEMS PLUS 7 REGISTERED TRADEMARKS OF PEACHTREE SOFTWARE 8 REGISTERED TRADEMARKS OF ASHTON TATE INC

Yearly membership fee is $50.00 U.S., $58 Canada, $74 Europe & So. America, $81 Australia, Mid East & Asia.
Your fee may be tax deductible.
Send checks with your name and address, made out to: Super ★ Star International. (U.S. Currency)

I would like to join Super ★ Star International. Enclosed in my check for $________

Name ________ Company ________

Address ________ Phone ________

City/State/Zip ________

Computer Model ________ Version ________

Circle 365 on inquiry card.

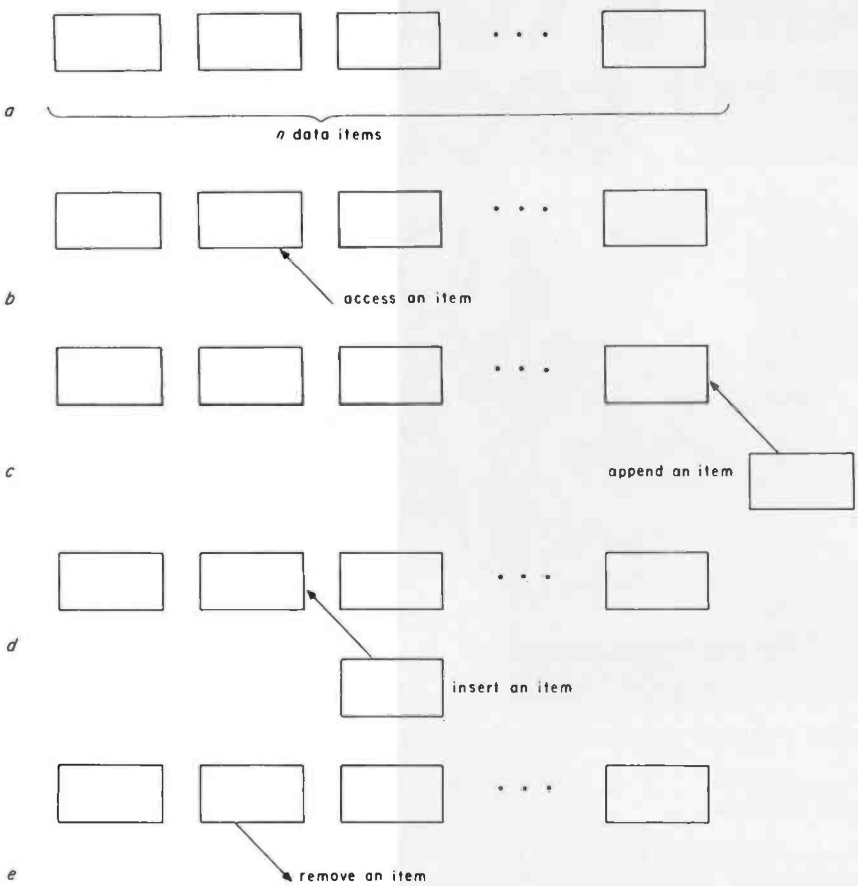


Figure 1: *A linear list (1a) is a collection of objects arranged in linear sequence. Permissible operations include accessing (1b), appending (1c), inserting (1d), and removing an item (1e).*

each card hand as a linear list of cards.

The operations that we might want to perform on a linear list include:

- determine how many items are in the list
- determine whether or not the list is empty
- access the *i*th item in the list
- append an item to the end of the list
- insert an item at some position in the list
- replace an item at some position in the list with some other item
- remove an item from the list

In order to implement a linear list of data items, we need to implement both the data items and the linear list. In all of our subsequent examples, we will assume that we have implemented the data items with one or more class definitions (eg: class Card). When we are describing things in general, we will use such terms as "data item" and "linear list." When we are describing a specific implementation, we will refer instead to the "object" (or "instance of a class") that represents the entity under consideration.

Linear lists are partly defined in the template given in table 2. Class LinearList, as defined in table 2, is incomplete since there is no mechanism for actually storing objects that represent data items. This is because there are several different strategies for storing these objects in a linear list. For each strategy, we will define a different class, each of which is a subclass of LinearList. All of these classes have some characteristics in common; these are captured in the superclass LinearList. For example, because all of the subclasses that we

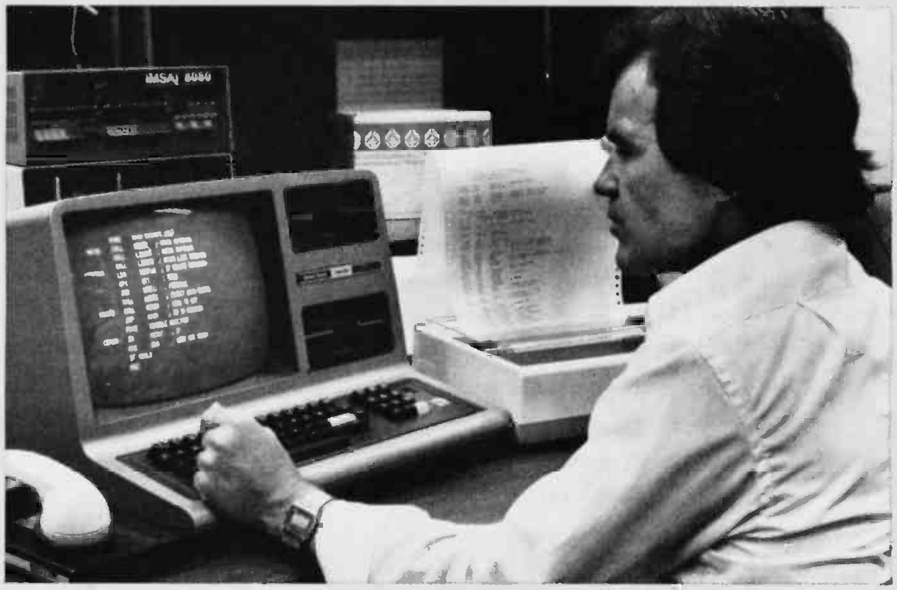
CompuServe is a lot more than fun and games and news.

Although we're probably best known for our consumer-oriented services, CompuServe maintains powerful services for the serious computer user. CompuServe has helped some of the nation's largest companies and financial institutions through a wide range of business and scientific-oriented computer programs. With our Information Service, we can extend this expertise to you. Here are some of the programs available to the personal computer user through the CompuServe Information Service:

PASCAL: DEC User Group version of this famous language.
XF4: Extended CompuServe Fortran compiler.
MACRO: Advanced Macro Assembly language for PDP-10. *Talk about fast.*
FILGE: Fast, easy file generator and editor. Line oriented, no line numbers required!
XBASIC: CompuServe extended BASIC.
JUMBLE: File encryption program.
TECO: High level text editor.
LINK: Linking loader program.
DDT: Dynamic debugging tool.
CREF: Symbolic cross-reference generator used with language compilers.
FILCOM: File comparison program.
SALARY: Calculates salary and increases in various time frames including per year, month, period and hour. This program is intended primarily for managers doing reviews.
SNOBOL: String manipulation language.
RUNFLO: Text formatting program (write resumes etc.).
RUNF10: Word processing and text formatting program (write resumes etc.).
CONCOR: Concordance generator. This program is very useful for documentation purposes. CONCOR reads an ASCII file and creates an output file which contains a line numbered listing of the original file, and a list of all the words contained in the file along with the numbers of the lines on which each word occurs (similar to an index).
BLIS10: High level implementation language for DEC PDP-10.
BINED: Binary file editor.
APL: A Programming Language.
FINTOL: Financial analysis tool. Contains several program modules which can perform financial analysis for business or personal needs.
—Loan Payment and Amortization
—Compound Interest Calculations
—Sum from a Periodic Investment
—Sinking Fund Deposit
—Present Value of Cash Flows
—Present Value and Internal Rate of Return (Capital Projects)
—Depreciation Analysis
—Compound Growth Rates
RANNO: Random number generator.
XEDIT: XF4 binary file editor.

We also offer high speed professional line printer service, error-free file transfer, CompuServe's Software Exchange, and computer manufacturers' newsletters. Computer Users Groups can exchange information and up-to-the-minute gossip in the computer world.

And . . . if Aunt Matilda comes over, you can still let her play Adventure. Demonstrations and software at all Radio Shack® Computer Centers and many Radio Shack® outlets.



CompuServe

Information Service Division
5000 Arlington Centre Boulevard
Columbus, Ohio 43220
(614) 457-8600

Radio Shack is a trademark of Tandy Corporation.

class name	LinearList
superclass	Object
instance variable names	count
class messages and methods	
"none defined here"	
instance messages and methods	

```
external
count | | ↑ count.
empty | | ↑ count = 0.
"at: anInteger | | ... to be defined in subclasses"
"append: anObject | | ... to be defined in subclasses"
"insert: anObject at: anInteger | | ... to be defined in subclasses"
"replace: anObject at: anInteger | | ... to be defined in subclasses"
"removeAt: anInteger | | ... to be defined in subclasses"

internal
initialize | | count ← 0.
checkIndex: anInteger | |
    (anInteger < 1) | (anInteger > count)
    ifTrue: [ ↑ self error: 'index out of range' ].
```

Table 2: *Class template for class* LinearList.

will define keep count of the number of objects (representing data items) in the list, a corresponding instance variable, count, is defined in the superclass LinearList. Similarly, all subclasses can make use of an internal message, initialize, that initializes count to zero, and another message, checkIndex:, that insures that any index specified as a parameter to one of the access messages (at:, insert:at:, and so on) is within range. Since we start the numbering of items in a linear list at 1, the range will always be between 1 and count (the number of items in the list). Also, the message empty is implemented in the superclass since the answer to whether or not the list is empty can be determined from the value of count.

The Indexed Table

The first strategy we will explore for actually storing data items in a linear list involves the sequential allocation of storage. In order to see how this works, we will interrupt our discussion of the linear list and introduce a very basic data structure that we will call an *indexed table* (see figure 2). An indexed table, which corresponds to what is called a one-dimensional array in many programming languages, is a relatively simple structure that closely matches the physical memory of most computers. As we will see, many useful data structures, including the linear list, can be implemented with an indexed table.

An indexed table comprises a sequence of variables into which we can store and from which we can retrieve data items. Each variable is designated by an integer. The smallest integer used to designate a variable in an indexed table is called the *lower bound* of the table. The largest integer is called the *upper bound*. The operations that we wish to perform on an indexed table are:

- specify the lower and upper bounds of the table (when it is created)
- determine the lower and upper bounds of the table
- determine the number of variables allocated to the table

MEMOREX

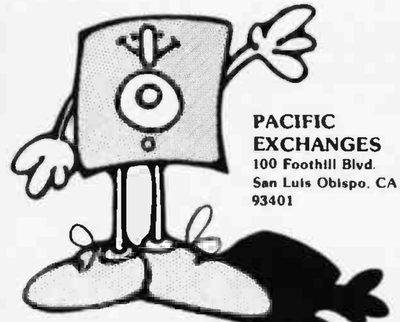
SUPERB QUALITY AT UNBEATABLE PRICES. THAT'S MEMOREX DISCS FROM PACIFIC EXCHANGES

For Data Reliability—
Memorex
Flexible
Discs

CALL FREE FOR PRICES & INFORMATION

(800)235-4137

In California, (800)592-5935 or (805)543-1037



PACIFIC EXCHANGES
100 Foothill Blvd.
San Luis Obispo, CA
93401

DEALER INQUIRIES INVITED VISA MasterCard C.O.D.'s ACCEPTED

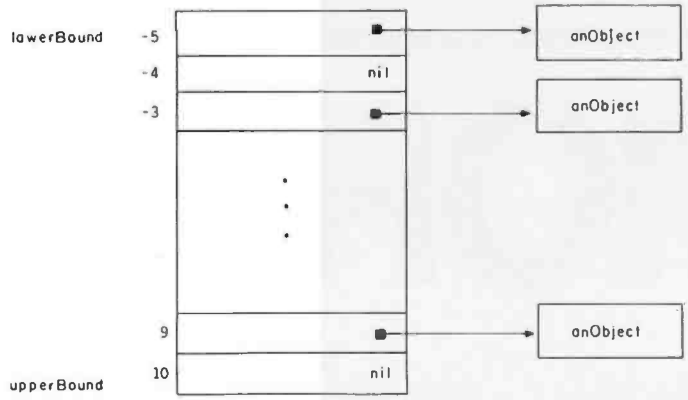


Figure 2: *An indexed table.*

- access an item at a particular position in the table
- put an item at a particular position in the table

In order to store into an indexed table, we specify an item to be stored and an integer that indicates the particular variable that will contain the item. In order to retrieve from an indexed table, we need only specify which variable of the table has the data item of interest.

The class definition in table 3 shows how to implement an indexed table. We have seen in the definition of classes Card and LinearList how to specify a fixed number of named instance variables in a class definition. What we need in order to implement an indexed table, however, is a sequence of unnamed variables that are designated by an integer index. How can we define such a sequence of variables? We do this by specifying the number of indexed variables needed for an instance at the time that an instance of a class is created. The creation message from:to: in class IndexedTable sends the message new:, whose parameter is the number of indexed variables required for the instance being created. In order to access these variables, we send low-level (ie: primitive) access messages with a parameter that specifies an appropriate index (starting at 1). The access message basicAt: i retrieves the object stored in the *i*th indexed instance variable. The access message basicAt: i put: anObject stores a pointer to anObject in the *i*th indexed instance variable.

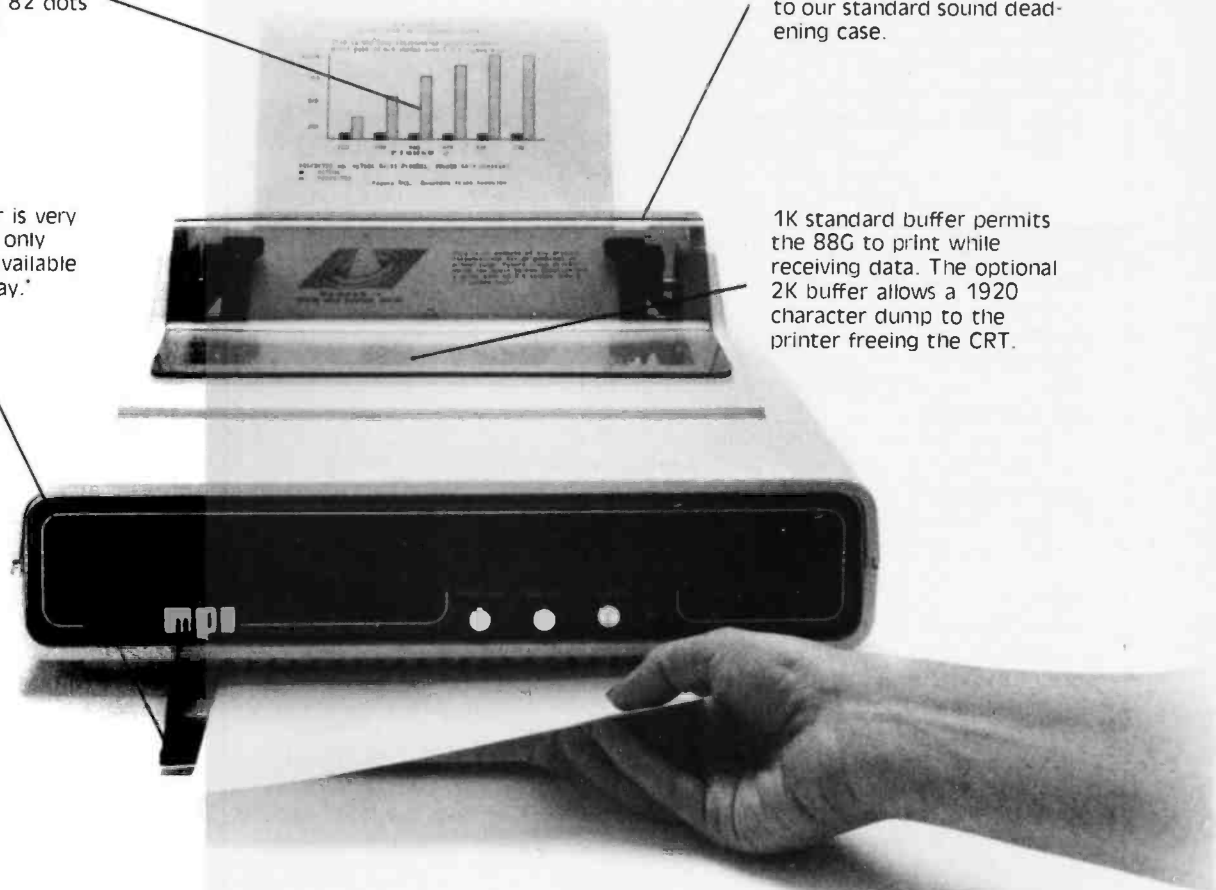
In addition to indexed instance variables, class IndexedTable has two named instance variables: lowerBound and upperBound. lowerBound is an integer that indicates the smallest allowable index for a particular instance of IndexedTable; upperBound indicates the largest allowable index. In order to create a new indexed table, we send the message

High resolution, dot addressable graphics with vertical resolution of 72 dots per inch and up to 82 dots per inch horizontal resolution.

"Q.T." cover reduces noise to an office comfort level. This is an optional feature to our standard sound deadening case.

Single sheet feeder is very simple to use. The only front load feeder available on the market today.*

1K standard buffer permits the 88G to print while receiving data. The optional 2K buffer allows a 1920 character dump to the printer freeing the CRT.



The Features Leader

Integrated Paper Handling System
Dual tractor/friction feed allows use of pin feed, roll or single sheet paper.

Versatile Interface
Data input from most computers can be supported by the 88G. RS232C serial and Centronics® type parallel is standard. Options can be added for current loop, IEEE 488 and high speed serial inputs.

Letter Quality Capability
The 88G provides a selectable 11 x 7 serif style dot matrix for correspondence printing.

Cost Effective
The 88G has more features than any other impact printer in its price class. First compare the quality of the 88G, then compare the price —the 88G wins! Single unit price is less than $800.

*Optional

mpi Micro Peripherals, Inc. 4426 South Century Drive Salt Lake City, Utah 84107 (801) 263-3081

The Printer People

California VITEK (714) 744-8305 **Colorado** PLS Associates (303) 773-1218 **Minnesota** Bohlig & Associates (612) 922-7011 **New Jersey** Hansen & Hughes (201) 652-7055 **Up-state New Jersey** QED Electronics (215) 674-9600 **Oregon** Microware (503) 620-8150 **Washington** Microware (206) 451-8586 **Utah** PLS Associates (801) 466-8729 Type-A-Line (801) 521-5310 **District of Columbia** Wright Marketing (301) 840-1928 **International-England** Russet Instruments, Ltd. (0734) 868147 Telex: 849721 **Phoenix** Sigma International (602) 994-3435 Telex: 165-745 Sigma **France** IER Tel. 333.67.81 Telex: 620-289 **Canada** Spectra Electronics (403) 264-7270.

Circle 258 on inquiry card.

class name	IndexedTable
superclass	Object
instance variable names	lowerBound upperBound
class messages and methods	

```
from: anInteger1 to: anInteger2 | |
    (anInteger1 > anInteger2) ifTrue: [ ↑ self error: 'invalid bounds' ].
    ↑ (self new: anInteger2 – anInteger1 + 1)
    lowerBound: anInteger1 upperBound: anInteger 2.
```

instance messages and methods

```
external
lowerBound | | ↑ lowerBound.
upperBound | | ↑ upperBound.
size | | ↑ upperBound – lowerBound + 1.
at: anInteger | |
    self checkIndex: anInteger.
    ↑ self basicAt: (anInteger – lowerBound + 1).
put: anObject at: anInteger | |
    self checkIndex: anInteger.
    self basicAt: (anInteger – lowerBound + 1) put: anObject.

internal
lowerBound: anInteger1 upperBound: anInteger2 | |
    lowerBound ← anInteger1. upperBound ← anInteger2.
checkIndex: anInteger | |
    (anInteger < lowerBound) | (anInteger > upperBound)
    ifTrue: [ ↑ self error: 'index out of range' ].
"basicAt: i | | ... this is a primitive Smalltalk-80 message that accesses the ith indexed
   instance variable."
"basicAt: i put: anObject | | ... this is a primitive Smalltalk-80 message that stores a pointer
   to anObject in the ith indexed instance variable."
```

Table 3: *Class template for class* IndexedTable.

Some Smalltalk Messages

The following messages are used in this article without having been previously defined. Each is either provided by the Smalltalk-80 system, or easily implemented using other messages provided by the system. For each message, we provide a brief, informal description of its intended effect.

new—*Creates a new instance.*
new: i—*Creates a new instance with* i *indexed instance variables.*
error: aString—*Causes some appropriate action to occur, such as interrupting program execution and displaying* aString.
not—*The "logical not" operation.*
| —*The "logical or" operation.*
+, –, *, /, =, <, >, <=—*Arithmetic operations and relations.*

Flow of control is affected by sending messages that correspond to basic control structures. For example:

a ifTrue: [b] *corresponds to:* if a then b end
a ifTrue: [b] ifFalse: [c] *corresponds to:* if a then b else c end
x to: y do: [: i | a] *corresponds to:* for i from x to y by 1 repeat a end
x downTo: y do: [: i | a] *corresponds to:* for i from x to y by –1 repeat a end
x timesRepeat: [a] *corresponds to:* repeat x times a end

from:to: to class IndexedTable. For example:

```
| table |
table ← IndexedTable from: –5 to:
   10.
```

creates a new instance of IndexedTable whose indices range from –5 to 10. This message is implemented using an internal message, lowerBound:upperBound:, that sets the instance variables of a newly created instance to their appropriate values.

Once we have created an instance of IndexedTable, we can perform the operations specified in the above description of indexed tables by sending the messages lowerBound, upperBound, size, at:, and put:at:. lowerBound and upperBound return the corresponding values of the instance variables; size computes and returns the number of indexed instance variables in the table. at: and put:at: both use an internal message, checkIndex:, in order to make sure that their index parameter is within range of the lower and upper bounds of the table. at: returns the object stored in the indexed instance variable indicated by the integer parameter; put:at: stores the object, specified as the first parameter, in the indexed instance variable indicated by the second parameter. Notice that both at: and put:at: use the value of lowerBound to map indices from the range of the table to the range of the indexed instance variables that are used to implement the table.

As an example of how we might use class IndexedTable, consider the following sequence of messages:

```
| table |
table ← IndexedTable from: 1 to:
   13.
1 to: 13 do: [: i | table put: (Card
   suit: 'heart' rank: i) at: i. ].
```

This creates a new instance of class IndexedTable with indices that range from 1 to 13 and fills it with instances of class Card whose ranks match the indices.

The Sequential List

Now that we have an implementa-

When you can't afford to buy wrong...

*"Sorry, Hawkins, we simply can't keep you **and** replace that non-expandable computer you bought...."*

...you need Novell's NEXUS,™ the starter-priced computer system designed to grow with you.

BUYING A COMPUTER is a big decision. How much can you afford to spend? Will the system you're considering do the job? And what happens when your needs outgrow that first computer? Can it expand to handle increasingly larger workloads, or will you have to spend a fortune replacing it? Expandable computer systems are strictly big-league. They've *been* very expensive, and unless you've had *at least* $40,000 to spend they've been out of reach.

But, now, there's Novell's new NEXUS Series—an incredibly versatile, surprisingly inexpensive computer that expands into a multiple terminal-computer network system just by adding components as your growth requires. You can begin using your NEXUS computer the day it arrives, because it works with the widest assortment of proven software available in the industry today. Exclusive RAM-GUARD™ protection detects and corrects memory errors automatically as they occur—a feature no other comparably priced computer offers. NEXUS is the one starter-priced computer system you'll never have to replace!

If you're in the market for *any* computer, you can afford the NEXUS I. Since you *can't* afford to buy wrong, you can't afford to miss seeing, trying and learning all about NEXUS.

Call us toll-free and we'll set up a hands-on demonstration. We'll prove how NEXUS will take you all the way to the top. 800-453-1188

NOVELL
DATA SYSTEMS, INC.

1170 No. Industrial Park Drive, Orem, Utah 84057
Telephone: (801) 226-8202

Circle 270 on inquiry card.

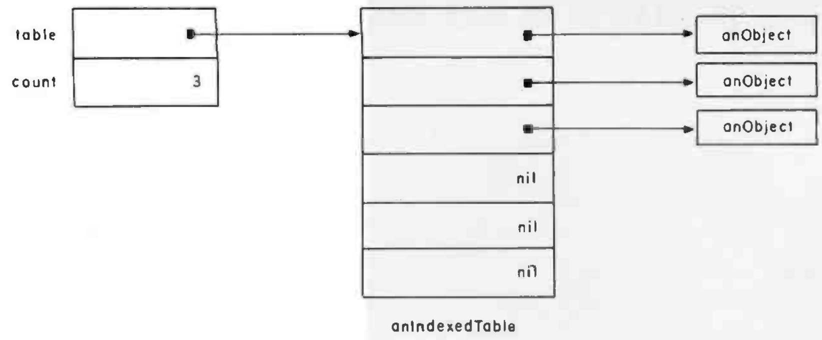


Figure 3: *A sequential list.*

tion for indexed tables, we can use them to demonstrate our first implementation of linear lists. We will call a linear list that uses an indexed table to store its data items a *sequential list* (see figure 3). The basic idea is to manage an indexed table so that the first *i* consecutive entries in the table are the *i* data items in our linear list. The most difficult operations using this strategy are the insertion and removal of items, since these cause parts of the indexed table to be copied from one area to another. An additional difficulty is that we must specify, at the time we create the linear list, the expected maximum number of items in the list. This is necessary because indexed tables come in fixed sizes, which means that if the list grows larger than this initial number, we must do something to accommodate the extra items. (Details are shown in the class definition given in table 4.)

The creation message size: is used to create an instance of SequentialList of some estimated maximum size. For example:

```
| list |
list ← SequentialList size: 5.
```

creates a list with enough space, initially, for five objects. The internal message initialize:, which is sent from size:, creates an instance of IndexedTable of the appropriate size and assigns it as the value of the instance variable named table. The other internal message, expand, is used to enlarge table when it becomes full. This is done by creating a new instance of IndexedTable that is twice as large as the original and by copying the objects from the original table into the first half of the new table. The new table is then assigned as the value of table for subsequent use.

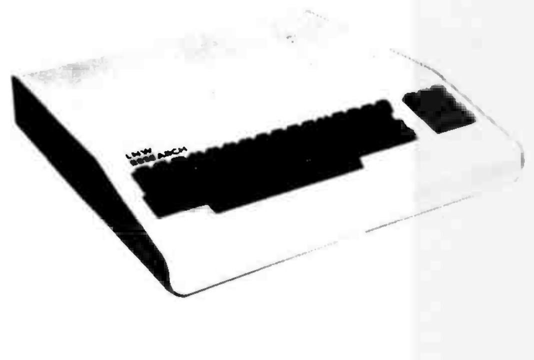
Retrieval from SequentialList is done by retrieving from its associated indexed table. A new object can be appended to the list by storing it in the next available location of the indexed table of that list. This location is determined by the value of count. If there is still room in the table, count is incremented and the object is stored. Otherwise, the sequential list has to be expanded, which is accomplished using the message expand, described previously. Insertion into the list is done by copying from their current location to the next, all objects after, and including, the one at the desired location. A new object can then be stored at that location. Removing an object from a list is done analogously. An object is replaced by storing another object in the corresponding position in the indexed table.

The advantage of the sequential list is that it is easy to access and replace (not remove) an arbitrary item. The disadvantages are that it is necessary both to estimate the maximum size of the list when it is created (although, as we have seen, the list can expand when necessary) and to move items around when inserting or removing them from the list.

Let us now consider an example that shows how to create and send messages to an instance of class SequentialList. Suppose we want to represent a deck of cards and two hands, dealt from the deck. To create

★★★

4MHZ, DOUBLE DENSITY, COLOR & B/W GRAPHICS . . THE LNW80 COMPUTER



COMPARE THE FEATURES AND PERFORMANCE

FEATURES	LNW80	PMC-80**	TRS-80* MODEL III
PROCESSOR	4.0 MHZ	1.8 MHZ	2.0 MHZ
LEVEL II BASIC INTERP.	YES	YES	LEVEL III BASIC
TRS80 MODEL 1 LEVEL II COMPATIBLE	YES	YES	NO
48K BYTES RAM	YES	YES	YES
CASSETTE BAUD RATE	500/1000	500	500/1500
FLOPPY DISK CONTROLLER	SINGLE/ DOUBLE	SINGLE	SINGLE/ DOUBLE
SERIAL RS232 PORT	YES	YES	YES
PRINTER PORT	YES	YES	YES
REAL TIME CLOCK	YES	YES	YES
24 X 80 CHARACTERS	YES	NO	NO
VIDEO MONITOR	YES	YES	YES
UPPER AND LOWER CASE	YES	OPTIONAL	YES
REVERSE VIDEO	YES	NO	NO
KEYBOARD	63 KEY	53 KEY	53 KEY
NUMERIC KEY PAD	YES	NO	YES
B/W GRAPHICS, 128 X 48	YES	YES	YES
HI-RESOLUTION B/W GRAPHICS, 480 X 192	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (NTSC), 128 X 192 IN 8 COLORS	YES	NO	NO
HI-RESOLUTION COLOR GRAPHICS (RGB), 384 X 192 IN 8 COLORS	OPTIONAL	NO	NO
WARRANTY	6 MONTHS	90 DAYS	90 DAYS
TOTAL SYSTEM PRICE	$1,915.00	$1,840.00	$2,187.00
LESS MONITOR AND DISK DRIVE	$1,450.00	$1,375.00	---

When you've compared the features of an LNW80 Computer, you'll quickly understand why the LNW80 is the ultimate TRS80 software compatible system. LNW RESEARCH offers the most complete microcomputer system at an outstanding low price.
We back up our product with an unconventional 6 month warranty and a 10 days full refund policy, less shipping charges.

LNW80 Computer $1,450.00
LNW80 Computer w/B&W Monitor & one 5" Drive $1,915.00
All orders must be prepaid, CA residents please include 6% sales tax.
Contact us for shipping charges

* TRS80 Product of Tandy Corporation.
** PMC Product of Personal Microcomputer, Inc.

LNW80

- BARE PRINTED CIRCUIT BOARD & MANUAL $89.95

The LNW80 - A high-speed color computer totally compatible with the TRS-80*. The LNW80 gives you the edge in satisfying your computation needs in business, scientific and personal computation. With performance of 4 MHz, Z80A CPU, you'll achieve performance of over twice the processing speed of a TRS-80*. This means you'll get the performance that is comparable to the most expensive microcomputer with the compatibility to the world's most popular computer (TRS-80*) resulting in the widest software base.

FEATURES:
- TRS-80 Model 1 Level II Software Compatible
- High Resolution Graphics
  - RGB Output - 384 x 192 in 8 Colors
  - NTSC Video or RF MOD - 128 x 192 in 8 Colors
  - Black and White - 480 x 192
- 4 MHz CPU
- 500/1000 Baud Cassette
- Upper and Lower Case
- 16K Bytes RAM, 12K Bytes ROM
- Solder Masked and Silkscreened

LNW SYSTEM EXPANSION

- BARE PRINTED CIRCUIT BOARD AND MANUAL $69.95
- WITH GOLD CONNECTORS $84.95

The System Expansion will allow you to expand your LNW80, TRS-80*, or PMC-80** to a complete computer system that is still totally software compatible with the TRS-80* Model 1 Level II.

FEATURES:
- 32K Bytes Memory
- 5" Floppy Controller
- Serial RS232 20ma I/O
- Parallel Printer
- Real Time Clock
- Screen Printer Bus
- On Board Power Supply
- Solder Masked and Silkscreened

LNDoubler & DOS PLUS 3.3D

- Assembled and Tested W/DOS PLUS 3.3D $175.00

Double-density disk storage for the LNW Research's "System Expansion" or the Tandy's "Expansion Interface". The LNDoubler™ is totally software compatible with any double density software generated for the Percom's Doubler***. The LNDoubler™ provides the following outstanding features.

- Store up to 350K bytes on a single 5" disk
- Single and double density data separation
- Precision write precompensation circuit
- Software switch between single and double density
- Easy plug in installation requiring no etch cuts, jumpers or soldering
- 35, 40, 77, 80 track 5" disk operation
- 120 day parts and labor Warranty

*** Doubler is a product of Percom Data Company, Inc.

DOS PLUS 3.3D

Micro Systems software's double density disk operating system. This operating system contains all the outstanding features of a well developed DOS, with ease in useability.

KEYBOARD

LNW80 KEYBOARD KIT $84.95

The Keyboard Kit contains a 63 key plus a 10 key, P.C. board, and remaining components.

CASE

LNW80 CASE $84.95

The streamline design of this metal case will house the LNW80, LWN System Expansion, LNW80 Keyboard, power supply and fan, LNDoubler™, or LNW Data Separator. This kit includes all the hardware to mount all of the above. Add $12.00 for shipping

PARTS AVAILABLE FROM LNW RESEARCH
- 4116 - 200ns RAM
  - 6 chip set $26.00
  - 8 chip set $33.50
  - 16 chip set $64.00
  - 24 chip set $94.00
  - 32 chip set $124.00

- LNW80 "Start up parts set" LNW80-1 . . . . $82.00
- LNW80 "Video parts set" LNW80-2 . . . . $31.00
- LNW80 Transformer LNW80-3 . . . . $18.00
- LNW80 Keyboard cable LNW80-4 . . . . $16.00
- 40 Pin computer to expansion cable $15.00
- System Expansion Transformer $19.00
- Floppy Controller (FD1771) and UART (TR1602) . . . $30.00

LNW RESEARCH
C O R P O R A T I O N

2620 WALNUT ST.
TUSTIN CA. 92680

ORDERS & INFO. NO. 714-544-5744
SERVICE NO. 714-641-8850

Circle 198 on Inquiry card.

VISA MASTER CHARGE ACCEPTED

UNLESS NOTED ADD $3 FOR SHIPPING

two initially empty hands we write:

```
| hand1 hand2 deck |
hand1 ← SequentialList size: 5.
hand2 ← SequentialList size: 5.
```

To create an unshuffled deck of fifty-two cards we write:

```
deck ← SequentialList size: 52.
1 to: 13 do: [: i | deck append:
  (Card suit: 'heart' rank: i). ].
1 to: 13 do: [: i | deck append:
  (Card suit: 'diamond' rank: i). ].
1 to: 13 do: [: i | deck append:
  (Card suit: 'club' rank: i). ].
1 to: 13 do: [: i | deck append:
  (Card suit: 'spade' rank: i). ].
```

Then, to deal five cards from the deck to the first hand we write:

```
5 timesRepeat: [ hand1 append:
  (deck removeAt: 1). ].
```

To deal from the bottom of the deck to the second hand we write:

```
5 timesRepeat: [ hand2 append:
  (deck removeAt: deck
  count). ].
```

The Linked List

A second approach for managing the storage of items in a linear list is to use a *linked list*. The strategy for

class name	SequentialList
superclass	LinearList
instance variable names	table
class messages and methods	

```
size: anInteger | |
   (anInteger > 0) ifTrue:  [ ↑ (self new) initialize: anInteger ]
                   ifFalse: [ ↑ self error: 'invalid size' ].
```

instance messages and methods

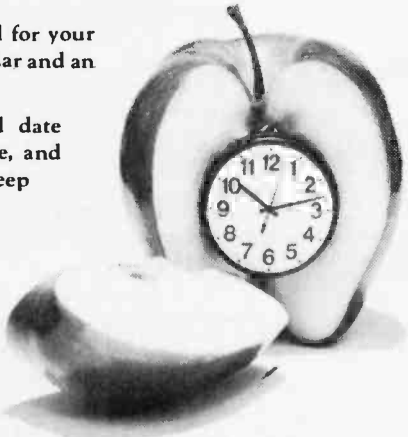
```
external
at: anInteger | | self checkIndex: anInteger. ↑ table at: anInteger.
append: anObject | |
   (count = table size) ifTrue: [ self expand. ].
   table put: anObject at: count + 1.
   count ← count + 1.
insert: anObject at: anInteger | |
   self checkIndex: anInteger.
   (count = table size) ifTrue: [ self expand. ].
   count downTo: anInteger do: [: i | table put: (table at: i) at: i + 1. ].
   table put: anObject at: anInteger.
   count ← count + 1.
replace: anObject at: anInteger | |
   self checkIndex: anInteger.
   table put: anObject at: anInteger.
removeAt: anInteger | anObject |
   anObject ← self at: anInteger.
   anInteger + 1 to: count do: [: i | table put: (table at: i) at: i − 1. ].
   count ← count − 1.
   ↑ anObject.

internal
initialize: anInteger | |
   super initialize.
   table ← IndexedTable from: 1 to: anInteger.
expand | anIndexedTable |
   anIndexedTable ← IndexedTable from: 1 to: 2 * count.
   1 to: count do: [: i | anIndexedTable put: (table at: i) at: i. ].
   table ← anIndexedTable.
```

Table 4: *Class template for class* SequentialList.

Put Time and BSR/X-10 Control in Your APPLE II

THUNDERCLOCK PLUS™

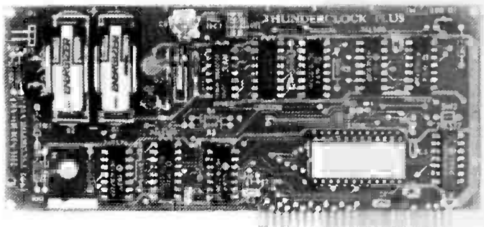


The THUNDERCLOCK PLUS is two peripheral systems on one card for your APPLE II, II PLUS, or III. An accurate, reliable, real-time clock/calendar and an interface for the popular BSR X-10 Home Control System.

The THUNDERCLOCK clock/calendar makes accurate time and date available to your programs: month, date, day-of-week, hour, minute, and second, in any of four software selectable formats. On-board batteries keep your THUNDERCLOCK running when your APPLE II is turned off - for up to four years before battery replacement. On-card 1K firmware makes reading or setting the time easy from APPLESOFT or INTEGER BASIC, PASCAL, or assembly language programs. And it provides software selectable interrupts at any of three rates: 64, 256, or 2048 interrupts/second. All features are software selectable - no switches or jumpers!

THE PLUS

Add THUNDERWARE'S X-10 ULTRASONIC INTERFACE OPTION to your THUNDERCLOCK and your programs can send all 22 BSR X-10 commands so you can remotely control lights and appliances. Plus a powerful disk software package! The THUNDERWARE SCHEDULER software lets you create schedules to control lights, appliances, security systems, or almost any other electrical device. The software includes: SCUTIL - the SCHEDULER utility that lets you make or change a schedule, and SCHED - executes your schedules in real-time using the THUNDERCLOCK. SCHED runs in the 'background' so you can run other programs in the 'foreground'. Our PASCAL software lets you use all the THUNDERCLOCK'S features and sets the filer date whenever you boot. The THUNDERCLOCK PLUS is a SYSTEM for your APPLE II. Supported by intelligent, easy to use firmware, a powerful software package, and good documentation!



Let the THUNDERCLOCK PLUS time/date stamp your DOS files whenever you create or modify them with our DOS-DATER software.

The THUNDERCLOCK PLUS will work in any APPLE, including the APPLE III.

See your APPLE dealer.

Suggested retail prices:

THUNDERCLOCK PLUS $139
Clock/calendar card with batteries and user's manual

X-10 INTERFACE OPTION $49
BSR X-10 Ultrasonic interface, disk with SCHEDULER SOFTWARE & demos, and user's manual

PASCAL SOFTWARE $29
Disk with PASCAL interface for clock and X-10 interface, and user's guide

MANUALS ONLY, each $5

California residents add 6% sales tax

If your dealer doesn't carry the THUNDERCLOCK PLUS:
ORDER TOLL FREE (VISA/MC) CALL:
800-227-6204 Ext 307 (Outside California)
800-632-2131 Ext 307 (California Only)

OR WRITE TO:
THUNDERWARE INCORPORATED
P.O. Box 13322, Oakland, CA 94661

BSR X-10 is a trademark of BSR (USA) LTD.
APPLE II is a trademark of APPLE COMPUTER, INC

using a linked list is the following: instead of allocating sequentially the storage needed to hold data items, we allocate separate storage objects, called *links*, each of which keeps track of a data item and either one or two other links. A set of links are connected together to form a linked list. A *single link* (see figure 4a) is one that keeps track of a data item and one other link, which is its successor. A *double link* (see figure 4b) has a data item and two other links: its successor and its predecessor.

Class SingleLink is defined as shown in table 5. It has instance variables named entry and successor; entry points to an object that represents a data item, successor points either to another instance of class SingleLink, or, if there is no successor, to the object nil. We specify the entry and successor of a single link at the time we create it. For example:

```
| link1 link2 |
link1 ← SingleLink entry: (Card
    suit: 'club' rank: 4) successor:
    nil.
link2 ← SingleLink entry: (Card
    suit: 'diamond' rank: 6)
    successor: link1.
```

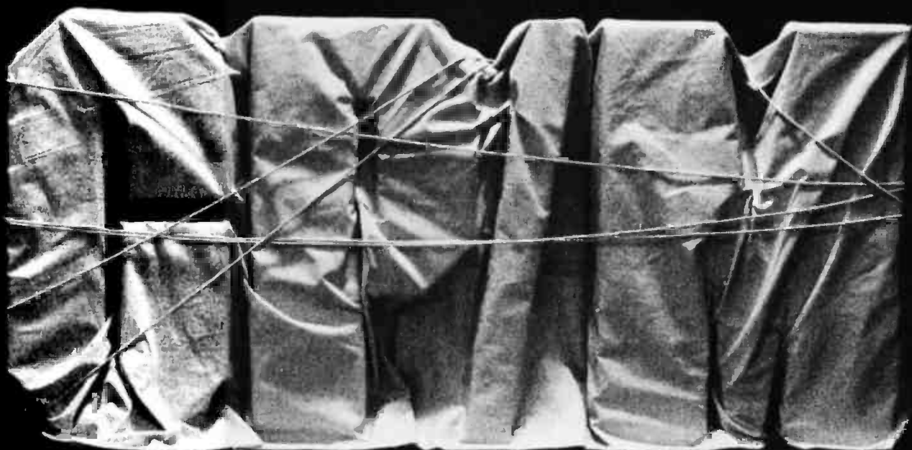
creates two links. The entry of the first link is an instance of class Card that represents the four of clubs. Its successor is nil. The entry of the second link is an instance of class Card that represents the six of diamonds; its successor is the first link.

The class definition for double links is given in table 6. Class DoubleLink inherits from class SingleLink the instance variables and messages that are used to implement the entry and successor of a double link. In addition, there is an instance variable named predecessor that points either to an instance of class DoubleLink or to nil. The messages predecessor: and predecessor set and return, respectively, the value of predecessor.

As stated previously, a linked list is a sequence of links connected in a linear arrangement. We can make different kinds of linked lists depending on the links we use and the precise

Introducing CP/M-86

From Digital Research



The Best Gets Better

CP/M®, the industry standard, continues to expand, because your needs continue to expand.

CP/M-80™

For cost-effective computing on 8-bit Z-80, 8080 and 8085-based microcomputers, CP/M-80 gives you the widest variety of mature, specialized software products anywhere.

CP/M-86™

For jobs that require more address space and increased computing resources, CP/M-86 provides the software power you need. CP/M-86 is enhanced to operate with Intel's new 16-bit 8086 and 8088 microprocessors, with all the qualities that have given CP/M industry-wide support.

And there's more to come: MP/M™, our multi-programming monitor, and CP/NET™, our network operating system, and PL/I, now available for 8-bit machines, will soon be available for the 8086/8088 family.

CP/M. It's available on over 250 types of computers. For a closer look, ask your dealer, your manufacturer, or Digital Research.

U.S.A.
DIGITAL RESEARCH
P.O. Box 579
801 Lighthouse Avenue
Pacific Grove, CA 93950
408-649-3896
TWX 910 360 5001

EUROPE
VECTOR INTERNATIONAL
Research Park
B-3030 Leuven
Belgium
32 (16) 20-24-96
Telex 26202 VECTOR

FAR EAST
MICROSOFTWARE ASSOC.
102 Plasada
3-16-14 Minami Aoyama
Minato-ku
Tokyo 107, Japan
03-403-2120
Telex 2426875 MSA

DIGITAL RESEARCH®

1979 datapro HONOR ROLL

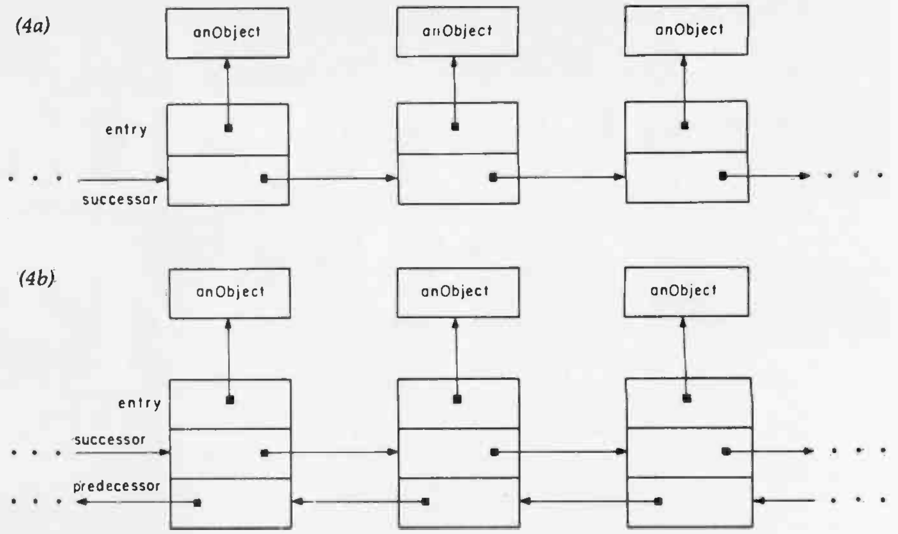


Figure 4: *Two kinds of links. Figure 4a shows a list of storage objects joined by single links, while figure 4b shows a similar list joined by double links.*

class name	SingleLink
superclass	Object
instance variable names	entry successor
class messages and methods	

```
entry: anObject successor: aSingleLink | |
   ↑ ((self new) entry: anObject) successor: aSingleLink.
```

instance messages and methods	

```
external
entry | | ↑ entry.
entry: anObject | | entry ← anObject.
successor | | ↑ successor.
successor: aSingleLink | | successor ← aSingleLink.

internal
"none defined here"
```

Table 5: *Class template for class* SingleLink.

way that they are connected together. Table 7 defines class LinkedList, which acts as the superclass of the various linked lists we will consider. It collects several messages that are suitable for all of the LinkedList subclasses.

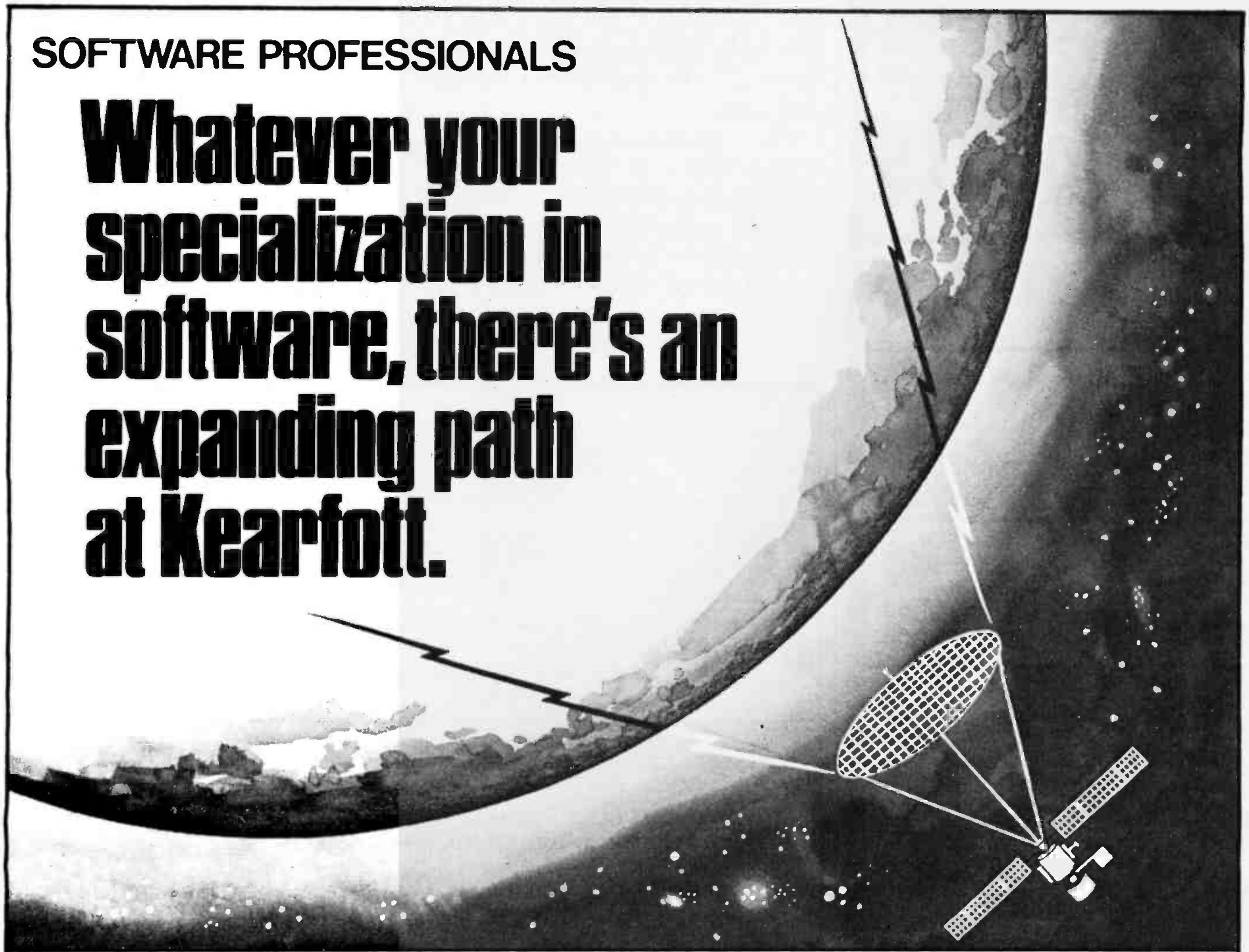
The message linkAt: is used internally by LinkedList methods. Taking an integer as a parameter, it traverses a sequence of connected links looking for the link in the position indicated by that integer. It returns this link as a result. This message is not intended for use outside of the class since we don't want the rest of the system to have access to the internal structure of the list. The messages at: and replace:at: can be defined using linkAt: since, once the appropriate link is found, it is easy to return or replace its corresponding entry.

The Singly Linked List

The first type of linked list we will examine is the *singly linked list*. A singly linked list is a sequence of single links connected together so that the successor of the first link is the second link, the successor of the second

SOFTWARE PROFESSIONALS

Whatever your specialization in software, there's an expanding path at Kearfott.



From high technology to commercial applications, opportunities at Kearfott span the software spectrum. Regardless of the area that intrigues you, you'll be working in one of the most sophisticated DP complexes, using the most advanced IBM Software.

The focus at our Data Center is on breakthrough systems expanding a global network. To this end, we've assembled an elite group of software professionals. Our growth dictates the demand for more. We have a battery of computers that include the 3033, AMDAHL V/6, 43XX series, and more, with complementing front end processors. In support of this hardware, we run a multitude of software including MVS/SE-2 (going MVS/SP), VM/SP, VS1, IMS DB/DC, CICS, TSO/SPF, WYLBUR, ACF/NCP, ACF/VTAM, and more.

In Engineering applications, realtime software designs operate airborne computers in Kearfott avionics systems—from aircraft navigation to missile guidance. You could also be designing for programs comparable in complexity to Kearfott's inertial measurement units on the Space Shuttle and guidance control on Trident submarines. Assignments may include simulation on our 3033.

In business applications, we run the MIS gamut—accounting, finance, inventory, manufacturing, payroll and a whole lot more.

In the Data Center, we support all the hardware, operating systems and language compilers that Kearfott applications professionals need. Prior experience installing System Software qualifies you for our consideration.

Whatever your area of software expertise, you should have an appropriate degree and at least a 3-year record indicating potential to achieve higher professional levels. Send your resume to: **Carol Batte, Singer Company, Kearfott Division, 1150 McBride Avenue, Little Falls, N.J. 07424.**

Kearfott

a division of The **SINGER** Company

An equal opportunity employer, m/f
who creates opportunities.

link is the third link, and so on (see figure 5). The successor of the last link is nil.

The definition for class SinglyLinkedList is given in table 8. Class SinglyLinkedList has an instance variable named firstLink that points either to the first object in the list or to nil if the list is empty. The internal message initialize, which is sent when an instance of SinglyLinkedList is created, sets firstLink to nil. The internal message firstLink, which is never sent to an empty list, returns the SingleLink instance pointed to by firstLink.

In the implementation of the message append:, we first create a new link whose entry is the object passed as a parameter. We then check

class name	DoubleLink
superclass	SingleLink
instance variable names	predecessor

class messages and methods

```
entry: anObject successor: aDoubleLink1 predecessor:
  aDoubleLink2 | |
    ↑ (self entry: anObject successor: aDoubleLink1) predecessor:
      aDoubleLink2.
```

instance messages and methods

```
external
predecessor | | ↑ predecessor.
predecessor: aDoubleLink | | predecessor ← aDoubleLink.

internal
"none defined here"
```

Table 6: *Class template for class* DoubleLink.

class name	LinkedList
superclass	LinearList
instance variable names	"none defined here"

class messages and methods

```
new | | ↑ (super new) initialize.
```

instance messages and methods

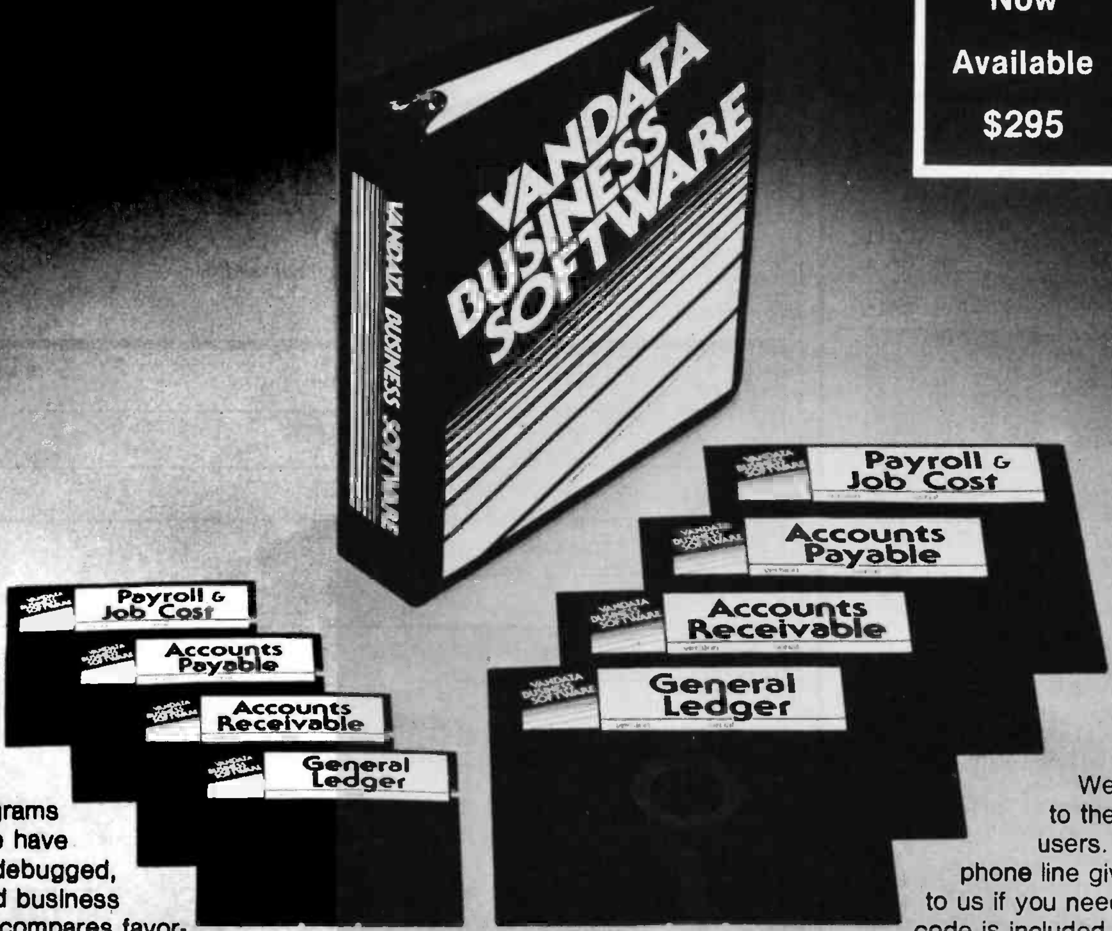
```
external
at: anInteger | |
    self checkIndex: anInteger.
    ↑ (self linkAt: anInteger) entry.
replace: anObject at: anInteger | |
    self checkIndex: anInteger.
    (self linkAt: anInteger) entry: anObject.

internal
"firstLink | | ... to be defined in subclasses"
linkAt: anInteger | aLink |
    aLink ← self firstLink.
    (anInteger – 1) timesRepeat: [ aLink ← aLink successor. ].
    ↑ aLink.
```

Table 7: *Class template for class* LinkedList.

Account on it.

Inventory
Now
Available
$295



With the Osborne programs as a base, we have developed a debugged, easily installed business package that compares favorably with systems costing much more.

General Ledger produces trial, monthly, and quarterly balance sheets and income statements. Journal entries can be entered manually, or automatically from the A/R and A/P systems.

Accounts Receivable is an open-item system that handles invoice, payment, credit memo, debit memo, and progress billing transactions. Customer statements are produced when desired.

Accounts Payable writes checks to specified vendors from invoice, credit memo, and debit memo transactions. You can distribute each transaction over a series of G/L accounts and job numbers.

Circle 420 on inquiry card.

Both the A/R and A/P systems produce aged invoice analysis listings based on user-specified time periods.

The *Payroll* system allows hourly, salaried, vacation, holiday, piecework, overtime and miscellaneous pay. Any number of deductions can be entered for each employee. 941-A and W-2 forms are produced when needed. A Job Cost subsystem keeps track of project dates and status, and records hours, cost and overhead information by employee for each job.

The checks and statements fit standard forms readily available from mail-order forms suppliers. You have your choice of a number of different formats.

We are committed to the support of our users. A tech support phone line gives you access to us if you need it. Full source code is included with every system. Our money-back guarantee speaks for itself.

Minimum requirements are 48K RAM, CP/M™ or CDOS, CBASIC2™, a CRT, and a 132-column printer. We can provide standard 8", NorthStar 5" double-density, or Heath/Zenith 5" diskettes — call for availability of other formats. The price is $295 per system, or $995 for the complete set of four.

For more information, write VANDATA, Suite 205, 17544 Midvale Ave. N., Seattle, Wa. 98133, or call (206) 542-7611.

Vandata Business Software. *You can account on it.* Hundreds of other businesses already do.

to see if the list is empty, and if so we set firstLink to point to the new link. If the list is not empty, we get the last link in the list and make its successor the new link. In either case, we increment the value of count to keep track of the new number of objects in the list.

In general, to insert a data item into a singly linked list, we create a new link for the item and then find the link that the new link is to follow. We then make this link point to the new link, and have the new link point to the former successor of this link (see figure 6a). The only exception to this process occurs if we are adding the data item to the beginning of the list. In this case there is no predecessor, so we simply point the new link to the

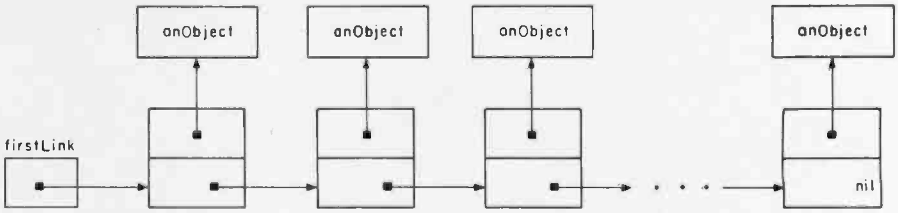


Figure 5: *A singly linked list.*

class name	SinglyLinkedList
superclass	LinkedList
instance variable names	firstLink
class messages and methods	

"none defined here"

instance messages and methods

```
external
append: anObject | aSingleLink |
   aSingleLink ← SingleLink entry: anObject successor: nil.
   self empty
      ifTrue: [ firstLink ← aSingleLink. ]
      ifFalse: [ (self linkAt: count) successor: aSingleLink. ].
   count ← count + 1.
insert: anObject at: anInteger | aSingleLink |
   self checkIndex: anInteger.
   (anInteger = 1)
      ifTrue: [ firstLink ← SingleLink entry: anObject successor: firstLink. ]
      ifFalse: [ aSingleLink ← self linkAt: anInteger − 1.
         aSingleLink successor: (SingleLink entry: anObject successor:
         aSingleLink successor). ].
   count ← count + 1.
removeAt: anInteger | aSingleLink anObject |
   self checkIndex: anInteger.
   (anInteger = 1)
      ifTrue: [ anObject ← firstLink entry. firstLink ← firstLink successor. ]
      ifFalse: [ aSingleLink ← self linkAt: anInteger − 1.
         anObject ← aSingleLink successor entry.
         aSingleLink successor: aSingleLink successor successor. ].
   count ← count − 1.
   ↑ anObject.

internal
initialize | | super initialize. firstLink ← nil.
firstLink  | | ↑ firstLink.
```

Table 8: *Class template for class* SinglyLinkedList.

Circle 70 on inquiry card.

former first link in the list. This procedure is used to implement the message insert:At: in class SinglyLinkedList. We also increment the value of count, just as we do in the message append.

The general procedure for removing a data item from a singly linked list is analogous to that for inserting an item. First we find the link that precedes the one at the position of interest. We then point this link to the link that follows the one of interest. This deletes the link of interest from the list (see figure 6b). We then return the entry of the deleted link. Again, the exceptional case is removing the first item since there is no preceding link. The message removeAt: in class SinglyLinkedList is implemeneted using this procedure. Since an object has been deleted from the list, we decrement the value of count.

Suppose we wish to use a singly linked list instead of a sequential list in our previous example of a deck of cards. We simply create instances of class SinglyLinkedList for the deck and hands, as shown in the following:

```
| hand1 hand2 deck |
deck ← SinglyLinkedList new.
hand1 ← SinglyLinkedList new.
hand2 ← SinglyLinkedList new.
```

We can then use the rest of the code, unchanged, from that example. We are able to do this because we have hidden the details of each implementation inside the corresponding class definition and, in using the classes, have limited ourselves to a clearly defined set of external messages.

The Circular List

Another type of linked list is the *circular list* (see figure 7). A circular list is a singly linked list in which the successor of the last link in the list is the first link in the list. This makes a circular chain of links. If we have access to the last link in a circular list, then we also have easy access to the first link of that list since it is the immediate successor of the last link. By keeping track of the last link of a circular list, we can easily insert and remove items from both the begin-

64K Static RAM

available now from stock

Ultra Fast - 100 nsec. chips
Fast access allows memory management manipulation without wait states.

8/16 - 8 or 16-bits wide
Dynamically switches data path width per IEEE Standard.

Low Power
Typical power consumption less than 2 amps for active board. Less for power down boards.

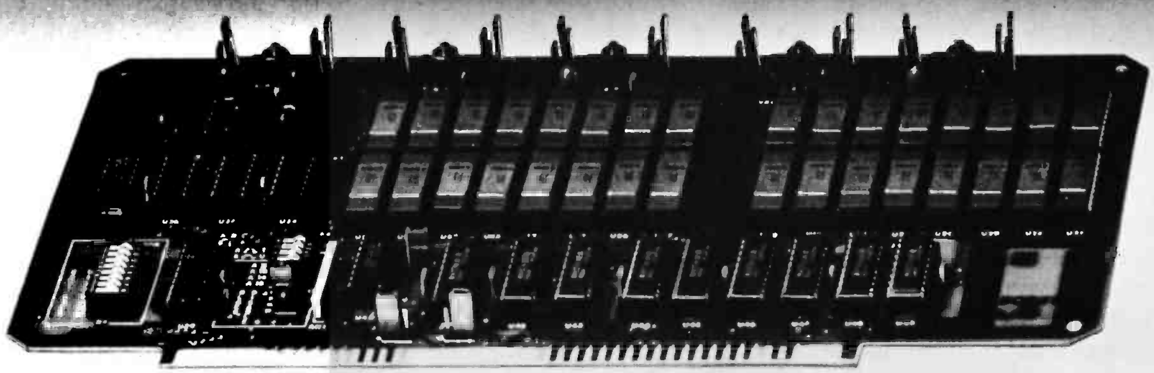
Extended Addressing
24-bit IEEE addressing allows 16-megabyte range. Single shunt changes to 16-bit addressing.

Fully Static
No clocks, no refresh required for easy DMA use.

Special Features
Any 4K block can be disabled. Or, can disable everything above or below any 4K boundary. Available in 16K increments for OEM quantities.

$1,295

100 nsec. Chips - Qty. 1-9
OEM & Dealer prices also available.



TO ORDER:
May be ordered through your local computer store or factory direct. Personal checks, CODs, VISA and MC accepted from within USA. 10-day return privilege on factory orders. Shipping paid by SCP on prepaid USA and Canadian orders. All boards fully assembled, guaranteed one year.

SEATTLE COMPUTER

1114 Industry Dr. Seattle WA 98188

Information Hotline: 206/575-1830

Send more information: ( )__________
Name __________
Company __________
Address __________
City__________ State______ Zip______

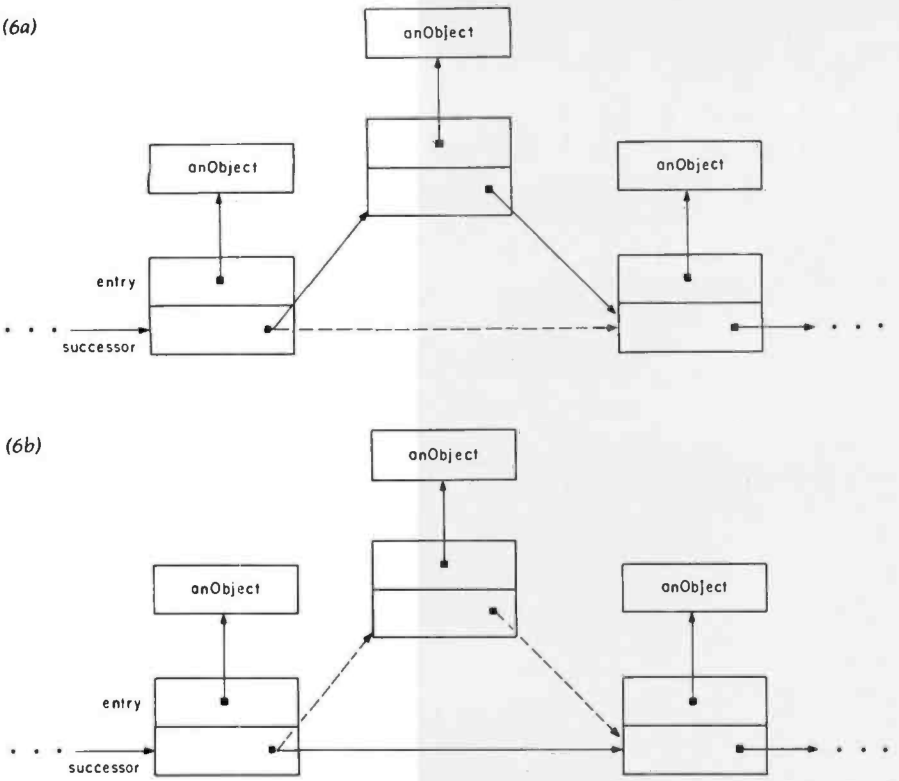


Figure 6: *The insertion and deletion of data items from a singly linked list. In both insertion (6a) and deletion (6b) processes, the dotted lines represent the links existing before the process, while the solid lines represent the links existing after the process.*

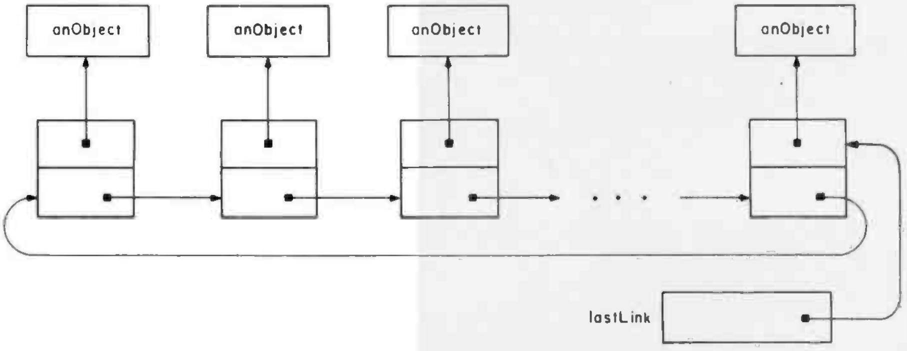


Figure 7: *A circular list.*

ning and the end of the list. This will be a useful property in some of the data structures that we will build out of circular lists.

The definition of class CircularList is given in table 9. Class CircularList has an instance variable named lastLink that points either to the last link in the list or to nil if the list is empty. The internal message initialize sets lastLink to nil. The internal message firstLink (again, as in the case of class SinglyLinkedList, sent to nonempty lists only) returns the successor of lastLink. Since the list is circular, this is the first link in the list.

The append, insert, and remove operations on a circular list are similar to those on a noncircular list. Since we always have a link that precedes any given link in a circular list, we don't have to make exceptions for operations on the beginning of the list. The implementation of these operations is demonstrated in the methods for the messages append:, insertAt:, and removeAt:.

The Doubly Linked List

Now we will consider the *doubly linked list* (see figure 8). A doubly linked list is a sequence of double links connected together. The successor of a given link is the link that follows it in the sequence, just as in the case of the singly linked list. The predecessor of a given link is the link that precedes it in the sequence. A doubly linked list can be made into a circular list, just as a singly linked list can, by connecting the first and last links. In this case, the successor of the

Text continued on page 260

ALL THESE FEATURES... IN THIS SMALL SPACE... AT THIS LOW PRICE!

4,695

Greater computer power . . . fewer separate components . . . larger capability . . . simpler to operate . . .. modular maintenance . . .

These are the unique benefits of the Quasar Data QPD-100 Floppy Disk Computer . . . plus unsurpassed reliability...plus 12-month warranty on all PC boards.

Its highly reliable, double density drive is compact. Accepts both single AND double-sided disks.

Upgradeable from the Z-80™ microprocessor-based system to our 16 BIT microprocessor-based system by simply plugging in extra PC cards. Hard disk and multi-user systems available.

As your requirements grow, your QDP-100 can grow to fit them.

The Quasar Data QDP-100H is a larger version with 6-megabyte capacity; includes one double-sided floppy and one 5¼ microwinchester hard disk.

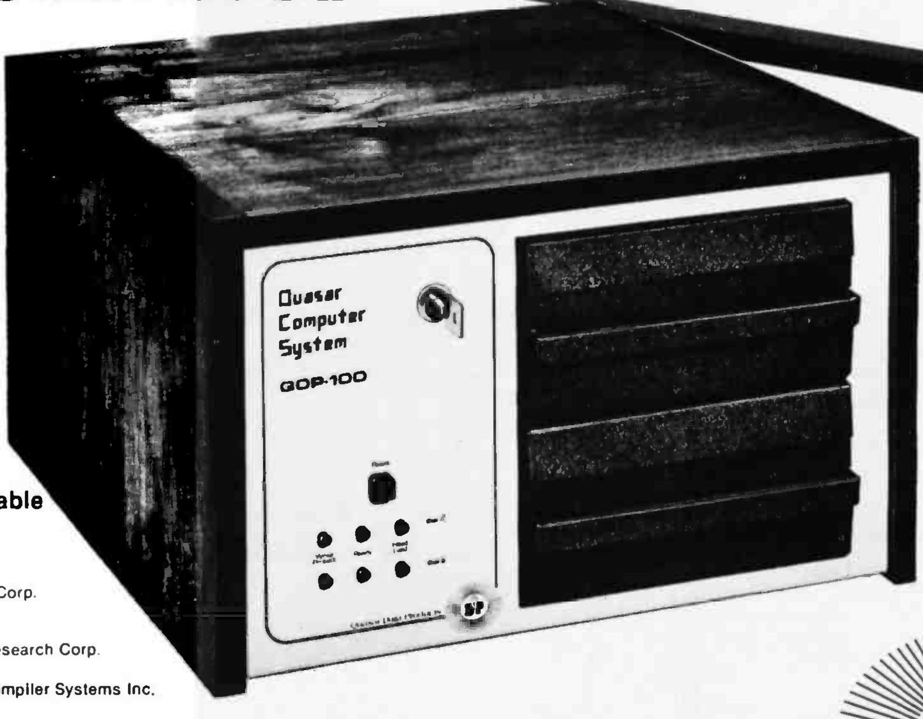
Both the Quasar Data QDP-100 and QDP-100H are fully compatible with all standard terminals.

Phone or write for descriptive bulletin and specifications. And ask for a demonstration. Dealer inquiries invited.

QUASAR DATA'S QDP-100 COMPUTER SYSTEM.

FEATURES

Z-80, 4-MhZ CPU
64K memory, bank selectable
Two (2) double-sided, double-density 8" floppies, 2 megabytes
Four (4) ports...2 serial, 2 parallel
Double-sided, double-density disk controller, to 4 MB
CP/M 2.2 DOS. MP/M multi-user operating system. (Optional)
S-100 (IEEE) motherboard
BASIC LANGUAGE . . . CBASIC compiler
Real-time clock
Monitor in PROM
Manuals supplied: All documentation and schematics, including "CP/M Handbook" by Sybex.
Accounting systems: G/L, A/R, A/P, P/R, included.



18" wide
16⅞" deep
11" high

Complete systems available

Z-80 is a trademark of Zilog Corp.

CP/M and MP/M are trademarks of Digital Research Corp.

CBASIC is a trademark of Compiler Systems Inc.

Quasar Data Products

10330 Brecksville Road, Brecksville (Cleveland), Ohio 44141
Phone: 216/526-0838 / 526-0839
Telex: 241596

Circle 324 on inquiry card.

class name	CircularList
superclass	LinkedList
instance variable names	lastLink
class messages and methods	

"none defined here"

instance messages and methods

```
external
append: anObject | aSingleLink |
   self empty
      ifTrue: [ lastLink ← SingleLink entry: anObject successor: nil.
         lastLink successor: lastLink. ]
      ifFalse: [ aSingleLink ← SingleLink
         entry: anObject successor: lastLink successor.
         lastLink successor: aSingleLink. lastLink ← aSingleLink. ].
   count ← count + 1.
insert: anObject at: anInteger | aSingleLink |
   self checkIndex: anInteger.
   aSingleLink ← self linkAt: anInteger − 1.
   aSingleLink successor:
   (SingleLink entry: anObject successor: aSingleLink successor).
   count ← count + 1.
removeAt: anInteger | aSingleLink anObject |
   self checkIndex: anInteger.
   aSingleLink ← self linkAt: anInteger − 1.
   anObject ← aSingleLink successor entry.
   (count = 1)
      ifTrue: [ lastLink ← nil. ]
      ifFalse: [ aSingleLink successor: aSingleLink successor successor.
         (anInteger = count) ifTrue: [ lastLink ← aSingleLink. ]. ].
   count ← count − 1.
   ↑ anObject.

internal
initialize | | super initialize. lastLink ← nil.
firstLink | | ↑ lastLink successor.
linkAt: anInteger | |
   (anInteger = count) | (anInteger = 0) ifTrue: [ ↑ lastLink ].
   ↑ super linkAt: anInteger.
```

Table 9: *Class template for class* CircularList.

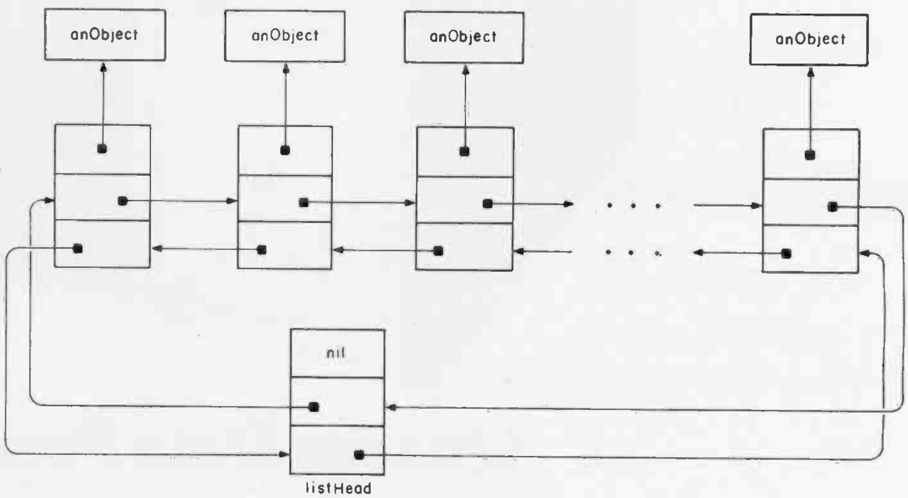


Figure 8: *A doubly linked list.*

The A2-3D1 Graphics Family...

professional 3D and 2D graphics for the Apple II

Now for non-programmers!

Running on the Apple II:
A2-3D/A Saturn Navigator

A2-3D1 Graphics Package
$59.95 on disk (32K required)
$49.95 on cassette (16K required)

A2-3D2 Enhancement
$24.95 on disk (48K and A2-3D1 required)
$19.95 on cassette (32K and A2-3D1 required)

A2-GE1 Graphics Editor
$34.95 on disk (48K and A2-3D1 required)

A2-3D/A Saturn Navigator
$24.95 on disk (48K and A2-3D1 required)

For direct order, include $3 for UPS or $5 for first class mail delivery. Illinois residents add 5% sales tax. Visa and Master Card accepted.

The **A2-3D1** is the graphics utility you can depend on whether you're mapping a town, presenting charts at a business meeting, or animating games.

Now this versatility is available for the non-programmer with the **A2-GE1** graphics editor and programmer. Create images as you view them. Scan them, animate them, combine them, or add text or labels. With a minimum of fuss, you can prepare all sorts of scientific, business, or educational presentations.

Add the **A2-3D2** enhancement package for color, and as a bonus you'll also be able to manipulate images independently of each other—as many different objects at once as your memory will accommodate.

When it's time for some challenging and educational entertainment, run the **A2-3D/A** Saturn Navigator. You'll enjoy an adventurous flight to Saturn, enter its orbit, and rendezvous with an orbital space station that awaits your arrival.

We've reached our goal of giving you the most sophisticated graphics utilities in the market-place . . .

see them now at your dealer!

subLOGIC
Communications Corp.
Box V, Savoy, IL 61874
(217) 359-8482
Telex: 206995

class name	DoublyLinkedList
superclass	LinkedList
instance variable names	listHead
class messages and methods	

"none defined here"

instance messages and methods

```
external
append: anObject | | self insert: anObject after: listHead predecessor.
insert: anObject at: anInteger | |
    self checkIndex: anInteger.
    self insert: anObject after: (self linkAt: anInteger − 1).
removeAt: anInteger | aDoubleLink |
    self checkIndex: anInteger.
    aDoubleLink ← self linkAt: anInteger.
    aDoubleLink successor predecessor: aDoubleLink predecessor.
    aDoubleLink predecessor successor: aDoubleLink successor.
    ↑ aDoubleLink entry.

internal
initialize | |
    super initialize.
    listHead ← DoubleLink entry: nil successor: nil predecessor: nil.
    listHead successor: listHead. listHead predecessor: listHead.
firstLink | | ↑ listHead successor.
linkAt: anInteger | aDoubleLink |
    (anInteger = 0) ifTrue: [ ↑ listHead ].
    (anInteger < = (count / 2)) ifTrue: [ ↑ super linkAt: anInteger ].
    aDoubleLink ← listhead.
    (count − anInteger + 1) timesRepeat:
    [ aDoubleLink ← aDoubleLink predecessor. ].
    ↑ aDoubleLink.
insert: anObject after: aDoubleLink1 | aDoubleLink2 |
    aDoubleLink2 ← DoubleLink entry: anObject
        successor: aDoubleLink1 successor predecessor: aDoubleLink1.
    aDoubleLink1 successor: aDoubleLink2.
    aDoubleLink2 successor predecessor: aDoubleLink2.
```

Table 10: *Class template for class* DoublyLinkedList.

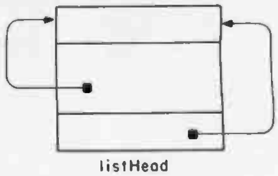


Figure 9: *An empty doubly linked list.*

Text continued from page 256:

last link is the first link, and the predecessor of the first link is the last link. The class definition for a circular, doubly linked list is given in table 10.

Class DoublyLinkedList has an instance variable named listHead, which points to a special kind of link known as a *list head*. A list head is a link whose entry is unused. The idea is to keep the list head in the list so that even when there are no data items in the list, at least one link is present. Having a link present at all times simplifies the implementation of some linked list operations. A list head can be used in the implementation of a singly linked list, but it is especially convenient in the implementation of a circular doubly linked list. In a circular doubly linked list, the list head successor points to the first link in the list (excluding the list head itself), or to itself if the list is empty (see figure 9). The list head predecessor points to the last link in the list (excluding the list head itself), or to itself if the list is empty. In class DoublyLinkedList, the internal message initialize sets listHead to an instance of DoubleLink whose entry is nil and whose successor and predecessor are both that same instance (ie: the double link is made circular). The message firstLink has been modified to return the list head successor.

Because a doubly linked list is composed of a sequence of double links, it is possible to traverse the list in both directions, forward and backward, with equal facility. The internal message linkAt: in class DoublyLinkedList has been modified to access objects past the middle of the list by starting from the rear and traversing toward the front. This improves the performance of the access message at:.

Inserting an item in a doubly linked list is similar to inserting an item in a singly linked list. We first create a new link for the item. Then we find the link that this new link is to follow, set the successor and predecessor pointers of the new link, and adjust both the successor pointer of the link that precedes the new link and the predecessor pointer of the link that follows the new link (see figure 10a). If we are using a circular list with a list head, we don't have to consider any exceptional cases. Removing an item from a list is an analogous process (see figure 10b). The details of these procedures are demonstrated in the methods for the messages append:, insert:, and removeAt:.

The Stack

The next data structure that we will look at is the *stack* (see figure 11). A stack is a linear list of items that is accessed in a very restricted way. In fact, only one side of a stack, the *top*, can be accessed. The *bottom* of the stack cannot be accessed. These names are useful because most stack diagrams list their items vertically, with the accessible end higher. The item at the accessible end of the stack

Text continued on page 264

PrintersPlus

...computers, peripherals, accessories and supplies!

APPLE ACCESSORIES

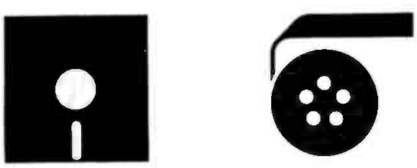
LOBO Disk II Add-On	419.
SUPERTERM 80 Col. Card	329.
Z80 Soft Card	295.
H.S. Serial Card	179.
COMM. Card	179.
HAYES Micromodem	319.
PARALLEL Printer Card	149.
16K Ram Card	189.
GPIB IEEEE-488 Card	259.
VISTA A40 Disk II Add-On	349.
VISTA A80 Disk II Add-On	529.
VISTA A160 Disk II Add-On	799.
VISTA A800 Dbl. Den. 8" Con.	529.

SOFTWARE

VISICALC	119.00
DESKTOP Plan II	169.00
DB MASTER	209.00
ADDRESS Book	40.00
SUPER Text II	125.00
CCA Data Mgmt	85.00

RIBBONS

NEC	$77.00/Doz.
QUME	45.00/Doz.
DIABLO	66.00/Doz.
ANADEX	135.00/6 ea.
TRITEL	95.00/Doz.
TI/DEC/TTY	45.00/Doz.
EPSON	13.95/ea.
MPI/Axiom/Base 2	10.00/ea.



MAGNETIC MEDIA

Premium Quality At Bargain Prices
5¼" Diskettes, all Formats
100% Certified with hub rings, box of 10

Single sided, single density	26.50
Single sided, double density	29.50
Double sided, double density	38.50

8" DISKETTES, ALL FORMATS
100% CERTIFIED

Single sided, single density	29.50
SSSD Error Free	34.50
Single sided, double density	39.50
Double sided, double density	49.50

Diablo 630 RO	$2,395.
Diablo 1640 RO	2,795.
Diablo 1650 RO	3,095.
C.Itoh Starwriter RO	1,695.
TI 810 RO	1,695.
TI 820 RO	1,795.
Anadex DP9500/9501	1,345.

EPSONS

Complete Stock of MX-80, MX-80 F/T MX-100 Printers, Graphics Chip Sets Cards and Cables

NEW!

NOVELL IMAGE 800

150 CPS Heavy Duty Matrix

15" wide carriage, expanded, compressed and double density "correspondence quality" printing at 80, 96 and 136 columns, true descenders, underlining, superscripts, subscripts. Up to 3K Buffer, optional character set and graphics option.

List $1,395. .... $1,295.00

PRINT ELEMENTS

NEC Thimbles	$14.95
Plastic Daisy Wheels *for Qume, Diablo, Starwriter*	6.00
Metal Daisy Wheels	59.00
IBM Selectric Elements	19.00

MODEMS

UDS 103 LP, *direct*	$169.
103 JLP *Auto Answer*	219.
NOVATION CAT, *acoustic*	159.
D-CAT, *direct*	169.
Auto Cat	219.
Apple Cat	309.
LEXICON LX—11, *acoustic*	147.
HAYES Micromodem, S100	349.

VIDEO MONITORS

Sanyo 9" B/W	$169.
NEC 12" Green	229.
Amdek 12" B/W (Leedex)	135.
Amdek 13" Color	399.

VIDEO TERMINALS

Ampex Dialog 80	$995.
Ampex Dialog 30	795.
Televideo 920C	845.
Televideo 950	995.
Soroc IQ 120	795.
Soroc IQ 140	1,195.

FLOPPY DRIVES

1—SA 400 Case, power	$399.
1—SA 800/801 Case, power	995.
2—SA 800/801 Case, power	1,495.
2-SA 850/851 Case, power	1,995.

MPI 88 G Matrix

High resolution dot-addressable graphics for Apple. Enhanced "correspondence quality" printing. Tractor and Friction feed. Serial and Parallel Input. 100 cps Bidirectional printing, 80, 96, and 132 column widths!

List $799.00 .... $599.00

Apple II I/O Card	$110.00
PET/IEEE I/O Card	55.00
Single Sheet Feeder	25.00
QT Cover	25.00

NEC SPINWRITERS

5510/5530 RO	$2,595.
5520 KSR	2,895.

NEW!

OLYMPIA ES100 RO

Letter quality, Daisy wheel printer/typewriter interfaces to Apple, Atari, NEC, TRS80 and RS232 Serial ports. A truly cost effective letter quality printer that functions as a typewriter.

List $1690. .... $1395.00

TO PLACE YOUR ORDER CALL:

TELEPHONE (714) 744-7314 — *TELEX* 697120

or write to:

PALOMAR
Computer Products
910-105 W. San Marcos Blvd., San Marcos, CA 92069

TERMS OF SALE: Cash, check, money order, bank wire transfer, credit card or purchase orders from qualified firms and institutions. Please include telephone number with order and expiration date on credit card orders. California residents add 6% sales tax. Advertised prices are for prepaid orders F.O.B. shipping point. Add 3% for shipping in U.S. Pricing and availability subject to change without notice.

Circle 297 on inquiry card.

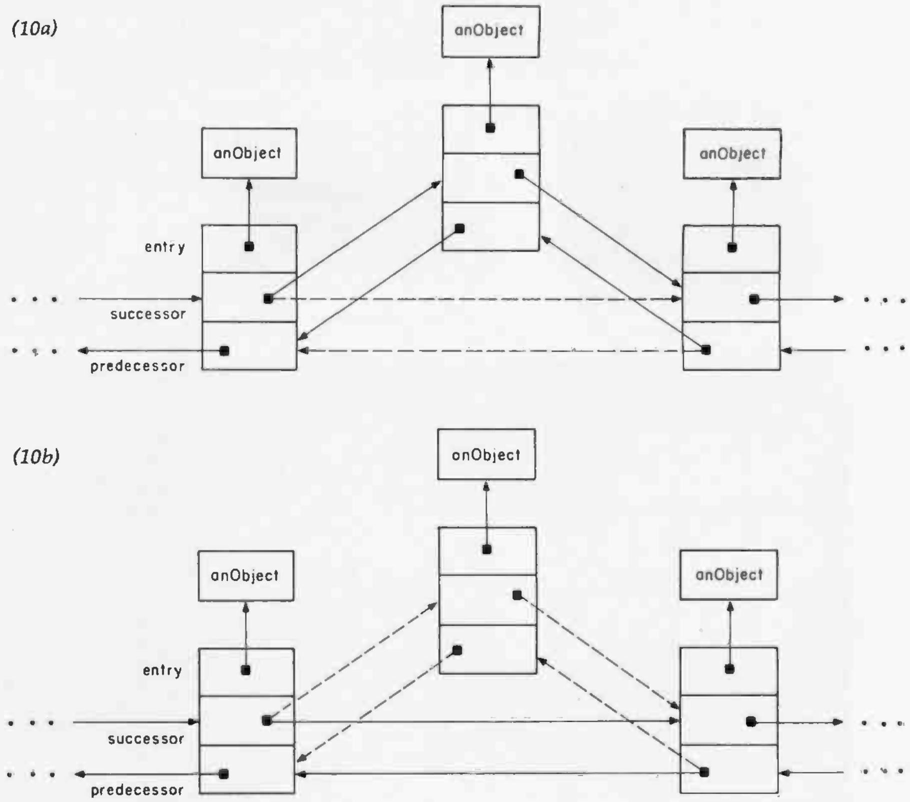


Figure 10: *The insertion and deletion of data items from a doubly linked list. In both insertion (10a) and deletion (10b) processes, the dotted lines represent the links existing before the process, while the solid lines represent the links existing after the process.*

Text continued from page 260:
is called the *top item*. A new item is added to the accessible end, thereby making it the new top item. This is called *pushing* an item onto a stack. Only the top item can be removed, or *popped*, from a stack. By adding and removing in this fashion (pushing and popping), we are able to access items in a last-in-first-out manner—that is, the last item pushed on a stack is the first item to be popped off the stack. Because of this, a stack is often called a *LIFO* (last-in-first-out).

Many examples of collecting and accessing in stack fashion exist outside the realm of programming. A pile of trays in a cafeteria rack is often used in this way. The same can be true of papers piled on a desk. In programming systems, a number of algorithms call for the use of a stack. For example, arithmetic expressions expressed in prefix or postfix notation can be evaluated using a stack to keep track of partial results.

The operations that we want to perform on a stack include:

- determine the number of items on the stack
- determine whether or not the stack is empty
- push an item onto the stack
- pop an item off the stack
- access the top item on the stack

It is easy to implement a stack using a linear list as the basic storage mechanism. Since we have several kinds of linear lists, it is possible to have several different stack implementations. Table 11 gives the definition of class Stack, which serves as a superclass for subsequent stack classes. Each kind of stack has a buffer which is a linear list, either sequential or linked. The messages count and empty are implemented using the corresponding messages of the linear list. The message emptyCheck, which sends an error message if the stack is empty, will be used in the implementations of the messages pop and top.

The Sequential Stack

The first stack implementation we

MULTI-USER OASIS HAS THE FEATURES PROS DEMAND. READ WHY.

(THEN COMPARE.)

Computer experts (the pros) usually have big computer experience. That's why when they shop system software for Z80 micros, they look for the big system features they're used to. And that's why they like Multi-User OASIS. You will too.

DATA INTEGRITY: FILE & AUTOMATIC RECORD LOCKING

The biggest challenge for any multi-user system is co-ordinating requests from several users to change the same record at the same time.

Without proper co-ordination, the confusion and problems of inaccurate or even destroyed data can be staggering.

Our File and Automatic Record Locking features solve these problems.

For example: normally all users can view a particular record at the same time. But, if that record is being updated by one user, automatic record locking will deny all other users access to the record until the up-date is completed. So records are always accurate, up-to-date and integrity is assured.

Pros demand file & automatic record locking. OASIS has it.

SYSTEM SECURITY: LOGON, PASSWORD & USER ACCOUNTING

Controlling who gets on your system and what they do once they're on it is the essence of system security.

Without this control, unauthorized users could access your programs and data and do what they like. A frightening prospect isn't it?

And multi-users can multiply the problem.

But with the Logon, Password and Privilege Level features of Multi-User OASIS, a system manager can specify for each user which programs and files may be accessed—and for what purpose.

Security is further enhanced by User Accounting—a feature that lets you keep a history of which user has been logged on, when and for how long.

Pros insist on these security features. OASIS has them.

EFFICIENCY: RE-ENTRANT BASIC

A multi-user system is often not even practical on computers limited to 64K memory.

OASIS Re-entrant BASIC makes it practical.

How?

Because all users use a single run-time BASIC module, to execute their compiled programs, less memory is needed. Even if you have more than 64K, your pay-off is cost saving and more efficient use of all the memory you have available—because it services more users.

Sound like a pro feature? It is. And OASIS has it.

AND LOTS MORE...

Multi-User OASIS supports as many as 16 terminals and can run in as little as 56K memory. Or, with bank switching, as much as 784K.

Multi-Tasking lets each user run more than one job at the same time.

And there's our BASIC—a compiler, interpreter and debugger all in one. An OASIS exclusive.

Still more: Editor; Hard & Floppy Disk Support; Keyed (ISAM), Direct & Sequential Files; Mail-Box; Scheduler; Spooler; all from OASIS.

Our documentation is recognized as some of the best, most extensive, in the industry. And, of course, there's plenty of application software.

Put it all together and it's easy to see why the real pros like OASIS. Join them. Send your order today.

OASIS

MAKES MICROS RUN LIKE MINIS

OASIS IS AVAILABLE FOR

SYSTEMS: Altos; Compucorp; Cromemco; Delta Products; Digital Group; Digital Microsystems; Dynabyte; Godbout; IBC; Index; Intersystems; North Star; Onyx; SD Systems; TRS 80 Mod II; Vector Graphic; Vorimex.

CONTROLLERS: Bell Controls; Cameo; Corvus; Konan; Micromation; Micropolis; Tarbell; Teletek; Thinkertoys; X Comp.

Write for complete, free Application Software Directory.

PLEASE SEND ME:

Product	Price with Manual	Manual Only
OPERATING SYSTEM (Includes: EXEC Language; File Management; User Accounting; Device Drivers; Print Spooler; General Text Editor, etc.)		
SINGLE-USER	$150	$17.50
MULTI-USER	350	17.50
BASIC COMPILER/ INTERPRETER/DEBUGGER	100	15.00
RE-ENTRANT BASIC COMPILER/INTERPRETER/ DEBUGGER	150	15.00
DEVELOPMENT PACKAGE (Macro Assembler; Linkage Editor; Debugger)	150	25.00
TEXT EDITOR & SCRIPT PROCESSOR	150	15.00
DIAGNOSTIC & CONVERSION UTILITIES (Memory Test; Assembly Language; Converters; File Recovery; Disk Test; File Copy from other OS; etc.)	100	15.00
COMMUNICATIONS PACKAGE (Terminal Emulator; File Send & Receive)	100	15.00
PACKAGE PRICE (All of Above)		
SINGLE-USER	500	60.00
MULTI-USER	850	60.00
FILE SORT	100	15.00
COBOL-ANSI '74	750	35.00

Order OASIS from:

Phase One Systems, Inc.
7700 Edgewater Drive, *Suite 830*
Oakland, CA 94621
Telephone (415) 562-8085
TWX 910-366-7139

NAME ____________
STREET (NO BOX #) ____________
CITY ____________
STATE ________ ZIP ________

AMOUNT $ ________
(Attach system description; add $3 for shipping; California residents add sales tax)

☐ Check enclosed ☐ VISA
☐ UPS C.O.D. ☐ Mastercharge

Card Number ____________
Expiration Date ____________
Signature ____________

Circle 309 on inquiry card.

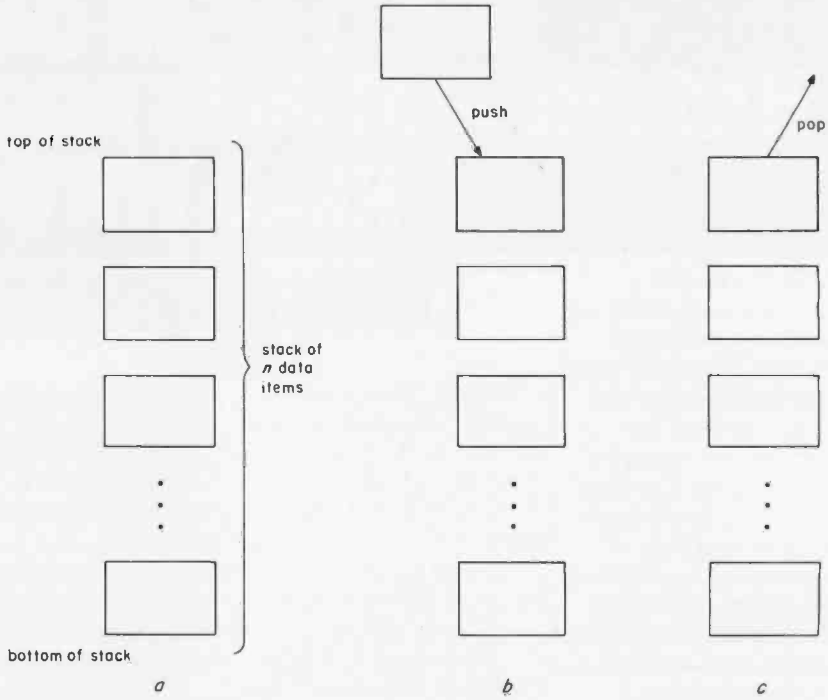


Figure 11: *A stack, shown in figure 11a, is a linear collection of objects arranged so that items can be added to or removed from the stack only at the top end of the stack. Figure 11b shows an item being added, or pushed, to the stack. Figure 11c shows an item being taken, or popped, from the stack.*

will consider is the *sequential stack.* A sequential stack is simply a stack implemented using a sequential list. The definition of class SequentialStack is given in table 12. An instance of SequentialStack is created by sending class SequentialStack the message size:, whose parameter is an integer indicating the estimated maximum size of the stack. For example:

```
| stack |
stack ← SequentialStack size: 20.
```

creates an instance of SequentialStack with space initially for twenty items. This size is expanded when necessary since the sequential list used as a buffer is expanded when required.

The message push: is implemented by appending to the buffer the object passed as a parameter. As we have noted, this is an easy operation for sequential lists to perform, except when the list overflows and requires expansion. The message pop is implemented by first checking to see if the buffer is empty, in which case an error is reported. Otherwise, the last item from the buffer is removed. Again, we should recall that this is an easy operation for a sequential list to perform. Similarly, in order to access the top of the stack (using the message top), we check to see that the stack is not empty, in which case we return (without removing) the last item in the buffer.

The following is an example using class SequentialStack:

```
| stack a b c |
stack ← SequentialStack size: 10.
a ← (Card suit: 'heart' rank: 5).
b ← (Card suit: 'heart' rank: 6).
c ← (Card suit: 'heart' rank: 7).
stack push: a.
stack push: b.
stack push: c.
a ← stack pop.
b ← stack pop.
c ← stack pop.
```

This example creates an instance of class SequentialStack that initially has space for ten objects. The variables a, b, and c are assigned to instances of class Card with ranks 5, 6, and 7, respectively. These instances are pushed on the stack and then popped

QUALITY DISK SOFTWARE

BACKED BY ON-GOING APPLICATIONS SUPPORT

APPLE II Ⓐ *TRS•80* Ⓣ

HOME FINANCE PAK I: Entire Series $49.95 Ⓐ Ⓣ

CHECK REGISTER AND BUDGET: This comprehensive CHECKING ACCOUNT MANAGEMENT SYSTEM not only keeps complete records, it also gives you the analysis and control tools you need to actively manage your account. The system provides routines for BUDGETING INCOME AND EXPENSE, AUTOMATIC CHECK SEARCH, and BANK STATEMENT RECONCILING. CRT or printer reports are produced for ACTUAL EXPENSE vs BUDGET, CHECK SEARCH DISPLAY RECONCILIATION REPORT and CHECK REGISTER DISPLAY by month. Check entry is prompted by user-defined menus of standard purposes and recipient codes, speeding data entry and reducing disk storage and retrieval time. Six fields of data are stored for each check: amount, check no., date, purpose, recipient and TAX DEDUCTIBLE REMINDER. CHECK SEARCH routines allow searching on any of these data fields. Up to 100 checks/mo. storage $39.95

SAVINGS: Account management system for up to 20 separate Savings accounts. Organizes, files and displays deposits, withdrawals and interest earned for each account. $14.95

CREDIT CARD: Get Control of your credit cards with this program. Organizes, stores and displays purchases, payments and service charges for up to 20 separate cards or bank loans. $14.95

UNIVERSAL COMPUTING MACHINE: $49.95 Ⓐ

A user programmable computing system structured around a 50 row x 50 column table. User defines row and column names and equations forming a unique computing machine. Table elements can be multiplied, divided, subtracted or added to any other element. Hundreds of unique computing machines can be defined, used, stored, and recalled, for later use. Excellent for sales forecasts, budgets, inventory lists, income statements, production planning, project cost estimates-in short for any planning, analysis or reporting problem that can by solved with a table.

COLOR CALENDAR: $29.95 Ⓐ

Got a busy calendar? Organize it with Color Calendar. Whether it's birthdays, appointments, business meetings or a regular office schedule, this program is the perfect way to schedule your activities.
The calendar display is a beautiful HI-RES color graphics calendar of the selected month with each scheduled day highlighted in color. Using the daily schedule, you can review any day of the month and schedule an event or activity in any one of 20 time slots from 8:00 A.M. to 5:30 P.M.

BUSINESS SOFTWARE: Entire Series $159.95 Ⓐ Ⓣ

MICROACCOUNTANT: The ideal accounting system for small businesses. Based on classic T-accounts and double-entry booking, this efficient program provides a journal for recording posting and reviewing up to 1,000 transactions per month to any one of 300 accounts. The program produces CRT and printer reports covering:

TRANSACTION JOURNAL	BALANCE SHEET
ACCOUNT LEDGERS	INCOME AND EXPENSE STATEMENT

Includes a short primer on Financial Accounting. (48K) $49.95

UNIVERSAL BUSINESS MACHINE: This program is designed to SIMPLIFY and SAVE TIME for the serious businessman who must periodically Analyze, Plan and Estimate. The program was created using our Universal Computing Machine and it is programmed to provide the following planning and forecasting tools.

CASH FLOW ANALYSIS	SALES FORECASTER
PROFORMA PROFIT & LOSS	SOURCE AND USE OF FUNDS
PROFORMA BALANCE SHEET	JOB COST ESTIMATOR
REAL ESTATE INVESTMENT	INVENTORY ANALYSIS

Price, including a copy of the Universal Computing Machine $89.95

BUSINESS CHECK REGISTER AND BUDGET: Our Check Register and Budget programs expanded to include up to 50 budgetable items and up to 400 checks per month. Includes bank statement reconciling and automatic check search (48K) $49.95

ELECTRONICS SERIES VOL I & II: Entire Series $259.95

LOGIC SIMULATOR: SAVE TIME AND MONEY. Simulate your digital logic circuits before you build them. CMOS, TTL, or whatever, if it's digital logic, this program can handle it. The program is an interactive, menu driven, full-fledged logic simulator capable of simulating the bit-time response of a logic network to user-specified input patterns. It will handle up to 1000 gates, including NANDS, NORS, INVERTERS, FLIP-FLOPS, SHIFT REGISTERS, COUNTERS and user-defined MACROS, up to 40 user-defined random, or binary input patterns. Accepts network descriptions from keyboard or from LOGIC DESIGNER for simulation .... $159.95 Ⓐ Ⓣ

LOGIC DESIGNER: Interactive HI-RES graphics program for designing digital logic systems. Draw directly on the screen up to 10 different gate types, including NAND, NOR, INVERTER, EX-OR, T-FLOP, JK-FLOP, D-FLOP, RS-FLOP, 4 BIT COUNTER and N-BIT SHIFT REGISTER. User interconnects gates using line graphics commands. Network descriptions for LOGIC SIMULATOR generated simultaneously with the CRT diagram being drawn .... $159.95 Ⓐ

MANUAL AND DEMO DISK: Instruction Manual and demo disk illustrating capabilities of both program (s) .... $29.95 Ⓐ Ⓣ

ELECTRONIC SERIES VOL III & IV: Entire Series $259.95

CIRCUIT SIMULATOR: Tired of trial & error circuit design? Simulate & debug your designs before you build them! With CIRCUIT SIMULATOR you build a model of your circuit using RESISTORS, CAPACITORS, INDUCTORS, TRANSISTORS, DIODES, VOLTAGE and CURRENT SOURCES and simulate the waveform response to inputs such as PULSES, SINUSOIDS, SAWTOOTHS, etc. . .all fully programmable. The output is displayed as an OSCILLOSCOPE-STYLE PLOT of the selected waveforms (Apple only) or as a printed table of voltage vs time. Handles up to 200 notes and up to 20 sources. Requires 48 RAM .... $159.95 Ⓐ Ⓣ

CIRCUIT DESIGNER: Interactive HI-RES graphics program for designing electronic circuits. Draw directly on the screen up to 10 different component types, including those referenced above. Components interconnect list for CIRCUIT SIMULATOR generated automatically. Requires $159.95

MATHEMATICS SERIES: Entire Series $49.95

STATISTICAL ANALYSIS I: This menu driven program performs LINEAR REGRESSION analysis, determines the mean, standard deviation and plots the frequency distribution of user-supplied data sets. Printer, Disk, I/O routines $19.95

NUMERICAL ANALYSIS: HI-RES 2-Dimensional plot of any function. Automatic scaling. At your option, the program will plot the function, plot the INTEGRAL, plot the DERIVATIVE, determine the ROOTS, MAXIMA, MINIMA, INTEGRAL VALUE $19.95

MATRIX: A general purpose, menu driven program for determining the INVERSE and DETERMINANT of any matrix, as well as the SOLUTION to any set of SIMULTANEOUS LINEAR EQUATIONS. $19.95

3-D SURFACE PLOTTER: Explore the ELEGANCE and BEAUTY of MATHEMATICS by creating HI-RES PLOTS of 3-dimensional surfaces from any 3-variable equation. Disk save and recall routines for plots. Menu driven to vary surface parameters. Hidden line or transparent plotting $19.95

ACTION ADVENTURE GAMES: Entire Series $29.95 Ⓐ

RED BARON: Can you outfly the RED BARON? This fast action game simulates a machine-gun DOGFIGHT between your WORLD WAR I BI-PLANE and the baron's. You can LOOP, DIVE, BANK or CLIMB-and so can the BARON. In HI-RES graphics plus sound. $14.95

BATTLE OF MIDWAY: You are in command of the U.S.S. HORNETS' DIVE-BOMBER squadron. Your targets are the Aircraft carriers, Akagi, Soryu and Kaga. You must fly your way through ZEROS and AA FIRE to make your DIVE-BOMB run. In HI-RES graphics plus sound. $14.95

SUB ATTACK: It's April 1943. The enemy convoy is headed for the CONTROL SEA. Your sub, the MORAY, has just sighted the CARRIERS and BATTLESHIPS' Easy pickings. But watch out for the DESTROYERS - they're fast and deadly. In HI-RES graphics plus sound $14.95

FREE CATALOG-All programs are supplied on disk and run on Apple II w/Disk & Applesoft ROM Card & TRS-80 Level II and require 32K RAM unless otherwise noted. Detailed instructions included. Orders shipped within 5 days. Card users include card number. Add $1.50 postage and handling with each order. California residents add 6½% sales tax. Foreign orders add $5.00 postage and handling.

SPECTRUM SOFTWARE
142 Carlow, P.O. Box 2084
Sunnyvale, CA 94087

FOR PHONE ORDERS: (408) 738-4387
DEALER INQUIRIES INVITED.

VISA · master charge

Circle 358 on inquiry card.

class name	Stack
superclass	Object
instance variable names	buffer
class messages and methods	

"none defined here"

instance messages and methods

external
count | | ↑ buffer count
empty | | ↑ buffer empty
"push: anObject | | ... to be defined in subclasses"
"pop | | ... to be defined in subclasses"
"top | | ... to be defined in subclasses"

internal
emptyCheck | | self empty ifTrue: [↑ self error: 'stack empty'].

Table 11: *Class template for class* Stack.

class name	SequentialStack
superclass	Stack
instance variable names	"none defined here"
class messages and methods	

```
size: anInteger | |
    (anInteger > 0)
     ifTrue: [ ↑ (self new) initialize: anInteger ]
     ifFalse: [ ↑ self error: 'invalid size' ].
```

instance messages and methods

external
push: anObject | | buffer append: anObject.
pop | | self emptyCheck. ↑ buffer removeAt: buffer count.
top | | self emptyCheck. ↑ buffer at: buffer count.

internal
initialize: anInteger | | buffer ← SequentialList size: anInteger.

Table 12: *Class template for class* SequentialStack.

off. The effect is to reverse the assignments to a, b, and c, such that the ranks are 7, 6, and 5, respectively.

The Linked Stack

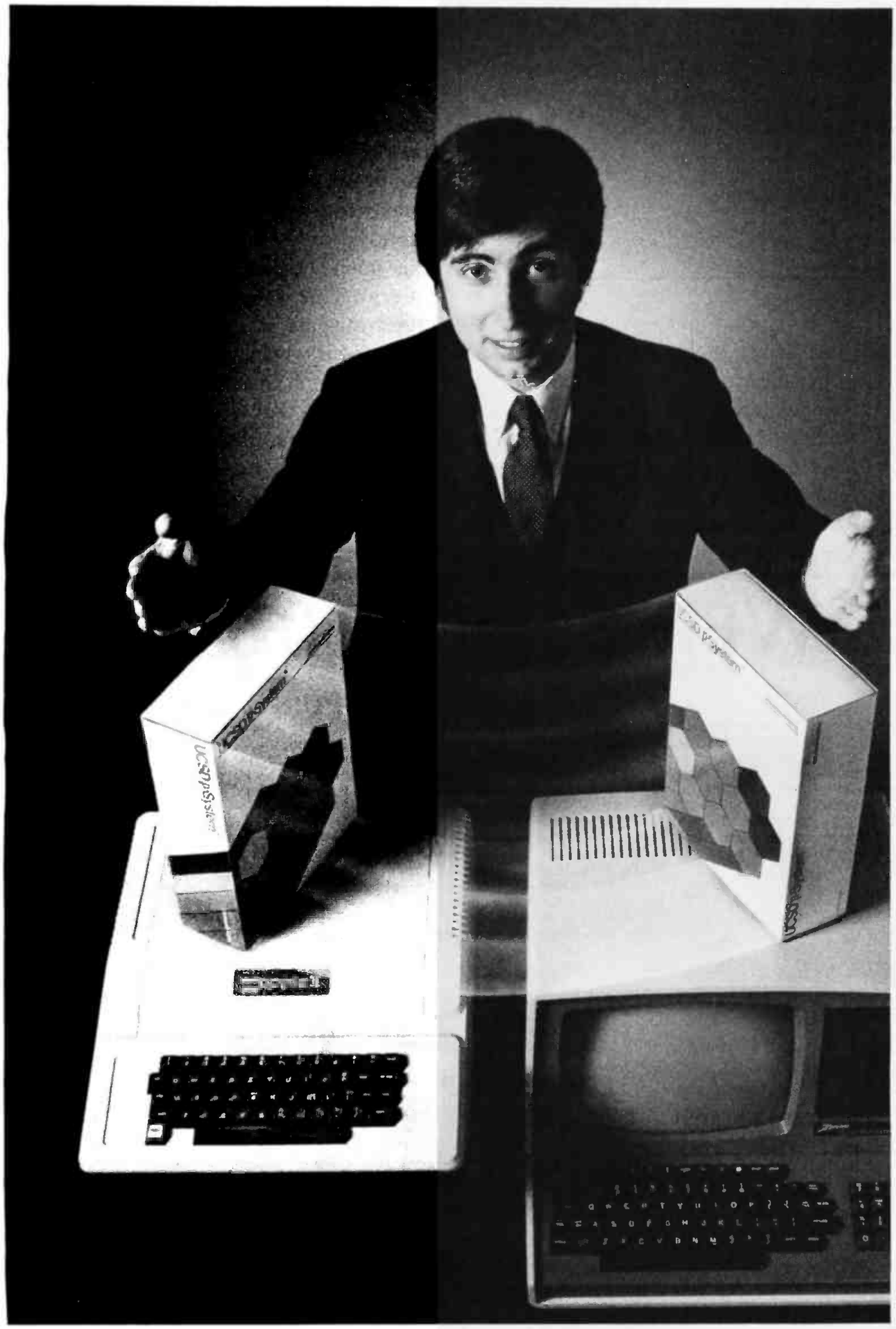
Alternatively, we can define a *linked stack*, which is a stack whose buffer is a linked list. The definition of class LinkedStack is given in table 13. A linked stack is created by sending the message new to class LinkedStack. Since we are using a linked list for the buffer, there is no need to specify a maximum size estimate. For example:

```
| stack |
stack ← LinkedStack new.
```

creates a new instance of class

"WITH THE UCSD p-SYSTEM,™ WE CAN WRITE ONE APPLICATION THAT GOES FROM APPLE TO ZENITH."

HARRY BLAKESLEE, President, Denver Software



UCSD p-System and UCSD Pascal are trademarks of the Regents of the University of California.

Our business is bigger and better than ever.

A lot of the credit for that goes to the UCSD p-System software from SofTech Microsystems. It's given us ten times the market we used to have.

We can write a single, sophisticated applications program with the UCSD p-System—like our financial management package—and it just keeps on running. On Apple, Commodore, Ohio Scientific, Texas Instruments, Zenith, and more. That's the real beauty of the UCSD p-System. Any program you write for one microcomputer runs on others, both today and tomorrow. You protect your software investment, without restricting your hardware options.

And with the UCSD p-System, you can use the language of your choice—UCSD Pascal,™ FORTRAN-77, BASIC, or assembly language. All are backed by SofTech Microsystems, a leading system software company who's been around for over a decade, who knows how to develop professional quality software, and who's committed to delivering it.

Get a head start on tomorrow. With the microcomputer software that goes from "A" to "Z." Distribution licensing and single copies available. Write or call for details, so you can start going places, too.

SOFTECH MICROSYSTEMS
A SUBSIDIARY OF SOFTECH

For the software that's going places.

9494 Black Mountain Road, San Diego, CA 92126. (714) 578-6105
TWX: 910-335-1594

Circle 352 on inquiry card.

class name	LinkedStack
superclass	Stack
instance variable names	"none defined here"
class messages and methods	

```
new | | ↑ (super new) initialize
```

instance messages and methods

```
external
push: anObject | | buffer insert: anObject at: 1.
pop | | self emptyCheck. ↑ buffer removeAt: 1.
top | | self emptyCheck. ↑ buffer at: 1.

internal
initialize | | buffer ← LinkedList new.
```

Table 13: *Class template for class* LinkedStack.

LinkedStack. The message push: is implemented by inserting the object passed as a parameter at the beginning of the buffer (ie: at position number 1). This is an easy operation for a singly linked list. The message pop is done by removing the first object from the buffer—another easy operation. The message top is implemented by accessing the object that is the entry of the first link of the buffer. We can use an instance of class LinkedStack in the example given for class SequentialStack by doing the following:

```
| stack |
stack ← LinkedStack new.
...
```

The rest of the example is unchanged.

The Queue

The *queue* is an important data structure that, like the stack, occurs often both in programming systems and outside the realm of programming (see figure 12). A queue is a linear list of items whose access is restricted to the two ends. An item can be appended to only one end of a queue, called the *rear*. An item can be removed only from the other end of the queue, called the *front* of the queue. This causes a sequence of items that are added to a queue and subsequently removed, to be accessed in a strict first-in-first-out fashion (ie: the first item that we put in a queue is the first item that we get out). Because of this, a queue is sometimes called a *FIFO* (first-in-first-out).

Lines of customers at a bank win-

COMPUTERS–TERMINALS–MODEMS!

MODEMS AND COUPLERS

Connect your Apple, TRS–80 or any other computer or terminal to the phone lines!

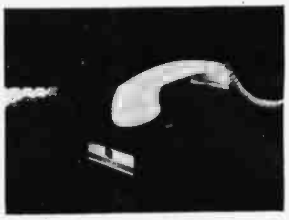
Penril

Penril 300/1200

Penril 300/1200—Bell 212A style $799
Bell 212A style. 1200 baud and 300 baud. Manual originate, auto-answer. Full duplex. RS232. Direct connect to phone lines via RJ11C standard extension phone voice jack. 1 year warranty.

U.S. Robotics
USR-330A
Bell 103/113 style
USR-330D
Bell 103/113 style

USR-330D $339
Bell 103/113 style. 330 baud. Manual originate, auto-answer. Half/full duplex. RS232. 1 year warranty. Direct connect to phone lines via RJ11C standard extension phone voice jack.
USR-330A $399
Same as USR-330D but includes auto-dial capability.

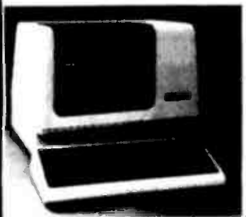


U.S. Robotics
The Phone Link Acoustic Modem

Bell 103/113 style $179
300 baud. Sleek, low profile. Originate and answer capability. Half/full duplex. Self-test. RS232. Light displays for On, Carrier, Test, Send Data, Receive Data. 15 oz.

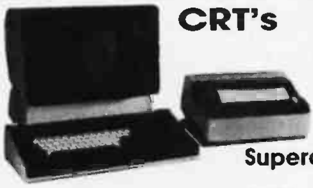
CRT's

Digital Equipment Corporation



DEC VT100

DEC VT100 ... $1668
Detachable keyboard. Separate numeric keypad with function keys. Business forms character set. Reverse video. Selectable double-size characters. Bidirectional smooth-scrolling. 80 cols or 132 cols. Split screen. Settable tabs. Line drawing graphic characters. Status line. Key-Click.



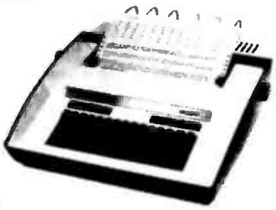
Perkin-Elmer Corporation
Superowl 1251

Perkin-Elmer Superowl 1251 .... $1564
Intelligent, editing CRT. Detachable keyboard. 32 fully programmable function keys. Intelligent printer part. Business forms character set. Block mode. Protected fields. Blinking fields. Numeric fields. Reverse video. Half intensity. Polling. Down line loading of options. Remote control of all options by host computer. Settable tabs. Status line. Separate numeric keypad. Transparent mode.

Perkin-Elmer Corporation

Bantam 550B $694
Compact. Silent. Upper/lower case. 80th col. wrap-around. Bell. Integrated numeric pad. Printer port. Transparent mode. Editing features. Tabbing.
Bantam 550E ... $755
Same as 550B plus separate numeric keypad and cursor direction keys.
Bantam 550S $879
Same as 550E plus block mode. 8 function keys, and protected fields, reverse video fields, half intensity fields, blinking fields.
550 Options
- 20mA Current Loop Interface $70
- Non-Glare Screen $25
- 2nd page of memory (550S only) .. $100

HARDCOPY TERMINALS & PRINTERS



Teletype Model 43

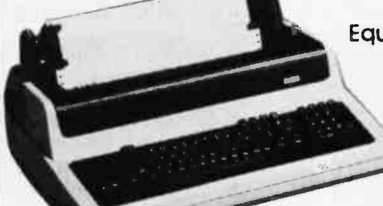
Teletype Corporation

Teletype Model 43 KSR with RS232 and Connector Cable $999
30 CPS. Dot matrix. 132 cols. True descenders on lower case. Excellent print quality for dot matrix printer. Pin feed.

DEC LA120

Digital Equipment Corporation

DEC LA120 ... $2388
180 CPS. Dot matrix. Upper/lower case. 1K buffer. Designed for 1200 baud communications. 30 character answerback message. Adjustable line spacing. Adjustable character sizes including double sized characters. Settable horizontal and vertical tabs. Top-of-form capability. RS232.

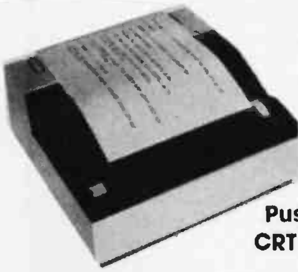


Digital Equipment Corp.

DEC LA34DA ... $939
30 CPS. Dot matrix. Upper/lower case. 4 character sizes. Up to 217 cols per line. 6 lines per inch settings. Friction feed. Settable tabs. RS232.
DEC LA34AA $1095
30 CPS. Dot matrix. Upper/lower case. 8 character sizes including double size characters. 6 lines per inch settings. Up to 217 cols per line. Friction feed. Settable horizontal and vertical tabs. Top-of-form capability.
Options for LA34AA and LA34DA
- Tractor Feed Mechanism $114
- Numeric Keypad w/ Function Keys .. $69
- Pedestal $100
- Paper Out Sensor $25
- APL Capability with APL Keycaps .. $499
- 2K Buffer with Text Editor and 1200 Baud Communications Capability $499

NEC Corporation
NEC Spinwriter 5510 & 5520

5520 KSR Spinwriter $3088
55 CPS. Impact printer. Selectric print quality. Changeable print fonts. 110, 300 and 1200 baud data rate. Numeric keypad. Friction and tractor feed.
5510 Spinwriter $2754
55 CPS. Impact printer. Selectric print quality. Changeable print fonts. 110, 300 and 1200 baud data rate. Friction and tractor feed.



Perkin-Elmer Corporation
Pussycat 650/655 CRT Screen Printer

650/655 Pussycat CRT Screen Printer. $899
100 CPS. Extremely compact and quiet. 110 to 9600 baud rate. 2K buffer. Ideal for producing rapid, reliable hardcopy of your CRT screen display. Can be added to any CRT with our interface option.

Circle 391 on inquiry card.

Leasing rates and lease/purchase plan information is available on request.
All equipment is shipped with a 10 day money back guarantee.
We offer full service, on site maintenance plans on all equipment.
All equipment in stock.

U.S. ROBOTICS INC.
203 N. WABASH SUITE 1718 CHICAGO, ILL 60601

SALES (312) 346-5650
GENERAL OFFICES (312) 346-5651
SERVICE (312) 733-0497

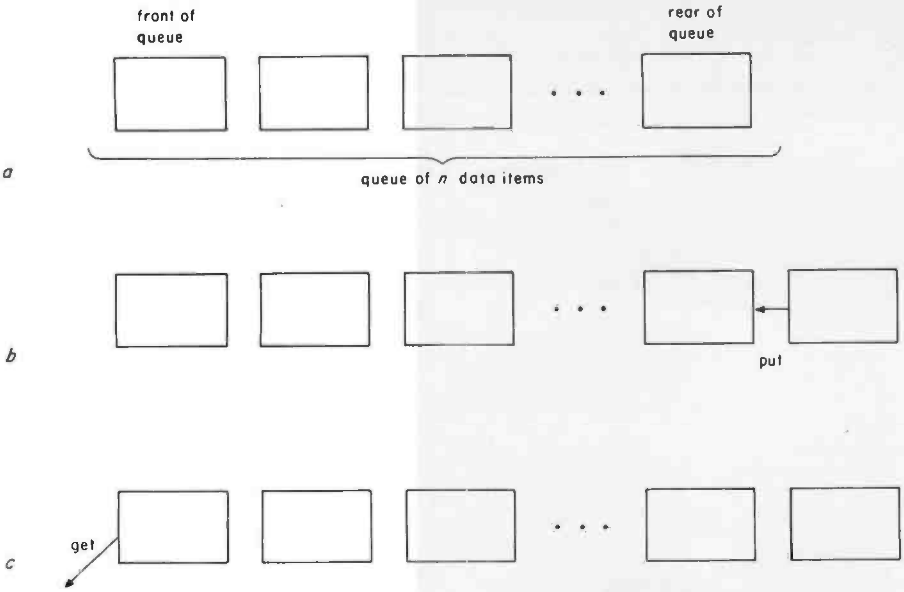


Figure 12: *A queue (12a) is a linear collection of objects arranged so that items can be added (or put) only at the rear of the queue (12b) and taken away (or gotten) only at the front of the queue (12c).*

dow or checkout counter are everyday examples of this kind of discipline. In programming systems, queues are used for many purposes, for example, to represent a line of customers in a simulation program or to handle ordered lists of events and processes in operating systems.

The operations we want to perform on a queue include:

- determine the number of items in the queue
- determine whether or not the queue is empty
- put an item in the queue
- get an item from the queue

Just as in the case of the stack, we can have different implementations of the queue depending on the type of buffer we use for storing the data items. Class Queue, which serves as a superclass for the queue classes, is given in table 14. Class Queue contains an instance variable named buffer that points to the object that provides the storage for items in the queue. The external messages have been listed to show what must be defined in all subclasses. The message emptyCheck, which sends an error message if the queue is empty, will be used in the implementation of get.

The Linked Queue

The first queue we will consider is the *linked queue*. A linked queue is one whose buffer is a linked list. Because we want to remove and add items easily, we will use a circular, singly linked list in our implementation. Class LinkedQueue is shown in table 15. An instance of class LinkedQueue is created by sending the creation message new to the class. For example:

```
| queue |
queue ← LinkedQueue new.
```

creates and initializes a new linked queue. The internal message initialize creates a new instance of CircularList and stores a pointer to it in buffer.

To put an object in a linked queue we use the message put:, passing the object as the parameter. This object is then added to the circular list by sending buffer the message append:. Similarly, the next object can be removed by using the message get. The method for get first checks to see if buffer is empty. If it is, an error message is sent. If not, the first object is removed from buffer and returned.

The messages count and empty are implemented by sending the respective messages to buffer and returning

class name	Queue
superclass	Object
instance variable names	buffer
class messages and methods	
"none defined here"	
instance messages and methods	

external
"count | | ... to be defined in subclasses"
"empty | | ... to be defined in subclasses"
"put: anObject | | ... to be defined in subclasses"
"get | | ... to be defined in subclasses"

internal
emptyCheck | | self empty ifTrue: [↑ self error: 'queue empty'].

Table 14: *Class template for class* Queue.

class name	LinkedQueue
superclass	Queue
instance variable names	"none defined here"
class messages and methods	

new | | ↑ (super new) initialize.

instance messages and methods	

external
count | | ↑ buffer count.
empty | | ↑ buffer empty.
put: anObject | | buffer append: anObject.
get | | self emptyCheck. ↑ buffer removeAt: 1.

internal
initialize | | buffer ← CircularList new.

Table 15: *Class template for class* LinkedQueue.

the result. A simple example of the use of LinkedQueue is the following:

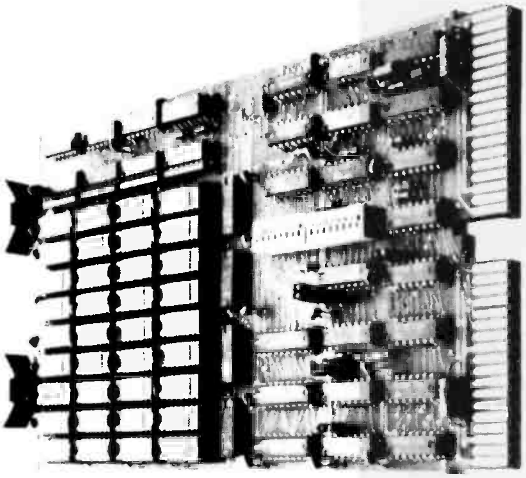
```
| queue a b c |
queue ← LinkedQueue new.
a ← (Card suit: 'heart' rank: 5).
b ← (Card suit: 'heart' rank: 6).
c ← (Card suit: 'heart' rank: 7).
queue put: a.
queue put: b.
queue put: c.
a ← queue get.
b ← queue get.
c ← queue get.
```

This sequence creates an instance of class LinkedQueue and assigns to the variables a, b, and c, instances of class Card with ranks 5, 6, and 7, respectively. These instances are put into the queue in the order listed and are then removed and assigned to the variables a, b, and c. The original order is preserved; the ranks of a, b, and c are 5, 6, and 7, respectively.

The Sequential Queue

The next implementation of a queue that we might expect to see is

STATE OF THE ART MEMORY SYSTEMS



256KB LSI 11/23® SINGLE DUAL WIDTH BOARD

The First and Only 256KB Memory on a Single Dual Board.

4 MEGABYTE ADDRESS FIELD — Most memories available for the DEC PDP 11/23 are only addressable to 256K bytes (18 address lines). The CI-1123 is addressable to 4 mega bytes (22 address lines) so there is no need to worry about obsolescence.

FAST ACCESS AND CYCLE TIME — With an access time of 240 NSEC and cycle time of 400 NSEC one is insured the best throughput on the PDP 11/23 system.

PARITY — The CI-1123 generates and checks parity for each byte of memory. Totally DEC compatible.

BATTERY BACKUP POWER CONSUMPTION — Power requirement for the module is only 1.2 AMP from the 5 volt supply. The CI-1123 is easily configured for battery back-up mode of operation requiring only 300MA from a single 5 V back-up supply for 256KB memory in the down state.

SINGLE QTY. PRICE: 32K x 18 **$575.** 128K x 18 **$1925.**

512KB SINGLE BOARD MULTIBUS® MEMORY

State of the Art Multibus Memory Design.
First to Offer 512KB on One Board.

The CI-8086 module is compatible with both 8 or 16 bit Multibus Systems.

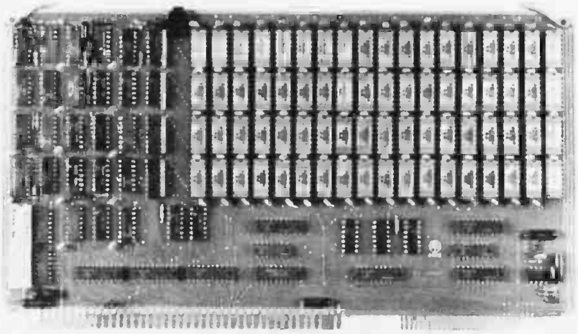
PARITY — The CI-8086 generates and checks even parity with selectable interrupt on parity error.

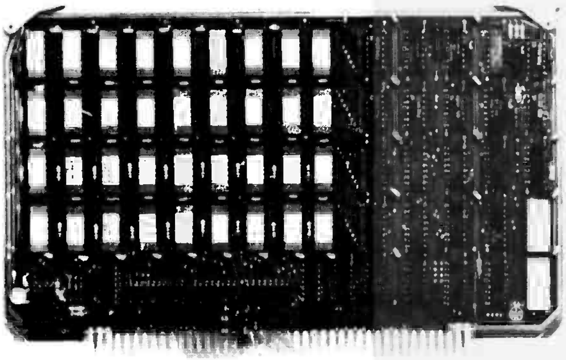
FAST ACCESS AND CYCLE TIME — Data access is 270 NSEC and cycle time is 375 NSEC.

16 MEGA BYTE ADDRESSING — The memory is addressable in 16K increments up to 16 mega bytes.

LOW POWER CONSUMPTION — Total power consumption is under 8 watts.

SINGLE QTY. PRICE: 128K x 9 **$1350.** 512K x 9 **$2995.**





64K x 9 EXORCISER® I SINGLE BOARD MEMORY

For Exorciser I, Exorciser II and Rockwell System 65.

FAST ACCESS AND CYCLE TIME — Data access time is 225 NSEC and cycle time is 400 NSEC, allowing the unit to work as a static RAM at clock rates in excess of 1.5 mega hertz. For 2 mega hertz operation the board can be easily configured to utilize a cycle stealing refresh operation.

ADDRESSING — On-board memory select is available in 4K increments up to 64K words of memory on either the VUA or VXA control inputs.

PARITY — On board even parity with output jumper select to the system bus as a parity error or non-maskable interrupt.

Complete board power consumption is under 7 watts.

SINGLE QTY. PRICE: 64K x 9 **$575.**

Tested and burned in. Full year warranty.

DON'T ASK WHY WE CHARGE SO LITTLE, ASK WHY THEY CHARGE SO MUCH.

Chrislin Industries, Inc.

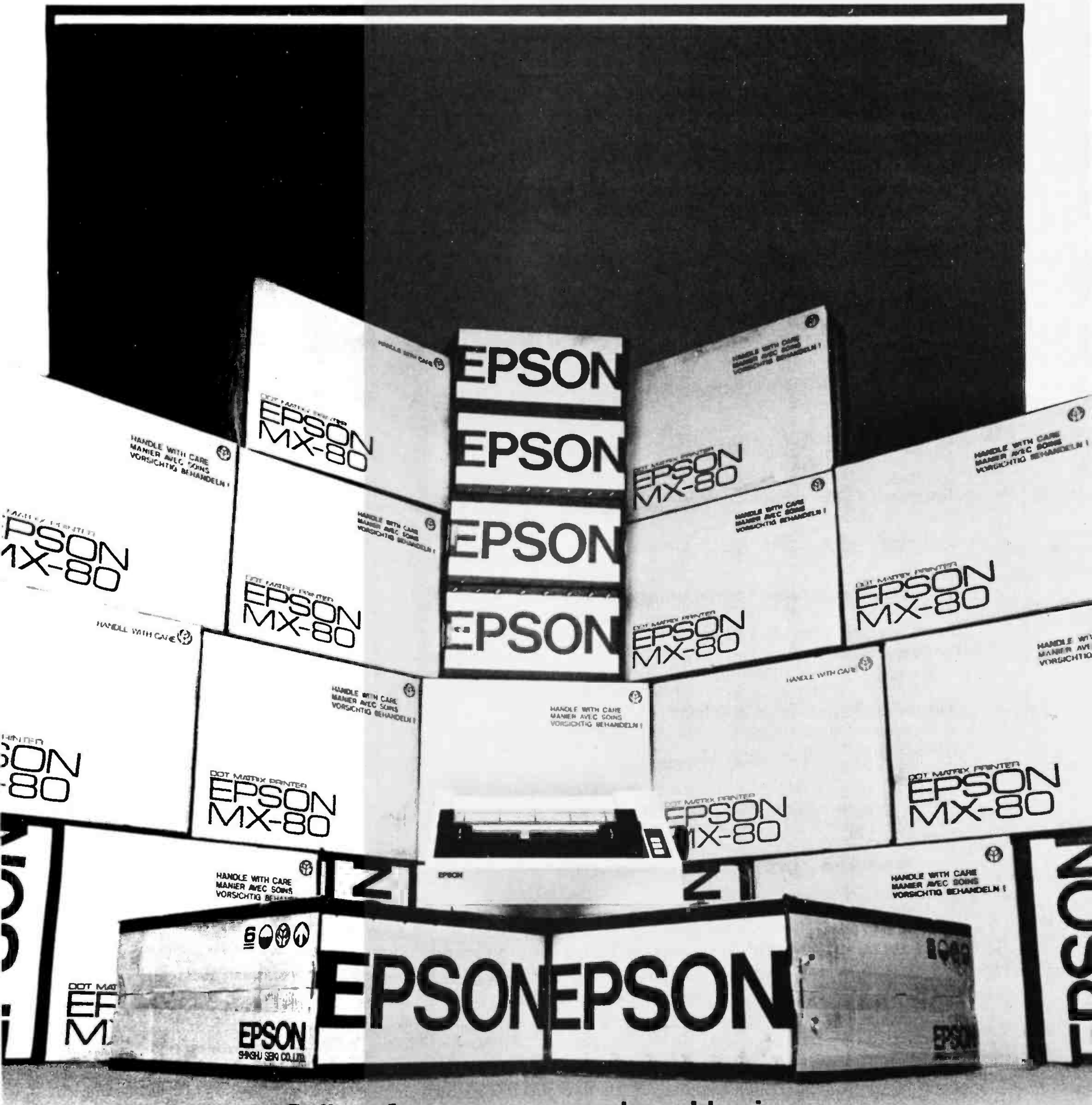
31352 Via Colinas • Westlake Village, CA 91362 • 213-991-2254

Circle 54 on inquiry card.

one that uses a sequential list to store data items. Unfortunately, a sequential list is not well suited to this purpose, because we need to add items to one end of the list and remove them from the other. You will recall that adding items to the end of a sequential list is an easy operation, but removing them from the beginning is difficult since we have to copy forward all of the succeeding items in the list. Rather than copy forward all items after the first, we would prefer to ignore the item at position 1 of the list and consider the item at position 2 to be the first item in the list. The problem, however, is that as items are added and removed from the list, the actual positions of the first and last items migrate toward the end of the list. This could cause the list to expand even if it is not full. Fortunately, we can treat the last position in the list as if it preceded the first position: that is, we consider the list to be circular. After we have added an item to the last position, we can start adding items to the beginning of the list, provided some have already been removed. If we use this strategy, then we don't have to expand the list until it is full.

The class definition in table 16 uses the strategy just described to implement a queue using sequential storage. Class SequentialQueue uses an instance of class IndexedTable as its buffer. Since class IndexedTable does not provide facilities for counting the number of objects stored in an instance (those facilities are provided by class LinearList), we need to define an instance variable count in class SequentialQueue. Additionally, we have instance variables named front and rear. front is the index of the first object stored in buffer (an instance of class IndexedTable); rear is the index of the last object stored in buffer. Since we are treating buffer as a circular sequence of positions, front and rear will repeatedly cycle through the values between the lower and upper bounds of buffer.

ALPHA BYTE DOES IT AGAIN...



Call us for our never undersold price.

ALPHA BYTE STORES

(213) 883-8594

Circle 360 on inquiry card.

5115 Douglas Fir Road • Suite B • Calabasas, CA 91302

class name	SequentialQueue
superclass	Queue
instance variable names	front rear count
class messages and methods	

```
size: an Integer | |
   (anInteger < 1) ifTrue: [ ↑ self error: 'invalid size' ].
   ↑ (self new) buffer: (IndexedTable from: 1 to: anInteger) count: 0.
```

instance messages and methods

```
external
count | | ↑ count.
empty | | ↑ count = 0.
put: anObject | |
   (count = buffer size) ifTrue: [ self expand. ].
   buffer put: anObject at: rear.
   rear ← self advance: rear.
   count ← count + 1.
get | anObject
   | self emptyCheck.
   anObject ← buffer at: front.
   front ← self advance: front.
   count ← count − 1.
   ↑ anObject.

internal
buffer: anIndexedTable count: anInteger | |
   buffer ← anIndexedTable. count ← anInteger.
   front ← buffer lowerBound. rear ← front + count.
advance: anInteger | |
   anInteger = buffer upperBound
      ifTrue: [ ↑ buffer lowerBound ] ifFalse: [ ↑ anInteger + 1 ].
expand | anIndexedTable anInteger |
   anIndexedTable ← IndexedTable from: 1 to: (2 * buffer size).
   anInteger ← front.
   1 to: count do:
      [: i | anIndexedTable put: (buffer at: anInteger) at: i.
      anInteger ← self advance: anInteger. ].
   self buffer: anIndexedTable count: count.
```

Table 16: *Class template for class* SequentialQueue.

Because we are using an instance of class IndexedTable for storing objects, we must specify an estimate of the maximum size of an instance of class SequentialQueue when we create it. This is done with the creation message size:, which creates a new instance of SequentialQueue and sends it the internal messsage buffer:count:. The first parameter of buffer:count: is an instance of class IndexedTable; the second is the number of objects stored in the first parameter (initially zero).

The message buffer:count: is also sent from the internal message expand, which is used to expand buffer when it becomes full. expand is implemented by creating a new instance of IndexedTable that is twice as large as the current one. All of the objects stored in buffer are copied to the first half of the new instance, which then becomes the new buffer.

The internal message advance is used to advance the values of front and rear. Normally, this is done by incrementing the current value by 1. However, if the current value is equal to the upper bound of buffer, then we must set the value back to the lower bound of buffer. The external messages are those specified in the superclass Queue. The message count returns the value of the instance variable count. The message empty tests to see if count is zero.

For the message put:, we first test to see if buffer is full. If buffer is full, it is expanded using the message expand. The object passed as a parameter to put: is then stored in buffer at the position indicated by rear. rear is then advanced one position forward, using the message advance. Finally, the value of count is incremented.

Similarly, for the message get, we first test to see if the queue is empty. If it is, an error message is sent; otherwise, the object stored at the position indicated by front is removed from buffer. front is advanced one position forward, and the value of count is decremented. Finally, the removed object is returned.

Summary

The class construct is an extremely useful tool for implementing data structures. Implementing a data structure with a class makes it possible to confine the details of the implementation to one place and to insure that the resulting object will be accessed by the rest of the system in a secure manner, namely, through the use of a set of messages that correspond to the operations that are well defined for that data structure. Additionally, the ability to create subclasses makes it possible to share variables and methods among similar class definitions, thereby reducing the amount of work needed to implement a set of data structures. ■

References

1. Horowitz, E and Sartaj, S. *Fundamentals of Data Structures*. Potomac MD: Computer Science Press, 1976.
2. Knuth, D E. *The Art of Computer Programming: Volume 1/Fundamental Algorithms*, Second Edition. Reading MA: Addison-Wesley, 1973.
3. Robson, D and Goldberg, A. "The Smalltalk-80 System," August 1981 BYTE, page 36.
4. Wirth, N. *Algorithms + Data Structures = Programs*. Englewood Cliffs NJ: Prentice-Hall, 1976.

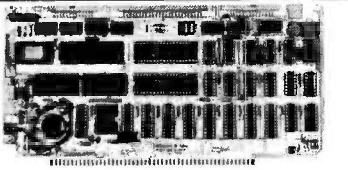
asap computer products, inc.

NEW LOCATION
1198 E. Willow Street
Signal Hill, CA 90806
Toll Free (800) 421-7701 Outside Calif.
(213) 595-6431 Inside Calif.

ORDERING INFO
Name, address, phone
Ship by UPS or Mail
Shipping Chrg. Add $2.50 up to 1 lb. Call for larger shipments
Freight, U.S. Mail Add $1.50
U.S. Only up to 2 lbs.

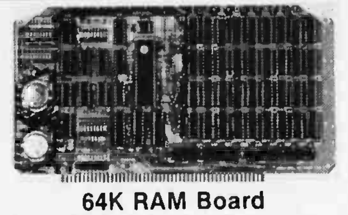
TERMS
We Accept Cash, Check, Money Orders, Visa & Master Charge
(U.S. Funds Only)
Tax: 6% Calif. Res.
COD's & Terms Available on Approval (School PO's Accepted)
($25.00 Minimum Order)

MICROBYTE S-100 BOARDS



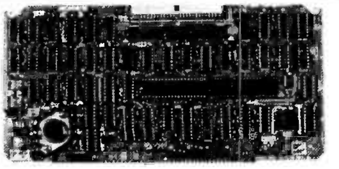
Z-80A/I-O $349.00
Assembled & Tested
Optional Monitor Program $50.00

- A complete single board Z-80A CPU with serial/parallel interface
- Fully compatible with the proposed IEEE S-100 Bus Standard
- Z-80A CPU (4MHz version of the Z-80)
- 158 instructions—superset of and upward compatible from the 8080's 78 instructions
- Up to 4K of on board Eprom with optional Z-80 monitor program — 1K(2708), 2K(2716) or 4K(2732)
- Full vectored interrupt capability — 8 bit with MNI (1 bit)
- 2MHz or 4MHz operation is jumper selectable
- Selectable auto-wait state insertion for extending M1*, MREQ*, IORQ* and/or on board ROM
- Dual RS-232 serial I/O ports using the Z80A-DART with individual baud rate selection (from 50-19,200 baud)
- Up to 24 bit parallel I/O port—fully programmable Intel 8255A



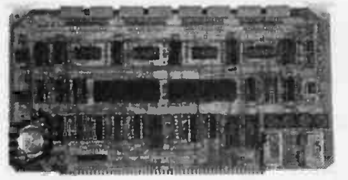
64K RAM Board
Assembled & Tested *Call for Price*

MICROBYTE
- Fully S100 bus compatible
- 64K x 8 bit dynamic RAM
- Low power
  - 8VDC @ 700 ma
  - 16VDC @ 100 ma
  - −16VDC @ 25 ma
- Built-in-parity with LED indicator and vector interrupt
- Memory addressable in four 16K banks
- Hidden refresh
- Gold contacts for high reliability
- 72-hour Burn-in
- Memory mapped via DIP switch
- Built-in programmable write-protect
- Programmable control port for parity and bank control
- Alpha Micro Compatible



Disc Controller $389.00
Assembled & Tested
CPM Available (Optional)

MICROBYTE
- DMA to within 16M byte of memory
- State-of-the-art NEC765 LSI Controller
- IEEE-S100 compatible
- DMA arbitration allows use of multiple boards within a system
- PLL data recovery for totally reliable operation
- Write pre-comp switched at mid-disc for reliable double density operation
- Supports up to four (4) drives
- Power On, Power Off or Reset deselects drives to avoid damaging files
- Drive deselect Time Out, deselect drives not in use
- Single or double sided operation
- Single density/double density operation
- 8" standard drives
- Separate V_{CC} supply for data recovery to eliminate possible noise problems



I/O Board $289.00
Assembled & Tested
Cables Available (Optional)

MICROBYTE
- Quad RS-232C Serial Ports, One 20mA Current Loop Port
- Fully IEEE S-100 Bus Compatible
- Asynchronous Communications with Z80A-Dart(TM) or Synchronous Communications with Z80A-SIO(TM)
- Full Set of Modem Control Signals, including RI (Ring Indicator)
- Easily Configurable to Any Type of Terminal Interface
- I/O Servicing Environments: (1) Polled, (2) Bus Vector, (3) Z80 Mode 2 Vector
- Off-Board Interrupt Daisy Chain Capability
- Special Receive Conditions: (1) Framing Error; (2) Parity Error; (3) Receiver Overrun Error
- Baud Rates Selected Individually from 50 Baud to 300K Baud
- 72 Hour Burn-In

CALIFORNIA COMPUTER

2032	32K STATIC RAM BRD.
2065	64K DYNAMIC RAM BOARD
2116	16K STATIC RAM BRD.
2200	MAINFRAME
2422	DISK CONTROLLER
2501	MOTHERBOARD
2710	4-PORT SERIAL I/O
2718	2 SER. PORT & 2 PAR.
2720	4-PORT PARALLEL I/O
2802	6502 CPU BOARD
2810	Z-80 CPU BOARD
7114A	12K ROM/PROM BRD.
7424A	CALENDAR CLOCK BD.
7440A	PROGRAMMABLE TIMER
7470	A/D CONVERTER
7710A	SERIAL SYNCH. BRD.
7712A	SERIAL SYNCH. BRD.
7720A	PARALLEL INTERFACE
7728A	CENTRONICS INTERFACE

CALL FOR PRICE & DELIVERY

SD SYSTEM / S-100 BOARDS

EXPANDORAM I
2 MHz DYNAMIC RAM BOARD KITS

16K	$240.00
32K	$258.00
48K	$276.00
64K	$294.00

EXPANDORAM II
4 MHz DYNAMIC RAM BOARD KITS

16K	$250.00
32K	$268.00
48K	$286.00
64K	$304.00

SBC-100 KIT
2.5 MHz/Z80 CPU with Serial I/O Ports & SBC 100 Monitor of your choice at No Chrg.
$299.00

SBC-200 KIT
4 MHz/Z80A CPU with Serial & Parallel I/O Ports & SBC 200 Monitor of your choice at No Chrg.
$325.00

VERSAFLOPPY I KIT
Disk Controller for 5¼" & 8" Drives, Single or Double Sided/Single Density, S-100 Compatible
$250.00

VERSAFLOPPY II KIT
Disk Controller for 5¼" or 8" Drives, Single or Double Sided/Single or Double Density, S-100 Compatible
$300.00

PROM 100 KIT
S-100/EPROM PROGRAMMER for 2708, 2716, 2732 & (TI) 2516
$210.00

ALL BOARDS ARE AVAILABLE ASSEMBLED & TESTED CALL FOR PRICES

ATARI 800

(16K) PERSONAL/BUSINESS COMPUTER

- Computer Console
- Atari 8K Basic
- 57 Full Stroke Alpha-numeric keys & (4) Function Keys
- Operators Manual
- RF Modulator
- Power Supply

CALL FOR PRICE

★ *Add'l 16K RAM FREE w/Purchase of System*

ATARI OPTIONAL ACCESSORIES

MODEL #	DESCRIPTION	PRICE
810	Disk Drive System	$ 475.00
815	Disk Drive System	$1199.00
820	40-col. Dot Matrix Printer	$ 279.00
822	40-col. Thermal Printer	$ 349.00
825	80-col. Dot Matrix Printer	$ 625.00
830	Acoustic Modem	$ 159.00
850	Interface Module	$ 139.00
410	Cassette Recorder	$ 60.00

ATARI SOFTWARE

Description	Price
Basketball	$29.00
Super Breakout	$28.00
Chess	$28.00
Video Easel	$29.00
3-D Tic Tac Toe	$28.00
Star Raiders	$34.00
Music Composer	$42.00
Educational System ROM	$19.95
Assembler/Editor	$45.00
Telelink I	$19.95
Space Invaders	$15.95
Kingdom	$12.95
Blackjack	$12.95
Biorhythm	$12.95
Graph It	$15.95
Energy Czar	$12.95
Mailing List	$16.95
Statistics I	$16.95
Paddle Controls	$17.95
Joysticks (pair)	$17.95
Touch Typing	$19.95
Stock Charting	$19.95
Stock Analysis	$19.95
Bond Analysis	$19.95
Scram	$16.95

MANY MORE AVAILABLE

MAIN/FRAME & DISK DRIVE CABINETS from INTEGRAND

MODEL X5 — Desktop Mainframe - 5 Cards - Small Power Supply $200
Cabinet size: 9.4"w x 16"d x 7.5"h. Cabinet painted dove grey, front panel is black. **No optional colors!** 5-position motherboard, 5 connectors installed, card cage with all guides. Reset switch on front panel. Power switch, 4 DB25 cutouts, 1 BNC mounting hole, 70CFM fan, EMI filter, 6' power cord, line fuse, and clamped flat cable exit on rear panel. PX/5 power supply (+8@10A, +16@1.5A, −16@1.5A). Power supply is a removable module.

MODEL 7000 — Horizontal Desktop Disk/Cover - 2 Eight Inch Drives - Drives Horizontal $265
Cabinet size: 20"w x 23"d x 7.5"h. Cabinet painted dove grey, front panel is black. Mounting for 2 eight-inch Shugart SA801R Floppy Disk Drives (or mechanical equivalent). Drive mounting brackets supplied. Drives not supplied. 70CFM fan, 6' three-wire line cord, power switch, line fuse, EMI filter and clamped flat cable exit on rear panel. P794 power supply: +5@4A, +24@5A—6A peak, −5@.75A. All voltages regulated. Power supply is a removable module.

MODEL 8000 — Desktop Main/Frame - 15 Cards - Standard Power Supply $255
Cabinet size: 17"w x 20.5"d x 7.5"h. Cabinet painted dove grey, front panel is black (other color schemes optional). 15-position IEEE compatible motherboard (will accept T801 terminator kit, optional), card cage with all guides. Reset switch on front panel. Power switch, 8 DB25 cutouts, 2 BNC mounting holes, 70CFM fan, EMI filter, 6' power cord, line fuse, and clamped flat cable exit on rear panel. P800 power supply (+8@15A, +16@3A, −16@3A). Power supply is a removable module. Motherboard connectors optional.

MODEL 7000S — Vertical Desktop Disk/Cover - 2 Eight Inch Drives - Drives Vertical $265
Cabinet size: 13.5"w x 23"d x 11"h. Cabinet painted dove grey, front panel is black. Mounting for 2 eight-inch Shugart SA801R Floppy Disk Drives (or mechanical equivalent). Drive mounting brackets supplied. Drives not supplied. 70CFM fan, 6' three-wire line cord, power switch, line fuse, EMI filter and clamped flat cable exit on rear panel. P794 power supply: +5@4A, +24@5A—6A peak, −5@.75A. All voltages regulated. Power supply is a removable module.

PRINTERS

MFG./MODEL #	PRICE
ANACOM-150	$ 995.00
ANADEX-9501	$1300.00
BASE 2-800B	$ 650.00
CENTRONICS 739	$ 795.00
DIABLO-630R0	$2300.00
C. ITOH-Starwriter 45	$1925.00
TEXAS INSTR.-810	$1650.00

MONITORS

MFG.	MODEL #	PRICE
Amdek	100/12" B&W	$139.00
Amdek	100-80	$169.00
Amdek	100G/12" Grn.	$169.00
Amdek	Color I	$399.00
APF	TVM-10/10" B&W	$149.00
Hitachi	VM910/9" B&W	$210.00
Hitachi	VM129/12" B&W	$340.00
Sanyo	DM5012/12" B&W	$260.00
Sanyo	DM5112ex/12" Grn.	$280.00
Sanyo	DMC6013/13" Color	$450.00

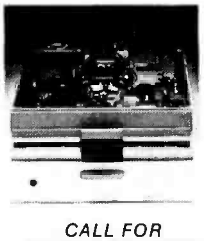
MODEMS

MFG.	MODEL #	PRICE
Novation	CAT	$149.00
Novation	D-CAT	$169.00
Novation	Auto-CAT	$229.00
Lexicon	Lex-11	$139.00
Livermore	LIV-Star 20M	$149.00
UDS	UDS 103	$189.00
UDS	UDS 202	$295.00

TERMINALS

MFG.	MODEL #	PRICE
Ampex	Dialogue 80	$ 945.00
Soroc	IQ120	$ 750.00
Soroc	IQ140	$1250.00
Televideo	TVI 910C	$ 625.00
Televideo	TVI 912C	$ 725.00
Televideo	TVI 920C	$ 760.00
Televideo	TVI 950C	$ 975.00

QUME DT-8 DISK DRIVE



Specifications
- Double-sided Sgle-Dble Density
- IBM-compatible 1.2 Mbytes/Disk
- Fast—3 ms. Track to Track
- 154 Tracks/Daisy Chain 4 Drives
- ISO Standard Write Protect
- Programmable Door Lock

CALL FOR PRICE & DELIVERY

O.E.M. Pricing Available on Request
120 Day Factory Warranty

WAMECO INC. Bare Boards & Kits

KITS

PART #	DESCRIPTION	PRICE
EPM-1	4K EPROM	$ 59.95
EPM-2	16K or 32K EPROM	$ 74.95
MEM-1	8K Static	$ 71.95
MEM-2	16K Static	$ 80.95
FPB-1	Front Panel	$159.95
CPU-1	8080A CPU	$119.95
RTC-1	Real Time Clock	$ 75.95
QMB-9	9 Slot Motherboard	$ 99.95
QMB-12	12 Slot Motherbrd.	$109.95

KITS LESS EPROM OR RAM CHIPS

BARE BOARDS

PART #	DESCRIPTION	PRICE
EPM-1	4K EPROM	$29.95
EPM-2	16K or 32K EPROM	$29.95
MEM-1	8K Static	$29.95
MEM-2	16K Static	$31.95
MEM-3	32K Static	$35.95
FPB-1	Front Panel	$49.95
FDC-1	Disk Controller	$44.95
CPU-1	8080A CPU	$31.95

BARE BOARDS

PART #	DESCRIPTION	PRICE
CPU-2	Z80 CPU	$39.95
RTC-1	Real Time Clock	$27.95
QMB-9	9 Slot Motherboard	$34.95
QMB-12	12 Slot Motherbrd.	$39.95
CRT-1	80 x 24 Video	CALL
IOB-1	2 Par. & 1 Ser. I/O	CALL
IOB-2	8-Parallel I/O Ports	$35.95
IOB-5	4-Serial I/O Ports	$35.95

Circle 25 on inquiry card.

COMPONENTS

4116's (200 ns.)
Apple, TRS-80, Heath
8 for $18.80

16-49	$2.25 ea.
50-99	$2.15 ea.
100 Up	$2.05 ea.

2114 L-2/200 NS

Lo-Power 1Kx4 Static RAM

1-16	$3.05 ea.
17-49	$2.95 ea.
50-99	$2.85 ea.
100 Up	$2.70 ea.

74LS240	$1.25 ea.
74LS241	$1.10 ea.
74LS244	$1.25 ea.
74LS373	$1.25 ea.
74LS374	$1.25 ea.
8T245	$1.50 ea.

2708/450 NS

1K x 8 EPROM
$4.25 ea.
or
8/$32.00

2716/5 VOLT

2K x 8 EPROM
$6.95 ea.
1 YR. WARRANTY

8080A - CPU	$ 2.50
Z80A - CPU	$ 8.95
Z80A - CTC	$ 8.95
Z80A - DART	$13.95
Z80A - SIO	$22.00
8255AC5	$ 6.95
8257AC5	$15.00

320T5	.80	320T12	.80
340T5	.70	340T12	.75

	1-9	10-24	25 Up
DB25P	2.65	2.50	2.40
DB25S	3.60	3.40	3.25
DB25C	1.00	.90	.80

100 PIN IMSAI

Gold / S-100
Soldertail
Connectors
$2.40 each
OR
10/$2.25 each

CAPACITORS

.1 @ 12 Volt
Ceramic
8¢ ea.
or
100/$7.00

DISKETTES FROM asap

VERBATIM

5¼" DISKETTES

PART #	SECTORING	PRICE
MD525-01	SOFT SECTOR	10/27.50
MD525-10	HARD 10 SECTOR	10/29.50
MD525-16	HARD 16 SECTOR	10/29.50

8" DISKETTES

PART #	SECTORING	PRICE
FD32-1000	HARD SECTOR	10/35.00
FD34-1000	SOFT SECTOR	10/35.00

MEMOREX

5¼" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
MEM 3401	1/SINGLE	SOFT SECTOR	10/25.00
MEM 3403	1/SINGLE	HARD 10 SECTOR	10/25.00
MEM 3405	1/SINGLE	HARD 16 SECTOR	10/25.00

8" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
MEM 3060	1/SINGLE	SOFT SECTOR	10/35.00
MEM 3101	2/SINGLE	SOFT SECTOR	10/45.00
MEM 3090	1/DOUBLE	SOFT SECTOR	10/45.00
MEM 3102	2/DOUBLE	SOFT SECTOR	10/55.00

DYSAN

5¼" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
D-0130	1/SINGLE	SOFT SECTOR	10/50.00
D-0225	1/DOUBLE	SOFT SECTOR	10/53.00
D-0235	2/DOUBLE	SOFT SECTOR	10/65.00

8" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
D-0505	1/SINGLE	SOFT SECTOR	10/59.00
D-0605	2/DOUBLE	SOFT SECTOR	10/75.00

SCOTCH 3M

5¼" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
744-0	1/SINGLE	SOFT SECTOR	10/33.00
744-10	1/SINGLE	HARD 10 SECTOR	10/33.00
744-16	1/SINGLE	HARD 16 SECTOR	10/33.00
745-0	2/DOUBLE	SOFT SECTOR	10/59.00
745-10	2/DOUBLE	HARD 10 SECTOR	10/59.00
745-16	2/DOUBLE	HARD 16 SECTOR	10/59.00

MAXELL

5¼" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
MD1	1/SINGLE	SOFT SECTOR	10/39.00
MD2D	2/DOUBLE	SOFT SECTOR	10/65.00
MH1	1/SINGLE	HARD 16 SECTOR	10/39.00
MH2D	2/DOUBLE	HARD 16 SECTOR	10/65.00

8" DISKETTES

PART #	SIDES/DENSITY	SECTORING	PRICE
FD1-128	1/SINGLE	SOFT SECTOR	10/45.00
FH1-32	1/SINGLE	SOFT 32 SECTOR	10/45.00
FD2-XD	2/DOUBLE	SOFT SECTOR	10/55.00

SRW

MEDIA STORAGE CASES

PART #	SIZE	PRICE
SRW-5	5¼"	$2.50 ea.
SRW-8	8"	$3.25 ea.

DIP SOCKETS/LOW PROFILE TIN SOLDERTAIL

DESCRIPTION	1-9	10-49	50-99	100 Up
14 PIN TIN ST	.15	.13	.12	.11
16 PIN TIN ST	.16	.14	.13	.12
18 PIN TIN ST	.19	.18	.16	.14
20 PIN TIN ST	.25	.23	.21	.20
24 PIN TIN ST	.26	.24	.22	.20
28 PIN TIN ST	.32	.30	.29	.27
40 PIN TIN ST	.42	.40	.38	.34

INTRODUCING
asap's Atari 800

Computer System • 16K RAM Module
$75.00
1 YEAR WARRANTY PARTS AND LABOR

PERSONAL SOFTWARE for APPLE, TRS80, PET, & ATARI

DESCRIPTION	PRICE
VISICALC APPLE DISK	125.00
DESKTOP PLAN APPLE DISK	79.95
MICROCHESS 2.0 APPLE DISK	21.95
MICROCHESS 2.0 APPLE	17.95
CHECKER KING APPLE DISK	21.95
CHECK KING APPLE	17.95
GAMMON GAMBLER APPLESOFT DISK	21.95
GAMMON GAMBLER APPLE	17.95
BRIDGE PARTNER APPLESOFT DISK	21.95
BRIDGE PARTNER APPLE	17.95
CCA DATA MGMT SYS APPLE DISK	79.95
MICROCHESS 2.0 8-32K PET	17.95
CHECKER KING PET	17.95
GAMMON GAMBLER PET	17.95
BRIDGE PARTNER PET	13.95
VISICALC - PET	175.00
CCA DATA MGMT SYS TRS80 DISK	65.00
MICROCHESS 1.5 TRS80	17.95
CHECKER KING TRS80	17.95
BRIDGE PARTNER TRS80	13.95
TIME TREK TRS80	13.95
VITAFACTS PKG/6 PET APPLE TRS	100.00
VISICALC - ATARI	175.00

APPLE SOFTWARE
by EDU-WARE

DESCRIPTION	PRICE
COMPU-MATH (FRACTIONS)	29.95
COMPU-MATH (DECIMALS)	29.95
COMPU-READ	19.95
EDU-PAK I	35.00
TERRORIST	24.95
WINDFALL	16.95
NETWORK	16.95
SPACE	24.95
PRISONER	24.95

(ALL SOFTWARE ON DISK)

PANAVISE

BASES, HEADS, MTS. & COMBINATIONS

PART #	DESCRIPTION	PRICES
300	STANDARD BASE	11.95
301	STANDARD PANAVISE	24.95
303	STANDARD HEAD	14.49
304	LOW PROFILE HEAD	15.25
305	LOW PROFILE BASE	11.95
308	WEIGHTED BASE	14.25
310	SURFACE PLATE	33.95
311	BENCH CLAMP	14.49
315	CIRCUIT BOARD HOLDER	16.95
333	RAPID ASSEMBLY	30.95
350	WORK CENTER STATION	38.95
366	WIDE OPEN HEAD	13.95
376	SELF-CENTERING HEAD	16.95
380	VACUUM BASE	16.95

ACCESSORIES

PART #	DESCRIPTION	PRICE
316	EXTRA ARMS	9.50
318	12" BAR	3.49
343	NYLON JAWS (PAIR)	2.00
344	GROOVED NYLON JAWS	2.00
346	NEOPRENE JAWS	2.50
353	STEEL JAWS	2.95
359	UNIVERSAL HOLDER	6.95

SHUGART 801R DISK DRIVE

Capacity	Single Density	Double Density
Unformatted		
Per Disk	400K	800K
Per Track	5.2K	10.4K
IBM Format		
Per Disk	256K	512K
Per Track	3328	6656
Transfer Rate	250 kilobit/sec	500 kilobits/sec
Latency (avg.)	83 ms	83 ms
Access Time		
Track to Track	8 ms	8 ms
Average	260 ms	260 ms
Settling Time	8 ms	8 ms
Head Load Time	35 ms	35 ms

Model 801 .... $400.00
Case & Power Supply $265.00

ZIP DIP II®

Zero Insertion Pressure Test Socket

PART #	PINS	1-9	10-24	25 UP
ZD1116	16	5.35	5.15	4.95
ZD1124	24	7.35	7.10	6.85
ZD1140	40	9.75	9.50	9.25

DIP SWITCHES®

PART #	POSITIONS	1-9	10-24	25 UP
DS4P	4	1.25	1.20	1.15
DS5P	5	1.30	1.20	1.10
DS6P	6	1.35	1.25	1.10
DS7P	7	1.40	1.25	1.10
DS8P	8	1.40	1.20	1.05

IDS SOCKET CONNECTORS
Crimp-On Type

Contacts	1-9	10-24	25 Up
20 PINS	2.95	2.75	2.50
26 PINS	3.25	2.95	2.75
34 PINS	4.45	4.25	3.95
40 PINS	5.65	5.35	4.95
50 PINS	5.95	5.65	5.25

IDS CARD-EDGE CONNECTORS
Crimp-On Type

Contacts	1-9	10-24	25 Up
20 PINS	3.95	3.75	3.50
26 PINS	4.95	4.55	4.25
34 PINS	5.25	4.95	4.75
40 PINS	6.25	5.85	5.50
50 PINS	6.95	6.35	5.95

The Epson MX-80
80 COLUMN DOT MATRIX PRINTER

SPECIFICATIONS
Print method · serial impact dot matrix
Print rate · 80 CPS
Print direction · bidirectional
Number of pins in head · 9
Matrix · 9 x 9
Line spacings · 1/8", 1/6", 7/72" + programmable
Throughput at 10 CPI · logical seeking function · 105 LPM, 20 character line; 73 LPM, 43 char. line; 48 LPM, 80 char. line

PRINTING CHARACTERISTICS
Character set · full 96-character ASCII with descenders
Graphics characters · 64 block characters

INTERFACES
Standard · Centronics-style 8-bit parallel
Optional · RS232, IEEE488.
Buffer size · 1 line

New MX80FT Available
CALL FOR PRICE & DELIVERY

MICROBYTE 32K STATIC RAM BOARD

- 2 MHz or 4 MHz operation
- 4K hardware or software selectable
- Will operate with or without front panel
- Low power consumption 800mA
- Fully warranted for 120 days from date of shipment
- Uses Intel low-power 2141L-4 4Kx1 Static RAM
- Each 4K bank addressable to any 4K slot within a 64K boundary

$450.00

- Fully S100 bus compatible IMSAI, SOL, ALTAIR, ALPHA MICRO

GODBOUT 32K ECONORAM XX
Static S-100 Memory

32K Bank Select. IEEE S-100 compatible. One 32K block can be addressed on 4K boundaries. Compatible with IEEE proposed standard of 24 address lines and all currently used bank select configurations. Disable any or all of the eight 4K blocks to create as many windows in memory to avoid system memory conflicts.

PART #	DESCRIPTION	PRICE
GB ER XX 16K	16K A & T	$339.00
GB ER XX 24K	24K A & T	$449.00
GB ER XX 32K	32K A & T	$579.00

asap DISK DRIVE CABLE ASSEMBLY

PART #	DESCRIPTION
CA832PT	CONNECTS (2) 8" DISK DRIVES (Shugart Qume, etc.) TO STANDARD DISK CONTROLLER BOARD

$24.50 ea.

CATALOG REQUEST

Please send me your
1981 asap
Full Line Catalog

Name ____________
Address ____________
City ____________
State ________ Zip ________

asap computer products, inc.

NEW LOCATION
1198 E. Willow Street
Signal Hill, CA 90806
Toll Free (800) 421-7701 Outside Calif.
(213) 595-6431 Inside Calif.

ORDERING INFO

Name, address, phone
Ship by UPS or Mail
Shipping Chrg. Add $2.50 up to 1 lb.-Call for larger shipments
Freight. U.S. Mail Add $1.50
U.S. Only up to 2 lbs.

TERMS

We Accept Cash, Check, Money Orders, Visa & Master Charge
(U.S. Funds Only)
Tax: 6% Calif. Res.
COD's & Terms Available on Approval (School PO's Accepted)
($25.00 Minimum Order)

Circle 25 on inquiry card.

Continued from page 34:

Venice, *only to find the wares* Much Ado About Nothing, *or even* The Comedy of Errors? *Or, after conceiving a program during* A Midsummer Night's Dream, *who has not labored until the* Twelfth Night *just to get the output* As You Like It? . . . **CPF**

Modification Caveat

While I especially enjoyed the article "What's Inside Radio Shack's Color Computer" (March BYTE 1981, page 90), there is a problem I would like to pass on to other BYTE readers.

The authors indicated that the processor speed can be doubled by issuing a POKE 65495,0 command. Before I had my computer upgraded for Extended Color BASIC, I used this method to make programs run faster. But after getting the Extended BASIC upgrade, I had problems with double speed. During program execution, everything worked. But if the machine was still operating at double speed when the program ended, the computer would hang up, requiring me to reset it. (I solved this by restoring the normal speed with POKE 65494,0 before the program ended.) But if the program ended unexpectedly, before I could restore normal speed, the computer would hang up.

Richard A Schafer
POB 1171
Fond du Lac WI 54935

The people at Radio Shack advise us that the processor and other parts are designed for 1 MHz operation, and that any time you try to double this speed, you're inviting problems. The reason you had problems with Extended BASIC at the higher speed is that it keeps certain parts (eg: processor and the peripheral interface adapter) busier than non-Extended BASIC does. At 2MHz, these parts are overloaded. . . . **GS**

Define the Problem

I read Gregg Williams's "Is This Really Necessary? A First Look at Design Techniques" (March 1981 BYTE, page 6) with interest. Concerning the lifespan of a medium-sized system (described on page 8), the first phase will also be called *system and problem analysis* instead of (system) design.

In the *system analysis*, the system environment is studied and all the parameters that have an influence on the system are résuméd and their interrelation is defined (perhaps using decision tables). In the *problem analysis*, the designer must devise alternative schemes to solve the problem and choose the best approach. By the end of the analysis, the system has been completely specified (hardware and software). But, more important than the designation of the different phases is the fact that, as Mr Williams mentioned, the designer must at first respond to the "what" of the question. In practice, most people try to solve a problem before it has been specified.

The importance of the analysis/specification and design phases in a well-managed project is shown by T H Bruggere in his article "On-Schedule, Reliable Software Depends on Sound Methodology" (*EDN* January 7, 1981).

Finally, in the references, Mr Williams failed to mention M A Jackson's *Principles of Program Design* (New York: Academic

Press, 1975), which shows how to correctly dissect a problem. In his method, the program structure is based on the data structure that is first defined.

Roland Vannay
Kirchweg 43a
5415 Nussbaumen
Switzerland

Correction

I want to correct an inaccuracy in Chris Morgan's editorial in the May 1981 BYTE. (See "How Can We Stop Software Piracy?", page 6.) RCS/MicroModeller was developed in the United States by Ferox Microsystems Inc (Falls Church, Virginia) and is marketed in England by Intelligence (UK) Limited. RCS has been marketed in the United States and Canada under the name Micro DSS/F by Addison-Wesley Publishing Company since June, 1981.

Any BYTE readers interested in further information about RCS should contact Phil Evans, our vice-president of marketing, at the address below or call him at (800) 336-4766; in Virginia (703) 998-0330.

Rusty Luhring
President
Ferox Microsystems Inc
5881 Leesburg Pike
Suite B-1
Falls Church VA 22041

Manual Printers

"The Epson MX-80 and MX-70 Printers" was a very informative article. (See the May 1981 BYTE, page 22.) However, I called Epson in Great Neck, New York, to see if I could get David Lien's *MX-70 User's Manual*, as mentioned on page 30, and I was told it does not exist! Does BYTE know something Epson doesn't? If so, how can I get this manual?

Richard FitzHugh
3806 Everett St
Kensington MD 20795

Early shipments of Epson printers were not accompanied by a user's manual. Owners of Epson printers can obtain a user's manual, free of charge, by contacting Kari Westlake, Epson America Inc, 23844 Hawthorne Blvd, Torrance CA 90505, (213) 378-2220. . . . MH■

Circle 39 on inquiry card.

Design Principles Behind Smalltalk

Daniel H H Ingalls
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

The purpose of the Smalltalk project is to provide computer support for the creative spirit in everyone. Our work flows from a vision that includes a creative individual and the best computing hardware available. We have chosen to concentrate on two principal areas of research: a language of description (programming language) that serves as an interface between the models in the human mind and those in computing hardware, and a language of interaction (user interface) that matches the human communication system to that of the computer. Our work has followed a two- to four-year cycle that can be seen to parallel the scientific method:

- Build an application program within the current system (make an observation)
- Based on that experience, redesign the language (formulate a theory)
- Build a new system based on the new design (make a prediction that can be tested)

The Smalltalk-80 system marks our fifth time through this cycle. In this article, I present some of the general principles we have observed in the course of our work. While the presentation frequently touches on Smalltalk "motherhood," the principles themselves are more general and should prove useful in evaluating other systems and in guiding future work.

Just to get warmed up, I'll start with a principle that is more social than technical and that is largely responsible for the particular bias of the Smalltalk project:

Personal Mastery: *If a system is to serve the creative spirit, it must be entirely comprehensible to a single individual.*

The point here is that the human potential manifests itself in individuals. To realize this potential, we must provide a medium that can be mastered by a single individual. Any barrier that exists between the user and some part of the system will eventually be a barrier to creative expression. Any part of the system that cannot be changed or that is not sufficiently general is a likely source of impediment. If one part of the system works differently from all the rest, that part will require additional effort to control. Such an added burden may detract from the final result and will inhibit future endeavors in that area. We can thus infer a general principle of design:

Good Design: *A system should be built with a minimum set of unchangeable parts; those parts should be as general as possible; and all parts of the system should be held in a uniform framework.*

Language

In designing a language for use with computers, we do not have to look far to find helpful hints.

BETA COMPUTER DEVICES

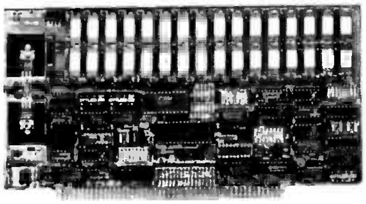
FEATURE PRODUCT

ADDS VIEWPOINT TERMINAL

$629.00

- Detachable keyboard weighs only 2 lbs.
- 110-19,200 Baud - RS-232C
- Cursor control keys - audible tone
- 24 x 80 characters - 12" screen
- 14 key numeric keypad
- 7 switch selectable character sets
- Addressable cursor
- 2 position screen tilt
- Normal or reverse video
- Half or zero intensity
- 3 function keys (six functions)
- Lightweight (22 lbs. with keyboard)
- Switch select block or underline cursor
- Switch select blinking or steady cursor

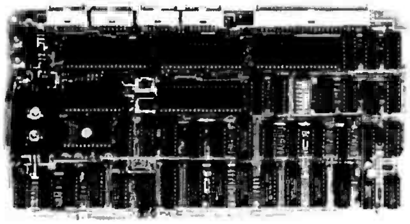
S-100 PRODUCTS



QUALITY RAM FROM SYSTEMS GROUP

- Z-80 4MHZ operation with no wait states
- IEEE compatible timing - 200 NS 4116's
- Factory assembled, tested & burned in

DMB6400 64K (Bank Select, shown)......$749.00
DM6400 64K 545.00
DM4800 48K 520.00
DM3200 32K 495.00



CONFIGURE A COMPLETE S-100 SYSTEM WITH 2nd GENERATION* PRODUCTS FROM SYSTEMS GROUP.

- CPC 2810 (shown) Z-80A processor board (4MHZ) with 4 serial & 2 parallel ports..........$369.00
- CPC2813 - same as CPC2810 but 2 serial ports only..........$345.00
- FDC2801/8 - 8" floppy disk controller board, up to 4 single/double sided drives, single or double density..........$349.00
- INO-2804 - 4 channel serial I/O...... 329.00
- CRA-100 - Cromix* adaptor board.. 45.00

CALL US FOR OUR MOST CURRENT PRICES!

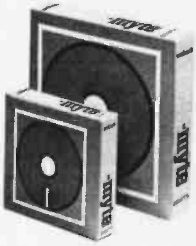
*2nd Generation is a trademark of Measurement Systems and Controls. Cromix is a trademark of Cromemco, Inc. Tilt-Back is a trademark of Wabash, Inc.

16K MEMORY EXPANSION KIT $29.00

For Apple, TRS-80 keyboard, Exidy, and all other systems using 4116 dynamic rams or equivalent. All IC's are prime Mitsubishi MK 4116-3.

- 200 NSEC access, 375 NSEC cycle
- Burned-in and fully tested
- 1 full year parts replacement guarantee

wabash



8" or 5¼" flexible diskettes certified 100% error free with manufacturers 5 year limited warranty on all 8" media. Soft sectored in tilt-back* boxes of 10. 5¼" available in 10 Sector. *(Add $3.00 for plastic library cases)*

8" single sided, single density..........$29.95
8" single sided, double density.......... 37.95
8" double sided, double density.......... 48.95
5¼" single sided, single density.......... 27.95
5¼" single sided, double density.......... 29.95

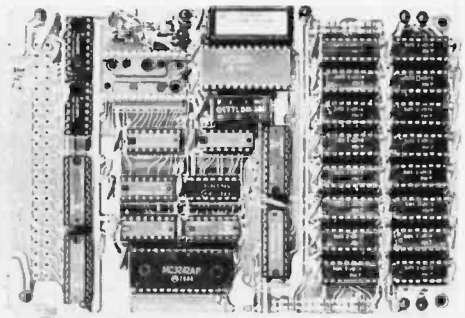
8" DISK DRIVES

Shugart 801R..........$390.00
NEC FD1160 (double sided).......... 595.00
Memorex MRX-101 8" Winchester style, hard disk drive, 10 megabytes..........$2,000.00

TERMS: *Minimum order $15.00. Minimum shipping and handling $3.00. Calif. residents add 6% sales tax. Cash, checks, Mastercard, Visa and purchase orders from qualified firms and institutions are accepted. Product availability and pricing are subject to change without notice.*

INTERNATIONAL ORDERS: *Add 15% to purchase price for all orders. Minimum shipping charge is $20.00. Orders with insufficient funds will be delayed. Excess funds will be returned with your order. All prices are U.S. only.*

6502 PRODUCTS

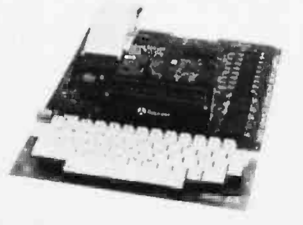


BETA 32K BYTE EXPANDABLE RAM FOR 6502 AND 6800 SYSTEMS
AIM 65 KIM SYM PET S44-BUS

- Plug compatible with the AIM-65/SYM expansion connector by using a right angle connector (supplied).
- Memory board edge connector plugs into the 6800 S44 bus.
- Connects to PET using an adaptor cable.
- Uses +5V only, supplied from the host computer.
- Full documentation. Assembled and tested boards are guaranteed for one full year. Purchase price is fully refundable if board is returned undamaged within 14 days.

Assembled with 32K RAM..........$349.00
& Tested with 16K RAM.......... 329.00
Bare board, manual & 6 hard-to-get parts. 99.00
PET interface kit. Connects the 32K RAM board to a 4K or 8K PET..........$ 69.00

ROCKWELL AIM 65



AIM 65 with 1K ram..........$425.00
AIM 65 with 4K ram.......... 485.00
AIM power supply.......... 125.00
Professional AIM enclosure.......... 169.00
Budget AIM enclosure.......... 50.00
KIM enclosure.......... 40.00
SYM enclosure.......... 30.00

BETA COMPUTER DEVICES
1230 W. COLLINS AVE.
ORANGE, CA 92668
(714) 633-7280

master charge VISA

Everything we know about how people think and communicate is applicable. The mechanisms of human thought and communication have been engineered for millions of years, and we should respect them as being of sound design. Moreover, since we must work with this design for the next million years, it will save time if we make our computer models compatible with the mind, rather than the other way around.

Figure 1 illustrates the principal components in our discussion. A person is presented as having a body and a mind. The body is the site of primary experience, and, in the context of this discussion, it is the physical channel through which the universe is perceived and through which intentions are carried out. Experience is recorded and processed in the mind. Creative thought (without going into its mechanism) can be viewed as the spontaneous appearance of information in the mind. Language is the key to that information:

Purpose of Language: *To provide a framework for communication.*

The interaction between two individuals is represented in figure 1 as two arcs. The solid arc represents explicit communication: the actual words and movements uttered and perceived. The dashed arc represents implicit communication: the shared culture and experience that form the context of the explicit communication. In human interaction, much of the actual communication is achieved through reference to the shared context, and human language is built around such allusion. This is the case with computers as well.

It is no coincidence that a computer can be viewed as one of the participants in figure 1. In this case, the "body" provides for visual display of information and for sensing input from a human user. The "mind" of a computer includes the internal memory and processing elements and their contents. Figure 1 shows that several different issues are involved in the design of a computer language:

Scope: *The design of a language for using computers must deal with internal models, external media, and the interaction between these in both the human and the computer.*

This fact is responsible for the difficulty of explaining Smalltalk to people who view computer languages in a more restricted sense. Smalltalk is

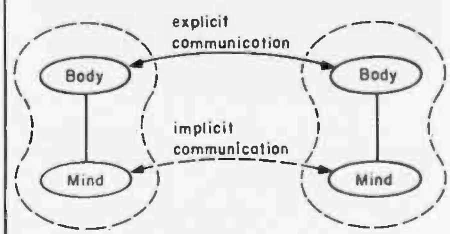


Figure 1: *The scope of language design. Communication between two people (or between one person and a computer) includes communication on two levels. Explicit communication includes the information that is transmitted in a given message. Implicit communication includes the relevant assumptions common to the two beings.*

not simply a better way of organizing procedures or a different technique for storage management. It is not just an extensible hierarchy of data types, or a graphical user interface. It is all of these things and anything else that is needed to support the interactions shown in figure 1.

Communicating Objects

The mind observes a vast universe of experience, both immediate and recorded. One can derive a sense of oneness with the universe simply by letting this experience be, just as it is. However, if one wishes to participate, literally to *take a part*, in the universe, one must draw distinctions. In so doing one identifies an object in the universe, and simultaneously all the rest becomes not-that-object. Distinction by itself is a start, but the process of distinguishing does not get any easier. Every time you want to talk about "that chair over there," you have to repeat the entire process of distinguishing that chair. This is where the act of reference comes in: we can associate a unique identifier with an object, and, from that time on, only the mention of that identifier is necessary to refer to the original object.

We have said that a computer system should provide models that are compatible with those in the mind. Therefore:

Objects: *A computer language should support the concept of "object" and provide a uniform means for referring to the objects in its universe.*

The Smalltalk storage manager provides an object-oriented model of memory for the entire system. Uniform reference is achieved simply by associating a unique integer with every object in the system. This uniformity is important because it means that variables in the system can take on widely differing values and yet can be implemented as simple memory cells. Objects are created when expressions are evaluated, and they can then be passed around by uniform reference, so that no provision for their storage is necessary in the procedures that manipulate them. When all references to an object have disappeared from the system, the object itself vanishes, and its storage is reclaimed. Such behavior is essential to full support of the object metaphor:

Storage Management: *To be truly "object-oriented," a computer system must provide automatic storage management.*

A way to find out if a language is working well is to see if the programs look like they are doing what they are doing. If they are sprinkled with statements that relate to the management of storage, then their internal model is not well matched to that of humans. Can you imagine having to prepare someone for each thing you tell them or having to inform them when you are through with a given topic and that it can be forgotten?

Each object in our universe has a life of its own. Similarly, the brain provides for independent processing along with the storage of each mental object. This suggests a third principle for object-oriented design:

Messages: *Computing should be viewed as an intrinsic capability of objects that can be uniformly invoked by sending messages.*

Just as programs get messy if object storage is dealt with explicitly, control in the system becomes complicated if processing is performed extrinsically. Let us consider the process of adding 5 to a number. In most computer systems, the compiler figures out what kind of number it is and generates code to add 5 to it. This is not good enough for an object-oriented system because the exact kind of number cannot be determined by the compiler (more on this later). A possible solution is to call a general addition routine that examines the type of the arguments to determine the appropriate action. This is not a good approach because it means that this *critical* routine must be edited by novices who just want to experiment with their own class of numbers. It is also a poor design because intimate knowledge about the internals of objects is sprinkled throughout the system.

Smalltalk provides a much cleaner solution: it sends the *name* of the desired operation, along with any arguments, as a *message* to the number, with the understanding that the receiver knows best how to carry out the desired operation. Instead of a bit-grinding processor raping and plundering data structures, we have a universe of well-behaved objects that courteously ask each other to carry out their various desires. The transmission of messages is the only process that is carried on outside of objects and this is as it should be, since messages travel between objects. The principle of good design can be restated for languages:

Uniform Metaphor: *A language should be designed around a powerful metaphor that can be uniformly applied in all areas.*

Examples of success in this area include LISP, which is built on the model of linked structures; APL, which is built on the model of arrays; and Smalltalk, which is built on the model of communicating objects. In each case, large applications are viewed in the same way as the fundamental units from which the system is built. In Smalltalk especially, the interaction between the most primitive objects is viewed in the same way as the highest-level interaction between the computer and its user. Every object in Smalltalk, even a lowly integer, has a set of messages, a *protocol*, that defines the explicit communication to which that object can respond. Internally, objects may have local storage and access to other shared information which comprise the implicit context of all communication. For instance, the message + 5 (add five) carries an implicit assumption that the augend is the present

Ten reasons why your floppy disk should be a BASF FlexyDisk.®

More than four decades of experience in magnetic media – BASF invented magnetic recording tape, the forerunner of today's wide range of magnetic media, back in 1934, and was the first independent manufacturer of IBM-compatible floppy disks.

Cross-linked oxide coating – for low head wear and long trouble-free media life.

Total capability – one of two manufacturers in the world that makes both 8" and 5.25" models, has tape and disk experience, and manufactures floppy disk drives.

Tough Tyvek sleeve – no paper dust, no static electricity.

Special self-cleaning jacket and liner help eliminate data errors and media wear and tear.

Center hole diameter punched to more accurate standards than industry specifications, for top performance.

Bi-axially oriented polyester substrate – for uniform and reliable performance year after year.

Double lubrication – lubricants both in the formula and on the disk surface, to minimize media wear due to head friction.

Packaging to suit your requirements – standard flip-top box, Kassette 10® storage case, or bulk pack.

100% certification – every single disk is tested at thresholds 2-3 times higher than system requirements, to be 100% error-free.

For the name of your nearest supplier, write BASF Systems, Crosby Drive, Bedford, MA 01730, or call 617-271-4030.

BASF

Floppy Disks   Mag Cards   Cassettes   Computer Tapes   Disk Packs   Computer Peripherals

Circle 33 on inquiry card.

value of the number receiving the message.

Organization

A uniform metaphor provides a framework in which complex systems can be built. Several related organizational principles contribute to the successful management of complexity. To begin with:

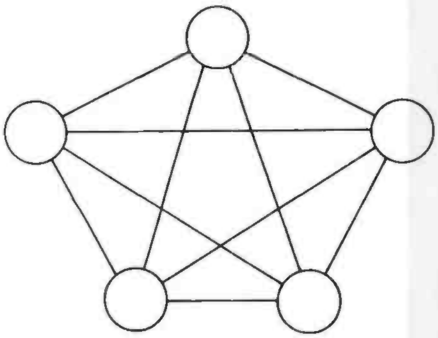


Figure 2: *System complexity. As the number of components in a system increases, the chances for unwanted interaction increase rapidly. Because of this, a computer language should be designed to minimize the possibilities of such interdependence.*

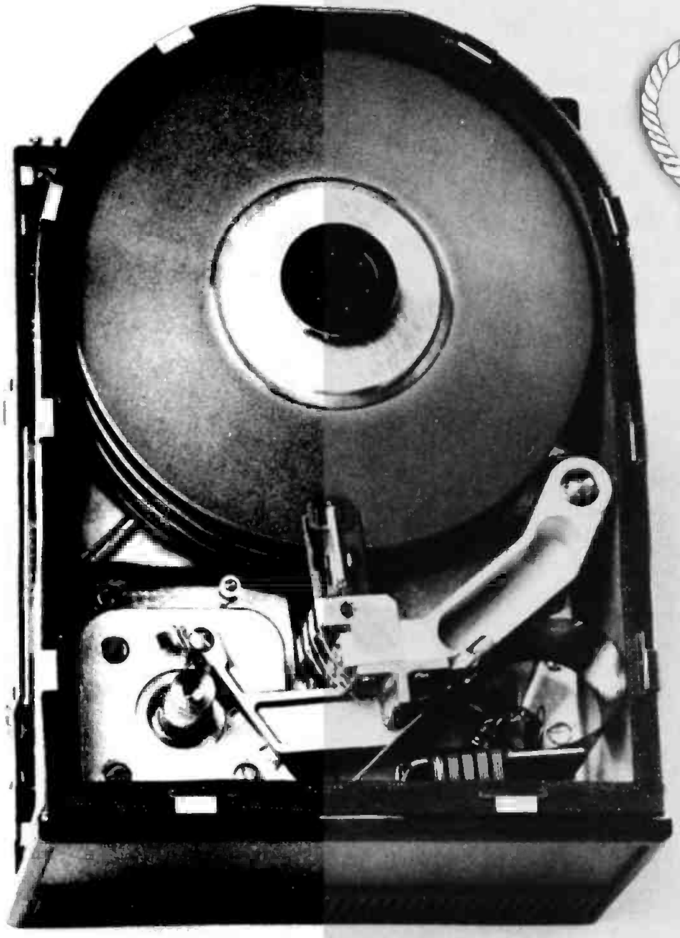
Modularity: *No component in a complex system should depend on the internal details of any other component.*

This principle is depicted in figure 2. If there are *N* components in a system, then there are roughly *N-squared* potential dependencies between them. If computer systems are ever to be of assistance in complex human tasks, they must be designed to minimize such interdependence. The message-sending metaphor provides modularity by decoupling the *intent* of a message (embodied in its name) from the *method* used by the recipient to carry out the intent. Structural information is similarly protected because all access to the internal state of an object is through this same message interface.

The complexity of a system can often be reduced by grouping similar components. Such grouping is achieved through data typing in conventional programming languages, and through *classes* in Smalltalk. A class describes other objects—their internal state, the message protocol they recognize, and the internal methods for responding to those messages. The objects so described are called *instances* of that class. Even classes themselves fit into this framework; they are just instances of class Class, which describes the appropriate protocol and implementation for object description:

Classification: *A language must provide a means for classifying similar objects, and for adding new classes of objects on equal footing with the kernel classes of the system.*

Classification is the objectification of *ness*ness. In other words, when a human sees a chair, the experience is taken both literally as "that very thing" and abstractly as "that chair-like thing." Such abstraction results from the marvelous ability of the mind to merge "similar" experience, and this abstraction manifests itself as another object in the mind, the Platonic chair or chair*ness*.



THE HARD DISK YOU'VE BEEN WAITING FOR

XCOMP introduces a complete micro-size disk subsystem with more...

- MORE STORAGE
- MORE SPEED
- MORE VALUE
- MORE SUPPORT

S100 users . . . The XCOMP subsystem is now available with 10 megabytes of storage; 5 megabytes also available at $2,898.00. Compare the price and features of any other 5¼-inch — or even 8-inch system, and you'll agree that XCOMP's value is unbeatable.

OUTPERFORMS OTHER HARD DISKS
Floppy disk and larger, more expensive hard disks are no match for this powerful little system. More data is available on every seek: 64K on 10MB and 32K on 5MB. Faster seek time too — an average of 70MS. It provides solid performance anywhere with only 20 watts of power. Data is protected in the sealed enclosure, and the landing zone for heads provides another margin of safety. The optional power board plugs directly into the S100 bus and provides power for the drive.

FAST CONTROLLER
The XCOMP controller is the key to this system's high efficiency operation. Speed-up features include interleave without table lookup, block-deblock with controller buffer, and read lookahead. OEMs worldwide have already proven the outstanding performance of the XCOMP controller.

MORE SOFTWARE
Included with the system is software for testing, formatting, I/O drivers for CP/M®, plus an automatic CP/M driver attach program. Support software and drivers for MP/M® and Oasis® are also available. The sophisticated formatting program assigns alternate sectors for any weak sectors detected during formatting, assuring the lowest possible error rate — at least ten times better than floppies.

WARRANTY
The system has a full one-year warranty on parts and workmanship.

ALSO AVAILABLE FROM XCOMP

- General Purpose controllers (8 bit interface), with easy interface to microprocessor-based systems.
- GP controller adapter that plugs directly into most Z80 computers.
- ST/R GP controller for the 5MB and 10MB drive above, with ST506 type interface.
- SG/R GP controller for SA1000 interface.
- SM/R GP controller for storage module drives.
- ST/S, SG/S, and SM/S, same as above, for the S100 bus.

Quantity discounts available. Distributor, Dealer, and OEM inquiries invited.

See your local Dealer, or call:

XCOMP

XCOMP, Inc.
7566 Trade Street
San Diego, CA 92121
Tel: (714) 271-8730
Telex: 182786

Circle 405 on inquiry card.

Classes are the chief mechanism for extension in Smalltalk. For instance, a music system would be created by adding new classes that describe the representation and interaction protocol of Note, Melody, Score, Timbre, Player, and so on. The "equal footing" clause of the above principle is important because it insures that the system will be used as it was designed. In other words, a melody could be represented as an ad hoc collection of Integers representing pitch, duration, and other parameters, but if the language can handle Notes as easily as Integers, then the user will naturally describe a melody as a collection of Notes. At each stage of design, a human will naturally choose the most effective representation if the system provides for it. The principle of modularity has an interesting implication for the procedural components in a system:

Polymorphism: *A program should specify only the behavior of objects, not their representation.*

A conventional statement of this principle is that a program should never declare that a given object is a SmallInteger or a LargeInteger, but only that it responds to integer protocol. Such generic description is crucial to models of the real world.

Consider an automobile traffic simulation. Many procedures in such a system will refer to the various vehicles involved. Suppose one wished to add, say, a street sweeper. Substantial amounts of computation (in the form of recompiling) and possible errors would be involved in making this simple extension if the code depended on the objects it manipulates. The message interface establishes an ideal framework for such extension. Provided that street sweepers support the same protocol as all other vehicles, no changes are needed to include them in the simulation:

Factoring: *Each independent component in a system should appear in only one place.*

There are many reasons for this principle. First of all, it saves time, effort, and space if additions to the system need only be made in one place. Second, users can more easily locate a component that satisfies a given need. Third, in the absence of proper factoring, problems arise in synchronizing changes and ensuring that all interdependent components are consistent. You can see that a failure in factoring amounts to a violation of modularity.

Smalltalk encourages well-factored designs through *inheritance*. Every class inherits behavior from its superclass. This inheritance extends through increasingly general classes, ultimately ending with class Object which describes the default behavior of all objects in the system. In our traffic simulation above, StreetSweeper (and all other vehicle classes) would be described as a subclass of a general Vehicle class, thus inheriting appropriate default behavior and avoiding repetition of the same concepts in many different places. Inheritance illustrates a fur-

MAKE YOUR SYSTEM "CHRISLIN"

If your looking for reliability instead of promises and you need high performance at low prices, Chrislin Industries, Inc. can bring it to you!

Chrislin Industries, Inc.

31352 Via Colinas • Westlake Village, CA 91362 • 213-991-2254 • TWX 910-494-1253 CHRISLIN WKVG

DEC, LSI, PDP are Trademarks of Digital Equipment Corp.

Circle 55 on inquiry card.

ther pragmatic benefit of factoring:

Leverage: *When a system is well factored, great leverage is available to users and implementers alike.*

Take the case of sorting an ordered collection of objects. In Smalltalk, the user would define a message called sort in the class OrderedCollection. When this has been done, all forms of ordered collections in the system will instantly acquire this new capability through inheritance. As an aside, it is worth noting that the same method can alphabetize text as well as sort numbers, since comparison protocol is recognized by the classes which support both text and numbers.

The benefits of structure for implementers are obvious. To begin with, there will be fewer primitives to implement. For instance, all graphics in Smalltalk are performed with a single primitive operation. With only one task to do, an implementer can bestow loving attention on every instruction, knowing that each small improvement in efficiency will be amplified throughout the system. It is natural to ask what set of primitive operations would be sufficient to support an entire computing system. The answer to this question is called a *virtual machine* specification:

Virtual Machine: *A virtual machine specification establishes a framework for the application of technology.*

The Smalltalk virtual machine establishes an object-oriented model for storage, a message-oriented model for processing, and a bitmap model for visual display of information. Through the use of microcode, and ultimately hardware, system performance can be improved dramatically without any compromise to the other virtues of the system.

User Interface

A user interface is simply a language in which most of the communication is visual. Because visual presentation overlaps heavily with established human culture, esthetics plays a very important role in this area. Since all capability of a computer system is ultimately delivered through the user interface, flexibility is also essential here. An enabling condition for adequate flexibility of a user interface can be stated as an object-oriented principle:

Reactive Principle: *Every component accessible to the user should be able to present itself in a meaningful way for observation and manipulation.*

This criterion is well supported by the model of communicating objects. By definition, each object provides an appropriate message protocol for interaction. This protocol is essentially a microlanguage particular to just that kind of object. At the level of the user interface, the appropriate language for each object on the screen is presented visually (as text, menus, pictures) and sensed through keyboard activity and the use of a pointing device.

It should be noted that operating systems seem to violate this principle. Here the programmer has to depart

SPEND $62.40 TO READ THIS ADVERTISEMENT.*

A salesman generating 1.5 million dollars in sales annually for his company does so at the rate of $12.48 per minute. That's expensive time—should it really be used in rummaging through filing cabinets, writing long reports or talking to dozens of people looking for one small, crucial piece of information?

Of course not, so you hire an accounting staff, customer support personnel, and marketing people to support the business and let your salespeople sell. But the overhead takes a large slice of that $12.48.

A Delta system can do the work of a swarm of secretaries, a fleet of filers, a ton of telephones—simultaneously. It's a highly developed work processing system that can maintain files, generate reports, process orders and do all routine office work with speed and accuracy. It lets your people get on with the business of making money.

We at Delta Products have spent five years designing the most reliable, efficient Z80 based microcomputer available on the marketplace. It's fast—some models use multi processors to eliminate the delays associated with other multi user systems. It's expandable, allowing your Delta system to grow with your company's growth and change with your company's needs. And it's rugged; requiring a minimum of service or maintenance.

But the soul of any computer system is the software; therefore, having perfected the hardware techonology, Delta is now dedicated to the development of application packages designed to warm the cockles of a corporate executive's heart. Our "Uni-form", for example, will keep purchase orders, account statements, sales and shipping orders indexed, cross-indexed and filed in any manner required.

And when your Delta system has helped your business grow, it's ready to grow right along with you—every Delta System is completely expandable and configurable.

You have spent five minutes reading this advertisement, at a cost of $62.40 in potential sales. Have you calculated what a Delta system can save your company? (Hint: a Delta system can pay for itself in less than 24 hours of time saved.)

Call us today for the name of your nearest Delta distributor.

*(and save thousands later)

DELTA PRODUCTS

Delta Products
15392 Assembly Lane
Huntington Beach, CA 92649
Telephone (714) 898-1492
TELEX: 681-367 DELTMAR HTBH

Circle 107 on inquiry card.

from an otherwise consistent framework of description, leave whatever context has been built up, and deal with an entirely different and usually very primitive environment. This need not be so:

Operating System: *An operating system is a collection of things that don't fit into a language. There shouldn't be one.*

Here are some examples of conventional operating system components that have been naturally incorporated into the Smalltalk language:

- Storage management—Entirely automatic. Objects are created by a message to their class and reclaimed when no further references to them exist. Expansion of the address space through virtual memory is similarly transparent.
- File system—Included in the normal framework through objects such as Files and Directories with message protocols that support file access.
- Display handling—The display is simply an instance of class Form, which is continually visible, and the graphical manipulation messages defined in that class are used to change the visible image.
- Keyboard input—The user input devices are similarly modeled as objects with appropriate messages for determining their state or reading their history as a sequence of events.
- Access to subsystems—Subsystems are naturally incorporated as independent objects within Smalltalk: there they can draw on the large existing universe of description, and those that involve interaction with the user can participate as components in the user interface.
- Debugger—The state of the Smalltalk processor is accessible as an instance of class Process that owns a chain of stack frames. The debugger is just a Smalltalk subsystem that has access to manipulate the state of a suspended process. It should be noted that nearly the only run-time error that can occur in Smalltalk is for a message not to be recognized by its receiver.

Smalltalk has no "operating system" as such. The necessary primitive operations, such as reading a page from the disk, are incorporated as primitive methods in response to otherwise normal Smalltalk messages.

Future Work

As might be expected, work remains to be done on Smalltalk. The easiest part to describe is the continued application of the principles in this paper. For example, the Smalltalk-80 system falls short in its factoring because it supports only hierarchical inheritance. Future Smalltalk systems will generalize this model to arbitrary (multiple) inheritance. Also, message protocols have not been formalized. The organization provides for protocols, but it is currently only a matter of style for protocols to be consistent from one class to another. This can be remedied easily by providing proper protocol objects that can be consistently shared. This will then allow formal typing of variables by protocol without losing the advantages of polymorphism.

The other remaining work is less easy to articulate. There are clearly other aspects to human thought that have not been addressed in this paper. These must be identified as metaphors that can complement the existing models of the language.

Sometimes the advance of computer systems seems depressingly slow. We forget that steam engines were high-tech to our grandparents. I am optimistic about the situation. Computer systems are, in fact, getting simpler and, as a result, more usable. I would like to close with a general principle which governs this process:

Natural Selection: *Languages and systems that are of sound design will persist, to be supplanted only by better ones.*

Even as the clock ticks, better and better computer support for the creative spirit is evolving. Help is on the way.■

TWO SIZZLING SPECIALS

FOR THE IEEE 696/S-100 BUS: CPU Z for $199!

CPU Z hardly needs any introduction–since the day we introduced this Z80* workhorse, professional systems integrators have made it **the** CPU board of choice for high performance 8 bit systems.

What **is** new is the price: Until September 30th, **CPU Z** (assembled) is yours for an amazingly low **$199!**

For new systems, **CPU Z's** superior flexibility (24 bit addressing, sockets for adding up to 8 Kbytes of on-board RAM or ROM, 4 MHz operation, on-board fully maskable interrupts, and much more) puts it miles ahead of the competition. For upgrading older systems, **CPU Z** is backward compatible with most S-100 mainframes, down to a switch selectable choice of 2 or 4 MHz operation–there's even a plug that accepts the connector from an IMSAI front panel.

Here's one deal you can't afford to pass up. . .visit your local **CompuPro** representative, or order direct from the factory, but hurry –quantities are limited.

FOR MEMORY EXPANSION: EIGHT 16K DYNAMIC RAMS for $19.95!

You can't beat the quality or the price: eight low power, high speed dynamic RAMs, suitable for expanding memory in TRS-80* -I, -II, and -III (color computer too); H89; Apple; newer PETs; etc. Backed by 1 year limited warranty. Add $3 for two DIP shunts plus TRS-80 conversion instructions.

IEEE 696/S-100 COMPONENT LEVEL PRODUCTS

DISK EQUIPMENT/SYSTEMS

Disk 1 Controller Board Ultra-fast operation, thanks to properly implemented DMA (with arbitration) and data transfer that's independent of CPU speed. Handles up to four 8" or 5.25" floppy disk drives, single or double-sided, single or double density (soft sectored). Includes BIOS for CP/M-80 (provided on 8" soft sectored diskette). Manual only: $25. A/T $495, CSC $595.

Available only with Disk 1 purchase: CP/M-80 diskette with documentation, $175; CP/M-86 diskette with documentation, $300.

Complete Dual Disk Drive System With Disk 1 board, desktop dual drive enclosure with Shugart SA-800 series drives, disk cables, and power supply cable. Also includes CP/M-80. Introductory special: $2195.

COMPUTER ENCLOSURES

Computer Enclosure 2. With fused, constant voltage power supply (+8V at 25A, +16V at 3A, and -16V at 3A); line filter; 20 slot shielded/active terminated motherboard; and rugged, all-metal enclosure that minimizes interference problems. $825 desk top version, $895 rack mount version.

Computer Enclosure 1. Same as CE2, but enclosure only. $289 desktop, $329 rack mount (slides included).

INTERFACERS

Interfacer 1. Two RS-232 serial ports, with full handshaking and independently selectable Baud rates. $199 Unkit, $249 A/T, $324 CSC.

Interfacer 2. Three full duplex parallel ports, plus one serial port. $199 Unkit, $249 A/T, $324 CSC.

Interfacer 3-5. Five RS-232 serial ports (2 synchronous/asyncronous, 3 asynchronous) with full handshaking. $599 A/T, $699 CSC.

Interfacer 3-8. Eight full RS-232 serial ports (2 synchronous/asynchronous, 6 asynchronous). Ideal for multi-user/multi-terminal systems. $699 A/T, $849 CSC.

MEMORY BOARDS

48K/64K RAM 17 Static Memory Board. Exceptionally low power (4W max, 2W typ for 64K), high speed static memory; runs faster, cooler, and handles DMA better in ultra-high speed systems than competing dynamic memory boards. **RAM 17-48K: $1048 A/T, $1198.50 CSC. RAM 17-64K: $1095 Unkit,** $1395 A/T, $1595 CSC.

96K/128K RAM 21 Static Memory Board. Exceptionally low power, high speed static memory. RAM 21-96K and RAM 21-128 K: Price upon request.

2708 EPROM Board. This board is the way to store often used routines or pieces of software. $85 Unkit, $135 A/T, $195 CSC (2708s not included).

DOCUMENTATION

User manuals are available for all products for $5, with the following exceptions: Interfacer 3, $10; Disk Controller, $25; System Support 1, $20. Also available: "CompuPro Product User Manuals: 1975-1980". 250+ pages on all Godbout/CompuPro products up through 1980. Excellent for evaluating the innovative engineering behind CompuPro products, or studying the nuts and bolts of high speed computer operation. $20 plus shipping.

FLASH! Phase 1's single- and multi-user Oasis operating system is now available configured for Disk 1. See next month for full details and prices.

Most CompuPro products are available in Unkit form, **Assembled/Tested,** or qualified under the high-reliability **Certified System** Component (CSC) program (200 hour burn-in, more). Note: Unkits are not intended for novices, as de-bugging may be required due to problems such as IC infant mortality. Factory service is available for Unkits at a flat service charge.

TERMS: Prices shown do not include dealer installation and support services. Cal res add tax. Allow at least 5% shipping; excess refunded. Orders under $15 add $2 handling. VISA® and Mastercard® orders ($25 min) call our 24 hour order desk at (415) 562-0636. Include street address for UPS delivery. Prices and specifications subject to change without notice.

*LEGAL CORNER: Z-80 is a registered trademark of Zilog; CP/M is a registered trademark of Digital Research; TRS-80 is a trademark of the Tandy Corporation.

If your computer store doesn't stock CompuPro products yet, call (415) 562-0636 and we'll tell you who does.

CompuPro™ division of GODBOUT ELECTRONICS

BOX 2355, OAKLAND AIRPORT, CA 94614 (415) 562-0636

Circle 147 on inquiry card.

The Smalltalk-80 Virtual Machine

Glenn Krasner
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

The Smalltalk-80 system is a powerful system that encourages the development of large applications programs. The system contains a compiler, a debugger, a storage management system, text and picture editors, and a file system. It also contains a highly interactive user interface based on graphics that include overlapping windows.

Typically the task of bringing up such a powerful system on a new computer includes writing code to implement these pieces. The Smalltalk-80 system is different in that most of these pieces are written in Smalltalk-80 itself. The part that can be written in Smalltalk-80 is called the *Smalltalk-80 Virtual Image*, and it includes the compiler, debugger, editors, decompiler, and the file system.

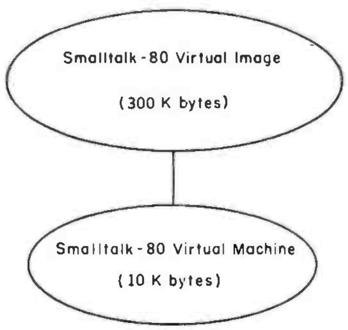


Figure 1: *The Smalltalk-80 Virtual Machine. Most of Smalltalk-80 is written in Smalltalk-80 (the Virtual Image), leaving only a small amount of code that has to be rewritten for each processor on which the language is implemented (the Virtual Machine).*

The remaining part of the Smalltalk-80 system is defined in terms of an abstract machine called the *Smalltalk-80 Virtual Machine* (see figure 1). The Smalltalk-80 compiler translates source code into machine instructions for this virtual machine, rather than translating directly into machine instructions for a particular hardware machine. The task of bringing up a Smalltalk-80 system on a new "target" computer consists only of implementing (writing a program to simulate) the Smalltalk Virtual Machine on the target computer.

In this article, we will present an overview of the elements needed to implement the Smalltalk Virtual Machine. These elements are:

- the *Storage Manager*
- the *Interpreter*
- the *Primitive Subroutines*

Background

A Smalltalk-80 system is made up of *objects* that have state and exhibit behavior. Their state consists of the values of both named and indexed instance variables (which we will call *fields*), and their behavior is exhibited through sending and receiving *messages*. Objects are members of *classes*.

Classes may be *subclasses* of other classes—that is, they may inherit attributes from other classes. Programming in Smalltalk-80 is done by defining the procedures, or *methods*, that are executed when objects receive messages. Typically, messages are sent to other objects to invoke their methods. Sometimes messages invoke *primitive* (machine-code) *subroutines* rather than Smalltalk-80 methods.

From this brief description of Smalltalk-80, we can consider the information needed to implement each of the three elements of the Smalltalk Virtual Machine:

1. To implement the storage manager, we need the information necessary to represent objects in the computer's memory. This information consists of the amount of memory that each object will occupy, which can be computed from the number of fields the object has, and the representation of fields in memory. Objects that describe classes define the number of fields their instances will have, so we also need to know how this number is represented. With this information, we can design a storage manager for objects in a Smalltalk-80 system that will:

- fetch the class of objects
- fetch and store fields of objects
- create new objects
- collect and manage free space

2. The interpreter executes the machine instructions of the Smalltalk-80 Virtual Machine. The information needed to design the interpreter is a description of these machine instructions, called bytecodes (the idea is similar to Pascal p-codes). The bytecodes are contained in methods, so we also need to know the representa-

Who's Who

The design of the Smalltalk-80 Virtual Machine is based on previous Smalltalk systems implemented by the Learning Research Group at Xerox PARC. The original bytecode interpreter design was made for Smalltalk-76 by Dan Ingalls (Ingalls, Dan. "The Smalltalk-76 Programming System: Design and Implementation." In Fifth Annual ACM Symposium on Principles of Programming Languages, *1978, pages 9 through 16). Smalltalk-76 was implemented on the Xerox Alto by Dan Ingalls, Ted Kaehler, Dave Robson, Steve Weyer and Diana Merry, on the Xerox Dolphin by Peter Deutsch, and on the Xerox Dorado by Bruce Horn. TinyTalk was implemented on a Xerox microcomputer by Larry Tesler and Kim McCall (McCall, Kim and Larry Tesler. "Tiny Talk, a Subset of Smalltalk-76 for 64KB Microcomputers."* In Proceedings of the Third Symposium on Small Systems, *ACM Sigsmall Newsletter, Volume 6, Number 2, 1980, pages 197 through 198). Smalltalk-78 (a revised version of Smalltalk-76 similar to Smalltalk-80) was implemented on the Xerox microcomputer by Dan Ingalls, Ted Kaehler, and Bruce Horn, on the Xerox Dorado by Jim Stamos, and on a Norwegian microcomputer (under a research license from Xerox) by Bruce Horn. Smalltalk-80 has been implemented on the Xerox Dorado by Peter Deutsch, on the Xerox Dolphin by Kim McCall, and on the Xerox Alto by Glenn Krasner. The designs of these systems were made by the implementors and other members of the Learning Research Group.*

tion of methods. From this information we can decide how the interpreter will fetch and execute bytecodes and how it will find methods to run when messages are sent.

3. The last piece of information we need to know is which messages will invoke primitive subroutines; that is, which methods we must implement in machine code to terminate the recursion of message sending and to optimize performance.

Before we go into more detail about these elements of a Smalltalk-80 Virtual Machine implementation, here are a few typical figures that will provide a little "reality" to implementors. For the systems that we have implemented at Xerox, the Smalltalk-80 Virtual Image consists of about 300 K bytes of objects. Our typical implementation of the Smalltalk-80 Virtual Machine is 6 to 12 K bytes of assembly code, or 2 K microcode instructions plus 10 K bytes of assembly code. Of this, about 40% is in the storage manager, 20% in the interpreter, and 40% in the primitive subroutines. Our average is about one person-year to implement a fully debugged version of this code.

The Storage Manager

Although the storage manager tends to be the largest and most complex of the three parts of a Smalltalk-80 implementation, the functions it provides are few and relatively simple to understand.

Everything in a Smalltalk-80 system is an object.

Everything in a Smalltalk system is an object, so from a storage point of view memory needs to be divided into blocks, one for each object, plus a pool of memory that is not yet used. Every time a new object is created, a new block of the appropriate size must be found for that object: when objects are no longer used, their memory block may be returned to the pool (see figure 2).

A special entity called an *object pointer* is assigned to each object. If an object pointer were the actual core address of the memory occupied by that object, then there would be fast access to an object given its pointer. However, in the Smalltalk-80 system the object pointer is an *indirect* pointer to the object through a table kept by the storage manager. This allows the storage manager to move an object around in memory without affecting any object that refers to it. It also insures that the storage manager is the only entity in the system concerned with (and allowed to change)

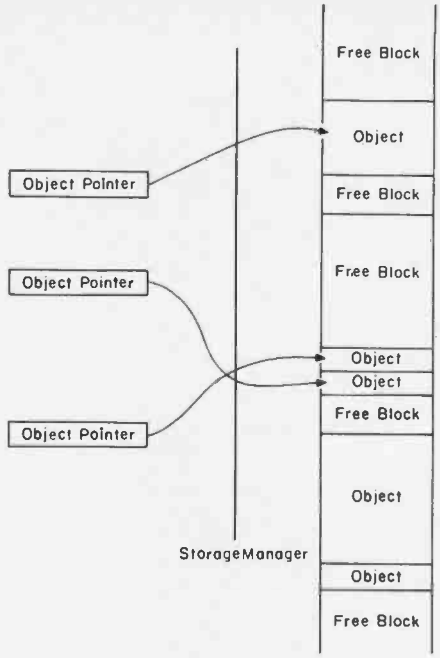


Figure 2: *Objects and memory usage in Smalltalk-80. Each Smalltalk-80 object has an object pointer that points to a block of memory that describes the object. When an object is no longer used, its memory is made available for use.*

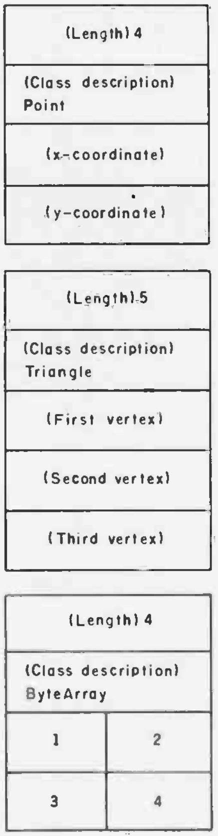


Figure 3: *Typical object representations in Smalltalk-80.*

the actual memory. In the Smalltalk-80 Virtual Image, object pointers are single 16-bit words. This allows for 64 K objects in the system; these objects may take up much more than 64 K words of memory.

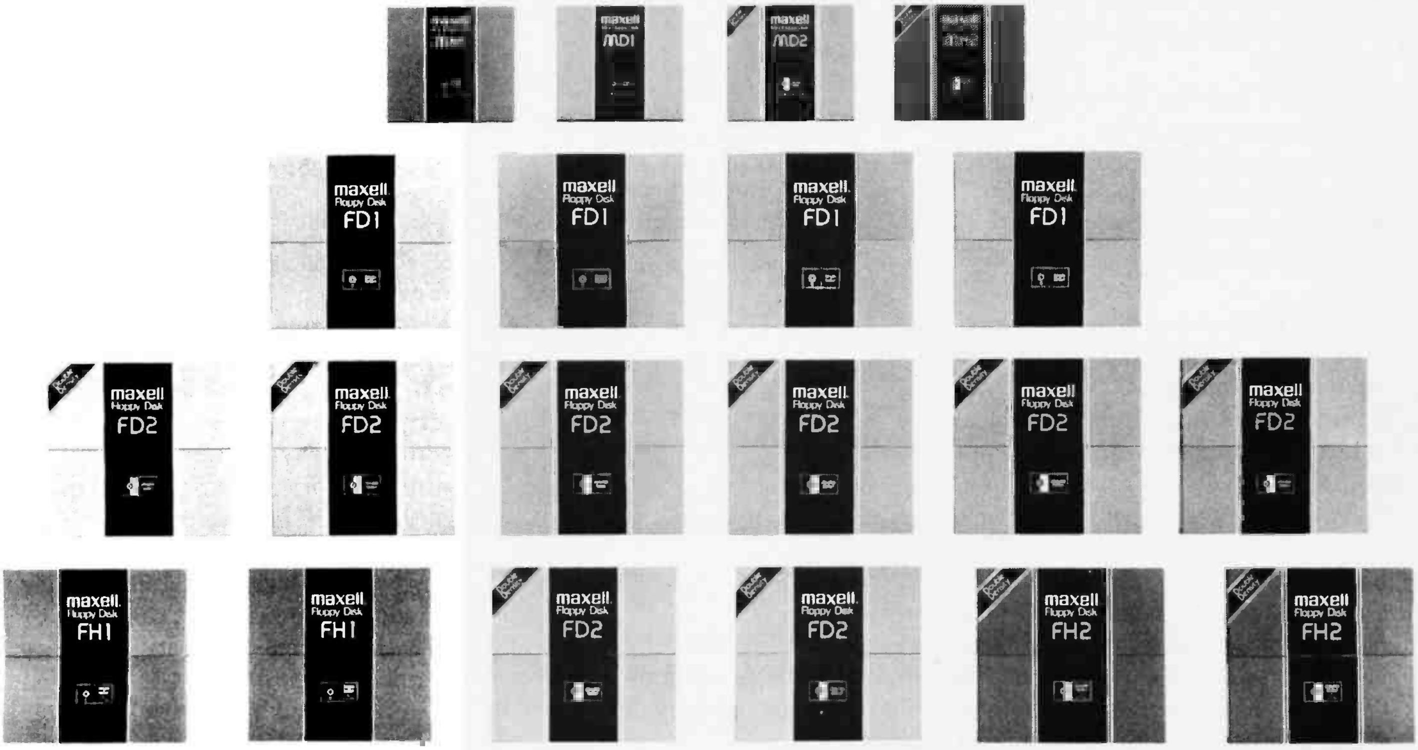
Since an object's class and fields are themselves objects, we can see that the block of memory corresponding to an object contains the object pointer of the object's class plus the object pointer for each of the object's fields. The storage manager also keeps the length of the block as one word of the block. This means, for example, that the block corresponding to an object that is an instance of class Point (see figure 3) will have:

- one word that says this block is four words long
- one word that is the object pointer of the object that describes class Point
- one word that is the object pointer of an object that is the *x*-coordinate field of the point
- one word that is the object pointer of an object that is the *y*-coordinate field of the point

Similarly, the block corresponding to an object that is an instance of class Triangle will have:

- one word saying this block is five words long
- one word that is the object pointer of the object that describes class Triangle
- one word that is the object pointer of an instance of class Point, representing one vertex field
- one word that is the object pointer of an instance of class Point, for the second vertex field
- one word that is the object pointer of an instance of class Point, for the third vertex field

For performance optimization, the values in the fields of some objects, such as instances of class ByteArray, will be interpreted as the numerical values themselves, rather than as object pointers. The block corresponding to the byte array containing the elements 1, 2, 3, and 4, in order, will have:



Maxell Floppy Disks. Class of '81.

Not a single dropout among them.

These are the disks that achieve all you expect from them. They are certified free of dropouts. And each one meets or exceeds the most demanding specifications every computer authority can set. That includes ISO, IBM, ECMA, ANSI, JIS and Shugart.

The quality begins with the finest raw materials available, and we make sure the quality stays high. Every Maxell floppy disk must pass an exhaustive series of eight quality control inspections. Under test conditions, after 10,000,000 passes, there is no loss of quality.

Maxell Floppy Disks actually help protect your computer drive heads. The self-cleaning jacket liner inside every Maxell disk removes dust before it can affect your system. The surface lubricant reduces any chance of disk-caused head-wear.

There are Maxell disks for every disk drive system in operation today. Maxell is leading the way with new disk technology for tomorrow's computers. Your Maxell Business or Maxell Personal Computer Products supplier can put our "honor-grad" to work for you, and for your computer, now and in the future.

Call or write for more information. You'll learn that the care we take manufacturing Maxell Floppy Disks makes them live up to your highest expectations.

maxell®

Circle 212 on inquiry card.

Maxell Corporation of America, Business Products Division, 60 Oxford Drive, Moonachie, N.J. 07074. (201) 440-8020

- one word saying this block is four words long
- one word pointing to the object that describes class ByteArray
- one byte encoding the number 1
- one byte encoding the number 2
- one byte encoding the number 3
- one byte encoding the number 4

We will represent all objects as having fields interpreted as object pointers or numerical values, not both. Objects may store numerical values as bytes or words, but not both.

As we have mentioned, the objects that describe classes also need to represent the form of instances of those classes. The essential information is the number of fields the instances will have, and whether these will be pointer or nonpointer fields. For example, the describer of class Point says that its instances will have two fields (*x*- and *y*-coordinates) and that these will be pointers (see figure 4). The describer of class ByteArray says that its instances may have a variable number of fields and that these fields will not be pointers but will be numerical values stored in bytes.

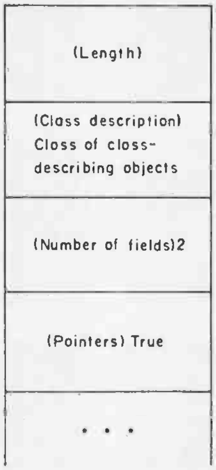


Figure 4: *Class-describing object for class* Point.

The purpose of the storage manager is to fetch and store fields of objects, to create objects, and to manage free space. A clean implementation of the storage manager would be one in which the other parts of the system had access only to the object pointers and made requests of the storage manager only through the following subroutine calls:

- getClass(objectPointer) returns the object pointer of the class of the given object
- getField(objectPointer,fieldOffset) returns the field
- storeField(objectPointer,fieldOffset,newValue) replaces that field with the new value newValue
- newInstance(classObjectPointer,numberOfFields) returns the object pointer of a new instance of that class, and, if that class can have indexed instance variables, this instance has the given number of fields (numberOfFields)

Requests can be made for new storage (with the newInstance subroutine), but not to return used storage. In some other systems, storage that is no longer used must be explicitly returned to the free storage pool. The Smalltalk-80 philosophy is that neither the user nor any part of the system other than the storage manager need have such concerns. Therefore the storage manager must know which objects are no longer being used, so that their storage may reenter the free pool. Typically, Smalltalk-80 Virtual Machine implementations use *reference-counting* to accomplish this. For every object in the system, the storage manager keeps a count of the number of other objects that point to it. This number will change only during execution of the four storage-manager subroutines. When this count reaches zero, the object's memory block may be reused because there are no references to that object anywhere else in the system.

The Interpreter

The interpreter is that portion of the Smalltalk-80 Virtual Machine that performs the actions described in the bytecodes of methods (ie: the machine code of the Virtual Machine). The information needed to implement the interpreter is the

Now a microcomputer financial planning program so advanced it's like having a main frame on every desk.

Introducing FPL™

FPL is the remarkable new Financial Planning Language software that, for the first time, turns the microcomputer into the most sophisticated financial planning tool.

FPL is comprehensive.

Incredibly, FPL is comparable in capabilities to Autotab™ and other successful packages previously available only on main frame computers.

With FPL, you can plan, analyze, project, track and control an enormous number of business variables with a single microcomputer program.

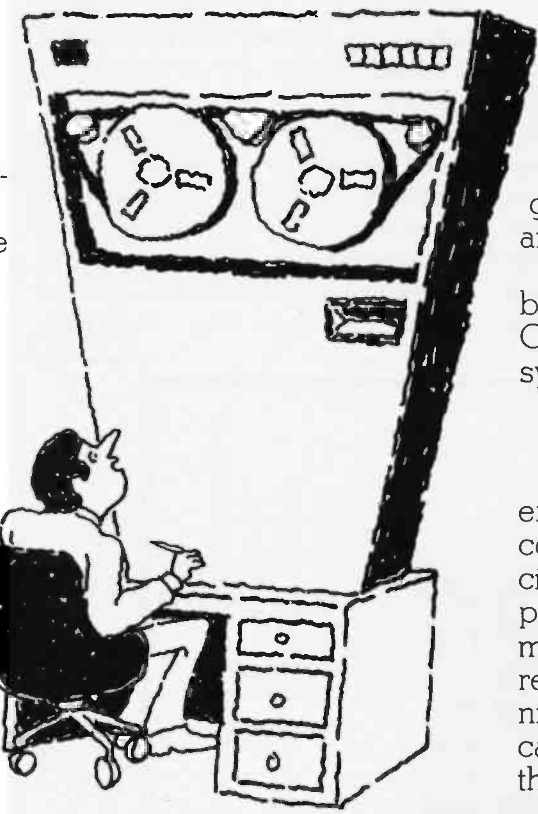
FPL can perform such functions as Profit and Loss Forecasts, Budget Planning and Consolidation, Acquisition or Merger Analysis, Capital Investment Analysis, Product Line Planning and many more.

Unique features include the handling of complex rules that are necessary with varying tax rates and the conditional handling of investment tax credits.

With FPL, you can preview the results on the screen and then use the powerful report generator to produce presentation-quality financial reports directly.

FPL: an alternative to time-sharing.

FPL gives you the same conversational ease of time-sharing, enhanced with a screen-oriented Decision Support System, with none of the runaway costs. You are able to try many more alternatives, examine many more options, and better understand models.



Priced at only $695, FPL gives you improved service and reduces costs.

FPL runs on most small business computers with CP/M® or similar operating systems.

Get full support from Lifeboat.

FPL is brought to you exclusively and supported completely by Lifeboat Associates, world's largest computer software marketer. For more information about this revolutionary financial planning package and how you can profit from it, send us the coupon below.

Mail coupon to: Lifeboat Associates, 1651 Third Ave., NY, NY 10028. Or call (212) 860-0300.

☐ Please send me more information on FPL.
☐ Please send me a free Lifeboat catalog.

Name ________________ Title ________________

Company ________________

Street ________________

City ________________ State ______ Zip ________

FPL is a trademark of Information Access
CP/M is a trademark of Digital Research, Inc

2006

Autotab is a trademark of Capex Corporation

LIFEBOAT WORLDWIDE offers you the world's largest library of software. Contact your nearest dealer or Lifeboat:

Lifeboat Associates
1651 Third Ave.
New York, N.Y. 10028
Tel: (212) 860-0300
Telex 640693 (LBSOFT NYK)
TWX: 710-581-2524

Lifeboat Inc.
OK Bldg., 5F
1-2-8, Shiba-Daimon
Minato-ku, Tokyo, 105 Japan
Tel: 03-437-3901
Telex 2422723 (ASRTYOJ)

Lifeboat Associates, Ltd.
PO Box 125
London WC2H 9LU, England
Tel: 01-836-9028
Telex: 893709 (LBSOFTG)

Lifeboat Associates GmbH
PO Box 168, Aegeristrasse 35
CH 6340 Baar, Switzerland
Tel: 042-31-2931
Telex: 865265 (MICO CH)

Intersoft GmbH
Schlossgartenweg 5
D-8045 Ismaning, W. Germany
Tel: 089-966-444
Telex: 5213643 (ISOFD)

Lifeboat Associates, SARL
10, Grande Rue Charles de Gaulle
92600 Asnieres, France
Tel: 1-733-08-04
Telex: 250303 (PUBLIC X PARIS)

Lifeboat Associates

Software with full support

Circle 410 on inquiry card.

description of the bytecodes, the representation of methods, and the technique to find the method to run when sending a message.

The bytecodes define the Smalltalk-80 Virtual Machine as a stack-oriented machine. Each bytecode represents one of the following actions:

- push an object onto the stack
- store the top of the stack as the value for a variable
- pop the top of the stack
- branch to another bytecode
- send a message using the top few elements of the stack
- return the top of the stack as the value for this method

In the Smalltalk-80 Virtual Machine, each of these actions is realized by one or more bytecodes. Note that pushing, storing, popping, and branching are standard instruction types for any stack machine, that sending a message corresponds to calling a procedure using the top few elements of the stack as arguments, and that returning an object from a method corresponds to returning a value from a procedure. The difference between the Smalltalk-80 Virtual Machine and procedure-based stack machines is in the way the procedure is found. In most procedure-based stack machines the address of a procedure is provided in the *execute procedure* instruction; in the Smalltalk-80 system only the "name," called the *selector*, of the message is provided; the method (or procedure) to be executed is found through a strategy involving the receiver of the message and its class. We will first describe the bytecodes, then how methods are represented, and finally give a strategy for finding methods.

Bytecode	Stack Contents After Execution (Top of Stack to Right)
-1- Push 3	(3)
-2- Push 4	(3 4)
-3- Push 5	(3 4 5)
-4- Send +	(3 9)
-5- Send *	(27)

Table 1: *Bytecodes for the Smalltalk expression* 3 * (4 + 5).

Stack Operations

The Smalltalk-80 Virtual Machine and corresponding bytecode set are stack oriented. Object pointers are pushed and popped from a stack, and when a message is sent, the top few elements of the stack are used as receiver and arguments of the method. These are replaced by the object returned as the value of that method. For example, the Smalltalk-80 expression:

3 * (4 + 5)

is encoded by the bytecodes shown in table 1.

As bytecodes labeled -1-, -2-, and -3- are executed by the interpreter, the objects 3, 4, and 5 are pushed onto the stack. When bytecode -4- is executed, the message + is sent to the second object on the stack (4) with the top object of the stack as the argument (5). The 4 and 5 are popped off this stack when the message is sent, and the interpreter begins executing the bytecodes for the method corresponding to the message + in the Smalltalk class of small integers. This method will eventually return an object, in this case 9, as its value, and the interpreter will push the 9 onto the original stack above the 3 and resume execution with bytecode -5-. Bytecode -5- will produce an effect similar to that produced by -4-, leaving the object 27 on the stack. In the same way that other stack machines push *data* onto a *stack* and use the top few data items as *arguments* for a *procedure*, replacing them with the *value* returned from that procedure, the Smalltalk-80 Virtual Machine pushes *object pointers* onto a *stack*

Bytecode	Stack Contents After Execution (Top of Stack to Right)
-1- Push 3	(3)
-2- Push 4	(3 4)
-3- Send +	(7)
-4- Store into a	(7)

Table 2: *Bytecodes for the Smalltalk expression* a ← 3 + 4.

Bytecode	Stack Contents After Execution (Top of Stack to Right)
-1- Push 3	(3)
-2- Store into a	(3)
-3- Pop	( )
-4- Push 4	(4)
-5- Store into b	(4)

Table 3: *Bytecodes for the Smalltalk expression* a ← 3. b ← 4.

Bytecode	Stack Contents After Execution (Top of Stack to Right)
-1- Push 3	(3)
-2- Store into a	(3)
-3- Pop	( )
-4- Push a	(3)
-5- Return top of stack	( )

Table 4: *Bytecodes for the Smalltalk expression* a ← 3. ↑ a.

and uses the top few as *receiver* and *arguments* of a *message*, replacing them with the *object* returned from that method.

In both machines, values from the top of the stack may be stored as the values of variables. As an example, the Smalltalk expression:

```
a ← 3 + 4
```

will be represented by the bytecodes in table 2. Here, -1-, -2- and -3- act as before and the interpreter executes bytecode -4- by storing the top of the stack 7 into the variable a.

Stack machines in general, and the Smalltalk-80 Virtual Machine in particular, also have the ability to pop the top element off the stack. In the statements:

```
a ← 3.
b ← 4
```

once the 3 is stored into variable a, it is no longer needed, so it is popped from the stack. These statements are represented by the bytecodes shown in table 3.

The top of the stack may be returned as the value for the method. The statements:

```
a ← 3.
↑ a
```

are represented by the bytecodes shown in table 4.

Branching Operations

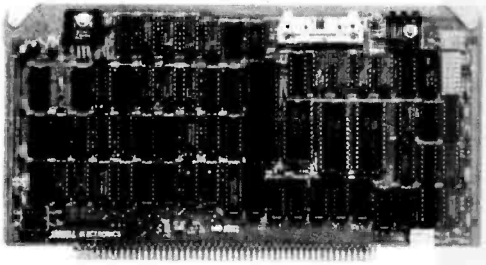
Conditional and looping messages are used so often that they are represented not by actual messages but by bytecodes for conditional and unconditional jumps. (This is *only* for performance reasons; these branching and looping messages would work if they were actually sent like other messages.) For example:

```
a > 4 ifTrue: [a ← a – 1]
```

(which in the Smalltalk-80 system means execute the code within the brackets only if the object returned from the > message is not false) is represented in table 5 (ignoring the stack from now on).

Q. What do these four boards have in common?

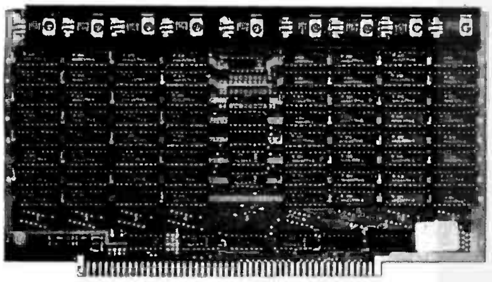
A. Tarbell quality.



CPU/IO BOARD

Allows dynamic mapping of logical to 1 Megabyte of physical memory in 4K blocks. □ Designed to implement multi-user operating systems, such as MP/M® from Digital Research. □ Includes crystal-controlled programmable timer (8253), which can be used for time-slicing multi-tasking operations. □ Programmable priority vectored interrupt hardware allows the programmer to selectively disable any combination of six interrupt lines.

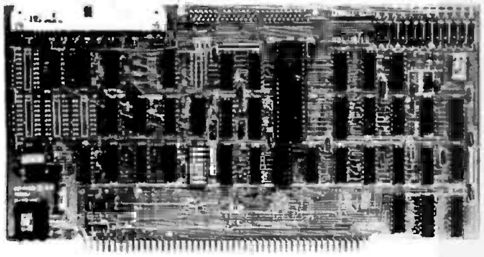
A & T $450



32K RAM

S-100 Bus □ Works at 4 MHz □ Static Memory for Ease of Maintenance □ 9 Regulators Provide Excellent Heat Distribution □ Extended Addressing (Bank Switching) □ Low Power Requirement □ Phantom Line □ Each 4K Block is Individually Addressable Within 32K □ Full 1-Year Warranty

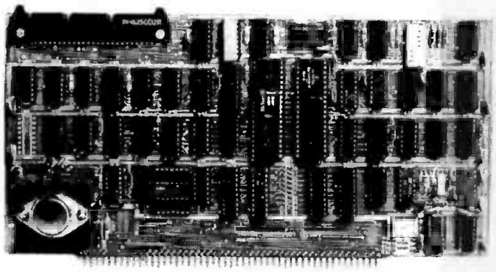
A & T $725



SINGLE DENSITY FLOPPY DISK INTERFACE

Adaptable to wide variety of drives, including older models, 5-inch, 8-inch, Shugart, PerSci. □ Fully software-supported by Tarbell with a CP/M® disk operating system. □ Capable of running with several formats, including standard IBM (128 bytes per sector, 26 sectors, 76 tracks), 256, 512, or 1024 bytes per sector. □ Available in kit or fully assembled and tested form. □ Supports up to 4 8-inch drives, single or double sided. 5-inch drives can be used with modifications to the interface (included in manual).

KIT $225 A & T $325



DOUBLE DENSITY FLOPPY DISK INTERFACE

Fully software-supported by Tarbell with the CP/M disk operating system and the MP/M multi-user multi-tasking operating system. □ Under the Tarbell double-density CP/M, single and double density disks can be mixed automatically. □ True Direct Memory Access (DMA) in single or double density mode makes possible efficient multi-user and multi-tasking systems. □ Also capable of programmed-data-transfer method, which works in single density at 2 or 4 Mhz, and double density at 4 Mhz. □ Extended addressing capability provides 8 extra address bits on the lines defined by the IEEE S-100 standard. This allows direct transfers to and from anyplace in 16 Mbyte address range.

A & T $495

You'll find these quality S-100 boards at your local Tarbell Dealer.

Tarbell Electronics

MANUFACTURER OF COMPUTERS, COMPONENTS AND SOFTWARE.

950 Dovlen Place • Suite B • Carson, CA 90746 • (213) 538-4251

CP/M and MP/M are trademarks of Digital Research

Circle 375 on Inquiry card.

	Bytecode
-1-	Push 4
-2-	Push a
-3-	Send >
-4-	Jump to -10- if the top of the stack is false
-5-	Push a
-6-	Push 1
-7-	Send −
-8-	Store into a
-9-	Pop
-10-	< the next bytecode >

Table 5: *Bytecodes for the Smalltalk expression* a > 4 ifTrue: [a ← a − 1].

	Bytecode
-1-	Push a
-2-	Push 4
-3-	Send >
-4-	Jump to -11- if top of stack is false
-5-	Push a
-6-	Push 1
-7-	Send −
-8-	Store into a
-9-	Pop
-10-	Jump to -1-
-11-	< the next bytecode >.

Table 6: *Bytecodes for the Smalltalk expression* [a > 4] whileTrue: [a ← a − 1].

Table 6 shows the bytecodes for the looping expression:

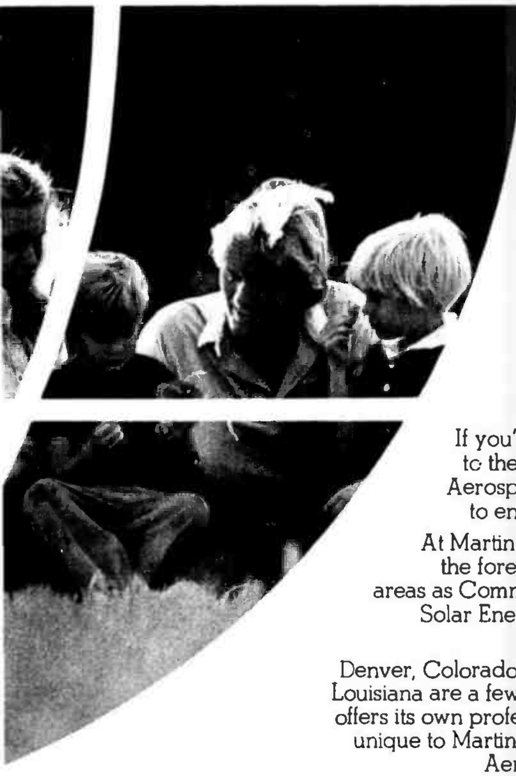
[a > 4] whileTrue: [a ← a − 1]

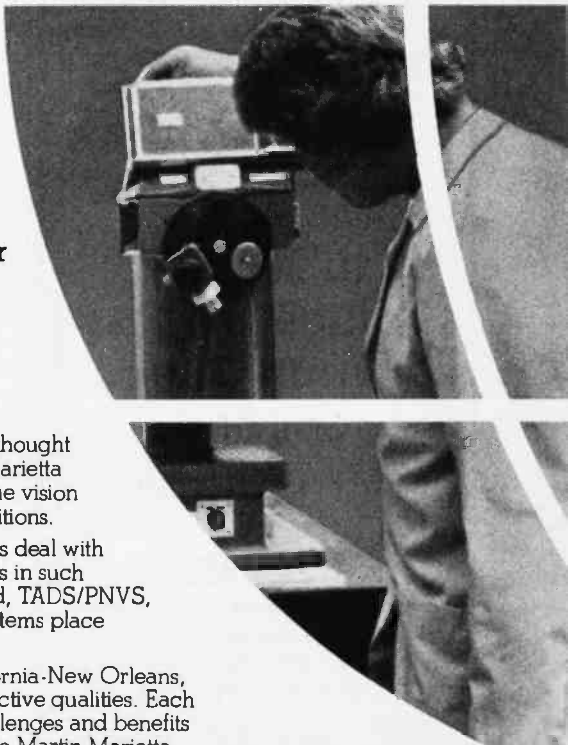
(which means execute the code in the second brackets as long as the code in the first set of brackets evaluates to something other than false).

Addressing Variables

Methods are implemented as objects whose fields contain the bytecodes plus a group of pointers to other objects called the *literal frame*. The interpreter can use the getField subroutine of the storage manager to fetch the next required bytecode to execute. This takes care of returns, jumps, and pops, but for the other bytecodes we need to represent more information. In particular, for the push and store bytecodes, we need to represent where to find the object pointers to push; for the send bytecodes, we need to represent where to find the selector of the message and which stack elements are the receiver and arguments.

The source code for a method contains variable names and literals, but the bytecodes of the Virtual Machine are defined only in terms of field offsets. From the Virtual Machine's point of view, there are three types of variables: variables local to the method (called *temporaries*), variables local to the receiver of the message (*instance variables*), or variables found in some dictionary that the receiver's class shares (*global variables*). Note that *class variables* are treated in the same way as other global variables. The Smalltalk-80 compiler (itself written in Smalltalk-80) translates references to these variables into bytecodes that are references to field offsets of the receiver, the temporary area, or globals. The instance variables are translated using a field of class-describing objects that associates instance variable names with field offsets. The assignment of offsets to temporaries is done when the compiler translates a method by associating





names of temporaries to offsets in the temporary area. The compiler creates instances for the literals, puts their object pointers into the literal frame of the method, and produces bytecodes in terms of offsets into the literal frame. For global variables, the compiler uses system dictionaries that associate global names to indirect references to objects. Object pointers of the indirect references to the global objects are also placed in the literal frame of the method. The bytecodes for accessing globals are encoded as indirect references through field offsets of the literal frame.

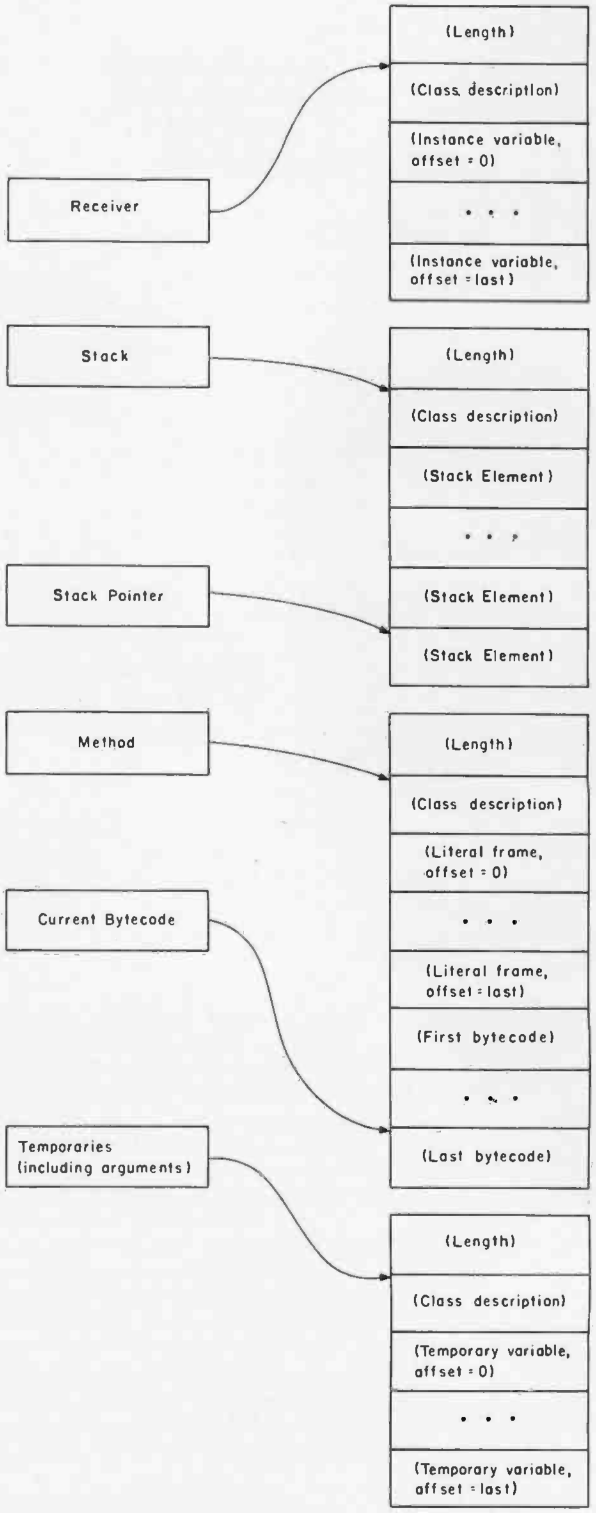


Figure 5: *Object pointers held by the interpreter.*

Hayden APPLESOFT COMPILER means Speed for your Apple II™—

New! **HAYDEN APPLESOFT™ COMPILER** (Eiten) At last — a program that translates your standard Applesoft™ BASIC program into true machine code! The resulting binary program runs 3 to 10 times faster than normally interpreted code ... the longer and more complex the source program, the greater the increase in execution speed. The file is B RUN to execute the final compiled product. ***#08809, Apple II Disk, $200.***

DISK CERTIFIER AND COPIER (Jacc Inc.) A handy utility program that certifies the acceptability of blank diskettes and rejects those with flaws. It also includes a fast machine language disk copying program that will work on single and dual drive systems. ***07809, APPLE II Disk, $19.95***

LINE & VARIABLE CROSS REFERENCE GENERATOR (Johnson) Provides a cross-reference of line numbers and variable names. ***07301, PET tape, $16.95***

RENUMBER & APPEND: Utility Programs for the Apple (Gilder) Renumber your Applesoft program and append a second program to the one in memory. ***03804, Apple II tape, $14.95***

REVIVE (Gilder) When a program is accidentally erased, REVIVE searches through memory and finds the information that enables it to restore the pointers that have been changed. ***03604, Apple II tape, $19.95***

ORDER NOW!

Hayden Book Co., Inc.
50 Essex St. Rochelle Park, NJ 07662

Please send me the software checked on a 10-day FREE examination. At the end of that time, I will send payment, plus postage and handling, or return the software and owe nothing. On all prepaid orders, Visa, and Master Card charges, publisher pays postage and handling — same return guarantee. Residents of NJ and CA must add sales tax. Offer good in USA only. Prices subject to change without notice. Payment must accompany orders from PO Box numbers. Allow 4 to 6 weeks for delivery. Name of individual ordering must be filled in.

☐ 03504	☐ 04909	☐ 05208	☐ 08809
☐ 03604	☐ 05004	☐ 05409	☐ 09109
☐ 03804	☐ 05009	☐ 05509	☐ 09409
☐ 03904	☐ 05103	☐ 07301	☐ 09704
☐ 04609	☐ 05108	☐ 07809	
☐ 04804	☐ 05203	☐ 08609	

Name ______________________

Street ______________________

City / State / Zip ______________________

B 8/81-009

APPLESOFT UTILITY PROGRAMS (Gilder) Increase your BASIC programming speed and flexibility. Contains 9 useful subroutines: 1. REM Writer 2. PRINT Writer 3. POKE Writer 4. Hexadecimal/Decimal Converter 5. Line Counter 6. Renumber 7. Append 8. Byte Counter 9. Slow List/Stop List. ***03504, Apple II tape, $29.95***

SLOW LIST/STOP LIST: Utility Programs for the Apple (Gilder) Start, stop, and control the speed of your program with Apple II's game paddles. ***03904, Apple II tape, $10.95***

PSEUDODISK (Neuschatz) This money-saving program simulates a disk memory system for Integer BASIC programs. It allows multiple programs in memory at the same time which can be run from a catalog. ***04804, APPLE II tape, $24.95***

6502 DISASSEMBLER (Stamm) Produce assembly language source files with labeled subroutines and references from programs already in memory. It is compatible with Hayden's ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM. ***08609, APPLE II Disk, $39.95***

DISK CATALOGER (LeBar) Automatically maintains a cross-reference listing of all your programs, their location by disk number, their function and use. Catalogs, lists and sorts programs. ***05203, TRS-80 Level II tape, $16.95; 05208, TRS-80 Level II Disk, $21.95***

FINPLAN: A Financial Planning Program for Small Businesses (Montgomery) Allows you to enter data from a balance sheet into the program, to make assumptions about the future growth of business, and to have the computer project results for up to a five year period based on those assumptions. And if you change any data, the program revises all resulting data automatically. The disk version can be used only with TRSDOS version 2.3. ***05103, TRS-80 Level II tape, $69.95; 05108, TRS-80 Level II Disk Version, $74.95***

DATA MANAGER: A Data Base Management System and Mailing List (Lutus) Store information on a floppy disk, and retrieve it quickly and easily by specific names, or by category. ***04909, Apple II Disk Version, $49.95.***

PROGRAMMING IN APPLE™ INTEGER BASIC: Self-Teaching Software (Banks & Coan) Teach yourself Apple Integer BASIC and control your own progress at all times with this interactive programmed instruction format. ***05004, Apple II, tape, $29.95; 05009, Apple II Disk Version, $39.95***

APPLE™ ASSEMBLY LANGUAGE DEVELOPMENT SYSTEM: An Assembler/Editor/Formatter (Lutus) Write and modify your machine language programs quickly and easily. ***04609, Apple II Disk Version, $39.95.***

SUPER APPLE™ BASIC (Lutus) A structured BASIC that compiles into an optimized Applesoft or Integer BASIC program. ***05409, Apple II Disk, $39.95***

Super FORTH (Bugbee) This is a fast, high-level, expandable language that features integer and floating-point math, high-resolution graphics and string handling capability. ***05509, APPLE II Disk, $49.95***

NEW!

OP-AMP DESIGN (Gabrielson) Provides the necessary values for your design and will suggest appropriate op-amp types. Includes a choice of six op-amps, and the program will then determine if your selection of an op-amp will be acceptable within your chosen parameters. Can be updated to accommodate future op-amps. ***09704, Apple II tape, $16.95***

DOUBLE PRECISION FLOATING POINT FOR APPLESOFT (S-C Software) Extends the accuracy of the arithmetic available on the Apple from nine digits to a full 21-digit precision on all functions in Applesoft compatible format. ***09409, Apple II Disk, $49.95***

DATA-GRAPH (Boyd) Aids in the preparation of graphs and charts. Numeric data can be entered into Data-Graph and used to create colorful one-, two-, or four-quadrant graphs. ***09109, Apple II Disk, $49.95***

Apple is a trademark of Apple Computer Company, Inc. and is not affiliated with Hayden Book Company, Inc.

Available at your local computer store!

For Orders and Inquiries Call Toll Free

HAYDEN HOTLINE 800-631-0856

Hayden

50 Essex Street, Rochelle Park, NJ 07662 **Book Company, Inc.**

Circle 153 on inquiry card.

This means that when the interpreter is executing a method, it has to keep a stack, a temporary area, a pointer to the receiver and arguments of the method, and a pointer to the method itself (see figure 5). It uses the storage manager's getField and storeField subroutines to push and pop pointers from the stack object, to retrieve and set values of variables in the temporary area, to retrieve and set values of variables of the receiver, and to get bytecodes and values of global variables from the method.

Finding Methods

When a message is sent, the receiver and arguments must be identified, and the appropriate method must be found by the interpreter. The technique used in Smalltalk-80 is to include in each class-describing object a dictionary, called the *method dictionary*, that associates selectors with methods. Pointers to the selectors that will be sent by any method are kept in the method (along with global variable pointers and bytecodes). The bytecodes that tell the interpreter to send a message encode a field offset in the literal frame where the selector is found, plus the number of arguments that that method needs. By convention, the top elements of the stack are the arguments and the next one down is the receiver. For example, the send bytecode for the expression:

```
3 + 4
```

will stand for "send the selector in field X of the method (which will be +), and it takes one argument." The interpreter will ask the storage manager for the X field of the method, will get the top of the stack (4) as the argument, and the next element down (3) as the receiver. It will locate the receiver's class, its method dictionary, search it for an association of the + selector with some method, and, when found, execute that method.

If no such association is found, the searching does not end. The receiver's class may be a subclass of another class, called its *superclass*. If this is the case, the method for + may be

(Length) 7
(Class description) Class of class-describing objects
(Number of fields) 2
(Pointers) True
(Instance Variable Names) "xCoordinate yCoordinate"
(Global Variable Dictionaries)
(Method Dictionary)
(SuperClass)

Figure 6: *Class-describing object for class* Point, *revisited.*

defined in the superclass, so the interpreter must check there. This means that each class must have a field that refers to its superclass (see figure 6). The interpreter searches the method dictionary of the superclass, its superclass, and so on, until either an appropriate method is found or it runs out of superclasses, in which case an error occurs.

To execute a method, the interpreter needs a place for temporaries and a stack for that method. In the Smalltalk-80 Virtual Machine, this is done by allocating an object that is an instance of class MethodContext. Objects in MethodContext keep track of the method, the stack for that method, a pointer to the next bytecode to be executed in that method, the temporary variables for that method, and the context from which that method was invoked, called the *caller* of that method (see figure 7). When a method returns, the value returned is pushed on the stack of the caller context, and execution continues at the next bytecode of the caller's method.

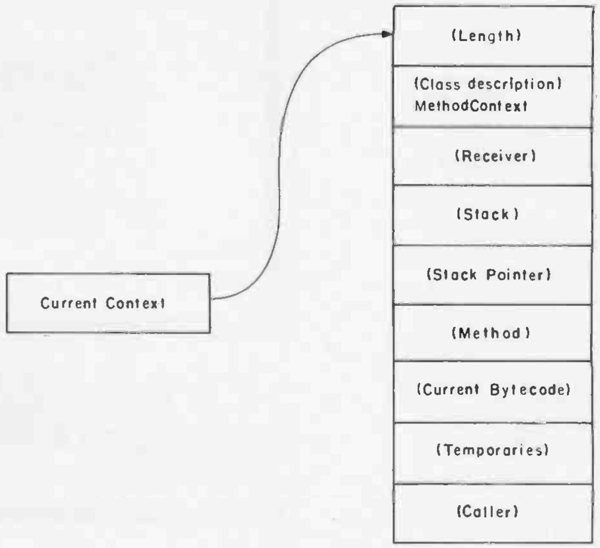


Figure 7: *The only object pointer used by the Smalltalk-80 interpreter is a reference to a* MethodContext.

The Smalltalk-80 Virtual Machine implementation is a program running in the machine language of the target computer.

Primitive Subroutines

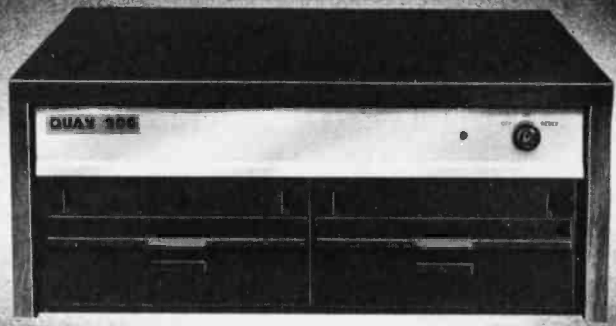
The Smalltalk-80 Virtual Machine implementation is a program running in the machine language of the target computer. The storage manager is the collection of subroutines in this program that deals with memory allocation and deallocation. The interpreter is the collection of subroutines in this program, one of which fetches the next bytecode from the currently running method and calls one of the others to perform the appropriate action for that bytecode. In addition to these functions, we have found that there are several other places in the Smalltalk-80 system where performance considerations make it necessary, or at least desirable, to implement certain functions as machine-code subroutines in the Smalltalk-80 Virtual Machine. These places are:

- input/output: connecting the Smalltalk-80 system to the actual hardware
- arithmetic: basic arithmetic for integers
- subscripting indexable objects: fetching and storing indexable instance variables
- screen graphics: drawing and moving areas of the screen bitmap quickly
- object allocation: connecting the Smalltalk-80 code for creating a new instance with the storage manager subroutines

We call this set of subroutines the *primitive subroutines*.

The primitive subroutines are represented in the Smalltalk Virtual Image as methods with a special flag that says to run the corresponding subroutine rather than the Smalltalk-80 bytecodes. When the interpreter is executing the code to send a message and finds one of these flags set, it calls the subroutine and uses the value returned from it as the value of the method. The number of these methods in Smalltalk-80 is small (around one hundred) in order to keep the rest of the system as flexible and extensible as possible. We will not list those methods that are primitives, but will refer the reader to *Smalltalk: the Language and Its Implementation* (Goldberg, Robson, and Ingalls, 1981) for details.

2.5 MB.



standard on our 900 SERIES microcomputer system . . . under $4,000.00*

Having so much disk capacity as standard in a low cost microcomputer system is reason enough to make the 900 Series your logical choice — but the fact is, it's only one of the reasons why this system offers the best price/performance value of any now on the market. There's also a simple modular design, a reliable single board computer, dual flexible disk drives, a versatile disk operating system, plenty of room for expansion, and attractive quantity discounts — plus a lot more.

Just check out these standard features and expansion capabilities.

STANDARD ON THE 900 SERIES:

- ☐ Single board microcomputer: Z80 based; 4 MHz. operation; DMA controlled disk access.
- ☐ Dual eight inch flexible disk drives: on-line formatted capacity of 2.5 megabytes expandable to 5 Mb; access time of 3 milliseconds track-to-track; 8000 hour MTBF reliability rating.
- ☐ IBM 3740 format compatible
- ☐ 48 kilobytes of dynamic RAM, expandable to 65 Kb.
- ☐ CP/M® Disk Operating System with assembler, editor and debug subsystems.
- ☐ RS232 or TTY serial port for system console.
- ☐ Parallel line printer port (Centronics-compatible).

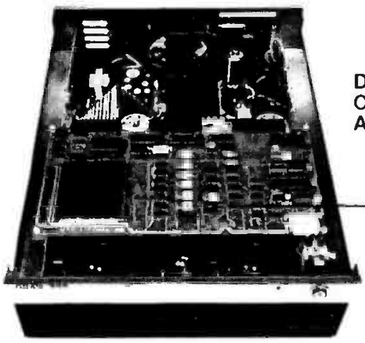
OPTIONS FOR THE 900 SERIES:

- ☐ Disk expansion: up to 5 Mb formatted capacity.
- ☐ Serial I/O expansion: two additional RS232 ports (serial printer, modem, etc.)
- ☐ S100 bus adaptor for system expansion.
- ☐ Multi-user operation
- ☐ Hard disk subsystem ☐ OASIS operating system

AVAILABLE SOFTWARE FOR THE 900 SERIES:

- ☐ High level languages include: BASIC, FORTRAN, COBOL and PASCAL.
- ☐ Application packages include: Inventory, Word Processing, GL, AR, AP and Payroll.

the Quay 900 Microcomputer System offers the most complete package for the money



DESIGNED FOR OPTIMUM RELIABILITY AND EASY SERVICING

Single board design
Quad-density flexible disk drives
Turn-key operation and security
Expansion capabilities
Industrial quality construction

QUAY CORPORATION

P.O. Box 783, 527 Industrial Way West,
Eatontown, N.J. 07724 ■ (201) 542-7340

DISTRIBUTOR AND REPRESENTATIVE INQUIRIES WELCOME

*In OEM/Dealer quantities, please contact factory for pricing detail.

CP/M® is a registered trademark of Digital Research

Circle 325 on inquiry card.

SW-208

A few of these primitive methods are executed so often that even the cost of looking them up in their classes' method dictionaries would be excessive. These methods are instead represented as special versions of the Send Message type of bytecodes. The message + , for example, is represented this way. When this bytecode is executed and the top two elements of the stack are small integers, then the primitive method is called as a subroutine. When this bytecode is executed and the top two elements of the stack are not small integers, then the + message is sent normally.

Conclusion

The Smalltalk-80 Virtual Machine is a fairly small computer program that consists of a storage manager, an interpreter, and a set of primitive subroutines. The task of implementing a Smalltalk-80 Virtual Machine for a new target computer is not large (especially when compared with the task of implementing other large programming systems) because most of the functions that must usually be implemented in machine code are already part of the Smalltalk-80 Virtual Image that runs on top of the Virtual Machine.

The Smalltalk-80 Virtual Machine could also be implemented in hardware, although this has not yet been done. Such an implementation would sacrifice some of the flexibility of software, but it would result in the performance benefits that hardware provides. Given the evolving nature of Smalltalk, it may not yet be time to implement the Virtual Machine in hardware: new Smalltalks that are more powerful would likely need at least small changes in Virtual Machine definition and implementation. However, hardware assists to Smalltalk-80 Virtual Machine software can greatly improve performance. Writable microcode stores for the pieces of code that are frequently run, hardware assists for graphics, or hardware assists for the fetching of bytecodes could all potentially improve the performance of a Smalltalk-80 Virtual Machine implementation. ■

INTRODUCING...

COMES WITH: (ADDITIONAL)

- ▲ WORD STAR® WORD PROCESSOR
- ▲ ACCOUNTS PAYABLE
- ▲ ACCOUNTS RECEIVABLE
- ▲ GENERAL LEDGER
- ▲ SALES ORDER ENTRY
- ▲ INVENTORY CONTROL

ONLY

$3450.00

QUANTITY DISCOUNTS AVAILABLE!

INCLUDING CP/M2.2®

($4950.00 INCLUDING ACCOUNTING SOFTWARE AND WORD STAR®)

320K MINI DRIVES SHOWN, 8" and 5¼" 10MB HARD DISK OPTIONAL

IMMEDIATE DELIVERY!

1 YEAR PARTS WARRANTY!

(90 DAYS ON DRIVE PACKAGE, KEYBOARD AND LABOR)

U.S. *MICRO SALES* **S-100-8**

CHECK THESE FEATURES!

TERMINAL

- Feather Touch Capacitance Keyboard
- 60 Key Standard ASCII
  PLUS + Hex Keypad
  PLUS + 8 Special Function Keys
  PLUS + 20 Screen Editing Keys
- SOROC Type Screen Attribute Set
- Half Intensity

COMPUTER

- 8 Slot S-100
- 64K Dynamic Ram
- 4MHZ Z-80
- Serial Printer Port (150 - 19.2K)
- Double Density Disk Controller
- Programmable Baud Rate
- Programmable Keyboard Set

DISK STORAGE

- Dual Double Density 5¼ Single Sided Drives
- DOUBLE SIDED Option
- Double Sided, 77 Track, Option
- Color Matched Enclosure
- Self Contained Power Supply

OPTIONS:

- ♦ Dual 5¼" Double Sided MPI B51 (640K) add $225.00
- ♦ Dual 5¼" Double Sided MPI B91 (1.2MB) add $360.00
- ♦ Dual 8" SIEMANS FDD120-8 Drives (1MB) add $250.00
- ♦ Dual 8" QUME Double Sided Drives (2MB) add $625.00

U.S. *MICRO SALES*

11 EDISON DRIVE ★ NEW LENOX, ILLINOIS 60451 ★ (815) 485-4002

WORD STAR is a TM of Micropro Inc. – CP/M2.2 is a TM of Digital Research Inc.

Circle 389 on Inquiry card.

Building Control Structures in the Smalltalk-80 System

L Peter Deutsch
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

Just as *data structures* refer to the ways that we group data together by using simple *objects* to represent more complex objects, *control structures* refer to the ways a programmer can build up complex sequences of *operations* from simpler ones. The easiest example of a control structure is sequencing: do something and then do something else. Two other familiar examples are the *conditional* structure (if some condition is true, do something, otherwise do something else) and the *loop* (do something as long as some condition remains true).

Most languages provide a few common control structures, typically sequencing, conditional, looping, and procedures, but no way for a programmer to define new structures. One useful control structure that many languages omit is the simple *case* statement (given *N* alternative things to do, numbered from 1 to *N*, and a variable *K*, do the *K*th thing). If the language doesn't provide a case statement, you can always simulate it with a long string of conditionals, but it makes your program harder to read. Other useful control structures are much more difficult to simulate if the language fails to provide them.

The Smalltalk-80 language and system (which will be called simply "Smalltalk") is one of the few languages in which a programmer can invent and implement, with relative ease, new control structures that aren't provided by the system implementors. The rest of the article illustrates this point with examples that have actually been run on a Smalltalk-80 implementation.

What's Built In

Smalltalk provides very few built-in control structures. There is the conditional structure, implemented as follows:

```
someCondition ifTrue: [somethingToDo]
someCondition ifFalse: [somethingToDo]
someCondition
   ifTrue: [somethingToDo]
   ifFalse: [somethingElseToDo]
```

and the simple loop:

```
[someCondition] whileTrue: [somethingToDo]
[someCondition] whileFalse: [somethingToDo]
```

The most powerful tool for building new structures is the *block*. Two examples are:

```
[somethingToDoLater]
```

and:

```
[:anArgumentName| somethingToDoLater]
```

The block allows a caller to pass to the implementor of a control structure a piece of code to be executed (possibly with arguments, as in the second example) at an appropriate time.

Case Statement

Our first example is the case statement described before. We would like a construct that includes an indexed collection of blocks for the expected cases and another block for the situation where the index is out of range. Without any particular trouble we can have a construct like this:

```
someExpression
   case: (Array with: [case1] with: [case2] with:
     [case3])
   otherwise: [somethingElse]
```

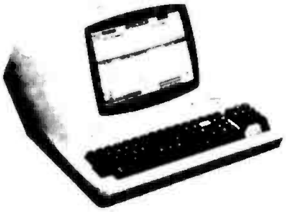
where [somethingElse] gets evaluated if someExpression isn't 1, 2, or 3. Then the definition is simple. We add a message to the existing class Number. In order to distinguish adding methods to existing classes from creating new classes, we will label templates "existing" if they are to be seen as partial templates adding new methods to existing classes.

Table 1 shows the code necessary to add the case method to the class Number. As far as the control struc-

AUTOMATED EQUIPMENT INCORPORATED

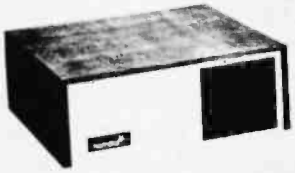
18430 Ward, Fountain Valley, CA 92708

Call Toll-Free for latest low prices!
1-800-854-7635 Outside CA
714-963-1414 Inside CA
1-800-854-7635 Outside Cont. USA
Prices change daily to meet competition.



TERMINALS

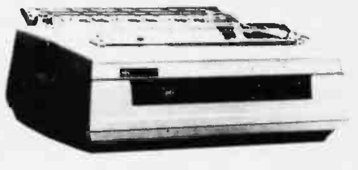
TELEVIDEO 912 B	CALL
TELEVIDEO 912 C	CALL
TELEVIDEO 920 B	CALL
TELEVIDEO 920 C	CALL
SOROC IQ-120	675
ZENITH A-19	750
HAZELTINE 1500	995
TELEVIDEO 950	CALL



NORTHSTAR

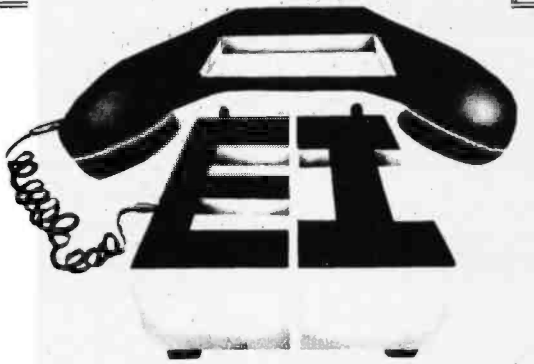
HRZ-1D-32K	CALL
HRZ-2D-32K	CALL
HRZ-1Q-32K	CALL
HRZ-2Q-32K	CALL
ADDITIONAL 16K RAM	CALL
ADDITIONAL 32K RAM	CALL
HARD DISK SYSTEM	CALL

SPECIAL MEMORY CONFIGURATIONS AVAILABLE, INCLUDING SYSTEMS GROUP.



PRINTERS

NEC 5510 (TRACT., RIB., THIM)	$2600
NEC 5515 (TRACT., RIB., THIM)	2600
NEC 5520 (TRACT., RIB., THIM)	2900
NEC 5530 (TRACT. RIB., THIM)	2540
TI-810	1495
TI-820	1625
EPSON MX 100	CALL
EPSON MX 80	CALL
EPSON MX 70	CALL
ANADEX DP-9500/9501	CALL



VIP's Call A.E.I.

VIP's customarily need top quality and service within stringent budgetary limits, naturally, they call A.E.I.

Item: A.E.I. tests virtually every* item sold, before shipping.

Item: A.E.I. initializes every piece of software, and makes a copy. If you have a problem, A.E.I. can check to locate the problem by using the in-house duplicate, saving you time.

Item: A.E.I. has in-house expetise on every item offered.

Item: A.E.I. prices are competitive with the lowest, no-service, no in-house expertise dealer.

40% OF ALL A.E.I. SALES ARE TO PUBLIC AND SEMI-PUBLIC INSTITUTIONS.

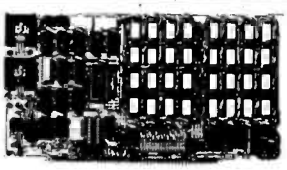
A partial list** of A.E.I. customers who purchased during the last quarter of 1980 includes: University of Nebraska, University of Virginia, U.S. Dept. of Interior, University of Kentucky, University of California, Massachusetts Institute of Technology, U.S. Air Force, Naval Air Development Center, Brown University, University of Oregon, University of Utah, Ohio State University, University of Southern California, California State Dept. of Water Resources, University of Michigan, and Princeton University.

In the private sector, an equal number of major national organizations purchased during the same period.

You can call A.E.I. too!

*With our normal fast shipping, we have time to test: expedited shipment may preclude testing.

**A.E.I. does not wish to imply that any of these fine organizations endorse A.E.I., merely that A.E.I. is proud to have them as customers.



S.S.M.	KIT	ASM
CB2 Z80 CPU	$200	$265
VB1C VIDEO	140	190
VB2 VIDEO	155	210
VB3 VIDEO	375	440
IO4 INTERFACE	165	225
SB1 SYNTHESIZER	195	270

MEASUREMENT SYSTEMS MEMORY

DM3200 32K 4MHZ	480
DM6400 64K 4MHZ	595
DMB3200 32K 4MHZ BANK SELECT	630
DMB6400 64K 4MHZ BANK SELECT	745

DYNABYTE SYSTEMS ALSO AVAILABLE—CALL FOR THE EXCITING NEWS ABOUT NEW COMPETITIVE PRICING!

WE WILL TRY TO BEAT ANY ADVERTISED PRICE.

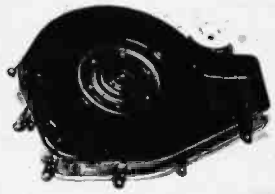
TERMS: All prices listed are cash discounted and subject to change. COD's are 2% additional. Universities and well-rated firms Net-10.

SHIPPING: ADDITIONAL IN ALL CASES.

TECHNICAL ASSISTANCE:
WE TRY TO HELP INTERFACE AND TROUBLESHOOT—CALL (714) 963-1414.

Open Monday-Friday, 8:00 a.m.-5:00 p.m.

Dealer Inquiries Invited.



MORROW

DECISION 1 BASIC	$1550
DISCUS-1 2 DRIVE	1550
DISCUS 2D 1 DRIVE	935
DISCUS 2D 2 DRIVE	1550
DISCUS 2+2 1 DRIVE	1250
DISCUS 2+2 2 DRIVE	2190
DISC JOCKEY 2D	350
DISCUS M26 HARD DISC	3925
ADDITIONAL HARD DISC	3685
DISCUS M10	2990

MISCELLANEOUS

NEC THIMBLES	$16
NEC RIBBONS	7
RS2332 CABLE 5'	20
RS 232 CABLE 10"	25
LEDEX MONITOR	145
NOVATION CAT	145

SOFTWARE

WORDSTAR	$330
MAILMERGE	100
DATASTAR	250
N.S. PASCAL	160
MAGIC WAND	290
C BASIC	100

GRAHAM-DORIAN

JOB COSTING	$700
INVENTORY	475
CASH REG.	475
APARTMENT	475
MEDICAL	700

ADDITIONAL SOFTWARE DISCOUNTS WITH SYSTEM PURCHASE

DISCS—BOX OF 10

VERBATUM 5¼ 1 SIDE	$27
VERBATUM 5¼ 2 SIDE	45
VERBATUM 8 1 SIDE	35
VERBATUM 8 2 SIDE	55
OTHERS	CALL
PLASTIC STORAGE BOXES	3

OUR SYSTEMS WORK!

All systems normally tested and configured in our repair facility before delivery. Service contracts available. Prompt repairs and warranties.

Circle 31 on Inquiry card.

ture goes, this is all there is to it: alternativeBlocks is an array of blocks, and the method in Number simply picks the appropriate one to evaluate. However, the syntax looks clumsy. We might like to have something that looks more like the following:

```
someExpression
    case: [case1], [case2], [case3]
    otherwise: [somethingElse]
```

One way to do this is to arrange for appropriate interpretation of the message , (comma) by BlockContext (table 2a) and to invent a new subclass of IndexedCollection (table 2b) that will also interpret , appropriately. We also have to add some protocol to BlockContext to handle the situation of a single block. Note that double quote marks delineate comments in Smalltalk.

As a matter of style, we generally discourage syntactic embellishments of this kind: their implementation tends to be obscure and they don't add that much to the ease of writing programs.

Generator Loops

Many languages provide a kind of loop called a *generator*, which sets a variable to successive values generated by some algorithm each time through the interior of the loop. The familiar kind of loop that runs through successive integers from 1 to *N* is one such example. Another example is looking at successive elements of a linked list, or any ordered collection.

Smalltalk actually provides simple generators of the form:

```
someCollection do:
    [:anElement| doSomethingWithTheElement]
```

but it is instructive to see how we could have constructed them ourselves. This could be accomplished by having each kind of collection object implement the message do:

class name (existing)	Number
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	
"none added here"	
instance messages and methods	

```
control
case: alternativeBlocks otherwise: aBlock | |
    (self >= 1 and: [self <= alternativeBlocks size])
        ifTrue: [↑(alternativeBlocks at: self) value]
        ifFalse: [↑aBlock value]
```

Table 1: *Template showing additions to existing class* Number.

Cameo's DC-500 Subsystem increases data capacity to 10 megabytes for your Apple II, TRS-80 Model I or Model II, Heath H89 or Zenith Z89 computer and most S-100 based systems.

Cartridge Drives have removable disk packs, allowing interchangeability of on-line data, simply by swapping packs. Back-up is not a problem . . . It's simple and efficient. Now you can have "Big Computer" capability without the expense of buying one.

The Cameo DC-500 Subsystem . . . the cost effective solution to give your micro megabytes.

OPERATING SYSTEMS AVAILABLE FOR THE CAMEO CARTRIDGE DISK

APPLE II and APPLE II Plus
- Apple DOS 3.2
- Apple DOS 3.3
- CP/M
- Pascal

Standard S-100 Bus or Z-80 processor
- CP/M
- MP/M
- La Salle Screen Edit Processor
- Oasis

TRS-80 Model II
- CP/M
- Oasis
- TRS DOS

TRS-80 Model I
- La Salle Screen Edit Processor-C Basic

HEATH H89 and ZENITH Z89
- CP/M

MEGABYTES FOR YOUR MICRO

CAMEO ELECTRONICS INC.

1626 Clementine, Anaheim, CA 92802 (714) 535-1682

Circle 49 on Inquiry card.

directly; we would get simple arithmetic loops by using do: with an Interval, a kind of collection that represents a bounded arithmetic progression. Using do: is convenient when we know that we want to look at all the elements of the collection, and do the same thing to each one. For example IndexedCollection might implement do: as shown in table 3.

However, if we want to retain more flexibility in controlling the generation process, there is a better way. We define the notion of a *supplier*, which will deliver the elements of a collection one at a time in response to messages. The protocol (set of messages and their intended meanings) for suppliers consists of the messages:

s atEnd

class name (existing)	BlockContext
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
constructing
, aBlock | |
    ↑BlockCollection with: self with: aBlock
accessing
size | |
    "Behave like a BlockCollection with self as the only element"
    ↑1
at: index | |
    "Behave like a BlockCollection with self as the only element"
    index = 1 ifTrue: [↑self].
    self error: 'Subscript out of bounds'
```

class name (existing)	BlockCollection
superclass	IndexedCollection
instance variable names	"none defined here"
class messages and methods	

"none defined here"

instance messages and methods

```
constructing
, aBlock | |
    ↑self add: aBlock
```

Table 2: *Templates showing additions to existing class* BlockContext *(2a) and the creation of a class template for class* BlockCollection *(2b).*

which returns true if there are no more elements to be supplied, and:

```
s next
```

which returns the next element. Now we can build our do: operation as shown in table 4. Then each kind of collection needs to implement the message asSupplier, which returns an appropriate supplier. Table 5 shows what a supplier might look like for IndexedCollection (including its creation). If an attempt is made to read past the end, position will be incremented beyond the size of the collection, and next will provoke an error when the at: tries to

class name (existing)	IndexedCollection
superclass	Collection
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
enumeration
do: aBlock
    | index limit |
    index ← 1.
    limit ← self size.
    [index < = limit] whileTrue:
        [aBlock value: (self at: index).
        index ← index + 1]
```

Table 3: *Template showing additions to existing class* IndexedCollection.

class name (existing)	Collection
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
enumeration
do: aBlock
    | supplier |
    supplier ← self asSupplier.
    [supplier atEnd] whileFalse:
        [aBlock value: supplier next]
```

Table 4: *Template showing additions to existing class* Collection.

access an element beyond the size. An alternative approach, which gives a more useful error message at the expense of duplicating a check that at: must perform anyway, is to define next as follows:

```
next | |
   position > = collection size
      ifTrue:
         [self error: 'Attempt to read beyond last
            element'].
   position ← position + 1.
   ↑ collection at: position
```

Similar supplier classes would be needed to provide generation capability for all of the different kinds of Collections.

With the supplier approach to generators, we can easily build a loop that sequences through two collections in parallel (see table 6). This would be very difficult if we did not have suppliers, but made collections implement do: directly. The problem is that while we could use do: to get one of the two collections to deliver its elements to a block of our choosing, there would be no way to get the other collection to deliver exactly one element each time the block is invoked.

Suppliers are so useful as a concept and as a protocol that Smalltalk actually includes them, under the name of ReadStream. The important point is that we could have built them ourselves if the system implementors hadn't gotten there first.

Although the only kind of supplier we have constructed is one that sequences through a collection, other kinds of suppliers are possible: they just have to respond appropriately to atEnd and next. For example, one could imagine a supplier that selected elements at random from a collection in response to next.

Exceptional Conditions

One of the difficulties in designing programs that (at least appear to) work reliably is designing the control structures for handling "infrequent" events. An infre-

class name (existing)	IndexedCollection
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	
"none added here"	
instance messages and methods	
enumeration **asSupplier** | | ↑ IndexedCollectionSupplier of: self	

class name	IndexedCollectionSupplier
superclass	Object
instance variable names	collection position
class messages and methods	
creation **of: aCollection** | | ↑self new of: aCollection	
instance messages and methods	
creation **of: aCollection** | | collection ← aCollection. position ← 0 *accessing* **atEnd** | | ↑position > = collection size **next** | | position ← position + 1. ↑collection at: position	

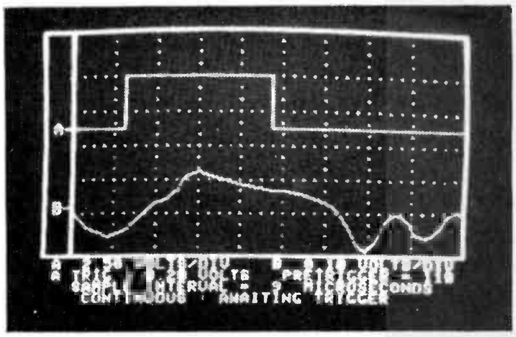
Table 5: *Templates showing additions to existing class* IndexedCollection *(5a) and the creation of a class template for class* IndexedCollectionSupplier *(5b).*

Circle 329 on inquiry card.

APPLESCOPE

DIGITAL STORAGE OSCILLOSCOPE

Interface for the Apple II Computer



The APPLESCOPE system combines two high speed analog to digital converters and a digital control board with the high resolution graphics capabilities of the Apple II computer to create a digital storage oscilloscope. Signal trace parameters are entered through the keyboard to operational software provided in PROM on the DI control board.

- DC to 3.5 Mhz sample rate with 1024 byte buffer memory
- Pretrigger Viewing up to 1020 Samples
- Programmable Scale Select
- Continuous and Single Sweep Modes
- Single or Dual Channel Trace
- Greater than or less than trigger threshold detection

Price for the two board Applescope system is **$595**

For futher information contact:

RC ELECTRONICS INC.
7265 Tuolumne Street
Goleta, CA 93117
(805) 968-6614

Dealer Inquiries Invited

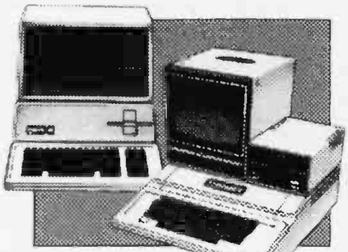
Circle 138 on inquiry card.

ASSESS YOUR ASSETS.

Get a better insight into your expenditure decisions with an Apple personal computer.

Evaluate your financial position with Tax Planner. Chart your progress with Apple Plot. And take stock of your portfolio with The Dow Jones News & Quotes Reporter.

To discover how an Apple can be your greatest asset, drop by our store today.



apple computer
• Authorized Dealer

August Special
10% off all Apple Products
Sale ends Aug 31

Visit us at the Midwest Computer Show, Chicago, Il., Sept 10 thru 13. See an original Apple I on display

FARNSWORTH COMPUTER CENTER
1891 N. Farnsworth Ave. (at the E-W Tollway)
Aurora, Il. 60505 Ph. (312) 851-3888
Weekdays 10-8; Sat. 10-5

THE UNBEATABLE COMBINATION:

apple & ATARI®

AND TEAM ELECTRONICS

1 (800) 547-2492

APPLE	16k+	$1039
	48k+	$1089
ATARI	400 (16k)*	$329
	800 (16k)	$749

*W/o BASIC

APPLE

DISK DRIVE W/3.3 CONTROLLER	499
DISK DRIVE ONLY	429
SILENTYPE PRINTER W/INTERFACE	349
GRAPHICS TABLET	629
APPLESOFT OR INTEGER FIRMWARE	139
LANGUAGE CARD (PASCAL)	369
PARALLEL PRINTER CARD	129
SERIAL PRINTER CARD	159
CENTRONICS PRINTER INTERFACE CARD	149
C.C.S. 7710A	139
C.C.S. 7720A	109
DATA SHIFT ADAPTOR	59
16K RAM CARD (MICROSOFT)	169
Z 80 CARD (MICROSOFT)	289
HAYES MICROMODEM	279
A.B.T. 10 KEY PAD	99
M&R SUP R TERM	299
M&R SUP R MOD (MODULATOR)	22
16K MEMORY EXPANSION	49
PROGRAMMA JOYSTICK	49

ATARI

410 PROGRAM RECORDER	59
810 DISK DRIVE	429
820 PRINTER	499
822 THERMAL PRINTER	369
825 80 COLUMN PRINTER	609
830 MODEM	169
850 INTERFACE MODULE	139
852 8K MEMORY EXPANSION	45
853 16K MEMORY EXPANSION	89
BASIC LANGUAGE CARTRIDGE	49
VISICALC (ATARI)	159
WE HAVE ATARI GAME CARTRIDGES	

HARDWARE

9" B&W MONITOR (SANYO)	159
9" B&W MONITOR (N.E.C.)	169
12" B&W MONITOR (SANYO)	199
12" GREEN MONITOR (SANYO)	259
13" COLOR MONITOR (T.I.)	349
I.D.S. 445G PRINTER	699
I.D.S. 460G PRINTER	1099
I.D.S. 560G PRINTER	1329
EPSON MX-80 PRINTER	499
EPSON CABLE AND INTERFACE	99
CENTRONICS 737-1 PRINTER	749
CENTRONICS 779-2 PRINTER	889
N.E.C. SPINWRITER PRINTER	2639
OUME SPRINT PRINTER	2499
TEXAS INST. 99/4	499

APPLE SOFTWARE

VISICALC	109
VISIDEX	139
VISIPLOT	129
VISITERM	109
VISITREND	179
D.O.S. TOOL KIT	59
D.O.S. 3.3 UPDATE	52
APPLE WRITER	59
SUP R TEXT II	109
GENERAL BUSINESS CONTROLLER	459
SOFT TECH PAYROLL	179
STOCKFILE INVENTORY PROGRAM	369
APPLE ADVENTURE	29
ZORK	29
SARGON CHESS	29
GALAXIAN	22
HI RES FOOTBALL	35
COMPUTER QUARTERBACK	35
MANY OTHER BUSINESS, PERSONAL, AND GAME SOFTWARE AVAILABLE	

VISA® master charge THE INTERBANK CARD

TOLL FREE NUMBER FOR ORDER DESK ONLY. IN OREGON CALL 479-8723. REPAIRS, PARTS, AND WARRANTIES CALL (503) 479-4150. SORRY NO C.O.D.'S. MASTERCHARGE AND VISA ADD 3%. WE WILL SHIP U.P.S. FREIGHT COLLECT OR ADD 3% FOR FREIGHT AND INSURANCE TO AVOID C.O.D. CHARGES. ALLOW 10 DAYS FOR PERSONAL CHECKS TO CLEAR. PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PRICES GOOD AT MAIL ORDER DEPARTMENT OF STORE #162 ONLY.

530 N.E. "E" STREET
GRANTS PASS, ORE
97526

TEAM ELECTRONICS

Circle 377 on inquiry card.

quent event is any event which is (a) qualitatively different from what happens most of the time and (b) not so common that one wants to test for it in the normal flow of control. One example of an infrequent event is an additional exit from a loop. Suppose we would like to write a searching loop that finds the maximum element of a collection of non-negative numbers but stops searching if it finds an element greater than 1000. Such a loop might be implemented as shown in table 7.

We want the block [[supplier atEnd] ...] to respond to the withExit message by giving back a blocklike object which we can assign to the variable theLoop. The ability to name this object allows us to exit from it midcourse. These BlockWithExit objects (see table 8) need to remember only two pieces of information: the original block, to execute in response to the value message, and where to send control if an exit message is sent.

The original statement theLoop ← ... doesn't actually

class name (existing)	Collection
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
enumerating
with: anotherCollection do: aBlock
    | mySupplier itsSupplier |
    mySupplier ← self asSupplier.
    itsSupplier ← anotherCollection asSupplier.
    [mySupplier atEnd or: [itsSupplier atEnd]]
        whileFalse:
            [aBlock
                value: mySupplier next
                value: itsSupplier next]
```

Table 6: *Template showing additions to existing class* Collection.

class name (existing)	OrderedCollection
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
searching
maxBefore1000
    | supplier max value theLoop |
    max ← 0.
    supplier ← self asSupplier.
    theLoop ←
        [[supplier atEnd]
            whileFalse:
                [value ← supplier next.
                value > 1000 ifTrue: [theLoop exit].
                max ← max max: value]] withExit.
    theLoop value. "Actually do the loop block"
    ↑max
```

Table 7: *Template showing additions to existing class* OrderedCollection.

class name	BlockWithExit
superclass	Object
instance variable names	block exitBlock
class messages and methods	

```
creation
with: aBlock | |
    ↑ self new with: aBlock
```

instance messages and methods

```
creation
with: aBlock | |
    block ← aBlock

control
value | |
    exitBlock ← [↑ nil]. "Exit to my caller if the block ever
    sends me the exit message"
    ↑ block value "Actually do the computation"
exit | |
    exitBlock value "Exit from the computation to the caller
    who sent the value message to me in the method just above"
```

class name (existing)	BlockContext
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
control
withExit | |
    ↑ BlockWithExit with: self
```

Table 8: *Templates showing the creation of a class template for class* BlockWithExit *(8a) and additions to existing class* BlockContext *(8b).*

Circle 130 on inquiry card.

Circle 328 on inquiry card.

DISK DRIVE WOES?
PRINTER INTERACTION?
MEMORY LOSS?
ERRATIC OPERATION?

Don't Blame The Software!

Power Line Spikes, Surges & Hash could be the culprit! Pat. #4,259,705
Floppies, printers, memory & processor often interact! Our patented ISOLATORS eliminate equipment interaction AND curb damaging Power Line Spikes, Surges and Hash.

- ISOLATOR (ISO-1) 3 filter isolated 3-prong sockets; integral Surge/Spike Suppression; 1875 W Maximum load, 1 KW load any socket $62.95
- ISOLATOR (ISO-2) 2 filter isolated 3-prong socket banks; (6 sockets total); integral Spike/Surge Suppression; 1875 W Max load, 1 KW either bank $62.95
- SUPER ISOLATOR (ISO-3), similar to ISO-1 except double filtering & Suppression $94.95
- ISOLATOR (ISO-4), similar to ISO-1 except unit has 6 individually filtered sockets $106.95
- SUPER ISOLATOR (ISO-11) similar to ISO-2 except double filtering & Suppression $94.95
- CIRCUIT BREAKER, any model (add-CB) .... Add $ 8.00
- CKT BRKR/SWITCH/PILOT (-CBS) .... Add $16.00

AT YOUR DEALERS

Master-Card, Visa, American Express
Order Toll Free 1-800-225-4876
(except AK, HI, PR & Canada)

ESP *Electronic Specialists, Inc.*
171 South Main Street, Natick, Mass. 01760
Technical & Non-800: 1-617-655-1532

KILL SURGES LIKE LIGHTNING!

AC power line surges are destructive, can cost you money, and can't be prevented. But you can stop them from reaching your sensitive electronic equipment with a Surge Sentry.

Surge Sentry acts in picoseconds to dissipate up to a 1,000,000 W, 100μ second surge. Triggers at 10% above nominal peak voltage. Works in parallel with the power line. Is easy to install for immediate protection. No complicated wiring or special tools required.

Several different models to choose from, including an OEM version. Call or write today for a *free* brochure

SURGE SENTRY
It'll clean up your AC

RKS ENTERPRISES, INC.
643 South 6th Street, San Jose, CA 95112
(408) 288-5565

DEALER INQUIRIES INVITED

CW ComputerWatch

Clock/Calendar

Now available on Three Buses

Features

- 12/24 Hr. Format
- Month-Day-Year
- Day of Week
- Leap Year Bit
- 4 Interrupts
- +- 30 Sec. Adjust
- Battery Backup
- Simple to Program

*APPLE II

*TRS-80

S100

$150 FOB
CompuTime

* Apple is a Trademark of Apple Computer Co.
* TRS80 is a Trademark of Tandy Corp.

Dealer Inquire (714) 536-5000
P.O. Box 5343 Huntington Beach, CA 92646

Circle 61 on inquiry card.

execute the loop: it creates a block whose code is [supplier atEnd] ... . This block becomes the block variable of a new BlockWithExit as a result of the withExit message being sent. theLoop is set to the BlockWithExit just created. When theLoop is sent the message value, the value method in BlockWithExit first creates another block, the exitBlock, which, if evaluated, will return to the sender of value *regardless of how many other activations have intervened.* The value method in BlockWithExit then sends value to the original block, causing it to execute. If no exit is sent, the loop completes normally. If an exit is sent, the exitBlock is evaluated and control returns to the last statement of maxBefore1000, just as if the loop had completed.

Dynamic Binding

Another common kind of infrequent event is a request for information. For example, suppose we want to specify a default directory for disk files throughout some part of a program. We could pass this information as an argument through all intervening calls, but this would place an added burden (in time, space, and complexity) on many parts of the program that have no interest in this information. An alternative would be to set a global variable before starting the computation, and reset it afterwards; unfortunately, if the computation is interrupted (say by something like the loop exit construct we described earlier), this leaves the variable with the wrong value. Ideally, we would like to set up a structure that will get control if the default information is ever needed, without getting in the way of the rest of the program. Such an arrangement is called *dynamic binding*. We will illustrate how it can be used both for data and control.

Suppose we want to write something such as the following:

```
#defaultDirectory bindTo: 'Smith' in:
    [someComputation]
```

and then have the file system be able to ask for the current default directory by:

```
#defaultDirectory binding
```

Since we want the binding of defaultDirectory to 'Smith' to last only for the duration of someComputation, it follows that in order to find the binding of a dynamic variable, we must examine the data structures that Smalltalk uses to represent the state of a computation. In

class name	Binding
superclass	Association "Provides key and value variables, and messages for accessing them"
instance variable names	"none defined here"
class messages and methods	

```
creation
of: aSymbol to: aValue in: aBlock | |
    ↑ self new of: aSymbol to: aValue in: aBlock
```

instance messages and methods	

```
initialization
of: aSymbol to: aValue in: aBlock | |
    key ← aSymbol.
    value ← aValue.
    ↑ aBlock value "Actually does the computation"
```

class name (existing)	Symbol
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods	

```
binding
bindTo: value in: aBlock | |
    ↑ Binding of: self to: value in: aBlock
```

Table 9: *Templates showing creation of a class template for class* Binding *(9a) and additions to existing class* Symbol *(9b).*

class name (existing)	Symbol
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	
"none added here"	
instance messages and methods	

```
binding
binding | context |
   context ← thisContext. "Start here. thisContext is a
   machine register"
   [context = nil] whileFalse:
      [((context receiver isMemberOf: Binding)
         and: [context selector = #of:to:in: "Is it a
         binding..."
         and: [context receiver key = self]])  "...of this
         variable?"
            ifTrue: "Yes, return its value"
               [↑ context receiver value]
            ifFalse: "No, go on to the next context in the
            chain"
               [context ← context sender]].
   self error: ('No binding for' concatenate: self)
```

Table 10: *Template showing additions to existing class* Symbol.

particular, even though many messages may be sent in someComputation before the file system needs to find the binding of defaultDirectory, there must be some way to search the stack of methods that have been started but not completed, looking for whatever represents the binding of defaultDirectory. In Smalltalk, each element of this stack is a MethodContext object, and the variable in a MethodContext that refers to its caller is called its *sender*. So searching this stack just means checking the current context's sender, its sender, and so on, until we find a binding of the variable. We know we have found a binding when we recognize a MethodContext in which the receiver of the message is a Binding (see tables 9a and 9b), and which was created in response to a particular message. During this computation (↑ aBlock value in table 9a), a MethodContext will exist in which the receiver is the Binding and the message is of:to:in:. This is how we recognize a binding in the stack of MethodContexts. The searching process is shown in table 10.

Note that by combining dynamic binding with the ability to name exit points (eg: by doing #theExit bindTo: to create a BlockWithExit), we can arrange for dynamically bound exceptional events to stop a computation in midstream. More complicated arrangements that allow the parts of the computation being stopped to clean up after themselves are also easy to construct.

Coroutines

Generator loops are an example of *producer/consumer*

Circle 99 on inquiry card.

Find Your Way Around The New Apple® DOS With The Dakin5® Programming Aids 3.3®

Dakin5 Corporation, a Colorado software house, is making available to the public 12 utility programs on one 16 sector diskette, utilizing the new Apple DOS 3.3, which provides 23% more storage.

All of the Dakin5 Programming Aids 3.3 programs are also compatible with the Corvus Disk Drive system.

Features

- Remove REM statements, unreferenced (dead) code, and compress code to increase program speed and save memory and disk space.
- Copy any file or program from one diskette to another. Only the name is needed.
- Print or display a line cross reference and variable name cross reference.
- Print or display all or selected records from a text file.
- Display any sector of a given file or program, and then update any data within that sector, or specify the sector you wish to update, such as directory sectors and sectors occupied by DOS.
- Create, print and modify your own text and Exec files.
- Perform 20-digit arithmetic.
- Copy a diskette without DOS; initialize without DOS; verify source diskette; verify copied data is the same as the original.
- Use a powerful data entry routine that handles both string and numeric data.

Plus Many More Utility Programs for Sophisticated Programmers

Many of these utility programs have been developed and tested for in-house use while producing The Controller™ business package for Apple Computer Inc.

Each programming aids package includes a program diskette and very complete documentation, all attractively packaged in a padded, blue print vinyl 3-hole notebook with silver lettering. An identifying tab separates each program for convenient reference.

See your Apple dealer or contact Dakin5 Corporation, P.O. Box 21187, Denver, Colo. 80221. Telephone: 800-525-0463. VISA or MC welcome.

Apple is a registered trademark of Apple Computer Inc. The Controller is a registered trademark of Dakin5 Corporation.

DAKIN5 CORPORATION

Components Express, Inc.

"Have you kissed your computer lately?"

1380 E. Edinger, Unit CC Santa Ana, CA 92705 (714) 558-3972

BROAD BAND MICROWAVE RECEIVER SYSTEM 1.8GHZ to 2.4 GHZ

only **$295.00**

With built-in-converter to channel 2, 3, or 4 of any standard TV set.

RANGE: Line of sight to 250 miles.

SCOPE: Will receive within the frequency band from satelites, primary microwave stations, and repeater microwave booster stations.

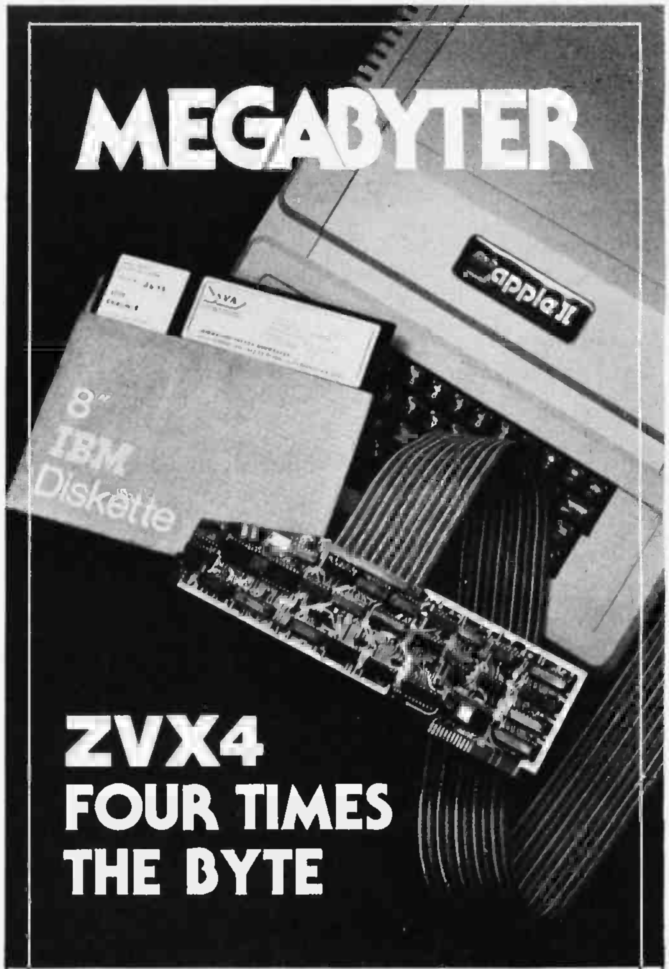
CONTENTS: Packaged in 19"x19"x4 1/2" corrugated carton complete with:

- 24" Dish
- Feed-Horn Receiver
- Mounting Bracket
- Mounting Clamp
- Instructions
- 300 Ohm to 75 Ohm Adapter
- 750 Ohm to 300 Ohm Adapter
- 60 Feet Coax Cable with Connectors
- 3 Feet Coax Cable with Connectors

WARRANTY:
180 days for all factory defects and electronic failures for normal useage and handling. Defective sub assemblies will be replaced with new or re-manufactured sub assembly on a 48 hour exchange guarantee.

This system is not a kit and requires no additional devices or equipment other than a TV set to place in operation. **DEALER INQUIRIES INVITED.**

Circle 355 on inquiry card.



The ZVX4 MEGABYTER is for the APPLE II user who wants to DOUBLE file size, expand the capability of existing business software, and make other SERIOUS applications more viable.

Now you can have compatibility with IBM, INTEL, CP/M*, Z80 Softcard*, UCSD Pascal, and others.

Look what the MEGABYTER dual density 8" floppy disk controller, with its LSI circuitry and reliable industry standard IBM 3740 format, means to you:

INCREASED STORAGE

- Increase online storage to 2 Mega bytes
- Double your maximum accounts and file size
- Add high capacity efficient hard disk backup
- Control up to 4 Shugart SA800/SA850 drives

IMPROVED COMPATIBILITY

- Operate APPLE DOS 3.1/3.2/3.3, mini disks
- Preserve existing software investment
- Interchange data with other computers

SIMPLIFIED OPERATION

- Reduce disk handling and I/O slot usage
- Gain automatic single/double density operation
- Change to double sided drives with one switch

Available at your Apple dealer. Call or write today!!

SVA

SORRENTO VALLEY ASSOCIATES
11722 SORRENTO VALLEY ROAD
SAN DIEGO, CA 92121
(714) 452-0101

* CP/M trademark of Digital Research, Inc.
Z80 Softcard trademark of Microsoft, Inc.

structures: the supplier produces elements, and the program that invoked the loop construct consumes them. As we saw earlier, one way to do this is to assign responsibility as follows:

Producer
implements: do: aBlock
delivers values by: aBlock value: theNextElement

Consumer
receives values using: [:elementName|
    dosomethingToTheElement]

Under this arrangement, the producer can use any desired control structure internally, just by sending the message:

```
aBlock value: theNextElement
```

to the block whenever a new element has been generated; the consumer, however, is confined to executing the same block for each element. The other arrangement reverses the situation:

Producer
implements: atEnd, next
delivers values by: returning a value from next

Consumer
receives values using: producer next

Under this arrangement, the producer has to use instance variables, rather than control variables, to remember what state it is in, but the consumer can call for new elements using any control pattern it wants.

The control structure *coroutines* allows *both* the producer and consumer to use any control pattern. Notice that in the first arrangement, the producer has to retain its argument aBlock to be able to send it value: for each element; in the second arrangement, the consumer has to retain the producer to be able to send it next for each element. In the coroutine arrangement, both sides retain a common object called a *port*. The purpose of the port is to remember the control state of one partner while the other partner is running. Let us now build a port in which the consumer invokes the producer with the messages next and atEnd, and the producer invokes the consumer with the messages nextPut: anElement and markEnd. A loop in this implementation might look similar to the following:

Consumer

```
| first second |
portForProducer ← someCollection asProducer.
"Here is a sample loop that takes elements two at a time"
[portForProducer atEnd]
   whileFalse:
      [first ← portForProducer next.
      second ← portForProducer next.
      "Do something with first and second"]
```

Producer Collection

```
asProducer | port |
      port ← Port new.
      port producer: [CollectionProducer of:
         self with: port].
      "Create a new process for the producer"
      ↑ port
```

CollectionProducer

```
of: aCollection with: portForConsumer | |
      "Here is a sample loop that generates elements three at a
      time"
      [someCondition]
         whileTrue:
            [portForConsumer nextPut:
               someComputation1.
            portForConsumer nextPut:
               someComputation2.
            portForConsumer nextPut:
               someComputation3].
      portForConsumer markEnd
```

The code in both consumer and producer can involve any combination of loops, messages, or other control structures: the consumer can request a new element at any time with portForProducer next, and the producer can deliver an element any time it has control with port-

ForConsumer nextPut: anElement. Interleaving a consumer that wants pairs of elements with a producer that generates triplets is a very simple example of the freedom that both partners enjoy in this arrangement.

To implement Port we need to consider how Smalltalk allows us to get hold of our current control state, since whenever control goes from consumer to producer or vice versa, we have to save the state of the partner that is giving up control. For just such purposes, Smalltalk provides a primitive notion of a *process*, an entity which has its own control state and can be suspended and resumed. The usual way to create a new process is with:

aProcess ← [someComputation] newProcess.

The process can then be started up by:

aProcess resume

and it will compute "in parallel" with the current computation until it finishes someComputation or it (or some other process) executes:

aProcess terminate

which stops it midflight. Alternatively:

[someComputation] fork

creates and starts an unnamed process that will proceed until the computation finishes.

To allow processes to synchronize their control or their use of data in an orderly way, Smalltalk provides *semaphores*. A semaphore logically represents the current availability of a finite resource: aSemaphore signal indicates that one unit of the resource has just become available, and aSemaphore wait indicates that the currently running process needs to take one unit of the resource and must wait if none is available (presumably until some other process does aSemaphore signal). A useful special case of this is a semaphore that always holds either 1 (meaning a resource is available) or 0 (meaning it is unavailable).

As an aside, we note that semaphores could have been implemented in Smalltalk (ie: not as primitive entities) at a considerable cost in performance: we only need the ability to temporarily guarantee that no other process could run aside from the one currently running (on this processor in a multiprocessor system). Smalltalk provides semaphores at a primitive level because they are such a help in building multiprocess systems that we wanted people to feel free to use them without worrying about their cost.

Given processes and semaphores, we are ready to implement Port (see table 11). The producer and consumer will each run in a process of their own, and we will use semaphores to make sure only one of them is running at a time. (The reader can easily imagine and might enjoy thinking about a version of coroutines which allows the producer to "get ahead" of the consumer. This requires a queue between the two, like the SharedQueue we will develop later.) The "resource" controlled by the semaphores will be free access to the variables in the port, nextElement and endMark, under the following arrange-

class name	Port
superclass	"none added here"
instance variable names	consumerSemaphore producerSemaphore nextElement endMark
class messages and methods	
"none defined here"	
instance messages and methods	

```
initialize
producer: aBlock | |
    "Assume we are running in the consumer process, so create a
    new process for the producer."
    endMark ← false.
    consumerSemaphore ← Semaphore new.
    producerSemaphore ← Semaphore new.
    producerSemaphore signal. "So producer will proceed
    the first time"
    aBlock fork
consumer
next | anElement |
    consumerSemaphore wait. "Wait for producer to deliver
    an element"
    endMark ifTrue: "No more elements"
        [self error: 'Attempt to read past last element'].
    anElement ← nextElement.
    producerSemaphore signal. "Restart producer"
    ↑ anElement
atEnd | |
    consumerSemaphore wait. "Wait for an element or end
    mark"
    consumerSemaphore signal. "Doesn't consume the ele-
    ment"
    ↑ endMark

producer
nextPut: anElement | |
    producerSemaphore wait. "Wait for consumer to have
    taken last element"
    nextElement ← anElement.
    consumerSemaphore signal "Restart consumer"
markEnd | |
    producerSemaphore wait.
    endMark ← true.
    consumerSemaphore signal
```

Table 11: *Class template for class* Port.

Circle 208 on inquiry card.

GENERAL LEDGER • PAYABLES
RECEIVABLES • ORDER ENTRY
INVENTORY CONTROL • PAYROLL
JOB COSTING • WORD PROCESSING
DATA BASE MANAGEMENT

Quick up and running
Step by step instruction manual
Complete instructions—over 900 pages
Free telephone assistance
All Bookkeeping packages are Interactive or Stand Alone
Originally developed by Osborne and Associates
Return within 15 days if not satisfied for refund
CRT independent—runs on any terminal
Requires 2.2 CP/M and 2.07 C-Basic
Up and running on: Altos, any 8″ Single density CP/M system format, Altos, Cromemco, Dynabyte, TRS-80 Mod II, Northstar DD, Vector Graphics.
Many others. Sample data with each program

General Ledger	$195
Payables	$195
Receivables	$195
Payroll and Job Costing	$195
Order Entry	$395
Manuals for above	$20
Inventory (Manufacturing)	$395
Inventory (Wholesale)	$395
Inventory (Retail)	$395
Manuals for above	$20

MARATHON COMPUTER SYSTEMS
575 Middlefield Road Suite # J
Palo Alto, CA 94301, 415-328-5391
VISA • Master Charge • C.O.D. • Company Check
TRS-80 is a Trademark of Radio Shack, Inc.
CP/M is a Trademark of Digital Research, Inc.

Spelling Errors?
Does your TRS-80* wordprocessor need help?

PROOFREADER™

***CAN SPELL* rendezvous *AND* mnemonic**
AND OVER 38,000 OTHER WORDS

Now let your TRS-80 and Proofreader by Soft-Tools check your Scripsit*, Electric Pencil, or other documents for spelling and typographical errors. It has all of the features needed to meet your proofreading requirements.

- Checks every single word of even your biggest document in under 5 minutes.
- The 38,000 word dictionary is one of the largest available.
- Dictionary can be easily extended to add more words such as technical terms or names.
- All unknown words are listed on the screen and can be saved on a file for printing.
- Works with almost any TRS-80 wordprocessor including Scripsit and Electric Pencil.
- Comes with complete and easy to understand User's Manual.
- Developed for the TRS-80 by a Ph.D. in Computer Science.

MODEL-I Requires 32 K RAM, 1 disk drive, TRSDOS* or NEWDOS $54.00
MODEL-II Requires 64K RAM, 1 disk drive, TRSDOS Version 2.0 .... $109.00
MODEL-III Requires 32 K RAM, 1 disk drive, TRSDOS $64.00

User's Manual only, specify model $3.00
When ordering, specify model, memory size, number of drives.

Other professional quality software tools available from Soft-Tools include: SOFT-SCREEN™- a full screen text editor for the Model-II and III. Ratfor - a structured programming language pre-processor for FORTRAN. PP-Ratfor - an automatic program pretty printer for Ratfor. plus more in the coming months. Please call or write for more details.

SOFT-TOOLS™

Orders sent postpaid by first class mail.
Terms: Cash, check, money order, VISA, or MASTERCARD. NM residents add 4% tax.
Dealer inquiries invited

SOFT-TOOLS
P.O. Box 339
Dept. B
Tijeras, NM 87059
(505) 281-1834

Proofreader, Soft-Tools, and Soft-Screen are trademarks of Soft-Tools.
* Trademark of Tandy Corporation

Circle 350 on inquiry card.

TOLL FREE OUTSIDE CALIFORNIA 1(800) 423-5886

QSTAR PRESENTS the QRAM

16K Ram Expansion Board for the Apple II*

- Expands your 48K Apple to 64K of programmable memory
- Works with Microsoft Z-80 card, Visicalc, LISA ver 2.0 and other software
- Eliminates the need for an Applesoft* or Integer Basic ROM Card
- Includes installation and manual
- Fully assembled and tested
- FULL ONE YEAR warranty including parts and labor

Introductory Price: $149.00

* Apple is a registered trademark of Apple Computer, Inc.

Apple II & II Plus

16K-Call 32K-Call 48K-Call

APPLE III is Here

CALL TODAY and be the first to have the most powerful professional computer in its class!

apple computer
Authorized Dealer

APPLE CARDS

Hi-Speed Serial Interface • Communications Interface • Parallel Printer Interface • Hobby/Prototype • Integer Basic Firmware • Applesoft Firmware

NEC

Letter quality high speed printer, bidirectional, high resolution plotting, graphics. RO with Tractor Feed **$2865** • KSR with Tractor Fee **$2995** • **Paper Tiger 445** with Graphics **$699.00** • **Anadex** DP9500 **$1449** DP 8000 **$849** • Epson MX 80 Call

DYSAN DISKETTES

8″ (Box of 10) 3740/1 sgl side/sgl density **$4.50** ea.
3740/1D sgl side/dbl den **$6.95** ea.
5″ (Box of 5) 104/1 soft sector
107/1 10 sectors
105/1 16 sectors **$4.50** ea.

AMPEX Dialogue 80

Dialogue 80 fully-featured video terminal:

- Full ASCII with numeric and edit keypads
- Elegant case with detachable keyboard
- Display 24 lines with 25th status line
- 20 user programmable function keys
- 2 pages display memory (4 optional)
- 11 graphics and 21 control codes
- 10 modes including block, protect, program
- Transparent mode displays control codes

DIALOGUE 80 $1045

MONITORS

9″ Black and White Only **$185.**
Also available in Sanyo
12″ Black and White
12″ Green and Black **$225**

PRINT WHEELS AND THIMBLES

Huge selection for Qume, Diablo, NEC. Plastic or metal. Call

THE HP-85

The HP-85 is a powerful BASIC language computer complete with keyboard, CRT display, printer, and tape drive — all in one compact unit.

OUTSIDE CA CALL TOLL FREE 1(800) 423-5886. IN CA (213) 996-2252

SEND ALL MAIL ORDERS TO:
Telex: 1820852
Answer: MICKO TZNA

MICRO
BUSINESS WORLD
18720 OXNARD, SUITE 108,
TARZANA, CA 91356

Prices subject to change without notice. Please allow time for checks to clear. Add 2% for shipping and handling — $5.00 minimum. California residents please add 6% sales tax. Sorry, no C.O.D.

WHEN IN CALIFORNIA VISIT OUR RETAIL LOCATIONS

In Torrance/Lawndale
Computer World
16206 Hawthorne Blvd.
(213) 370-1577

In Woodland Hills
20929 Ventura Blvd.
(213) 704-6895

Circle 222 on inquiry card.

Consumer	Producer
"In portForProducer next:"	
consumerSemaphore wait.	
"Semaphore started with 0, consumer waits."	
	"In port nextPut:"
	producerSemaphore wait.
	"Semaphore started with 1, now has 0"
	nextElement ← anElement.
	consumerSemaphore signal.
	"Semaphore started with 0, now has 1"
anElement ← nextElement.	
producerSemaphore signal.	
"Semaphore had 0, now has 1"	
↑ anElement	
	"nextPut: returns, producer proceeds."
	"Later, producer does another port nextPut:"
	producerSemaphore wait.
	"Semaphore goes from 1 to 0 again"

Table 12: *Dialog between consumer and producer objects using the* Port *defined in table 11.*

ment: when consumerSemaphore has a 1, it means nextElement has something in it (or endMark has been set) and the consumer needs to run; when producerSemaphore has a 1, it means nextElement is vacant and the producer needs to run. Notice that the next and nextPut: methods are very similar.

A partial trace through an exchange of control would look like the dialog shown in table 12. Note that if the producer reached the second wait before the consumer took the first element, the producer would wait until the consumer did the producerSemaphore signal. A full discussion of how semaphores should be used to produce minimum waiting, minimum process switching, and correct synchronization is beyond the scope of this article; one important and useful special case will be presented in the following section.

Monitors—Asynchronous Structures

Even in personal computer systems there are often reasons to allow for the possibility of several things happening "at once" (ie: not synchronized with each other beforehand). The best examples involve communication with other users. For example, your machine could be listening for incoming messages through a network connection. But even on an isolated personal machine, you would like to be able to start the system on a time-consuming project (like printing on a hardcopy device) and continue to do interactive work. As we saw before, Smalltalk provides the ability to create independent *processes* and set them going "in parallel," and provides

class name	Queue
superclass	Object
instance variable names	array writer reader
class messages and methods	

```
creation
new: size | |
   ↑ self allocate init: size
```

instance messages and methods

```
initialization
init: size | |
   array ← Array new: size.
   reader ← 0.
   writer ← 0
access
removeFirst | |
   reader ← reader + 1.
   ↑ array at: reader
addLast: anElement | |
   writer ← writer + 1.
   array at: writer put: anElement
```

Table 13: *Class template for an initial implementation of class* Queue.

Process A	Process B
reader ← reader + 1.	
	reader ← reader + 1.
↑ array at: reader	
	↑ array at: reader

Table 14: *Execution of the* removeFirst *method using the implementation of table 13.*

class name	SharedQueue
superclass	Object
instance variable names	array writer reader accessSemaphore
class messages and methods	

```
creation
new: size | |
   ↑ self allocate init: size
```

instance messages and methods

```
initialization
init: size | |
   array ← Array new: size.
   reader ← 0.
   writer ← 0.
   accessSemaphore ← Semaphore new.
   accessSemaphore signal "Give it the baton"
```

Table 15: *Class template for class* SharedQueue.

semaphores for synchronizing their behavior.

From semaphores we can easily build a more useful construct, called a *monitor*. The purpose of a monitor is to allow several processes to communicate with a data structure without getting in each other's way; failing to provide for this is another common source of bugs—consider the simple-minded implementation of a queue given in table 13. (The reader should ignore the obvious bugs: there is no check for an empty queue or for exceeding the size of the array.)

Suppose two processes both try to remove an element at about the same time, and the removeFirst method gets executed as shown in table 14 (the flow of time is vertical down the page, interleaving the statements executed by process A in the left column and process B in the right). One element is skipped—and one is returned twice! The solution to this problem is to consider "permission to update the state of the queue" as a resource that only one process can hold at any given time, like the baton in a relay race. So we can construct a safe Queue by giving it a semaphore that starts out with one unit of the resource (see table 15).

A pattern we will encounter in the implementation of SharedQueue will be to reserve a resource during the execution of a piece of code:

```
someSemaphore wait.      "Acquire the resource"
someComputation.
someSemaphore signal.    "Release the resource"
```

The code someComputation is called a *critical section*. We would like to be able to write the previous code fragment as:

```
someSemaphore critical: [someComputation].
```

class name (existing)	Semaphore
superclass	"none added here"
instance variable names	"none added here"
class messages and methods	

"none added here"

instance messages and methods

```
critical sections
critical: aBlock | result |
   self wait. "Acquire the resource"
   result ← aBlock value. "Do the computation, save the result"
   self signal. "Release the resource"
   ↑ result "Return the result of the computation"
```

Table 16: *Template showing additions to existing class* Semaphore.

Circle 119 on Inquiry card.

Circle 140 on Inquiry card.

Circle 236 on Inquiry card.

The system actually provides this message to Semaphore, with a straightforward implementation which is shown in table 16. It is then easy to appropriately modify the two messages in SharedQueue (see table 17).

If two processes try to access the queue, the interchange shown in table 18 occurs (with a few steps left out). Note that the variable anElement is a local variable, and since the two processes have different contexts (despite the fact that they share the same instance of SharedQueue in this example), the variable anElement in Process A is different from anElement in Process B.

class name	SharedQueue
superclass	"none defined here"
instance variable names	"none defined here"
class messages and methods	
"none defined here"	
instance messages and methods	

```
access
removeFirst | anElement |
   ↑ accessSemaphore critical: "Reserve access for the duration of the block"
      [reader ← reader + 1.
      array at: reader]
addLast: anElement | |
   accessSemaphore critical: "Reserve access for the duration of the block"
      [writer ← writer + 1.
      array at: writer put: anElement]
```

Table 17: *Class template for class* SharedQueue.

Final Comments

Many languages don't have the flexibility we've just described; others, such as assembly language, have great flexibility at the expense of readability. What is it about the Smalltalk-80 language and system that makes all of the foregoing both possible and fairly readable? Three things come to mind:

- The existence of blocks, with and without arguments, and the simple square-bracket notation for writing them. This makes it possible to pass a piece of code to the implementor of a control structure, which can then execute the code whenever and however it is appropriate. ALGOL and LISP have constructs which capture some, but not all, of the power of blocks.
- The ability to manipulate the control state directly, as in the dynamic binding example. Of course disaster can result if you aren't careful, but a challenge like this is necessary to exploit the full power of your imagination. InterLISP (a widely used LISP dialect) has facilities which capture some of the power of Smalltalk in this area.
- The accessibility of the entire system to modification. Several of the examples we've described involve adding messages to fundamental classes like Object and BlockContext. Restraint is important here too. Several LISP systems derive tremendous power from this kind of openness.

Of course, we pay a price for all this flexibility and simplicity. A discussion of the time and space cost of blocks, visible control state, and a completely accessible system is beyond the scope of this article; we will just observe that the elementary instructions which implement control structures (branch, call, and return) take about the same proportion of the total execution time in a typical Smalltalk-80 implementation as they do in more conventional languages that don't use globally optimizing compilers. ■

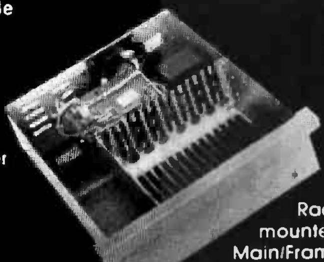
Process A	**Process B**
accessSemaphore wait	
"Semaphore now has 0 units of resource"	
reader ← reader + 1.	
	accessSemaphore wait.
	"Waits here"
anElement ← array at: reader.	
accessSemaphore signal.	
"Process B can proceed now, but immediately reacquires the semaphore"	
	reader ← reader + 1.
	anElement ← array at: reader.
	accessSemaphore signal.
	↑ anElement
↑ anElement	

Table 18: *Execution of the* removeFirst *method using the implementation of table 17.*

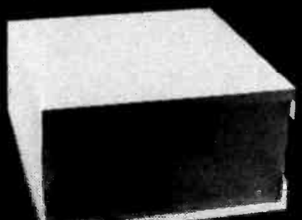
Main/Frames from $200

Main/Frames from $200

- 14 Basic Models Available
- Assembled & Tested
- Power Supply: 8v@15A, ± 16v@3A
- 15 Slot Motherboard (connectors optional)
- Card cage & guides
- Fan, line cord, fuse, power & reset switches, EMI filter
- 8v@30A, ± 16v@10A option on some models



Rack mounted Main/Frame



8" Floppy Main/Frame (includes power for drives and main/frames)

Write or call for our brochure which includes our application note: 'Building Cheap Computers'

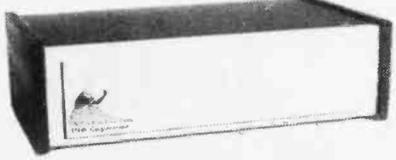
INTEGRAND

8474 Ave. 296 • Visalia, CA 93277 • (209) 733-9288

We accept BankAmericard/Visa and MasterCharge

STRETCH THE POWER

Of Your HP-85 or Commodore Pet/CBM With TNW's IEEE-488 Bus System Building Blocks...



TNW-2000

TNW's RS-232 SERIAL INTERFACES

Connect your PET/CBM to any RS-232 Serial Printer, Plotter, CRT Terminal, Modem, or other device:

TNW-1000	ONE CHANNEL OUTPUT ONLY	$129
TNW-2000	ONE CHANNEL INPUT AND OUTPUT	$229
TNW-232D	TWO CHANNELS, INPUT & OUTPUT, 12 RS-232 CONTROL SIGNALS	$369

TURN YOUR PET INTO A TERMINAL

Access Timesharing Systems and Bulletin Boards with TNW's Pterm Software and full service telephone modem:

TNW-103	AUTO ANSWER/AUTO DIAL USE WITH DAA	$389

Pterm also works with acoustical couplers and other modems interfaced to the PET with the TNW-2000 or TNW-232D. Electronic mail and TWX Terminal programs also available. All units are addressable IEEE-488 devices, complete with power supply cabinet, full documentation and one year warranty.

TNW CORPORATION

3351 Hancock St. • San Diego, CA., 92110 (714) 225-1040

TWX910-335-1194

Visa/Mastercharge Welcome • Dealer inquiries invited

THE SYSTEM INTEGRATERS

- Are you tired of installing systems that cannot expand to meet your needs?
- Are you tired of the problems of interfacing multi-vendor systems?
- Are you tired of receiving new systems that don't work and waiting days or weeks for replacements?
- Are you tired of making a computer investment and not receiving the professional help and support you deserve?

If you have answered yes to any one of the above questions, you need a change!

We have combined the most flexible microcomputer on the market (Ithaca InterSystems™) with reliable, large capacity floppy and hard disk storage systems from Qume, Memorex, Shugart and Priam, along with the most dependable CRTs and printers available today. Using the industry standard CP/M* Operating System, our turnkey systems are delivered to you fully assembled, tested and burned in.

PROVEN RELIABILITY — Our turnkey systems have been performing daily for over a year in high volume point-of-sale operations throughout the country.

SOFTWARE AVAILABILITY — A wide variety of application software packages are ready for CP/M systems. Our library contains many of these systems, and it is expanding daily.

CUSTOM DESIGN — P.O.S. Terminals, hardware and software interfaces between Ithaca Intersystems and other specialized I/O devices.

COMPETITIVE PRICES — Floppy-based systems start at $7,950, 10MB hard-disk systems with floppy back-up start at $10,650. These are true turnkey system prices that include CRT, printer, and double-sided/density floppies, tested and burned in.

TALK TO THE PEOPLE WHO SELL CUSTOMER SATISFACTION

Specialized Business Systems

5306 S. Bannock, Littleton, CO 80120

(303) 797-8709

™Trademark of Ithaca Intersystems, Inc.

*CP/M is a Registered Trademark of Digital Research.

Is the Smalltalk-80 System for Children?

Adele Goldberg and Joan Ross
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

For many years our work on the Smalltalk project has carried with it the purpose of creating new technologies that can be used effectively for instruction, both to teach programming and to support the implementation of educational activities. While the Smalltalk-80 system is not specifically designed for school-age children, most of the applications that we developed as tests of the earlier Smalltalk systems were.

This article will present a brief history of the development of the Smalltalk-80 system that focuses on the instructional uses of its various predecessors. A significant part of this history is the redesign of the language syntax. Programming in Smalltalk involves creating a language for communicating among objects; this language is created within the syntactic restrictions of the Smalltalk-80 system. Often the programmer adds an additional level of syntax in which the language for communicating among objects is presented in terms of graphic images. An example of an instructional activity, the *Dance Kit*, illustrates the idea of such a language. Its design was motivated by the rich support for generalization and interactive graphics available in the Smalltalk-80 system.

Our original intention in writing this article was to *disabuse* readers of the idea that the Smalltalk-80 system, like LOGO, is a language for children. We concluded, however, that the other articles in this issue and the two books on the system (see references) will easily accomplish that task. It remains, then, for us to comment on the style of use of the system that our instructional work has taught us. Although there are a few places where knowledge of the Smalltalk-80 system is helpful, this article does not, in general, require such knowledge.

Learning to Program in Smalltalk

Initially when we ventured out into the schools to teach programming classes, we used a version of Smalltalk known as Smalltalk-72 (see reference 3). Our purpose in teaching these classes was threefold. First, we wanted to know if the language was teachable. In particular, we wanted to devise an appropriate pedagogical approach that could provide feedback on the design of the user interface as well as a basis for language redesign. And we wanted to begin to find out if software based on the concepts of objects and message-passing offered something special in the way of problem-solving tools for children and adults alike. The outcome of these investigations reinforced the value of the semantics of Smalltalk: that is, from the point of view of supporting computer-based problem solving, we found that the ability to organize information into objects that can be independently explored and linked together to create new kinds of behavior is a powerful computational tool.

Smalltalk-72 took the approach that the syntax was defined by the receiver of the message: the receiver read as much of the message as the receiver's method determined and then passed control to the next remaining token, which was seen as the receiver of the remainder of the message. This design came out of our assumption that the system user should have total flexibility in making the system be, or appear to be, *anything* that the user might choose. However, this meant that the only way that a reader could understand an expression was to execute the methods in his head. Furthermore, if a human could not parse an expression without executing the methods, the system itself would not be able to parse it. Thus Smalltalk-72 was a purely interpretive system, and its performance suffered accordingly.

The syntax design (or lack of it) was an example of taking the "flexibility" position to an extreme. Our experience in teaching Smalltalk-72 convinced us that overly flexible syntax was not only unnecessary, but a problem. In general, communication in classroom interaction breaks down when the students type expressions not easily readable by other students or teachers. By this we mean that if the participants in a classroom cannot read each other's code, then they cannot easily talk about it. Our intention was that the Smalltalk system serve as a communication mediator, but the lack of communication due to the runtime parsing of expressions was hindering this goal.

The Smalltalk-76 system took a stricter approach to

DON'T BE HELD UP!

QUALITY SOFTWARE

DISCOUNT PRICES

Creative Discount Software
256 S. Robertson, Ste. 2156
Beverly Hills, CA. 90211

CALL for our catalog
TOLL FREE

Operator 831

800-824-7888
Alaska/Hawaii 800-824-7919 California 800-852-7777

What's New With The SoHo Group?

WORKSHEET — *The CP/M "What-if" Language.* For any problem that can be attacked by a row-column spreadsheet, this is the professional choice of CP/M users. Define the cells in your report as numbers or by formulas, try the result, substitute new values, and reiterate it interactively. Available for use with *MicroSoft Basic, CBasic*, or the North Star Basic-Matchmaker combination. Requires 48K RAM.

SuperBatch — Much faster and more convenient than SUBMIT, this excellent tool allows you to build batches, "stack" many commands on a single line of keyboard input, and return control to the keyboard during a program started in batch mode.

COMPARE — Compares two ASCII files (text, programs, etc.) and identifies differences *including inserted lines*. Perfect for use with editors that make BAK files (ED, WordStar, etc.).

MATCHMAKER II — This is a very professional piece of systems software that *allows CP/M users to run the powerful North Star Basic interpreter*. North Star Basic has multi-line functions, files that can be addressed both sequentially and randomly, and many other features. Includes release 5.2.

CP/M for North Star — *The North Star factory version.* It runs with the North Star hard disk system as well as with Horizon and Micro-Disk systems.

North Star Basic and DOS release 5.2 — A really major upgrade. All the software (DOS, Monitor, Basic, etc.) is relocatable.

	Complete	Manual Only
WORKSHEET Language (MicroSoft Basic, CBasic, or North Star/Matchmaker . . . specify)	199.95	19.95
SuperBatch + COMPARE	44.95	14.95
MATCHMAKER II (includes 5.2)	109.95	9.95
CP/M for North Star	209.95	
North Star Release 5.2	24.95	
CP/M plus MATCHMAKER	299.95	
CP/M, MATCHMAKER, WORKSHEET	459.95	

ALL SOFTWARE RUNS ON ANY STANDARD CP/M SYSTEM

The SoHo Group
140 Thompson St., Suite 4-B
New York, NY 10012

Note: Horizon, CBasic, CP/M are trademarks of Compiler Systems, North Star Computers, and Digital Research respectively.

MICROSTAT

Microstat is an advanced statistics package designed for use in research, education and industry. Microstat is a file-oriented statistics package with a Data Management Subsystem (DMS) that creates the data files plus the ability to: edit, list, destroy, delete cases, augment, sort, rank-order, lag, move, merge and transform the data. The data transforms include: add, subtract, multiply, divide, reciprocal, log, natural log and antilog, exponential, linear transformations plus adding any number of variables to create new variables.

Once the file is created, it can be used to produce: Descriptive statistics, Hypothesis tests (mean and proportion), ANOVA (one-way, two-way and random blocks), Scatterplots, Frequency distributions, Correlation analysis, Simple and Multiple regression, Time Series, Nonparametric tests (11 of them), Crosstabs and Chi-square, Factorials, Permutations, Combinations, and 8 Probability distributions.

The price of Microstat is $250.00 and the user's manual is available for $20.00 and includes sample printouts. Since the printouts reference standard statistics textbooks and journal articles, you can compare the accuracy of Microstat to results produced on much larger systems. No other statistics package seems to have the confidence to do that . . . at any price.

Microstat is available for the North Star DOS and Basic, Microsoft's Basic-80™ (5.03 or later) and Compiler Systems' CBasic2™. Please specify 8" SD (soft-sectored) or North Star 5¼" disk when ordering.

ECOSOFT
P.O. Box 68602
Indianapolis, IN 46268
(317) 283-8883

master charge THE INTERBANK CARD

INTERCHANGE

If you use the CP/M™ operating system, life just got a whole lot easier for you. Interchange is a Z-80™ assembly language program that gives you all of the features that PIP doesn't, plus several unique features. Some of the features of Interchange include:

DIR, in the usual fashion, *plus* listing all files *excluding* those with a specified character. Read/write status is also given.

ERA, as usual plus *exclusive* erases. In addition, a "Q" switch can be used to query on each erase, a "W" allows erases of R/O files without query (normally you are queried), and an "R" switch if system files are to be included.

LIST permits printer listings with formatting controlled by TAB, WIDTH, LINES and WRAP. If you are using the QT Systems Clock Board, listings include the date and time.

COPY including exclusive copies and the optional "Q", "W" and "R" switches plus an "E" switch that queries if the file already exists. It also allows for changing disks in the middle of a copy if either the disk or directory become full. It automatically verifies copies.

STAT, with ambiguous, unambiguous and exclusive listings. It produces an alphabetized listing and includes each file length, total directory entries and space used and unused.

Other commands include RENAME (including ambiguous), HELP, START, END, CLEAR, RESET, DATE, TIME, TAB, WIDTH, LINES, WRAP, QT, SETIT and TYPE. Once you've used Interchange, we doubt that you'll ever use PIP again. The price of Interchange is $59.95 and the manual is available for $10.00. Orders must be accompanied with your CP/M serial number. Interchange is recommended for a 32K or larger system and will not run with an 8080 CPU. At the present time, only User 0 is supported.

CBasic2 is a registered trademark of Compiler Systems.
CP/M is a registered trademark of Digital Research.

syntax, making an incremental compiler a vital part of the system design. Expressions could be parsed by the human reader, although full understanding of the expressions required that the programmers choose identifiers and message names wisely. In this way, the programs could be read by other students or teachers. This approach to syntax remains in the Smalltalk-80 system.

In Smalltalk, languages are designed whenever the programmer specifies the message protocol of a class description. These are the languages with which objects in the system share information among themselves as well as with the human user. Users can profit enormously from defining their own language, learning about their native language in the process of constructing another. In addition, the concept of classes and instances provides a uniform way to organize information in Smalltalk. Communication and organization of information are fundamental aspects of problem-solving activities. In this regard, the needs of school children match those of system designers.

In order to teach Smalltalk programming, the pedagogical approach we developed is to present a fully implemented model of something that the student can use and then modify. The idea is to help early learners grow accustomed to computer interaction and to the notion of sending messages in order to invoke behavior from existing objects. The students can then create two or more instances of an existing class and, through experimentation with the messages to which the class of objects responds, discover the similarities and differences among the instances. In this way, the students apply observation and hypothesis-generating skills while enjoying a highly interactive, graphical discourse with the system. This latter characteristic depends, of course, on the user's ability to provide enticing visual displays of the instances.

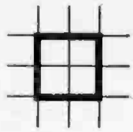
We can use this pedagogical approach for learners with varying levels of skills by adjusting the complexity of the initial model. Instruction proceeds by having the students learn to "read" the description of the model (that is, the code). They then modify it so that each existing instance demonstrates a new, shared behavior (ie: the student adds a message/method to the class description). At this level, we are teaching students fairly standard programming skills that involve sequencing of messages to objects. The concept of naming variables was previously explored as part of the process of creating instances of classes. It is further explored in declaring and using temporary variables in support of a method. Self-reference in the form of messages to the object denoted by *self* comes naturally and is not dealt with as extraordinary. The curriculum framework we follow involves:

- use of an already existing model
- reproduction of the model with some addition
- substitution into the model to produce a new result
- introduction of the model into new contexts (ie: using it as a component of some other example)

One introductory example we employed with elementary and junior high school students was a series of projects to use, modify, and extend the definition of a Box description. A box is an object that looks like a square: it can be drawn on the display screen or erased. It can grow bigger or smaller, and turn right or left, and it can be moved to different screen locations.

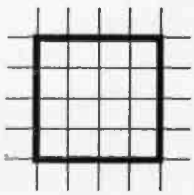
Suppose we create jill as an instance of a Box:

jill ← Box new.

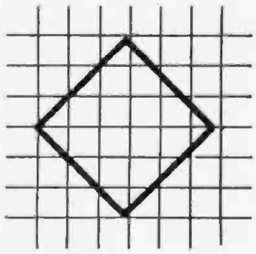


Then jill can grow and turn:

jill grow: 50.

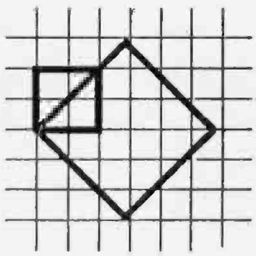


jill turn: 45.

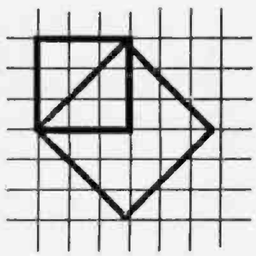


Many boxes can be created:

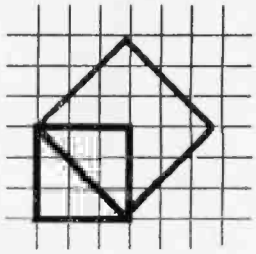
jan ← Box new.



jan grow: 25.



jan turn: 90.



Animations and pretty designs come from sending a sequence of grow:, turn:, and move: messages to the various boxes.

Once the students used several instances of Box, they modified the definition of Box in order to have all its instances follow the display screen cursor as the cursor was moved about by a pointing device. Generalizations of Box led to descriptions of triangles, hexagons, and other polygons. Simple games of "leap frog" or space war

Circle 83 on inquiry card.

COMPUTERWARE™

COLOR COMPUTER

PROGRAMMERS TOOLS Monitor • Assembler • Editor • PASCAL • Diagnostics

GAMES Color Invaders • Action Games • Asteroid Action • Adventures and More

HOME PROGRAMS Data Organizer • Home Finance • Educational Programs

MEMORY • BOOKS • ACCESSORIES
Shipping from Stock

Call or Write:
COMPUTERWARE™
6809 Specialists
Dept. C • Box 668
Encinitas, CA 92024 • (714) 436-3512

Computerware is a trademark of Computerware.

Computers, Peripherals, Unlimited!
DON'T MISS THIS MONTH'S SPECIALS!!!

19" COLOR MONITORS
Manufactured by CONRAC, studio quality, full color monitors with built-in de-Gauss, independent R.G.B. & Sync inputs & much, much more. Originally over $1K.

- 19" Diagonal Screen
- by CONRAC; Pro-Quality
- 120VAC, 50/60 Hz
- R, G, B & Sync Inputs
- Perfect for Graphics, Etc.
- Locked Access Door
- Ideal Color Monitor for All Purposes
- Like New, Unused (as-is)

Model #5111/19
Only **$479.00** each W DATA

Packaging and Handling - $20 Pay Shipping On Delivery

*Selectric-II I/O PRINTER
Stepper Modified

A REAL BARGAIN!!!

DC stepper motors position the carrier and platen, and the standard "Selectric" selection and function solenoids offer parallel control capabilities. Driver circuitry not included. Fantastic bidirectional capabilities for plotting, proportional spacing and more!! Used, removed from sophisticated word processors, whole, AS-IS. Includes data and info. No type element included. Only... **$349.00** each

*Selectric-II is a trademark of IBM Corp

Packaging & Handling - $20 Pay Shipping On Delivery

12" P-31 VIDEO MONITORS OEM-QUALITY!!
Motorola #XM 351, featuring adjustable horizontal osc. for all display configurations. 117/230 VAC operation, xfr input for isolation, BNC composite video input, contrast & brightness controls. Used, tested, and operational, good cond. 16x64 or 80x24 formats. Originally cost over $200.00!

Only... **$79.00** each Plus Shipping

Packaging & Handling - $5.00

TOP QUALITY DISPLAY!! DATA INCLUDED.

DAISY WHEEL TERMINAL Tested & Functional ....NOW ONLY **$999.00**

COMPUTERS, PERIPHERALS, UNLIMITED!
(Formerly CFR Associates, Inc.)
— NEW NUMBER —
617/372-8637
18 GRANITE STREET
HAVERHILL, MASS. 01830
MasterCharge & VISA Accepted

Circle 51 on inquiry card.

NEMESIS
FOR CP/M

■ Theus, a level twenty-Raver, finds himself cornered by two fierce Chimera during his exploration of level ten. With lightning quick dexterity he makes five mighty swings with his Vorpal Blade, slaying both attackers. He considers himself lucky - not only has he survived, but he is able to remove the Chimeras' Mithril Cloak.

■ NEMESIS...a journey into the unknowns of a multi-level dungeon. There are many factors contributing to the success or demise of your character, not only your character's innate and acquired abilities, but also your ability to react in REAL TIME to the changing situations your character encounters. You are given abundant information to aid you in your quest, including a map of your characters knowledge of the current level. The player may create as many characters as he desires, and there is no limit to the power your character can acquire as it delves into the mysteries of the dungeon.

■ DUNGEON MASTER allows you to create entire dungeons for Nemesis. You have complete control over the many facets of information required on each level, including the make-up of the monster population, the items which may be found, and the architectural layout of the dungeon. Up to one thousand levels are allowed in each of the dungeons created.

■ NEMESIS and DUNGEON MASTER are available on the following CP/M media: 8" soft sectored, 5" Northstar, 5" Micropolis, 5" Apple II Plus, Vector MZ, and Superbrain DD/QD.

NEMESIS: $40 for discette and manual.
DUNGEON MASTER: $35 for discette and manual (requires NEMESIS).

First In Software Technology
SUPERSOFT ASSOCIATES
P.O. BOX 1628
CHAMPAIGN, IL 61820
Technical Hot Line: (217) 359-2691
(answered only when technician is available)

All Orders: (217) 359-2112

were new contexts in which to place the geometric objects. Students discovered that judicious placement of geometric shapes formed pictures, and so "painting editors" were popular project areas for the students.

The resource-center approach we took in locating our computer system in a school emphasized shared projects, so that each student might bring a different skill to a project. Because we feel *design* is at least as important as implementation (programming), we encouraged students with good ideas for projects to act as resources for those students who preferred to write programs. Miniature research teams seemed to form in a natural way. The nonprogrammers on the team did their designs both visually (by sketching drawings of desired outcomes) and verbally. In the latter case, they designed by determining the needed objects and then specifying the language with which these objects would interact. The students benefited from the Smalltalk approach to description even before completing, or perhaps without completing, a running program.

After our experiences in the schools, we felt that further studies of graphical user interfaces were needed in order to improve the visual feedback Smalltalk provides as its programming interface. The Smalltalk-76 system was created primarily as a basis for implementing and studying various user-interface concepts. It gave the users, mostly adult researchers, further ability in refining existing classes through the use of subclassing. This meant that the programmer could now modify a running model without creating a change to already existing examples of that model. *Programming-by-refinement*, then, became a key idea in our ability to motivate our users.

Contrary to the idea that a computer is exciting because the programmer can create something from seemingly nothing, our users were shown that a computer is exciting because it can be a vast storehouse of already existing ideas (models) that can be retrieved and modified for the user's personal needs. Programming could be viewed and enjoyed as an evolutionary rather than a revolutionary act. The frustration of long hours of writing linear streams of code and then hoping to see some aspect of that code execute was replaced by incremental development. Emphasis was placed on learning how to make effective use of existing system components (objects in the Smalltalk sense). Much of the teaching we did was to show users how to search for and read the descriptions of the many useful components we and others (and even new users) continued to add to the system.

Fundamentally, the Smalltalk approach to software has exciting potential for educational use. But why only "potential"? As the system development work has proceeded from our initial work in the schools using Smalltalk-72, greater emphasis has been placed on providing a powerful system that is of interest to computer professionals as well as children. The Smalltalk-80 system, in its approach to providing a programming

INMAC INTRODUCES THE SOLUTION TO YOUR MICRO SUPPLY AND ACCESSORY NEEDS.

- One-Stop Shopping. This new catalog offers over 1,000 products specifically for Micro Computers. Compatible with Apple, Atari, Northstar, TRS-80s and many others.
- Convenient Ordering. By mail or phone, ordering supplies and accessories from this catalog will be quick and easy.
- Fast Delivery. We'll ship your order within 24 hours from our distribution centers in New Jersey, California, Illinois and Texas. Overnight delivery available.
- Top Quality Products. Virtually all our products are guaranteed for at least one year. Risk-free trial of any product for 45 days.

Send for your FREE Inmac Catalog or call (408) 727-1970.
Available June 1, 1981.

Inmac
Dept. Micro, 2465 Augustine Drive,
Santa Clara, CA 95051

LEAPAC SERVICES
EAPAC SERVICES
APAC SERVICES
PAC SERVICES
AC SERVICES
C SERVICES
SERVICES
SERVICES
ERVICES
RVICES
VICES
ICES
CES
ES
S

ITS HERE

AUTOMATED DESIGN AND GRAPHICS

$695.00

Camera Ready Integrated Circuit Logic Diagram and Printed Circuit Board Layout for Double Sided Cards with up to 100 ICs

CALL or WRITE for DETAILS

LEAPAC SERVICES (916) 381-1717
8245 Mediterranean Way
Sacramento, California 95826

SOFTWARE PRODUCTS

Olympic Sales Company

SERVING YOU SINCE 1947

Main Showroom & Offices:
216 South Oxford Avenue
Los Angeles, CA 90004

WE HONOR VISA and MASTERCHARGE

TELEX: 67 34 77
ORDER OESKS open 7 Days a Week!
7:00 AM to 7:00 PM Mon thru Sat
Sunday Noon to 5:00 PM
Order Oesks: (213) 739-1130

TOLL-FREE (outside Calif.) 800-421-8045
TOLL-FREE (within Calif.) 800-252-2153

Write & request our FAMOUS Catalog!
Hundreds & hundreds of products-from many manufacturers-such as SONY, CASIO, VICTOR, CODE-A-PHONE, MATTEL, SHARP, CANON, and on and on. . .too many to list here!

All goods subject to availability; this ad supersedes all previous ads; we are not responsible for typographical errors; we will meet or beat any advertised prices if the competition has the goods on hand.
Minimum shipping and handling $4.95.
All orders subject to verification and acceptance.

HEWLETT PACKARD

	Retail	Your Cost
HP-85 Microcomputer	3250.00	2595.00
HP-83 Microcomputer	2250.00	1795.00
16K Exp-Memory Module	295.00	259.95
Graphics Plotter 7225	2450.00	2089.95
Personality Mod. for 7225	750.00	679.95
2631B Impact prnter/hvy dty	3950.00	3295.00
Option 020 for 2631B	150.00	129.95
8 Disk Drives to choose from		
82902S	1300.00	1149.95
9895A 8" Dual Drive	6850.00	5595.00
Graphics Tablet 9111A	2050.00	1699.95
HP-41CV New 2.2K bytes mem	325.00	259.95
HP 41C Calculator	250.00	188.95
Card Reader for 41CV/C	215.00	168.95
Printer for 41CV/C	385.00	284.95
Optical Wand for 41CV/C	125.00	97.95
Quad Ram equals 4 Mem. Mods	95.00	84.95
Memory Modules for 41C		26.95
HP-97 Progrmble Printer	750.00	579.95
HP-67 Progrmble Calculator	375.00	297.95
HP-34C Progrmble Scientific	150.00	117.95
HP-38C Progrmble Bus. R/E	150.00	119.95
HP-32E Adv. Scientific	55.00	48.95
HP-37E Business Mgmt.	75.00	58.95

We carry a large inventory of Libraries, accessories and supplies.

apple computer

We are an AUTHORIZED SERVICING APPLE DEALER

the best price in America!

16K--32K--48K--96K--128K

Drive with controller DOS 3.3 and others. . .
80 column cards
Dow Jones & Quote Reporter
DC Hayes Micromodem II
and others. . .
Graphics Tablet
Pascal and Fortran Languages
VisiCalc and more and more
APPLE III 96K and 128K "CALL US"
Ask for Package One to Three Special Prices!

Texas Instruments

TI-99/4 Home Computer	950.00	$379.95
10" Color Monitor for 99/4	650.00	319.95
32K Exp. Mem. Module	399.95	314.95
Extended Basic, a MUST for 32K Module	100.00	75.00
Speech Synthesizer	150.00	129.95
Disk Memory Drive	500.00	397.95
RF Modulator	69.50	49.50
Telephone Coupler (Modem)	225.00	189.95
Printer (solid state)	400.00	319.95
TI-59 Progrmble Calculator	295.00	199.95
TI-58C Progrmble Calculator	130.00	93.95
PC-100C Prntr/Plotr for 59/58	225.00	149.95
TI-57 Scientific Calculator	99.95	39.95
MBA Finance & Business	70.00	51.95
TI Investmt Analyst	65.00	46.95
TI-55 Slide Rule	40.00	32.95
TI-Progrmr Hexidecml/Octal	65.00	48.50

We carry a large inventory of software, accessories and supplies.

OHIO SCIENTIFIC

Professional Computers

	Retail	Your Cost
C8PDF–48K	3495.00	3195.00

- Dual 8" Drives
- 64 col x 32 line/color
- .7 MIPS *FAST!*
- Many more stndard features

Fortran & Pascal available

Many other OSI products available —at discounted prices, of course!

ATARI® PERSONAL COMPUTER

★★★★★SPECIAL! ATARI 400 (16K)★★★★★
Retail: $595.00 Your Cost: $339.95
Language cartridge not included;
Optional basic language cartridge: $54.95

800 16K bytes of RAM	1080.00	759.95
410 Program Recorder	90.00	79.95
810 Disk Drive	600.00	469.95
825 Printer (80 col Centronic 737)	999.95	779.95
820 Printer (40 col impact)	450.00	359.95
830 Acoustic Modem	200.00	159.95
850 Interface Module	220.00	179.95
Atari VisiCalc	200.00	169.95

Large inventory of software and accessories.

PRINTERS

• DIABLO (Letter Quality)	Retail	Your Cost
630 R102 bi-directnal/tractors	2965.00	2699.00
1640K109 keyboard, tractors	3072.00	2899.95
630 RO Receive only	2710.00	2499.95
1650K136 keyboard/tractors	3220.00	2999.95
• CENTRONICS dot matrix		
700-9 Parallel, heavy duty	1460.00	1199.95
704-9 Serial, heavy duty	1795.00	1599.95
737-1 Parallel	995.00	799.95
737-3 Serial	1045.00	899.95
704-11 Parallel	1870.00	1695.00
P-1 Electrostatic	495.00	189.95
• PAPER TIGER		
445G with Graphics	795.00	695.00
460G with Graphics	1394.00	1195.00
560G New full size	1695.00	1399.00
• EPSON		
MX 80 Impact	645.00	499.95
MX 70 Impact	500.00	399.95

WE ALSO HAVE . . .

• NOVATION Modems	Retail	Your Cost
CAT	199.95	159.95
D-CAT	199.95	159.95
APPLE-CAT Direct connect	349.95	314.95
• SANYO Monitors		
High Resolution, Number 1 seller!		
13" Color (new) high quality	550.00	399.95
12" Green Phosphorous	360.00	239.95
12" Black and White	340.00	219.95
15" Black and White	370.00	239.95
9" B/W the best seller!	235.00	149.95

AMDEK (Leedex) High Quality Monitors

100	12" B/W, 12 MHz	179.00	129.95
100-80	12" B/W, metal cab., space for floppy	199.00	159.95
100-G	12" Green, 12 MHz	199.00	159.95
300-G	12" Green, 18 MHz	249.00	189.95
Color I	13" Color, NTSC comp. input, audio amp & speaker	449.00	329.95
Color II	13" Color, RBG input, hi res graphics, speaker	999.00	699.95

- HAZELTINE Video Display Terminals
- SHUGART Disk Drives
- DEC VT100 & VT103

Call us for your DISCOUNTED price TODAY!

NEW! From TI—Series 10 Personal Information Terminal *Retail* 995.00 *Your Cost* 795.00

interface, focuses more on software development for the *professional*. But the basic design of the system remains that of collections of objects. There is a clear layering of these objects in terms of system versus user-interface support. Our success in bringing this system back into the classroom depends upon our ability to create a set of useful components (class descriptions) that the user can manipulate, as well as modify and combine, in order to create new components. Among the components already developed toward this goal are text and text editors, graphical images and "sketching" and animation editors, as well as "browsers" for seeking out other, already existing components from libraries of such information. We have begun, but we still have a great deal of work ahead of us to design and store in libraries the viewing and controlling components of graphical user interfaces.

Kits for Instructional Activities

So far we have commented on the use of the Smalltalk-80 system for programming. In doing so, we have placed a great deal of importance on the existence of a library of components. Such a library is needed for both professionals and nonprofessionals. In order to improve the system for educational use, better support is needed to assist computer-based curriculum designers in developing flexible instructional activities (perhaps in the form of a special library). Several examples of instructional activities that have been implemented in Smalltalk-72 or Smalltalk-76 are described in Laura Gould and William Finzer's "A Study of TRIP: A Computer System for Animating Time-Rate-Distance Problems", (see reference 5) and Adele Goldberg's "Educational Uses of a Dynabook" (see reference 2).

More recently, we have been trying to work out the idea of a kit for constructing such activities. By a "kit" we mean a set of components and a set of tools (by means of which these components can be viewed and manipulated) that can be used to create many different but related things. Thus, the VisiCalc program (see reference 1) can be viewed as a kit for making business forms; any text editor is a kit for creating textual documents, and any "painting" system such as the Smalltalk ToolBox is a kit for making sketches (see "ToolBox: A Smalltalk Illustration System," by William Bowman and Bob Flegal, on page 369 of this issue).

For developing instructional activities, we believe that a kit can be used as an interface to hide the unnecessary details of the Smalltalk-80 system. A kit could provide a (possibly graphical) interface to the system for the user (student, teacher or curriculum developer) who prefers to focus attention on only one or two aspects of the system. In such a kit, we maintain the Smalltalk approach of selecting objects that respond by receiving a message. The experience gained using one level of the system can be applied to learning successively lower levels. Of utmost importance, the code that implements the kit should be accessible at the next level of interface so that the kit can act as a starting point for further refinement and instructional design.

For the most part, the kits we have designed create new programming interfaces. Most came about by looking at instructional activities from other systems and seeing which ones we liked. We then used the concepts of Smalltalk classes and instances in order to help us generalize the idea of the activity into kit form so that a teacher or student would be able to create personal variations of the activity. The remainder of this article presents an example of a kit that could be implemented in the Smalltalk-80 system.

Invitation to the Dance: Prelude

Imagine that you are a choreographer, able to direct the movements of a dancer on the stage. As the dancer follows your instructions and you see their effect, you may modify them, partly to more closely fulfill your initial images, and partly because observing the actual execution may give rise to new creative ideas.

Since you probably don't have access to a real stage and a real dancer, imagine that your computer's video screen is the stage on which you can direct the movement of a graphical dancer by means of a simple programming language. You can experiment with different sequences of instructions that direct your graphical dancer to replace parts of itself with other parts (thus raising and lowering its arms and legs) and to move in various directions across the screen. The system that allows you to create such dances is called the "Dance Kit."

Circle 387 on inquiry card.

TERMINALS FROM TRANSNET

PURCHASE PLAN • 12-24 MONTH FULL OWNERSHIP PLAN • 36 MONTH LEASE PLAN

	DESCRIPTION	PURCHASE PRICE	PER MONTH 12 MOS	24 MOS	36 MOS
DEC	LA36 DECwriter II	$1.095	$105	$ 58	$ 40
	LA34 DECwriter IV	995	95	53	36
	LA34 DECwriter IV Forms Ctrl.	1.095	105	58	40
	LA120 DECwriter III KSR	2.295	220	122	83
	LA120 DECwriter III RO	2.095	200	112	75
	VT100 CRT DECscope	1.595	153	85	58
	VT132 CRT DECscope	1.995	190	106	72
TEXAS INSTRUMENTS	TI745 Portable Terminal	1.595	153	85	58
	TI765 Bubble Memory Terminal	2.595	249	138	93
	TI Insight 10 Terminal	945	90	53	34
	TI785 Portable KSR. 120 CPS	2.395	230	128	86
	TI787 Portable KSR. 120 CPS	2.845	273	152	102
	TI810 RO Printer	1.895	182	102	69
	TI820 KSR Printer	2.195	211	117	80
DATAMEDIA	DT80/1 CRT Terminal	1.695	162	90	61
	DT80/3 CRT Terminal	1.295	125	70	48
	DT80 5L APL 15" CRT	2.295	220	122	83
LEAR SIEGLER	ADM3A CRT Terminal	875	84	47	32
	ADM31CRT Terminal	1.450	139	78	53
	ADM42 CRT Terminal	2.195	211	117	79
HAZELTINE	1420 CRT Terminal	945	91	51	34
	1500 CRT Terminal	1.095	105	58	40
	1552 CRT Terminal	1.295	125	70	48
TELEVIDEO	920 CRT Terminal	895	86	48	32
	950 CRT Terminal	1.075	103	57	39
NEC SPINWRITER	Letter Quality, 55/15 RO	2.895	278	154	104
	Letter Quality, 55/25 KSR	3.295	316	175	119
QUME	Letter Quality KSR, 55 CPS	3.395	326	181	123
	Letter Quality RO, 55 CPS	2.895	278	154	104
CENTRONICS	730 Desk Top Printer	715	69	39	26
	737 W/P Desk Top Printer	895	86	48	32

FULL OWNERSHIP AFTER 12 OR 24 MONTHS • 10% PURCHASE OPTION AFTER 36 MONTHS

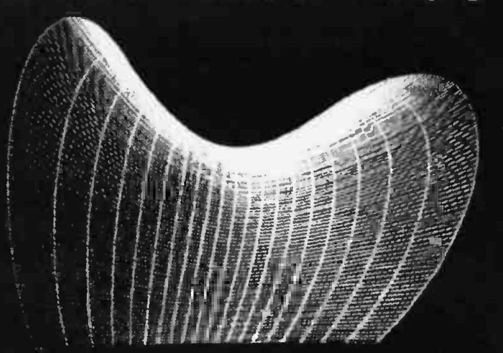
MICROCOMPUTERS
APPLE • COMMODORE • HP85 • DEC LSI 11

ACCESSORIES AND PERIPHERAL EQUIPMENT
ACOUSTIC COUPLERS • MODEMS • THERMAL PAPER • RIBBONS • INTERFACE MODULES • FLOPPY DISK UNITS

TRANSNET CORPORATION
1945 ROUTE 22 • UNION, N.J. 07083 • (201) 688-7800
TWX 710-985-5485

Circle 48 on inquiry card.

S-100 GRAPHICS



Unretouched photograph

- 512 x 640 matrix available in black and white, gray tones, or color
- Bit mapped design for high speed performance
- Easily expandable from basic black and white by adding memory planes.
- Variety of software: graphical BASIC, Tektronix emulator, printer drivers, character editor
- Compatible monitors and printers available.

CDL

CAMBRIDGE DEVELOPMENT LABORATORY
36 Pleasant Street, Watertown, MA 02172
(617) 926-0869

NOW! FOR ATARI®

BASIC A+

NEW! FOR APPLE®

FROM THE AUTHORS OF ATARI® BASIC

BASIC A+ for the ATARI 800™

BASIC A+ will rate an A+ from any Atari user! Upward compatible with Atari Basic, it adds statements and features that enhance the Atari 800's real power, flexibility, and ease of use: Superior I/O features for business and other applications. Additional file manipulation commands. Significant help in program development and debug. Structured programming aids. And MORE! A partial list of the enhancements of **BASIC A+** includes:

PRINT USING (for business, sophisticated)
RPUT/RGET (record I/O) **SET TAB**
BPUT/BGET (binary I/O) **INPUT"..." DIR**
ERASE PROTECT RENAME TRACE
WHILE...ENDWHILE IF...ELSE...ENDIF
PLAYER/MISSILE GRAPHICS

BASIC A+ requires a disk and 32K bytes of RAM. Since no cartridge is used, BASIC A+ will take advantage of all the RAM (48K bytes) in a maximum Atari 800 system (recommended).

OS/A+ for the ATARI 800

Simple. Flexible. Powerful. Compatible. A command driven DOS Control Program that allows user-written commands, ease of interface, and total compatibility with all devices and features of the Atari DOS and file system. Using less room than a menu-driven DOS, **OS/A+** allows utilities to be dynamically accessed from disk as needed.

Powerful Utilities INCLUDED with OS/A+

All the following utilities are **included** in the price of **OS/A+**, but you can easily add your own for even more flexibility and power.

EDITOR/ASSEMBLER/DEBUG

EASMD is a simple but complete all-in-one assembly language development package for the 6502 microprocessor. The editor provides global functions such as FIND and REPLACE (with optional query!) and can be used to edit **BASIC A+** programs. The assembler supports standard 6502 mnemonics; can include multiple files in a single assembly; outputs the listing to printer, screen, or disk; produces readable error messages and a flagged symbol table; places the object code in memory or to a disk file. The object code produced is compatible with Atari DOS or Apple DOS (BLOAD) as appropriate. The debug capabilities include STEP, TRACE, mini-assembler, disassembler, and more.

DUPDSK and FORMAT

Allows creation of master disks, slave disks, and sector-by-sector copies of any **OS/A+** disk.

COPY

Single file copy utility. Destination can be disk, screen, printer, or any device.

PARTIAL SOURCE CODE

For system equates and some system drivers. Customize your system.

BASIC A+ for the APPLE II®

All the features* of our Atari **BASIC A+**! Includes the advanced commands and programming aids that make Atari Basic flexible, easy-to-use, and powerful:

DECIMAL ARITHMETIC (10 digits to the penny)
SYNTAX CHECK ON PROGRAM ENTRY
LONG VARIABLE NAMES (all chars. used)
STRINGS UP TO 32K BYTES IN LENGTH
SEMI-COMPILED CODE (no penalty for those long names)

BASIC A+ requires and takes advantage of all the features and power of **OS/A+**.

*Some Atari hardware related features cannot be supported on the Apple II.

OS/A+ for the APPLE II®

A DOS with a **DOCUMENTED** assembly language interface! Simple. Elegant. Upward compatible with the file systems of Apple's DOS 3.2 and 3.3 but with flexibility not available until now. Add your own commands. Add your own device drivers. Easy FAST random access from assembly language or **BASIC A+**. Requires 48K RAM and one disk drive. Hundreds of Apple owners enjoy OS/A+ under its former name, CP/A.

ORDER TODAY!

All software is licensed for single system use only. **PLEASE SEE YOUR DEALER FIRST.** If he cannot supply you, ordering info is below. DEALER AND DISTRIBUTOR INQUIRIES INVITED.

Optimized Systems Software
10379-B Lansdale Avenue
Cupertino, CA 95014
(408) 446-3099

master charge · VISA · Checks, M.O.

	Atari	Apple
OS/A+	$ 80	$ 80
BASIC A+	$ 80	N/A
OS/A+ & BASIC A+	$150	$150

Add $5 per package shipping in U.S. 6% tax in CA.

Circle 281 on inquiry card.

Setting

The original idea for the Dance Kit came from Bill Finzer, a mathematics teacher at San Francisco State University. Bill was introducing a friend to a Commodore PET computer. Because both he and his friend are fans of an Indonesian dancer called Pak Jana, Bill conceived the idea of teaching his friend about programming in the context of choreography. He wrote a BASIC program called PAKJANA that allowed her to control the movements of a highly stylized dancer on the screen. (It has subsequently been used as a very successful introduction to programming for students in a course called "Computers without Fear.")

The PAKJANA figure is shown in figure 1. It is controlled by a sequence of commands, including a repetition construct. The commands either:

- replace a face, an arm, or a leg
- move the whole body up, down, to the right, or to the left
- create a pause (wait command)
- create a repetition of the commands

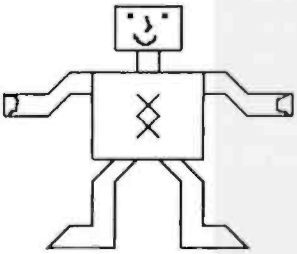


Figure 1: *The PAKJANA figure. Children were taught the basic ideas of programming by teaching this figure how to "dance."*

A large set of "replacement parts" is provided: there are nine different expressions and nine different positions in which any arm or leg may appear. The user specifies these replacement parts and the movements that the dancer can make by choosing from a list of commands in a very simple language. Thus, users can create programs that move the dancer in a predictable sequence of dance routines. (That users may initially find the effects of their programs not entirely predictable only adds to the fun.) The replacement parts for PAKJANA are shown in figure 2. (The program is available from Bill Finzer at the Center for Mathematical Literacy, Mathematics Department, San Francisco State University, 1600 Holloway, San Francisco CA 94132. The project was supported by an Academic Development Grant for the California State College System.)

Theme

Our Dance Kit evolved from Bill's BASIC program by considering possible extensions given the interactive graphics support of the Smalltalk-80 system. The goal of the Dance Kit is to provide a very flexible programming language by giving the user (the "programmer") the ability to draw the figure for which a dance can be choreographed. This figure not only moves about the screen, but also may change the position, size, shape, or color of its parts. One of the editing capabilities provided to the user of the kit is the ability to draw and subdivide the figure into parts. The user can then draw a set of images that replace each of the subdivisions. We call these replacement parts. They appear on the display screen as a part of the programming language the user can employ to create dance routines. An example figure is shown next to the label POSITIONS in figure 3. The user can view replacement parts of a particular subdivision by pointing on the screen to the part of the figure to be replaced. As an example, see the sequence of display screen views shown in figure 5 on pages 362 and 364.

The programming language also contains "steps" for placing the figure and "bridges" that allow repetition of some sequences of instructions. The steps, GO, TURN,

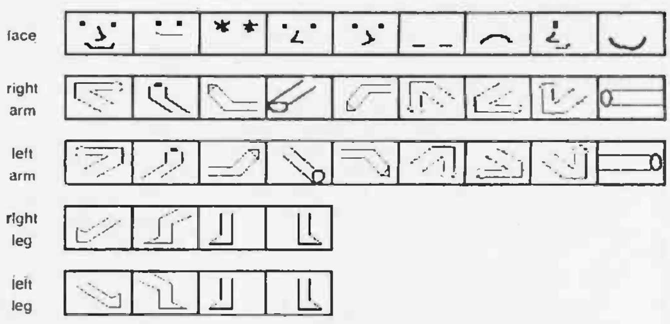
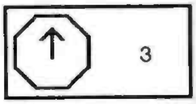


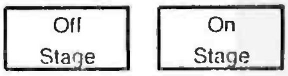
Figure 2: *Replacement parts for the PAKJANA figure. Combinations of these options allow the figure to be animated.*

and PAUSE, are given numerical parameters that indicate how large a step the figure should take. The user selects steps GO and TURN in cases where relative directional placement is desired. Alternatively, the user programs with a step that combines a direction and movement. For example, to take three steps in an upward (↑) direction, the step instruction is:



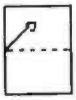
The user sets the arrow icon to specify the direction.

Bridge REPEAT is given a numerical parameter specifying the number of times a sequence of positions and steps should be repeated. Bridge REPEAT UNTIL is associated with a condition for terminating the repetition. We envision a fixed set of conditions such as:

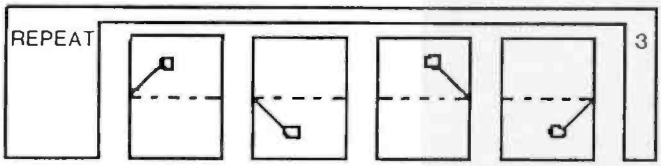


A GHOST bridge indicates that an image of the dancer should remain on the screen in the dancer's last position whenever the figure steps using the GO instruction. If replacement parts include:

for the right arm, and:

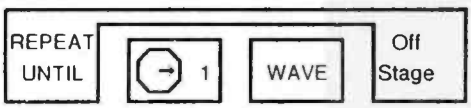


for the left arm, then a simple sequence to have the dancer wave each arm three times looks like:



Notice that the replacement parts can overlap. For example, the arm parts are large and overlap the head part so that it is possible to lift the arms above the head. Similarly, the leg parts allow overlap with arm parts. The bridge "covers" the steps to be requested, with a condition specified at the right girder. The figure can slowly dance stage right using:

The user is also able to define "dance routines" that enable certain fixed sequences to be named, stored, retrieved for further editing, and used as a "sub-routine." Suppose the first sequence of commands is stored as the Dance Routine known as WAVE. We can then use this routine in another one to get:



On the screen, one routine (the one being edited by the user) is active at a time. Controls for managing routines are:

- DELETE (delete the routine from the language)
- STORE (store the current dance act as this routine)
- NEW (start a new dance act)
- COPY (make a dance act exactly like the current one)
- EDIT (make the selected routine be the current one you are editing)

A new dance act has the initial name CURRENT DANCE, as shown in the figure 4.

The user creates a Dance Act by using these elements (steps, bridges, and routines) of the programming language "DanceTalk" as shown in figure 4. This is done by simply pointing at the desired element and moving it

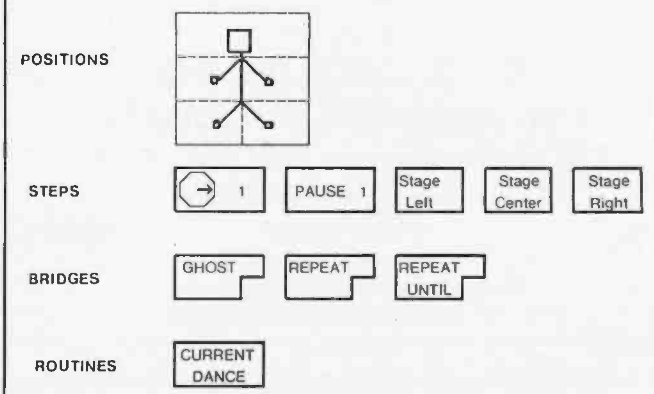


Figure 3: *A choreographer's programming language.*

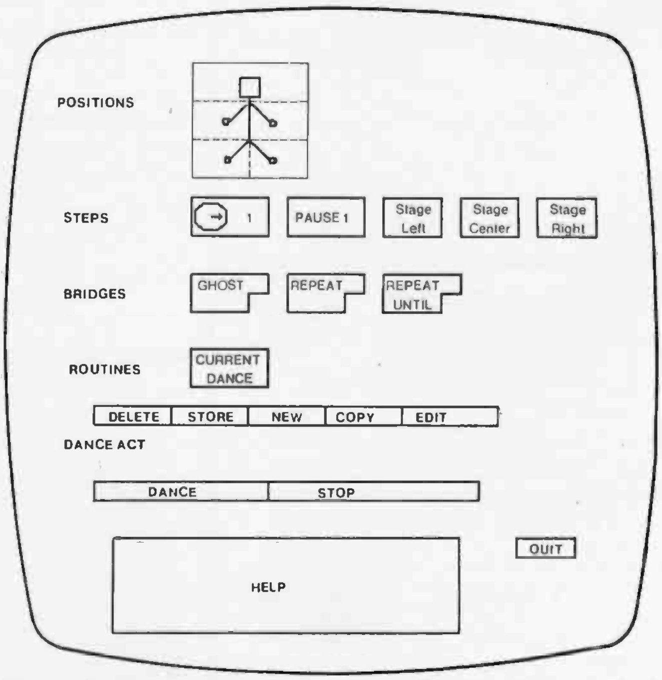


Figure 4: *A screen view of DanceTalk. This image, which appears on the video display of a Smalltalk system running the Dance Kit program, gives the user a menu of options with which to animate the "dancer."*

into the initially empty area in the lower part of the screen. Selected elements are highlighted by complementing their screen area. Notice the rectangular area labeled HELP at the bottom of the screen. When the user points into this area, a description of what to do next is shown, or a comment about a selected element is given.

First Variation: The Stick Person

A user of our Dance Kit might see the sequence of screen views shown in figures 5a through 5f. After a user has completed a longer Dance Act with two choreographed (sub-)routines KICK and JUMP, the screen might look like figure 5f. Now when the user indicates DANCE in the bottom menu of commands, the top part of the screen clears as if a curtain were rising, and the user sees the given sequence of views—an animation (see figure 6).

Note that a grid with a scale underlies both the space and time dimensions. These could be specified and experimented with by the user.

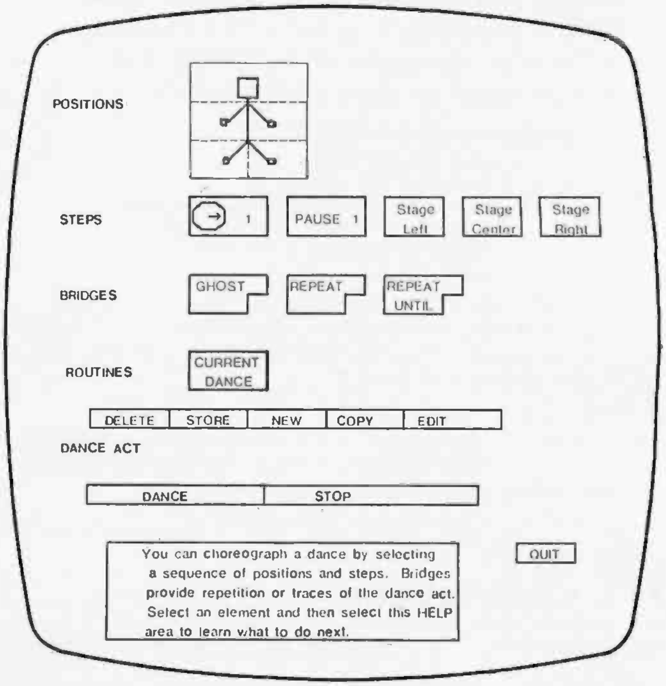
Second Variation: The Big Turtle

Our dancer may assume any size and shape we desire, and we can subdivide the dancer into any number of rectangular areas in order to create replaceable parts. The basic figure shown in figure 7 might be used. The dotted lines show the user's subdivision of the figure. Replacement parts for the section labeled D overlap section A, and might appear as shown in figure 8. Other replacement parts are left to the imagination of the reader.

Dance Acts can be shared by different figures, except that both replacement parts and routines will have to be

Text continued on page 365

(5a)



(5b)

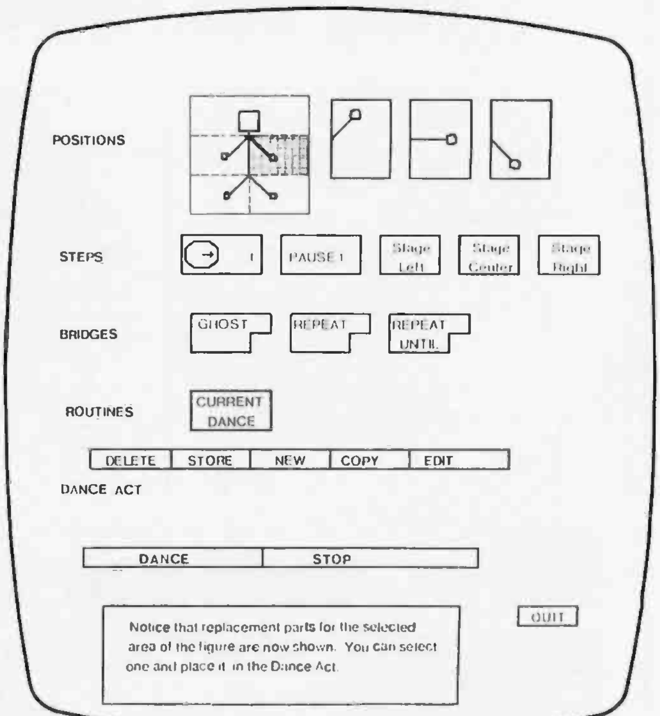


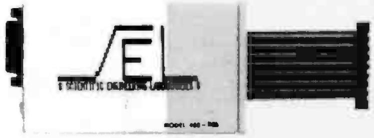
Figure 5: *Here and on page 364 are six views of the Dance Kit program during the creation of a dance. The "help" box, shown at the bottom of each figure, is always active. The shaded area indicates the item currently being worked on.*

Circle 338 on inquiry card.

IEEE-488 TO TRS-80* INTERFACE

Everything needed to add *powerful* BASIC GPIB-488 controller capability to TRS-80 Model 1 or 3, Level 2 or DOS with a minimum of 16K.

MODEL 488-80B
For Model 1 Operation



MODEL 488-80C
For Model 3 Operation

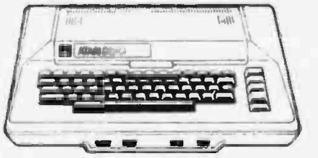
Price of Model 488-80B or 488-80C $325.
+ shipping, insurance & tax

WHEN ORDERING SPECIFY DISK OR TAPE

SCIENTIFIC ENGINEERING LABORATORIES
11 Neil Drive • Old Bethpage, NY 11804
Telephone: (516) 694-3205

**Trademark of Tandy Corp.*
There is no affiliation between Scientific Engineering Laboratories and Tandy Corp. or Radio Shack.

Circle 36 on Inquiry card.



ATARI®

ATARI 800 32K $810.00!

Atari 400 with 16K	$399	Atari 822 Printer	$360
Atrai 810 Disk	$460	Atari 825 Printer	$650
Atari 410 Cassette	$69	Atari 850 Interface	$145
Atari 820 Printer	$280	Atari 16K RAM	$99
Ramcram 32K RAM	$199	Visicalc	$170
Kurta Graphics Tablet	$560	Epson MX80 Printer	$499

NEW! VOTRAX TYPE 'N TALK

Even at these low prices, we will take the time to answer your questions, accept suggestions, track down new products, and help you with your programming problems. We are here even after the sale.

ALSO
Software by PDI, THESIS, CRYSTAL and more

Z19 Terminals	$800
Novation DCAT Modems	$169
Intertec Superbrain 64K	$2810

PLUS
NEC Spinwriters, Diablo Printers, Centronics, Commodore, Soroc Terminals. ALL at reduced prices.

To Order: Credit Card* or C.O.D. Customers Call (617) 783 3144
In stock units shipped within 24 hours. Most items in stock at all times
*Credit card orders add 3%. Mass. residents add 5% sales tax.

The Bit Bucket
P.O. BOX 365
NEWTON HIGHLANDS, MA 02161
617-783-3144

RACET SORTS — RACET UTILITIES — RACET computes — RACET SORTS — RACET UTILITIES — RACET computes — RACET SORTS — RACET UTILITIES — RACET computes —

FIELD PROVEN!!
10 MEGABYTES and MORE for the TRS-80* Model II plus SHARED ACCESS to HARD DISK DRIVE

Hard/Soft Disk System (HSDS) Software allows access as single drive. You can have that 10 Megabyte continuous file - that 50,000 name maillist or inventory! Or a directory with 1000 entries! All completely compatible with TRSDOS 2.0 BASIC. You can mix floppy and hard disk drives. Includes special utilities including HPURGE, DCS Directory Catalog System, HZAP Hard Disk Superzap, and many special formatting options. Three to eight times faster than floppy! RACET quality.

HARD DISK DRIVE & CONTROLLER $5995. Second User $595.
HSDS Software $400. (Note: HSDS now also available for CORVUS drives!!)

INFINITE BASIC (Mod I & III Tape or Disk) **Mod I $50.00, Mod III $60.00**
Extends Level II BASIC with complete MATRIX functions and 50 more string functions. Includes RACET machine language sorts! Sort 1000 elements in 9 seconds!! Select only functions you want to optimize memory usage.

INFINITE BUSINESS (Requires Infinite BASIC) **Mod I & III $30.00**
Complete printer pagination controls — auto headers, footers, page numbers. Packed decimal arithmetic — 127 digit accuracy +, −, *, /. Binary search of sorted and unsorted arrays. Hash codes.

BASIC CROSS REFERENCE UTILITY (Mod II 64K) **$50.00**
SEEK and FIND functions for Variables, Line Numbers, Strings, Keywords. 'All' options available for line numbers and variables. Load from BASIC — Call with 'CTRL'R. Output to screen or printer!

DSM **Mod I $75.00, Mod II $150.00, Mod III $90.00**
Disk Sort/Merge for RANDOM files. All machine language stand-alone package for sorting speed. Establish sort specification in simple BASIC command File. Execute from DOS. Only operator action to sort is to change diskettes when requested! Handles multiple diskette files! Super fast sort times — improved disk I/O times make this the fastest Disk Sort/Merge available on your TRS.
(Mod I Min 32K 2-drive system. Mod II 64K 1-drive. Mod III 32K 1-drive)

GSF (Mod I & III Tape or Disk - Specify Memory Size)
Mod I $25; Mod II $50; Mod III $30
Generalized Subroutine Facilities. The STANDARD against which all other sorts are compared! And then compare prices! Machine language — fast and powerful! Multi-key multi-variable and multi-key character string. Zero and move arrays. Mod II includes USR PEEKS and POKES. Includes sample programs.

DISCAT (32K 1-drive Min) **Mod I, III $50.00**
This comprehensive Diskette Cataloguing/Indexing utility allows the user to keep track of thousands of programs in a categorized library. Machine language program works with all TRSDOS and NEWDOS versions. Files include program names and extensions, program length, diskette numbers, front and back, and diskette free space.

KFS-80 (1-drive 32K Min — Mod II 64K) **Mod I, III $100.00; Mod II $175.00**
The keyed file system provides keyed and sequential access to multiple files. Provides the programmer with a powerful disk handling facility for development of data base applications. Binary tree index system provides rapid access to file records.

MAILLIST (1-drive 32K Min - Mod II 64K) **Mod I, III $75.00; Mod II $150.00**
This ISAM-based maillist minimizes disk access times. Four keys — no separate sorting. Supports 9-digit zip code and 3-digit state code. Up to 30 attributes. Mask and query selection. Record access times under 4 seconds!!

COMPROC (Mod I & Mod III — Disk only) **Mod I $20; Mod III $30**
Command Processor. Auto your disk to perform any sequence of instructions that you can give from the keyboard. DIR, FREE, pause, wait for user input, BASIC, No. of FILES and MEM SIZE, RUN program, respond to input statements, BREAK, return to DOS, etc. Includes lowercase driver software, debounce and screenprint!

UTILITY PACKAGE (Mod II 64K) **$150.00**
Important enhancements to the Mod II. The file recovery capabilities alone will pay for the package in even one application! Fully documented in 124 page manual! XHIT, XGAT, XCOPY and SUPERZAP are used to reconstruct or recover date from bad diskettes! XCOPY provides multi-file copies, 'Wild-card' mask select, absolute sector mode and other features. SUPERZAP allows examine/change any sector on diskette include track-0, and absolute disk backup/copy with I/O recovery. DCS builds consolidated directories from multiple diskettes into a single display or listing sorted by disk name or file name plus more. Change Disk ID with DISKID. XCREATE preallocates files and sets 'LOF' to end to speed disk accesses. DEBUGII adds single step, trace, subroutine calling, program looping, dynamic disassembly and more!!

DEVELOPMENT PACKAGE (Mod II 64K) **$125.00**
Includes RACET machine language SUPERZAP, Apparat Disassembler, and Model II Interface to the Microsoft 'Editor Assembler Plus' software package including uploading services and patches for Disk I/O.

CHECK, VISA, M/C, C.O.D., PURCHASE ORDER
TELEPHONE ORDERS ACCEPTED (714) 997-4950

*TRS-80 IS A REGISTERED TRADEMARK OF TANDY CORPORATION

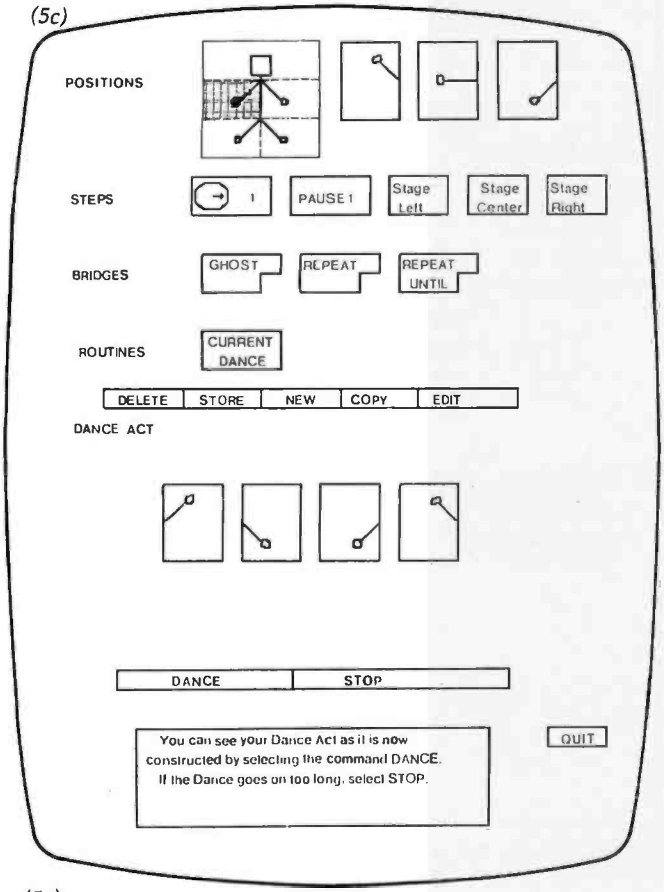
RACET COMPUTES
1330 N. GLASSELL, SUITE M,
ORANGE, CA 92667

RACET SORTS — RACET UTILITIES — RACET computes — RACET SORTS — RACET UTILITIES — RACET computes — RACET SORTS — RACET UTILITIES — RACET computes —

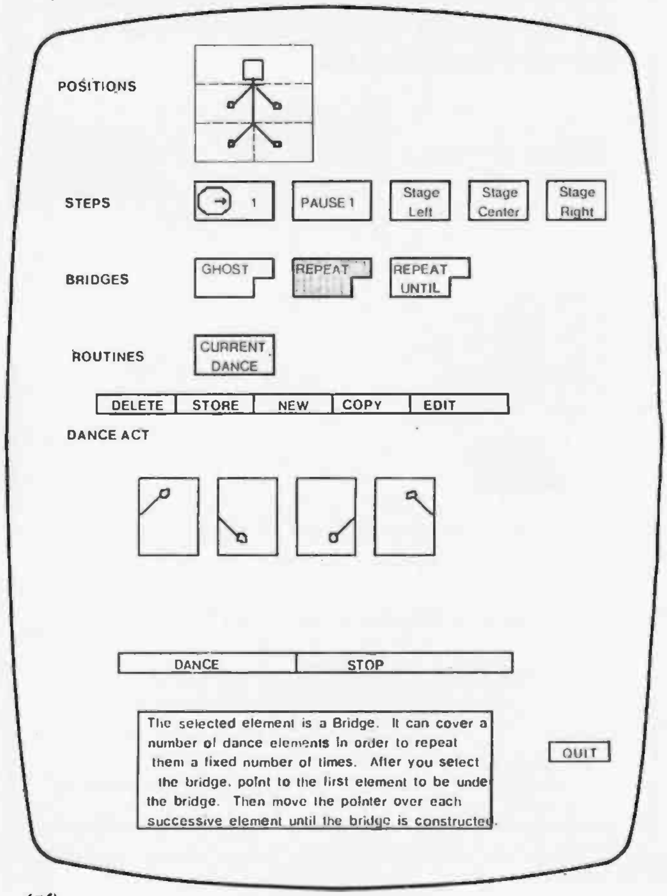
Circle 331 on inquiry card.

Figure 5 continued:

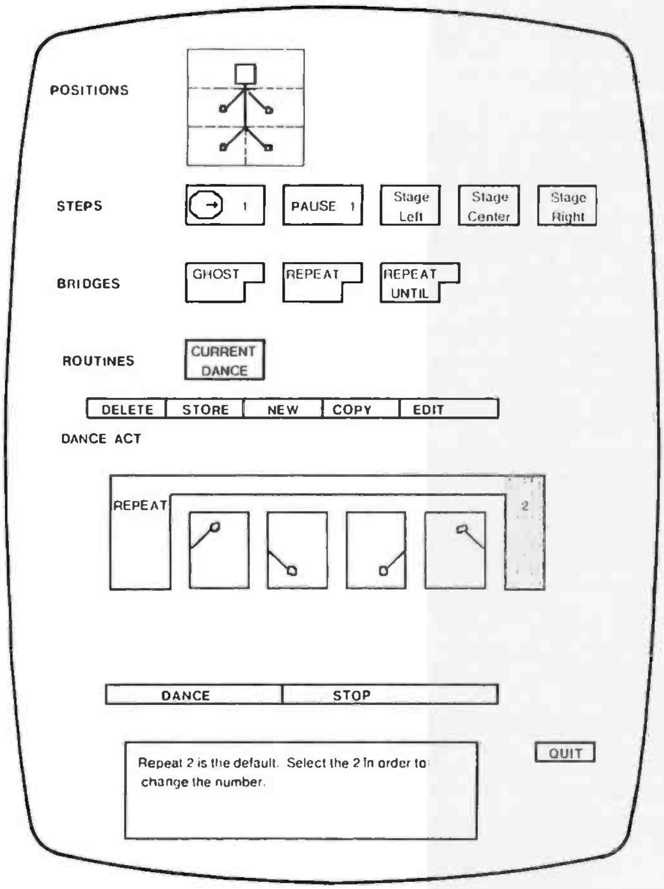
(5c)



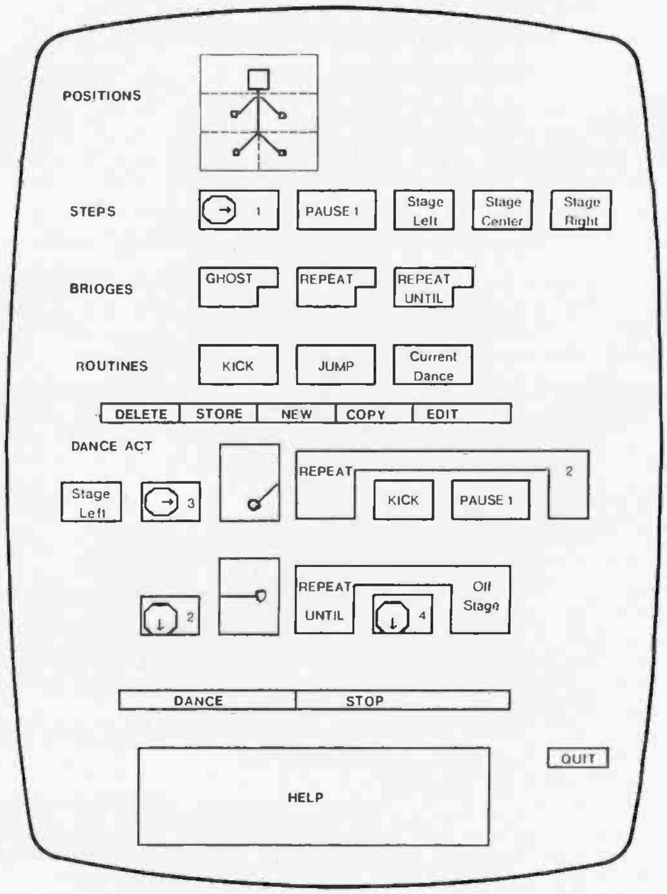
(5d)



(5e)



(5f)

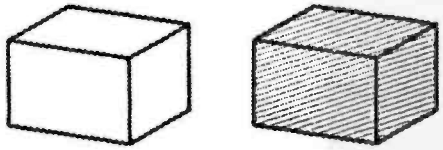


Text continued from page 362:
changed appropriately. A Turtle Dance Act that is akin to the Stick Person Dance Act shown in the first variation appears in figure 9. The animation for this Dance Act consists of the sequence of views shown in figure 10.

Third Variation: Boxes

The dancer might be a simple geometrical shape. The dancing needn't be subdivided, but replacement parts for the whole figure might be available.

For example, the user might create the following replacement parts:



Suppose the initial dance is set with the dancer moving toward the right. A possible Dance Act is shown in figure 11, where next HEX is defined as:

GO 1 | TURN 60

The ghost is used to leave a trace of the box after each step. Each step unit was presumably scaled by the user to be the size of the box so that no overlapping occurs. At the end of this act the screen would look like figure 12.

Another possible geometric design comes from the building blocks shown in figure 13. If the dance act is defined as shown in figure 14, then at the end of the dance the screen will look like figure 15. When a figure of one color is superimposed on a figure of another color, the underlying figure disappears.

Fourth Variation: The Degenerate Turtle

The Dance Kit can be used to do conventional Turtle geometry (see reference 6) by allowing the figure to degenerate to a point (no replacement parts need apply) and defining a scale such that GO 1 means to go to the next point on the screen.

Dancing School

The Dance Kit is one example from a variety of kits and ideas for kits that we have entertained and that have entertained us. One of our major concerns is to create an environment in which the design of interesting and imaginative educational materials will be fostered, and we believe that the Smalltalk-80 system will make it easier to create such kits.

We have given much thought to some necessary characteristics of a framework for a Dance (or any other) Kit. We suggest that certain services always be present on the screen. For example, a help system is of supreme importance. We have provided an indication of the help system we would incorporate into the Dance Kit. The TRIP system for animating algebra word problems (see reference 5) provides such a complete HELP facility that even fearful users need be told only how to use the pointing device in order to control all the functionality of the system. Other possibilities for services include a LIBRARY, a GUIDE to other activities that might be appropriate, and a facility that allows users to enter sug-

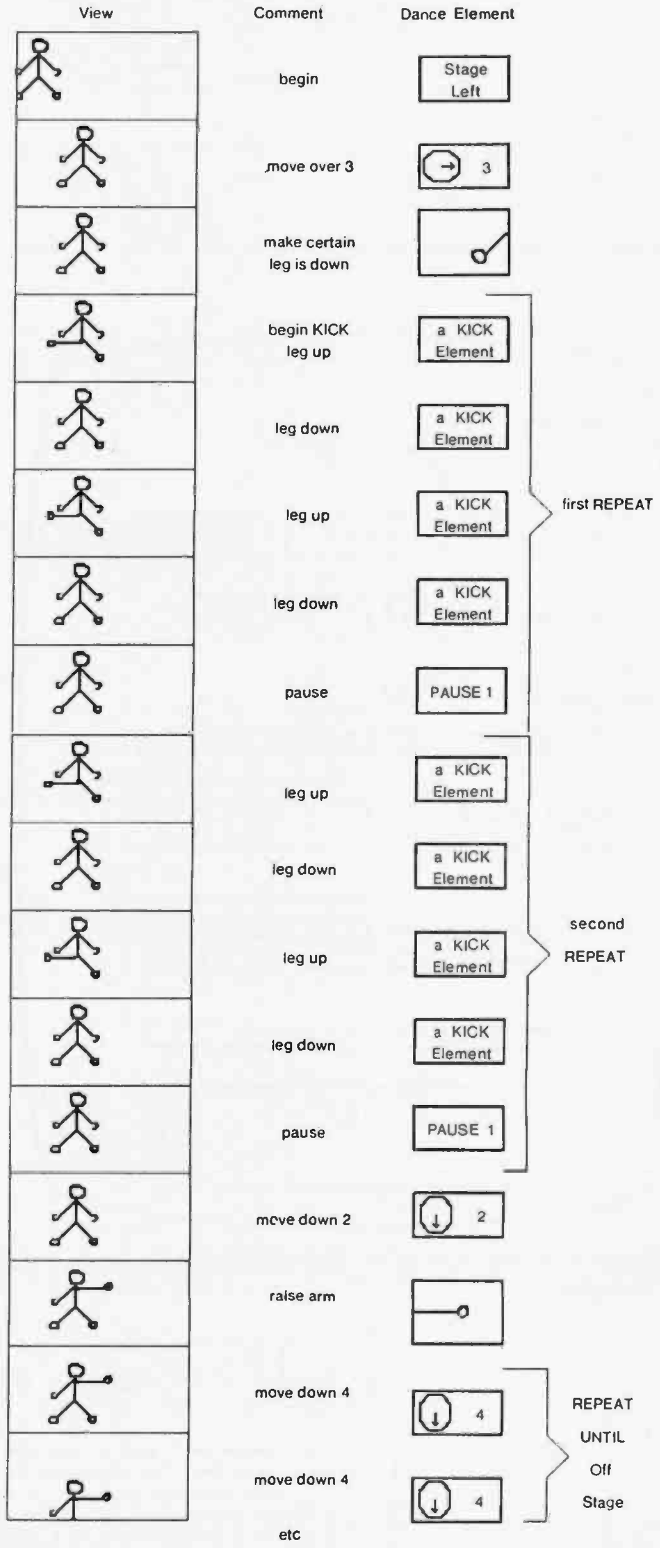


Figure 6: *Execution of the dance given in figure 5f.*

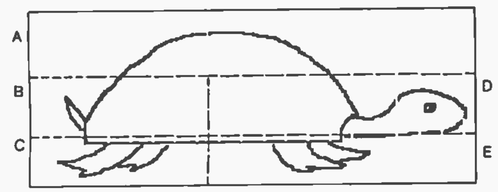


Figure 7: *A basic drawing of a big turtle that can be animated.*

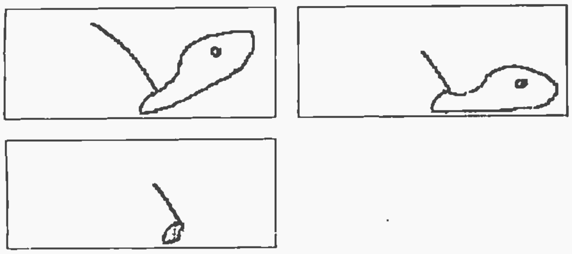


Figure 8: *Example alternate replacement parts for the big turtle.*

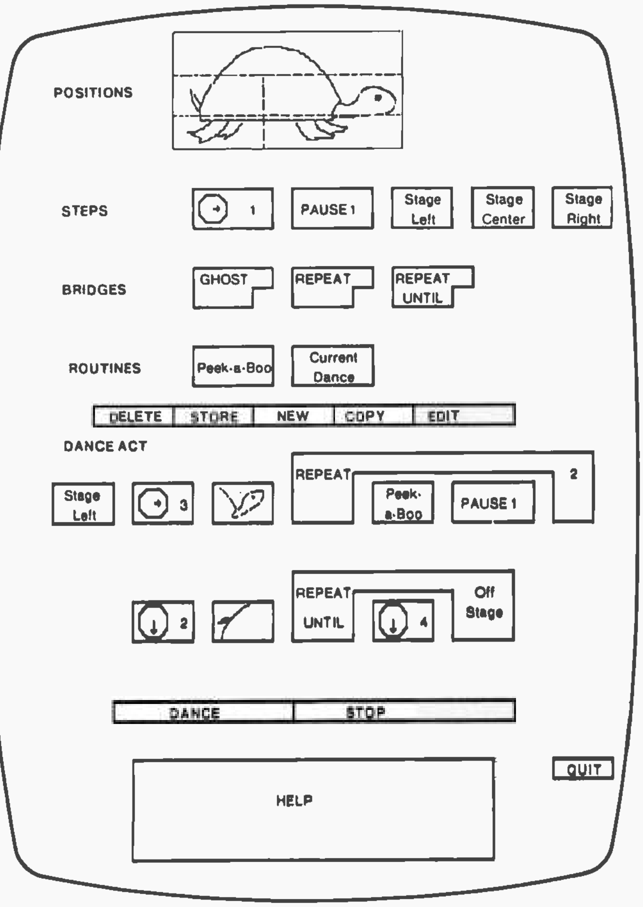


Figure 9: *Screen view of the Dance Kit being used to animate the big turtle.*

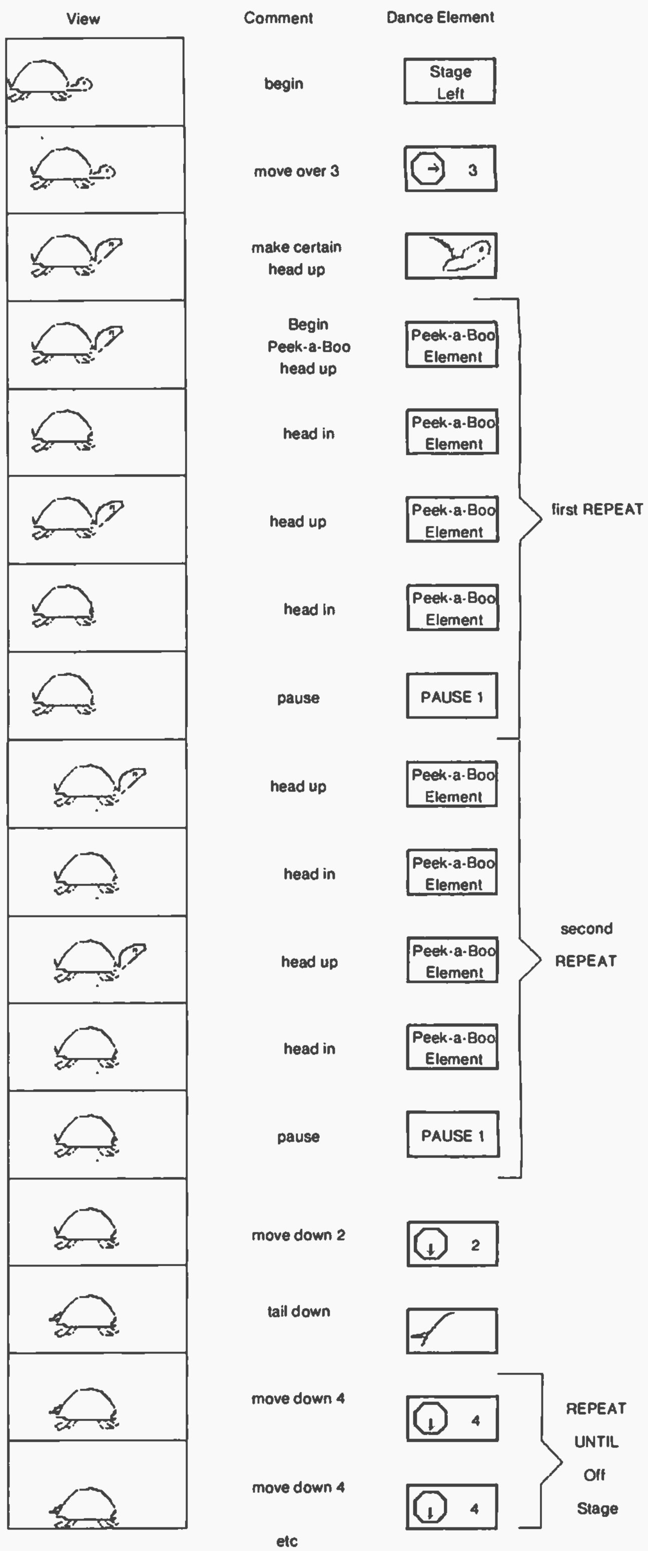


Figure 10: *Execution of the dance given in figure 9.*

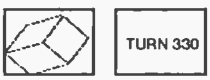
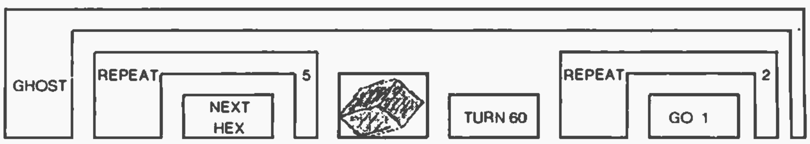


Figure 11: *Possible Dance Act for a set of box shapes.*



gestions and other feedback for the instructor (ie: a GRIPE).

We have also imagined a Dance Kit in a computerless classroom. The idea that computer-based activities should have concrete analogues, especially for young children, has been well received in the experience of the MIT LOGO group. We would use the children as the figures in the dances and create the Dance Act instructions and routines on paper or a blackboard or.... Of course if we want to leave ghosts, we will need to enlist the services of more than one child.

In this mode of use of the Dance Kit we are fond of imagining children as the design elements of the seven possible friezes shown in figure 16; each frieze is characterized by the group of transformations or symmetries that

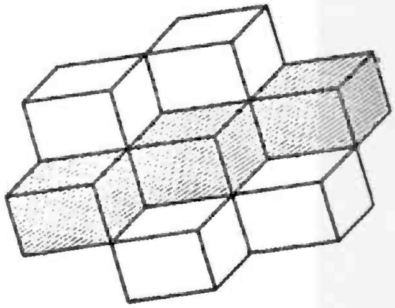


Figure 12: *Drawing made by the Dance Act of figure 11.*

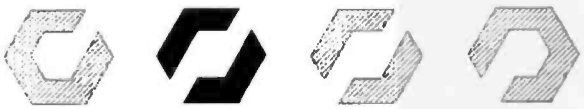


Figure 13: *A basic drawing of some geometric designs that can be used by the Dance Kit.*

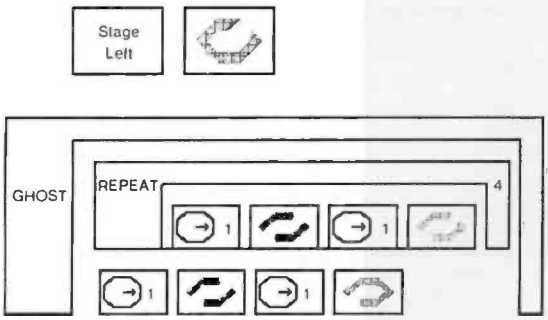


Figure 14: *Possible Dance Act for the set of geometric designs.*

Figure 15: *A drawing made by the Dance Act of figure 14.*

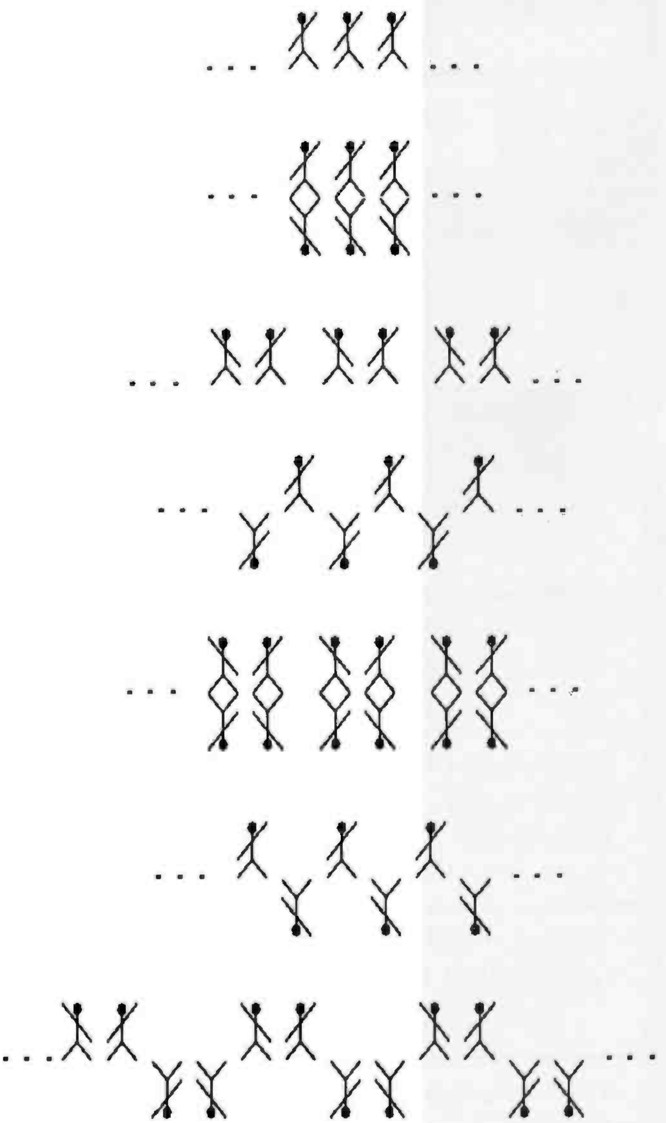


Figure 16: *Frieze patterns of stick men. By combining a basic pattern and its variations, many frieze patterns can be made.*

preserve them. (A symmetry is a one-to-one transformation that preserves distance.) The basic symmetries are translations, rotations, and reflections. We envision the children casting their shadows to form the patterns—or perhaps even lying on the floor. (Of course, mathematical friezes are like lines—infinitely long—but we can enjoy thinking about finite pieces.)

Frieze patterns might look like those in figure 16. However, we will leave the Dance Acts for the frieze patterns as an exercise for the reader.

The Dance Kit can be thought of as a forum for learning introductory programming concepts. A curriculum developer would create a dancer and replacement parts that are of interest to the student; the developer would also select steps, bridges, and initial (sub-)routines that support recommended or assigned exercises. The combination of dancer replacement parts, steps, bridges, and subroutines makes up a "programming language." Alternatively, the student could do more of the creation of the language. The Dance Kit has our approval because of this possibility of dual and flexible use.■

References

1. Bricklin, Dan and Bob Frankston. VisiCalc™ Computer Software Program, 1979.
2. Goldberg, Adele. "Educational Uses of a Dynabook." *Computers in Education*, Volume 3. Great Britain: Pergamon Press Ltd, 1979, pages 247 through 266.
3. Goldberg, Adele and Alan Kay. *Teaching Smalltalk*. Technical Report SSL 77-2, Xerox Palo Alto Research Center, 1977.
4. Goldberg, Adele, Dave Robson, and Dan Ingalls. *Smalltalk-80: The Language and Its Implementation* and *Smalltalk-80: The Interactive Programming Environment* (forthcoming).
5. Gould, Laura and William Finzer. "A Study of TRIP: A Computer System for Animating Time-Rate-Distance Problems." *Proceedings of the IFIP Third World Conference on Computers in Education (WCCE-81)*. July 1981, Lausanne, Switzerland.
6. Papert, Seymour. *Mindstorms: Children, Computers, and Powerful Ideas*. New York: Basic Books, 1980.

ToolBox:
A Smalltalk Illustration System

William Bowman and Bob Flegal
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Road
Palo Alto CA 94304

Computer art is usually thought of as linear, geometric, and repetitious. The Smalltalk group at the Xerox Palo Alto Research Center has been exploring the potential image-making capabilities of the computer-powered display medium for almost ten years. We have investigated the idea of using the computer and its associated display as an art medium for a user/artist to create visual material. We allow the mixture of an artist's free-hand sketches with structured commands for manipulating graphic forms. This approach can be contrasted with the more traditional approach where the machine is programmed to "draw," usually with lines, some visual image on the display screen. Figure 1 is a typical computer-generated pattern in which symmetrically ordered lines form an illusion of spherical volume.

This article reports on one of our developments in the area of computer-assisted image creation. ToolBox is a drawing system designed for general-purpose, interactive image creation and editing. ToolBox was designed jointly by artist William Bowman and computer scientist Bob Flegal to explore graphic specialization within the computer-powered display medium. We were interested in determining the areas within the visual and graphic arts for which the computer-powered display medium is a particularly suitable and efficient graphic tool. To do so we investigated possible tools, techniques, and image-making capabilities of this new medium. The underlying implication (and intention) of this approach is a new role in professional graphics: that of the illustrator/artist who creates images with computer machine tools rather than with conventional hand tools.

ToolBox is a graphics system designed for general-purpose, interactive image creation and editing.

The ToolBox system receives input from the user/artist from a graphics tablet and keyboard and modifies the screen image based on his/her actions. The computer program does not generate the image from a set of programmed drawing instructions. For example, to specify a straight-edge line, the artist need only specify the two end points of the line with the graphics tablet and the program completes the line. This is in contrast to methods where a "pen" is programmed with up, down, and draw commands with coordinates as arguments. This idea is illustrated in figure 2.

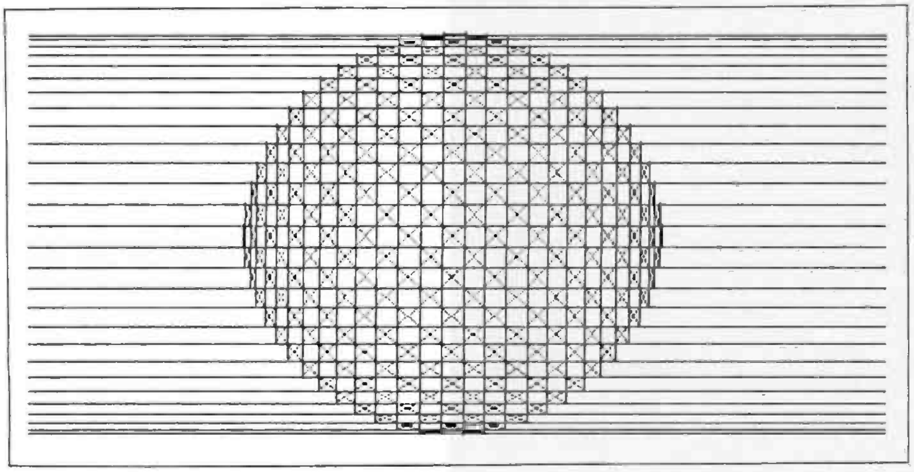


Figure 1: *A typical computer-generated geometric design in which symmetrically ordered lines form an illusion of spherical volume.*

System Description

ToolBox consists of a coordinated set of graphic tools that provide a wide range of form construction options for use in testing machine illustration concepts. Five fundamental tool functions comprise the basic graphical form vocabulary. Each of these tools can be modified in its use by one or more of four sets of variables that can affect its form source, color tone, grid spacing, and functional mode. Brief descriptions of the

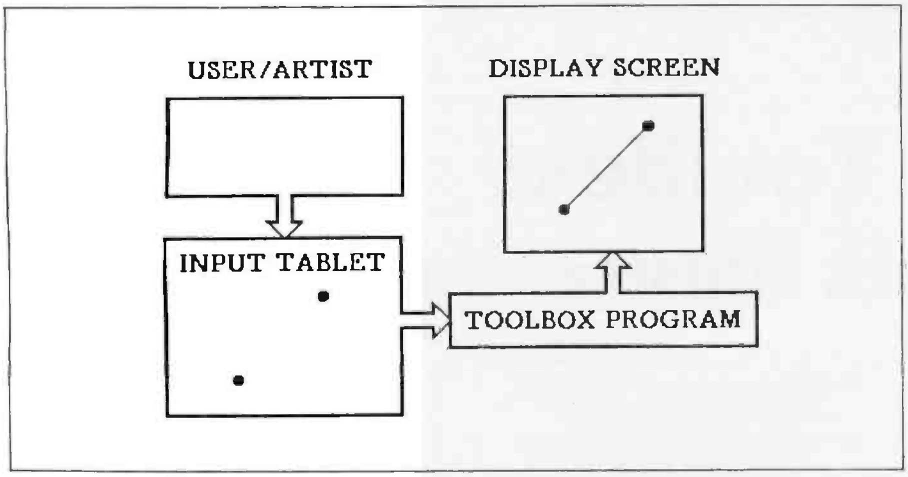


Figure 2: *Modification of the ToolBox screen image based on user/artist input. The computer assists in drawing a line after the artist has entered end points on a graphics tablet.*

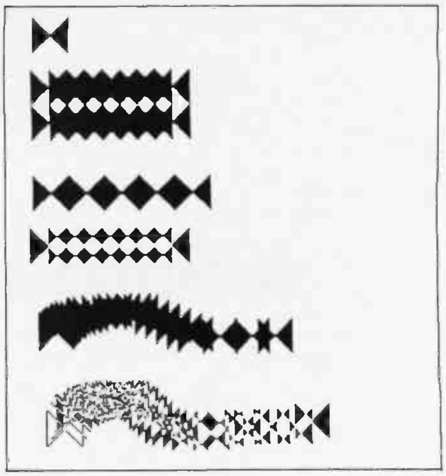


Figure 3: *ToolBox variations on a single form source—two triangles.*

tools and the variables affecting them follow.

Select Form allows the user/artist to select a rectilinear-shaped picture from the display screen as the form source. The form selected can be thought of as a brush which the other five tools use as their source picture. The artist can create a form source using any of the tools available in the ToolBox system, from Smalltalk graphic commands, from the Smalltalk text editor, or from a library of form sources.

The following are ToolBox tool functions:

- COPY enables continuous individual copies of the form source onto the display screen. This can be thought of as painting on the display screen using a brush (the form source)
- DRAW enables freehand line drawing or sketching by connecting form source copies with line segments
- ARC enables curve construction (using spline functions)
- BLOCK enables solid rectangles to be formed
- LINE enables straight-line construction between two points

Grid spaces modulate the tools to function on specifiable horizontal and vertical grid lines.

Color tones allow creation of form in black, white, or one of the four intermediate grays (spatial-halftones).

There are three *modes* affecting the copying of source forms onto the display: *store*, *or*, and *xor*. We called these modes "over," "under," and "reverse."

Art Examples

Figure 3 shows some of the visual effects that are possible with a single form source—two triangles. Since each form source can have five tools, five griddings, six colors, and three modes, the number of possible pictorial effects is staggering.

The display screen upon which the pictures in this article were made is 606 by 808 dots, and each dot is either black or white (no gray scale). The display is refreshed out of the computer's main memory. Thus, to turn a display dot black or white, 1 or 0 is written into memory.

During the programming and development of the ToolBox system, a series of image-making experiments were conducted, both as active input to the evolving design of the system and as a preliminary test of its capabilities. The main purpose of these experiments was to explore the potential of the machine tools for enabling

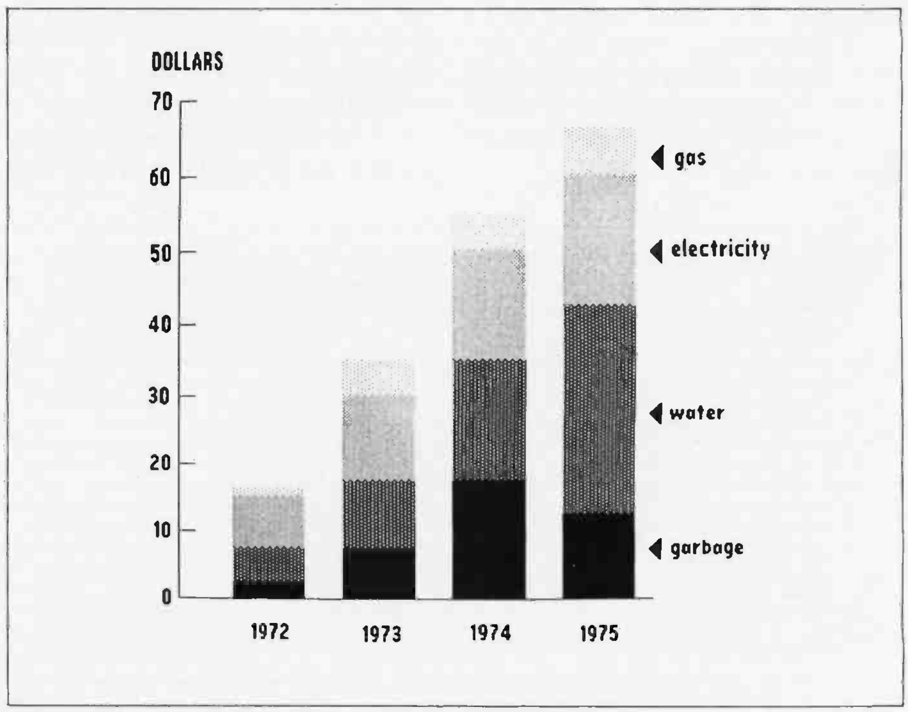


Figure 4: *A bar chart designed by William Bowman.*

Qume® Data Trak™ Floppy Disk Drives

Distributed by: asap computer products, inc.

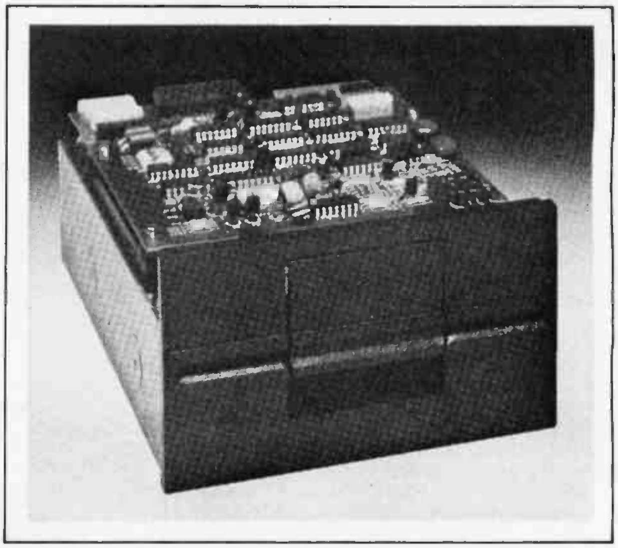
The Data Trak™ 5

The Data Trak™ 5 double-sided double-density drive uses state-of-the-art technology to give you superior data integrity through improved disk life, data reliability, and drive serviceability using 5¼"media.

Qume's independent head load yields wear characteristics far superior to competitive drives. This superior wear performance produces savings on both diskette usage and drive maintenance.

Improved data reliability, resulting from superior amplitude and bit shaft characteristics, optimizes operator efficiency and reduces processing time for end-users.

And Data Trak's unique modular design means simplified field servicing for you and your customers.



Design Features

Expanded storage capacity • Two-sided, double-density

Proven head carriage assembly • Ceramic head with tunnel erase • Dual-head flex mounting arrangement • Superior head load dynamics

Precise lead screw actuator • Fast access time — 12 ms track-to-track • Low friction and minimum wear • Low power dissipation

Additional features • Industry standard 5¼" media format • ISO standard write protect • Door lock out for media protection • Requires DC voltage only • Daisy Chain up to 4 drives • Heads load on command independent of loading media

Product Specifications

Performance Specifications • Capacity: Unformatted: 437.5K or 500K bytes; Qume Formatted: 286.7K or 327.7K bytes • Recording Density: 5456 BPI • Track Density: 48 TPI • Cylinders: 35 or 40 • Tracks: 70 or 80 • Recording Method: FM or MFM • Rotational Speed: 300 RPM • Transfer Rate: 250K bits/second • Latency (avg.): 100 ms • Access Time: Track-to-track 12 ms; Settling 15 ms • Head Load Time: 50 ms

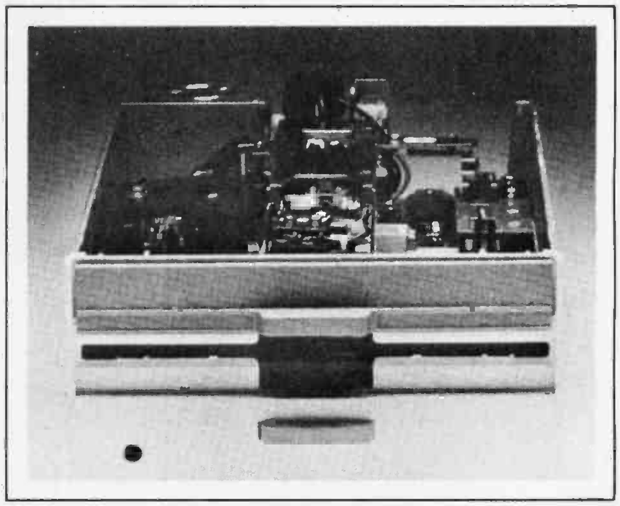
The Data Trak™ 8

The Data Trak™ 8 double-sided double-density drive uses state-of-the-art technology to give you superior data integrity through improved disk life, data reliability, and drive serviceability.

Qume's innovative approach to controlling head load dynamics yields wear characteristics far superior to competitive drives. In independent evaluation, Data Trak 8 is setting industry standards for tap test performance. This superior wear performance produces savings on both diskette usage and drive maintenance.

Improved data reliability, resulting from superior amplitude and bit shift characteristics, optimizes operator efficiency and reduces processing time for end-users.

And Data Trak's unique modular design means simplified field servicing for you and your customers.



Design Features

Expanded storage capacity • Two-sided, double-density

Fully IBM compatible • IBM 3740 and System 32 drives • IBM 3600 and 4964 drives • IBM System 34 drives

Proven head carriage assembly • Ceramic head with tunnel erase • Dual-head flex mounting arrangement • Superior head load dynamics

Fast, precise steel belt drive • Fast access time — 3 ms track-to-track • Low friction and minimum wear • Low power dissipation

Additional features • ISO standard write protect • Programmable door lock • Negative DC voltage not required • Daisy Chain up to 4 drives • Side-by-side mounting in standard 19" RETMA rack • Compatible with Shugart SA850/SA851

Product Specifications

Performance Specifications • Capacity: Unformatted: 1.6 Mbytes/disk; IBM Format: 1.2 Mbytes/disk • Recording Density: 6816 BPI • Track Density: 48 TPI • Cylinders: 77 • Tracks: 154 • Recording Method: MFM • Rotational Speed: 360 RPM • Transfer Rate: 500Kbits/second • Latency (avg.): 83 ms • Access Time: Track-to-track 3 ms; Settling 15 ms; Average 91 ms • Head Load Time: 35 ms • Disk: Diskette 2D or equivalent

asap computer products, inc.

1198 E. Willow, Signal Hill, CA 90806

Call Toll Free (800) 421-7701

AUTHORIZED DISTRIBUTOR FOR QUME
CALL FOR PRICE AND DELIVERY

(213) 595-6431 or (714) 891-2663 In California

Circle 415 on inquiry card.

Figure 5

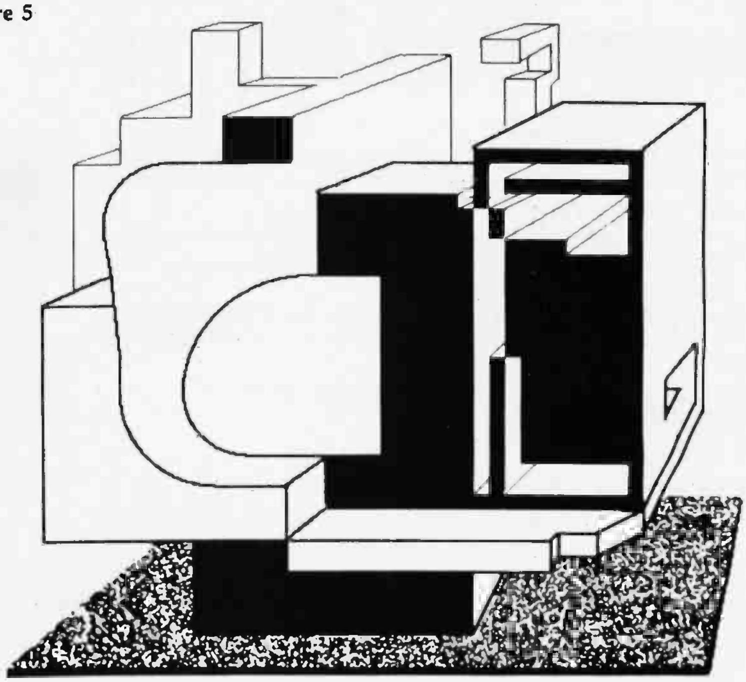
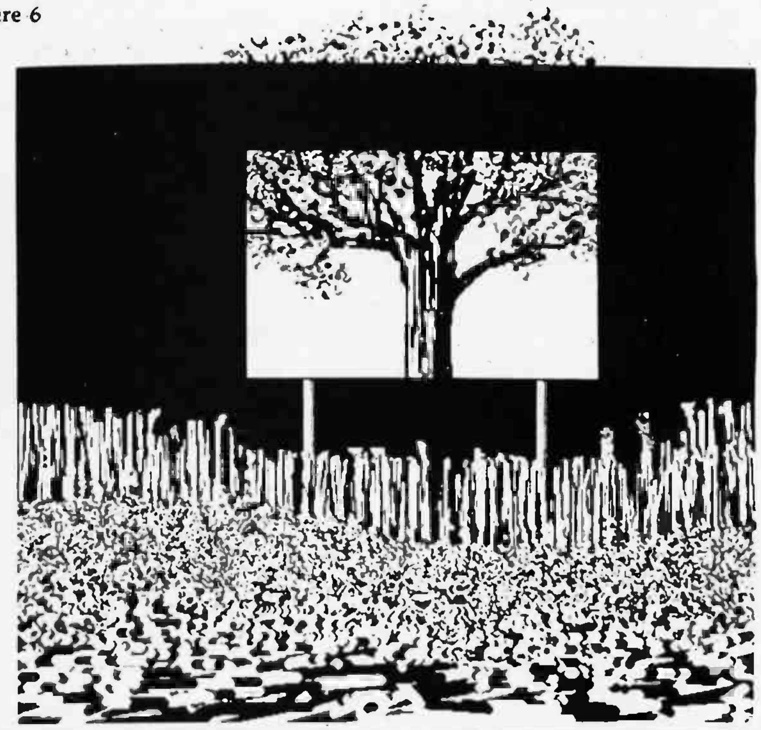


Figure 6



Figures 5, 6, 7, 8: *These four illustrations by Bowman were created using the ToolBox graphics system.*

a variety of graphic strategies for image design and execution. Some of these strategies resembled conventional graphic techniques; however, most of them turned out to be unique to the machine medium.

The remainder of this article consists of pictures that grew out of these early experiments. They are intended as a demonstration of the range and depth of graphic language effects that can be achieved with the ToolBox system.

Figure 4 is a simple bar chart. This figure made heavy use of the BLOCK tool and several grid settings. The

Figure 7

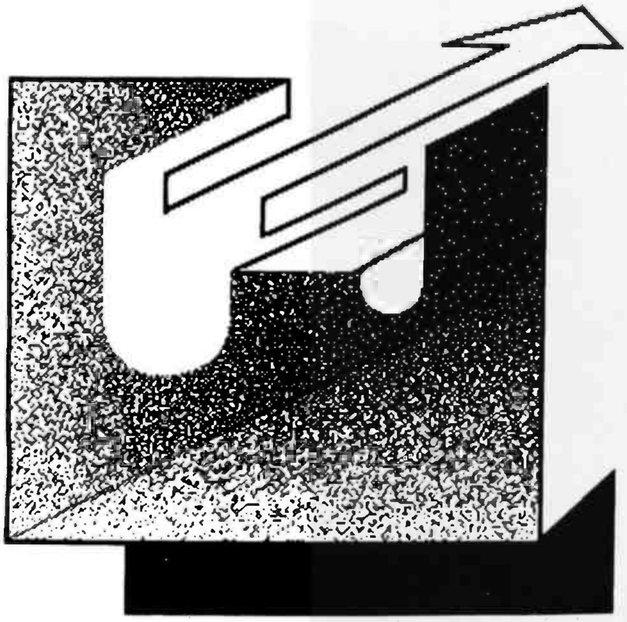


Figure 8

illustration was done in a very short amount of time compared to the amount of time it would take to draw a simple bar chart using conventional media. The ToolBox system is particularly effective for images involving horizontal and vertical elements. (Figures 4, 5, 6, 7, and 8 were executed by William Bowman.)

The BLOCK, LINE, and CURVE tools were heavily used in figure 5. Note the texturing at the bottom of the illustration; it was created using the COPY tool in reverse mode with the color variable set to black.

In figure 6, the COPY tool in

reverse mode was used to create the effects in the bottom half of the image and for the leaves and the bark on the tree.

The perspective effect in figure 7 was easily obtained using the grid settings in the system. The shading was created using a "brush" containing just a few black dots with the COPY tool used in erase mode on a black background.

Note the use of the COPY tool and grid settings to construct the chain on the socket in figure 8. The ToolBox system proved particularly effective for rapid construction of repeated patterns.

The next four pictures were done by Howard Foote, an artist and college art teacher who had never worked on a computer system or terminal. He was contracted to use the system and push it to its graphical limits. In the picture in figure 9, Foote made considerable use of the COPY tool and DRAW tool.

In the picture in figure 10, Foote was able to represent his subject with remarkable loyalty to physical realities when he wanted to and at the same time seemed able to maintain a flexible control over compositional features. His form vocabulary was wide and included a rich use of line, shape, texture, and tonal value.

In the picture in figure 11, Foote made considerable use of the DRAW tool to achieve a free and open effect. Geometrical forms and exact technical mastery of fine detail were the only major areas of pictorial interest with which he did not choose to deal when using the ToolBox system.

The illustration in figure 12 shows a technique often used by Foote: a spatial-saturation strategy using personally constructed form units with the COPY tool in different tones and modes.

The final illustration, figure 13, was done by Bob Flegal. The motifs in the border were taken from North

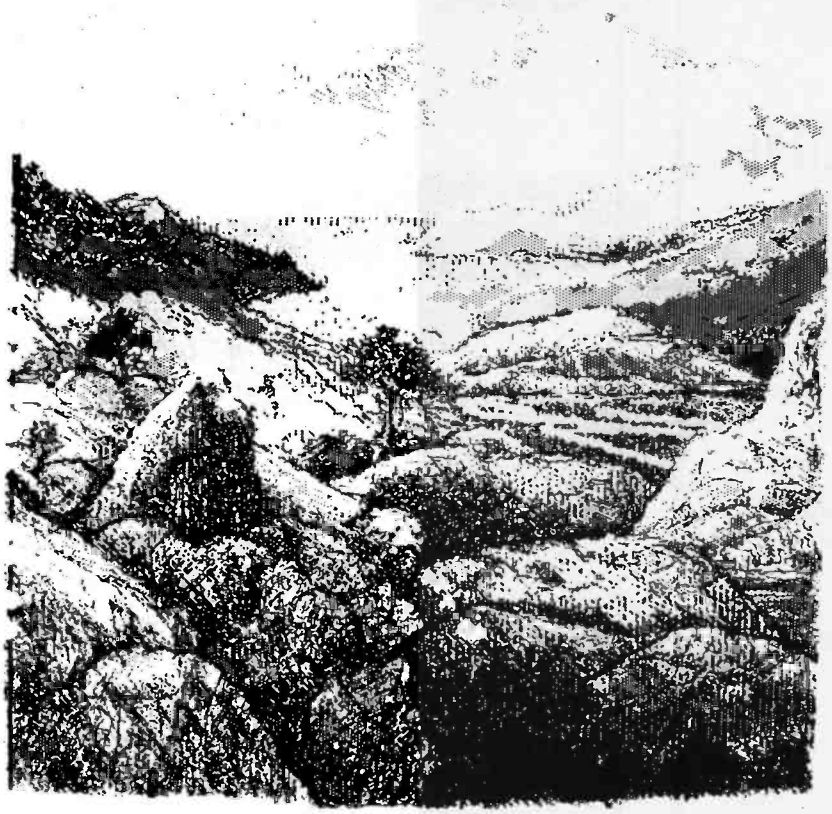
Figure 9

Figure 10

Figures 9, 10, 11, 12: *The drawings in these four figures were done by Howard Foote, an artist and college art teacher who was contracted to use the ToolBox system and to push it to its graphical limits.*

Figure 11

Figure 12



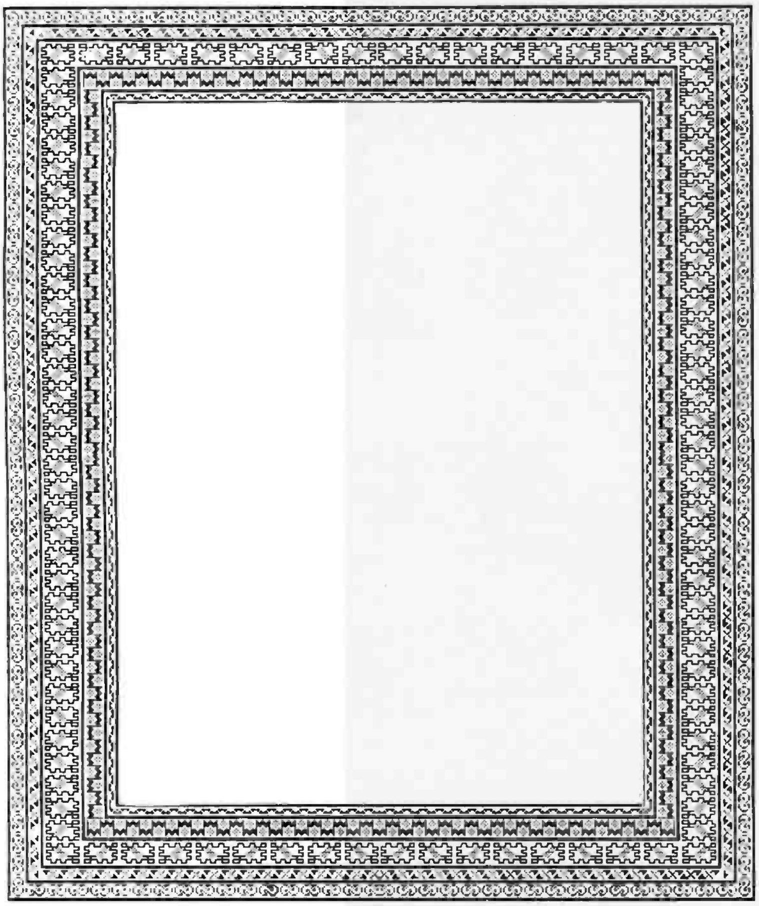
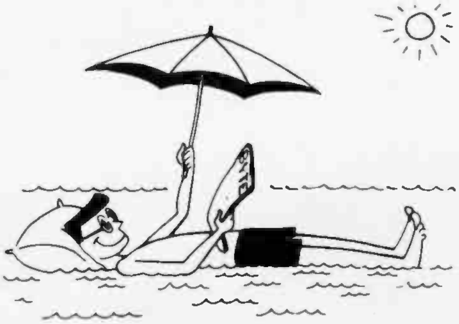


Figure 13: *A border design created by Bob Flegal. The motifs are from North African carpet patterns.*

African carpet designs. They were pieced together using the COPY tool with various grid settings. The ToolBox system allows rapid construction of material involving repeated design modules.

Summary

Based on the speed of execution and the range and depth of graphic language effects that can be created with the ToolBox system we feel that similar systems will become another common graphic tool for professional-level designers and illustrators. Extensions of the basic ideas presented in this article are numerous and provide a fertile ground for research in computer-mediated illustration and design. ■



Do more with your Commodore. Plug in the printer that business professionals prefer.

Discover the quality difference and move up to Mannesmann Tally printing. The high speed 8024 serial printer comes ready to plug into and work with your Commodore system. No fussing with convertors or adapter boxes.

Here's what you get. Print speeds up to 200 lines per minute. Full 132 column printing. Conforms with Commodore specified program functions for full software compatibility. Whisper quiet operation. Clean, crisp and pleasing print quality that's always consistent copy to copy. Rugged, industrial strength construction. A print head that promises years of usage before replacement. A machine you can drive as hard as you want, yet it never requires preventive maintenance. Never needs periodic adjustments.

There's more. An easy to change, snap-in ribbon cartridge. Dual tractor paper engagement for positive alignment. A built-in self-test routine. Double wide printing on demand. A nine-needle print head model for true descenders on lower case characters. An optional Quick-Tear kit for forms removal immediately after printing. See this machine for yourself.

Ask for the Model 8024 at your nearest Commodore dealer or contact us.

Mannesmann Tally, 8301 S. 180th St. Kent, WA 98031. Phone: (206) 251-5524.

MANNESMANN
TALLY

OFFICIALLY APPROVED BY COMMODORE

Virtual Memory for an Object-Oriented Language

Ted Kaehler
Learning Research Group
Xerox Palo Alto Research Center
3333 Coyote Hill Rd
Palo Alto CA 94304

The amount of information in a person's brain is truly vast; even the amount accessed in the course of a few hours of thought is vast. This is in contrast to the amount of information in the main memory of a computer, which is minuscule by comparison. The exciting thing about computers, though, is that we can use them to extend and enhance our thought. If a computer is to serve effectively as an aid to thought, it must be able to hold enough information to be useful. However, the memory of the largest computer today is so small that it severely limits what that computer can do. There are so many orders of magnitude between the capacity of the brain and the capacity of a computer that given the question "How much memory will the computer need?" the answer should always be "As much as possible."

Software for personal computers is just crossing a threshold of usefulness and flexibility. There are tasks, such as revising a draft of a paper, which are tremendously easier to do with a computer than without. Once you have edited with a computer, it seems absurd to edit by hand. The *number* of tasks for which the computer is essential is growing rapidly, causing a very sharp rise in the demand for storage in each personal computing system. As we design more useful aids to human thought, we will immediately want to access an amount of information closer to the amount in someone's head. Many extraordinary ideas will become software realities in the next few years. And large quantities of memory will be needed to run and store all of that wonderful software.

Given the question "How much memory will the computer need?" the answer should always be "As much as possible."

The practical limit on the size of a computer's memory is cost. Every project, especially a personal computer, has cost limits. The question becomes how to get the most memory for the least cost. Roughly speaking, memory falls into two categories: fast, expensive memory and slow, inexpensive memory. *Main memory* and *core* are common names for the fast, semiconductor memory. The slow memory, *secondary memory*, is almost always a disk. If we bought all slow memory, the processor would continually wait for the disk and would give very poor performance. If we spent all our money on fast memory, we would not get very much of it, and many of the bigger and better programs would not fit in. The game is to buy some fast memory and some slow memory and arrange things so that the processor rarely has to wait for the slow memory. This game, and specifically the mechanism which hides the slow memory from the processor, is called *virtual memory*.

If there were no way at all to predict which byte of memory the processor might want next, it would be impossible to win the game of virtual memory. However, pieces of data that are used together are often stored together, and program instructions tend to be executed and stored in a sequence. The principle of *locality of reference* states that the processor is most likely to access a memory location very near the last one it accessed (see reference 2 at the end of this article). The game of virtual memory is based on a trick: when the processor starts to ask for bytes from a block of code or data, it should move that code or data into the fast memory. If the processor continues to access that information, all of the accesses will be to fast memory. When the program moves on to a new activity, it may again be forced to get its information from the slow memory. To win the game, a virtual memory must maintain a situation where most of the processor's accesses are to the fast memory. If the strategy fails and the processor often wants data from the slow memory, the entire system will run very slowly.

The act of moving programs or data between the two kinds of memory is called *swapping* (see figure 1). The program that the user is running may or may not control the swapping explicitly. Overlays are large groups of subroutines that are moved to and from the disk under control of the user program. In an *automatic virtual memory*, however, the user program is unaware that swapping is occurring. The programmer does not specify how the program should be divided up into pieces or when swapping should occur.

In certain cases, letting the programmer control swapping directly can result in good performance. However, the virtual memory game is very complex and is played very quickly inside the computer. We believe that the programmer should not be burdened with deciding what part of the data to swap and when to do it. Asking the programmer to instruct the virtual memory is like asking a race car designer to write down, for the driver, exactly how to move the steering wheel in some future race.

In this article, we first look at a common type of automatic virtual memory called *paging*. We then introduce a new type of virtual

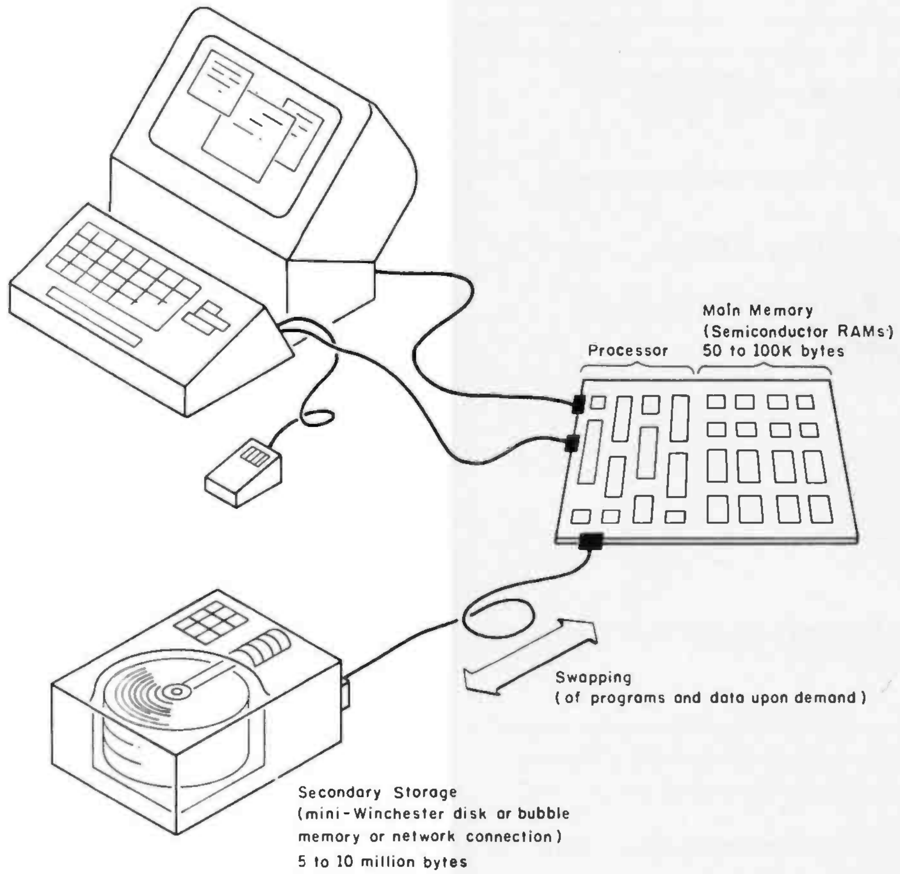


Figure 1: *Main memory, secondary memory, and swapping combine to form a virtual machine that seems to have more memory.*

memory that takes advantage of its knowledge of objects. We describe in detail a specific object-oriented virtual memory for the Smalltalk-76 system and explain how it plays the virtual memory game better than a paging system.

Paging

The most common kind of automatic virtual memory is called paging. In paging, the program is cut up arbitrarily into pieces. Each piece is called a *page* and contains the same number of bytes as every other page —say, 512. There are many more pages than will fit into main memory at once, so most of them stay on the disk. The processor knows only about byte addresses in one large address space called the *virtual address space*. Every time the processor accesses a byte, the address of the byte is checked. The high-order bits of the address tell which page contains that byte. (The low-order bits tell which byte within the page.) If that page is not in main memory, the user program stops. The virtual memory program starts up, finds an old page, moves it to the disk, and brings the desired page into memory in its place. (We will use the term "memory" to refer to the fast, main memory only.) The act of discovering that a page is needed from the disk and bringing it into memory is called a *page fault*.

An advantage of paging is that it works regardless of the contents of the pages. The mechanism needed to determine whether a given page is in memory is simple. Many computers have special hardware to speed up the translation between an address in the virtual space and a page in memory.

There are problems with paging, however. If the program needs a particular byte, the entire page surrounding that byte must be brought into memory. If no other bytes on that page are useful at the moment, a large amount of main memory is wasted. Since programs are cut up arbitrarily into pages in the first place, it is common that the rest of the page has nothing to do with the part currently wanted. Sometimes a significant fraction of memory is taken up by pages from which the processor wants only a few bytes (see figure 2). These pages crowd out pages containing other parts of the program, causing many pages to be swapped to run the rest of the program. The many accesses to slow, secondary memory cause the whole system to be slow.

Another problem with paging is that every address of a byte or a word must be a long address. When an object-oriented language is built on a paging system, a pointer to an object is typically the address of the first word of the object. Every pointer must be capable of reaching any word in the entire virtual space, and each one must have enough bits to span the space. Pointers comprise a large fraction of many programs and data structures. If they could be shorter, more of the program could be packed into one page in memory and the entire program would take fewer pages of memory.

Object-Oriented Virtual Memory

Smalltalk is a system composed of *objects*. An object is a little package of functionality. It contains the values of a few variables or a small piece of program. The important thing about an object is that its parts belong together. If a program wants a part of an object, it probably wants other parts, too. Different pieces of information were packaged together in that object exactly because they will be used together. Locality of reference is strong inside an object and, in general, weak between objects.

An object-oriented virtual memory swaps individual objects instead of entire pages between disk and main memory. Objects that are brought into memory are packed end to end with the objects already there. Memory is thus entirely filled with useful or likely-to-be-useful data. A larger percentage of memory is actually holding useful information than it would under a paging system. The result is that a larger part of the program can fit into memory at once.

There is a penalty for swapping objects, however. Objects are generally smaller than pages, and there are a lot of them in memory at once. The virtual memory program must keep track of which object is in which place in the memory, and it must be able to find out where each object came from on the disk. Managing individual objects is more complicated than managing pages, but the advantage of packing main memory with useful objects makes up for the time spent managing the objects.

By object-oriented virtual memory, we mean a system that swaps objects which have meaning in the high-level language and which are typically small. Segments in the B5500 (reference 4) and objects in HYDRA (reference 5), while being the units of swapping in their systems, are large. These "objects" require tens or hundreds of bytes of overhead information each. An object-oriented virtual memory, in our sense, gives an object the same swapping freedom as a segment and shrinks the overhead to a few bytes per object.

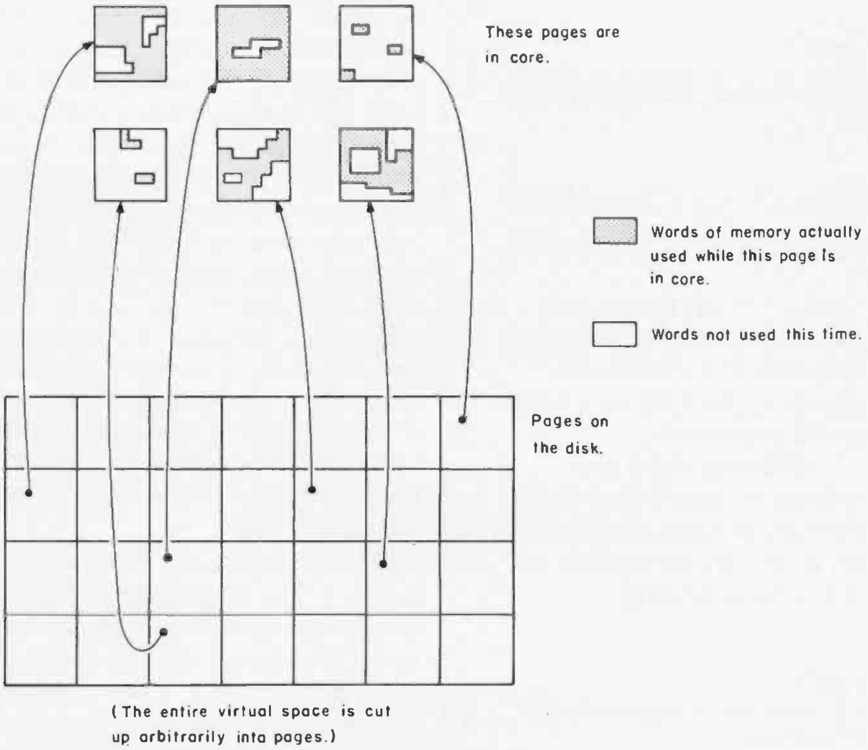


Figure 2: *Virtual memory by paging.*

Pointers to Objects

An object consists of *fields*, which hold the values of their named and indexed instance variables. Each field contains a numeric value, which can be interpreted as itself or (usually) as a pointer to another object. This number, called the *object pointer*, is the unique identifier of the other object. Every object has an object pointer. Given an object pointer, the virtual memory must be able to locate that object, whether it is in memory or on the disk (see figure 3).

Creating, destroying, and moving objects in memory is the job of a storage manager. The virtual memory program takes the place of the storage manager (as described in Glenn Krasner's article, "The Smalltalk-80 Virtual Machine," on page 300 of this issue). It fetches and stores the fields of objects, creates new objects, and collects and manages free space. It also keeps track of the length of each object and the Smalltalk class of each object.

When the interpreter is working on

an object that is in memory, the operations of fetching a field and storing a field must run fast. Both the fetch and store operations specify an object by giving its unique object pointer. The translation from the object pointer to the object's location in memory must be fast. The virtual memory spends most of its time doing this translation. A fixed correspondence between object pointers and locations in memory does not work, since almost any combination of objects may be in memory at the same time. The translation from object pointer to memory location must be highly variable.

Once in a while, the interpreter attempts access to an object that is not in memory. The virtual memory must detect the attempt, find the object on the disk, and bring it into memory. This process is called an *object fault*. Sometimes other objects must first be removed from memory to make room for the incoming object. In order to find an object on the disk, there must be a correspondence between an object pointer and that object's location on the disk. The data needed to hold this correspondence must be compactly represented, as there may be many objects in the system.

OOZE

In 1975 and 1976, Dan Ingalls and I designed and built a virtual memory to support the Smalltalk-74 system, called OOZE (Object-Oriented Zoned Environment). It then became the foundation for the Smalltalk-76 system (reference 3). The combination was very successful, and many interesting projects have been built in it. OOZE serves as an excellent illustration of a usable object-oriented virtual memory implemented entirely in software. At the end of this article, we discuss possible modifications of OOZE for the Smalltalk-80 system.

For OOZE to play the game of virtual memory well, we had to design it to fit the rules. Economics (of our existing hardware) dictated the size of

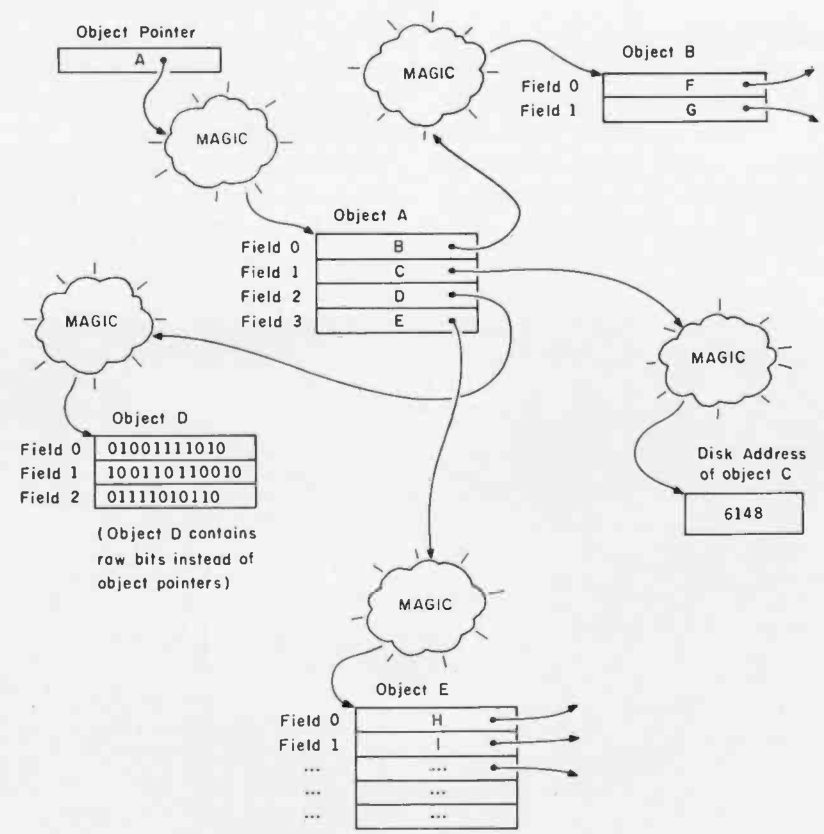


Figure 3: *Objects and object pointers (as seen by casual observers). The "magic" is the unspecified process of translating the value of the object pointer to the actual address at which the object is stored.*

main memory, the size of the disk, and the ratio of their speeds. The rules also included the things that the Smalltalk interpreter expected objects to do. We considered these and decided that in OOZE an object pointer would be 16 bits long, to fit into a machine word. We wanted every combination of 16 bits to be a legal object pointer, giving a total of 64 K objects. With a mean object size of 10 to 20 words, this was a good match to the size of our disk. To guarantee good performance during a fault on an object, we specified that any object can be brought into memory by reading, at most, one place on the disk. We did not allow one disk read to look up the disk address and another disk read to get the actual object.

The design of OOZE centers around the handling of the two important object pointer translations. Finding an object's location in memory from its object pointer must be fast. This mapping must also be flexible, since the exact combination of objects in memory changes from moment to moment. The correspondence between object pointer and memory location is a large hash table, called the *Resident Object Table* (ROT). Of the 64 K objects on the disk, perhaps 4000 are in memory at once. Each of these has an entry in the ROT. To find the location of an object, the hash routine uses the object pointer to compute where to look in the ROT. If it finds an entry whose object pointer matches, that entry also contains the memory address of the object (see figure 4). If the hash routine finds no match in the few entries it searches, the object is not in memory. The magic puffs of smoke in figure 3 depict the act of hashing an object pointer into the ROT to find its memory address.

OOZE must maintain the ROT. When an object is brought in from the disk, OOZE hashes its object pointer and looks in the ROT. When it finds an empty entry among the few possibilities, it claims that entry for the new object. Conversely, when an object is removed from memory and put back on the disk, its entry in the

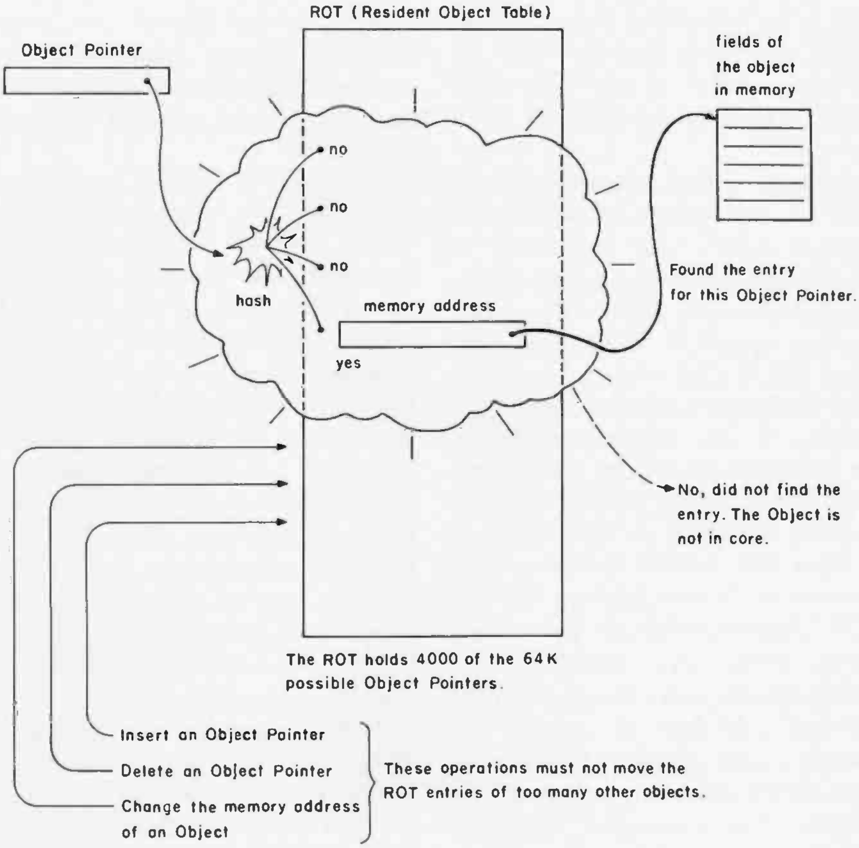


Figure 4: *Hashing an object pointer in the Resident Object Table (ROT).*

ROT is marked empty. Sometimes an object moves in memory, and its memory address in its ROT entry must be updated (as referred to in figure 4).

Hashing object pointers into the ROT to find memory addresses is the highest bandwidth operation in OOZE. If hashing were supported by special-purpose hardware, the hashing operation would not consume much time. (Many machines provide similar hardware support for paging.) In our implementations of the Smalltalk-76 system, the best we were able to do was to write the ROT hashing algorithm in microcode. In spite of this, OOZE spends a large fraction of its time hashing into the ROT. Any hash that can be avoided saves time. We modified the Smalltalk interpreter to remember the memory addresses of certain frequently used objects. During the straight-line execution of a Smalltalk method, the interpreter holds the memory address of the currently executing method, the receiver, and the object on the top of the stack. Smalltalk spends significantly less time in OOZE when hashes of these frequently used objects are circumvented.

Hashing into the ROT is optimized in yet another way. As mentioned before, the hash routine uses the object pointer to compute a series of places to search in the ROT. The entries examined form a chain, with different object pointers having different chains. These chains crisscross throughout the ROT. An entry on one chain is many times filled by an object pointer from a different chain that also uses this entry. The hash routine is searching for an entry that matches a certain object pointer. The search will succeed faster if the chain has all its own entries at the beginning and all other chains' entries at the end. The algorithm for deleting an entry from the ROT provides this optimization. After deleting the proper entry, it shuffles the remaining entries and moves them forward in their chains. Because of this strategy, the average number of entries examined to find an object in memory is only 1.8. Typically, the resident object table is 80 percent full.

Finding an Object on the Disk

The translation from an object pointer to the disk address of the object is also important. Since a list of the disk addresses of all 64 K objects would easily fill up main memory, OOZE must use a trick. Instead of object pointers being assigned randomly to objects, information is encoded in each object pointer. This is done by dividing the set of object pointers into *pseudoclasses*. The bits in the upper part of the pointer indicate to which pseudoclass that object belongs. All objects in a pseudoclass have the same Smalltalk class and have the same length. The *Pseudoclass Map* is a table that is indexed with the pseudoclass number. There OOZE finds the length of the object and its class (see figure 5). A single Smalltalk class may own as many pseudoclasses as it needs to cover all of its instances. Classes whose instances may have indexable variables, such as class *String*, own a different pseudoclass for each length or range of lengths. The pseudoclass encoding saves space because each object does not use a word to hold its class or a word to hold its length. Objects in memory in OOZE are actually two words shorter than objects in the Smalltalk-80 system.

The disk address of an object is also found by using its pseudoclass. All objects in a pseudoclass are the same length, and they are stored consecutively on the disk. By knowing which object we want within the pseudoclass, we can compute its offset from the beginning of the pseudoclass. If we know the starting disk address of the pseudoclass, we can add the offset and find the object. The Pseudoclass Map contains the starting disk address of the object's pseudoclass (see figure 5). The low bits of the object's pointer tell which object it is within the pseudoclass. This encoding allows the disk addresses of all 64 K objects to be stored in 512 words of memory.

(There are actually two additional levels of translation for the disk address. Tables for these take another 740 words).

By using the Pseudoclass Map, OOZE can find the disk address of any object from its object pointer. If it is in memory, OOZE also finds the object from its object pointer. *Thus the same object pointer serves to identify and find an object, no matter where the object is.* Because moving an object between disk and memory does not change its pointer, fields that point to the object need not change when the object moves. A field always contains the object pointer of the object to which it refers, regardless of the field's location and regardless of the object's location.

Storage Management

The management of the swapping space has several aspects. Objects are created and destroyed by Smalltalk upon request, and they are also moved in and out of memory. Each of these actions causes insertion or deletion in the ROT and allocation or deallocation in memory. Consider a class that wants to create a new instance: the new instance must receive an object pointer whose pseudoclass is already owned by that class. For this reason, we treat free instances of a class as legitimate objects. They "belong to the class" and can be swapped to and from the disk just like normal instances. Each class keeps a linked list of free instances. The class thinks that there are an infinite number of free instances on the disk, waiting to be swapped in. To create a new instance, the class merely pulls the first object off its "free list." If that object is not in memory, a fault brings it in from the disk. When a free list on the disk runs out, OOZE constructs new free instances on the disk as they are requested.

We have reduced the problem of managing memory and the ROT to the problem of swapping. Main memory has some free blocks between the areas being used for objects. These free blocks are linked together on free lists according to their size. The ROT also contains unused entries, which are marked as such. During an object fault, OOZE

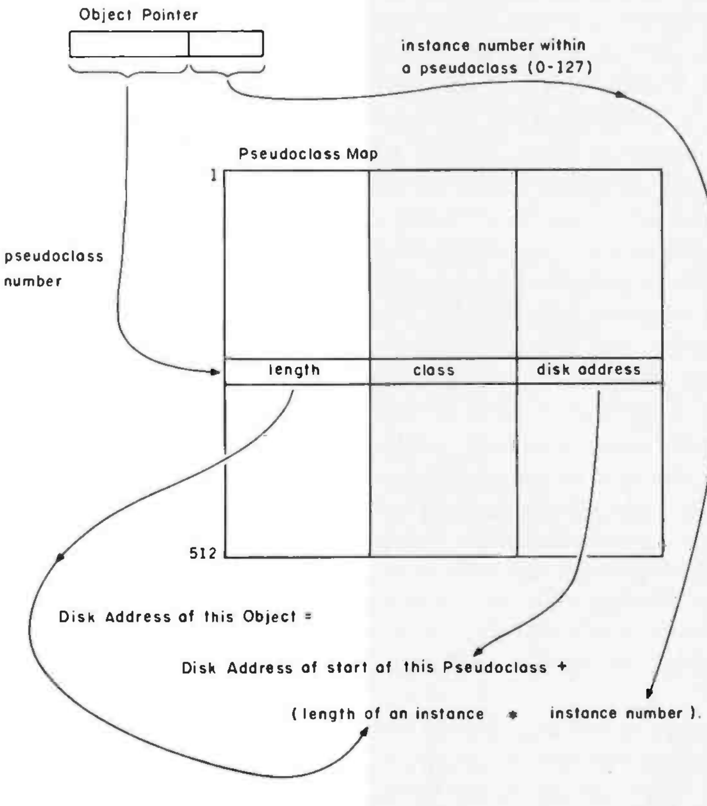


Figure 5: *Information encoded in an object pointer.*

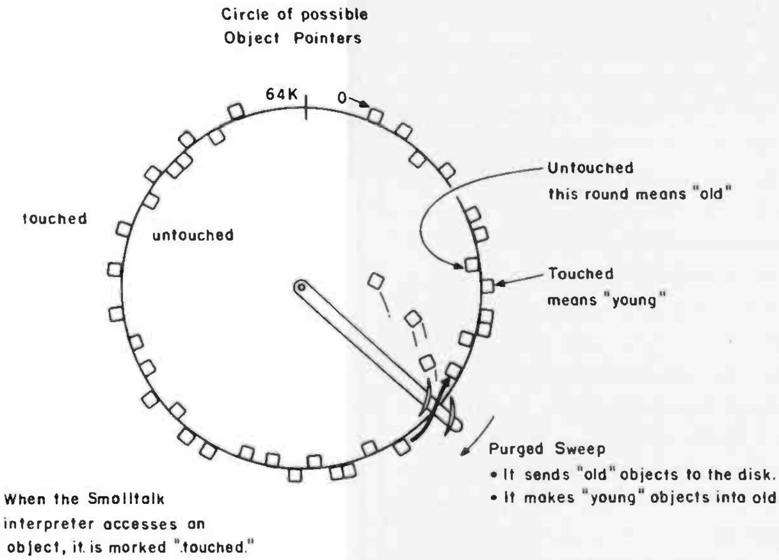


Figure 6: *The order in which objects are purged from main memory.*

claims a free ROT entry and a proper-sized block of memory for the incoming object. Occasionally, OOZE cannot find a legal ROT entry or a free block of memory that is large enough. The fault routine stops, and OOZE starts purging objects from memory by copying them to their proper places on the disk. It then frees the memory space and ROT entries of the objects it throws out. When the purge routine finishes, the fault routine resumes its work.

The purge routine must decide which objects to throw out of memory. To play the game of virtual memory perfectly, OOZE should keep the objects which will be used soon and throw out those which will not. Since OOZE cannot see into the future, it throws out the least recently used objects. Objects that have been active recently are kept, and inactive ones are tossed out. The purge routine examines objects in memory in an order determined by their object pointers. Consider the space of all object pointers to be a circle. The purge routine tours the circle, keeping objects that have been accessed since the last time around. Objects that have remained unaccessed since the routine last visited them are purged to the disk (see figure 6). Typically, it takes several calls on the purge routine to complete a tour of the circle of object pointers.

Purging objects in order of their object pointers has a very important side effect. Since all objects in a pseudoclass are consecutive on the disk, purge sends out the objects it is purging in the same order that they appear on the disk. This minimizes the movement of the disk head and saves time.

Objects that have not been changed since they came in from the disk do not have to be rewritten. They are correct as they stand on the disk. A single bit in each object in memory tells if it is "dirty" (ie: if it has been changed since it was copied to memory). If an object about to be purged is not dirty, we do not rewrite it on the disk and thus save time. This savings can be enhanced by purging in the background. Normally the purge routine runs in response to an immediate demand for space in memory. A special version of the routine runs when Smalltalk is idle and looks ahead in the circle of object pointers. It writes dirty objects to the disk and marks them as being "clean." A subsequent demand call on the purge routine will run quickly because many of the objects it wants to throw out are already written on the disk.

After each round of purging, the degree of fragmentation of memory is tested. If there are too many small blocks and no big ones, we perform a *compaction*. All objects are moved to one end of memory and all free blocks are merged into a single block at the other end. Memory addresses are updated in the ROT entries of the objects that have moved. OOZE performs this operation without using additional storage in order to keep a list of which objects have moved to which place in memory.

As a storage manager, OOZE must detect when an object is no longer being used. Like the storage manager mentioned in Krasner's article, OOZE uses *reference counting*. When the reference count of an object goes to zero, its object pointer is not in any field of any other object. At this point, it is impossible for that object ever to be accessed by the interpreter. OOZE, therefore, puts the object on its class's free list. Before doing so, however, it decreases the reference count of the object pointed to by each field of this object. In the process, more counts may go to zero, and more objects may get freed. To save space, reference counts are only four bits wide. The few objects with fifteen or more fields pointing at them are noted in a separate overflow reference count table.

Performance

An average Smalltalk-76 system with OOZE contains 40,000 objects and occupies one megabyte of disk space. In main memory, the system uses 96 K words, including 8 K words for the ROT and 40 K words for the objects that are currently swapped in. (We sometimes run with only 64 K words of memory.) On the Alto computer (see reference 1), we implement hashing into the ROT and the allocation of common objects in microcode. Performance is equivalent to a paging system with several times the swapping space. The OOZE virtual memory has allowed the Smalltalk-76 system to grow from an experiment into a system for building large and serious applications.

OOZE was designed in 1975. Several rules of the virtual memory game have changed since then. Here are some ways in which OOZE shows its age at Xerox PARC:

- Users can afford more disk and more memory. They want to build systems that contain more than 64 K objects. OOZE cannot be easily expanded beyond this limit.
- Several extensions to the Smalltalk language encourage the user to create lots of classes. OOZE has a limit of 245 classes, and many serious users have encountered this limit.

Naturally, our minds have turned to building a virtual memory for the Smalltalk-80 system with even better performance than OOZE. In 1980, a group of us at Xerox PARC designed just such a system, the *Large Object-Oriented Memory* (LOOM). Individual objects in LOOM carry slightly more overhead than objects in OOZE. (Since users can afford more memory, this is not a problem.) Besides allowing a much larger virtual space and unlimited classes, LOOM provides some new properties:

- LOOM accesses objects that are in memory simply by indexing a table, as does the resident Smalltalk-80 system. LOOM thus saves the time that OOZE spends hashing into the ROT whenever it wants a memory address. During the table lookup which finds an object's memory address, LOOM tests for the case when the object is not actually in memory. To run faster than a hash in OOZE, the test must be very simple and fast.
- LOOM is designed with the idea in mind of grouping objects on the disk. If objects that are faulted on together can be arranged into groups on the disk, the system will run faster. LOOM will be a test bed for schemes that optimize the organization of objects on the disk.

Conclusion

The goal of the virtual memory game is to make a mixture of fast and slow memory perform almost as well as if it were all fast memory. The strategy is to guess what information the processor will need soon and move it to fast memory. In an object-oriented language such as Smalltalk, the object is an excellent unit for locality of reference. Once an object is accessed, it will most likely be accessed again soon. Recently used objects have a similar degree of locality to recently used pages, and many more objects than pages fit into a given amount of fast memory.

OOZE is the first representative of the new category of object-oriented virtual memories. These systems use a construct in the high-level language, the object, as the unit of swapping. Objects as small as one field in length are swapped individually by the same mechanism used for large strings and arrays. To be a member of this category, a virtual memory must also have automatic control of swapping and automatic creation and freeing of objects. While OOZE is implemented in software, we believe that future systems will be implemented like languages: hardware assist for a few high-bandwidth operations, some microcode, and support code in machine- or high-level language. We expect that mature object-oriented virtual memories will identify groups of objects that are used together and swap them as a unit.

As the virtual memory which supports the Smalltalk-76 system, OOZE is interesting in itself. It provides the ability to address 2^N *objects* with N-bit pointers. Only currently active objects occupy memory, and they are packed end to end. This provides exceedingly good use of memory. Because the class and length of an object are encoded in the object pointer, that information does not occupy space with each object in memory. Movement of the disk head is reduced because objects are purged to the disk in the order of their disk addresses. OOZE is implemented in software without any special hardware support. It runs in an amazingly sprightly fashion and performs as well as paging systems with several times the swapping space.

The fact that Smalltalk uses objects consistently and completely allows its virtual memory to be radical in design. Object-oriented virtual memories get their power from a close coupling with the high-level languages they serve. The success of OOZE and the changing rules of the virtual memory game have inspired the design of LOOM, a larger and more efficient object-oriented virtual memory. ■

References

1. Bell, C G and Alan Newell. *Computer Structures: Readings and Examples*, New York: McGraw-Hill, 2nd edition, 1980.
2. Denning, P J. "Virtual Memory," *Computing Surveys*, Volume 2, Number 3, September 1970, page 153.
3. Ingalls, Daniel H H. "The Smalltalk-76 Programming System: Design and Implementation," *Conference Record, Fifth Annual ACM Symposium on Principles of Programming Languages*, 1978.
4. Shaw, Alan C. *The Logical Design of Operating Systems*, Englewood Cliffs NJ: Prentice-Hall, 1974.
5. Wulf, W A, et al. *HYDRA/C.mmp*, New York: McGraw-Hill, 1981, Chapter 11.

Ask BYTE

Conducted by Steve Ciarcia

Language Requirements

Dear Steve,

How much ROM (read-only memory) and programmable memory is necessary to program in languages like BASIC, FORTRAN, Pascal, and COBOL? I have read your articles in BYTE, but I haven't seen anything about this subject.

Stephen Walaski
Russellville AR

The actual amount of memory in a system is often more dependent upon economics than on need. There are systems sold with anywhere from 2 K- to 12 K-byte BASIC interpreters. Generally speaking, a "tiny" BASIC would require 2 K to 4 K bytes of ROM (read-only memory) and from 1 K to 4 K bytes of programmable memory for operator entries. A full BASIC, or extended BASIC as it's often called, usually occupies between 8 K and 12 K bytes of ROM space. Systems that have a ROM BASIC usually have 4 K to 16 K bytes of programmable memory. This is what's typically found on the Radio Shack TRS-80 and Apple II computers. In both of these systems, the programmable memory can be expanded to 48 K bytes.

For high-level languages such as FORTRAN, Pascal, or COBOL, which are compilers rather than interpreters, a disk is a necessary part of the computer system. The disk operating system can often occupy 4 K to 8 K bytes and is generally stored in the programmable memory when in use. When you load the compiler software, it can use an additional 12 K to 20 K bytes. So, for FORTRAN, Pascal, or COBOL, you may have 20 K to 28 K bytes of programmable memory occupied before you've written a single line of code.

Generally speaking, anyone wishing to use such high-level languages would be well advised to have, at a minimum, 48 K bytes of programmable memory. When operating with a disk, the ROM often becomes immaterial other than as a "bootstrap" loader, so I don't see that any particular amount is necessary. . . . **Steve**

A Tank List Job

Dear Steve,

I would like to know two things about your article "A Computer-Controlled Tank." (See the February 1981 BYTE, page 44.)

- What computer was the control program written for?
- Can the circuitry be modified for an Ohio Scientific C1P to control a small Radio Shack tank?

Ken Pataska
Kenosha WI

The control program for my computerized tank was written in standard extended BASIC. I used a Digital Group Z80-based computer to write the original program, but the same program has been run on both a Radio Shack Model I and Model III.

As far as using a similar circuit for the Radio Shack tank, I would guess that the circuit could provide on/off control, but the operation of Radio Shack's tank is very different from Milton Bradley's Big Trak. If you can live with sending out single commands and no local program storage in the tank, there should be no reason why the Radio Shack tank could not be controlled by any computer. . . . **Steve**

Modem Inquiries

Dear Steve,

I have a few questions about your August 1980 BYTE article "A Build It Yourself Modem for Under $50."

- How does one calibrate the frequencies accurately?
- Is this modem a two-line, full-duplex coupler?
- Are the kits you mentioned at the end of the article still available?
- Where can I purchase cables and connectors?

I own a Heathkit H-89 (alias Zenith Z89) with a three-port RS-232C board installed.

Brian J Mork
Holland MI

The modem presented in that article has been very popular, and many hundreds have been purchased by experimenters. It is still available from The Micromint (917 Midway, Woodmere NY 11598). It costs $39.95, plus $2 for shipping.

Regarding the electronics of the modem, it could be considered a two-line, full-duplex modem except that there are really three wires between the computer. One carries data from the modem to the computer, one carries data from the computer to the modem, and the third is the ground. You should have no problems attaching the modem to a Heath H-89; and, to my knowledge, the connectors and cables are available from Radio Shack.

As far as calibrating the frequencies: the manual provided with the Modem Kit describes calibration using standard test instruments. It also describes a fairly quick and easy way to accomplish this. The method uses an answer modem to serve as a frequency source. The Micromint also has recorded answer-modem frequencies on cassette tape available. . . . **Steve**

Multi-Dimensional Problem

Dear Steve,

We bought an Olivetti electronic typewriter that features a daisy-wheel printhead, proportional spacing, memory, etc. We were told it would "interface" with a computer. At that time we didn't even know what interface meant, but found out later. We then looked at word processors, such as Vydec and Dictaphone, that are able to show a whole page of 69 lines with 160 columns. In our ignorance, we thought that was standard, even though we saw some machines with only 80 columns by 24 lines. Not being able to afford the $8500 to $15,000 cost of a word processor, we thought that we had a line printer in the Olivetti. We decided to get a cheap computer, hook them together, and then we would have what we needed, and cheap.

That's when we ran up against the 24-line, 80-column problem. Now giving us 24 lines and 80 columns when we have hundreds of pages to lay out, with printing to go around pictures, etc, is like trying to do layouts on a sheet of 8½- by 11-inch paper with about two-thirds of it covered at all times. Sure, you can scroll up and down and sideways, but how can you judge a layout if you can't see the whole page? When you are writing, how can you remember what you said in the first paragraph when you are at the bottom of the page?

Everywhere we went, we asked why microcomputers were limited to 80 columns and 24 lines, and we got a different answer from each store. One said it was the video display that limited it, one said it was some circuit in the computer, one said it was the cheap way that computers are built, but mostly they looked at us blankly and said they didn't know. We wrote to manufacturers, to companies all over, and no one has even answered our letters, so now it's your turn: What limits the format size of the video display, and can we get a full 160-character by 69-line page on a video display using one of the less expensive computers such as the Radio Shack TRS-80?

Sam Millar
Olympia WA

Let me assure you that video displays with 69 lines by 160 characters are very unusual. Most personal computers have 16 or 24 lines of 64 characters, and most commercial units have 24 lines of 80 characters. The difference between them is not that one is a cheap computer and the other is not, but that the electronics of a 69 by 160 format is considerably more expensive than a 24 by 80 format.

When you buy a word-processing system, be aware that there are many more features than the number of lines that are displayed on the screen. The software is far more important. Frequently, word-processing systems have 16 by 64 characters on a screen, but good word-processing software will allow you to print the final copy at any line length. In fact, the system that I use has a 16-line by 64-character display, but it allows me to print out up to 132 characters per line.

One possible approach for you is to attach your Olivetti to an inexpensive personal computer and get some high-powered software. If you don't mind the time limitations involved with occasionally dumping the full document to the printer to see how it looks, it should not be too cumbersome.

Keep in mind that you get what you pay for. If you buy a $20,000 word-processing system, one of the features you can get is full-page display. However, you should be able to configure a microcomputer-based word-processing system that produces almost identical final copy for under $4000.

I hope I've helped you in some way. I do all of my writing on a word processor and I find it invaluable.
. . . Steve

Coming Across Assemblers

Dear Steve,

I can't seem to be able to find a cross-assembler for the Texas Instruments TMS-1000 microcomputer, written in FORTRAN or in BASIC, that could run on a home computer such as the Apple II. Does something like this exist? If not, do you know of a development system?

Guy Chemla
Le Kremlin Bicetre, France

Texas Instruments has cross-assemblers that run on Digital Equipment Corporation's PDP-11/70 and VAX systems and on the IBM 370. These are hardly inexpensive cross-assemblers. Texas Instruments does, however, sell a 9900-based computer that emulates and supports the TMS-1000. The hardware includes a video display, two floppy-disk drives, the chassis with 9900 processor, 64 K bytes of memory, and the software. It's called the TAM 9000 system. It costs approximately $20,000.
. . . Steve

Article Information

Dear Steve,

I would like to interface my IBM Selectric typewriter to my 16 K-byte TRS-80 Level II. I do not have the Expansion Interface, but I would like to have Selectric-quality hard copy.

Where can I get information on buying or building the necessary interfacing circuitry and other items essential for the conversion?

J W Rankin, Jr
Memphis TN

There are many different ways of attaching an IBM Selectric to a computer. You don't necessarily need the Expansion Interface to do it with a TRS-80.

Many articles have been published in the past few years concerning the Selectric. You may do better to look up a few and choose among the different ways presented.

The following is a partial list:

Interface Age, *January 1978, page 148.*
Kilobaud, *May 1978, page 64*
Kilobaud, *June 1978, page 22*
Kilobaud, *July 1978, page 40*
Kilobaud, *November 1979, page 134*
Kilobaud, *December 1979, page 144*
BYTE, *June 1977, page 46*
BYTE, *October 1977, page 174*
BYTE, *October 1977, page 36*
Kilobaud, *July 1977, page 5*

These magazine article listings came from the Periodical Guide for Computerists *by E Berg Publications, 622 E Third, Kimball NE 69145.*
. . . Steve

One Eye Toward the Past

Dear Steve,

I read your columns in BYTE and enjoy them very much. A few years back there was an article about a solid-state television-camera project called Cyclops. The heart of the system was a 32 by 32 photosensitive array. Have you heard of this device or the article?

Dennis Sprague
Great Falls MT

The article that you are interested in is indeed called "Cyclops." It was in the February, 1965, Popular Electronics. *The 32 by 32 photosensitive array is in fact a dynamic memory chip.*
. . . Steve

Off to a Slow Start

Dear Steve,

In college, the only computer I had a chance to use was a PDP-8. Since that time, I haven't had an opportunity to use a computer, with the exception of my Texas Instruments SR-56 and a TRS-80 down at the Radio Shack. I try to keep up-to-date on the microcomputer field as much as possible. I have basic knowledge of electronics and microcomputers, but the language used in BYTE is sometimes too technical for me. Could you recommend some books, articles, etc?

I have concentrated my study on Intel's 8080 microprocessor, and am interested in building a system around it, using the S-100 bus. I envision using a video display for writing programs and a cassette for storage.

My budget is limited, so I was wondering if this system is my best approach? I plan to buy bare boards and do most of the construction myself. How do I know which boards will be best for my system? Where can I get more information on system components, such as floppy disks, video-display and processor boards, etc?

Any advice would be greatly appreciated.

Douglas B Powers
North Platte NE

Many people write and ask me where to start. Generally, I have the same answer: It really depends upon what you mean by "starting." Are you just concerned with learning about microcomputers or are you trying to build a system, one board at a time, that will compete with an IBM 370? You either have to have an idea of what you want as an end result when you start, or be satisfied with learning the basics and possibly replacing that system. Your second system would attempt to be closer to the final system that you want.

As far as books, the best suggestion, obviously, is to go to a bookstore that has many technical books and look through them. Or join the McGraw-Hill Electronic Engineers Book Club—I've belonged to it for years.

I have just written a book on building your own Zilog Z80-based computer from scratch that I would like to recommend, but it is intended to teach you about the Z80. I doubt that it could ever compete with a quad-disk Cromemco System simply by the fact that much more support is needed to add disk drives, etc.

If you are intent upon starting with a system that is not of your own design, then I recommend buying blank S-100 boards and "populating" them. It is a very inexpensive path to follow and can result in a valuable system later on. Unfortunately, populating boards does not necessarily teach you much about designing a custom computer system nor does it allow you to deviate from the functions available on those cards.

One final note, this month's and last month's "Circuit Cellar" articles are about a 4- by 4½-inch tiny BASIC computer, which is offered as an inexpensive kit. All you have to do is add a video terminal (you envisioned starting with video display anyway) and immediately you would be able to start off with a tiny BASIC preprogrammed in ROM. It also has 4 K bytes of programmable memory on board. You might want to consider it as an inexpensive way of starting. . . . **Steve**■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury CT 06033
If you are a subscriber to The Source, send your questions by electronic mail or chat with Steve (TCE317) directly. Due to the high volume of inquiries, personal replies cannot be given. Be sure to include "Ask BYTE" in the address.

Books Received

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

Basic Business Software, E G Brooner. Indianapolis IN: Howard Sams & Company, 1980; 13.5 by 22 cm, 141 pages, softcover, ISBN 0-672-21751-1, $9.95.

Basic Electrical Engineering, Fifth Edition, A E Fitzgerald, D Higginbotham, and A Grabel. New York: McGraw-Hill, 1981; 17.5 by 24.5 cm, 937 pages, hardcover, ISBN 0-07-021154-X, $28.95.

Computer Language Reference Guide, Harry L Helms Jr. Indianapolis IN: Howard Sams & Company, 1980; 13.5 by 22 cm, 109 pages, softcover, ISBN 0-672-21786-4, $6.95.

Computer Networks and Distributed Processing: Software, Techniques, and Architecture, James Martin. Englewood Cliffs NJ: Prentice-Hall, 1981; 19 by 24.5 cm, 562 pages, hardcover, ISBN 0-13-165258-3, $34.

Computer Networks in the Chemical Laboratory, G Levy and D Terpstra, editors. New York: John Wiley & Sons, 1981; 16 by 23.5 cm, 221 pages, hardcover, ISBN 0-471-08471-9, $27.50.

Computer Programs in BASIC, Paul Friedman. Englewood Cliffs NJ: Prentice-Hall, 1981; 23 by 29.5 cm, 271 pages, hardcover, ISBN 0-13-165225-7, $19.95. Available in softcover for $10.95.

Database Security and Integrity, E Fernandez, R Summers, and C Wood. Reading MA: Addison-Wesley, 1981; 16.5 by 24.5 cm, 320 pages, hardcover, ISBN 0-201- 14467-0, $17.95.

Data Dictionaries and Data Administration — Concepts and Practices for Data Resources Management, Ronald G Ross. New York: AMACOM, 1981; 16.5 by 23.5 cm, 454 pages, hardcover, ISBN 0-8144-5596-4, $29.95.

History of Programming Languages, R Wexelblat, editor. New York: Academic Press, 1981; 18.5 by 26 cm, 758 pages, hardcover, ISBN 0-12-745040-8, $45.

Introduction to 8080/8085 Assembly-Language Programming: A Self-Teaching Guide, J Fernandez and R Ashley. New York: John Wiley & Sons, 1981; 17.5 by 25.5 cm, 303 pages, softcover, ISBN 0-471-08009-8, $8.95.

Introduction to Pascal for Scientists, James W Cooper. New York: John Wiley & Sons, 1981; 16 by 23.5 cm, 260 pages, hardcover, ISBN 0-471-08785-8, $19.95.

Lecture Notes in Computer Science, Directions in Human Factors for Interactive Science, H Ledgard, A Singer, and J Whiteside, edited by G Goos and J Hartmanis. New York: Springer-Verlag, 1981; 16.5 by 24.5 cm, 190 pages, softcover, ISBN 3-540-10574-3, $11.80.

Managing a Programming Project, Second Edition, Philip W Metzger. Englewood Cliffs NJ: Prentice-Hall, 1981; 16 by 23.5 cm, 244 pages, hardcover, ISBN 0-13-550772-3, $22.95.

Microcomputer Architecture and Programming, John F Wakerly. New York: John Wiley & Sons, 1981; 17.5 by 23.5 cm, 692 pages, hardcover, ISBN 0-471-05232-9, $27.95.

More TRS-80 BASIC, A Self-Teaching Guide, D Inman, R Zamorá, and B Albrecht. New York: John Wiley & Sons, 1981; 18.5 by 23.5 cm, 280 pages, softcover, ISBN 0-471-08010-1, $9.95.

Nailing Jelly to a Tree, J Willis and W Danley Jr. Beaverton OR: Dilithium Press, 1981; 14 by 22 cm, 244 pages, softcover, ISBN 0-918398-42-8, $12.95.

Structured COBOL, Fundamentals and Style, Tyler Welburn. Palo Alto CA: Mayfield Publishing, 1981; 22 by 27.5 cm, 535 pages, softcover, ISBN 0-87484-543-2, $18.95.

Systems Programmer's Problem Solver, William S Mosteller. Englewood Cliffs NJ: Prentice-Hall, 1981; 16 by 23.5 cm, 223 pages, hardcover, ISBN 0-87626-830-0, $18.95.

Telecommunications— Management for Business and Government, Larry A Arrendondo. New York: Telecom Library, 1981; 22 by 28 cm, 270 pages, softcover, ISBN 0-936648-07-4, $30.

User's Guidebook to Digital CMOS Integrated Circuits, Eugene R Hnatek. New York: McGraw-Hill, 1981; 16 by 23.5 cm, 339 pages, hardcover, ISBN 0-07-029067-9, $24.50.■

Software Received

Automatic Graphing of Functions, multifaceted function plotter for the TRS-80 Model I Level II and Model III. Cassette, $19.95. David L Modney, 4144 N Via Villas, Tucson AZ 85719.

B.I.T.S. BASIC Interactive Terminal Software, Version 3.0, intelligent terminal software for the Apple II. Floppy disk, $44.95. Software Sorcery Inc, 7927 Jones Branch Dr, McLean VA 22102.

Hyper-B.I.T.S., 1200 baud version of B.I.T.S. for the Apple II. Floppy disk, $64.95. Software Sorcery Inc (see above).

Mailing List Package Version 3.1, name and address data base for the Apple II. Floppy disk, $49.95, Software Sorcery Inc (see above).

Pool 1.5, pool table simulation for the Apple II. Floppy disk, $34.95. IDSI, 3210 Mercury, Las Cruces NM 88004.

Raster Blaster, electronic pinball simulation for the Apple II. Floppy disk, $19.95. BudgeCo, 428 Pala Ave, Piedmont CA 94611.

Super Invasion, Space-Invader-type game for the Sinclair ZX80. Cassette, $14.95. Softsync Inc, POB 480, Murray Hill Sta, New York NY 10156.■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

Clubs and Newsletters

UNIX Users Club

Uni-ops is a new group for UNIX supporters. Uni-ops publishes a monthly journal and a directory. Contact Uni-ops at POB 5182, Walnut Creek CA 94596, (415) 933-8564.

TI-99/4 Users Groups In Your Area

San Diego 99/4 Users Group, 4037 Johnson Dr, Oceanside CA 92054, (714) 758-4292. Contact Paul Yates.

Denver 99/4 Users Group, CRS Inc, 4860 Ironton, Suite E, Denver CO 80239, (303) 371-8272. Contact Rick Savage.

99/4 Home Computer Users-Group Inc, POB 95148, Oklahoma City OK 73143, (405) 787-8521. Contact Charles LaFara.

Pacific Northwest TI-99/4 Users Group, POB 5537, Eugene OR 97405, (503) 485-8796. Contact Gary Kaplan.

Pittsburgh 99/4 Users Group, 111 Teeple Ave, Donora PA 15033, (412) 379-5976. Contact R Riley.

Houston Users Group, 8922 Roos Rd, Houston TX 77036, (713) 771-3483. Contact Raymond Wells.

Washington DC 99/4 Users Group, POB 267, Leesburg VA 22075, (703) 777-2017. Contact Bill Whitmore.

Atlanta TRS-80 Users

The TRS-80 Users Group of Atlanta, Georgia, meets on the second Tuesday of each month at 7:30 PM at radio station WABE on 740 Bismarck Rd NE in Atlanta. Contact Bob Green, 1315 Rustic Ridge Dr NE, Atlanta GA 30319, (404) 451-9813.

Users Group of Floridia

The Tallahassee Amateur Computer Society meets on the second Thursday of the month. Members' computers range from HP-41Cs to Apples, Ataris, TRS-80s, and S-100 systems. Club interests are in the uses of microcomputers in education, business, and personal applications. A monthly newsletter, *Text File*, is published. Contact the group at POB 6716, Tallahassee FL 32301.

CAPE

CAPE (Capital Area PET Enthusiasts) meets monthly and discusses problems, swaps ideas and programs, and works on hardware projects. For information, contact CAPE, c/o Bob Karpen, 2054 Eakins Ct, Reston VA 22091, (703) 860-9116.

Robot Builders and Users

David Smith is starting a club in the northern New Jersey/New York Metropolitan area for those interested in building or working with robots. Even if you are too far away to attend meetings, he wishes to hear from you. David offers help to anyone with questions or problems concerning robots. Contact him at 4505 Kennedy Blvd, North Bergen NJ 07047, (201) 856-4890.

Atari Users Group

The Cincinnati area has a new group for Atari 400 and 800 users. Anyone who uses or owns Atari microcomputers is welcome. Contact Ron Shaefer, (513) 671-1671; or Tom Candelaresi, c/o Computer-Tutor, 4012 Benjamin Dr, Cincinnati OH 45245, (513) 752-7522.

DENSPET

DENSPET is an international association for the exchange of programs for the MTU 200 by 320 dot high-resolution PET accessory. Send a sample of your work or $5 and receive a sample in return plus a subscription to a newsletter and lists of available programs. Contact DENSPET, Rock House, Ballyoroy, Westport, County Mayo, Ireland.

Vancouver Users

The Vancouver TRS-80 Users Group wishes to exchange newsletters and information on homebrew software and hardware with other TRS-80 clubs. Contact them at POB 46608, Station G, Vancouver, British Columbia, V6R 4G8, Canada. Their newsletter is entitled *USR(80)*. ■

BYTE's Bugs

Incorrect BASIC Sorcery

We regret that some errors popped up in "Whose BASIC Does What?" by Teri Li (January 1981 BYTE, page 318) in the entries for the Exidy Sorcerer computer.

Checkmarks should have appeared in the Exidy column for these BASIC statements: CLEAR *n*, DEF FNY (*name*), DIM *var*(*k*), and OUT *port-num, val*. The column for the HOME command should have contained the equivalent PRINT CHR$(17), and the column for the CLS keyword should have included PRINT CHR$(12).

The Sorcerer's BASIC interpreter also contains some features not found in other versions of BASIC, but due to the nature of the article, we were not able to include many of these. In any event, when choosing a computer or translating a program, you may still need to consult the reference manuals for the computers involved.

Thanks to Robert W Harrison of Cortland, New York, and others for pointing out the errors.

Forgotten Line

One line of BASIC code was inadvertently omitted from listing 1 of "Generating Bar Code in the Hewlett-Packard Format," by Thomas McNeal. (See the January 1981 BYTE, page 148.) The line, which should be placed at the beginning of page 162, is shown in listing 1.

We regret the error.

Listing 1

```
1855 M1 = 1   !START MACHINE-
   CODE ARRAY INDEX AT 1
```

March Editorial Error

An error occurs in listing 1 (page 212) of Gregg Williams' March 1981 editorial, "Is This Really Necessary?" The second *else* in the listing, the one that precedes the statement "check-amount=0" should *follow* that statement. In other words, the check amount should be set to 0 only when no table match has been found. Our thanks go to Mr M F Fay of Cincinnati, Ohio, for pointing this out. ■


A SHOPPERS DREAM
BY TOM SLOAN
HONEY, WOULD YOU GO SHOPPING FOR DINNER TONIGHT.
SURE THING SWEETIE PIE.
CAN I BORROW YOUR TINY COMPUTER?
HERE IT IS HONEY BUNCH
FOODLA
10¢ LBS
HMM?...
GIANT ECONOMY SIZE
EXTRA STRENGTH
NEW AND IMPROVED
TIN
1001 USES
10¢ OFF
LETS SEE... ONE BOX IS 13 OZ. AND COSTS 1.99, THE OTHER IS 29 OZ. AND IS A BUCK 2.80. AND WE HAVE 6 OZ. AT HOME STILL AND WE ONLY USE 2 OZ. A YEAR AND I HAVE ONLY $10.00 TO SPEND, AND INFLATION IS 12% AND..UH...
...NUTS! THIS IS GETTING TOUGH.
I BETTER CALL MY WIFE AND ASK HER ABOUT STRING VARIABLES.
PICKLES
27
PRINT "X=";ASC(A$)
OK GUYS, HE'S GONE.
FORA=1TO100:PRINT:NEXT
WE'VE GOT TO WORK FAST
:CLS
I'LL CONNECT UP THIS MINI-MODEM.
HERE'S THE PHONE.
OK, HE NEEDS A DOZEN EGGS, TOMATOES, CARROTS, TUNA STICKS...
DAG-NABIT! THE PHONES BEING USED.
...AND THAT SHOULD BE ALL OF IT.
OK. LETS GET GOING.
NEXT!
OH OH! HE'S COMING BACK.
WHATS GOING ON?
EVERYONE COOL IT.
WOW! THIS IS EXACTLY EVERYTHING I NEED.
GEE HONEY, YOU REALLY DID A GOOD JOB OF BUYING THE GROCERIES.
THAT'S WHAT YOU THINK!
TOM SLOAN

Event Queue

August 1981

August-October
Writing for Results: A Course for Computer Professionals, various sites throughout the US. These courses are intended to help those in the computer field write clear and simple prose. Fees range from $490 to $660 for the weekend courses. For schedules of cities and dates, contact American Management Associations, 135 W 50th St, New York NY 10020, (212) 586-8100.

August 3-7
Workshops in Digital Sound Synthesis and Processing, Digital Music Systems Inc, Boston MA. These courses will provide a hands-on introduction for electronic-music composers and performers, recording engineers, psychoacoustic researchers, and others working in the digital-audio field. Fundamentals of digital audio, unit generators, automated synthesis and processing, nonlinear techniques, digital delay, filtering and reverberation, digital-audio hardware, and future trends in digital audio will be covered. The fee is $300. Contact Digital Music Systems Inc, POB 1632, Boston MA 02110, (617) 542-3042.

August 10-12
Financial Fundamentals Using Computers, Boston MA. This seminar will focus on the nonfinancial manager's needs to understand the fundamentals of accounting and finance in a computerized environment. Attendees will learn to use Apple II microcomputers for financial procedures and transactions. Registration fees are $795. Contact the American Institute for Professional Education, Carnegie Bldg, 100 Kings Rd, Madison NJ 07940, (201) 377-7400.

August 10-14
Reliability and Life Testing, UCLA, Los Angeles CA. Engineers and scientists involved with the reliability, design, product assurance, quality, and safety aspects of components, equipment, and systems are invited to attend this course. The fee is $775. Contact the Short Course Program Office, 6266 Boelter Hall, UCLA Extension, Los Angeles CA 90024, (213) 825-1047.

August 10-14
Workshops in Digital Sound Synthesis and Processing, Digital Music Systems Inc, Boston MA. For details, see August 3-7.

August 17-21
Workshops in Digital Sound Synthesis and Processing, Digital Music Systems Inc, Boston MA. For details, see August 3-7.

August 24-27
Software Design, Reliability, and Testing, Sheraton Motor Inn, Lexington MA. This four-day seminar for engineers, programmers, and technical managers examines concepts and techniques for developing and testing reliable, cost-effective software. Management concerns and recommended policies are also addressed. Tuition is $600, which includes course notes, luncheon, refreshments, and an evening reception. Contact Professor Donald D French, Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158, (617) 964-1412.

August 24-28
The Seventh International Joint Conference on Artificial Intelligence, University of British Columbia, Vancouver BC, Canada. This conference will examine computer applications of medical diagnosis, computer-aided design, robotics, programmable automation, speech understanding, vision, and other related topics. A tutorial program and artificial-intelligence exhibits will also be presented. For more information, contact Louis G Robinson, American Association for Artificial Intelligence, Stanford University, POB 3036, Stanford CA 94305, (415) 495-8825.

August 25-27
BASIC: A Computer Language for Managers, Sheraton Centre and the New York Hilton, New York NY. This course is for managers needing to learn the fundamentals of computers and programming. Programming basics, simple examples of BASIC programs, problem solving, and simulation modeling will be covered. Contact American Management Associations, 135 W 50th St, New York NY 10020, (212) 586-8100, ext 514.

August 25-28
Vector and Parallel Processors in Computational Science, Chester, England. The conference will concentrate on hardware, software, algorithms, applications, and case studies concerning vector and parallel processors. For details, contact Mrs S A Lowndes, Science Research Council, Daresbury Laboratory, Daresbury, Warrington, WA4 4AD, England.

August 26-29
The Fifth Annual National Small Computer Show, New York Coliseum, New York NY. Daily lectures and a five-hour executive-only seminar will be featured. The executive seminar is designed for upper-level managers who need an introduction to the understanding, acquisition, and use of computers in business. The registration fee for the show is $10 per day. The seminar for executives is $200, which includes all materials and show registration. For information, contact the National Small Computer Show, 110 Charlotte Pl, Englewood Cliffs NJ 07632, (201) 569-8542.

August 28-30
Personal Computer Arts Festival (PCAF '81), Philadelphia Civic Center, Philadelphia PA. PCAF '81 will include technical sessions, demonstrations, and exhibits. Also featured is the annual computer-music concert and computer-graphics film and video show. PCAF '81 is being held in conjunction with the Personal Computing Show '81. For complete details, contact PCAF '81, POB 1954, Philadelphia PA 19105.

September 1981

September-December
Four Seminars from Management Information Corporation (MIC), various sites throughout the US. These seminars are designed for businesspeople who need an introduction to system selection and use. For a complete schedule of seminars, fees, and locations, contact Carol Bell, c/o MIC, 140 Barclay Ctr, Cherry Hill NJ 08034, (609) 428-1020.

September 1-3
Computerized Office Equipment Expo (COEE), Civic Center, Atlanta GA. COEE provides a forum where the owners and executives of small and large businesses can learn about office automation. Office equipment for word processing, record storage and retrieval, and micrographics will be exhibited. Contact Cahners Exposition Group, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

September 9-11
Eurographics '81, Technical University, Darmstadt, West Germany. Almost seventy exhibitors are expected to attend this computer-graphics show. Detailed information can be obtained from Diebold Deutschland GmbH, Attn: Dr H J Grobe, Feuerbachstrasse 8, D-6000 Frankfurt/Main, West Germany.

September 10-13
Mid-West Computer Show, McCormick Place, Chicago IL. This show features office systems, data- and word-pro-

cessing equipment, telecommunications equipment, microcomputers, computer graphics, peripherals, and other related supplies. For information, contact the National Computer Shows, 824 Boylston St, Chestnut Hill, MA 02167, (617) 739-2000.

September 14-17
Software Info '81, Merchandise Mart Expocenter, Chicago IL. The conference theme is "Productivity Through Packaged Software." Fran Tarkenton will be the keynote speaker. For more information, contact Software Info, 1730 N Lynn St, Suite 400, Arlington VA 22209, (703) 521-6209.

September 14-17
Productivity—An Urgent Priority, Capital Hilton Hotel, Washington DC. This conference is intended to provide a focus on productivity throughout the computer industry. General inquiries for program information should be addressed to Compcon Fall '81, POB 639, Silver Spring MD 20901, (301) 589-3386.

September 15-17
WESCON/81, Brooks Hall, Municipal Auditorium, and Hilton Hotel, San Francisco CA. Sessions on communications, components and devices, computer and microprocessor hardware and software, office automation, and memory systems will be presented. Exhibits of computer equipment and related products will be featured. Contact Electronic Conventions Inc, Suite 410, 999 N Sepulveda Blvd, El Segundo CA 90245, (213) 772-2965.

September 16-18
Diagnostic Software: Planning and Design, Boston MA. This seminar is directed toward the design, test, and diagnostic engineer and manager. Design examples, lectures, informal sessions, and individual and group diagnostic-programming sessions are part of the course. Tuition is $495. Contact Professor Donald D French, Institute for Advanced Professional Studies, One Gateway Ctr, Newton MA 02158, (617) 964-1412.

September 16-18
The Engineer as a Communicator, Crystal City Marriott, Arlington VA. This conference will feature discussions on communications technology, information gathering, storage, and retrieval, using computers in technical communications, and other related topics. Contact Dr Daniel Rosich, School of Business Administration, University of Connecticut, Stamford CT 06903, (203) 322-1673.

September 24-25
Microprocessors: Hardware, Software, and Applications, Worcester Polytechnic Institute, Worcester MA. Among the courses to be offered are hardware and software basics, selection and evaluation of microprocessors, memory and input/output systems, multiprocessor systems, real-time-system design, and debugging and circuit testing. For more information, contact Ginny Bazarian, c/o Worcester Polytechnic Institute, Worcester MA 01609, (617) 753-1411.

September 24-27
Mid-Atlantic Computer Show, Washington Armory, Washington DC. For details, see September 10-13.

September 30-October 2
Data and Telecommunications Expo '81, Rhein-Main-Halle, Wiesbaden, West Germany. This exhibition and conference will cover all areas of technology in data handling and distribution and telecommunications networks in office environments will also be discussed. Contact Cahners Exposition Group, 222 West Adams St, Chicago IL 60606, (312) 263-4866. In Europe, contact Kiver Communications S A, U K Brtanch Office, Millbank House, 171/185 Ewell Rd, Surbiton, Surrey, KT6 6AX, England.

October 1981

October 7-21
The 1981 Far East Computer Tour, Hong Kong, Japan, Korea, and Taiwan. This tour group visits various computer-related conferences and exhibitions throughout the Far East. Transportation for this three-week tour, plus shows, meals, and other items are included in trip packages, ranging in price from $2290 to $3095. For more information, contact Terry Butler, Commerce Tours International Inc, 870 Market St, Suite 742-744, San Francisco CA 94102, (415) 433-3072.

October 12-15
Information Management Exposition and Conference/ INFO 81, Coliseum, New York NY. Discussions on prepackaged, customized prepackaged, and custom-designed software will complement hardware and software exhibits. For more information, contact Clapp & Poliak Inc, 245 Park Ave, New York NY 10167, (212) 661-8410.

October 19-23
Systems 81, Munich, West Germany. Computer systems and their applications will be featured. Additional information is available from Kallman Associates, 30 Journal Sq, Jersey City NJ 07306, (201) 653-3304.

October 20-22
Computertized Office Equipment Expo/Southwest, Astrohall, Houston TX. Approximately 100 exhibitors will present office equipment and supplies, including word-processing systems, at this show. Contact Industrial Scientific and Conference Management Inc, 222 W Adams St, Chicago IL 60606, (312) 263-4866.

October 21-24
Computa 81, World Trade Center, Singapore. This international show attracts professionals and buyers from Hong Kong, India, and Sri Lanka. Additional information can be obtained from Kallman Associates, 30 Journal Sq, Jersey City NJ 07306, (201) 653-3304.

October 25-30
The Information Community: An Alliance for Progress, Washington DC. This conference provides a forum for professionals in information technology, research operations, management, and education. The technical program includes presentations, contributed papers, special-interest group sessions, exhibits, and more. Contact the American Society for Information Science, 1010 16th St, NW, Washington DC 20036, (202) 659-3644.

October 27-29
Computer Graphics 81, Regent Centre Hotel, London, England. Conference topics include graphics systems hardware and software, animation, image processing, simulation, business graphics, and home graphics. An equipment exhibition will also be presented. Contact Online Conferences Ltd, Argyle House, Northwood Hills, Middlesex, HA6 1TS, England. ■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc, notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, 70 Main St, Peterborough NH 03458. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

ADVANCED APPLICATIONS
Advanced Applications
Business Analysis
Calculator (BASIC Program)
Data Base Management
Electronic Engineering Computations
Files
Mathematical Computations
Mechanical Engineering Computations
Program Debugger
Programming—Basic Language
—Cobol Language
—Cross Assemblers
—Fortran Language
—RPGII Compiler
Programming Guides
Reference Manuals
Simulation of Pollutants
Statistical Computations/Analyses
System Commands

BUSINESS & MONEY MATTERS
Aid, Financial for College
Bartering Goods, Services
Business
Business Analysis, Planning:
- Analysis Programming
- Annuities Analysis
- Aware Financial Service
- Charting
- Planning, Forecasting

Business Programs:
- Amortization of Loans
- Amortization of Loan UNK Term
- Annuity Debt Payment
- Balancing Checkbook
- Capital, Cost of Equity
- Cashflow, Present Value
- Commission, Sales Report
- Depreciation Schedule
- Equipment, Lease vs Purchase
- Equity Capital, Cost of
- Interest, Bonds
- Interest, Loans
- Sales Commission Report

Business News
Business Outlook, Current
Business Outlooks, Previous
Company Profiles, Reports
Consumer Behavior
Credit Cards
Daily Investor
Economy
Economic Planning
Economist
Electronic Funds Transfer Systems
Employee Owned Companies
Executives
Fast Food Industry
Financial Advice (Raylux)
Financial Commentary, Current
Financial Commentary, Previous
Financial Model for Forecasting
Financial Interpretation
Industrial & Occupational Hazards
Industrial Production Index
Information on Demand (research)
Interest, Money
Int'l Monetary Systems
Jewels & Jewelry
Labor & Management
Labor & Politics
Management
Money Savers
Office Equipment
Pensions
Raylux (financial advice)
Stock, Bond, Commodity listings
Trading Business Goods, Services

COMMUNICATIONS INDUSTRY
Cable Television
CBS News
Citizens Band Radio
Newspapers
Personal Computers
RKO Forum
Television
Writing & Writers

CONSUMER/SHOPPING
Automobiles
- Safety & Defects
- New Models
- Sales
- Electric Vehicles
- Gas Rationing
- Synthetic Fuels

Beauty & Fashion
Collectables
Collectors/Collections
Consumer Issues
- Behavior
- "Consumer Question Box"
- Consumer Reports
- Credit
- Credit Cards
- Protection

Decorating & Design
- Antiques
- "Decorating"
- "Interior Decorating"
- Painting & Decorating

Food & Cooking
- "Food"
- Food Additives
- "Slim Gourmet"
- Trading of goods & services
- WINE (31 separate listings)

"Growing Older" (advice)
Health Care Advice
Home Repairs
- Energy Savings
- "First Aid for Ailing House"
- Hardware
- Solar Energy

Inventions & Inventors
Shopping & Trading
- Bartering
- Catalog (of goods)
- Discounts
- Equipment, Lease vs Purchase
- "Family Shopper"
- Generic vs Brand Names
- Joining a Merchandise Service
- Merchandise
- Money Savers
- Premiums, Coupons
- Price Quotes
- Shopping at Home
- Trading of Goods & Services

Office Equipment
Purchase vs Production Comparison
Software
Toll-free Numbers (over 90 listed)

CURRENT NEWS
Anderson, Jack
Domestic News
Foreign News
International News
National News
News (50 states)
New Focus
News Summary
Tomorrow's News Today
United Press International
United States Nat'l News

EDUCATION
Addition
Aid, Financial for College
Aphorisms
Art Objects
Arts
Book Reviews
College Admissions
Counting Lesson
Days (spelling lesson)
Education
English Lesson
Esperanto Lesson
French Vocabulary Drill
Geometry Lesson
German Adjectives
German Vocabulary Drill
Gifted Students
Grammar (story fun)
Greek Root Exercises
Information on Demand (Research)
Italian Vocabulary Drill
Library
Mathematics
Metric System
Numbers
Poetry (random)
Quotations
Random Sonnets
Remedial Education
Sayings
Spanish Vocabulary Drill
Spelling Lessons
Translation Services
Writing & Writers
Wisdom of the Ages

ENERGY
Gasoline Rationing
Energy (22 savings subjects)
Nuclear Wastes
Regulatory Agencies
Solar Energy
Synthetic Fuels

ENTERTAINMENT/HOBBIES
Absurdity
Aces on Bridge
Adventure
Amusement
Arts
Astrology
Cinema (reviews)
Collectables
Collectors/Collections
Computer Conferencing
Dating
Drawings
Hobbies
Horse Racing
Humor
Marriage Analysis
Mockridge, Norton
Movie Reviews
Music
Photography
"Pop Scene"
Previews (TV)
Q & A (TV)
Satellite TV
Science Fiction
Sewing
Sounds (rock)
Single Persons
Soap Operas
SOURCEWORLD Magazine
Stereo/TV
"Stitch-N-Time" (sewing)
Television—Features, Previews, Quiz
Time of Your Life (Aging)
Unidentified Flying Objects
Video
Wines
Words, Wit & Wisdom
"Wry Comment"

GAMES & TRICKS
Ace—(trick)
Backgammon
Blackjack
Bridge
Card Tricks
Casino 21
Checkers
Chess
Children's Programs
Civil War (game)
Coin Flipping
Craps
Danger
Decks (cards)
Draw (trick)
Farmer (game)
Fill in Letters (game)
Flipping Coins
Football (game)
Golf (game)
Guess Computer's Number (game)
Hangman (word game)
Horserace (game)
I-Ching
Intelligence Test (game)
IQ Test (game)
Joker (trick)
Life (game)
Lunar Landing (game)
Magic
Market A Product (game)
Mastermind (game)
Maze Generation (game)
Mind Reading (tricks)
Nim (game)
Patrol Streets (game)
Pica-Centre (game)
Pits (game)
Poker (game)
Posters (game)
Puzzles
Rocket Game
Rule Sumeria (game)
Score Four (game)
Selling Product (game)
Sinners (game)
Slot Machine (game)
Sonnets (game)
Statistics (date game)
Star-Trek (game)
Target Practice
Tic Tac Toe (game)
Tic Tac Toe in Spanish
Toro (bullfight game)
Tricks
Vegas (game)
Wumpus Hunt (game)

GOVERNMENT
Anderson, Jack
Armed Services
Arms Control
Business Role in Politics
Census
Democratic Nat'l Convention
Equal Rights Amendment
Federal Revenue Sharing
Intelligence Services
Issue and Debate
Labor & Management
Labor & Politics
Lobbying & Lobbyists
Loftan, John
Medicare
Metric System
National Health Insurance
Political Action Report
Population—Vital Statistics
Postal Service
Presidential Elections (1980)
Privacy
Regulatory Agencies
Republican Nat'l Committee
Social Security
Taylor, Henry
U.S. Population Stats
Veterans
Volunteer Military
Washington, D.C.:
- Capitol News Service
- Editorial Summary
- Emergency Numbers
- "Everything Else"
- Hotline
- House Committee Hearings
- Meetings, Conferences
- People, Places, Things
- President's Schedule
- Senate Committee Hearings

Whistle Blowers

HEALTH
Abortion
Acupuncture
Alcoholism
Aylward, Jim (Journal)
Birth Control
Care
- Arthritis
- Chest Pain
- Childhood Rashes with Fever
- Common Skin Problems
- Digestive Tract
- Ear, Nose & Throat
- Eye Problems
- For Women Only
- Nervousness & Nerve Problems
- Poisons
- Urinary Tract

All these programs

Now you can get up-to-the-minute news and business information, current market quotes and financial advice, and over 1,000 other valuable programs on your microcomputer, data terminal, or communicating word processor. You can even make hotel and airline reservations, send electronic mail across the country instantly, carry out research and shop at home.

All these programs and more are available with THE SOURCE℠, America's first information and communication utility. The Source is a product of Source Telecomputing Corporation, a subsidiary of The Reader's Digest Association, Inc.

With The Source you can have a UPI news service right in your office or home with international, national, local and business news available minutes after release. The Source also gives you regularly updated market reports, portfolio management systems, business accounting programs, plus educational and entertainment programs for all members of the family. Many Source programs have keyword search capability.

The Source is economical to use.

All the programs currently offered through The Source are available for an initial, one-time subscription fee of $100. The connect time is an unbelievable 7 cents per minute during evenings and weekends, 25 cents per minute on weekdays, and 4½ cents per minute from after midnight to 7 A.M.* You can be on-line with The Source quickly, for the cost of a local phone call in over 300 cities.

The Source can increase the storage and programming capacity of your microcomputer to infinity.

You can now store your own data and program your own systems directly on The Source's mainframes. Basic, Cobol, Fortran, RPG II and assembly language are all available. The cost is 50 cents per month for 1K block of storage. That's it! All other costs are covered in the subscriber fee plus the normal connect time costs. As for

Drug Addiction
Drugs & Drugstore
Food Additives
Health & Smoking
Health Care Advice
Industrial & Occupational Hazards
Marijuana
Medical
Medicare
Mental Health & Disorders
National Health Insurance
Obstetrics
Pregnancy/Maternal
Saccharin
Sleep
Therapy for Addicts
Transplants
Vitamins
LAW
Cases Accepted
Cases Refused
Fair Trial vs Free Press
International Law
Legal Profession
"What's the Law"
White Collar Crime
REAL ESTATE/HOME:
About Real Estate
"Aid for Ailing House"
Amortization of Loans
Amortization of Loan, UNK Term
Apartments (rent)
Home:
Ailing
Buying
Decorating
Loans
"Household Hints"
Selling
Interest, Loan
"Interior Decorating"
Loan:
Installment Interest
Amortization, UNK Term
Amortization Schedule
Malino, Emily (home decorating)
Mortgage Analysis
Moving Plans
Painting & Decorating
Property for Rent
Property for Sale
Property for Swap
Property Wanted
Real Estate
SCIENCE & TECHNOLOGY:
Advanced Applications/Programs
Aircraft
Amperage
Angle, Quandrant Ref
Base Conversion
Bessel Function (statistics)
Binomial Coefficients (statistics)
Binomial Probabilities (statistics)
Chi-Square (statistics)
Circular Path Speed
Cloning
Coefficients, Binomial (statistics)
Commands
Coordinates (polyhedra: statistics)
Correlation Coefficient (statistics)
Cross Assemblers
Data Computation (statistics)
Denominator
Dispersion Measures (statistics)
Electric Vehicles
Electrical Engineering
Engineering
Exobiology
Factorial (statistics)
Fall Distance (statistics)
Filter Capacitor Values (statistics)
Filter Design (statistics)
Fortran
Geography
Genetic Engineering
Greatest Common Denominator
Greek Root Exercise
Ham Radios
Hardware
Inertia Moment
Inventions & Inventors
Least Squares (statistics)
Manuals
Markov Chain (statistics)
Mathematics
Mean Computation (statistics)
Mechanical Engineering
Medical
Metric System
Molecule Thickness
Motion Graphs
Nuclear Wastes
Ohm's Law (statistics)
Parabola Graphing (statistics)
Perfect Number?
Personal Computers
Pet Computers
Poison (statistics)
Pollutants
Primes (statistics)
Probabilities (statistics)
Programming Manuals
Research
Science & Engineering
Science & Technology
Smithsonian Exhibits
Software
Space Shuttle
Statistics
Transplants
Unidentified Flying Objects
Weather
SOCIAL AFFAIRS
Adolescence
Adoption
Age (elderly)
Alcoholism
Battered Wives
Behavior
Birth Control
Black Studies
Capital Punishment
Child Abuse
Child Custody
Child Support
Divorce
Drug Addiction
Equal Rights Amendment
Etiquette
Family Life
Gasoline Rationing
Homosexuality
Labor & Management
Labor & Politics
Life Styles
Marijuana
Prostitution
Religion & Churches
Retirement
Sex Crimes
Single Persons
Social Commentary
Social Contacts
Teenagers
Teen Forum
Therapy for Addicts
"Time of Your Life" (elderly)
White Collar Crime
Women's Liberation
SPORTS
Baseball
Basketball
Box Scores (sports)
Football
Olderman (sports)
Olympic Games (1980)
Sports (50 states)
STOCKS & BONDS/INVESTMENTS
Advice
American Stock Exchange:
Daily Listing
Daily Prices
Ten Most Active
Weekly Comp. Prices
Wknd. Bond Prices
Bonds:
AMEX Daily Listing
Fed. Land Bank, Dly.
NYSE Daily Listing
Treasury OTC, Dly
World Bank, OTC, Dly
Treasury, OTC, Wknd.
Bond Yield
Bond Price, Accrued Interest
Boston & Northeast OTC Exchange
California North & South OTC Exchange
Chicago Mercantile OTC Exchange
Citrus
Closings
Commodities
Dividends, Earnings
Dow Jones
Annual Stock Avgs.
Market Indexes
Earnings Dividends
Earnings Reports
Exchange Rates, Foreign
Federal Land Bank Bonds
Foreign Exchange Rates
Funds, Mutual
Futures, Treasury Bills
Futures & Options
Cotton Futures
Lumber and Plywood Futures
Orange Juice Futures
Potatoes Futures
Sugar Futures
Glossary of Stock Investment Terms
Gold:
Stories
Spot Prices
Indexes, Stock Market Dly. Avgs.
Interest, Bonds
Jewels & Jewelry
Metals:
NY/London Mkt Prices
NY/Chicago Mkt Prices
Midwest OTC Exchange Market
Moody's Index
Money Market News and Comments:
Futures
Opening Lead
Noon Lead
Afternoon Lead
Night Lead
Markets at a Glance
Stock Pulse
NYSE Trends
What the Market Did
Mutual Funds
Mutual Funds: Prices
Summaries
New York Stock Exchange:
Bonds
Dly Prices
Wknd: Comp. Prices
Notes, Treasury
Options & Futures (AMEX, CBOE)
Over-the-Counter Exchange Markets
Daily:
Banks & Insurance
Closings (Complete)
Gainers & Losers
Index, NASDAQ
Industrials
Weekend:
Gainers & Losers
NASDAQ, Weekly
Boston & Northeast:
Selected Stocks
Closing Prices
California North & South
No.—Selected OTC
So.—Selected OTC
Chicago Mercantile: Quotations
Midwest:
Price
Weekend
Pacific:
Advs. & Dealings
Closing
Most Active
Options
Pacific OTC Exchange
Platinum, Prices
Silver:
Coins
Spot Prices
Stories
Stocks:
Daily Avgs, 11:00 A.M.
Daily Avgs, 12:00 A.M.
Daily Avgs, 1:00 P.M.
Daily Avgs, 2:00 P.M.
Daily Avgs, 3:00 P.M.
Daily Avgs, Closings
Daily Avgs, Hi's & Lows (NYSE)
Daily Avg, Market Indexes
Weekend Summaries (NYSE)
Weekly Comp. Prices (NYSE)
Annual Avgs, Dow Jones
Standard & Poors: Hourly Index
Toronto OTC Exchange
Selected Stocks, Weekend
Treasury:
Notes, Daily Lstg
Bonds, OTC, Daily Lstg
Bonds, OTC, Weekend
Unistox Report Index
World Bank Bonds, OTC
SUBSCRIBER COMMUNICATION
Advertising (personal classified)
Announcements (from The Source)
Apple Computer Information
Bulletin Board
CHAT (direct communication)
Clubs
Computer Conferencing
Contents of The Source
Correspondence
Dating
Express (sends letters with express alert)
Gripes (about The Source)
Help Wanted
Mail
Personal Calendar & Notebook
Services
Suggestions (for The Source)
User Directory (for The Source)
Users On-Line
TAXES
Assets
Calculation of Income Stmt
Capital Gains Tax
Computing Taxes
Contributions
Credits
Debts
Deductions
Dependents
Depreciation Schedule
Donations
Expenses
Income Statement, Pro Forma
Income Tax
Joint Tax Filing
Taxes
TRAVEL & LEISURE
Airline Schedules
Airline Toll-Free Numbers
Alert (astrol/travel)
Bargains (travel)
Car Rentals (toll free no.)
Climate (geography)
Customs (tariff)
Dining Out
Fairs & Festivals
Flight Reservations
Flight Schedules
National Parks
Restaurants & Wine
Restaurants
Ski Resorts (toll free nos.)
Smithsonian Exhibits
Tour Packages
Travel Plans
Vacation Specials
Weather
Weekend-Getaway

etc.

and more for $100.

response time, it's faster than ever, thanks to The Source's new bank of larger, mainframe computers.

Today, The Source is faster and better than ever.

If you're not a subscriber to The Source already, send in the coupon and we'll send you our free Information Kit. Or call (800) 336-3330 from 8:30 a.m. to 6:30 p.m., EST, for further information.

Join The Source now and you'll have an incredible information utility system at your fingertips for just pennies a day.

*Usage Fees: $4.25/hour or 7.1¢/minute on weekends and evenings from 6 p.m. to midnight. $15/hour or 25¢/minute on weekdays from 7 a.m. to 6 p.m. $2.75/hour or 4.6¢/minute after midnight to 7 a.m. $10 minimum monthly charge. Rates applicable to 300 baud only in the 48 contiguous United States.

Please send me your free Information Kit. I'm ready to see what $100 can do for my system.

Name ____________________
Address ____________________
City ____________ State ________ Zip ________
Phone ( ) ____________________
My current equipment is ____________________
(manufacturer)
____________________ , ____________________
(model # & description) (specific configuration)

Send to: Source Telecomputing Corp., 1616 Anderson Road, McLean, Virginia 22102. (703) 821-6660.

THE SOURCE
AMERICA'S INFORMATION UTILITY

Circle 413 on inquiry card.

Microsoft Editor/Assembler Plus

Keith Carlson, 43 McDill Rd, Bedford MA 01730

When I opened the manual for Microsoft's Editor/Assembler Plus, I felt like crying. I had just spent a hard-earned $29.95 for Radio Shack's original Editor/Assembler, and now I felt cheated. It has been my experience with electronics that no matter what I buy, the price goes down soon after I buy it. Perhaps the old cliché *is* true: all things come to he who waits.

The price for Editor/Assembler Plus is actually the same as the earlier version, but its value has increased enormously. This is what prompted me to consider wreaking havoc on nearby inanimate objects. As I read the manual and discovered its extensively upgraded features, however, my resentment and frustration turned to delight. Microsoft had turned my Level II 16 K TRS-80 into a full-blown assembly-language development system, something that Radio Shack had failed to do.

The features of Editor/Assembler Plus are those of a much larger machine. There are some limitations, but the result satisfies my need to economize by squeezing every last drop of value out of my TRS-80.

It helped that one of the authors of Editor/Assembler Plus, Mark L Chamberlin, wrote Radio Shack's Editor/Assembler. Both authors have previous experience with the TRS-80 and probably were involved with the design of Level II BASIC.

After all the plaudits, however, some problems remain. One of the major problems is documentation.

Documentation

The documentation, fine as far as it goes, is definitely not enough. The manual was written by William Barden Jr, who has written several other books on both the TRS-80 and the Zilog Z80 microprocessor. Helpful hints and warnings are printed throughout the manual. They deal with the problem of printing a screen full of information in a book that measures only 4¾ by 6½ inches. There are also copious notes explaining that Shift-Up Arrow was printed as $ on the screen in the Z-BUG debugging mode. The text is simple and easy to read with plenty of illustrations and examples included. The only problem is the assumption that the reader has had previous experience with Radio Shack's Editor/Assembler and assembly-language coding.

In fact, that assumption pervades Microsoft's attitude about Editor/Assembler Plus. When I bought Radio Shack's Editor/Assembler, I received all the goodies, such as the instruction-set data, *Z80 Micro-Reference Manual*, and some handy ROM (read-only memory) entry points. All these are conspicuously absent from Editor/Assembler Plus. People having an interest in assembly-language programming would buy Editor/Assembler Plus instead of Editor/Assembler. Doing so, though, would leave them wondering where the rest of the documentation was. Luckily, auxiliary documentation is available at low cost elsewhere (Radio Shack's new T-BUG manual, for example). However, this kind of information should have been included by Microsoft.

Other documentation is also needed. There is *no* documentation concerning Editor/Assembler Plus itself. The manual doesn't even give the load address, ending address, or entry address! If it weren't for the errata sheet included, it would be irritating and time-consuming to find the proper addresses needed to make a backup copy. A backup copy is a necessity, especially when you are using ordinary cassette tapes. It would be even more convenient to have certain entry points available to make modifications, such as adding a hard-copy print routine, which is sadly lacking in Z-BUG.

In these times of software piracy, it is easy to understand why Microsoft is highly protective of its software. But it doesn't explain why it won't even sell documentation! In short, the existing documentation is adequate for anyone who is merely an end user of Editor/Assembler Plus, as long as the additional Z80 instruction-set documentation is available.

At a Glance

Name
Editor/Assembler Plus

Type
Assembly-language development package, including a Z80 macro assembler, line-oriented text editor, and interactive debugger

Manufacturer
Microsoft Consumer Products
10800 NE Eighth, Suite 507
Bellevue WA 98004
(206) 454-1315

Price
$29.95

Format
Cassette tape

Language
Z80 machine language

Computer
Radio Shack TRS-80 Level II with at least 16 K memory

Documentation
112 pages softcover, 4¾ by 6½ inches; Quick Reference Card

Audience
TRS-80 assembly-language programmers

Editor

The editor, which was adequate before, is better now. The functions remain much the same as in Editor/Assembler, but new power and versatility have been added through the extension of the range and line-number specifications. They are a necessity in a line-oriented editor.

Where there was only one way to specify a range of line numbers, there are now four. You can specify a range by two line numbers separated by a colon, a line number followed by the number of lines separated by an exclamation mark, an offset (either plus or minus), or no line number at all. Also, these specifiers can be used in any editing-command parameter requiring a line number, allowing various combinations. They can even be used in the E(dit) command to edit a set of contiguous lines without constantly entering the Edit command. The F(ind) command accepts a range, searches for a string over that range (the whole buffer, if necessary), and finds every occurrence, not just the first. While range specification greatly extends the versatility of both the editor commands and subcommands, more was needed to produce a top-notch editor, and Microsoft responded.

Editor/Assembler Plus adds five new commands that further increase the editor's efficiency. The first two are related: M(ove) and C(opy). Copy merely duplicates a specified range of lines to another range. Move duplicates the lines and also deletes the source lines. To add to the power of these commands, you can specify a new line increment for the destination code. The S(ubstitute) command has the capability to substitute all occurrences in a range. This feature is useful when you have to change some labels or have finally realized that RET, not RTN, is the mnemonic for return. The X(eXtend) command is useful for adding comments to finished programs.

The frosting on the cake is the Q(uash) command. It allows you to delete either Z-BUG or both the assembler and Z-BUG from memory, increasing the editor-buffer space. Quashing Z-BUG presents certain problems since debugging is difficult without it, to say the least. Microsoft has an answer in the form of a stand-alone Z-BUG on the other side of the cassette. Quashing the assembler usually results in a source file that is too large to assemble in 16 K bytes, but it leaves plenty of room for general text editing.

Assembler

The assembler portion of this package unlocks the machine-language power of the TRS-80. In addition to interesting new ways to set the origin of the assembly code, the assembler now supports assembly into memory. Also, the assembler supports macroinstructions and conditional assembly. This lets my "plain old" Level II 16 K-byte machine become a powerful assembly-language development system; before and after is like Clark Kent and Superman.

The inconvenience of writing object code to tape and then reloading it (usually with a monitor program like T-BUG or RSM-2) is gone. An assembler switch (option) signifies that the object code is to be loaded into memory where it can be run under Z-BUG. The origin of the code is automatically set by the assembler at the end of the text buffer, which is variable in size (it must be, but the documentation is unclear on this point). That's where the difficulty comes. Suppose the buffer is filled with a 3 K-byte source file. That represents around 60 lines of 50 bytes, including comments—not unreasonable. If there are fifteen labels, the symbol table is a maximum of 135 bytes. Since the text buffer starts at location hexadecimal 7263 and the text buffer is 3 K bytes long, that leaves 412 bytes for the symbol table and object code in a 16 K-byte machine. This may be enough for most programs, but the only alternative is to quash Z-BUG, write the object code to tape, reload the stand-alone Z-BUG, and load the object code again. This defeats the in-memory assembly. If you have more than 16 K bytes of memory, the problem becomes trivial. The ORG statement should not be used for automatic origin as it will add the address given in the origin statement to the automatic origin.

If you want to choose that automatic origin, another assembler switch allows you to set it. This may be helpful when you want to debug the code at its actual location. The last new assembler switch allows for an absolute origin. In this case, an ORG statement must be used. This is the default for all assemblies to tape. It is possible to have an in-memory assembly with an absolute origin, but it is not recommended. To overcome this, set the automatic origin as in the manual and use the manual-origin assembler switch.

These additions are efficient and pleasing, but the most interesting features are macros (macroinstructions) and conditional assembly. These two features contribute most of the power to Editor/Assembler Plus.

This is probably why Barden spends an entire chapter on macros. Macros in the Editor/Assembler Plus resemble those of much larger machines. Several rules apply, but they are very reasonable. The manual states that there can be "...any reasonable number of macro definitions..." and "...each macro definition may have many arguments...." Since this is rather vague, I assume that they are limited by available space. Macros must be defined before they are referenced, so it is wise to define all macros at the beginning of the source text. Parameters can be passed to the macro, but the manual doesn't state whether a macro reference can be passed. I tried it, and found they can't. This is logical since nested macros are not allowed. Editor/Assembler Plus does allow synthetic labels in order to avoid doubly defined labels upon expansion. Barden gives several examples to demonstrate possible uses of the macro facility. He uses the long-standing practice of using macros for subroutine calls. He also demonstrates the use of macros to build a cross-assembler for the Motorola 6800 microprocessor (I used them to work on an Intel 8080 assembly-language translator). These examples are only a small portion of the numerous uses.

The conditional-assembly facility is explained as a tool for production of software for different configurations.

Even though this is the only example, it is still impressive. It is nice to have if you need it, but most users don't. Its use is extended greatly by the updated expression evaluation, which adds operators for logical, arithmetic, and parenthesized operations. The flexibility is enhanced by the ability to nest conditions.

The symbol table adds codes to indicate how labels are defined (or undefined). One thing that is lacking is a cross-reference facility for the symbol table. While not necessary, a cross-reference is extremely helpful. Unfortunately, it is expensive in overhead code.

Z-BUG

Z-BUG is a new item, rather than an update of part of a previous system. It only remotely resembles Radio Shack's T-BUG. In fact, this debugger is one of the best I've seen, presenting an exceptional value. The editor, assembler, and debugger come in one package for the price of Radio Shack's Editor/Assembler. If you add T-BUG, which is inferior to Z-BUG, you have a bigger bill. Z-BUG can't do everything, but it can do many interesting and helpful things. It can display and modify memory in several modes, set up to eight breakpoints, single-step through machine-language programs, act like a calculator, and reference the symbol table so you can use symbolic references when you are debugging.

First, let's see what Z-BUG can't do. My main complaint is that it cannot provide hard copy. It seems like such a simple task to have the displays shuttled off to the printer. Combine this with the fact that there are no entry points given for the program itself and you have a frustrating and time-consuming task if you want to correct the omission. My only suggestion is to place a print driver somewhere in memory so you can use the $G command to jump to it and then have it return to the beginning of Editor/Assembler Plus. The "Quick Reference Card" indicates that an entry point is provided that does not destroy the contents of the buffer.

My second complaint is the lack of a routine to disassemble to tape. That would be handy if you had an object module without the source code. It also might be useful for modifying a routine provided in ROM. You couldn't replace it in ROM, of course, but there are many routines already worked out if you can get to them.

Now, what can Z-BUG do? It's truly amazing what they can do at Microsoft. There are four modes in which you can examine memory: mnemonic, byte, word, and ASCII. Each one is descriptive of what is displayed. To open any memory location for display, just type its location followed by a slash. You can then examine the location and type in a new value, as you like. If you use the Down Arrow key, it automatically opens the next location, dependent on the mode you are in. If in byte mode, the next byte; if in word mode, the next word; if in mnemonic mode, the next instruction, and so on. To close the location and end the parade of locations, type Enter and Z-BUG responds with its prompt. The process is simple and convenient. Z-BUG doesn't stop there, however. You can easily set the input and output radices. This allows, say, decimal input and hexadecimal output or almost any other combination between base 2 and base 16. You can also modify any of the registers (except the refresh register) after they are displayed. There are several commands to get a one-time display in a different mode.

If you liked that, you'll love the fact that you can set up to eight breakpoints. Each one is numbered automatically. You can examine locations and registers and even modify them before continuing the program. You can also specify the number of times the breakpoint is passed before it stops the program. Single stepping can be ordered after a breakpoint or all by itself. You can also reference your breakpoints and single-stepping entry points by symbolic reference.

Symbolic reference can be used throughout the program with any command. You can set the mode to $S, denoting symbolic reference, or just use them. If you are not in symbolic mode, any nonnumeric input sends Z-BUG to the symbol table to resolve the address associated with that reference. In fact, you can use any standard suffix (such as T for decimal, H for hexadecimal, etc) no matter what the radix is set to and the program resolves it. And if it isn't flexible enough, it also works as a calculator, doing all your arithmetic in any base between 2 and 16.

I am quite impressed with Z-BUG. It is an extremely flexible debugging tool. However, there are two minor problems that need pointing out. First, if you have to use the stand-alone version of Z-BUG, you won't be able to use symbolic references. This is because Z-BUG resolves symbolic references by a look at the symbol table. When you reload the object module, you don't have the symbol table to look at. Second, the manual suggests that you use a dummy address for the entry or execution address when you punch out a system tape if you don't have one. *Don't do it!* When you read it back in under SYSTEM and type the slash to start it, it tries to start it at the dummy address. Instead, use the starting address for the entry address. It will avoid problems when you try to run the program you spent two days on.

Conclusions

Microsoft's Editor/Assembler Plus is an excellent editor/assembler/debugger. It has a few problems that prevent it from being outstanding. It can turn any Radio Shack TRS-80 Level II with at least 16 K bytes of memory into an assembly-language development system with little effort. Microsoft has learned from the problems and complaints that came from the users of Radio Shack's Editor/Assembler.

Documentation has usually been a problem with Microsoft products, and that has not changed with Editor/Assembler Plus. There is a definite lack of support documentation with the package. The documentation that is included is well done.

Editor/Assembler Plus is an outstanding value for its price. Not only is an editor and macro assembler included in the package, but a powerful debugger as well. ■

BOSS: A Debugging Utility for the TRS-80 Model I

Scott Mitchell, 346 S Taylor St, Manchester NH 03103

BOSS is a utility program to help debug programs written in TRS-80 Microsoft BASIC by dynamically tracing steps in execution. Essentially, this program intercepts the TRACE function included with TRS-80 BASIC and modifies its operation. The result is a more versatile debugging utility with a more meaningful and readable screen display.

The first thing you notice after BOSS is loaded is that the line numbers normally output by the TRACE function no longer print all over the screen, making the display scroll uncontrollably. The trace-line numbers now print in a vertical column in the upper right-hand part of the screen. Four line numbers are displayed, with an arrow pointing to the one currently executing. This is a big advantage when trying to debug a graphics program or any program that specially formats information output to the screen. With BOSS, all the graphics and formatted information stay where they should; BOSS doesn't destroy or interfere with the video output of the program being debugged.

The numbers of the program lines being traced may be output to a printer, if necessary. The functions of tracing and sending the trace-line numbers to the video display or printer can be controlled either manually during the program execution and debugging, or by POKE commands within the program being tested. Using the POKE commands, you can start and stop BOSS functions at points specified by the program being traced.

BOSS stands for BASIC Operated Single Stepper, meaning that instead of watching your regular trace whiz by, you can slow down or single-step the trace. You can step through the program line by line, or in the case of multi-instruction lines, instruction by instruction. Tracing a program is made much easier.

Variables can be examined any time, and BOSS lets you tell it which ones you're trying to keep track of. Once you've told BOSS what you want, pressing two control keys lists out the variables and their contents.

You can also stack programs in memory to the extent of memory available. With this function, you can append one program with others quite easily. You load a program and give the command to push it to locations high in memory. BOSS does this and resets the pointers for the new limits of your BASIC source-code buffer. Now, load a second program and give the command to append it with the first program. BOSS is happy doing its own memory management. It checks the amount of memory you have and keeps track of how much you have used or will need. BOSS asks how much memory to protect and locates itself just under your stated protected-memory limit. It also tells what memory size to give when you enter BASIC. The BOSS program has no problem working with either a TRS-80 Level II cassette system or the TRSDOS disk operating system.

BOSS did lock up on me sometimes, but this was mostly because I did not follow directions. For instance, I did not set a memory size, or I pressed the control keys to send output to the printer when no printer was on line.

Overall, BOSS has many good features, with only a few bad ones. Since it works so well, BOSS has become one of my most used BASIC utilities. ■

At a Glance

Name
BOSS (BASIC Operated Single Stepper)

Type
Debugging utility (replaces the TRACE function)

Distributor
Level IV Products Inc
32238 Schoolcraft
Livonia MI 48150
(800) 521-3305

Price
$29.95

Format
5-inch floppy disk or cassette tape

Language used
Z80 machine language

Computer needed
TRS-80 Model I, minimum of 16 K bytes of memory, cassette or disk based

Documentation
13-page pamphlet

Audience
TRS-80 BASIC programmers dissatisfied with the operation of the present TRACE function

Indirect I/O Addressing on the 8080

Paul Zarucki, 30 Long Leasow, Selly Oak,
Birmingham, B29 4LT United Kingdom

It is frequently useful to be able to specify the address of an I/O (input/output) port by the contents of a register or memory location, to allow a common I/O routine to service a number of similar devices connected to separate ports. If you have a system based on Intel's 8080 microprocessor that does not have memory-mapped I/O, you cannot do this using the 8080 I/O instructions in the normal manner, because only direct addressing is allowed for I/O instructions.

One solution is to modify the I/O instruction each time, prior to executing it, so it addresses the required port. Two possible problems with this method are:

- the program will not work if stored in ROM (read-only memory) since the instructions cannot be modified
- the program is not reentrant, which makes simultaneous I/O to several ports impossible (as in multiprogramming or multitasking)

For the program to be reentrant, it must store variable data either in the processor's registers or in memory locations assigned at execution time. If the I/O instruction could be regarded as a variable and stored in this manner (but also executed as though it were part of the program), we could solve the two problems mentioned above.

Enter the Stack

The stack is an area of programmable memory that is dynamically assigned at execution time and is present in most 8080 systems; thus, it is ideal for this application.

In the method presented here, we assemble the I/O instruction code in the processor's registers and store it on the stack together with a RET (subroutine return) instruction. Then it is called as though it were a subroutine, and, finally, the instructions are cleared from the stack (see figure 1).

One problem with calling a subroutine on the stack is that its *absolute start address* cannot be predicted when

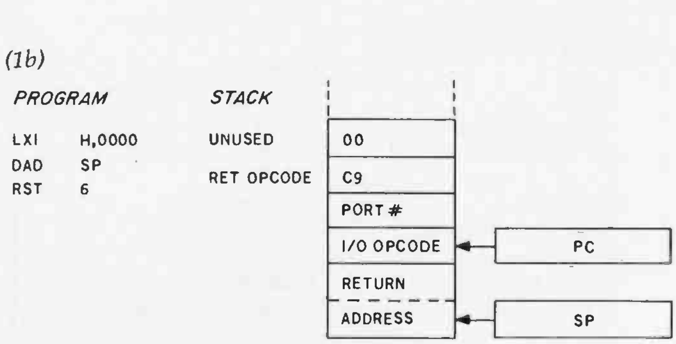


Figure 1: *Stages in the assembly and execution of an indirect I/O subroutine. The C register is assumed to contain the I/O port address. Figure 1a shows how the code is assembled in the registers and pushed onto the stack. In figure 1b, the start address for the code on the stack is loaded into the HL register pair and an indirect subroutine call is performed.*

Listing 1: *Subroutines for performing indirect input and output operations. With the I/O port address stored in the C register, data is transferred to (or from) register A, as with normal 8080 I/O instructions.*

(1a)

```
                                 ;P6S1
                                 ;= = = =
                                 ;DATE: 21/7/1980                          INDIRECT INPUT SUBROUTINE.

0000      21C900        INPUT       LXI       H,0C9H
0003      E5                        PUSH      H                  ;STORE "RET" OPCODE ON STACK.
0004      61                        MOV       H,C
0005      2EDB                      MVI       L,0DBH
0007      E5                        PUSH      H                  ;STORE "IN" OPCODE ON STACK.
0008      210000                    LXI       H,0
000B      39                        DAD       SP                 ;MOVE SP TO HL.
000C      F7                        RST       6                  ;CALL TO ADDRESS IN HL.
000D      E1                        POP       H                  ;CLEAR STACK.
000E      E1                        POP       H
000F      C9                        RET

                                    END
```

(1b)

```
                                 ;P6S2
                                 ;= = = =
                                 ;DATE: 21/7/1980                          INDIRECT OUTPUT SUBROUTINE.

0000      21C900        OUTPUT      LXI       H,0C9H
0003      E5                        PUSH      H                  ;STORE "RET" OPCODE ON STACK.
0004      61                        MOV       H,C
0005      2ED3                      MVI       L,0D3H
0007      E5                        PUSH      H                  ;STORE "OUT" OPCODE ON STACK.
0008      210000                    LXI       H,0
000B      39                        DAD       SP                 ;MOVE SP TO HL.
000C      F7                        RST       6                  ;CALL TO ADDRESS IN HL.
000D      E1                        POP       H                  ;CLEAR STACK.
000E      E1                        POP       H
000F      C9                        RET

                                    END
```

Listing 2: *A simulated indirect subroutine call. A call to this subroutine causes a jump to the address contained in the HL register pair.*

This code is necessary for the indirect subroutine call. It consists of a single indirect jump instruction, located at address 0030H, which is executed when the RST 6 instruction is performed.

```
                                 ;P6S3
                                 ;= = = =
                                 ;DATE: 21/7/1980                          INDIRECT SUBROUTINE CALL.

0030      E9                        PCHL                         ;JUMP TO ADDRESS IN HL.

                                    END
```

the program is written. Thus, we need an indirect subroutine call—something the 8080 microprocessor does not have. This can be simulated by a call to a subroutine that causes a jump to an address contained in the HL register pair (shown as an RST 6, but it could be an ordinary subroutine).

After the assembled code is pushed onto the stack, SP points to the first byte of the I/O subroutine. SP is loaded into HL and an indirect call is performed. The stack now appears as figure 1b, with the return address at the top and the PC (program counter) pointing to the first byte of the I/O subroutine. The 3 bytes of code on the stack are then executed. The RET instruction causes the return address to be popped off the stack and execution continues within the main body of the program.

Listings 1a and 1b show subroutines for performing indirect input and output operations, respectively. They are both relocatable and reentrant and can reside in either programmable or read-only memory.

Both subroutines shown assume that register C contains the I/O port address. Data is loaded into register A or stored from register A, as with the normal 8080 I/O instructions. The only other registers modified are H and L.

Indirect subroutine calls are also useful in other applications where it is desired to specify the start address of a subroutine at execution time. ■

A Disk Catalog for the Eighties

Bob Liddil, POB 66, Peterborough NH 03458

DISK/CAT, a NEWDOS-based, commercial-quality cataloging program for a Radio Shack TRS-80 with two or more drives, performs several useful services (see listing 1). In addition to recording and filing the contents of every disk run through it, the program assigns to each a permanent number (which is placed in the directory). Updating is performed by simply reinserting the disk and running DISK/CAT again. The contents of the disk are then recataloged, and file names are deleted or added while retaining the number.

DISK/CAT can remember a particular program and report its whereabouts, on a disk-by-disk basis, repeating all occurrences of the program. The search routine can be initialized from the beginning or from the end.

The display mode will print all disk directories to the screen (or to a printer, see listing 2a), give the directory of any specified disk, or alphabetize all file names and print them to screen or printer with their disk number (see listing 2b). ■

Listing 1: *DISK/CAT for the Radio Shack TRS-80. The program numbers each disk, and catalogs its contents. The stored files can be printed or displayed on the video monitor in alphabetical order or on a disk-by-disk basis.*

```
5   GOSUB500:
      CLS:
      CLEAR5000:
      PRINT@276,"       DO YOU WANT TO
      1   CATALOG A NEW DISK OR UP DATE
      OLD DISK      2    LOOK   AT PROGRAM
      FILE OR SEARCH FOR PROGRAM";
10 A$=INKEY$:
      IF A$="" THEN GOTO 10
15 A=VAL(A$):
      IF A<1 OR A>2 THEN GOTO 10
20 ON A GOTO 25,200
25 TROFF:
      CLS:
      GOSUB 395:
      CLS:
      PRINT@512,"PLEASE INSERT THE DISK
      TO BE CATALOGUEDIN DRIVE #";DK;
      " AND PRESS   <ENTER> ";
30 QQ$=INKEY$:
      IF QQ$=""THEN GOTO 30
35 DIMA$(50):
      CLS:
      GOSUB420:
      N=15360+(63*2)+2
40 X=PEEK(N):
      IFX<>32ANDPEEK(N-1)=191THENI=I+1:
      C=0
45 IFC>30THEN70
50 IFN>16382THEN70
55 IFX=32THENPOKEN,191:
      N=N+1:
      C=C+1:
      GOTO40
60 POKEN,191:
      POKEN,X:
      A$(I)=A$(I)+CHR$(X):
      N=N+1:
      IFC>30THEN70
65 IFN<16382THEN40
70 CLS:
      FORX=0TOI:
      IFA$(X)="P"ORA$(X)="NUMBER"THEN
      A$(X)=CHR$(191):
      GOTO80
75 PRINTA$(X),:
      IFPOS(0)+LEN(A$(I+1))+9>64THEN
      PRINT
```

```
80 NEXT:
    ONERRORGOTO85:
    OPEN"I",1,"DN:Ø":
    INPUT#1,DH:
    CLOSE:
    GOTO9Ø
85 CLOSE:
    OPEN"O",1,"DN:Ø":
    PRINT#1,Ø:
    CLOSE:
    RESUME
9Ø ONERRORGOTO1ØØ:
    OPEN"I",1,DK$:
    INPUT#1,DN:
    CLOSE:
    SK=DN:
    IFDH>DNTHEN115
95 OPEN"O",1,"DN:Ø":
    PRINT#1,DN:
    CLOSE:
    GOTO115
1ØØ CLOSE:
    OPEN"I",1,"DN:Ø":
    INPUT#1,DN:
    CLOSE:
    OPEN"O",1,DK$:
    PRINT#1,DN+1:
    CLOSE:IFDN+1<=DHTHEN11Ø
1Ø5 OPEN"O",1,"DN:Ø":
    PRINT#1,DN+1:
    CLOSE
11Ø RESUME
115 ONERRORGOTO14Ø:
    CLOSE:
    CLS:
    PRINT"THIS IS DISK #";DN:
    OPEN"I",1,"FILE:Ø":
    INPUT#1,NP:
    DIMN$(NP+I+1),D(NP+I+1),O(NP+I+1):
    IFNP=ØTHEN13Ø
12Ø FORX=1TONP:
    INPUT#1,N$(X):
    NEXT:
    CLOSE:
    ONERRORGOTOØ:
    OPEN"I",1,
    "FILEO:Ø":
    FORX=1TONP:
    INPUT#1,D(X):
    IFD(X)=SKTHENN$(X)=CHR$(191)
125 NEXT
13Ø CLOSE:
    ONERRORGOTOØ:
    X=NP:
    N=Ø:
    CLS:
    FORL=X+1TOX+I+1:
    N$(L)=A$(N):
    N=N+1:
    D(L)=DN:
    NEXT:
    NP=NP+I+1:
    FORI=1TONP:
    O(I)=I:
    NEXT:
    GOSUB145:
    FORX=1TONP:
    IFN$(O(X))<>CHR$(191)THENNP=X
135 NEXT:
    OPEN"O",1,"FILE:Ø":
    PRINT#1,NP:
    FORI=1TONP:
    PRINT#1,N$(O(I)):
    NEXT:
    CLOSE:
    OPEN"O",1,"FILEO:Ø":
    FORI=1TONP:
    PRINT#1,D(O(I)):
    NEXT:
    CLOSE:
    GOTO5
14Ø CLOSE:
    OPEN"O",1,"FILE:Ø":
    PRINT#1,Ø:
    CLOSE:
    RESUME
145 L=1:
    C=Ø:
    FORN=1TONP:
    IFN$(O(N))=CHR$(191)THENC=C+1
15Ø NEXT:
    FORX=1TONP-C-1:
    IFN$(O(X))=CHR$(191)THENGOSUB16Ø
155 NEXT:
    GOTO165
16Ø CLS:
    PRINT"PRE SORT":
    A=O(X):
    FORN=XTONP-1:
    O(N)=O(N+1):
    NEXT:
    O(NP)=A:
    X=X-1:
    RETURN
165 C=Ø:
    FORX=LTONP-1:
    IFN$(O(X))>N$(O(X+1))THENGOSUB175:
    X=NP-1:
    NEXT:
    GOTO165
17Ø L=X:
    NEXT:
    TROFF:
    RETURN
175 CLS:
    PRINT"SORTING DATA":
    FORI=X+1TO1 STEP-1:
    IFN$(O(I))<N$(O(I-1))THENA=O(I):
    O(I)=O(I-1):
    O(I-1)=A:
    C=1
18Ø IFC=ØTHENI=1:
    NEXT:
    GOTO19Ø
185 C=Ø:
    NEXT
```

Listing 1 continued on page 406

Listing 1 continued:

```
19Ø L=L-1:
    IFL<1THENL=1
195 RETURN
2ØØ ONERRORGOTO5:
    OPEN"I",1,"FILE:Ø":
    INPUT#1,NP:
    DIMN$(NP),D(NP):
    FORX=1TONP:
    INPUT#1,N$(X):
    NEXT:
    CLOSE:
    OPEN"I",1,"FILEO:Ø":
    FORX=1TONP:
    INPUT#1,D(X):
    NEXT:
    CLOSE:
    OPEN"I",1,"DN:Ø":
    INPUT#1,DN:
    CLOSE
2Ø5 CLS:
    PRINT"DO YOU WANT TO1   SEARCH
    FOR PROGRAM       (N) CHAR. FROM
    BEGING2  SEARCH       (N) CHAR. FROM
    END3          PRINT ALL DISKS TO
    PRINTER4           PRINT ALL DISKS TO
    SCREEN
21Ø PRINT"5          ALL PROGRAMS TO PRI
    NTER IN ALPH. ORDER  WITH DISK#":
    PRINT"6          DIR OF ANY DISK":
    PRINT"7          RESTART8          END
215 QQ$=INKEY$:
    IF QQ$=""THEN GOTO 215
22Ø FL=VAL(QQ$):
    IF FL<1 OR FL>8 THENGOTO 215
225 ON FL GOTO23Ø,3ØØ,335,345,36Ø,365,
    5,39Ø
23Ø CLS:
    PRINT"YOU GIVE ME ANY NUMBER OF
    CHAR. I WILL LIST ALL DISKSTHAT
    CONTAIN A PROGRAM THAT START WITH
    THOSE CHAR.":INPUT"CHAR. TO SEARCH
    FOR";A$:L=LEN(A$):PRINT"OUTPUT TO
    PRINTER       Y/N"
235 P$=INKEY$:
    IF P$=""THEN GOTO 235
24Ø IF P$="Y"THEN P=1:
    GOTO255
245 IF P$="N"THEN P=Ø:
    GOTO255
25Ø GOTO235
255 CLS:
    P$="":
    FORX=1TONP:
    IFLEFT$(N$(X),L)=A$THEN265
26Ø GOTO28Ø
265 IFP=1THEN275
27Ø PRINTN$(X),"DISK #";D(X):
    GOTO28Ø
275 LPRINTN$(X),"DISK #";D(X)
28Ø NEXT
285 PRINT@98Ø,"PRESS <ENTER> TO CONT
    INUE";
29Ø QQ$=INKEY$:
    IF QQ$="" THEN GOTO 29Ø
295 GOTO 2Ø5
3ØØ CLS:
    PRINT"YOU GIVE ME ANY NUMBER OF
    CHAR.I WILL LIST ALL THE PROGRAMS
    THAT END IN THOSE CHAR.":INPUT"TO
    SEARCH FOR----";A$:
    L=LEN(A$):PRINT"OUTPUT TO PRINTER
    Y/N  "
3Ø1 P$=INKEY$:
    IFP$=""THEN 3Ø1
3Ø2 IF P$="Y"THEN P=1:
    GOTO3Ø5
3Ø3 IF P$="N"THEN P=Ø:
    GOTO3Ø5
3Ø4 GOTO 3Ø1
3Ø5 CLS:
    FORX=1TONP:
    IFRIGHT$(N$(X),L)=A$THEN315
31Ø GOTO33Ø
315 IFP=ØTHEN325
32Ø LPRINTN$(X),"DISK #";D(X)
325 PRINTN$(X),"DISK #";D(X)
33Ø NEXT:
    GOTO285
335 OPEN"I",1,"DN":
    INPUT#1,DN:
    CLOSE:
    FORX=1TODN:
    LPRINT"  ":
    LPRINT"  ":
    LPRINT"------------DISK #";X;
    " -----------------":
    LPRINT"  ":
    FORN=1TONP:
    IFD(N)=XTHENLPRINT"              ";
    N$(N)
34Ø NEXT:
    NEXT:
    GOTO285
345 FORX=1TODN:
    CLS:
    PRINT"DISK #";X:
    PRINT:
    PRINT:
    PRINT:
    FORN=1TONP:
    IFD(N)<>XTHEN355
35Ø PRINTN$(N),:
    IFPOS(Ø)>5ØTHENPRINT
355 NEXT:
    PRINT:
    PRINT:
    FORI=1TO2ØØØ:
    NEXT:
    NEXT:
    GOTO2Ø5
36Ø CLS:
    FORX=1TONP:
    LPRINTN$(X),"DISK    #";D(X):
```

```
     PRINTN$(X),"DISK     #";D(X):
     NEXT:
     GOTO2Ø5
365 CLS
37Ø INPUT"DIR OF WHAT DISK";D:
     IFD>DNTHENPRINT"DISKS ONLY CATALOG
     ED UP TO ";DN:
     GOTO37Ø
375 CLS:
     PRINT"DISK   #";D:
     PRINT:
     FORX=1TONP:
     IFD(X)=DTHENPRINTN$(X),
38Ø IFPOS(Ø)>5ØTHENPRINT
385 NEXT:
     GOTO285
39Ø END
395 CLS:
     PRINT"ON WHICH DRIVE (1 THRU 3)
     WILL YOU PLACE YOUR DISK TO BE
     CATALOGED?":
     LINEINPUT DK$
4ØØ DK=VAL(DK$):
     IF DK<1 OR DK>3 THEN CLS:
     GOTO395
4Ø5 IF DK=1 THEN DK$="NUMBER:1":
     RETURN
41Ø IF DK=2 THEN DK$="NUMBER:2":
     RETURN
415 IF DK=3 THEN DK$="NUMBER:3":
     RETURN
42Ø IF DK=1THEN CMD"DIR :1":
     RETURN
425 IF DK=2THEN CMD"DIR :2":
     RETURN
43Ø IF DK=3THEN CMD"DIR :3":
     RETURN
5ØØ CLS:
     PRINTCHR$(23):
     PRINT@24,"NOTICE":
     PRINT:
     PRINT"THIS PROGRAM WILL NOT WORK
     WITH A SINGLE DRIVE DISK SYSTEM"
51Ø FOR ZZ=1TO 15ØØ:
     NEXT:
     RETURN
```

Listing 2: *Sample printer output from DISK/CAT. The directories of all disks, in disk-number order, are shown in listing 2a; listing 2b shows the directories in alphabetical order.*

(2a)

```
------------DISK # 1  -----------------


           BARTEND
           DISKED35/CMD
           FCC1
           FCC2
           FCC3
           FCC4
           FCC5
           TEMP1

------------DISK # 2  -----------------


           DSHIP/CMD
           DUTCHMAN
           INTRO
           SPIDER

------------DISK # 3  -----------------


           DSHIP/CMD
           STARTREK

------------DISK # 4  -----------------


           CATALOG
           DECODE
           ETCH/PCL
           LCPRINT/CMD
           LETTER
           PENCIL/CMD
           REPORT/PCL
           TEST
           VOICE
```

(2b)

```
BARTEND          DISK   # 1
CATALOG          DISK   # 4
DECODE           DISK   # 4
DISKED35/CMD     DISK   # 1
DSHIP/CMD        DISK   # 2
DSHIP/CMD        DISK   # 3
DUTCHMAN         DISK   # 2
ETCH/PCL         DISK   # 4
FCC1             DISK   # 1
FCC2             DISK   # 1
FCC3             DISK   # 1
FCC4             DISK   # 1
FCC5             DISK   # 1
INTRO            DISK   # 2
LCPRINT/CMD      DISK   # 4
LETTER           DISK   # 4
PENCIL/CMD       DISK   # 4
REPORT/PCL       DISK   # 4
SPIDER           DISK   # 2
STARTREK         DISK   # 3
TEMP1            DISK   # 1
TEST             DISK   # 4
VOICE            DISK   # 4
```

DISK/CAT was written by David Huntress of Boston MA. Enhancements were added by Reese Fowler of Peterborough NH. Copies are available on tape for disk BASIC from The Programmer's Guild, POB 66, Peterborough NH 03458, for $19.95.

Alpha-Beta Tree Search Converted to Assembler

Stephen F Gale, 22 Lloyd Pl,
St Albert, Alberta T8N 2H4, Canada

In part three of his article "Machine Problem Solving" (November 1980 BYTE, page 224), Peter Frey discussed the alpha-beta pruning algorithm as applied to searching a look-ahead tree for the best strategy in a two-player game. He included a BASIC demonstration game of the alpha-beta procedure called Treasure Search. In this game, the user plays against the computer on an 8 by 8 grid that has a digit between 1 and 9 randomly assigned to each of the 64 grid locations. Players take turns moving from one spot to another, adding the value of each location they land on to their scores. Once a location has been occupied, its value is reduced to 0. Each player attempts to follow a path that leads to the highest numbers; the first player to reach 100 points wins.

Listings 1 and 2 are an improved version of this game for a Radio Shack TRS-80 Model I. The highly efficient alpha-beta tree search has been rewritten in Z80 assembly language, and it now runs about 300 times faster than the original BASIC program. My version has also been enhanced through the use of the *killer heuristic* that was described in Mr Frey's article. Effective moves stored by the regular tree-search routine are recalled by the killer heuristic when the current situation is recognized as being similar to one previously encountered in the course of a game.

This improved program plays a good game at levels five, six, and seven; at levels eight, nine, and ten it should be excellent. Note that even with the reduced computing time of the new version, level ten requires about forty minutes per move. By contrast, a move by the computer at level five in the original version required fifteen minutes; the same level on the improved version takes less than ten seconds.

As given, the program in listing 2 must be loaded beginning at hexadecimal memory location 6000. Altering the ORG statement prior to assembly will allow you to place the code elsewhere in memory. Line 400 of the BASIC program must also be modified so that it will know the new entry point for the machine code.

In a cassette-based system, after you have put these programs on tape, load the BASIC program of listing 1 with the CLOAD command. Then use the SYSTEM command to load the machine-language program assembled from listing 2. Press BREAK after the second program has been loaded to return to the BASIC editor, then type RUN. ■

Listing 1: *BASIC portion of an improved version of the game Treasure Search, described in the November 1980 BYTE. This program runs in conjunction with listing 2. Line 400 contains the code that gives the entry point for the machine-language routines in listing 2.*

```
0 CLS:PRINT@5," * TREASURE SEARCH *   BYTE  MAGAZINE - NOVEMBER, 1980"
5 PRINT:PRINT" TREE SEARCH CONVERTED TO ASSEMBLER BY S.F.GALE  B.SC ASPH(CPSC) IN DECEMBER, 19
80"
10 PRINT:PRINT
15 PRINT" THE OBJECT OF THE GAME IS TO SCORE 100 POINTS BEFORE"
20 PRINT"THE COMPUTER DOES. THE COMPUTER MOVES THE '*' AND YOU"
25 PRINT"MOVE THE 'X' ABOUT AN 8X8 BOARD THAT CONTAINS RANDOM"
30 PRINT"NUMBERS BETWEEN 1 AND 9.  WHEN A SQUARE HAS BEEN"
35 PRINT"VISITED, THE VALUE ON THE SQUARE IS THEN ZERO.  MOVES"
40 PRINT"ARE MADE BY PRESSING ONE OF THE FOUR ARROW KEYS."
45 PRINT:PRINT:INPUT"PRESS <ENTER> TO CONTINUE";A$
50 CLS:PRINT" THE PROGRAM USES THE ALPHA-BETA TREE SEARCH"
55 PRINT"ENHANCED BY THE KILLER HEURISTIC.
60 PRINT:PRINT"  MOVE TIMES ARE ROUGHLY AS FOLLOWS:"
65 PRINT"    LEVELS 1 TO 6 - UNDER 10 SECONDS,
70 PRINT"    LEVEL 7       - UNDER 60 SECONDS,
73 PRINT"    LEVEL 8       - UNDER  2 MINUTES,
```

```
75 PRINT"    LEVEL 9       - UNDER 10 MINUTES.
80 PRINT"    LEVEL 10      - ABOUT 40 MINUTES.
85 PRINT:PRINT" THESE TIMES COMPARE FAVORABLY TO BASIC WHERE":PRINT"LEVEL 5 TAKES ABOUT 15 M
INUTES."
95 PRINT:PRINT:INPUT"PRESS <ENTER> TO CONTINUE";A$
100 CLEAR100:CLS:DEFINTA-Z:RANDOM:SH=0:ST=0:Z$=STRING$(32," ")
110 PRINT@463,"PLEASE ENTER YOUR NAME";:INPUTN$
120 DIMA(8),B(99),D(4),E(12),M(12)
130 DIMPV(12,12),Q(12),V(12),Z(12)
140 D(1)=-10:D(2)=-1:D(3)=1:D(4)=10
150 A(1)=10:A(2)=-10:A(4)=-1:A(8)=1:CLS
160 PRINT@461,"COMPUTER PLAYING STRENGTH (1 TO 10) :";:INPUTY
170 DM=2*Y:FORI=11TO88:B(I)=RND(9):NEXTI
180 FORI=0TO10:B(I)=99:NEXTI:FORI=89TO99:B(I)=99:NEXTI
190 FORI=19TO79STEP10:B(I)=99:B(I+1)=99:NEXTI
195 CLS:PRINT@463,"DO YOU WANT TO GO FIRST";:INPUTA$
220 CLS:FORI=11TO88:IFB(I)=99THEN240
230 X$=RIGHT$(STR$(B(I)),I):GOSUB1000
240 NEXTI:PRINT@22,"TREASURE SEARCH";Y
250 PRINT@256,N$;:PRINT@448,"TRS-80";:Y$=STRING$(12," ")
260 T=54:T$=" *":H=45:H$=" X"
270 I=T:X$=T$:GOSUB1000:B(T)=99:B(H)=99
280 I=H:X$=H$:GOSUB1000
285 IFA$="YES"THEN300ELSE400
290 PRINT@788,"ILLEGAL MOVE, TRY AGAIN";:FORI=1TO999:NEXTI
300 PRINT@788,Z$;:PRINT@788,"WHICH DIRECTION FOR X";
310 IFINKEY$=""THEN310ELSER=PEEK(16444)
320 R=INT(R/8):J=H+A(R)
330 IFB(J)=99THEN290ELSEPRINT@788,Z$
360 I=H:B(I)=0:X$=" 0":GOSUB1000:SH=SH+B(J)
370 H=J:B(H)=99:I=H:X$=H$:GOSUB1000
380 PRINT@321,SH;:IFSH>99THEN930
400 POKE16526,0:POKE16527,96
410 FORI=0TO99:POKE32261+I,B(I):NEXTI
420 POKE32258,DM:POKE32259,T:POKE32260,H
430 BM=USR(N)
800 I=T:B(I)=0:X$=" 0":GOSUB1000:PRINT@179,Y$;
810 T=BM:ST=ST+B(T):B(T)=99:I=T:X$=T$
820 GOSUB1000:PRINT@513,ST;:IFST<100THEN300
910 PRINT@915,"THANK YOU FOR A PLEASANT GAME";
920 GOTO920
930 PRINT@917,"CONGRATULATIONS, YOU WIN";:GOTO920
1000 R=INT(I/10):C=I-10*R:K=141+(8-R)*64+C*4
1010 PRINT@K,X$;:RETURN
```

Listing 2: *The more time-consuming portions of the game have been coded in Z80 assembly language, improving the program speed 300 times. This section of the game must be loaded into otherwise unused memory before you attempt to run the program in listing 1.*

```
                ORG     6000H
        BRD     EQU     7E05H
        MXDPTH  EQU     7E02H
        TRS80   EQU     7E03H
        HUMAN   EQU     7E04H
        FROM    EQU     -12
        TO      EQU     +00
        DCOUNT  EQU     +01
        ALPHA   EQU     -04
        BETA    EQU     +02
        MAX     EQU     +08
        SAVSQR  EQU     +03
        SAVSCR  EQU     +04
        KILLER  EQU     +05
```

Listing 2 continued on page 410

Listing 2 continued:

```
;
;* * * SET UP TREE SEARCH PARAMETERS.
        LD      A,(MXDPTH)      ;SET SEARCH
        LD      (MAXLVL),A      ;  MAXIMUM DEPTH.
        LD      A,1             ;SET THE PLY
        LD      (PLYLVL),A      ;  LEVEL COUNTER.
        LD      A,-1
        LD      (SIDE),A        ;SET SIDE-TO-MOVE.
        LD      A,0             ;ZERO CUMULATIVE
        LD      (SCORE),A       ;  SCORE COUNTER.
        LD      IX,TREE+6       ;START OF TREE DATA.
        LD      (IX+ALPHA),-99
        LD      (IX+BETA),-99
        LD      A,(TRS80)       ;SET LOCATION OF
        LD      (IX-06),A       ;  COMPUTER'S PIECE.
        LD      A,(HUMAN)       ;SET LOCATION OF
        LD      (IX+00),A       ;  HUMAN'S PIECE.
;
;* * * MOVE DOWN ONE PLY LEVEL IN TREE.
NXTLVL  LD      HL,PLYLVL       ;INCREMENT THE
        INC     (HL)            ;  PLY LEVEL COUNTER.
        LD      DE,6            ;MOVE TREE POINTER
        ADD     IX,DE           ;  FORWARD TO NEXT PLY.
        LD      (IX+DCOUNT),5   ;SET THE MOVE COUNTER.
        LD      A,(SIDE)        ;CHANGE  THE
        NEG                     ;  SIDE-TO-MOVE
        LD      (SIDE),A        ;  INDICATOR.
        LD      A,(IX-10)       ;SET NEXT ALPHA,
        LD      (IX+BETA),A     ;  BETA VALUE.
;
;* * * CHECK IF THE KILLER MOVE IS LEGAL.
        LD      HL,DIR          ;DIRECTION TABLE.
        LD      B,4
NXTDIR  LD      A,(HL)          ;GET NEXT MOVE DIRECTION.
        ADD     A,(IX+FROM)     ;CALCULATE NEW SQUARE.
        CP      (IX+KILLER)     ;CHECK IF THIS SQUARE IS
        JP      Z,TRYKIL        ;  THE KILLER MOVE.
        INC     HL
        DJNZ    NXTDIR
;
;* * * CHECK A MOVE AT THIS PLY LEVEL.
NXTMOV  DEC     (IX+DCOUNT)     ;UPDATE MOVE COUNTER.
        JP      Z,PRELVL        ;IF DONE GOTO PLY-1.
        LD      HL,DIR-1        ;DIRECTION TABLE.
        LD      C,(IX+DCOUNT)
        LD      B,0
        ADD     HL,BC
        LD      A,(HL)          ;RETRIEVE DIRECTION.
        ADD     A,(IX+FROM)     ;CALCULATE NEW SQUARE.
;
;* * * CHECK IF MOVE IS KILLER (WHICH HAS BEEN DONE).
        CP      (IX+KILLER)
        JP      Z,NXTMOV
;
;* * * CHECK IF THE MOVE IS LEGAL.
TRYKIL  LD      (IX+TO),A       ;SAVE NEW SQUARE.
        LD      HL,BRD          ;BOARD TABLE.
        LD      C,A
        LD      B,0
        ADD     HL,BC
        LD      A,(HL)          ;RETRIEVE PIECE.
        CP      99              ;CHECK IF LEGAL MOVE.
        JP      Z,NXTMOV        ;IGNOR IF ILLEGAL.
```

```
        LD      (IX+SAVSQR),A   ;SAVE VALUE OF SQUARE.
;
;* * * 'MAKE' MOVE ON BOARD.
        LD      (HL),99         ;MARK NEW SQR ILLEGAL.
        LD      HL,BRD          ;HL=BOARD ADDRESS.
        LD      C,(IX+FROM)     ;RETRIEVE FROM SQR.
        ADD     HL,BC           ;CALCULATE SQR.
        LD      (HL),0          ;MARK SQR LEGAL.
;
;* * * UPDATE THE CUMULATIVE SCORE.
        LD      A,(SIDE)        ;RETRIEVE SIDE-TO-MOVE
        OR      A               ;  AND SET FLAGS
        LD      A,(IX+SAVSQR)   ;GET VALUE OF SQR.
        JP      P,SKIP02        ;BRANCH IF SIDE POSITIVE.
        NEG
SKIP02  LD      (IX+SAVSCR),A   ;SAVE SIDE*SAVSQR.
        LD      HL,SCORE        ;ADDR OF CUMULATIVE SCORE
        ADD     A,(HL)          ;UPDATE SCORE
        LD      (HL),A          ;  AND RESTORE.
;
;* * * CHECK IF SEARCHED TO MAXIMUM DEPTH.
        LD      HL,MAXLVL
        LD      A,(PLYLVL)
        CP      (HL)
        JP      C,NXTLVL        ;BRANCH IF NOT AT MAX.
;
;* * * SET SCORE ON THIS TERMINAL NODE.
        LD      A,(SIDE)        ;RETRIEVE SIDE-TO-MOVE,
        OR      A               ;  SET THE FLAGS,
        LD      A,(SCORE)       ;GET CUMULATIVE SCORE.
        JP      M,SKIP04        ;BRANCH IF SIDE NEGATIVE.
        NEG
SKIP04  LD      (IX+MAX),A      ;SET SCORE ON THIS NODE.
;
;* * * TAKE BACK THE MOVE.
TAKBAK  LD      A,(SCORE)       ;GET CUMULATIVE  SCORE.
        SUB     (IX+SAVSCR)     ;UPDATE THE SCORE
        LD      (SCORE),A       ;  AND RESTORE IT.
        LD      HL,BRD
        LD      C,(IX+TO)
        LD      B,0
        ADD     HL,BC           ;HL=TO SQR.
        LD      A,(IX+SAVSQR)
        LD      (HL),A          ;RESTORE BRD.
        LD      HL,BRD          ;HL=BRD ADDRESS.
        LD      C,(IX+FROM)
        ADD     HL,BC
        LD      (HL),99         ;RESTORE BRD AT FROM.
;
;* * * CHECK IF BEST SCORE AT THIS NODE.
        LD      A,(IX+MAX)
        NEG
        LD      B,(IX+BETA)
        CALL    CMPARE
        CP      1
        JP      NZ,NXTMOV
        LD      A,(IX+MAX)
        NEG
        LD      (IX+BETA),A
;
;* * * STORE BEST MOVE AT LOWEST PLY.
        LD      A,(PLYLVL)      ;CHECK IF AT
        CP      2               ;  LOWEST PLY LEVEL.
```

Listing 2 continued on page 412

Listing 2 continued:

```
                JP      NZ,SAVKIL       ;BRANCH IF NOT.
                LD      A,(IX+TO)       ;  OTHERWISE UPDATE
                LD      (BESTMV),A      ;  THE BEST MOVE.
                JP      PRUNE
       ;
       ;* * * STORE THE NEW KILLER MOVE.
       SAVKIL   LD      A,(IX+TO)
                LD      (IX+KILLER),A
       ;
       ;* * * PERFORM ALPHA-BETA PRUNING.
       PRUNE    LD      A,(IX+ALPHA)
                NEG
                LD      B,(IX+BETA)
                CALL    CMPARE
                CP      1
                JP      Z,NXTMOV
       ;
       ;* * * MOVE BACK IN TREE TO PREVIOUS LEVEL.
       PRELVL   LD      A,(SIDE)        ;CHANGE THE
                NEG                     ;  SIDE-TO-MOVE
                LD      (SIDE),A        ;  INDICATOR.
                LD      DE,-6           ;MOVE TREE POINTER
                ADD     IX,DE           ;  BACK ONE PLY LEVEL.
                LD      HL,PLYLVL       ;DECREMENT THE
                DEC     (HL)            ;  PLY LEVEL COUNTER.
                LD      A,1             ;CHECK IF DONE
                CP      (HL)            ;  LAST PLY.
                JP      C,TAKBAK        ;BRANCH IF NOT.
       ;
       ;* * * SET HL FOR THE RETURN TO BASIC.
                LD      A,(BESTMV)
                LD      L,A
                LD      H,0
                JP      0A9AH
       ;
       ;* * * THIS SUBROUTINE COMPARES TWO 8-BIT SIGNED
       ;      OPERANDS IN A AND B.
       CMPARE   CP      B
                JP      NZ,NOTEQL
                LD      A,0
                RET
       NOTEQL   PUSH    AF
                XOR     B
                RLA
                JP      C,DIFFER
                POP     AF
                JP      C,LESST
       GREATR   LD      A,1
                RET
       DIFFER   POP     AF
                JP      C,GREATR
       LESST    LD      A,-1
                RET
       MAXLVL   DEFS    1
       PLYLVL   DEFS    1
       SCORE    DEFS    1
       BESTMV   DEFS    1
       SIDE     DEFS    1
       DIR      DEFB    -10
                DEFB    -1
                DEFB    +1
                DEFB    +10
       TREE     DEFS    250
                END
```

AIM-65 16-Bit Hexadecimal to Decimal Conversion

R A Young, Bio-Medical Engineering Unit, Room 280, Earl Hall, Queen's University, Kingston, Ontario, K7L 3N6 Canada

In the early stages of programming our AIM-65 microcomputer, we could not find a 16-bit binary to decimal number conversion subroutine so we developed the subroutine shown in listing 1. The subroutine is entered with the 16-bit number to be converted stored at hexadecimal memory locations 5E (MSB) and 5F (LSB). The results are stored in locations 75 (MSB) to 79 (LSB). The decimal digits are stored with one digit per location. Therefore, if conversion to ASCII is also required, it becomes a simple matter of adding 30 to each digit at the end of the subroutine. Note that the values 10 E8 etc, shown at the end of the listing, must be stored starting at location 780 etc; they are the conversion constants.

Care must be taken if it is necessary to relocate this subroutine since there are several position-dependent instructions. ■

Listing 1: *A subroutine for the AIM-65 microcomputer which converts 16-bit binary numbers to decimal values.*

```
 K>*=700
/50
 0700 A9 LDA #00
 0702 85 STA 75
 0704 85 STA 76
 0706 85 STA 77
 0708 85 STA 78
 070A 85 STA 79
 070C A9 LDA #75
 070E 8D STA 0731
 0711 A9 LDA #80
 0713 8D STA 071F
 0716 A9 LDA #84
 0718 8D STA 0726
 071B 38 SEC
 071C A5 LDA 5E
 071E ED SBC 0785
 0721 85 STA 79
 0723 A5 LDA 5F
 0725 ED SBC 0789
 0728 90 BCC 0735
 072A 85 STA 5F
 072C A5 LDA 79
 072E 85 STA 5E
 0730 E6 INC 7A
 0732 4C JMP 071B
 0735 EE INC 071F
 0738 EE INC 0726
 073B EE INC 0731
 073E AD LDA 0731
 0741 C9 CMP #7A
 0743 F0 BEQ 0748
 0745 4C JMP 071B
 0748 A5 LDA 5E
 074A 85 STA 79
 074C EA NOP
 074D EA NOP
 074E EA NOP
 074F EA NOP
 0750 A0 LDY #00
 0752 A9 LDA #5C
 0754 8D STA 075A
 0757 B1 LDA (88),Y
 0759 4C JMP 076C
 075C D0 BNE 0765
 075E A9 LDA #20
 0760 91 STA (88),Y
 0762 4C JMP 0771
 0765 A9 LDA #6C
 0767 8D STA 075A
 076A B1 LDA (88),Y
 076C 18 CLC

<
 K>*=76D
/09
 076D 69 ADC #30
 076F 91 STA (88),Y
 0771 C8 INY
 0772 98 TYA
 0773 C9 CMP #06
 0775 D0 BNE 0757
 0777 EA NOP
 0778 EA NOP
 0779 60 RTS

<

 M>=0780 10 E8 64 0A
< > 0784 27 03 00 00
<
```

Fast Line-Drawing Technique

Mike Higgins, POB 197, Duncans Mills CA 95430

Almost everyone who has a home computer would like to take full advantage of its graphics capabilities, whether this is high-resolution graphics, an addressable cursor capability, or a printer or plotter capable of drawing lines.

Line drawing is the most basic of graphics functions, and in recent years, countless schemes have been put forth in an attempt to devise the best method of performing it. You've been advised to use the point-slope formula to draw lines, but this technique demands lots of floating-point arithmetic and does not draw solid lines when the slope of a line is greater than 1.0 or less than −1.0. One article I read suggested a problem reduction method, where the line segment to be drawn is repeatedly chopped in half until you have two adjacent points. This technique used only integer arithmetic, but it did a lot of redundant calculation. Home-computer owners have devoted an incredible amount of time and effort to coming up with new and creative ways to draw lines, when a simple, efficient algorithm has been available for at least a decade.

The technique I use is called the DDA, for Digital Differential Analyzer. I first learned about it from Newman and Sproull's book *Principles of Interactive Computer Graphics* (New York: McGraw-Hill, first edition, 1973; second edition 1979). The book was first printed in 1973, so DDA has been around for quite some time. DDA is a technique for producing discrete approximations to the solution of any differential equation, and calculating the values of the coordinates on a line is just one of its uses. DDA produces simple equations that make a lot of intuitive sense. Here's how DDA works: imagine that all the lines you wish to draw are always at angles between 0 and 45° (slope between 0 and 1) and are always drawn left to right, bottom to top.

In figure 1, the number of dots in each line is always equal to the length of the line along the x axis. This is the number of times you will have to perform a loop to generate all the dots in your line. According to the DDA, you should perform the equations inside this loop as shown in listing 1. X0 and Y0 are the coordinates of the starting point, and DX and DY are the lengths of the line along the x and y axes respectively. Incidentally, DY/DX is the slope of the line. Each time through the loop, X0 and Y0 are incremented until they are equal to the endpoint of the line, when the loop is finished. Notice that X0 is always incremented by 1, but Y0 is incremented by a floating-point value between 0 and 1. Presumably, the plotting device or graphics hardware on a computer can only plot to integer positions, so Y0 must be truncated or rounded off before it is used.

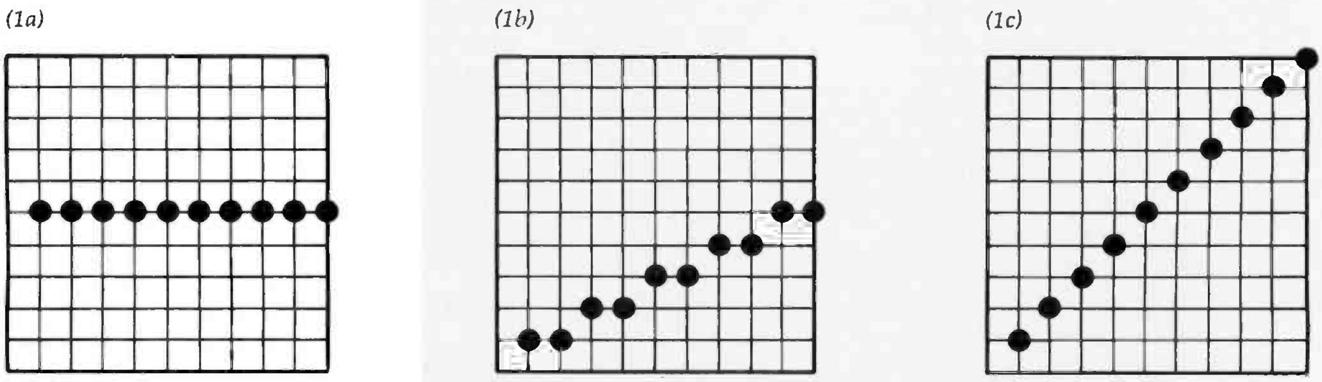


Figure 1: *Examples of simple lines represented by individual coordinate points.*

Newman and Sproull's most sophisticated algorithm separated all the integer operations from the floating-point ones. (See listing 2a.) In the first line of this routine, the remainder value, R, is initialized to ½, so that all results that follow will be rounded off automatically. The slope is calculated outside the loop, so the only floating arithmetic that must be done is addition and subtraction. The integer variable Y0 is incremented by 1 every time R climbs back to a value of 1 or more. After all this work, however, the algorithm still uses floating-point arithmetic, so one further step is required.

I took this algorithm and multiplied all the floating-point equations by DX to come up with a different procedure. (See listing 2b.) Note that the slope calculation can now be eliminated, because the slope, DY/DX, multiplied by DX is equal to DY. Now all the equations in the procedure can be done quickly with integers. The division where R is initialized to DX/2 is the only operation that might take more time; being outside the loop, it is done only once.

This procedure can be adapted to assembly language, where a divide by 2 is a right-shift instruction. In fact, I have written this procedure in Z80 assembly language in which all the variables were stored in the processor registers. That routine can flash a line onto the screen in between video refreshes, and allows some highly interactive programs to be written when called from BASIC.

Even this algorithm, however, has the restrictions mentioned earlier; ie: it only works on lines that have slopes between 0 and 1, and can only draw from left to right, bottom to top. To solve several of these problems, I changed the procedure so that variables are added to X0 and Y0 rather than a constant +1. (See listing 3.) These variables are initialized to 1, but are changed to −1 if the line goes right to left or top to bottom.

The algorithm still needs a way to cope with slopes that have absolute values greater than 1. My solution in those cases is to transpose the axes. That's not as complicated as it sounds, because it means I pretend that the x axis is the y axis and vice versa. When you do that, the slope of the resulting line is always the reciprocal of what it was before, and values greater than 1 become less than 1. To see how this is done, refer to the sample program in listing 4 on page 416.

The subroutine in listing 4 is very flexible. Instead of performing the loop with FOR . . . NEXT statements, it returns each point one at a time to the calling program. I use this routine to plot on a Qume printer/plotter, to move a spaceship or a torpedo on a graphics display grid, and even to draw lines. Each of these applications does something different with the x-y coordinate pairs that the routine returns, but the same routine is used in all of them. The routine returns coordinates and lets the individual main program decide what to do with each pair. Your programs would, perhaps, run faster if you optimized the subroutine for the individual program you use it in. I prefer using modular programming methods, where a routine like this one can be used in several different programs without change.

When I originally wrote the subroutine in listing 4, I used multiple-statement lines, making it much smaller. I also used more descriptive variable names like DX, AX, SX, etc. The routine has been rewritten in elementary BASIC to make it more transportable. Have fun, and good luck! ■

Listing 1: *In the simplest form of the DDA algorithm, DX is the difference of the x coordinates of the starting and end points of a simple line; DY is the difference of the y coordinates. The coordinates of the starting point, X0 and Y0, are incremented until they are equal to the coordinates of the end point.*

```
FOR I = 1 TO DX
     XØ=XØ+1
     YØ=YØ+(DY/DX)
NEXT I
```

Listing 2: *Improved line-drawing algorithms. Listing 2a, which is more easily adapted for graphics hardware, produces only integer values for Y0. Listing 2b is the same procedure with the floating-point calculations completely eliminated.*

(2a)

```
R=Ø.5
SLOPE=DY/DX
FOR I = 1 TO DX
     XØ=XØ+1
     R=R+SLOPE
     IF R >= 1.Ø THEN YØ=YØ+1 :  R=R-1.Ø
     PLOT XØ,YØ
NEXT I
```

(2b)

```
R=DX/2
SLOPE=DY
FOR I = 1 TO DX
     XØ=XØ+1
     R=R+SLOPE
     IF R >= DX THEN YØ=YØ+1 :  R=R-DX
     PLOT XØ,YØ
NEXT I
```

Listing 3: *Revision of listing 2 which will draw lines from right to left and top to bottom as well as vice versa.*

```
R=DX/2
AX=1
SY=1
IF DX < Ø THEN DX=ABS(DX) :  AX=-1
IF DY < Ø THEN DY=ABS(DY) :  SY=-1
FOR I = 1 TO DX
     XØ=XØ+AX
     R=R+DY
     IF R >= DX THEN YØ=YØ+SX :  R=R-DX
     PLOT XØ,YØ
NEXT I
```

Listing 4: *Sample BASIC program that returns the x and y coordinate points between given starting and end points. Lines of any slope between −1 and 1 can be calculated with this version of the DDA algorithm.*

```
10 REM ********************************************
20 REM PROGRAM TO DEMONSTRATE THE LINE SUBROUTINE
30 REM *********************************************
40 PRINT "WHAT IS THE FIRST POINT";
50 INPUT XØ,YØ
60 PRINT "WHAT IS THE SECOND POINT";
70 INPUT X1,Y1
80 GOSUB 6000
90 PRINT XØ,YØ
100 IF N1>D1 THEN STOP
110 GOSUB 6300
115 PRINT XØ,YØ
120 GO TO 100
5974 REM**********************************
5975 REM LINE DRAWING ROUTINE.  THIS ROUTINE RETURNS
5976 REM ALL THE X,Y CO-ORDINATE POINTS BETWEEN
5977 REM TWO POINTS.  THE STARTING AND ENDING CO-ORDINATES MUST
5978 REM BE SENT IN THE VARIABLES XØ,YØ AND X1,Y1.  TO INITIATE
5979 REM A LINE, YOU MUST GOSUB 6000.  TO GET EACH SUCCESSIVE POINT,
5980 REM YOU GOSUB 6300, AND THE NEXT POINT IS RETURNED IN XØ,YØ.
5981 REM TO TELL WHEN THE LINE IS FINISHED, YOU
5982 REM MUST CHECK THE VARIABLE N1, IF N1<=D1 THEN THERE ARE
5983 REM STILL MORE POINTS TO GO.
5984 REM
5985 REM VARIABLES USED:
5986 REM    XØ,YØ,X1,Y1 - PARAMETERS SENT TO THE LINE ROUTINE
5987 REM    XØ,YØ,N1,D1 - RETURN VALUES AND STATUS
5988 REM    D2,D3,S1,S2,A1,A2 - INTERNAL SCRATCH VARIABLES.
5989 REM NONE OF THESE VARIABLES SHOULD BE USED IN YOUR MAIN PROGRAM
5990 REM ******************************************************
6000 D1=X1-XØ
6010 D2=Y1-YØ
6020 S1=Ø
6030 S2=1
6040 A1=1
6050 A2=Ø
6060 IF D1>=Ø GO TO 6090
6070 A1=-1
6080 D1=-D1
6090 IF D2>=Ø GO TO 6120
6100 D2=-D2
6110 S2=-1
6120 IF D1>=D2 GO TO 6200
6130 N1=D1
6140 D1=D2
6150 D2=N1
6160 S1=A1
6170 A1=Ø
6180 A2=S2
6190 S2=Ø
6200 D3=D1/2
6210 N1=1
6220 RETURN
6230 REM ******************************************************
6240 REM HERE IS WHERE THE DDA (DIGITAL DIFFERENTIAL ANALYZER)
6250 REM ALGORITHM IS ACTUALLY PERFORMED.  EACH GOSUB TO THE ROUTINE
6260 REM INCREMENTS XØ,YØ BY THE CORRECT AMOUNT.   WHEN N1>D1 THE LAST
6270 REM POINT HAS ALREADY BEEN RETURNED, AND SUCCESSIVE CALLS WILL
6280 REM EXTRAPOLATE XØ,YØ PAST THE END POINT OF THE LINE.
6290 REM *******************************************************
6300 XØ=XØ+A1
6310 YØ=YØ+A2
6320 D3=D3+D2
6330 N1=N1+1
6340 IF D3<=D1 THEN RETURN
6350 D3=D3-D1
6360 XØ=XØ+S1
6370 YØ=YØ+S2
6380 RETURN
```

Word Ujbnmurle

Leonard Gorney, Box 91 RD 5, Clarks Summit PA 18411

Here is a short routine I use on my Radio Shack TRS-80 Model I Level II when I try to solve scrambled word puzzles in a "friendly" game of Scrabble, or the like.

The program accepts the letters you wish to form into an acceptable English word, rearranges the letters in a random fashion, and prints each rearrangement for viewing. This method parallels the situation in which a monkey is given a typewriter. How long will it take the monkey, typing at random, to type an English word? The program plays the part of the monkey.

The user of this short routine must look at each of these rearrangements to see if a valid English word is printed. At times, a valid English word will magically appear on the screen; however, the human eye and brain can, in more cases than not, discern a particularly scrambled string of letters as an English word. This will often be the case, even though many of the letters are not in their proper positions within the word.

As an example of this, look again at the second word of the title of this article. Can you discern what English word is represented by that string of letters? How about this string of letters: ENLIGSH ?

Listing 1: *This routine in Radio Shack TRS-80 Level II BASIC accepts a string of up to 30 letters and displays them in a randomly rearranged form. Ideally, the user will be able to discern the English word in the jumbled letters.*

```
1000 REM  WORD UNJUMBLER
          LEN GORNEY
1010 DIM A$(30), B(30)
1020 REM  FORCE 32 CHARACTERS/LINE MODE
1030 CLS: PRINT CHR$(23)
1040 PRINT TAB(7);"ENTER YOUR LETTERS": INPUT W$
1050 REM FILL EACH A$ LOCATION WITH ONE LETTER
       FROM W$
1060 FOR J = 1 TO LEN(W$): A$(J) = MID$(W$,J,1):
       NEXT J
1070 REM A LOCATION IN B WILL BE ZERO IF LETTER NOT
          USED YET OR A -1 IF LETTER USED BEFORE
1080 FOR J = 1 TO LEN(W$): B(J) = 0: NEXT J
1090 CLS: PRINT CHR$(23)
1100 REM GENERATE A RANDOM NUMBER IN THE RANGE 1
          TO LEN(W$) USE THIS NUMBER TO PICK A LETTER
          FROM A$
1110 N = RND(LEN(W$))
1120 IF B(N) = 0 THEN PRINT A$(N);: B(N) = 1
1130 REM HAVE ALL THE INPUT LETTERS BEEN
       REARRANGED ?
1140 FOR J = 1 TO LEN(W$): IF B(J) = 0 THEN 1110
1150 NEXT J
1160 REM STALL THE REARRANGED WORD FOR VIEWING
1170 FOR J = 1 TO 1000
1180 NEXT J
1190 GOTO 1080
1200 END
```

Permutations

Mathematically, rearranging a given set of letters involves the application of permutations. For example, given the letters GELNSIH, the number of different ways in which those 7 letters can be rearranged to give different rearranged strings is equal to 7 ! (read 7 factorial) or $7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$ which is equal to 5040 different rearrangements. This program does not use this idea; rather, the input set of letters is rearranged randomly. Usually, a certain rearrangement of the input string will be sufficient for the user to "see" the English word in that set of letters. This assumes that an acceptable English word can be spelled by using those input letters. Otherwise, you will continue to see gibberish on your screen.

Program Operation

Running the program is rather easy; the only external entry you need to make is to enter the letters you wish to unscramble. Just press each letter key, and when you are finished with the string, press the enter key.

Each rearrangement of those input letters will be displayed on the screen in 32-character-per-line mode. The choice of a maximum of 30 characters for the input set of letters was done so that the entire word would fit on a single line of the screen. Each rearrangement will be frozen on the screen for approximately 2 seconds. When you see a particularly suitable rearrangement, press the *break* key to stop the program. Not being a particularly intelligent monkey, the computer will continue printing rearrangements until it powers down, unless stopped in this way. ■

Binary-to-BCD Converter Program for the 8080

D M Brockman, 11648 Military Rd S, Seattle WA 98168

Conversion of multiple-precision binary numbers to BCD (binary-coded decimal) for printing or display output is often encountered in assembly-language programming. The algorithm described here makes use of the 8080's DAA (decimal-adjust accumulator) instruction to implement the BCD analogy of a binary shift-left register. With this algorithm, a binary number is converted to packed BCD (2 digits per byte) by shifting the binary number, MSB (most significant bit) first, bit by bit, into the least significant end of the BCD register. (See figure 1.) When the last binary bit has been shifted in, the result is in the BCD register.

To understand how the BCD register operates, consider a conventional binary-shift register. When shifted left, the numeric content doubles and the carry input (if any) comes in at the least significant end. The same thing happens when the BCD register is "shifted." The numeric doubling is accomplished by adding the BCD register to itself using BCD arithmetic. The carry is brought in by using the ADC (add with carry) instruction for the first "add."

A typical implementation of the algorithm is shown in listing 1 in the form of an 8080 assembly-language listing. Looping constructs have been employed to minimize size. For maximum speed, the loops should be "unrolled." The implementation converts a 32-bit (4-byte) binary number into a 10-digit (5-byte) packed BCD result. The number of bytes converted can be easily changed by altering the looping counters. Note that the number of BCD result bytes required is given by:

Number of BCD bytes = INT(0.5 + 1.204 × (Number of binary bytes))

An advantage of this algorithm is that the conversion time is independent of the size of the number being converted. The sample routine in listing 1 requires 13,944 machine cycles to execute. The results of a typical run of the sample routine are shown in table 1. ■

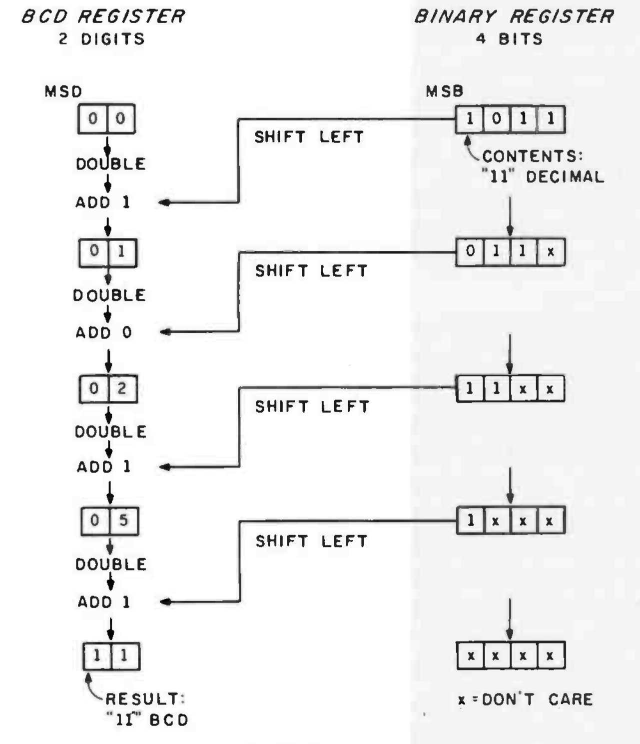


Figure 1: *Contents of the BCD and binary registers during the conversion process using the program shown in listing 1.*

Memory Address	Before Run	After Run
BIN:		
0200	3A	00
0201	F6	00
0202	23	00
0203	81	00
BCD:		
0204	XX	58
0205	XX	76
0206	XX	61
0207	XX	66
0208	XX	21

Table 1: *A sample run of the binary-to-BCD converter program shown in listing 1. All numbers shown are hexadecimal. XX indicates a don't care.*

Listing 1: *A binary-to-BCD converter program for the Intel 8080 microprocessor.*

```
                ;TITLE "BINARY TO BCD CONVERTER"
                ;BY D. M. BROCKMAN, 11648 MILITARY RD. SO., SEATTLE, WA 98168
                ;
                ;THIS SUBROUTINE CONVERTS THE 32-BIT BINARY NUMBER STORED
                ;  AT 'BIN' TO A 10-DIGIT PACKED BCD NUMBER STORED AT 'BCD.'
                ;  REGISTERS B, C, H, L, AND A ARE USED.
                ;
                ;
                ;DEFINE STORAGE FOR NUMBERS:
                ;
0200                    ORG 200H
0200            BIN:    DS 1            ;LSB BYTE
0201                    DS 2
0203                    DS 1            ;MSB BYTE
                ;
0204            BCD:    DS 1            ;LS DIGITS
0205                    DS 3
0208                    DS 1            ;MS DIGITS
                ;
                ;
                ;INITIALIZE THE BCD RESULT BYTES TO ZERO:
                ;
0100                    ORG 100H
0100 210402     BINBCD: LXI H,BCD       ;POINT AT RESULT
0103 0605               MVI B,5         ;SET LOOP COUNTER
0105 3600       ILOOP:  MVI M,0         ;STORE A ZERO
0107 23                 INX H           ;POINT TO NEXT BYTE
0108 05                 DCR B           ;DECREMENT LOOP COUNTER
0109 C20501             JNZ ILOOP       ;LOOP IF NOT DONE
                ;
                ;INITIALIZE THE BIT COUNTER TO EQUAL THE NUMBER OF
                ;  BINARY BITS TO BE SHIFTED:
                ;
010C 0620               MVI B,32        ;NUMBER OF BITS TO SHIFT
                CLOOP:                  ;THE MAIN LOOP POINT
                ;
                ;INITIALIZE FOR A MULTIPLE PRECISION LEFT SHIFT
                ;  OF THE BINARY NUMBER:
                ;
010E 210002             LXI H,BIN       ;POINT AT NUMBER
0111 0E04               MVI C,4         ;NUMBER OF BYTES
0113 AF                 XRA A           ;CLEAR THE CARRY
                ;
                ;SHIFT THE BINARY NUMBER ONE PLACE LEFT AND LEAVE THE MSB
                ;  IN THE CARRY:
                ;
0114 7E         RLOOP:  MOV A,M         ;GET BYTE
0115 17                 RAL             ;SHIFT LEFT
0116 77                 MOV M,A         ;STORE BYTE
0117 23                 INX H           ;POINT AT NEXT BYTE
0118 0D                 DCR C           ;DECREMENT BYTE COUNT
0119 C21401             JNZ RLOOP       ;LOOP IF NOT DONE
                ;

                ;INITIALIZE TO DOUBLE THE BCD RESULT REGISTER CONTENTS
                ;  BY PERFORMING A MULTIPLE PRECISION BCD ADD:
                ;
011C 210402             LXI H,BCD       ;POINT AT RESULT
011F 0E05               MVI C,5         ;SETUP BYTE COUNTER
                ;
                ;DOUBLE THE RESULT BCD FASHION, ADDING IN THE CARRY BIT:
                ;
0121 7E         BLOOP:  MOV A,M         ;GET BYTE
0122 8E                 ADC M           ;ADD IT TO ITSELF
0123 27                 DAA             ;BCD CONVERT
0124 77                 MOV M,A         ;RESTORE
0125 23                 INX H           ;POINT AT NEXT BYTE
0126 0D                 DCR C           ;DECREMENT BYTE COUNTER
0127 C22101             JNZ BLOOP       ;LOOP IF NOT DONE
                ;
                ;TEST TO SEE IF ALL BITS HAVE BEEN SHIFTED FROM BINARY
                ;  NUMBER TO THE BCD RESULT. IF NOT, RETURN TO MAIN LOOP.
                ;
012A 05                 DCR B           ;DECREMENT BIT COUNTER
012B C20E01             JNZ CLOOP       ;LOOP IF NOT DONE
012E C9                 RET


012F                    END

A>
```

What's New?

PERIPHERALS

Graphics for Okidata Printers

The PF/2A print formatter uses the plotting capabiltity of the Okidata SL125 and SL250 printers to create bar codes, variable-size and aspect-ratio characters, product and corporate logos, variable-forms layouts, banners, and signs. The formatter permits normal matrix-character printing as well. The PF/2A has a suggested retail price of $2295. Contact Technical Analysis Corporation, 120 W Wieuca Rd NE, Atlanta GA 30042, (404) 252-1045.

Circle 500 on inquiry card.

Phonetic Speech Kit from Votrax

A sample voice-synthesizer evaluation kit is available from Votrax. The Speech PAC (Phoneme Access Controller) is a circuit board made up of a speech integrated circuit, external controller, memory, and an on-board audio amplifier. The unit comes with 250 words and phrases stored in memory that can be intermixed with phoneme sequences to provide an unlimited vocabulary. Priced at $275, the Speech PAC can be expanded and configured into microcomputer systems.

For complete details, contact Vortrax, 500 Stephenson Hwy, Troy MI 48084, (800) 521-1350; in Michigan (313) 588-0341.

Circle 501 on inquiry card.

Hard Copy for $299

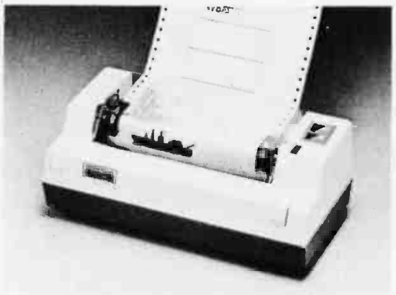
Microtek Inc has announced a $299 dot-matrix printer. The Bytewriter-1 features 80 columns and accepts single-sheet or roll paper up to 8½ inches wide. It prints at 60 lpm (lines per minute) using a 7 by 7 matrix. The interface is similar to Centronics's and has been designed to operate with the Apple II, Atari 400 and 800, and all TRS-80 microcomputers. Contact Microtek Inc, 9514 Chesapeake Dr, San Diego CA 92123, (714) 278-0633.

Circle 502 on inquiry card.

Amtek's Universal Terminal

The ABM 80 video terminal can replace most commercial terminals. It features a 12-inch high-resolution green screen; numeric and special-function keypad; editing, block, and monitor modes; protective and unprotective fields; foreground and background; programmable key click; and margin bell. It includes 7 by 9 dot matrix upppercase and 7 by 11 lowercase. Switch-selectable emulation of Hazeltine 1500, ADDS 25, ADM-3A, and VT-52, with block mode and advanced editing features, is included in this $800 terminal. Contact Amtek Business Machines Inc, 2255H Martin Ave, Santa Clara CA 95050, (408) 727-1510.

Circle 503 on inquiry card.



Single-Hammer Printer

The GP-80M printer uses a single print hammer in a 5 by 7 dot matrix. It can print graphics and alphanumerics. The GP-80M uses a rotating platen with protruding splines positioned behind the paper. The image is created by multiple hammer strikes as the printhead moves across the paper in front of the platen. Features include upper- and lowercase character sets, up to 80 columns with 12 characters per inch, tractor feed, three-copy reproduction, 12 W power consumption, and a Centronics parallel interface. RS-232C and other common interfaces are optional.

The graphics capability provides more than 60 dots per inch. Dot graphics and alphanumerics can be mixed under software control. Print speed is 30 cps (characters per second). The price is $399 from Axiom, 1014 Griswold Ave, San Fernando CA 91340, (213) 365-9521.

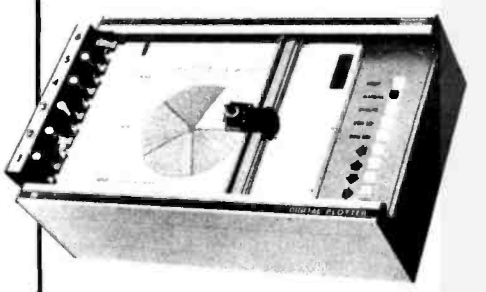
Circle 504 on inquiry card.

Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

What's New?

PERIPHERALS



Six-Pen Option for Hi-Plot Plotters

A six-pen plotter option is available for the Houston Instrument DMP plotters. The pens come in black, red, blue, green, violet, orange, and optional brown. They work under program control and can be retrofitted into any of the Hi-Plot plotters. The $395 pen option can be installed by users except on the DMP-5, -6, and -7, which can be connected at the factory for $100. A program for generating graphs and charts, HIgraph-1, is available. For details, contact Houston Instrument, 1 Houston Sq, Austin TX 78753, (512) 837-2820. Circle 505 on inquiry card.

A Clock for the Apple II

Time II is a real-time clock and calendar for the Apple II. It measures time in hours, minutes, and seconds, and provides dates with year, month, date, day of week, and leap-year information. The board features a 24-hour military format or a normal 12-hour format. Time II permits foreground and background operation of two programs simultaneously, so users can call up schedules, time events, and date listings. An onboard backup battery provides more than four months of power-off operation.

Time II is available for $150 from Applied Engineering, POB 470301, Dallas TX 75247, (214) 492-2027.

Circle 506 on inquiry card.

Smartmodem from Hayes

The Smartmodem is an FCC (Federal Communications Commission) approved direct-connect device. It has an RS-232C port and can be program-controlled in any language by ASCII (American Standard Code for Information Interchange) character strings. The modem analyzes and executes commands and can send codes in English words or decimal digits. The Smartmodem has auto-dial and auto-answer capabilities, both of which can be combined within a command.

The Hayes Stack Smartmodem can be connected to any kind of telephone. An audio monitor can alert users to wrong numbers and busy signals. If a busy signal is encountered, the Smartmodem redials the number at any time. Operation can be in full- or half-duplex with a data rate of 0 to 300 bps (bits per second). One command selects the dialing speed, escape-code characters, and number of rings to answer on. The suggested price for the modem is $279, including a power pack, a cable, and a manual. For details, contact Hayes Microcomputer Products Inc, 5835 Peachtree Corners E, Norcross GA 30092, (404) 449-8791. Circle 507 on inquiry card.

Disk Doubler

The Disk Doubler converts a single-sided 5-inch floppy disk into a double-sided floppy disk. Using the kit's tools, you can measure, mark, and punch new openings in the disk's protective sheath. The punch can't damage the disk. The Disk Doubler costs $6.95 and is available from the Beals Agency, 4141 Fairmount Ave, San Diego CA 92105, (714) 284-1145.

Circle 508 on inquiry card.

Speed-Up Board for the TRS-80

Simutek's Micro-Speed board is for the TRS-80 Model I Level II computer. The Micro-Speed increases the microprocessor clock rate to 2.66 MHz, which is almost 50% faster than the standard rate. The unit divides the system-clock signal differently to make the computer operate at this speed. Operation can be switched back and forth between regular and high speeds. The board is not software-dependent. Micro-Speed returns the computer to normal speed during access of the floppy disk or cassette; it returns to high speed upon completion of the I/O (input/output) operation. The only drawback to the device is that the Radio Shack warranty is void after installation of the unit, which requires some soldering.

The board, switch, and wires cost $29.95. Contact Simutek, POB 13687, Tucson AZ 85732.

Circle 509 on inquiry card.

Microcomputer Modem

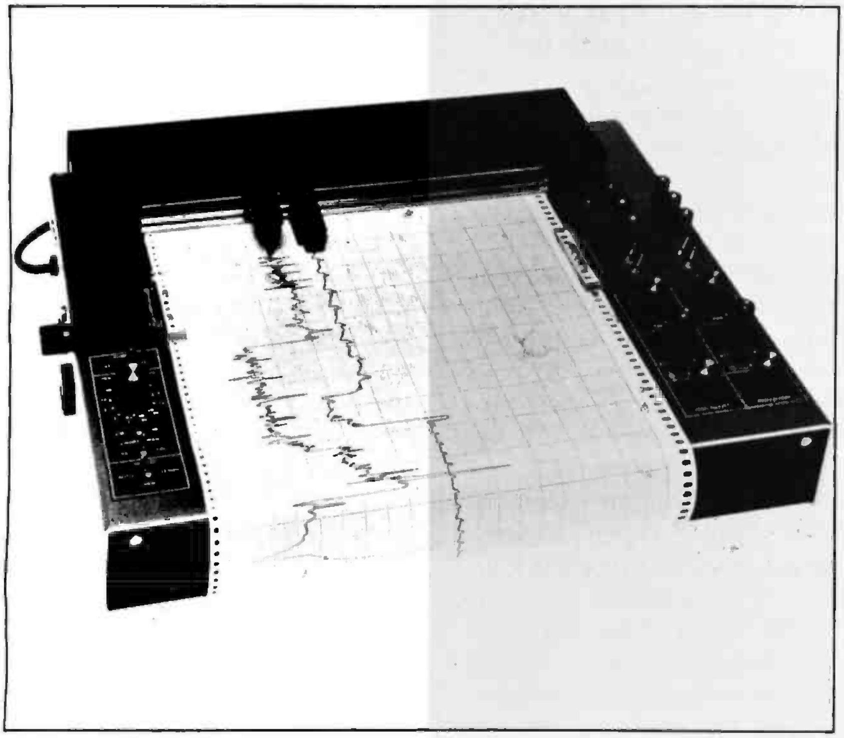
The 103J-L is a 300 bps (bits per second) modem that costs less than $200. It operates over all rotary-telephone lines, even those that cannot be used by line-powered units. Data or talk modes are switch-selectable, and the answer and originate modes are automatic. An indicator shows transmit- and receive-data activity, and a carrier-detect indicator shows a call is established. For installation, the plug from the telephone connects to a jack in the 103J-L's rear panel. A connector from the modem accesses the telephone line.

For complete details, contact General DataComm Industries Inc, 1 Kennedy Ave, Danbury CT 06810, (203) 797-0711.

Circle 510 on inquiry card.

What's New?

PERIPHERALS



Strip-Chart Recorders

The Series MR English/Metric strip-chart recorders in single- and dual-pen versions provide speeds of 0.05 to 20 inches per minute and per hour and 1 to 50 cm per minute and per hour. Other features of the Series MR include fifteen calibrated input ranges from 1 mV to 50 V, input on/off and positive or negative polarity reversal switches, manual chart rewind/advance, electric and remote pen lift, and automatic shutdown for over-range signals. The single-pen recorder is $810 and the dual-pen is $1180. Contact Pedersen Instruments, 2772 Camino Diablo, Walnut Creek CA 94596, (415) 937-3630.

Circle 511 on inquiry card.

Interface for Analytical Instruments

SmartFact connects to the analog output of any analytical instrument and uses an RS-232C format for transmission. Two instruments can be connected simultaneously. The instrument's output is sampled at 0.1 or 1 second intervals and transmitted at one of six selectable data rates. The analog signals are converted into 16-bit words. X and Y signals from an instrument can be monitored and digitized.

Applications include peak picking in UV or AA quantitative analysis, calculation of retention time in gas or liquid chromatography, preparing peak tables for qualitative infrared comparisons, logging sample weights from an analytical balance, or determining the endpoint of an automatic titration. For information, contact Analytical Computers, POB 285, Elmhurst IL 60126.

Circle 512 on inquiry card.

Super Keyboard

The MFJ Model MFJ-496 keyboard sends CW (continuous wave), baudot, and ASCII (American Standard Code for Information Interchange) with a 256-character buffer, 256-character programmable message memory, four automatic messages, two random-code practice modes, data-rate and buffer metering, backspace delete, buffer-memory hold, automatic serial numbering, repeat/delay, and a paddle input port. One or two keystroke combinations execute all commands. Five-level baudot is transmitted at 60 words per minute. In the ASCII mode, transmission speed is 110 bps (bits per second).

The MFJ-496 operates on 9 to 12 V DC. It costs $339.95 and is available from MFJ Enterprises Inc, POB 494, Mississippi State MS 39762, (800) 647-1800; in Mississippi (601) 323-5869.

Circle 513 on inquiry card.

Voice Synthesis for Heath Computers

The V-8 Voice Synthesizer for Heath H-8 and H-89 computers uses the Votrax VSL Phoneme Module, which, under program control, adds the capability of inflection or range to synthesized speech. Software for the V-8 includes a device driver and several English-speaking programs. The V-8 can be used with any computer having an available parallel port. Eight data and two handshaking lines are required.

The V-8 Voice Synthesizer costs $149, which does not include the VSL module. A sample voice cassette is available for $5.

For additional details, contact M.I.-8, 822 E County Rd 30, Fort Collins CO 80525, (303) 669-4116. Votrax can be contacted at 500 Stephenson Hwy, Troy MI 48084, (800) 521-1350; in Michigan (313) 588-0341.

Circle 514 on inquiry card.

What's New?

SOFTWARE

Ultrasort Gives CP/M Users Fast Sorts

Ultrasort II is an 8080 and Z80 machine-language program that allows CP/M and CBASIC2 users to sort, merge, or select records from data files, or to find the number of logical records in a file. It can be used as a stand-alone utility or as a subroutine called from CBASIC2. Ultrasort II sorts on up to five keys, and fields can have a fixed or a variable length. Strings can optionally be floated as numeric fields; numeric fields are automatically floated. A select capability permits either omitting or including records that are less than, equal to, or greater than up to four independent select keys. Ultrasort II is available from Computer Control Systems Inc, 298 21st Ter SE, Largo FL 33541.

Circle 516 on inquiry card.

Letter Perfect for the Atari

Letter Perfect is a word-processing package for the Atari 800. It features proportional spacing, page numbering, headers, footers, and underlining. Embedded commands in text for expanded, normal, and condensed print are possible. The program is menu-driven. The user can change drive numbers; edit, load, save, merge, print, lock and unlock, and delete files; format disks; and perform a data-base merge for mailings. Printing and screen formats are programmable. Text block moves, scrolling forward and backward, scrolling speed, search, tabbing, and character and line insertion and deletion are among its features. Letter Perfect is available for $150 from LJK Enterprise Inc, POB 10827, St Louis MO 63129, (314) 846-6124.

Circle 517 on inquiry card.

Tiny Pascal Plus+ for PET and Apple II

Tiny Pascal Plus+ is an enhanced version of Tiny Pascal with support for graphics. The package runs on 32 K-byte PET and Apple microcomputers. This Pascal includes a line editor, compiler, interpreter, and numerous structured programming commands. GRAPHICS, PLOT, POINT, TEXT, INKEY, ABS, and SQR are among the other command functions.

Tiny Pascal for the PET supports double-density plotting, giving 80 by 50 plot positions. The Apple version supports low- and high-resolution graphics. Tiny Pascal on floppy disk costs $50. The PET cassette version costs $55. Nongraphics versions are $35 on disk and $40 on cassette. Contact Abacus Software, POB 7211, Grand Rapids MI 49510.

Circle 518 on inquiry card.

Applegraph Your Business Charts

Applegraph is a software package for general-purpose data plotting in a variety of formats for the business, professional, and research decision maker. The program yields high-resolution, multicolor graphics for video display and hard-copy output. Display formats include pie charts, bar graphs, area plots, points, and solid or dashed lines, produced in any combination of overlays. Applegraph has simple commands that can be entered interactively or in advance. Data can be entered directly or supplied from other programs. Applegraph is available for $200 from Business & Professional Software Inc, POB 11, Kendall Square Branch, 238 Main St, Cambridge MA 02142, (617) 491-3377.

Circle 519 on inquiry card.

APL for the Apple

APL/V80 is now available for the Apple II. It requires the Microsoft SoftCard, CP/M, and a 24 by 80 video board. Another version is available that doesn't require the video card. APL/V80 includes APL arithmetic functions, Boolean and relational functions, selectional and structural functions, and nine general functions. The language has disk-based workspace and copy-object libraries, and supports arrays of up to eight dimensions. The software provides dynamic execution of system commands, canonical representation and function fix, and can use latent expression. APL/V80 allows booting directly into an application program from system power-on. A keyed ISAM (indexed-sequential access method) package, a text editor, and a check-management package are available as options for $50 each.

APL/V80 costs $500. It is available from Vanguard Systems Corporation, 6901 Blanco, San Antonio TX 78216, (512) 340-1978.

Circle 520 on inquiry card.

FORTH for SwTPC Computers

FORTH is available for SwTPC computers with Percom disk drives. This FORTH, based on fig-FORTH, comes on a single-density 5-inch floppy disk and requires 16 K bytes of memory and a Percom disk drive with Mini-DOS. The disk contains the object code, a text editor, and assorted utilities. The manual contains a description of FORTH words, a tutorial, an explanation of the screen editor, and more. The package sells for $24.95 from Greene Software, 6169 Fawn Meadow, Victor NY 14564.

Circle 521 on inquiry card.

What's New?

SOFTWARE

Apple II Graphics System

The 3-D Graphics module is designed for 48 K-byte Apple IIs. It features a drawing module for a high-resolution screen using paddles or a joystick. The 3-D graphics module helps create, view, and manipulate 3-D objects. Color figures can be viewed simultaneously, and each figure can be individually manipulated. An upper- and lowercase character set is provided, along with a set twice as tall and wide. A character editor allows programmers to create and edit large and small fonts. A text module places text anywhere on the screen. Programming instructions are included for using pictures, shape tables, and machine-language subroutines in other programs, along with the file structure for 3-D files.

Typing can be set to overlay, reverse, or erase the background. Editing functions can move points and lines, change colors, and enter, change, and delete coordinates. A shrink utility shrinks pictures to one-quarter to one-sixty-fourth of original size.

Options include a filing routine with more than 100 blended colors, a paintbrush mode that turns the cursor into one of nine different size and shape brushes, and a shape mode that rotates, scales, and plots shapes from a shape table.

The price for this package is $59.95. It requires a 48 K-byte Apple II and Applesoft firmware or the language system. Contact Micro Co-Op, POB 432, West Chicago IL 60185, (312) 231-0912.

Circle 522 on inquiry card.

C for Cromemco Systems

Cromemco has made the C programming language available for use on its microcomputers. C is a general-purpose language that features economy of expression, modern control-flow and data structures, and many operators. C combines the features of assembly languages with the structured-programming techniques available in higher-level languages. It is useful for writing operating systems, language systems, utilities and input/output drivers, communication software, data-base-management systems, file-management software, and fast graphics software.

C operates under Cromemco's Cromix operating system. It produces relocatable code that can be linked with other languages. It is available on 5- and 8-inch floppy disks for $595. For additional information, contact Cromemco Inc, 280 Bernardo Ave, Mountain View CA 94043, (415) 964-7400.

Circle 523 on inquiry card.

Two- and Three-Dimensional Hard-Copy Graphics Programs

Curve is a two-dimensional graphics package that provides users with the capabiltiy to plot Cartesian, parametric, and polar equations as well as data points. Full axes labeling and scaling are provided for linear or logarithmic plotting. Shaded-bar graphs are also included. The program works on Houston Instrument's Hi-Plot plotters and Watanabe plotters. It runs on Apple, TRS-80, PET, and North Star computers.

Another member of the Curve family is Three-D. It can plot surface functions and data or space curves and rotate them a complete 360° with scaled axes and labeling. Hidden lines are optional. The programs cost $199 each. For more information, contact West Coast Consultants, 1775 Lincoln Blvd, Tracy CA 95376, (209) 835-1780.

Circle 524 on inquiry card.

Collection of CP/M Programs

The CP/MUG (CP/M Users Group) has compiled more than 1000 programs for CP/M systems. On 40 floppy disks, these programs are available for a small charge.

CPM/UG.DB is a data base containing references to all the programs on these disks. Each program or collection is referenced by key words. The data base contains references to 22 assemblers and disassemblers, 138 games, 14 versions of Startrek, 35 file-maintenance programs, and 22 languages.

CPM/UG.DB is supplied with Information Master, a data-base program from Island Cybernetics, on single-density 5- or 8-inch disks. The program costs $20, or $15 when ordered with Information Master at $37.50 from Elliam Associates, 24000 Bessemer St, Woodland Hills CA 91367.

Circle 525 on inquiry card.

Data-Base System for Microcomputers

VIM (versatile information manager) is a data-base management system that aids in organizing and retrieving information. VIM can be used in keeping personnel records, inventory, mailing lists, stock transactions, property lists, or it can be used for cataloging items. VIM runs on the TRS-80 Model I and requires a minimum of 32 K bytes of programmable memory, an expansion interface, and one or more disk drives. It also requires a TRSDOS 2.2 or NEWDOS operating system.

The price for the three modules that comprise the entire package is $99.95. Contact Microcosm Inc, POB 2034, Dearborn MI 48123.

Circle 526 on inquiry card.

What's New?

SOFTWARE

Software Tools for Pascal Programmers

The Screen Handler program includes a program to create a file of prompts; a program for adding, changing, deleting, and listing prompts; a test file to include with user programs; and error checking. You can add, change, delete, or display data on a video display. It costs $75.

The Output Formatter has tab functions, automatic page and line counters during program execution, and top-of-form routines. It allows right, left, or center justification of data to be printed and handles printing of strings, integer, and log-integer variables. The Output Formatter costs $37.50.

The Forms Generator includes the Output Formatter and additional software for redesigning reports without programming. The user can choose any number of items from a data list and specify the column and row where they are to be printed. This $49.50 program is useful for insurance claims, checks, invoices, and other forms.

Source code for these programs is available on Apple-compatible or 8-inch floppy disks in UCSD Pascal or Pascal/M. Contact HDP Inc, 222 E Anapamu St, Santa Barbara CA 93101, (805) 965-4477.

Circle 527 on inquiry card.

TRS-80 Spelling Checker

Hexspell is compatible with most of the word-processing programs available for the TRS-80. Hexspell checks words in text files against its 29,000-word vocabulary, while displaying the text for a manual proofreading. Erroneous words are shown and can be immediately replaced. The replacement word is instantly rechecked. A single keystroke teaches Hexspell a new word. Hexspell requires a 48 K-byte TRS-80 Model I with two disk drives. The program is available for $69 from Hexagon Systems, POB 397, Station A, Vancouver, British Columbia, V6C 2N2, Canada, (604) 682-7646.

Circle 528 on inquiry card.

SB/E Version 4 for the SuperBrain

SB/E version 4 is a firmware and software set enhancing CP/M on the Intertec SuperBrain. Disk capacity is increased 16% and the track-to-track step rate is five times faster. With the new version, the spindle motor can be shut off when the disks are not being accessed.

SB/E Version 4 features the capability to program 35 keys, buffered I/O (input/output) on either RS-232C port, programmable handshaking modes, and automatic repeat on all keys. A real-time clock is included.

SB/E version 4 is available for standard and quad-density SuperBrains, for DOS versions 3.0 or later. The price is $195.

For additional information, contact IE Systems Inc, 98 Main St, POB 305, Newmarket NH 03857, (603) 659-5891.

Circle 529 on inquiry card.

Dow Jones Service for TRS-80

Owners of TRS-80 microcomputers and Videotex equipment can now access information services from the Dow Jones Corporation. The service's data base contains current and past news stories from the Dow Jones News Service, The Wall Street Journal, and Barron's National Business and Financial Weekly (all Dow Jones Company Inc publications). The service includes price quotations on more than 6000 stocks and other securities and offers access to revenues, earnings, dividends, price-earnings ratios, and stock-price performace on 3200 companies and 180 industries.

The package is designed for the Models I, II, III, the Color Computer, and the Videotex terminal. If you purchase the Videotex software ($29.95), terminal ($399), and terminal software ($19.95), you can receive one hour of the Dow Jones service free. Previous purchasers of Radio Shack's old Videotex package are also entitled to one free hour. This package is available from Radio Shack Computer Centers. Contact Radio Shack, 1800 One Tandy Ctr, Fort Worth TX 76102, (817) 390-3568.

Circle 530 on Inquiry card.

Pascal Programmer

The Pascal Progammer provides development modules for those knowledgeable in UCSD Pascal. Designed to lessen coding, testing, and debugging, the program provides source listings, examples, ideas and instructions for modifications, and all needed operating instructions. It contains two floppy disks with source code, library units, and demonstration and utility programs. The Pascal Programmer costs $90 from the Denver Software Company, 36 Steele St, Suite 19, Denver CO 80206, (303) 321-4551.

Circle 531 on Inquiry card.

What's New?

SYSTEMS

Introducing the Ensign

The Ensign microcomputer can support up to sixteen printers or video terminals. It includes a 6 MHz Z80B, 64 K bytes of programmable memory, and two extra Z80s to handle serial I/O (input/output) and disk and tape I/O. Supported software includes MP/M, CP/M, OASIS, and MVT-FAMOS.

The Ensign microcomputer with eight serial I/O ports and 2 megabytes of hard-disk storage costs $7000. Contact Integrated Business Computers, 22010 S Wilmington Ave, Carson CA 90745.

Circle 532 on inquiry card.

Graphics Color System

The MicroAngelo Graphics Color System offers 512 by 480 dot resolution and a choice of up to 256 colors. The system has a user-programmable color lookup table. This Z80-based, S-100 system allows overlays using a bit-plane technology that places no load on the host computer.

With the color system, Scion includes a CP/M package and Colorpak 1, which provides a high-level language interface. The price for the MicroAngelo Color System ranges between $2495 and $8495.

Also available is a $400 EPROM (erasable programmable read-only memory) called the Colorpak II. The Colorpak II doubles character generation, includes split-screen editing, a self-diagnostics routine, and a light-pen interface.

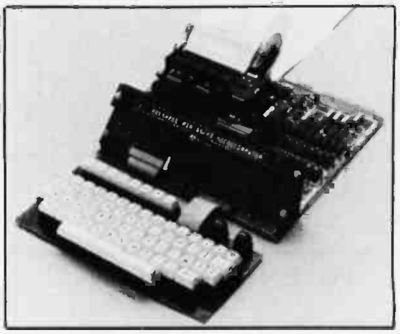
Contact Scion Corporation, 8455-D Tyco Rd, Vienna VA 22180, (703) 827-0888.

Circle 533 on inquiry card.

AIM-65/40

The AIM-65/40 microcomputer is made up of a 6502-based processor board with on-board expansion to 48 K bytes of programmable memory and 32 K bytes of ROM (read-only memory) or EPROM (erasable programmable ROM). It features a 40-column printer with a 280 by N dot matrix and an ASCII (American Standard Code for Information Interchange) keyboard with user-assignable function keys. Six-level priority-interrupt logic and six 16-bit timers are included. Other features include an RS-232C interface with data rates of up to 19 K bps (bits per second), a 20 mA current-loop TTY (teletypewriter) interface, dual audio-cassette interfaces, two user-definable 8-bit parallel ports with handshake control, and an 8-bit serial shift register. I/O (input/output) drivers are resident in ROM.

The printer contains a Centronics-compatible connector, provides upper- and lowercase



ASCII characters, graphics character font, and uses a separate microprocessor. The display module uses a vacuum fluorescent 40-character display. Assembler and other language packages are available.

The price of the AIM-65/40 Model 5000 is $1795. In module form, the single-board computer costs $1195, the printer is $375, the display is $340, and the keyboard is $125. Contact Rockwell International, Electronic Devices Division, 3310 Miraloma Ave, POB 3669, Anaheim CA 92803, (714) 632-2321.

Circle 534 on inquiry card.

The Expander S-100 System

The S-100 Expander microcomputer is built around a Z80 microprocessor. The system has keyboard, video and interrupt circuitry, a real-time clock, parallel printer and RS-232C interfaces, and color capabilities. There is an 80 by 24 screen format, upper- and lowercase, 4 K-byte ROM (read-only memory) monitor, 64 K bytes of programmable memory that's expandable to 512 K, and a tone generator with an internal speaker. The system comes with Microsoft's 24 K BASIC-80 on disk and 10 K BASIC-80 on cassette.

All CP/M and MP/M software

written for the Z80 and other Z80 operating systems will run on the Expander. Additional slots are provided for more S-100 boards. An external video monitor is required. The price is under $2200 from Micro-Expander Inc, 6835 W Higgins Ave, Chicago IL 60656, (312) 792-1196.

Circle 535 on inquiry card.

WE WILL NOT BE UNDERSOLD

DISK DRIVES

FOR TRS-80* Model I

CCI-100	5¼", 40 Track (102K)	$314

ADD-ON DRIVES FOR ZENITH Z-89

CCI-189	5¼", 40 Track (102K)	$394
Z-87	Dual 5¼" system	$995

External card edge and power supply included. 90 day warranty/one year on power supply.

RAW DRIVES
5¼" TEAC or TANDON $ CALL POWER SUPPLIES $ CALL

DISKETTES — Box of 10

5¼"	Maxell	$40	BASF/Verbatim	$26.95
8"	Maxell	$45	BASF/Verbatim	$36.00

PLASTIC FILE BOX-Holds 50 5¼" diskettes			$19.00
PLASTIC LIBRARY CASE	5¼" $3.00	8"	$ 4.00
HEAD CLEANING DISKETTE			$25.00
FLOPPY SAVER	$11.95	RINGS	$ 6.95

16K RAM KITS 2 for $37 $19

200 ns for TRS-80,* Apple II, (specify): Jumpers $2.50

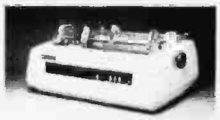
SYSTEM SPECIAL

Apple II Plus 48K w/drive and controller. Epson MX-80 printer and interface. SUP-R Mod RF Modulator: List $2965 You Pay $2299

COMPUTERS/TERMINALS

ARCHIVES	64K, 2-Drives, 77 Track			$ CALL
ALTOS	ACS8000 Series			$ CALL
TRS-80*	II-64K	$3499	III-16K	$ 899
ZENITH	48K, all-in-one computer			$2200
ZENITH	Z-19			$ 725
TELEVIDEO	920C	$ 729	950	$1039
IBM	3101 Display Terminal			$1189
ATARI	400	$ 479	800	$ 795
MATTEL	INTELLIVISION			$ 229
APPLE PERIPHERALS				$ CALL

PRINTERS



NEC SPINWRITER
Letter Quality High Speed Printer

R.O.	$2395
R.O. with tractor feed	$2555
KSR with tractor feed	$2795

NEC SPINWRITER	3500 Series, 5 new models			$CALL
EPSON	MX-70	MX-80	MX-80FT MX100	$CALL
PAPER TIGER				
IDS 445	Graphics & 2K buffer			$ 695
IDS 460	Graphics & 2k buffer			$1050
IDS 560	Graphics			$1450
ANADEX	DP-8000	$ 849	DP-9500/01	$1295
OKIDATA				
Microline 80	Friction & pin feed			$ 415
Microline 80	Friction, and pin & tractor feed			$ 500
Microline 82	Friction & pin feed feed			$ 615
Microline 83	120 cps, uses up to 15" paper			$ 849
CENTRONICS	739, new model with graphics			$ 825

PRINTER SPECIAL

SEIKOSHA GP-80M List $399 You Pay $319

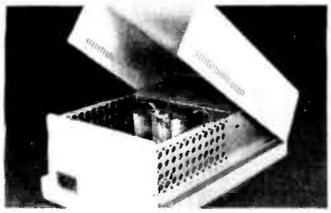
MONITORS

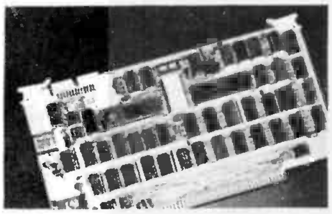
BELL & HOWELL	9" B & W BHD911			$195
LEEDEX	12" B & W	$ 129	13" Color	$369
SANYO	9" B & W VM4509			$149
SANYO	12" B & W DM5012			$219
SANYO	12" Green Screen DM5112			$238
SANYO	13" Color DMC6013			$406
ZENITH	13" Color			$349

TELECOMMUNICATIONS

LIVERMORE STAR MODEM 2-year guarantee	$125
UNIVERSAL DATA SYSTEMS UDS-103	$179
D-CAT HARD WIRED DIRECT MODEM	$189
AUTO-CAT Auto Answer, Direct Connect Modem	$249
D.C. HAYES MICRO-MODEM	$295
CCI Telnet Communications Package	$135

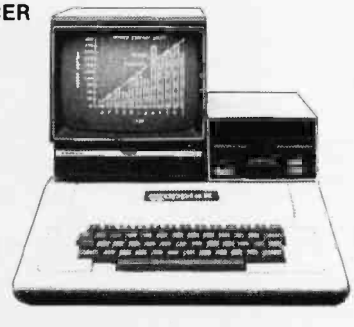
S-100 CALIFORNIA COMPUTER SYSTEMS





MAINFRAME	Model 2200A	$349
Z80 CPU	Model 2810	$259
MOTHER BOARD	Model 2501	$106
16K STATIC RAM, 200ns	Model 2116C	$309
32K STATIC RAM, 200ns	Model 2032C	$619
64K DYNAMIC RAM	Model 2065C	$580
FLOPPY DISC CONTROLLER	Model 2422A	$345
EXTENDER BOARD	Model 2520K	$ 52
2P + 2S I/O	Model 2718A	$309

APPLE ACCESSORIES AND SOFTWARE



VISICALC	$155.00
DB MASTER	$159.00
Z-80 SOFTCARD	$259.00
VIDEX BOARD	$259.00
KEYBOARD ENHANCER	$110.00
16K CARD	$169.00
APPLE JOYSTICK	$ 49.00
SUP-R MOD	$ 25.00
CCS CARDS	$ CALL
GALAXIAN	$ 22.95
SPACE ALBUM	$ 35.00
ASTEROIDS	$ 17.95
FLIGHT SIMULATOR	$ 29.00
WIZARD & PRINCESS	$ 28.00
SARGON 2	$ 29.00
HI-RES FOOTBALL	$ 35.00
MYSTERY HOUSE	$ 24.00

For fast delivery, send certified checks, money orders or call to arrange direct bank wire transfers. Personal or company checks require two to three weeks to clear. All prices are **mail order only** and are subject to change without notice. **Call for shipping charges.**

DEALER (NATIONAL/INTERNATIONAL) INQUIRIES INVITED **Send for FREE Catalogue**

The CPU SHOP

TO ORDER CALL TOLL FREE 1-800-343-6522
TWX: 710-348-1796 Massachusetts Residents call 617/242-3361

5 Dexter Row, Dept. B08M
Charlestown, Massachusetts 02129
Hours 10AM-6PM (EST) Mon.-Fri. (Sat. till 5)

Technical Information call 617/242-3361
Massachusetts Residents add 5% Sales Tax
Tandy Corporation Trademark/®Digital Research

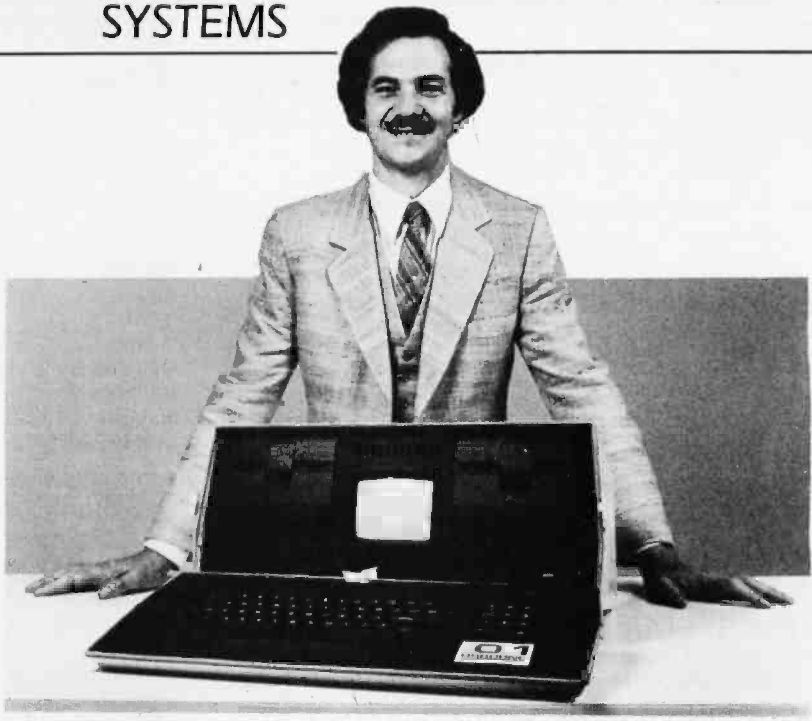
master charge THE INTERBANK CARD

VISA

Circle 93 on inquiry card.

What's New?

SYSTEMS



The Osborne Microcomputer

The Osborne 1 is a portable, briefcase-sized microcomputer. It features a Z80A microprocessor and a video terminal with a 5-inch monitor that displays 52 columns and 24 lines. There are 64 K bytes of programmable memory, serial and IEEE-488 interfaces, dual 100 K-byte floppy-disk drives, and the WordStar word-processing program with the MailMerge option, CP/M, CBASIC and MBASIC, and the SuperCalc program. The monitor is a window on a 128 by 34 row screen, which is implemented in a 4 K by 9-bit programmable memory. In addition, pockets are included for storing up to 20 floppy disks.

Options include double-density, double-sided floppy-disk drives, 9- and 12-inch monitors, a battery pack providing three to five hours of operation, modem electronics, and an acoustic coupler.

The Osborne 1 costs $1795.

Contact Osborne Computer Corporation, 26500 Corporate Ave, Hayward CA 94545, (415) 887-8080.

Talking Terminals for the Blind

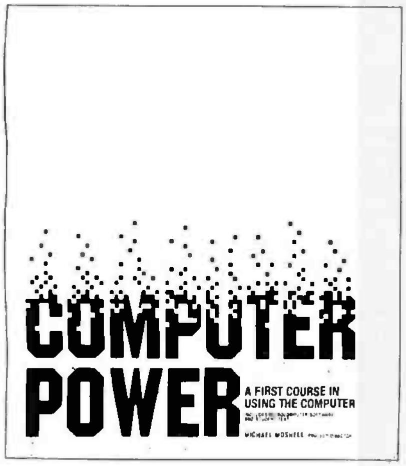
Triformation Systems has introduced a line of free-scan speech terminals (FSST). FSST is a talking unit with an unlimited vocabulary with both on-site and remote capabilities. It permits visually impaired operators to scan material horizontally or vertically through the use of function keys. Varying audible signals tell operators where they are on the page. FSST transmits the data audibly using full words, numerals, or letters spelling out the words. Headphones are available. Data is transmitted at rates up to 9600 bps (bits per second) and uses an RS-232C interface.

The FSST costs $2795 and is available from Triformation Systems Inc, 3132 SE Jay St, Stuart FL 33494, (305) 283-4817.

Circle 537 on inquiry card.

What's New?

MISCELLANEOUS



Computer Power

Computer Power is a new computer-literacy curriculum from the Gregg Division of McGraw-Hill. Based on a unique Pascal interpreter, the materials in each package include: Rascal, an extended version of UCSD Pascal including enhanced graphics and music commands as well as animation; INTERPAS, the Pascal interpreter which allows students to program in Pascal as easily as BASIC by providing an immediate execution mode, single-stepping of programs, extensive error-handling facilities, single-key entry of command words, simplified editing and filing procedures, and the ability to convert debugged INTERPAS programs into standard Pascal programs; and a student text that includes program listings and materials to provide extended learning experiences for each lesson. Also included is an extensive teacher's manual written with the computer-naive teacher in mind. The manual provides complete lesson plans, a step-by-step guide to lesson objectives, instructional activities, instructions on how to use the computer in each lesson, a tutorial on using the computer and the accompanying software, and sections on classroom organization, management, and grading.

Computer Power runs on a 48 K-byte Apple II computer with the Language System, one disk drive, and a color monitor. For more information, contact Computer Power, Gregg/McGraw-Hill (29th floor), 1221 Avenue of the Americas, New York NY 10020.

Circle 538 on inquiry card.

Memory Board from North Star

The HRAM memory boards are designed for North Star systems. The boards feature memory-parity checking and bank-switching capabilities. The boards are Horizon-compatible, and are available in 32 K-, 48 K-, and 64 K-byte configurations.

The boards range in price from $599 for the 32 K-byte board to $1099 for the 64 K-byte board. For more details, contact North Star Computers Inc, 14440 Catalina St, San Leandro CA 94577, (415) 357-8500.

Circle 539 on inquiry card.

8 K-Byte Memory for the VIP

The RCA VIP single-board microcomputer can now have an extra 8 K bytes of programmable memory. The VP-575 System Expansion Board uses 2114 integrated circuits, addresses each 4 K-byte block separately, plugs into the VIP expansion connector or system expansion board, and draws 600 mA from a +5 V supply. The VP-575 costs $149 assembled and tested, and the bare board is $49. Contact G J Krizek, 722 N Morada Ave, West Covina CA 91790.

Circle 540 on inquiry card.

Protecting Apple Software

The Soft Key system is a hardware-oriented antipiracy system for Apple software. The patent-pending system features a set of techniques that can be used by programmers to create their own security schemes. The custom algorithm used in the system is embodied in a noncopyable "key." The key, a custom integrated circuit, is plugged into a master security board to create a protection algorithm unique to the particular program.

The master board, which plugs into the Apple motherboard, is available in 1-, 8-, or 16-key versions, allowing the protection keys for several programs to coreside in the computer. The company claims that its protection scheme causes no significant slowdown in execution time of a program.

The protection key can be used to protect floppy disks, hard disks, and computer-network software. Programs written in Applesoft, Integer BASIC, Pascal, FORTRAN, and the various languages used in conjunction with the Microsoft Softcard, can all be protected by the Soft Key system.

The company charges an initial fee to instruct programmers in the techniques of using the system; program details need not be disclosed to Soft Key to protect the program. The OEM (original equipment manufacturer) price of the product is approximately $18 in quantity for a single keyboard with one custom key. Contact Soft Key Associates Inc, 44 Front St, Ashland MA 01721.

Circle 541 on inquiry card.

INCREDIBLE? BELIEVE IT!

PRINTERS

Qantex 6000

150 cps bidirectional-9x9 dot matrix, quietized case, 136 col, vertical form control and many other functions **$1195**

We feel this printer offers the best price/performance ratio available. RS-232 serial to 19,200 baud supporting X-ON, X-OFF or Current Loop — add $40

	Only
Teletype 40, 300 LPM-typewriter quality, RS-232 interface. This quality printer is available in many configurations including forms access, quietized case, etc.	from $2928
Teletype 43	from $995
NEC Spinwriter-55 cps, bidirectional, letter quality R.O. $2660 KSR	$2942
DIABLO 630-40 cps, bidirectional, daisy wheel, plot/graph	$2270
C. ITOH Starwriter, 25 cps, daisy wheel	$1575
C. ITOH Starwriter, 45 cps, daisy wheel	$1849
EPSON MX-80, 80 cps, 9x9 dot matrix	$515
ANADEX 9500/9501, up to 200 cps, high resolution dot	$1349
OKIDATA Microline 80, 80 cps, 9x7 dot matrix	$490
Microline 82, bidirectional, friction/pin feed	$599
Microline 83, bidirectional, 120 cps, uses 15" paper	$875
TI-810, 150 cps, Basic	$1695
Package-Compressed print, vertical form control	$1830
CENTRONICS 704-9,180 cps, 9x9 dot matrix, 132 col, RS-232	$1595
704-11,180 cps, 9x9 dot matrix, 132 col, parallel	$1695
730,100 cps, 7x7 dot matrix, same as R.S. LPII	$660
737,80 cps, nx9 dot matrix, same as R.S. LPIV proportional spacing	$849
DEC LA-34	$1085
IDS 460G	$1199

S-100 SPECIALTIES

We offer all of Delta's systems — from their cost effective single user system to extensive multi-user networks of computers and terminals. Many disk, tape and Winchester configurations are available.

Systems Group: Call us for best prices on these high quality 2nd generation boards and systems.

California Computer Systems: These high quality, reliable products have made CCS defacto industry standard for S-100 products. Assembled and tested:

		list	only
2200	H.D. Mainframe, 20 a. P.S., 12 slot MB	$434	$359
2065C	64K dynamic RAM/Bank Select	$720	$580
2810A	Z-80 CPU, serial port, ROM monitor	$310	$259
2422A	Floppy Cont, CP/M 2.2, ROM monitor	$425	$345
SSM	**CB2 Z-80 CPU**	$344	$295
	2P + 2S I/O interface	$290	$249

NNC 2 board set Z-80A CPU, CP/M 2.2, floppy disc controller 2 serial, 3 parallel ports, PROM, I/O cable — $765

SUPERBRAIN — $call

Similar savings on the full lines of **CCS, SSM, NNC, MORROW, DELTA, NORTHSTAR, ITHACA INTERSYSTEMS, GODBOUT, NEC, TELEVIDEO, IMS and ZENITH.**

8" DISK DRIVE SALE

8" SHUGART SA801R	$429
Premium double sided drives: **8" SHUGART SA851R**	$625
or **QUME DATATRACK 8**	2 for $1199
Enclosure, power supply for 2 8" drives A&T	$299
NNC industrial grade enclosure for 2 drives with P.S.	$415
POWER 1, power supply for 2 8" drives	$135
MORROW Discus 2D + CP/M®	$963
Discus 2+2+CP/M®	$1259

HARD DISK SPECIALS

	List	only
CORVUS 10MB and controller	$5350	$call
20MB and controller	$6450	$call
Constellation Network Multiplexer	$750	$call
Mirror Video Tape Disk Backup	$790	$call
MORROW 29MB+controller+CP/M 2.2®	$4995	$3995
CAMEO cartridge drive controller	$1500	$1275
controller, CDC Hawk Drive (5 fix, 5 rem)	$6995	$5995
controller, Western Dynex (5 fix, 5 rem)	$5995	$5099

XCOMP: Winchester 5¼ drives complete with case, cable, software, S-100 controller. Adapter avail. for use with any Z-80 system. Cartridge driver controllers avail.

	List
5MB	$2898
10MB	$3398

Quantity discounts available!

ADES: **S-100 CONTROLLER FOR PRIAM** — $693

PRIAM 8" and 4" Winchester/tape subsystems avail.

We carry the full line of ADES disk and tape controllers and subsystems.

FULLY CONFIGURED BUSINESS SYSTEMS

The following are some examples of the fully assembled and tested business and scientific computer systems which we offer. All include CP/M 2.2, 64K bytes dynamic RAM, Z-80A 4mh CPU. We offer a full line of quality, tested software.

CCS 2210A w/floppy controller, 1 serial port	$1849
CCS 300-1A w/1.2MB floppy drives, 2 serial, 2 parallel ports	$4849
CCS 400-1A w/10MB hard disc, 2 serial, 2 parallel ports	$6999
Optional CP/M for CCS 300, 400 (OASIS available)	$150
NNC 80 w/1MB floppy drives, 2 serial, 3 parallel ports	$3799
NNC 80W w/.5MB floppy, 8.4MB hard disc, (OASIS optional)	$6693
ALTOS single and multi-user systems	$call
MORROW Decision 1, MICROSOFT basic, UNIX	$call

TERMINALS

TELEVIDEO 912 C	$950	$725
920 C	$1030	$789
950C	$1195	$989
SOROC IQ 120	$995	$729
IQ 140	$1395	$1149
INTERTUBE III or **EMULATOR** (multi-terminal)	$895	$799
DEC VT-100	$2050	$1575

Similar savings for our **HAZELTINE** and **LEAR SIEGLER** lines

LOOK HERE!

Call us for ALL your software needs
SYSTEMS HOUSES & EDUCATIONAL INSTITUTIONS GIVEN SPECIAL CONSIDERATION.

ALL OF OUR PERIPHERALS CAN BE CONFIGURED FOR RADIO SHACK® MODEL II

DEALER and INTERNATIONAL INQUIRIES WELCOME

WASHINGTON COMPUTER SERVICES

an affiliate of WASHINGTON ELECTRIC COMPANY INCORPORATED est. 1912

CUSTOM COMPUTER ROOM WIRING SINCE 1960
97 Spring Street
New York, N.Y. 10012
Hours: 8AM-5:30PM (EST) Mon.-Fri.

TO ORDER: CALL OUR TOLL-FREE NUMBER: ★(800) 221-5416★ In N.Y. State and for technical information call 1-(212) 226-2121

For fast delivery, send certified checks, money order or call to arrange direct bank wire transfers. Personal or company checks require two to three weeks to clear. All prices are mail order only. Prices subject to change without notice; call for latest prices. Prices include 2% cash discount. N.Y. residents add sales tax.

VISA MasterCard

Circle 399 on inquiry card.

Circle 292 on inquiry card.

Circle 75 on inquiry card.

Circle 14 on inquiry card.

Circle 112 on inquiry card.

Circle 191 on inquiry card.

Circle 274 on inquiry card.

Circle 29 on inquiry card.

Circle 30 on inquiry card.

Circle 203 on inquiry card.

COMPUTER STOP

2545 W. 237 St. Torrance, CA. 90505

ORDER BY PHONE
MON.—SAT.
10-6

(213) 539-7670 PST
TELEX: 678401 TAB IRIN

LOWEST PRICES IN THE WEST,NORTH, SOUTH & EAST

apple computer 1-800-421-1947
Sales and Service

APPLE /// OPTION A: 3850
- APPLE /// 96K
- Information Analyst Package
- 12″ B/W Monitor

APPLE /// OPTION B: 4350
- SAME AS OPTION A PLUS:
- DISK II for APPLE ///

APPLE /// OPTION C: 4800
- SAME AS OPTION A PLUS:
- DISK II FOR APPLE ///
- SILENTYPE Thermal Printer

APPLE][Plus
16K.......$1075
48K.......$1193
Disk][Drive ..$529
with Controller & Dos. 3.3
PASCAL SYSTEM
$425
Z-80 Softcard
$299

APPLE HARDWARE

Parallel Printer Interface Card	160
Communications Card	195
High Speed Serial Interface	160
Pascal Language System	425
Centronics Printer Interface	185
Applesoft Firmware Card	160
Integer Firmware Card	160
Disk][with Controller DOS 3.3	529
Disk][only	475
Graphics Tablet	625

OTHER HARDWARE

Alf Music Synthesizer (3 Voice)	245
9 voice	175
ABT Numeric Keypad	119
Micromodem][	295
Apple Clock	245
Rom Plus with Keyboard Filter	175
Introl/X-10 System	250
Romwriter	150
DoubleVision 80 x 24 Video Interface	245
CCS Arithmetic Processor	399
CCS Parallel Interface	119
16K Ram Card	145
Microworks DS-65 Digisector	339
SVA 8 inch Disk Controller	335
Sup-R-Mod	30
CCS Synchronous Serial Interface	119
CCS Asynchronous Serial Interface	99
Corvus 10 Meg. Hard Disk	4395
Corvus Constellation	595

MISCELLANEOUS/SUPPLIES

16K RAM (200-250 NS)	29
Verbatium Datalife Diskette (Box of 10)	30
Dysan Diskettes (Box of 5)	22
Apple Diskettes (Box of 10)	45
Verbatim Diskette Boxes (Holds 50 Disks)	18
Silentype Paper (Box of 10 rolls)	40

MONITORS/DISPLAYS

Leedex Video 100 12″	140
Sanyo 9″ Monitor	195
KG-12C Green Phos. Monitor	275
Sanyo 12″ Green Phosphor. Monitor	275
NEC 12″ Green Phosphor. Monitor	275
Sanyo 12″ B/W Monitor	250

PRINTERS

Apple Silentype with Interface	525
IDS 445 (Paper Tiger) with Graphics	650
IDS 460 with Graphics	1049
IDS 560 with Graphics 10)	1199
Centronics 737	795
NEC Spinwriter (RO, Serial)	2650

SOFTWARE

The Controller	525
Apple Post (Mailing List Program)	40
Easywriter Professional System	195
Apple Pie 2.0	95
DB Master Data Management	175
The Cashier	210
Apple Writer	65
Visicalc	170
CCA Data Management System	90
Full Screen Mapping for CCA DMS	59
Pascal Interactive Terminal Software (PITS)	29
Basic Interactive Terminal Software (BITS)	29
Data Capture	29
Data Factory DMS	110
Apple Plot	55
Apple Pilot	120
Magic Wand Word Processor (Needs Z-80 Softcard)	345
Dow Jones Portfolio Evaluator	45
Fortran	140

ORDERING INFORMATION: Phone orders invited using VISA, MASTERCARD or bank wire transfers. VISA & MC credit card service charge of 2%.
Mail order may send charge card number (include expiration date), cashier's check, money order or personal check (allow 10 business days to clear.) Please include a telephone number with all orders. Foreign orders (excluding Military PO's) add 10% for shipping. All funds must be in U.S. dollars (letters of credit permitted). Shipping, Handling and insurance in U.S. add 3% (minimum $4.00). California residents add 6% sales tax. Our low margins prohibit us to send COD or on purchase orders or open account (please send for written quotation). All equipment is subject to price change and availability. Equipment is new and complete with the manufacturer warranty. We do not guarantee merchantibility of products sold. All returned equipment is subject to a 15% restocking fee. We ship most orders within 2 days.

WE ARE A MEMBER OF THE CHAMBER OF COMMERCE. **RETAIL STORE PRICES MAY DIFFER FROM MAIL ORDER PRICES.**

PLEASE SEND ORDERS TO:
COMPUTER STOP, 2545 W. 237 St., TORRANCE, CA 90505

Circle 77 on inquiry card.

MICROPROCESSOR SUPPORT I.C.'S

WE GUARANTEE FACTORY PRIME PARTS

2716 EPROM		1-9	10 & UP
HITACHI	+5	7.00	6.00
INTEL	+5	9.50	8.00
MOTOROLA	+5	7.00	6.00
NATIONAL	+5	7.00	6.00
TI	3 Supply	7.50	6.00

2708 EPROM 3 SUPPLY

AMERICAN MICRO DEVICES
AM2708DC

1-24	25-99	100 & UP
3.50	3.20	2.90

2732 EPROM	1-9	10 & UP
INTEL	17.00	16.00
MITSUBISHI	16.00	15.00
NEC	16.00	15.00

16K x 1 DYNAMIC RAM

NEC	UPD	416C-2	200NS
1-31	2.50	100-499	2.10
32-99	2.30	500 & UP	1.90

2114L STATIC RAM

1K x 4		1-31	31-99	100 & UP
HITACHI	200NS	2.85	2.60	2.35
INTEL	200NS	3.00	2.85	2.70
NEC	250NS	3.00	2.85	2.70

74LS SPECIAL

LS175	.75
LS240	1.15
LS241	1.15
LS244	1.00
LS245	1.95
LS373	1.15

Z80-P10	6.00	8755	49.95	4050	.69	4531	.99	74C925	6.95	74LS107	.45	74LS244	1.00
Z80A-P10	7.10	4000	.35	4051	1.10	4532	1.25	74LS00	.35	74LS109	.45	74LS245	1.95
Z80-CTC	6.00	4001	.35	4052	1.10	4539	.99	74LS01	.28	74LS112	.49	74LS247	1.10
Z80ACTC	7.10	4002	.35	4053	1.10	4543	1.99	74LS02	.28	74LS122	.55	74LS248	1.10
Z80-DMA	18.50	4006	1.39	4055	3.95	4553	3.50	74LS03	.28	74LS123	1.19	74LS249	1.69
Z80A-DMA	22.50	4007	.29	4056	2.95	4555	.75	74LS04	.39	74LS125	1.35	74LS251	1.79
Z80-S10/0	18.50	4008	1.39	4059	9.95	4556	.75	74LS05	.28	74LS126	.89	74LS253	.98
Z80A-S10/0	22.50	4009	.49	4060	1.39	4581	1.99	74LS08	.39	74LS132	.79	74LS257	.98
Z80-S10/1	18.50	4010	.49	4066	.75	4582	1.01	74LS09	.39	74LS136	.59	74LS258	.98
Z80A-S10/1	22.50	4011	.35	4068	.35	4584	.55	74LS10	.28	74LS138	.89	74LS259	2.95
Z80-S10/2	18.50	4012	.29	4069	.35	4585	.99	74LS11	.39	74LS139	.89	74LS260	.69
Z80A-S10/2	22.50	4013	.49	4070	.49	4702	9.95	74LS12	.39	74LS145	1.25	74LS261	2.49
3205	3.95	4014	1.39	4071	.35	74C00	.39	74LS13	.47	74LS148	1.49	74LS266	.59
3242	10.00	4015	1.15	4072	.35	74C02	.39	74LS14	1.25	74LS151	.79	74LS273	1.75
8155	11.25	4016	.59	4073	.35	74C04	.39	74LS15	.39	74LS153	.79	74LS275	4.40
8185	29.95	4017	1.19	4075	.35	74C08	.49	74LS20	.26	74LS155	1.19	74LS279	.59
8185-2	39.95	4018	.99	4076	1.29	74C10	.49	74LS21	.38	74LS156	.99	74LS283	1.10
8202	45.00	4019	.49	4078	.35	74C14	1.65	74LS22	.38	74LS157	.99	74LS290	1.29
8205	3.95	4020	1.19	4081	.35	74C20	.39	74LS26	.39	74LS158	.75	74LS293	1.95
8212	2.00	4021	1.19	4082	.35	74C30	.39	74LS27	.39	74LS160	.98	74LS295	1.10
8214	3.95	4022	1.15	4085	1.95	74C32	.99	74LS28	.39	74LS161	1.15	74LS298	1.29
8216	1.85	4023	.38	4086	.79	74C42	1.85	74LS30	.26	74LS162	.98	74LS324	1.75
8224	2.65	4024	.79	4093	.99	74C48	2.39	74LS32	.39	74LS163	.98	74LS347	1.95
8226	1.85	4025	.38	4099	2.25	74C73	.85	74LS37	.79	74LS164	1.19	74LS348	1.95
8228	5.00	4026	2.50	4104	1.99	74C74	.85	74LS38	.39	74LS165	.89	74LS352	1.65
8238	5.45	4027	.65	4501	.39	74C85	2.49	74LS42	.79	74LS166	2.49	74LS353	1.65
8243	4.65	4028	.85	4502	1.65	74C89	4.95	74LS47	.79	74LS170	1.99	74LS363	1.49
8251A	5.55	4029	1.29	4503	.69	74C90	1.85	74LS48	.79	74LS173	.89	74LS365	.99
8253	9.85	4030	.45	4505	8.95	74C93	1.85	74LS51	.26	74LS174	.99	74LS366	.99
8255A	5.40	4031	3.25	4506	.75	74C95	1.85	74LS54	.35	74LS175	.75	74LS367	.73
8255A-5	5.40	4032	2.15	4507	.95	74C107	1.19	74LS55	.35	74LS181	2.20	74LS368	.73
8257	9.25	4033	2.15	4508	3.95	74C151	2.49	74LS73	.45	74LS190	1.15	74LS373	1.15
8257-5	9.25	4034	3.25	4510	1.39	74C154	3.50	74LS74	.59	74LS191	1.15	74LS374	2.75
8259A	7.30	4035	.95	4511	1.39	74C157	2.10	74LS75	.68	74LS192	.98	74LS375	.69
8271	60.00	4037	1.95	4512	1.39	74C160	2.39	74LS76	.45	74LS193	.98	74LS377	1.95
8275	32.95	4040	1.29	4514	3.95	74C161	2.30	74LS78	.65	74LS194	1.15	74LS385	1.95
8279	10.80	4041	1.25	4515	3.95	74C163	2.39	74LS83	.99	74LS195	.95	74LS386	.65
8279-5	10.80	4042	.95	4516	1.69	74C164	2.39	74LS85	1.19	74LS196	.89	74LS390	1.95
8282	6.70	4043	.85	4519	.99	74C173	2.59	74LS86	.45	74LS197	.89	74LS393	1.95
8283	6.70	4044	.85	4520	1.39	74C174	2.75	74LS90	.75	74LS221	1.49	74LS395	1.70
8284	5.85	4046	1.75	4522	.99	74C175	2.75	74LS92	.75	74LS240	1.15	74LS399	2.95
8286	6.70	4047	1.25	4526	1.15	74C192	2.39	74LS93	.75	74LS241	1.15	74LS424	2.95
8287	6.70	4048	.99	4527	1.75	74C193	2.39	74LS95	.88	74LS242	1.95	74LS668	1.75
8288	25.40	4049	.69	4528	.99	74C195	2.39	74LS96	.98	74LS243	1.95	74LS670	2.29
8289	49.95												

MINIMUM ORDER $10.00
INCLUDE $3.00 FOR U.P.S. GROUND
$4.00 FOR UPS BLUE or 1st CLASS MAIL
Washington State Add 5.4% Sales Tax
(800-426-2668)

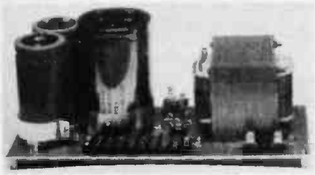
HANLEY ENGINEERING
(206) 643-0792
13400 NORTHUP WAY #22
BELLEVUE, WASHINGTON 98005

FOR THE FINEST IN MICROPROCESSOR SUPPORT I.C.'S

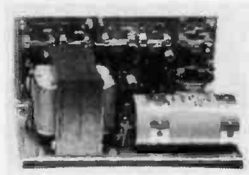
Circle 151 on inquiry card.

Circle 364 on Inquiry card.

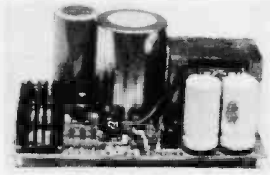
SUNNY LOW LOW COST POWER SUPPLIES FOR S-100, FLOPPY DISKS.



KIT 1, 2 & 3 For S–100



R3 For Three 8" or 5¼" Disk Drives



S3 2 in 1 Unit for S–100 and two 8" or 5¼" Disk Drives. It fits most Disk System Mainframes.

S-100 POWER SUPPLY KITS (OPEN FRAME WITH BASE PLATE, 3 HRS. ASSY. TIME)

ITEM	USED FOR	@ + 8 Vdc	@ – 9 Vdc	@ + 16 Vdc	@ – 16 Vdc	@ + 28 Vdc	SIZE W × D × H	PRICE
KIT 1	15 CARDS SOURCE	15A	———	2.5A	2.5A	———	12" × 5" × 4⅞"	52.95
KIT 2	SYSTEM SOURCE	25A	———	3A	3A	———	12" × 5" × 4⅞"	59.95
KIT 3	DISK SYSTEM	15A	1A	2A	2A	4A	14" × 6" × 4⅞"	67.95

DISK DRIVE POWER SUPPLY "R3" REGULATED, OPEN FRAME, ASSY. & TESTED 67.95

SPECS: + 5V @ 5A OVP, –5V @ 1A + 24V@ 5A, SHORTS PROTECT 2 SIZES AVAIL.. 1.) 9" (W) × 6¼" (D) × 4⅜" (H). 2) 9" (W) × 4⅞" (D) × 5¼" (H)
OPTION: 1.) REPLACE + 24V BY + 12V. 2.) FOR SIZE 1 ONLY. ADD ± 12V @ 1A. AT AN ADDITIONAL $12.00.
IDEAL FOR THREE 8" or 5¼ FLOPPY DISK DRIVES, SUCH AS SHUGART 801/851, SIEMANS FDD 100-8/200–8 OR 100–5 ETC.

DISK SYSTEM PWR SUPPLY "S3" OPEN FRAME, ASSY. & TESTED. COMPACT SIZE: 10"(W) × 6" (D) × 5" (H) 92.95

REGULATED OUTPUTS FOR DISK DRIVES +5V @ 4A, –5V @ 1A, +24V @ 4A (OR + 12V @ 4A) SHORTS PROTECT
UNREGULATED OUTPUTS FOR S–100 +8V @ 14A, ± 16V @ 3A (OPTION ADD OVP FOR +5V, ADD $5.00)
A COMPLETE UNIT FOR DISK SYSTEM WITH THE MAINFRAME CONTAINING 12 SLOTS & TWO 8" or 5¼" DISK DRIVES.

POWER TRANSFORMERS (WITH MOUNTING BRACKETS)

ITEM	PRIMARY	SECONDARY #1	SECONDARY #2	SECONDARY #3	SIZE W × D × H	PRICE
T_1	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A	———	3¾" × 3⅝" × 3⅛"	21.95
T_2	110/120	2 × 8 Vac, 25A	28 Vac, CT, 3.5A	———	3¾" × 4⅜" × 3⅛"	27.95
T_3	110/120	2 × 8 Vac, 15A	28 Vac, CT, 2.5A	48 Vac, CT, 2A	3¾" × 4⅜" × 3⅛"	29.95
T_4	110/120	2 × 8 Vac, 6A	28 Vac, CT, 1.5A	48 Vac, CT, 3A	3¾" × 3⅝" × 3⅛"	22.95
T_5	110/120	2 × 8 Vac, 6A	28 Vac, CT, 2A	———	3" × 3" × 2½"	14.95

SHIPPING For each power supply $5.50 in Calif., $7.50 in other states, $14.00 in Canada. For each Transformer $5.00 in all States, $10.00 in Canada. Calif. Residents add 6% Sales Tax.

BANKAMERICARD VISA

MAILING ADDRESS:
P.O. BOX 4296
TORRANCE, CA 90510
TELEX: 830-5010
ANSWER BACK FOR TELEX SUNYCO TRUC

SUNNY INTERNATIONAL
(TRANSFORMERS MANUFACTURER)
(213) 328-2425 MON-SAT 9-6

SHIPPING ADDRESS:
22129½ S. VERMONT AVE
TORRANCE, CA 90502

CALIFORNIA COMPUTER SYSTEMS

S100

- 2032 32K STATIC RAM A & T.
  450 NSEC. $579.00, 300 NSEC. $585.00, 200 NSEC. $629.00
- 2116 16K STATIC RAM A & T.
  450 NSEC. $285.00, 300 NSEC. $289.00, 200 NSEC. $329.00
- 2065 64K DYNAMIC RAM A & T. $548.95
- 2200 S-100 MAIN FRAM A & T $379.95
- 2422 FLOPPY DISC WITH CP/M 2.2™ $329.95
- 2802 6502 PROCESSOR A & T. $282.95
- 2810A Z80 CPU A & T $249.95
- 2710A 4 SERIAL 1/0 A & T $291.95
- 2718A 2 SERIAL, 2 PARALLEL A & T $305.95
- 2720A 4 PARALLEL A & T $214.95
- PROTO BOARDS WW .... $39.95, SOLDERTAIL $29.95

APPLE PRODUCTS

- 7114A 12K ROM/PROM $68.50
- 7424A CALENDAR/CLOCK $106.95
- 7440A PROGRAMMABLE TIMER $98.50
- 7470A A TO D CONVERTER $105.95
- 7490A GPIB (IE 488) INTERFACE $265.95
- 7710A ASYNC SERIAL $125.95
- 7712A SYNC SERIAL $153.95
- 7720A PARALLEL STANDARD $98.95
- 7720B PARALLEL CENTRONICS $98.95
- 7811B ARITHMETIC PROCESSOR W/DISC $342.95
- 7811C ARITHMETIC PROCESSOR W/ROM $342.95
- 7500A WW BOARD $22.95
- 7510A SOLDERTAIL BOARD $23.95

SOFTWARE

- 2610 CP/M™ MACRO ASSEMBLER ON DISK $76.95
- 2620 CP/M™ SYMBOLIC INSTRUCTION DEBUGGER ... $64.25
- 2630 CP/M™ TEXT FORMATER $64.25
- 2640 CP/M™ BACKGROUND PRINT UTILITY $42.95

OTHER CCS PRODUCTS ARE AVAILABLE. CALL FOR PRICE.

SSM MICROCOMPUTER PRODUCTS

S100 PRODUCTS

- CB1A 8080 PROCESSOR PCBD $32.95
  KIT .... $155.95, A & T $215.95
- CB-2 Z80 PROCESSOR BOARD.
  KIT .... $198.95, A & T $269.95
- VB1C 64 x 16 VIDEO, PCBD $32.95
  KIT .... $153.95, A & T $199.95
- VB2 64 x 16 VIDEO, PCBD $32.95
  KIT .... $175.95, A & T $234.95
- VB3 80 CHARACTER VIDEO 4MHZ.
  KIT .... $345.95, A & T $425.95
- UPGRADE RAMS FOR VB-3 .... $42.00
- IO4 2 PARALLEL, 2 SERIAL, PCBD $32.95
  KIT .... $155.95, A & T $194.95
- PB-1 2708, 2716 PROGRAMMER BOARD.
  KIT .... $135.95, A & T $185.95
- MB-10 16K STATIC RAM.
  KIT .... $299.95, A & T $339.95

APPLE PRODUCTS

- A488 IEEE 488 INTERFACE $399.95
- AIO SERIAL/PARALLEL INTERFACE.
  KIT .... $125.95, A & T $155.95
- ASIO SERIAL I/O
  KIT .... $87.95, A & T $97.95
- APIO PARALLEL 10
  KIT (W/O CABLES) ... $67.95, A & T (W/O CABLES) ... $87.95

OTHER SSM PRODUCTS ARE AVAILABLE. CALL FOR PRICES.

AUG. SPECIAL SALE ON PREPAID ORDERS

(CHARGE CARDS AND C.O.D. OR P.O. NOT AVAILABLE ON THESE OFFERS)

- MEM-3 KIT LESS RAM $89.95
- IOB-1 KIT $99.95

WMC inc. WAMECO INC.

BOARDS WITH MIKOS PARTS

- MEM-3 32K STATIC RAM, PCBD $36.95
  KIT LESS RAM .... $95.95, A & T $135.95
- CPU-2 Z80 PROCESSOR, PCBD $32.95
  KIT LESS ROM .... $109.95, A & T $149.95
- EPM-2 16K/32K EPROM, PCBD $32.95
  KIT LESS ROM .... $65.95, A & T $99.95
- FPB-1 FRONT PANEL, PCBD $48.50
  KIT .... $144.95, A & T $184.95
- CPU-1 8080 PROCESSOR, PCBD $29.95
  KIT .... $89.95, A & T $129.95
- QMB-12 13 SLOT MOTHER BOARD, PCBD $39.95
  KIT .... $95.95, A & T $135.95

OTHER WAMECO PRODUCTS ARE AVAILABLE. CALL FOR PRICES.

MIKOS PARTS ASSORTMENTS ARE ALL FACTORY MARKED PARTS. KITS INCLUDE ALL PARTS LISTED AS REQUIRED FOR THE COMPLETE KIT LESS PARTS LISTED. ALL SOCKETS INCLUDED.

LARGE SELECTION OF LS TTL AVAILABLE.
PURCHASE $50.00 WORTH OF LS TTL AND GET 10% CREDIT TOWARD ADDITIONAL PURCHASES. PREPAID ORDERS ONLY.

MIKOS

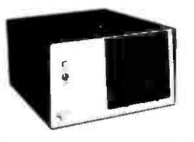
MONDAY-FRIDAY, 8:00 TO 12:00, 1:00 TO 5:30
THURSDAYS, 8:00 TO 9:00 P.M.
(415) 728-9121
P.O. BOX 955 • EL GRANADA, CA 94018
PLEASE SEND FOR IC, XISTOR AND COMPUTER PARTS LIST

VISA or MASTERCHARGE. Send account number, interbank number, expiration date and sign your order. Approx. postage will be added. Check or money order will be sent post paid in U.S. If you are not a regular customer, please use charge, cashier's check or postal money order. Otherwise there will be a two-week delay for checks to clear. Calif. residents add 6% tax. Money back 30-day guarantee. We cannot accept returned IC's that have been soldered to. Prices subject to change without notice. **$10 minimum order. $1.50 service charge on orders less than $10.00.**

Circle 244 on Inquiry card.

EW SAVE $1500

QT SYSTEM H+



SYSTEM H+ and SYSTEM+

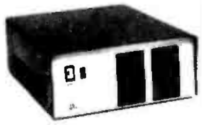
1 M Byte hard disk
MHz Z-80A, 4 serial, 2 parallel
2K Ram useable per user
MP/M multi-user DOS
ackup: 1 MByte floppy
oon: Optional tape cartridge

	List	Now Only
S H+1	$12,750	$11,250
S H+2	13,250	11,750
S H+3	13,750	12,250
S H+4	14,250	12,750

QT SYSTEM+

MHZ Z-80A, 2 serial, 2 parallel
8" floppies, double density
4K Ram, EPROM monitor for RS-232
P/M 2.2
ptional 6, 8, or 12 slot motherboard
ptional single or double-sided floppies
urned in—just add video terminal

QT MINI-SYSTEM+



Above with 5¼" floppies MINI-SYSTEM+ (5¼")

S+SS(6)	$3595	SYS+DS(6)	$4495
S+SS(8)	3695	SYS+DS(8)	4595
S+SS(12)	3795	SYS+DS(12)	4695
SYS+SS(6)	$2495	MSYS+DS(6)	$2795
SYS+SS(8)	2595	MSYS+DS(8)	2895
SYS+SS(12)	2695	MSYS+DS(12)	2995

pecial Offer: 2 Boxes of Diskettes Free with any T System+ or Mini-system+

2 MBYTE LOPPY FOR APPLE

double density, double sided 8" drives
abinet, power supply, cable, controller
OS 3.3 compatible (Pascal and CP/M optional)
his package is best, spec for spec; price for price.
ggested List ... $2550 Now Only $2050
VE $500 CP/M Patch $75 Pascal Patch $75

QT DISK PACKAGES

C-88-2	2-801R, cab., ps, fan	$1250
C-88-22	2-Qume DT-8, cab., ps, fan	1675
C-88-3	Cabinet, ps, fan, cables	325
C-88-4	Cabinet only	58
ugart 801R		$390
me DT-8		585
I B-51		250
I B-52		350

ADES S-100 HARD DISK

RIAM 3350 8" Winchester
1 MByte with CP/M 2.2
ith S-100 controller
ables, cabinet, power supply

33 List .... $5195 Now $3850

QT SBC+2/4
-100 Single Board Computer

-80A, 2 or 4 MHz, switch
K Ram, 1 parallel, 1 serial
PROM monitor (specify)
MA, programmable timers

d ... $60 Kit ... $195 A&T ... $300

QT Z+80 CPU

- 2 or 4 MHz, switch
- Monitor with jump
- Serial port to 9600 baud

Brd ... $50 Kit ... $165 A&T ... $225

QT CLOCK/CALENDAR+
Apple, S-100, TRS-80

(Specify)

- Date, month, year
- Day of week, leap year
- 24 hour or AM-PM
- 4 interrupt intervals
- With software
- **Now with on-board battery**

S-100/Apple/TRS $150

QT EXPANDABLE + REV II
S-100 64K Dynamic RAM

- 2 or 4 MHz, switch
- Bank switch, IEEE Standard
- On board refresh, 4 layer PC
- Burned in, tested

EXP+16	$299	EXP+48	$379
EXP+32	339	EXP+64	409

(Less $40—kit)

QT RAM+16
16K Static, S-100

- Bank switchable RAM
- Thousands of happy customers

Brd ... $35 4MHz Kit ... $180 4MHz A&T ... $210

QT I/O+
S-100 4 Parallel, 2 Serial

- On board crystal
- Prog. baud
- 16 prog. timers
- 8 level prog. interrupt

Brd ... $70 Kit ... $235 A&T ... $375

QT SILENCE+
S-100 Motherboards

- Full ground shield network
- Specify board, kit, or assembled

6-B	$25	8-B	$27	12-B	$30
6-K	40	8-K	55	12-K	70
6-A	50	8-A	70	12-A	90
18-B	$50	22-B	$75		
18-K	100	22-K	140		
18-A	140	22-A	190		

QT MAINFRAMES

- 18A power supply, S-100
- Drive power supply
- Specify motherboard slots
- Specify 8", 5¼" or no floppy

2-8" Floppy w/motherboard

MF8-6	$625
MF8-8	650
MF8-12	675

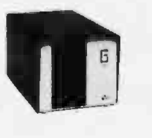
2-5¼" Floppy—w/Motherboard

MF5-6	$450
MF5-12	500

No Floppy—w/Motherboard

MF+12	$450
MF+18	500
MF+22	600

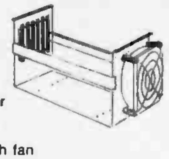
QT SINGLE 8" CABINET



- Accepts one 8" floppy
- Power supply, fan, AC filter
- 117v AC/220v AC
- Data cable, power cables

DDC+8 .... $175

QT S-100 CARD CAGES



- 6, 8 or 12 slot
- Accepts silence + mother
- With card guides
- Accepts 4" fan
- Specify with mother, with fan

6 Slot (5¾w x 10⅛d x 6"h)

CC+6	$24
CC+6M	90
CC+6M/F	115

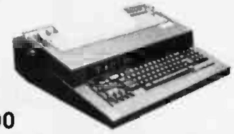
8 Slot (7¼w x 10⅛d x 6"h)

CC+8	$39
CC+8M	99
CC+8M/F	134

12 Slot (11½w x 10⅛d x 6"h)

CC+12	$61
CC+12M	114
CC+12M/F	149

XYMEC HY-Q 1000
Daisywheel Printer/Typewriter

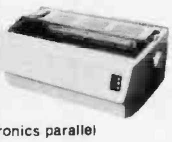


- Bold, underline, reverse, right justify, center
- 10, 12 and 15 pitch
- Automatic error correction
- 15 character display
- Fast, nationwide service

Save $400

Parallel	$2450
RS-232	2675
IEEE-488 (GPIB)	2525
Tractor	325

STARWRITER 25CPS



- Daisywheel printer, Centronics parallel interface
- Same as Vista V-300
- Nationwide service

Suggested List ... $1895 Now Only ... $1550
SAVE $345

IDS PAPER TIGERS

#445	$710
#460G	1050
#560G	1300

NEC SPINWRITER 55CPS

- Receive only, serial interface

Only $2500

NEW ADDS VIEWPOINT
Smart CRT Terminal

- 80 x 24
- Detachable keyboard

The Best for Less $650

SD SYSTEMS 20%+ Discount on A&T

All SD items available.

38007	Z-80 Starter Board	$424
38013	VDB-8024 (60 Hz)	444
38020	Expandoram II-16K	310
38023	Expandoram II-64K	370
38025	PROM 100	248
38059	Versafloppy II (RS-232)	400
38060	Versafloppy II (VDB-8024)	400
38061	SBC-200 (VDB-8024)	376
38062	SBC-200 (RS-232)	376

Call for kit, software, and cable prices.

CALIFORNIA COMPUTER SYSTEMS

15% Discount

All CCS items available.

S-100		
2032A	32K Static - 2 MHz	$561
2032B	32K Static - 4 MHz	641
2116A	16K Static - 2 MHz	297
2116B	16K Static - 4 MHz	331
2200A	Mainframe	368
2210A	System	1600
2422A	Floppy Controller	360
2710A	4-Port Serial	289
APPLE		
7114A	12K ROM/PROM Board	$68
7440A	Programmable Timer	97
7470A	A/D Converter	102
7490A	GPIB IEEE-488	255
7500A	Wire Wrap Board	20
7510A	Solder Tail Board	21
7520A	Extender Board	25
7710A	Serial Asynch Board	136
7728A	Centronics Parallel Bd	105
7811B	Arith Processor - disk	355
7811C	Arith Processor - ROM	355

TELETEK

FDC-1	Single Board Computer	$685
FDC-2	Double Density Controller	325

INTEGRATED CIRCUITS

4116 (200ns)	$2.00	8257	17.95
2114 (450ns)	2.00	8295	16.50
2708	3.50	MC14411	11.00
2716 (5V)	6.50	14411Xtal	4.95
2716 (5-12V)	8.00	1771B01	24.95
2732	13.00	1791A01	37.95
4164 (200ns)	25.00	S2350	7.95
Z-80A	12.95	N8T26	2.50
8080A	3.50	1488	1.25
8085A	20.00	1489	1.25
8086-4	60.00	D3242	10.15
TMS9900	29.95	TMS5501	19.00
8212	3.50	TR1602B	4.50
8214	4.50	6845P	22.00
8228	6.00	4118	18.95
8238	6.00	DP8304BN	4.00
8251	7.00		

CABLES

RS-232- male/male - 9 ft.	$24.00
RS-232 - male/male - 18 ft.	29.00
RS-232 - male/female - 9 ft.	29.00

Floppy-Data-Card Edge
Type SD • Jade

DSC-34-1	Single, mini	$24.00
DSC-34-2	Dual, Mini	29.00
DSC-34-4	Quad, Mini	34.00
DSC-50-1	Single, 8"	24.00
DSC-50-2	Dual, 8"	32.00
DSC-50-4	Quad, 8"	40.00

Floppy-Data-Pin Type
CCS • Tarbell • Teletek

DSP-34-1	Single, Mini	$24.00
DSP-34-2	Dual, Mini	29.00
DSP-34-4	Quad, Mini	34.00
DSP-50-1	Single, 8"	24.00
DSP-50-2	Dual, 8"	29.00
DSP-50-4	Quad, 8"	34.00

8" Floppy-DC Power

PDC-8 24" long $7.00

ISOBAR Surge Suppressor/ Power Strip

- 4 receptacle, 15A

IBAR4-6 .... $59.95

CONNECTORS

IDD-25P	$8.25	DB25C	$1.50
IDD-25S	8.75	IDS-20	2.75
CEC-34	6.05	IDS-26	3.50
CEC-50	7.50	IDS-34	4.50
DB25P	3.50	IDS-50	6.50
DB25S	4.60		

ZIP DIP SOCKETS

ZIP-16	$5.50
ZIP-24	7.50
ZIP-40	10.25

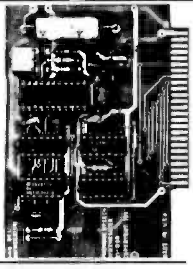
BISON PRODUCTS

MAIL ORDER: PO Box Q, Sherman Oaks, CA 91423
RETAIL: 15620 S. Inglewood Ave., Lawndale, California 90260
(213) 970-1476 (800) 421-5150

Circle 35 on inquiry card.

TERMS OF SALE: Cash, checks, credit cards, C.O.D. Calif. residents add 6% sales tax.

SPEECH SYNTHESIZERS



Now you can have unlimited speech for your computer!

JBE's Speech Synthesizers use the Votrax® SC-01 Phoneme Synthesizer chip. The SC-01 phonetically synthesizes continuous speech of unlimited vocabulary. The SC-01 contains 64 different phonemes and 4 levels of inflection accessed by an 8 bit code. It requires 10 Bytes/sec. for continuous speech. Both Boards have an audio amp for direct connection to an 8Ω speaker.

APPLE II®

NEW

PARALLEL INPUT

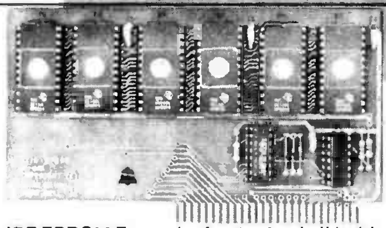
Documentation includes basic user programs, a phoneme chart and a listing of coded words to help you get started.

Documentation for the Apple II® Speech Synthesizer includes a disk with many user programs.

*Because of the high cost of the SC-01 at this time, it will be sold separately. In this way, as the price goes down, we can pass the savings on directly to you.

81-088	Apple II® Speech Synthesizer	$79.95
81-120	Parallel Input Speech Synth. (On board power supply, Wall transformer included)	$89.95
SC-01	Phoneme Synthesizer Chip	$59.95

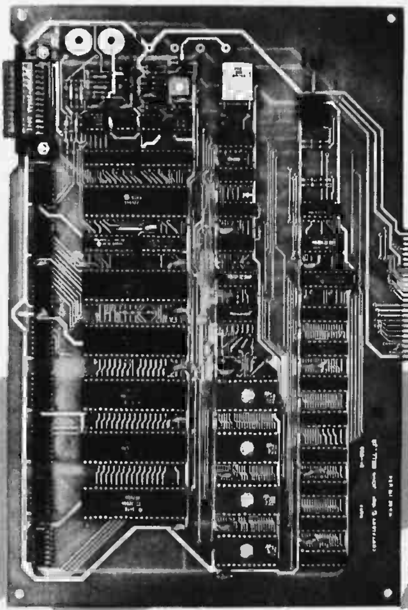
EPROM EXPANSION CARD



JBE EPROM Expander for the Apple II holds six 5 volt 2716s for a total of 12K bytes of ROM. This board takes the place of the on board ROM in the Apple. It is software switchable by the same technique used by the Apple® II firmware card. Solder jumpers are for reset to the Apple ROM or 2716s on the card. (EPROMs available separately). Use JBE EPROM programmer and parralel I/O cards to program your EPROMS.

81-085K	Kit	$49.95
81-085A	Assm.	$59.95
81-085B	Bare Board	$39.95

JBE I MICROCOMPUTER



JBE's 7 ¾" x 11 ¾" 6502 base Microcomputer has the capacity for 16K of EPROM, 4K of RAM, 8 Parallel Ports and 1 Serial Port. Monitor and Tiny Basic are also available. The fully populated version includes:

- 1 6502 CPU
- 4 6522 VIA (8 Parallel I/O Ports)
- 1 AY5-1013 (Serial I/O Ports)
- 8 2114 RAM (4K)
- 2 2716 EPROM (monitor & tiny basic)

The partially populated version includes:

- 1 6502 CPU
- 1 6522 VIA (2 Parallel I/O Ports)
- 1 AY5-1013 (Serial I/O Port)
- 2 2114 RAM (1K)
- 1 2718 EPROM (with monitor)

Both versions include sockets for 4 2716s or 2732s, 8 16 pin sockets for I/O interfacing and a DB25 connector for RS232.

All address and data lines, power supply, RDY, interrupts, DMA, phase 1 & phase 2 clock, R/W, reset and NMI & IRQ are brought off the board to the 50 pin edge connector. (similar to the Apple II® bus)

This board also features power on reset and cassette interface.

Documentation includes 6502 programming manual & Complete doc. for the 6522 VIA. Also included is doc. for interfacing with JBE A-D & D-A Converter, Solid State Switches, EPROM Programmer & Parallel Input Speech Synthesizer.

81-030C Fully Populated JBE I	$349.95
81-030M Partially Populated JBE I	$249.95
81-030B Bare Board JBE I (Doc.Incl.)	$ 89.95
2716 EPROM (with monitor)	$ 19.95
2716 EPROM (with tiny basic)	$ 19.95

A TO D CONVERTER

NEW

JBE's 16 channel A-D Converter plugs into your Apple II® Computer. It uses an ADC0817 which incorporates a 16 channel multiplexer and an 8 bit A-D Converter. The 16 inputs are high impedance and the voltage range is 0 to 5 volts. Conversion time is <100 μsec. The resolution is 8 bits or 256 steps, linearity is ± ½ step. Two 16 pin DIP sockets are used for input, GND & reference voltage connections. There are 3 single bit TTL inputs. Doc. includes sample program.

81-132B Bare Board	$29.95
81-132K Kit	$69.96
81-132A Assm. & Tested	$89.95

REAL TIME CLOCK

NEW

JBE's Real Time Clock Card for the Apple II® computer has automatic leap year calculation, month & date and can time down to .1 sec. It uses an MM58174 Real Time Clock chip, has interrupt capability and has separate time intervals of 60 sec, 5 sec & .5 sec. An on board 2716 holds 8 user programs which are switch selectable. A 32768 Hz crystal is used for accuracy. On board battery will keep correct time for up to one year.

81-135B Bare Board	$ 39.95
81-135K Kit	$ 99.95
81-135A Assm. & Tested	$119.95

EPROM SUBSTITUTION CARD

NEW

This board looks like RAM to the Apple® II and like an EPROM to the computer being programmed. It features 2K or 4K of RAM and emulates a 2716 or 2732. A 24 pin ribbon cable connects the computer being programmed to the EPROM sub. board. Documentation includes disk with basic & pascal utility routines including save, write, CMP, error checking. Complete Source Code User Manual also included. This board allows you to test programs without burning your EPROM. Three control lines from the board are used to control the computer being programmed (reset etc.)

81-070K2 Kit - 2K RAM	$149.95
81-070K4 Kit - 4K RAM	$159.95
81-070A2 Assm. - 2K RAM	$159.95
81-070A4 Assm. - 4K RAM	$169.95
Ribbon Cable with Connectors	$ 9.95

JOHN BELL ENGINEERING, INC.

ALL PRODUCTS ARE AVAILABLE FROM **JOHN BELL ENGINEERING** • P.O. BOX 338
REDWOOD CITY, CA 94064 • ADD SALES TAX IN CALIFORNIA • ADD 5% SHIPPING & HANDLING
(415) 367-1137 10% OUTSIDE U.S.A.

MC VISA

Circle 341 on inquiry card.

Circle 126 on inquiry card.

Circle 94 on inquiry card.

Circle 301 on inquiry card.

Circle 185 on inquiry card.

Circle 343 on inquiry card.

Circle 204 on inquiry card.

Circle 348 on inquiry card.

Circle 17 on inquiry card.

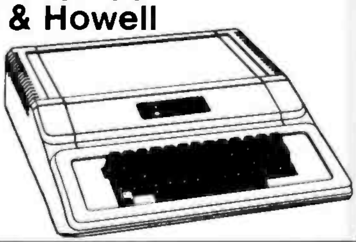
THE STAR MODEM

From Livermore Data Systems

RS232 MODEM	SALE $128
IEEE 488 MODEM	**SALE $199**
RS232 CCITT	$170
IEEE 488 CCITT	$280

STAR Modem is the price performance leader with a full 2 YEAR FACTORY WARRANTY.

We carry Apple II+ from Bell & Howell



REVERSAL (Spracklen) 32K Apple	28.00
Super FORTH 48K Apple	40.00
Energy Miser for PET, Apple, or Zenith	24.50
Data Manager (Lutus) 24K Apple	40.00
Histo-Graph (Boyd) 48K Apple	24.50
Data-Graph (Boyd) 48K Apple	40.00
Apple II User's Guide (Osborne)	12.00
Introduction to Pascal (Sybex)	10.30
Pascal Handbook (Sybex)	12.00
Graphics Cookbook for Apple	9.90
Musical Applications of Micros (Chamberlin)	20.00
Basic FORTRAN (Coan)	7.25

PROGRAM YOUR OWN EPROMS
Branding Iron for PET/CBM $79
EPROM Programmer with software for all ROM versions. Includes all necessary hardware and software to program or copy 2716 and 2532 EPROMS.

Paper-Mate Word Processor $39.95
PET/CBM full featured 60 command system by Michael Riley. Uses either tape or disk and any printer. Includes in-text commands, floating cursor, scrolling, etc.

FLEX-FILE Data Base for CBM/PET $60
Random file handling system with Report Writer and Mail Label Handler. By Michael Riley.

KMMM Pascal for PET $75
Subset of standard Pascal with true machine language translator for faster execution. 16K with tape or disk.

EARL for PET (disk file based) $65
Editor, Assembler, Relocator, Linker to generate relocatable object code.

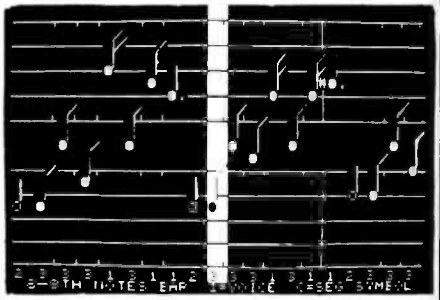
FORTH for PET/CBM or Apple $65
A full-featured FORTH with extensions conforming to Forth Interest Group standards. Includes assembler, string processing capabilities, disk virtual memory multiple dimensioned arrays, floating point and integer processing.

6502	7.45	10/6.95	50/6.55	100/6.15
6502A	8.40	10/7.95	50/7.35	100/6.90
6520 PIA	5.15	10/4.90	50/4.45	100/4.15
6522 VIA	6.45	10/6.10	50/5.75	100/5.45
6532	7.90	10/7.40	50/7.00	100/6.60
2114-L200 ns RAM		3.75	25/3.50	100/3.25
2114-L300 ns RAM		3.15	25/2.90	100/2.65
2716 EPROM		7.75	5/7.45	10/6.90
2532 EPROM				17.00
4116 200ns				8 for $20
S-100 Wire Wrap				2.65
Zero Insertion Force 24 pin Socket				$2.00

CASSETTES – AGFA PE-611 PREMIUM
High output, low noise, 5 screw housing, labels.

C-10	10/5.65	50/25.00	100/48.00
C-30	10/7.30	50/34.00	100/66.00

All other lengths available. Write for price list.



4 PART HARMONY MUSIC SYSTEM for PET
The Visible Music Monitor, by Frank Levinson, allows you to easily enter, display, edit, and play 4 part harmony music. Includes whole notes thru 64ths (with dotted and triplets), tempo change, key signature, transpose, etc. The KL-4M unit includes D to A converter and amplifier (add your own speaker).
KL-4M Music Board with VMM Program $59.90

commodore

CBM-PET SPECIALS
FREE Up to $375 free merchandise with purchase of one of following CBM-PET items:

		FREE
8032 32K - 80 Column CRT	$1495	295
8050 Dual Disk Drive	1795	375
4016 Full Size Graphics Keyboard	995	170
4032 Full Size Graphics Keyboard	1295	260
8096 96K - 80 Column CRT		
2040/4040 Dual Disk Drive - 340K	1295	260
4022 Tractor Feed Printer	795	140
CBM Voice Synthesizer	395	50
C2N External Cassette Deck	95	12
Used CBM/PET Computers		CALL
VIC Personal Computer	300	25

WRITE FOR SYSTEM PRICES

***** EDUCATIONAL DISCOUNTS *****
Buy 2 PET/CBM Computers, receive 1 FREE

WordPro 3+ – 32K CBM, disk, printer	250
WordPro 4+ – 8032, disk, printer	335
OZZ Data Base System for CBM 8032	335
VISICALC for PET or ATARI	170
SM-KIT - Super PET ROM Utilitites	**40**

Programmers Toolkit – PET ROM Utilities	34.90
PET Spacemaker II ROM Switch	36.00
2 Meter PET to IEEE or IEEE to IEEE Cable	40.00
Dust Cover for PET	6.90
IEEE-Parallel Printer Interface for PET	110.00
IEEE-RS232 Printer Interface for PET	120.00
The PET Revealed	17.00
Library of PET Subroutines	17.00

Source Hookup over 1000 programs/services **88**

MIPLOT Intelligent Plotter
by Watanabe Instruments (Digiplot)

SPECIAL $1195

Has all intelligent functions for producing graphs and drawings including 8 vector and 4 character commands. Solid and broken lines can be specified. Character generator for alpha, numeric, and symbols. Characters can be rotated in 4 orientations, and can be 16 sizes. Coordinate axes drawn by specifying graduation interval and number of repetitions. Parallel ASCII interface, 11 x 17 paper.

SPECIALS

EPSON MX-80 Printer	
EPSON MX-80 F/T Printer	
EPSON MX-70 Printer	
EPSON MX-100 Printer	
Centronics 739 Printer	750
STARWRITER Daisy Wheel Printer	1445
Leedex Video 100 12" Monitor	129
ZENITH DATA SYSTEMS	
Z19 Video Terminal	729
Z89 with 48K	2150
Extra 16K RAM	115
Z-47 Dual 8" Drive	2775

SYM-1	209
SYM BAS-1 BASIC or RAE-1/2 Assembler	85
KTM-2/80 Synertek Video Board	349

DISK SPECIALS

SCOTCH (3M) 5¼"	10/2.85	50/2.75	100/2.65
SCOTCH (3M) 8"	10/2.90	50/2.80	100/2.70
Verbatim 5¼"	10/2.45	50/2.40	100/2.35
(add 1.00 for 5¼" Verbatim plastic storage box)			
Verbatim 8" Dbl. Dens.	10/3.45	50/3.35	100/3.25
BASF 5¼"	10/2.40	20/2.35	100/2.30

WRITE for prices on WABASH Disks

WE STOCK MAXELL DISKS

Diskette Storage Pages		10 for 3.95
Disk Library Cases	8" - 2.85	5" - 2.15

ATARI 800 $745
All Atari Modules 20% OFF

ATARI EDUCATIONAL PLAN Write for details.

A P Products 15% OFF
A P Hobby-Blox 15% OFF

ALL BOOK and SOFTWARE PRICES DISCOUNTED

The 8086 Book (Osborne)	14.00
Z8000 Assembly Language Programming	16.90
PET Personal Computer Guide (Osborne)	12.75
PET and the IEEE-488 Bus (Osborne)	13.60
6502 Assembly Language (Osborne)	14.45
Programming the 6502 (Zaks)	10.45
6502 Applications Book (Zaks)	10.45
6502 Software Cookbook (Scelbi)	9.45
CP/M Handbook (w/ MP/M) Zaks	11.85
Practical BASIC Programs (Osborne)	13.60
Some Common BASIC Programs (Osborne)	12.75

252 Bethlehem Pike
Colmar, PA 18915

215-822-7727 **A B Computers**

WRITE FOR CATALOG.
Add $1.25 per order for shipping. We pay balance of UPS surface charges on all prepaid orders. Prices listed are on cash discount basis. Regular prices slightly higher.

Circle 1 on inquiry card.

16-K 8/$16.75
M E M O R Y

RAM

4116 200ns 8/$16.75 $2.75 ea.

2114L 300ns 8/$19.75 $2.55 ea.

4164 200ns $27.00 ea.

EPROMS

2732(5V) 450ns 8/$15.00 $16.95 ea.

2716(5V) 450ns 8/$5.75 $6.35 ea.

All chips are fully guaranteed
All chips factory new
Call for quantity pricing
We are Price Competitive

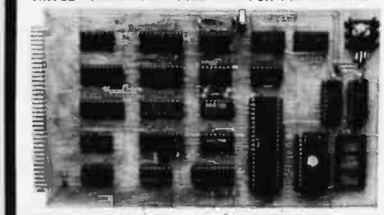
Add $2.50 Shipping & Handling
C.O.D. $3.00. Wash. residents add 5.4% Sales Tax

CHIPS & DALE
P.O. Box 31607
Seattle, Washington
Zip 98103 1-206-524-9126

Circle 53 on inquiry card.

CONTROL-Z™

SINGLE BOARD Z-80A* COMPUTER FOR CONTROL USES



USES: Industrial Test Equipment, Intelligent Peripheral Controller, Automatic Dialing Equipment, Solar Heating & Power Systems, Machine Control, Security Systems, Traffic Signal Control, Appliance Control, Robotics, OEM Products, Etc!

FEATURES: 4 MHZ Z-80A* (on board crystal), 1k RAM, sockets for 2 2716's (4K PROM), 3-8 bit parallel TTL output ports, 2-8 bit parallel TTL input ports, 8 analog input ports (100 μsec conversion time), 6 high current output lines (open collector), 4 opto-isolated input lines, extra single bit TTL output for serial I/O, Z-80 control lines brought to edge connector, extra port decodes brought to edge connector, 1 input port doubles as bus for port expansion, on board 5v regulator, 4½×8 PC board, uses standard 72 pin edge connector, fully socketed, requires +8 to 10 volts 500 mA

PRICE: $295 Monitor PROM $45 Full function monitor program with download capacity, software serial driver & self test feature

TERMS: CHECK, MC, VISA, or C.O.D. Cal. Res. add 6% tax. First Class Shipping Included

*Registered Trademark of Zilog Inc.

COMPUTER-AID
1122 DE LA VINA SANTA BARBARA, CA 93101 (805) 966-3077

Circle 66 on inquiry card.

CP/M COMMUNICATIONS

LYNC™

THE BEST AVAILABLE PROGRAM FOR CP/M COMMUNICATIONS

LYNC is extremely powerful and easy to use and a must for every computer user that wants to communicate with time-sharing systems or other CP/M computers.

TERMINAL MODE
In this mode your system acts as a terminal. Can send to or receive from a timesharing system. When receiving data from a remote system, received data is buffered to your maximum memory, then can be saved as a disk file

LYNC MODE
Communicate on-line with another computer similarly equipped. Both ends can type messages that appear simultaneously on both screens.

SEND: AUTOMATIC ERROR DETECTION & RETRY
LYNC sends block of information with 16 bit checksums. In case of error it will keep retrying until successful

FETCH
Once both systems are in LYNC mode, either operator can FETCH files from other system

REMOTE AND LOCAL DIRECTORY
Can display both local and remote directories

BAUD RATES: UP TO 9600 BAUD

SELF GENERATING I/O ROUTINES REQUIRE NO PATCHING

PRICE: $95 TERMS: MONEY ORDER, CHECK, COD, M.C. OR VISA

PLEASE SPECIFY DESIRED FORMAT: 8" Single Density, 5" Micropolis; TRS-80 Mod II with CP/M, North Star single or double density, Superbrain 3.0 DOS or later, Cromenco 5" single density

COMPUTER-AID
1122 DE LA VINA • SANTA BARBARA, CA 93101
(805) 966-3077

Circle 67 on inquiry card.

SAVE 90%

You CAN save up to 90% by building your own Micro or Minicomputer! If you can read - you can do it. SO DO IT!

F R E E D E T A I L S

DIGATEK CORP
SUITE 20
2723 W. BUTLER DR.
PHOENIX AZ 85021

You CAN afford a Computer of your own

Circle 109 on inquiry card.

68000

ERG68-696 68000 CPU available and in production. Meets or exceeds all aspects of IEEE696 S-100 standard.

$1995

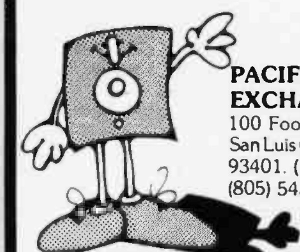
Z-80 emulation and integrated 68000 systems also available.

Empirical Research Group, Inc.
PO Box 1176
Milton, WA 98354
206-631-4855

Circle 162 on inquiry card.

Dysan CORPORATION

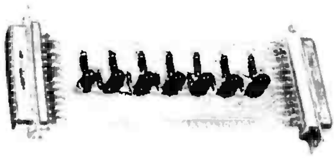
Solve your disc problems, buy 100% surface tested Dysan diskettes. All orders shipped from stock, within 24 hours. Call toll FREE (800) 235-4137 for prices and information. Visa and Master Card accepted. All orders sent postage paid.



PACIFIC EXCHANGES
100 Foothill Blvd.
San Luis Obispo, CA
93401. (In Cal. call (805) 543-1037.)

Circle 292 on inquiry card.

RS-232 PROBLEMS?



LET THE RS-232 TESTER HELP YOU SOLVE YOUR COMPUTER INTERFACE PROBLEMS. DESIGNED TO CONNECT IN SERIES WITH ANY RS-232 INTERFACE, IT DISPLAYS THE STATUS OF SEVEN OF THE MOST IMPORTANT LINES: TRANSMIT DATA, RECEIVE DATA, REQUEST TO SEND, CLEAR TO SEND, DATA SET READY, CARRIER DETECT, AND DATA TERMINAL READY. THE RS-232 TESTER REQUIRES NO POWER AND MAY BE LEFT IN THE LINE PERMANENTLY.

$39.95 POST PAID
B & B ELECTRONICS
BOX 475/MENDOTA, IL 61342

Circle 32 on inquiry card.

FACTORY PRIME STATIC RAM CHIPS

2114 Super Low Power 200ns. 1Kx4 .... $ 2.90
6514 CMOS 300ns. 1Kx4 .... $ 6.90
6116 CMOS 200ns. 2Kx8 .... $22.50
Add $5.00 Handling on Orders Under $200.00

FACTORY PRIME From the same shipments used in GIMIX Professional quality boards.

32KB STATIC RAM CARDS
for the SS50 and SS50C BUS
(16KB — $298.12), (24KB — 348.14) (32KB — $398.15)

NEW! **64KB BATTERY BACK UP CMOS RAM CARDS**
Two independently addressable 32KB blocks, each with extended addressing.
(56KB - $994.56), (64KB - $1088.64)

2MHZ 6809 56KB SS50 SYSTEMS $2498.29

DISK SYSTEMS AVAILABLE

GIMIX inc.
1337 W. 37th Place • Chicago, IL 60609
(312) 927-5510 • TWX 910-221-4055
The Company that delivers.
Quality Electronic products since 1975.
GIMIX® and GHOST® are Registered Trademarks of GIMIX INC.

Circle 146 on inquiry card.

ZEN is HERE

FAST SCREEN EDITING for CP/M & NORTH STAR

OPEN PROGRAMS WITH SOURCE FILES

ZEN™ offers you very fast screen editing without line numbers. You are in control and ZEN may be reassembled to change or add custom features. Call system and return without losing the file. Justify even old disc files to any line length. Save, append, find, print & much more, with ease. Monitor functions are built in, extensions can be added. A 32K system with console is necessary but addressable cursor is not required.

CPM version for 1.4 thru MPM releases, uses their assembler and line command conventions which can include multiple command lines.

North Star DOS versions have a disc assembler, an extensive monitor and some Basic utilities. They use the N.S. line editing conventions.

Specify version #
ZEN2.1 8" SD SS CPM
ZEN2.2 5" DD NS CPM
ZEN1.1 5" SD NS 2000
ZEN1.2 5" DD NS 2000
ZEN1.3 5" DD NS 0100

Disc and Manual $75
CA residents add 6%
Manual alone $15
Send check to:

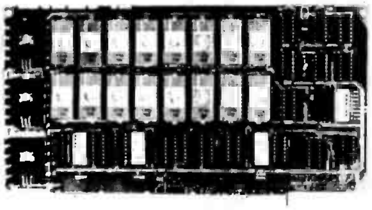
Dealer Enquiries welcome.

ZENRAD CONTROLS CO
1575 A.P.S.
Santa Barbara CA 93103

Circle 406 on inquiry card.

DIGITAL RESEARCH COMPUTERS
(214) 271-3538

32K S-100 EPROM CARD
NEW!



$79.95
KIT

USES 2716's

Blank PC Board - $34

ASSEMBLED & TESTED
ADD $30

SPECIAL: 2716 EPROM's (450 NS) Are $9.95 Ea. With Above Kit.

KIT FEATURES:
1. Uses +5V only 2716 (2Kx8) EPROM's.
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible.
4. Addressable as two independent 16K blocks.
5. Cromemco extended or Northstar bank select.
6. On board wait state circuitry if needed.
7. Any or all EPROM locations can be disabled.
8. Double sided PC board, solder-masked, silk-screened.
9. Gold plated contact fingers.
10. Unselected EPROM's automatically powered down for low power.
11. Fully buffered and bypassed.
12. Easy and quick to assemble.

32K SS-50 RAM

$329.00 KIT

NEW!

For 2MHZ
Add $10

Blank PC Board
$50

For SWTPC
6800 - 6809 Buss

Support IC's
and Caps
$19.95

Complete Socket Set
$21.00

Fully Assembled,
Tested, Burned In
Add $30

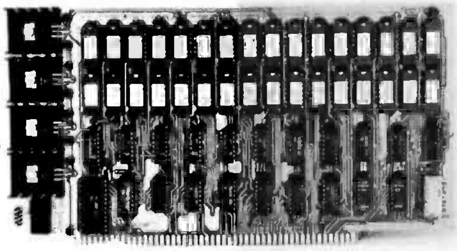
At Last! An affordable 32K Static RAM with full 6809 Capability.

FEATURES:
1. Uses proven low power 2114 Static RAMS.
2. Supports SS50C - EXTENDED ADDRESSING.
3. All parts and sockets included.
4. Dip Switch address select as a 32K block.
5. Extended addressing can be disabled.
6. Works with all existing 6800 SS50 systems.
7. Fully bypassed. PC Board is double sided, plated thru, with silk screen.

16K STATIC RAM KIT-S 100 BUSS

PRICE CUT!
$169.95 KIT

FOR 4MHZ
ADD $10



KIT FEATURES:
1. Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!). Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 1.5 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA-$33
LOW PROFILE SOCKET SET-$12
SUPPORT IC'S & CAPS-$19.95
ASSEMBLED & TESTED-ADD $35

OUR #1 SELLING
RAM BOARD!

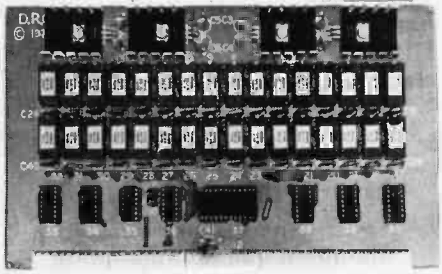
16K STATIC RAM SS-50 BUSS

PRICE CUT!

$159 KIT

FULLY STATIC!

FOR 2MHZ
ADD $10



FOR SWTPC
6800 BUSS!

ASSEMBLED AND
TESTED - $35

KIT FEATURES:
1. Addressable on 16K Boundaries
2. Uses 2114 Static Ram
3. Fully Bypassed
4. Double sided PC Board. Solder mask and silk screened layout.
5. All Parts and Sockets included
6. Low Power: Under 1.5 Amps Typical

BLANK PC BOARD—$35   COMPLETE SOCKET SET—$12
SUPPORT IC'S AND CAPS—$19.95

STEREO! S-100 SOUND COMPUTER BOARD
NEW!   NEW!

At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY3-8910 NMOS computer sound IC's. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE, etc.

COMPLETE KIT!
$84.95
(WITH DATA MANUAL)

BLANK PC
BOARD W/DATA
$31

KIT FEATURES:
* TWO GI SOUND COMPUTER IC'S.
* FOUR PARALLEL I/O PORTS ON BOARD.
* USES ON BOARD AUDIO AMPS OR YOUR STEREO.
* ON BOARD PROTO TYPING AREA.
* ALL SOCKETS, PARTS AND HARDWARE ARE INCLUDED.
* PC BOARD IS SOLDERMASKED, SILK SCREENED, WITH GOLD CONTACTS.
* EASY, QUICK, AND FUN TO BUILD, WITH FULL INSTRUCTIONS.
* USES PROGRAMMED I/O FOR MAXIMUM SYSTEM FLEXIBILITY.

Both Basic and Assembly Language Programming examples are included.

SOFTWARE:

SCL™ is now available! Our Sound Command Language makes writing Sound Effects programs a SNAP! SCL™ also includes routines for Register-Examine-Modify, Memory-Examine-Modify, and Play-Memory. SCL™ is available on CP/M* compatible diskette or 2708 or 2716. Diskette - $24.95 2708 - $19.95 2716 - $29.95. Diskette includes the source. EPROM'S are ORG at E000H.

SPECIAL PURCHASE!
UART SALE!

TR1602B — SAME AS TMS6011, AY5-1013, ETC.   40 PIN DIP

TR1602B

$2.95 EACH   **4 For $10.00**

CRT CONTROLLER CHIP
SMC #CRT 5037. PROGRAMMABLE FOR 80 x 24, ETC. VERY RARE SURPLUS FIND. WITH PIN OUT. $12.95 EACH.

4K STATIC RAM
National Semi. MM5257. Arranged 4K x 1. +5V, 18 PIN DIP. A Lower Power, Plug in Replacement for TMS 4044. 450 NS. Several Boards on the Market Will Accept These Rams. SUPER SURPLUS PURCHASE! PRIME NEW UNITS!

8 FOR $16   32 FOR $59.95

NEW! G.I. COMPUTER SOUND CHIP
AY3-8910. As featured in July, 1979 BYTE! A fantastically powerful Sound & Music Generator. Perfect for use with any 8 Bit Microprocessor. Contains: 3 Tone Channels, Noise Generator, 3 Channels of Amplitude Control, 16 bit Envelope Period Control, 2-8 Bit Parallel I/O, 3 D to A Converters, plus much more! All in one 40 Pin DIP. Super easy interface to the S-100 or other busses. $11.95   PRICE CUT!

SPECIAL OFFER: ~~$14.95~~ each   Add $3 for 60 page Data Manual.

Digital Research Computers
(OF TEXAS)
P.O. BOX 401565 • GARLAND, TEXAS 75040 • (214) 271-3538

TERMS: Add $2.00 postage. We pay balance. Orders under $15 add 75¢ handling. No C.O.D. We accept Visa and MasterCharge. Tex. Res. add 5% Tax. Foreign orders (except Canada) add 20% P & H. Orders over $50, add 85¢ for insurance.

ALL SALES ARE MADE SUBJECT TO THE TERMS OF OUR 90 DAY LIMITED WARRANTY. A COPY OF THIS WARRANTY IS AVAILABLE FREE, ON REQUEST.

*TRADEMARK OF DIGITAL RESEARCH.   WE ARE NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE SUPPLIERS OF CPM SOFTWARE.

Circle 117 on inquiry card.

HEADERS

PRINTED CIRCUIT

RIGHT ANGLE MOUNT

34 PIN HEADER
3M 3413–1003 $1.25 EA
40 PIN HEADER
ALPHA $1.50 EA
50 PIN HEADER
3M 3433–1002 $1.75 EA

40 PIN CONNECTOR
3M 3417
$1.50
EACH

22/44 EDGE CONNECTOR
TIN SOLDERTAIL .156" x .200"
LARGE QUANTITIES AVAILABLE
$1.35 each 10 for $12.50

8 POLE DIP SWITCH
$1.50 each

RFI LINE FILTER
for line to line
& line to ground
noise suppression
CORCOM # 10K6
Rated: 10 amp
115/250 v
50-400 hz
$ 3.75 ea.
10 for $35.00

SUB MINI L.E.D.
20 MA at 1.75 volt
.075" X .098"
10 for $1.00
PACKAGE of 200 PCS $18.00
400 for $32.00
1000 for $70.00

ALL ELECTRONICS CORP.

905 S. Vermont Ave.
P.O. BOX 20406
Los Angeles, Calif. 90006
(213) 380-8000
Mon.-Fri. 9 AM - 5 PM
Saturday 10 AM - 3 PM

TERMS
• Quantities Limited
• Min Order $10.00
• Add $2.00 Shipping USA
• Calif Res Add 6%
• Prompt Shipping

SEND FOR FREE CATALOG

Circle 10 on inquiry card.

WANTED:

APPLE, PET, TRS-80, CP/M

SOFTWARE

Westico is a publisher and distributor of professional software for microcomputers. If you have a new program ready for distribution or want your existing programs to reach a larger market, contact:

Phillip Woellhof, V.P. Mktg.
Westico, Inc.
25 Van Zant Street
Norwalk, CT 06855
(203) 853-6880

To increase your profits, take advantage of Westico's worldwide promotion and distribution.

WESTICO

The Software Express Service

PRO-SOFT MEDICAL BILLING

Our software for the Apple keeps the Doctor away...

...away from needless billing drudgery.

The Pro-soft Medical Billing System for the Apple II features:

- Up to ten physicians
- Over 7000 accounts
- RVS and IDCA codes
- Immediate Superbill
- MediCare, Medi-Cal, Other
- Menu driven, easy to use
- Support and training

For more information call or write us - today!

Professional Medical Software
(213) 248-2884
3604 Foothill Boulevard
La Crescenta, CA 91214

Circle 318 on inquiry card.

INVENTORY CONTROL SYSTEM

WITH PARTS EXPLOSION FOR FINISHED GOODS AND ASSEMBLIES

Parts requirements forecasting & Pull Sheets
Reorder Reports
Economic Order Quantities
5000 Items per 8" disk

AVAILABLE FOR CROMEMCO, CP/M®, AND OASIS OPERATING SYSTEMS

Hardware requirements: 64k RAM, 132 Column printer.

Manual and 8" floppy disk .... $250.
Multi-level explosion version .... $499.
Job Costing .... $350.

Accounts Receivable, Accounts Payable, Order Entry, General Ledger, Payroll and Mailing List programs also available.

FEITH SOFTWARE, INC.

204 MARVIN RD.
ELKINS PARK, PA. 19117
(215) 782-8240

Circle 139 on inquiry card.

Atari 800 16K • $789

THIS is only one of hundreds of unusual values . . .

Get your FREE CATALOG today!

TOLL FREE
1-800-343-8124

computer plus

Dept. C
245A Great Road
Littleton, MA
01460

Radio Shack's Color Computer 4K • $310

THIS is only one of hundreds of unusual values . . .

Get your FREE CATALOG today!

TOLL FREE
1-800-343-8124

computer plus

Dept. I
245A Great Road
Littleton, MA
01460

Circle 74 on inquiry card.

QUARTZ CRYSTALS

3218-B	5.2428-B	9.9336-B	20.000-B	36.2886-B	42.8518-B	46.8128-B
5380-B	5.610-B	9.98408-B	20.4988-B	36.3636-B	42.8768-B	47.3768-B
1.000-A	5.7143-B	9.98960-B	22.1184-B	37.9628-B	42.9258-B	47.8838-B
1.8432-A	5.955-B	10.000-B	22.6258-B	38.3768-B	42.9628-B	48.000-B
1.8437-B	5.982-B	10.2458-B	26.3556-B	38.4448-B	43.0008-B	48.3006-B
2.000-A	6.000-B	10.4968-B	26.5006-B	38.6258-B	43.0378-B	48.6668-B
2.0971-A	6.144-B	10.7755-B	26.6706-B	38.9258-B	43.0748-B	48.7006-B
2.4576-A	6.15030-B	10.8255-B	27.000-B	39.3128-B	43.1858-B	48.8768-B
2.500-A	6.29780-B	10.8386-B	27.0006-B	39.5038-B	43.2588-B	49.7006-B
2.6657-B	6.400-B	11.1360-B	27.6506-B	39.6668-B	43.3338-B	49.7338-B
2.9850-B	6.5536-B	11.155-B	28.4006-B	39.7538-B	43.3708-B	49.8128-B
3.000-A	6.72530-B	11.2186-B	28.6278-B	39.8768-B	43.4078-B	50.2505-B
3.067-B	6.75840-B	11.2880-B	28.7538-B	39.9628-B	43.4378-B	51.0556-B
3.200-B	6.9003-B	11.4778-B	29.8758-B	40.4448-B	43.4448-B	51.3128-B
3.2768-A	7.0083-B	11.6566-B	29.9378-B	40.5928-B	43.5558-B	51.7778-B
3.500-B	7.0338-B	11.6816-B	30.0648-B	40.8128-B	43.6298-B	51.8506-B
3.579-B	7.0916-B	12.440-B	30.3806-B	40.8336-B	43.6668-B	52.8128-B
4.000-B	7.1836-B	14.3182-B	30.6258-B	40.8758-B	43.7778-B	58.7506-B
4.1943-B	7.2586-B	14.4308-B	30.8768-B	40.8888-B	43.8128-B	60.6006-B
4.3426-B	8.000-B	15.000-B	31.4378-B	40.9258-B	43.8148-B	60.7508-B
4.4803-B	8.0556-B	15.4408-B	31.7538-B	41.0008-B	43.8518-B	66.7506-B
4.8103-B	8.1416-B	15.5066-B	31.9008-B	41.1666-B	43.8888-B	70.4006-B
4.6503-B	8.1818-B	16.000-B	32.000-B	41.3768-B	43.9258-B	75.0005-B
4.8303-B	8.3303-B	16.3848-B	33.2006-B	41.9378-B	44.0008-B	90.8338-B
4.9152-B	8.4998-B	17.2248-B	33.6258-B	42.0008-B	44.0378-B	99.9668-B
5.000-B	8.5766-B	17.2422-B	34.5568-B	42.5836-B	44.3788-B	100.6668-B
5.0688-B	8.6056-B	18.000-B	34.7538-B	42.6268-B	44.7778-B	101.4668-B
5.1203-B	8.9608-B	18.4320-B	34.9776-B	42.7006-B	45.1258-B	103.0668-B
5.1850-B	8.9906-B	19.4690-B	35.8258-B	42.7538-B	46.3006-B	103.4668-B
5.1856-B	9.47208-B	19.7508-B	36.000-B	42.8148-B	46.7006-B	104.9918-B

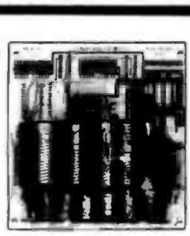
ALL "A" — $2.99 ALL "B" — $1.99 10 OR MORE DEDUCT 5%

ADD $1.00 SHIPPING
CAL. RES. ADD 6% SALES TAX
FREE OSCILLATOR SCHEMATICS
WITH ANY ORDER

QUALITY COMPUTER PARTS
P.O. BOX 743 / CHATSWORTH, CA 91311

Circle 321 on inquiry card.

POWER



THE AE-85 SINGLE CARD COMPUTER FOR DEDICATED CONTROL

The AE-85 with the many features listed below is ideal for dedicated control applications since all the necessary features are provided on-board. Even the interrupt control logic and space for custom electronics is provided so as to further reduce development costs. So save time with the simple solution and discover the AE-85.

Standard
- Standard 6 MHz 8085 MPU with serial port
- 22 programmable bidirectional I/O pins
- 256 bytes of RAM
- 14 bit crystal controlled counter/timer
- Up to 4K EPROM (accepts 2708, 2716 or 2732)
- Provisions for 190 wire wrap pins for various sockets and connectors
- On-board jumper definable logic allowing easy combining of interrupt requests for the 4 hardware interrupts
- 6 by 6 inches with four 3/16 inch holes for easy mounting
- Assembled and tested $179.00 singles

Optional-an extra
- 22 programmable bidirectional I/O pins
- 1280 bytes of RAM
- 14 bit crystal controlled counter/timer

Call today for more information. Phone: 614-221-3060
***Adroit Electronics, Inc.*, 5 East Long Street, Suite 1012, Columbus, Ohio 43215**

Circle 5 on inquiry card.

COLOR VIDEO MONITORS RGB AND COMPOSITE VIDEO

- **TC-700 13" color video monitor/receiver,** NTSC composite video. $399.00 **TC-900,** 19", $595.00. Use with Apple II and III and other computers.
- **CM-19RGB:** 19" screen, 3 modes: RGB, Composite video, TV. $895.00.
- **Apple III RGB Interface:** Converts RGB data from Apple III to produce 16 color display on RGB monitor. $129.00.
- **Hitachi Hi-Res RGB, 13"** character display, 2000, 80 x 24, 5 x 7 dot matrix, TTL inputs. $1200.00.
- **Sony TV to video monitor conversion kit, MCK 100:** $135.00.
- **OEM 13"** and **19"** RGB color monitors, immediate delivery, prices and specs, on request.

For additional information, contact:

Video Marketing, Inc.
P.O. Box 339
Warrington, Pa. 18976
(215) 343-3000

Circle 395 on inquiry card.

— Discounts Discounted —

We Feature
CP/M — Osborne — Rejas — Forth
Micro-soft — Micro-Pro —
Micro-AP — Fortran — S-Basic

Special Feature Packages
CP/M — Peachtree Programs

General Ledger
Acct. Rec.
Acct. Payable
Pay Roll
Inventory
Mailing Address

$1250.00
Plus — Sales Tax
Plus — Shipping

This sale terminates when this ad closes.
Act Now.

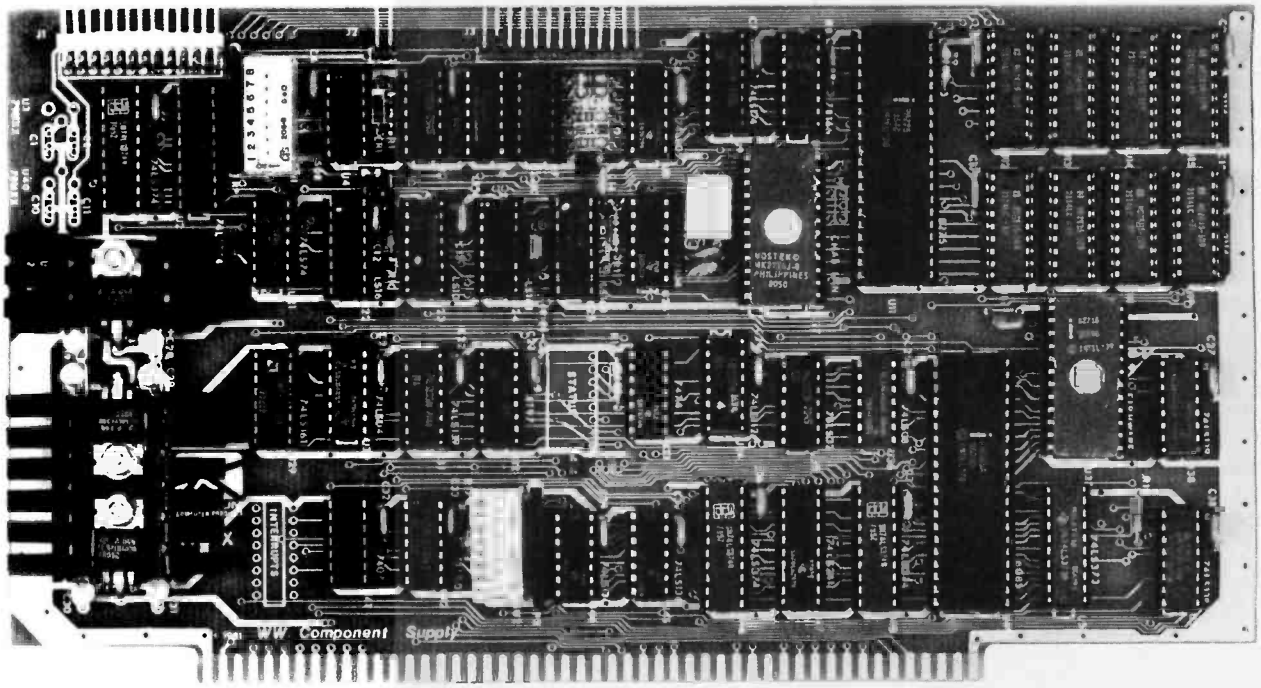
Write for our free catalog:

PACIFIC DISCOUNT
SOFTWARE

3204-A Production Avenue
Oceanside, California 92054
Telephone (714) 439-6201

Circle 291 on inquiry card.

INTELLIGENT VIDEO I/O FOR S-100 BUS



VIO-X

The VIO-X Video I/O Interface for the S-100 bus provides features equal to most intelligent terminals both efficiently and economically. It allows the use of standard keyboards and CRT monitors in conjunction with existing hardware and software. It will operate with no additional overhead in S-100 systems regardless of processor or system speed.

Through the use of the Intel 8275 CRT controller with an onboard 8085 processor and 4k memory, the VIO-X interface operates independently of the host system and communicates via two ports, thus eliminating the need for host memory space. The screen display rate is effectively 80,000 baud.

The VIO-X1 provides an 80 character by 25 line format (24 lines plus status line) using a 5 × 7 character set in a 7 × 10 dot matrix to display the full upper and lower case ASCII alphanumeric 96 printable character set (including true descenders) with 32 special characters for escape and control characters. An optional 2732 character generator is available which allows an alternate 7 × 10 contiguous graphics character set.

The VIO-X2 also offers an 80 character by 25 line format but uses a 7 × 7 character set in a 9 × 10 dot matrix allowing high-resolution characters to be used. This model also includes expanded firmware for block mode editing and light pen location. Contiguous graphics characters are not supported.

Both models support a full set of control characters and escape sequences, including controls for video attributes, cursor location and positioning, cursor toggle, and scroll speed. An onboard Real Time Clock (RTC) is displayed in the status line and may be read or set from the host system. A checksum test is performed on power-up on the firmware EPROM.

Video attributes provided by the 8275 in the VIO-X include:

- FLASH CHARACTER
- INVERSE CHARACTER
- UNDERLINE CHARACTER or
- ALT. CHARACTER SET
- DIM CHARACTER

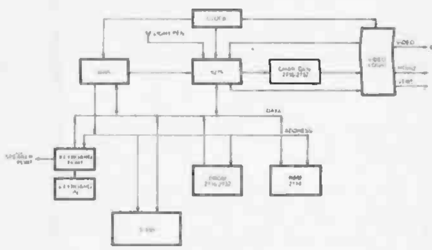
The above functions may be toggled together or separately.

The board may be addressed at any port pair in the IEEE 696 (S-100) host system. Status and data ports may be swapped if necessary. Inputs are provided for parallel keyboard and for light pen as well as an output for audio signalling. The interrupt structure is completely compatible with Digital Research's MP/M ®.

Additional features include:

- HIGH SPEED OPERATION
- PORT MAPPED IEEE S-100 INTERFACE
- FORWARD/REVERSE SCROLL or
- PROTECTED SCREEN FIELDS
- CONVERSATIONAL or BLOCK MODE (opt)
- INTERRUPT OPERATION
- CUSTOM CHARACTER SET
- CONTROL CHARACTERS
- ESCAPE CHARACTER COMMANDS
- INTELLIGENT TERMINAL EMULATION
- TWO PAGE SCREEN MEMORY

VIO-X1 - 80 × 25 5 ×7 A & T **$295.00**
Conversational Mode
VIO-X2 - 80 × 25 7 × 7 A & T **$345.00**
Conversational & Block Modes



VIO-X S-100 I/O INTERFACE

FULCRUM™ COMPUTER PRODUCTS

Distributed by:
WW COMPONENT SUPPLY INC. 1771 JUNCTION AVENUE • SAN JOSE, CA 95112 • (408) 295-7171

Circle 404 on inquiry card.

Quest ELECTRONICS

P.O. Box 4430X
Santa Clara, CA 95054
Will calls: 2322 Walsh Ave.
(408) 988-1640 TWX 910-338-2139

Same day shipment. First line parts only. Factory tested. Guaranteed money back. Quality IC's and other components at factory prices.

INTEGRATED CIRCUITS

7400 TTL	
7400N	19
7402N	20
7404N	25
7409N	27
7410N	25
7414N	70
7420N	25
7422N	39
7430N	25
7442N	58
7445N	82
7447N	63
7448N	77
7450N	25
7474N	35
7475N	49
7485N	88
7489N	1 70
7490N	43
7492N	43
7493N	43
7495N	69
74100N	1 35
74107N	35
74121N	34
74123N	59
74125N	45
74145N	77
74150N	1 20
74151N	69
74154N	1 25
74157N	69
74161N	67
74162N	85
74163N	87
74174N	96
74175N	85
74190N	1 15
74192N	87
74193N	85
74221N	1 25
74298N	1 65
74365N	75
74366N	75
74367N	75

74LS00 TTL	
74LS00N	29
74LS02N	29
74LS04N	35
74LS05N	25
74LS08N	35
74LS10N	35
74LS13N	55
74LS14N	1 00
74LS20N	35
74LS22N	35
74LS28N	35
74LS30N	35
74LS33N	60
74LS38N	50
74LS74N	45
74LS75N	65
74LS90N	60
74LS93N	75
74LS95N	1 00
74LS107N	45
74LS112N	45
74LS113N	45
74LS132N	89
74LS136N	50
74LS151N	75
74LS155N	79
74LS157N	1 10
74LS162N	1 10
74LS163N	1 10
74LS174N	1 15
74LS190N	1 25
74LS221N	1 25
74LS258N	1 00
74LS367N	89

LINEAR	
CA3045	90
CA3046	1.10
CA3081	1 80
CA3082	1 90
CA3089	3 40
LM301AN/AH	35
LM305H	87
LM307N	35
LM308N	1 00
LM309K	1 25
LM311H/N	90
LM317T	1 65
LM317K	3 75
LM318	1 50
LM320K-5	1 35
LM320K-12	1 35
LM320K-15	1 35
LM320T-5	95
LM320T-8	95
LM320T-12	95
LM320T-15	95
LM323K-5	5 95
LM324N	1 00
LM339N	1 00
LM340K-5	1 35
LM340K-8	1 35
LM340K-12	1 35
LM340K-15	1 35
LM340K-24	1 35
LM340T-5	85
LM340T-8	85
LM340T-12	85
LM340T-15	85
LM340T-18	85
LM340T-24	.85
LM350	5 50
LM377	2 95
LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1 60
LM709H	59
LM723H/N	50
LM733N	85
LM741CH	35
LM741N	38
LM747H/N	75
LM748N	50
LM1303N	1 75
LM1304	1 10
LM1305	1 27
LM1307	2 00
LM1310	1 95
LM1458	55
LM1812	7 50
LM1889	3 00
LM2111	1 75
LM2902	2 25
LM3900N	60
LM3905	1 75
LM3909N	.95
MC1458V	55
NE550N	1 35
NE555V	39
NE556A	85
NE565A	1 00
NE566V	1 50
NE567V	1 00
NE570N	4.75
78L05	60
78L08	60
78M05	85
75108	1 75
75491CN	50
75492CN	55
75494CN	89

A to D CONVERTER	
80388	4 50
8700CJ	13 95
8701CN	22 00
8750CJ	13 95
LD130	9 95
9400CJV/F	7 40
ICL7103	9 50
ICL7107	14 25

CMOS	
CD4000	25
CD4001	35
CD4002	35
CD4006	1 10
CD4007	35
CD4008	1 20
CD4009	45
CD4010	45
CD4011	35
CD4012	28
CD4013	.47
CD4014	1 25
CD4015	1 00
CD4016	55
CD4017	1 05
CD4018	94
CD4019	45
CD4020	1 02
CD4021	1 35
CD4022	1 10
CD4023	28
CD4024	75
CD4025	28
CD4026	2 50
CD4027	66
CD4028	85
CD4029	1 35
CD4030	45
CD4035	1 00
CD4040	1 35
CD4042	85
CD4043	85
CD4044	85
CD4046	1 67
CD4049	45
CD4050	60
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	40
CD4070	50
CD4071	45
CD4072	45
CD4073	45
CD4075	45
CD4076	1 45
CD4078	40
CD4081	35
CD4082	35
CD4116	47
CD4490	5 50
CD4507	1 00
CD4508	2 85
CD4510	1 00
CD4511	94
CD4515	2 52
CD4516	1 50
CD4518	1 50
CD4520	1 02
CD4527	1 51
CD4528	1 60
CD4553	3 50
CD4566	2 45
CD4583	2 35
CD4585	1 10
CD40192	3 00
74C00	35
74C04	40
74C10	35
74C14	89
74C20	35
74C30	35
74C48	1 95
74C74	85
74C76	1 25
74C90	1 25
74C93	1 25
74C154	3 50
74C160	2 75
74C175	1 35
74C192	1 65
74C221	1 90
74C905	6 00
74C906	75
74C914	1 95
74C922	5 00
74C923	5 50
74C925	6 95
74C926	6 95
74C927	6 95

INTERFACE	
8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	1 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1 69

MOS/MEMORY RAM	
2101-1	2 95
2102-1	95
2102AL-4	1 45
2102AN-2L	1 65
2104A-4	4 95
2107B-4	3 75
2111-1	3 95
2112-2	3 95
2114	3 75
2114L 300ns	4 25
2114L 450ns	4 00
4116 200ns	3 95
8-2116 200ns	18 40
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4 00
PD411D-4	5 00
P5101L	8 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165-5	6 95
MM57100	4 50
GIAY38500-1	9 95
MCM66751A	9 95
9368	3 50
4100	10 00
416	16 00

CLOCKS	
MM5311	5 50
MM5312	3 90
MM5314	3 90
MM5369	2 10
MM5841	14 45
MM5865	7 95
CT7010	8 95
CT7015	8 95
MM5375AA/N	3 90
MM5375AG/N	4 90
7205	16 50
7207	7 50
7208	15.95
7209	4 95
DS0026CN	3 75
DS0056CN	3 75
MM53104	2 50

MICROPROCESSOR	
6100	10 95
6504	9 95
6522	9.95
6800	6.95
6802	11.95
6820	4.95
6850	5.95
8080A	3 95
8085	12 95
8086	75 00
Z80	9 95
Z80A	11 95
8212	2 90
8214	3.95
8216	2 90
8224	3 45
8228	4.95
8251	6 95
8253	15 00
8255	5.75
8257	10 95
8259	14 95
1802CP plas	13.95
1802DP plas	17 95
1861P	9 50
CDP1802CD	28 95
CDP1802D	35 00
CDP1816P	7.95

UART/FIFO	
AY5-1013	5.50
AY5-1014	7 50
3341	6 95

PROM	
1702A	5 85
2708	6 10
2716T1	12 00
2716 5 Volt	10 50
B 2716 5 Volt	[illegible]
2732	19 95
2758	12 00
8741A	55 00
8748	55 00
8748-8	55.00
8755A	55 00
N82S23	2 95
N82S123	4 95
N82S126	4 75
N82S129	4 95
N82S131	4 95
N82S136	8 75
N82S137	8 75
DM8577	2 90
6223	3 50

CONNECTORS	
30 pin edge	2 50
44 pin edge	2.75
86 pin edge	4.00
100 pin edge	4 50
100 pin edge WW	5.25

IC SOCKETS

Solder Tin PIN	1 UP	Low Profile PIN	1UP
8	15	22	.30
14	14	24	.35
16	16	28	.42
18	27	36	.58
20	29	40	.57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	55	24	93
16	57	28	1.00
18	67	40	1.59

CRYSTALS	
1 MHz	4.50
2 MHz	4 50
4 MHz	4 25
5 MHz	4.25
10 MHz	4.25
18 MHz	3 90
20 MHz	3.90
32 MHz	3.90
32768 Hz	4 00
1 8432 MHz	4.50
3.5795 MHz	1,20
2 0100 MHz	1 95
2 097152 MHz	4 50
2 4576 MHz	4.50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4.50
5 7143 MHz	4 50
6 5536 MHz	4 50
14.31818 MHz	4.25
18.432 MHz	4 50
22.1184 MHz	4.50

KEYBOARD ENCODERS	
AY5-2376	$12.50
AY5-3600	17.95
AY5-9100	10 50
AY5 9200	16.50
74C922	5.50
74C923	5 50
HD0165-5	6.95
AY5 9400	10 50

D Connectors RS232	
DB25P	3 62
DB25S	5.20
Cover	1.67
DE9S	1.95
DA15P	2.10
DA15S	3.10
Complete Set	9 50

Hickok 3½ Digit LED multimeter	89.95
Stopwatch Kit	26 95
Auto Clock Kit	17.95
Digital Clock Kit	14.95

8K/16K Eprom Kit (less PROMS)	$89 00
Motherboard	$39 00
Extender Board	$15 00

RESISTORS ¼ watt 5%	
10 per type	03
25 per type	025
100 per type	015
1000 per type	012
350 piece pack 5 per type	6.75

½ watt 5% per type .05

Televideo Terminal	
Model 912	$785.00
Model 920	$885 00

KEYBOARDS	
56 key ASCII keyboard kit	$67.50
Fully assembled	77 50
53 key ASCII keyboard kit	60 00
Fully assembled	70.00
Enclosure Plastic	14.95
Metal Enclosure	29 95

LEDS	
Red TO18	15
Green Yellow TO18	20
Jumbo Red	20
Green Orange, Yellow Jumbo	.25
Cliplite LED Mounting Clips	8/$1 25

(specify red, amber, green yellow clear)

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip
MAX-100 8 digit Freq. Ctr. $149.95

OK WIRE WRAP TOOLS in stock
Portable Multimeter $18.00

Complete line of AP Products in stock.

SPECIAL PRODUCTS	
MM5865 Stopwatch Timer with 10 pg spec	9 00
PC board	7.50
Switches Mom Pushbutton	27
3 pos slide	.25
Encoder HD0165-5	6 95
Paratronics	
Model 10 Trigger Expander Kit	$229.00
Model 150 Bus Grabber Kit	$369 00
Clock Calendar Kit	$23.95
2.5 MHz Frequency Counter Kit	$37.50
30 MHz Frequency Counter Kit	$47.75

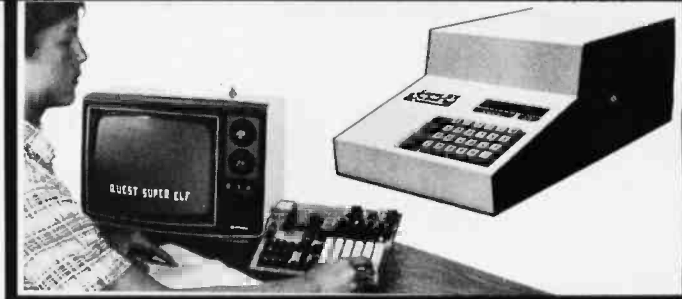
TRANSFORMERS	
6V 300 ma	3 25
12 Volt 300 ma transformer	1 25
12 6V CT 600 ma	3 75
12V 250 ma wall plug	2.95
12V CT 250 ma wall plug	3 75
24V CT 100 ma	3 95
10V 1.2 amp wall plug	4 85
12V 6 amp	12 95
12V 500 ma wall plug	4.75
12V 1 amp wall plug	6.50
10/15 VAC 8/16 VA wall plug	9.75

DISPLAY LEDS			
MAN1	CA	270	2 90
MAN3	CC	125	39
MAN72/74	CA/CA	300	1 00
DL704	CC	300	1.25
DL707/DL707R	CA	300	1,00
DL727/728	CA CC	500	1 90
DL747/750	CA/CC	600	1.95
FND359	CC	357	70
FND500/507	CC/CA	500	1,35
FND503/510	CC/CA	500	90
FND800/807	CC CA	800	2 20
3 digit Bubble			60
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9.50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
MAN4710	CA	40	95
MAN4740	CC	40	1 20
MAN6640	CC	56	2 95
MAN6710	CA	60	1.35
MAN6740	CC	60	1 35

MA1002A, C, E	8.95
MA1012A	8.95
102P3 transformer	2 25
MA1012A Transformer	2.25

DIP Switches			
4-position	5 95	7-position	1 00
5-position	1 00	8-position	1.05
6-position	1,00		

4116 200ns Dynamic RAM
8/$18.40



RCA Cosmac 1802 Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the Super Elf for so little money. The Super Elf is a small single board computer that does many big things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest address and data bus** displays **before, during and after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step.** Large, on board displays provide output and optional **high** and **low address.** There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** All metal Expansion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Free 14 page brochure.

Moews Video Graphics **$3.50.** Games and Music **$3.00,** Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface.** Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf.** The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and **is fully socketed.** EPROM can be used for the monitor and Tiny Basic or other purposes. **A 1K Super ROM Monitor** $19.95 is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake.** They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Quest Super Basic V5.0

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ± 2 billion; multi dim arrays, string arrays; string manipulation; cassette I/O; save and load, basic, data and machine language programs; and over 75 statements, functions and operations.

New improved faster version including **re-number and essentially unlimited variables.**

Also, an exclusive user expandable command library.

Serial and Parallel I/O included.

Super Basic on Cassette $55.00.

Ohio Scientific Computers

C1P Series 2 **$447.00.** Like an Apple at less than half the price! C1PMF Series 2 **$1199.00.** Minifloppy version with additional RAM/ROM. Complete software and peripherals available. Send for free brochure.

Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

Gremlin Color Video Kit $69.95

32 x 16 alpha/numerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit **$4.95**

Super Color S-100 Video Kit $129.95

Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

1802 16K Dynamic RAM Kit $149.00

Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$25.00**

Tiny Basic Extended on Cassette $15.00
(added commands include Stringy, Array, Cassette I/O etc.) S-100 4-Slot Expansion $ 9.95
Super Monitor VI.I Source Listing $15.00

Dealers: Send for excellent pricing/margin program.

Editor Assembler $25.00
(Requires minimum of 4K for E/A plus user source)
1802 Tiny Basic Source listing $19.00
Super Monitor V2.0/2.1 Source Listing $20.00

PROM Eraser

assembled. 25 PROM capacity **$37.50** (with timer **$69.50**). 6 PROM capacity OSHA/UL version **$69.50** (with timer **$94.50**).

Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50.** Full Kit **$99.00.** Monitor **$20.00.** Power Supply Kit **$35.00. Tiny Basic $30.00**

S-100 Computer Boards

8K Static Godbout Econo IIA Kit	149.00
16K Static Godbout Econo XIV Kit	269.00
24K Static Godbout Econo XX-24 Kit	414.00
32K Static Godbout Econo XX-32 Kit	537.00
16K Dynamic RAM Kit	289.00
32K Dynamic RAM Kit	328.00
64K Dynamic RAM Kit	399.00
Video Interface Kit	$161.00
Color Video Kit	129.95

81 IC Update Master Manual $79.95

Comp. IC data selector, 2 vol. master reference guide. Over 51,000 cross references. Free update service through 1981. Domestic postage $4.75.

Modem Kit $60.00

State of the art, orig., answer. No tuning necessary. 103 compatible 300 baud. Inexpensive acoustic coupler plans included. Bd. only $17.00. Article in May *Radio Electronics.*

LRC 7000+Printer $389.00

64/40/32/20 column dot matrix impact, std. paper. Interface all personal computers.

LRC 7000 printer interface cable for Super Elf with software $35.00

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$9.95**

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display, ROM monitor, fully expandable. **$405.00.** 4K version **$450.00.** 4K Assembler **$85.00,** 8K Basic Interpreter **$100.00.**

Special small power supply for AIM65 assem. in frame **$54.00.** Complete AIM65 in thin briefcase with power supply **$499.00.** Molded plastic enclosure to fit both AIM65 and power supply **$47.50.** Special Package Price: 4K AIM, 8K Basic, power supply, cabinet **$625.00.**

AIM65/KIM/VIM/Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95.**

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

Video Modulator Kit $9.95

Convert TV set into a high quality monitor w/o affecting usage. Comp. kit w/full instruc.

Multi-volt Computer Power Supply

8v 5 amp. ±18v .5 amp, 5v 1.5 amp, −5v .5 amp, 12v .5 amp, −12v option. ±5v, ±12v are regulated. Basic Kit $35.95. Kit with chassis and all hardware $51.95. Add $5.00 shipping. Kit of hardware $16.00. Woodgrain case $10.00. $1.50 shipping.

TERMS: $5.00 min. order U.S. Funds. Calif residents add 6% tax.
$10.00 min. BankAmericard and Master Charge accepted. $1.00 insurance optional.
Postage: Add 5%. C.O.D. $10.00 min. order.

FREE: Send for your copy of our NEW 1981 QUEST CATALOG. Include 48¢ stamp.

Circle 327 on inquiry card.

MICRO DESIGN CONSULTANTS

1 Bit through
32-Bit Machines

We handle concept through production prototypes with complete documentation.

HARDWARE - 916/723-1050
David Jenkins
7214 Springleaf Court
Citrus Heights, CA 95610

SOFTWARE - 916/381-1717
Richard Lerseth - LEAPAC
8245 Mediterranean Way
Sacramento, CA 95826

Circle 195 on inquiry card.

ATARI® GAME OWNERS

YOU ALREADY OWN A POWERFUL HOBBY COMPUTER

Realize its capabilities by plugging our MagiCard module into your unaltered Video Computer System™ console. If you have ever wanted to program a computer or learn about microprocessors, our MagiCard and detailed instruction manual are an unmatched educational value. If you have ever wanted to understand and use the video and audio capabilities of your ATARI game, our MagiCard will unlock its mysteries. Features include 1K bytes of RAM and a 2K byte ROM monitor. Using your keyboard controllers, you will soon be creating your own 6502 machine language programs. To receive your MagiCard and manual (including sample programs and instructions for building a cassette interface), send check or money order for $49.88 (in Illinois, add 6% tax) to Computer Magic, Inc., Box 3383A, Fox Valley Center, Aurora, Illinois 60505.

ATARI and Video Computer System are trademarks of ATARI Inc.

Circle 72 on inquiry card.

North Star BASIC UTILITY SET

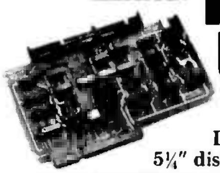
- EDITOR — Create & edit a Basic program using 26 commands, including GLOBAL locate & change.
- BPRT — Print & cross reference a Basic program.
- BPAK — Pack a Basic program.
- RE — Rename a disk file.

$69 plus $1.50 shipping, Calif. Res. add 6%. Check, VISA, M/C

SZ Software Systems
1269 Rubio Vista Road, Altadena, Calif. 91001
(213) 791-3202

Circle 372 on inquiry card.

ZENITH/ Heath Users



Double Your 5¼" disk storage capacity without adding a drive.

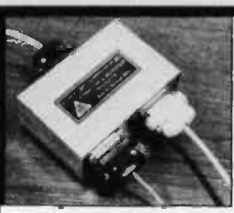
Get twice as much from your H88 or H89 microcomputer. Our FDC-880H floppy disk controller, in conjunction with your 5¼" drives, for example, expands memory capacity from 256 bytes to 512 bytes per sector.

And it handles single and double-sided, single and double-density, 8" and 5¼" drives — simultaneously.

Call 714/275-1272 today or write for details.

C.D.R. Systems Inc.
Controlled Data Recording Systems, Inc.
7667 Vickers St., San Diego, CA 92111

Circle 50 on inquiry card.



TERMINAL DATA CORPORATION

MODEL 1200 RS-232 BI-DIRECTIONAL DATA SPLITTER

available in kit form

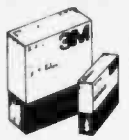
Model 1200K gives the terminal or microprocessor user a second interface for a printer, plotter, cassette or tape drive. It operates at any speed & isolates the two output devices from each other, while providing 2 RS-232 interfaces from the terminal or microprocessor.

The kit consists of 3 RS-232 connectors, printed circuit board, all necessary components, enclosure, mounting hardware & assembly instructions $69.00

write or call

TERMINAL DATA CORP.
11878 Coakley Cir.
Rockville, MD 20852
(301) 881-7655

Circle 382 on inquiry card.



Scotch® DISKETTES

SAVE 40% Write for our complete list.

5¼" Sgl. Dens. 26.70/10
Specify soft, 10 or 16 hard sectors

8" Sgl. Dens. 27.30/10
8" Dbl. Dens. 35.80/10
Specify soft or 32 hole hard

Add $2.00 shipping - Michigan add 4% tax

LYBEN COMPUTER SYSTEMS
27204 Harper Ave.
St. Clair Shores, MI 48081

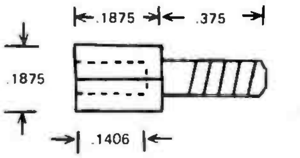
Authorized Distributor
Information Processing Products 3M

Circle 202 on inquiry card.

D TYPE CONNECTOR MOUNTING HARDWARE

at less than ½ the price

- Similar to Ansley #609-003
- Standard 4-40 male and female threads
- Complete with lock washers and 4-40 small pattern nuts



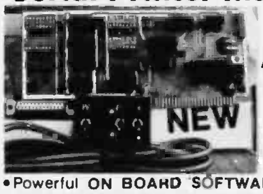
100 pc.	$40.00
500 pc.	$35.00/c
1000 pc.	$30.00/c

Over 1000 — please inquire

CCB Machine Products
1519 Sherbrook Rd.
Cleveland, Ohio 44121
1-216-381-1291

Circle 9 on inquiry card.

Serial Printer Interface



(RS232C) for **APPLE II**® only $179‡ assembled/tested burned in/docum

- Powerful **ON BOARD SOFTWARE** provides:
  - **TOP OF FORM & AUTO PAGING**
  - **LIST** format for program listings (inserts 1 or 2 blank lines after any user specified program line)
  - "**HARD COPY**" reproduces screen text on printer
  - **INPUT** from printers with keyboards
- **32 DIP SWITCH** levers select **ALL** printer interface parameters (columns/line, lines/page, vertical margins, and more)
- **BAUD** rates between 70 and 1500
- Output functions selected via **ATTRACTIVE** color coded - **CONTROL PANEL** (fits under keyboard)
- Control panel, 7 ft cable, connector included

ORDER NOW or send for **MORE INFORMATION**

RADIX, Inc.
P.O. Box 3465
Littleton, CO 80161
(303) 985-4152

‡CO residents add 3% sales tax
Foreign orders add 10%
MC/VISA/COD/MO
Personal Check (add 3 wks)

® registered trademark of Apple Computer, Inc.

Circle 326 on inquiry card.

PRIAM

Drives, Smart Controllers, Accessories, SMD interface available

lowest cost and greatest established reliability for H.P., DEC, Apple, Z-80, 8085 . . . and so on.

We can show you how to overcome "foreign" disk warranty worries—give us a call.

Special Opportunity:

S-100 Power Supply Kit
14A@ ±8VDC
2A@ ±18VDC
$29.95

Input: 95, 115, 205, 220 VAC, 50/60 Hz.
Includes: UL Spec. Transformer, Rectifiers, Computer Grade Capacitors, RFI line filter, and Schematics.

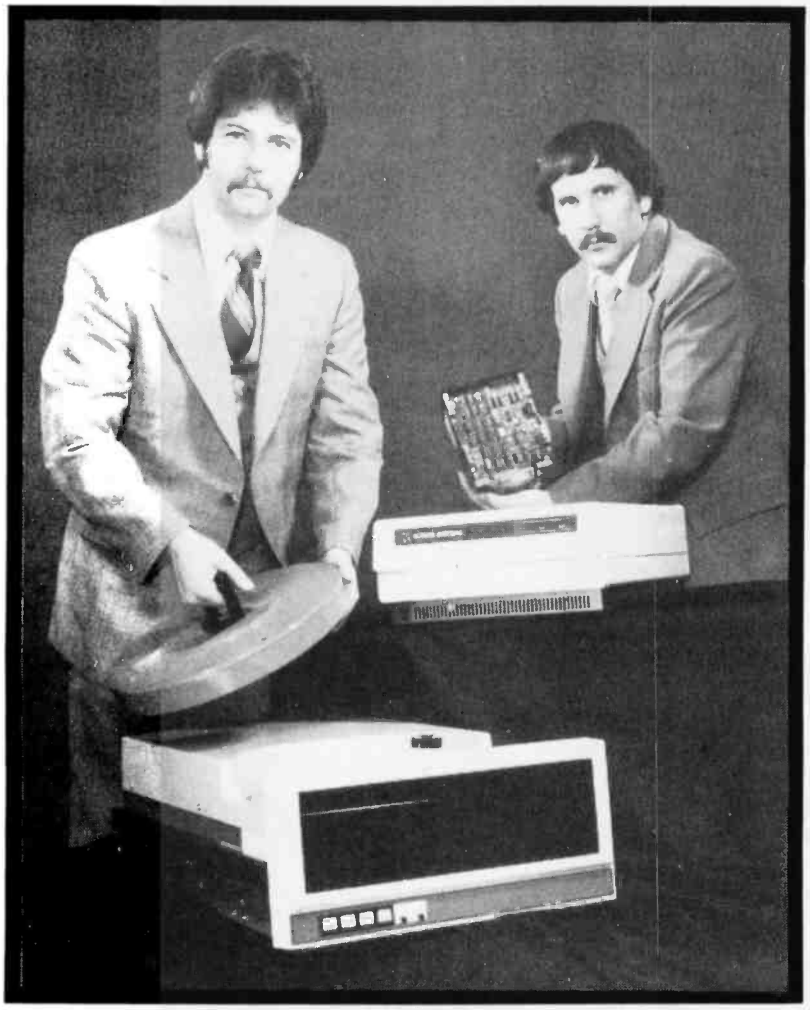
ADVANCED TECHNOLOGY
735 Loma Verde, Palo Alto, CA 94303
415-493-5930
Send 36 ct SASE for our 16 page flyer.

Circle 106 on inquiry card.

NOBODY KNOWS MORE ABOUT ADDING MEGABYTES TO YOUR TRS-80 MODEL II* THAN AMERICAN SMALL BUSINESS COMPUTERS

THE CAMEO CONNECTION

The Cameo 10 Million Character Disk Drive Subsystem (pictured in foreground) Is A 5 Megabyte Fixed, 5 Megabyte Removable Cartridge-Type Disk Drive. Advantages To This Unit Are Ease of Backup For Data and Program Files and Low Cost. By Attaching A Multiplexor Unit Several Model II's Can Be Attached To The Cameo Disk Drive. For Further Pricing, Availability, and Operating Systems Options, Call or Write to American Small Business Computers and ask for the CAMEO CONNECTION.



THE CORVUS CONNECTION

The Corvus Disk Drive Subsystem (center of picture) Is Available in 5, 10, and 20 Million Character Capacities. The Corvus System Is The Ultimate In The Sealed "Winchester, All-Fixed" Type Drive. The Corvus Is Designed To Operate In The Harshest Environments Such As Factories, Oil Rigs, Etc. Backup Of Data Is Accomplished Via Optional MIRROR Backup Device Whereby Data Is Written Onto A Standard Video Tape Recorder. A Great Number of Model II's May Be Attached To The Corvus Via An Optional CONSTELLATION Multiplexor. For Further Pricing, Availability, and Operating Systems, Call Or Write to American Small Business Computers and Ask for the CORVUS CONNECTION.

THE AMERICAN SMALL BUSINESS COMPUTERS MINI-WINCHESTER SPECIAL

The MINI-5 (being held by Corporate President Robert Webster) Is American Small Business Computer's Very Own Disk Subsystem. The MINI-5 Offers Approximately 5 Million Characters of Information Storage and is Based On the Famous Seagale Technology ST-506 Micro Winchester Drive. Now You Can Own State-Of-The-Art Technology At An Affordable Price — Only $3500 — Which Includes Drive, Controller Electronics, Power Supply, Cabinet, Cables, Documentation and Operating System Software.

DEALER INQUIRIES INVITED

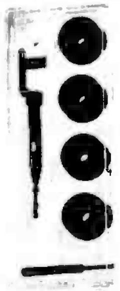
AMERICAN SMALL BUSINESS COMPUTERS

*TM TANDY CORPORATION

118 SOUTH MILL STREET PRYOR, OK. 74361 918-825-4844

Circle 16 on inquiry card.

PRODUCTS



JUST WRAP KIT

Just Wrap tool for daisy chain wiring. Tool strips as it wraps and cuts. Includes one 50 foot spool of wire.

Part No.	Description	Price
JW-1*	Just Wrap Tool	$14.95
JWK-6	Tool w/4 Spools and JUW1	24.95
R-JW*	50 Ft. Replacement Wire	3.49
JUW-1	Unwrapping Tool	3.49

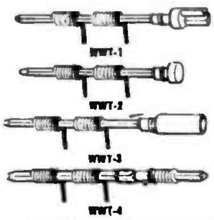
*Specify Color: Red, Blue, White or Yellow.

Regular Wrap

Modified Wrap

HAND WRAP TOOL

Part No.	Description	Price
WSU30	Regular	$6.95
WSU30M	Modified	7.95



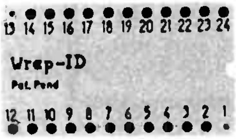
TERMINALS

- .025 (0,63mm) Square Post
- 3 Level Wire-Wrapping
- Gold Plated

25 PER PKG.

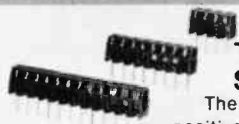
Part No.	Description	Price
WWT-1	Slotted Terminal	$4.98
WWT-2	Single Sided Terminal	2.98
WWT-3	IC Socket Term.	4.98
WWT-4	Double Sided Terminal	1.98
INS 1	Insertion Tool for above	2.49

SOCKET WRAP — ID



Slipped onto socket before wrapping to identify pins.

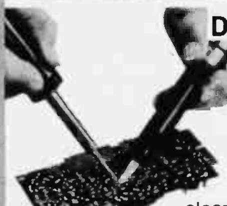
Part #	Price	Bulk Price	Part #	Price	Bulk Price
14ID	1.49/10	5.50/100	22ID	1.49/5	5.95/50
16ID	1.49/10	5.95/100	24ID	1.49/5	5.95/50
18ID	1.49/10	5.00/50	28ID	1.49/5	6.50/50
20ID	1.49/5	5.00/50	40ID	1.49/5	5.00/25



P.C.B. TERMINAL STRIPS

The TS strips provide positive screw activated clamping action, accommodate wire sizes 14-30 AWG (1,8-0, 25mm). Pins are solder plated copper, .042 inch (1mm) diameter, on .200 inch (5mm) centers.

Part No.	Description	Price
TS- 4	4-Pole	$1.69
TS- 8	8-Pole	2.59
TS-12	12-Pole	3.49
TS6MD	2-Pole Interlocking	3/1.79

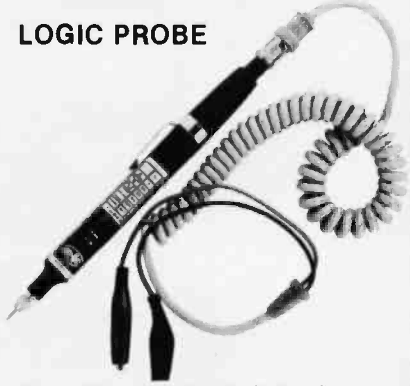


DESOLDERING PUMP

Easy one hand operation. Rugged all metal construction. Replaceable TEFLON® Tip. Self cleaning on each stroke. Suction precisely regulated for reliable desoldering without damage to delicate circuitry.

DSPI	Desoldering Pump	$9.95

LOGIC PROBE



Compatible with all logic families using a 4 to 15V power supply. Thresholds automatically programmed. Visual indication of logic levels to show high, low, bad level or open circuit logic pulses.

- 10 N sec. pulse responses
- 120 K input impedence.
- Automatic resetting memory.
- Includes tip with protective cap & coiled cord.

PRB-1 $36.95

LOGIC PULSER

Superimposes a pulse train (20 pps) or a single pulse onto the circuit node under test without un-soldering IC's.

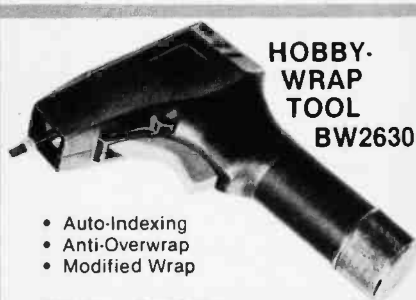
- Automatic polarity sensing
- 2 us pulse width
- Finger tip push button actuated
- Includes tip with protective cap & coiled cord.

PSL-1 $48.95

VACUUM VISE

Unique vacuum-based light duty vise for precision handling of small components and assemblies. Rugged ABS construction. 1½" (32mm) travel for maximum versatility. Also features screw lugs for permanent installation.

VV1	Vacuum Vice	$3.49



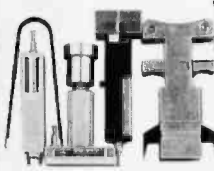
HOBBY-WRAP TOOL BW2630

- Auto-Indexing
- Anti-Overwrap
- Modified Wrap

Part No.	Description	Price
BW2630	Tool	$19.85
BT30	#30 Bit (not incl.)	3.95
BT2628	#28 Bit (not incl.)	7.95
BC1	Batteries & Charger	14.95

INSERTION/EXTRACTION TOOLS

Part No.	Description	Price
INS1416	14-16 pin Inserter	$3.49
MOS1416	14-16 pin MOS Safe Inserter	7.95
MOS2428	24-28 pin MOS Safe Inserter	7.95
MOS40	40 pin MOS Safe Inserter	7.95
EX1	14-16 pin IC Extractor	1.49
EX2	24-40 pin IC Extractor	7.95



WK-7 IC INSERTION KIT

Complete IC Inserter/ Extractor Kit Individual Components (listed above) $22.95

IC DISPENSER

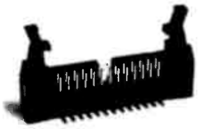
Allows IC's to be dispensed from their tube 1 at a time and picked up by insertion tools above.

- Dispenses 8-42 pin IC's • Compatable with all IC carrying tubes • Use with WK7 for MOS safe insertion. •

Part No.	Description	Price
MDD1	1 Chan. Dispenser	$21.85
MDD5	5 Chan. Dispenser	83.43
MDD10	10 Chan. Dispenser	160.45

*No Discount.

IDC CONNECTORS



RIGHT ANGLE HEADERS

	SOLDER TAIL		WIRE WRAP	
Size	Part No.	Price	Part No.	Price
10	IDH10SRB	$1.20	IDH10WRB	$2.60
20	IDH20SRB	1.90	IDH20WRB	4.15
26	IDH26SRB	2.75	IDH26WRB	5.35
34	IDH34SRB	3.75	IDH34WRB	6.25
40	IDH40SRB	3.75	IDH40WRB	7.35
50	IDH50SRB	4.75	IDH50WRB	9.20

.1" Spacing. Mounts on PC Board & Mates with IDS Socket below. Ejector Bars - 4/1.00.

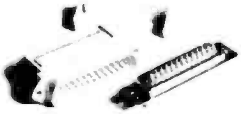
EDGE CARD CONNECTORS

Size	Part No.	Price
10	IDE10B	$3.95
20	IDE20B	4.35
26	IDE26B	5.00
34	IDE34B	6.05
40	IDE40B	6.90
50	IDE50B	7.50

.1" Spacing. Crimps onto cable with ordinary vise & mates with standard .062" Card Edge.

RIBBON CABLE

	Solid Color		Color Coded	
Size	10 ft.	100 ft.	10 ft.	100 ft.
10	2.90	17.00	4.00	30.00
14	3.40	23.80	5.00	42.00
16	3.70	27.20	5.60	48.00
20	4.40	34.00	7.00	60.00
24	5.00	40.80	8.00	72.00
26	5.40	44.20	8.60	78.00
34	6.80	57.80	11.00	102.00
40	7.80	68.00	13.00	120.00
50	9.50	85.00	16.00	150.00



25 PIN "D" CONNECTORS

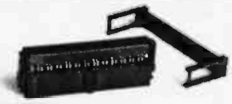
Solder Style	Part No.	Price
Male	DB25P	$2.95
Female	DB25S	3.95
Cover	DB25C	1.50
IDC Style		
Male	IDB25P	6.25
Female	IDB25S	6.60
Cover	IDB25C	1.60

Solder Style solders onto cable, IDC Style crimps onto cable with vise. 9, 15, 37 and 50 pin available also.

CABLE PLUGS

Size	Part No.	Price
14	IDP14B	$1.45
16	IDP16B	1.65
24	IDP24B	2.50
40	IDP40B	4.15

.1" Spacing. Crimps onto cable with ordinary vise & plugs into standard IC Socket.



SOCKETS

Size	Part No.	Price
10	IDS10B	$1.88
20	IDS20B	2.75
26	IDS26B	3.50
34	IDS34B	4.50
40	IDS40B	5.40
50	IDS50B	6.50

.1" Spacing. Crimps onto cable with ordinary vise & mounts to header sold above.

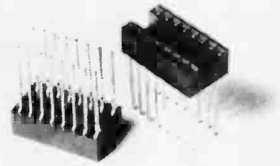
WIRE WRAP SUPPLIES

WIRE WRAP WIRE

#30 Wire Wrap Wire

Length	100/Bag	500/Bag	1K/Bag
2.5"	$1.38	$6.81	$3.94
3.0"	1.43	7.46	4.25
3.5"	1.51	8.11	4.57
4.0"	1.56	8.73	4.88
4.5"	1.63	9.39	5.21
5.0"	1.69	10.04	5.54
5.5"	1.74	10.69	5.92
6.0"	1.82	11.34	6.23
6.5"	2.11	12.99	7.08
7.0"	2.19	13.68	7.44
7.5"	2.29	14.40	7.78
8.0"	2.35	15.10	8.12
8.5"	2.40	15.80	8.46
9.0"	2.46	16.51	8.92
9.5"	2.53	17.22	9.15
10.0"	2.63	17.91	9.58

All lengths are overall, including 1" strip on each end. Choose from colors; Red, Blue, Black, Yellow, White, Green, Orange, and Violet.



Size	Part No.	Each	Tube
08	ICN083WBSG	.44	52x .39 = $20.28
14	ICN143WBSG	.53	30x .46 = $13.80
16	ICN163WBSG	.58	26x .50 = $13.00
18	ICN183WBSG	.78	23x .68 = $15.64
20	ICN203WBSG	1.00	21x .85 = $17.85
22	ICN224WBSG	1.07	19x .92 = $17.48
24	ICN246WBSG	1.09	17x1.09 = $15.98
28	ICN286WBSG	1.43	15x1.23 = $18.45
40	ICN406WBSG	1.85	10x1.60 = $16.00

Selective Plating provides gold in contact where it counts. 3-level wrap. Save by buying sockets by the tube. All gold available at ½¢/pin extra charge.

* * * No Discount

WIRE KITS

Kit No. 1 — $9.95

250	3"	100	4½"
200	3½"	100	5"
100	4"	100	6"

Kit No. 2 — $24.95

250	2½"	250	5"
500	3"	100	5½"
500	3½"	100	6"
500	4"	100	6½"
250	4½"	100	7"

Kit No. 3 — $34.95

250	2½"	500	4½"
500	3"	500	5"
500	3½"	500	5½"
500	4"	500	6"

Kit No. 4 — $59.95

500	2½"	1000	4½"
1000	3"	1000	5"
1000	3½"	1000	5½"
1000	4"	1000	6"

ORDERING INFORMATION

Prepaid orders over $50 shipped prepaid via UPS. All others add $3.00 for handling. VISA, MC, COD's and open account orders will be charged freight. $15 minimum order. $100 minimum open account order.

DISCOUNT SCHEDULE

Order	Amount
$15 - 99	Net
100 - 199	less 10%
200 - 499	less 15%
500 - 999	less 20%
1000 up	less 25%

Discount and the name of this magazine must be mentioned at time of order to get discount. Discount applies on all items except as noted, "No Discount."

16K Memory 8/$16.95

4116 300ns

ALL MERCHANDISE 100% GUARANTEED — **CALL US FOR VOLUME QUOTES**

LS SERIES

74LS00	.25	74LS163	.95
74LS01	.25	74LS164	.95
74LS02	.25	74LS165	.95
74LS03	.25	74LS166	2.40
74LS04	.25	74LS168	1.75
74LS05	.25	74LS169	1.75
74LS08	.35	74LS170	1.75
74LS09	.25	74LS173	.80
74LS10	.25	74LS174	.95
74LS11	.35	74LS175	.95
74LS12	.35	74LS181	2.15
74LS13	.45	74LS189	9.95
74LS14	1.00	74LS190	1.00
74LS15	.35	74LS191	1.00
74LS20	.25	74LS192	.85
74LS21	.35	74LS193	.95
74LS22	.25	74LS194	1.00
74LS26	.35	74LS195	.95
74LS27	.35	74LS196	.85
74LS28	.35	74LS197	.85
74LS30	.25	74LS221	1.20
74LS32	.35	74LS240	1.85
74LS33	.55	74LS241	1.85
74LS37	.55	74LS242	1.85
74LS38	.35	74LS243	1.85
74LS40	.25	74LS244	1.75
74LS42	.55	74LS245	2.85
74LS47	.75	74LS247	.76
74LS48	.75	74LS248	1.25
74LS49	.75	74LS249	.99
74LS51	.25	74LS251	1.30
74LS54	.35	74LS253	.85
74LS55	.35	74LS257	.85
74LS63	1.25	74LS258	.85
74LS73	.40	74LS259	2.85
74LS74	.45	74LS260	.65
74LS75	.50	74LS266	.55
74LS76	.40	74LS273	1.65
74LS78	.50	74LS275	3.35
74LS83	.75	74LS279	.55
74LS85	1.15	74LS280	1.98
74LS86	.40	74LS283	1.00
74LS90	.65	74LS290	1.25
74LS91	.89	74LS293	1.85
74LS92	.70	74LS295	1.05
74LS93	.65	74LS298	1.20
74LS95	.85	74LS352	1.55
74LS96	.95	74LS353	1.55
74LS107	.40	74LS363	1.35
74LS109	.40	74LS365	.95
74LS112	.45	74LS366	.95
74LS113	.45	74LS367	.70
74LS114	.50	74LS368	.70
74LS122	.45	74LS373	1.85
74LS123	.95	74LS374	1.80
74LS124	2.99	74LS377	1.45
74LS125	.95	74LS378	1.18
74LS126	.85	74LS379	1.35
74LS132	.75	74LS385	1.90
74LS136	.55	74LS386	.65
74LS137	.99	74LS390	1.90
74LS138	.75	74LS393	1.90
74LS139	.75	74LS395	1.65
74LS145	1.20	74LS399	1.70
74LS147	2.49	74LS447	.37
74LS148	1.35	74LS490	1.95
74LS151	.75	74LS668	1.69
74LS153	.75	74LS669	1.89
74LS154	2.35	74LS670	2.20
74LS155	1.15	74LS674	9.65
74LS156	.95	74LS682	3.20
74LS157	.75	74LS683	2.30
74LS158	.75	74LS684	2.40
74LS160	.90	74LS685	2.40
74LS161	.95	74LS688	2.40
74LS162	.95	74LS689	2.40

7400 SERIES

7400	.19	74128	.55
7401	.19	74132	.45
7402	.19	74136	.50
7403	.19	74141	.65
7404	.19	74142	2.95
7405	.22	74143	2.95
7406	.22	74144	2.95
7407	.22	74145	.60
7408	.24	74147	1.75
7409	.19	74148	1.20
7410	.19	74150	1.35
7411	.25	74151	.65
7412	.30	74152	.65
7413	.35	74153	.55
7414	.55	74154	1.40
7416	.25	74155	.75
7417	.25	74156	.65
7420	.19	74157	.55
7421	.35	74159	1.65
7422	.29	74160	.85
7423	.29	74161	.70
7425	.29	74162	.85
7426	.29	74163	.85
7427	.29	74164	.85
7428	.45	74165	.85
7430	.19	74166	1.00
7432	.29	74167	1.95
7433	.45	74170	1.65
7437	.29	74172	5.95
7438	.29	74173	.75
7440	.19	74174	.89
7442	.49	74175	.89
7443	.65	74176	.89
7444	.69	74177	.75
7445	.69	74178	1.15
7446	.59	74179	1.75
7447	.69	74180	.75
7448	.69	74181	2.25
7450	.19	74182	.75
7451	.23	74184	2.00
7453	.23	74185	2.00
7454	.23	74186	18.50
7460	.23	74190	1.15
7464	.39	74191	1.15
7465	.39	74192	.79
7470	.35	74193	.79
7472	.29	74194	.85
7473	.34	74195	.85
7474	.35	74196	.79
7475	.49	74197	.75
7476	.35	74198	1.35
7480	.59	74199	1.35
7481	1.10	74221	1.35
7482	.95	74246	1.35
7483	.50	74247	1.25
7484	.50	74248	1.85
7485	.65	74249	1.95
7486	.35	74251	.75
7489	4.95	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.49	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.00	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.55	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
		74490	2.55

T.V. CIRCUITS

MC1330	1.89
MC1350	1.29
MC1358	1.79
LM380	1.29
LM386	1.50
LM565	.99
LM741	.29
LM1310	2.90
LM1800	2.99
LM1889	2.49

MISC.

8T26	1.69	3242	9.95
8T28	2.49	AY5-1013	3.95
8T95	.99	TR1602	4.95
8T96	.99	IM6402	7.95
8T97	.99	1771	24.95
8T98	.99	1791	36.95
1488	.99	UPD765	39.95
1489	.99	8272	39.95
DM8131	2.95		

CMOS

74C00	.35	74C373	2.75	4018	.95	4093	.95
74C02	.35	74C374	2.75	4019	.45	4099	1.95
74C04	.35	74C901	.80	4020	.95	14409	8.95
74C08	.35	74C902	.85	4021	.95	14410	8.95
74C10	.35	74C903	.85	4022	1.15	14411	9.95
74C14	1.50	74C905	10.95	4023	.35	14412	12.95
74C20	.35	74C906	.95	4024	.75	14419	2.95
74C30	.35	74C907	1.00	4025	.35	4502	.95
74C32	.50	74C908	2.00	4026	1.65	4503	.65
74C42	1.75	74C909	2.75	4027	.65	4508	1.95
74C48	2.10	74C910	9.95	4028	.80	4510	.95
74C73	.65	74C911	10.00	4029	.95	4511	.95
74C74	.85	74C912	10.00	4030	.45	4512	.95
74C76	.80	74C914	1.95	4034	2.95	4514	1.25
74C83	1.95	74C915	2.00	4035	.85	4515	2.25
74C85	1.95	74C918	2.75	4040	.95	4516	1.55
74C86	.95	74C920	17.95	4041	1.25	4518	1.25
74C89	4.50	74C921	15.95	4042	.75	4519	1.25
74C90	1.75	74C922	5.95	4043	.85	4520	1.25
74C93	1.75	74C923	5.95	4044	.85	4522	1.25
74C95	1.75	74C925	6.75	4046	.95	4526	1.25
74C107	1.00	74C926	7.95	4047	.95	4527	1.95
74C150	5.75	74C927	7.95	4049	.55	4528	1.25
74C151	2.25	74C928	7.95	4050	.55	4531	.95
74C154	3.25	74C929	19.95	4051	.95	4532	1.95
74C157	1.75	74C930	19.95	4053	.95	4538	1.95
74C160	2.00	4000	.35	4060	1.45	4539	1.95
74C161	2.00	4001	.35	4066	.75	4543	2.70
74C162	2.00	4002	.25	4068	.40	4555	.95
74C163	2.00	4006	.95	4069	.35	4556	.95
74C164	2.00	4007	.29	4070	.35	4581	1.95
74C165	2.00	4008	.95	4071	.30	4582	1.95
74C173	2.00	4009	.45	4072	.30	4584	.95
74C174	2.25	4010	.45	4073	.30	4585	.95
74C175	2.25	4011	.35	4075	.30	4702	12.95
74C192	2.25	4012	.25	4076	.95	4724	1.50
74C193	2.25	4013	.45	4078	.30	80C07	.95
74C195	2.25	4014	.95	4081	.30	80C95	.85
74C200	5.75	4015	.95	4082	.30	80C96	.95
74C221	2.25	4016	.45	4085	.95	80C97	.95
		4017	1.15	4086	.95	80C98	1.20

DIP SWITCHES

4 position	.85
5 position	.90
6 position	.90
7 position	.95
8 position	.95

CONNECTORS

RS232 MALE	3.25
RS232 FEMALE	3.75
RS232 HOOD	1.25
S-100 ST	3.95
S-100 WW	4.95

TRANSISTORS

PN2222	10/1.00	100/8.99
2N3904	10/1.00	100/8.99
2N3906	10/1.00	100/8.99
2N3055	.79	10/6.99
IN4148		25/1.00
IN4004		10/1.00

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S258	1.49
74S02	.48	74S85	2.39	74S168	4.65	74S260	1.83
74S03	.48	74S86	1.44	74S169	5.44	74S274	19.95
74S04	.79	74S112	1.59	74S174	1.09	74S275	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S280	2.90
74S08	.48	74S114	1.50	74S181	4.47	74S287	4.75
74S09	.98	74S124	2.77	74S182	2.95	74S288	4.45
74S10	.69	74S132	1.24	74S188	3.95	74S289	6.98
74S11	.88	74S133	.98	74S189	14.95	74S301	6.95
74S15	.70	74S134	.69	74S194	2.95	74S373	3.45
74S20	.68	74S135	1.48	74S195	1.89	74S374	3.45
74S22	.98	74S138	1.08	74S196	4.90	74S381	7.95
74S30	.48	74S139	1.25	74S197	4.25	74S387	5.75
74S32	.98	74S140	1.45	74S201	14.95	74S412	2.98
74S37	1.87	74S151	1.19	74S225	8.95	74S471	9.95
74S38	1.68	74S153	1.19	74S240	3.98	74S472	16.85
74S40	.44	74S157	1.19	74S241	3.75	74S474	17.85
74S51	.78	74S158	1.45	74S251	1.90	74S482	15.60
74S64	.79	74S161	2.85	74S253	7.45	74S570	7.80
74S65	1.25	74S162	3.70	74S257	1.39	74S571	7.80

VOLTAGE REG'S

7805T	.89	7905T	.99
7808T	.99	7912T	.99
7812T	.89	7915T	1.19
7815T	.99	7924T	1.19
7824T	.99		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39		
78L05	.69	79L05	.79
78L12	.69	79L12	.79
78L15	.69	79L15	.79
LM309K	1.49	LM323K	4.95
LM317T	1.95	LM337K	3.95
LM317K	3.95		

T = TO-220 K = TO-3 L = TO-92

LINEAR

LM301V	.34	LM741V	.29
LM308V	.98	LM747	.79
LM309K	1.49	LM748V	.59
LM311	.64	LM1310	2.90
LM317T	1.95	MC1330	1.89
LM317K	3.95	MC1350	1.29
LM318	1.49	MC1358	1.79
LM323K	4.95	LM1414	1.59
LM324	.59	LM1458V	.69
LM337K	3.95	LM1488	1.39
LM339	.99	LM1489	1.39
LM377	2.29	LM1800	2.99
LM380	1.29	LM1889	2.49
LM386V	1.50	LM3900	.59
LM555V	.39	LM3909V	.98
LM556	.69	LM3914	3.95
LM565	.99	LM3915	3.95
LM566V	1.49	LM3916	3.95
LM567V	1.29	75451V	.39
LM723	.49	75452V	.39
LM733	.98	75453V	.39

T=TO-220 V=8 PIN K=TO-3

master charge VISA®

JDR MICRODEVICES, INC.
1101 South Winchester Blvd.
San Jose, California 95128
800-538-5000 800-662-6263 (Calif.)
408-247-4852

TERMS: For shipping include $2.00 for UPS Ground; $3.00 for UPS Blue Label Air; $10.00 minimum order. Bay Area Residents add 6½% sales tax Calif. Residents add 6% sales tax. We reserve the right to limit quantities and substitute manufacturer. Prices subject to change without notice.

Circle 184 on Inquiry card.

4K STATIC RAMS 8/18.95

2114 LOW POWER 450ns

ALL MERCHANDISE 100% GUARANTEED — CALL US FOR VOLUME QUOTES

8200

8202	45.00
8205	3.50
8212	1.95
8214	3.90
8216	1.85
8224	2.50
8226	1.85
8228	4.95
8237	19.95
8238	4.95
8243	4.50
8250	14.95
8251	5.50
8253	9.85
8253-5	9.85
8255	5.25
8255-5	5.25
8257	9.00
8259	7.00
8272	39.95
8275	29.95
8279	10.50
8279-5	10.50
8282	6.65
8283	6.65
8284	5.80
8286	6.65
8287	6.65
8288	25.00
8289	49.95

6800

6800	6.95
6802	11.95
6809	37.95
6810	4.60
6820	4.95
6821	4.95
6828	9.95
6834	16.95
6840	14.95
6843	42.95
6844	44.95
6845	29.95
6847	15.95
6850	4.75
6852	5.75
6860	10.95
6862	11.95
6871	25.95
6875	6.95
6880	2.95

Z80

Z80	8.95
Z80A	9.95
Z80B	19.95
Z80-PIO	6.50
Z80A-PIO	8.60
Z80-CTC	6.50
Z80A-CTC	8.65
Z80-DART	15.25
Z80A-DART	18.75
Z80-DMA	17.50
Z80A-DMA	27.50
Z80-SIO/0	23.95
Z80A-SIO/0	28.95
Z80-SIO/1	23.95
Z80A-SIO/1	28.95
Z80-SIO/2	23.95
Z80A-SIO/2	28.95
Z80-SIO/9	17.95
Z80A-SIO/9	22.95

6502

6502	6.95
6502A	12.95
6504	6.95
6505	8.95
6520	4.95
6522	9.95
6532	14.95
6551	14.95

MPU'S

8035	16.95
8039	19.95
8080A	3.95
8085	12.95
8086	99.95
8088	39.95
8155	11.95
8156	11.95
8185	29.95
8185-2	39.95
8741	39.95
8748	69.95
8755	49.95

IC SOCKETS

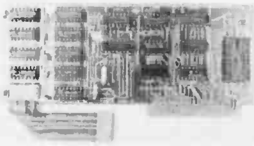
	1-100	100pcs
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
ST = SOLDERTAIL		
8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

WW = WIREWRAP

BEFORE YOU BUY CALL JDR FOR THE BEST PRICE.

800-538-5000
800-662-6233
(CALIFORNIA RESIDENTS)

APPLE OWNERS
EXPAND YOUR 48K COMPUTER TO 64K
SUPER RAM•II

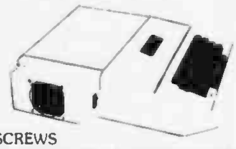


- PLUG IN SLOT Ø
- GOLD PLATED CONTACTS
- INCLUDES 5 JUMPER OPTIONS
- INCLUDES 5 RAM-ROM OPTIONS
- ENJOY THE BEST OF BOTH WORLDS
- 16K RAM (RANDOM ACCESS MEMORY)
- THIS IS SOPHISTICATED FIRMWARE
- EXPANDS YOUR 48K APPLE TO 64K OF PROGRAMMABLE MEMORY
- ELIMINATES THE NEED FOR APPLESOFT* OR INTEGER BASIC ROM CARD
- ALLOWS YOU TO RUN APPLE'S NEW FORTRAN PACKAGE ALSO PASCAL AND PILOT
- KEYBOARD CONTROL SELECTION OF RAM OR MOTHER BOARD ROM LANGUAGE
- INCLUDES: INSTALLATION INSTRUCTIONS AND APPLICATIONS NOTES
- THE SOFTWARE DEVELOPED BY VARIOUS VENDORS FOR YOUR (64K) SHOULD NOW WORK AS THEY ADVERTISED
- THE MOST VERSATILE RAM EXPANSION ON THE MARKET TODAY

UNIQUE 1 YEAR WARRANTEE!! $168.00

SUPER FAN II

"COOL-IT"



- TAN COLOR
- SAVE DOWN TIME
- LONG LIFE MOTOR
- LOW NOISE IS A MUST
- SAVE REPAIR CHARGES
- INCREASES RELIABILITY
- CLIPS ON—NO HOLES OR SCREWS
- MINIMUM QUIETNESS IS DUE TO THE DRAW EFFECT OF AIR THROUGH YOUR COMPUTER AND A SPECIAL FAN AND MOTOR DESIGN
- THOSE EXTRA PLUG-IN CARDS CAN CAUSE EXTRA HEAT

HOW TO HOOK IT UP

1. Clip it on your APPLE
2. Unplug your 120V cable (you won't need it)
3. Plug short 120V cable from Super Fan II to the back of your computer
4. Plug the supply cable from Super Fan II to your 120V power source
5. Turn on the rocker switch and a built-in red ready light comes on
6. You are all set *"COOL IT"*

UNIQUE 1 YEAR WARRANTEE!! $69.00

*APPLE IS A TRADEMARK OF APPLE COMPUTER INC.

LEDS

Jumbo Red	10/1.00
Jumbo Green	6/1.00
Jumbo Yellow	6/1.00
5082-7760 .43"CC	.79
MAN74 .3"CC	.99
MAN72 .3"CA	.99

DYNAMIC RAMS

			100pcs
4027	(250ns)	2.50	2.00
4116-150	(150ns)	8/21.95	2.65
4116-200	(200ns)	8/19.95	2.35
4116-300	(300ns)	8/16.95	2.00
4164	(200ns)	CALL	CALL

EPROMS

					8pcs
1702		256 × 8	(1us)	4.95	4.50
2708		1024 × 8	(450ns)	3.95	3.50
2716	(5v)	2048 × 8	(450ns)	6.95	5.95
2758	(5v)	1024 × 8	(450ns)	9.95	8.95
2716-1	(5v)	2048 × 8	(350ns)	12.95	11.95
TMS2716		2048 × 8	(450ns)	9.95	8.95
TMS2532	(5v)	4096 × 8	(450ns)	21.95	19.95
2732	(5v)	4096 × 8	(450ns)	17.95	16.95

STATIC RAMS

				100pcs
2101		(450ns)	1.95	1.85
2102-1		(450ns)	.89	.85
21L02-1	(LP)	(450ns)	1.29	1.15
2111		(450ns)	2.99	2.49
2112		(450ns)	2.99	2.79
2114		(450ns)	8/18.95	2.25
2114L-2	(LP)	(200ns)	8/22.95	2.45
2114L-3		(300ns)	8/21.95	2.45
2113L-4	(LP)	(450ns)	8/18.95	2.25
4044-4		(450ns)	3.49	3.25
4044-3		(300ns)	3.99	3.75
TMM2016		(200ns)	CALL	CALL
MB6116		(200ns)	CALL	CALL

LP = LOW POWER

PROMS

74S188	(82S23)	OC	32 × 8	3.95
74S287	(82S129)	TS	256 × 4	4.75
74S288	(82S123)	TS	32 × 8	4.45
74S387	(82S126)	OC	256 × 4	5.75
74S471		TS	256 × 8	9.95
74S472	(82S147)	TS	512 × 8	16.85
74S474	(82S141)	TS	512 × 8	17.85
74S570	(82S130)	OC	512 × 4	7.80
74S571	(82S131)	TS	512 × 4	7.80

master charge — VISA®

JDR MICRODEVICES, INC.
1101 South Winchester Blvd.
San Jose, California 95128
800-538-5000 800-662-6263 (Calif.)
408-247-4852

TERMS: For shipping include $2.00 for UPS Ground; $3.00 for UPS Blue Label Air; $10.00 minimum order. Bay Area Residents add 6½% sales tax Calif. Residents add 6% sales tax. We reserve the right to limit quantities and substitute manufacturer. Prices subject to change without notice.

Circle 184 on inquiry card.

U.S. MICRO SALES

DEALS □ DEALS □ DEALS

SHOP HERE AND

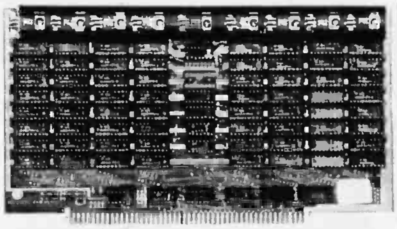
SAVE!

(MINIMUM ORDER $10.00)

This is ABSOLUTELY the LOWEST PRICE EVER for a Hi Speed (300 NS) LO-LO Power 32K RAM. 4K by 1 Chips are organized in Selectable Banks.

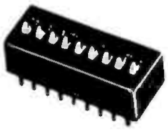
- *Extended Address Lines A16 - A17*
- *Phantom Line*
- *9 Regulators*

$299 (KIT)

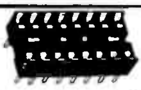


SCHOOLS

DIP SWITCHES



POS.	PRC.
4	.88
5	.92
6	.95
7	.99
8	1.05
9	1.15
10	1.19



PINS	PC	WW
8	.10	.26
14	.13	.29
16	.16	.32
18	.18	.34
20	.22	.38
24	.32	.48
28	.34	.50
40	.45	.61

AMP - Need we say more? There is a difference in sockets! These aren't the lowest prices you can find. But, if you've been "burned" before by bad connections in your computer, a few pennies for the best is worth it!

RESISTORS .02 ea!

(100 PACK) ¼W

1.0	75	2.7K	22K	220K
4.7	100	3.3K	24K	330K
6.8	150	3.9K	27K	470K
10	220	4.7K	33K	680K
15	330	6.8K	39K	1M
22	470	10K	47K	1.5M
27	680	12K	68K	2.2M
33	1K	15K	100K	4.7M
47	1.5K	18K	150K	10M
68	2.2K	20K		

WIRE WRAP WIRE

Packed in 500 Lot Bundles

(Length includes 2" x 1" Strip)

Color — R, Bu, G, Y, Bk, W

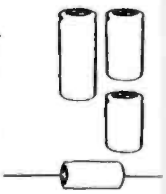
50 ft. $1.65 - 100 ft. $3.00 - 500 ft. $9.50

2.5—3.25	4.0—3.75	6.0—4.75
3.0—3.35	4.5—4.00	7.0—5.00
3.5—3.50	5.0—4.50	8.0—5.50
		10.0—6.50

OK WIRE WRAP TOOL $5.95

COMPUTER GRADE ELECTROLYTICS

Capac.	Volt	Type	$
150,000	15	CAN	12.50
18,000	25	CAN	5.50
6,000	50	CAN	5.75
10,000	16	AXIAL	4.95
4.700	35	AXIAL	3.50

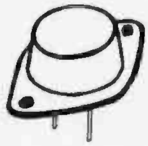


HOBBIEST

LM323K

5V. 3A. REGULATOR

$5.50

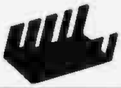


TAB MOUNT

7805	+5V	1A
7905	−5V	1A
7812	+12V	1A
7912	−12V	1A

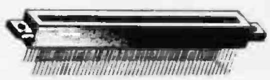
$1.25

HEAT SINKS 49¢



♦ GOLD ♦ S-100-CONNECTOR

TI or Better



SOLDER TAIL **$2.50**

WIRE WRAP **$3.25**

DIP PLUGS

PART#	PINS	PRICE
08DP	8	.40
14DP	14	.55
16DP	16	.58
24DP	24	.95
40DP	40	1.50

Socket and Dip Plug priced based on gold not exceeding $700 per ounce.

CONNECTORS

DUAL RDW .100 PINS	PRICE	CARD EDGE PINS	PRICE
20	2.35	20	3.35
26	3.00	26	3.80
34	3.85	34	4.65
40	4.50	40	5.50
50	5.50	50	5.90

RIBBON — 20 to 34 @ 1.00 ft.
40 & 50 @ 1.30 ft.

CRIMPING 2.00 / CONNECTOR

OEM'S

Z-80-A

$6.95

4MHZ Beastie with extra instructions!

Z-80 SUPPORT

CTC — $6.55

SIO — $25.50

PIO — $6.50

DMA — $18.75

All 4MHZ (who wants 2MHZ?)

74LSXX

74LS00	.33	74LS107	.59	74LS221	2.95
74LS01	.33	74LS109	.59	74LS240	2.95
74LS02	.33	74LS112	.59	74LS241	2.49
74LS03	.33	74LS113	.59	74LS242	1.95
74LS04	.59	74LS114	.49	74LS243	1.95
74LS05	.39	74LS122	.59	74LS244	2.95
74LS06	.39	74LS123	1.19	74LS245	8.95
74LS07	.39	74LS124	1.49	74LS247	1.19
74LS08	.59	74LS125	.89	74LS248	1.19
74LS09	.39	74LS126	.89	74LS249	1.69
74LS10	.29	74LS132	.79	74LS251	1.79
74LS11	.39	74LS133	1.19	74LS253	.95
74LS12	.39	74LS136	.69	74LS257	1.95
74LS13	.69	74LS138	.99	74LS258	1.95
74LS14	1.25	74LS139	.99	74LS259	2.95
74LS15	.49	74LS145	1.25	74LS260	.75
74LS20	1.95	74LS148	1.49	74LS266	1.15
74LS21	3.7	74LS151	.79	74LS273	1.75
74LS22	.29	74LS154	2.49	74LS275	4.39
74LS26	.39	74LS155	1.49	74LS279	.79
74LS27	.49	74LS156	1.49	74LS283	1.49
74LS28	.39	74LS157	1.49	74LS289	5.75
74LS30	.49	74LS158	1.49	74LS290	1.29
74LS32	.95	74LS160	.75	74LS293	1.95
74LS33	1.95	74LS161	1.99	74LS295	1.95
74LS37	.75	74LS162	1.25	74LS298	1.29
74LS38	.39	74LS163	1.25	74LS324	1.75
74LS40	.25	74LS164	2.15	74LS352	1.65
74LS42	1.39	74LS165	1.49	74LS353	1.65
74LS47	.79	74LS166	2.49	74LS365	.95
74LS48	.79	74LS168	2.95	74LS366	.79
74LS35	.25	74LS169	1.95	74LS367	.99
74LS54	.25	74LS170	1.95	74LS368	.99
74LS55	.70	74LS173	1.25	74LS373	2.95
74LS73	.79	74LS174	1.49	74LS374	3.95
74LS74	.59	74LS175	1.49	74LS377	1.95
74LS75	.79	74LS181	2.15	74LS378	1.95
74LS76	.79	74LS189	6.95	74LS379	1.95
74LS78	.49	74LS190	.99	74LS386	.59
74LS83	.95	74LS191	1.95	74LS390	1.95
74LS85	1.49	74LS192	1.95	74LS393	1.95
74LS86	.95	74LS193	1.95	74LS395	1.95
74LS90	.75	74LS194	1.49	74LS490	4.95
74LS92	.75	74LS195	.95	74LS668	1.69
74LS93	.95	74LS196	.95	74LS669	1.89
74LS95	1.29	74LS197	1.95	74LS670	3.55
74LS96	1.29				

Circle 390 on inquiry card.

DEALS □ DEALS □ DEALS

OUR BUYERS ARE IN
CONTACT WITH EVERY MAJOR
SUPPLIER AND O.E.M.
BUY HERE AT 1000 PIECE

QUANTITY PRICES

ALL MERCHANDISE 100%
GUARANTEED! 15 DAY FULL
CASH REFUND!

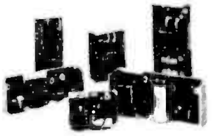
U.S. MICRO SALES

11 EDISON DRIVE ★ NEW LENOX ★ ILLINOIS 60451
CALL TOLL FREE: 1-800-435-9357 ★ MONDAY thru SATURDAY
(ILLINOIS RESIDENTS CALL: 815-485-4002) ★ 8:00 a.m. to 6:30 p.m.

TERMS: Prepayment – C.O.D. up to $100.00 – M/C Visa
$5.00 Processing and Handling added to each order PLUS
Shipping Charges. Please allow personal check
to clear before shipment.

JUST HOT STUFF

POWER SUPPLIES

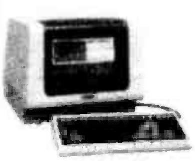


If you can beat these prices we will be truly amazed. OEM's at 500 lot pay more than this. Call or write for full spec. sheets.

DISK POWER SUPPLIES				
PRIAM–SHUGART–CENTURY–MICROPOLIS				
+5V @ 9A	–5V @ .8A	+24V @ 7A	US-384	89.00
SHUGART – SIEMANS – MPI 5¼″				
+5V @ .5A	+12V @ .9A		US-340	33.50
+5V @ 2A	+12V @ 4A		US-323	56.25
SHUGART – SIEMANS – CDC 8″				
+5V @ 1A	–5V @ .5A	+24V @ 1.5A	US-205	52.50
+5V @ 2A	–5V @ .5A	+24V @ 3A	US-206	69.00
+5V @ 3A	–5V @ .6A	+24V @ 5A	US-162	89.00
+5V @ 1.7A	–5V @ 1.5A	+24V @ 2A	US-272	69.00
+5V @ 2A	+12V @ .4A	–12V @ .4A	US-HTAA	37.50

TELEVIDEO 950

Televideo 950 –$950.00
Televideo 912C– 665.00
Televideo 920C– 720.00
ADDS R-25 – 710.00



Also have 920C, SOROC, HAZELTINE, etc. What we don't have is room on this page. Call Toll Free 800 number for prices.

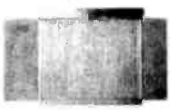
C-ITOH PRINTER

$499.00

Look closely at the photo and see other adds in this rag at $995.00. Perfect units, warranteed. Only 500 pcs. Same story, manufacturerer had too many.

S-100 CARD EXTENDER

$12.50
(Gold Contacts)



As long as there is a price war, we will fight your battle. Compare at your local Dept. store and buy U$ MICRO.

MEMOREX – VERBATUM – WABASH
BASF FLOPPIES

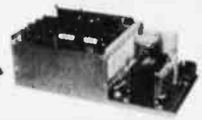
BOX OF 10 ONLY:

5¼″	SOFT	$2.65 ea.
5¼″	HARD 10	2.65 ea.
5¼″	HARD 16	2.65 ea.
8″	SOFT 1D	3.25 ea.
8″	SOFT 2D	3.85 ea.
8″	SOFT 2DDS	5.00 ea.

SPECIAL OF THE QUARTER

S1-MOD (KIT)

$189.00 MADE IN USA



Complete S-100 12 Slot Computer. Ample system power with regulated power for drives. Excellent for Subsystem or Hobby use. 4 hours to build. (6 conn. incl., less fans)

DUAL DRIVE SUBSYSTEM

$995.00
$195.00 w/no Drives

If this looks like a Lobo Drive System, don't be fooled. Just because it looks like one, works like one, smells like one, and tastes like one (?) doesn't mean it has to cost like one!

2 SHUGART 801R
POWER SUPPLY

TWIN VERTICAL DRIVE$

5″ $550.00 – 8″ $980.00

Attractive, convenient and compact Two Drive Mass Storage includes Power Supply, Drives, Cabinets and Cables. Double Sided, Double Track available too!

$145.00 Kit (Less Cable)

Z-80 CPU (KIT)

The first time this world popular CPU offered in Kit. 2 serial, 3 parallel, CTC, EProm Z-80 at 4 mhz. Software buad rate, etc. (less Prom & cable) $212.00

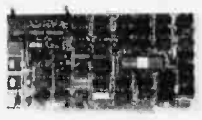
EXPANDABLE RAM
★SPECIAL★SPECIAL★SPECIAL★

This is the best all around 64K board you can buy. If after you see it, you don't agree return for full refund. Bank Select by extended address lines or I.O. 40H.

★$389.00 A&T★

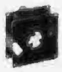
U$ – D$K $255.00

Double Density 8″ and 5″ Disk Controller disigned for S-100 IEEE standards. Uses Western Digital 1795, 1691 2143 Chip Set.



FANS $14.95

These are brand new, in the box fans. Not noisey bearing pullouts. Never again at these low prices!



3-1/8″

4-5/8″

SPECIALS OF THE MONTH

4116s $2.95

Expansion 16K Dynamic RAMs for Apple, TRS-80 S-100 systems. T.I., Mostek Intel, Call for manufacturer.

200 NS

INTEL

8251 $4.95
8255 $6.50
VERY POPULAR I.O. CHIPS
BY LEADING MANUFACTURER

2114s $3.25

One of the world's two most popular STATIC RAMs. Factory prime tested units. Sold in lots of 8 only. FUJITSU, HITACHI, etc.

200 NS

TMS-4044 / MM-5257 / INTEL 2147 $4.25

250 NS

CMOS Version $4.50!

The other of the world's most popular STATIC RAMs. This one is 4K by 1 organization. Don't buy Gold, buy these, the price won't last!

2716s $7.50 (450 NS)
2708s $6.95 (450 NS)

Remember when 2716s were $50.00 and hard to get? These units are so beautiful it's hard to part with them. But we will, for a small price. Guaranteed!

SHUGART DRIVE

8″ 801R
$395.00

8″ 851R $585.00

Manufacturer had too many, buys at 1000 piece rate, sales dropped, so we got'em. Fantastic buy, get them while they last! Full warranty.

SIEMANS DRIVE

8″ 100-8 **$375.00**

Very Special Price on these BRAND NEW current production units Add $10.00 for Extended 1 Year Warrantee!

Circle 390 on inquiry card.

7400

SN7400N	.19	SN74123N	.59
SN7401N	.22	SN74125N	.39
SN7402N	.22	SN74126N	.44
SN7403N	.22	SN74128N	.59
SN7404N	.22	SN74132N	.69
SN7405N	.23	SN74136N	.75
SN7406N	.23	SN74139N	.95
SN7407N	.23	SN74141N	.79
SN7408N	.26	SN74142N	2.95
SN7409N	.23	SN74143N	2.95
SN7410N	.22	SN74144N	2.95
SN7411N	.29	SN74145N	.62
SN7412N	.29	SN74147N	1.95
SN7413N	.39	SN74148N	1.20
SN7414N	.59	SN74150N	1.09
SN7416N	.29	SN74151N	.67
SN7417N	.29	SN74152N	.67
SN7420N	.22	SN74153N	.67
SN7421N	.35	SN74154N	1.19
SN7422N	.29	SN74155N	.78
SN7423N	.29	SN74156N	.78
SN7425N	.29	SN74157N	.69
SN7426N	.29	SN74158N	1.65
SN7427N	.25	SN74160N	.88
SN7429N	.45	SN74161N	.88
SN7430N	.23	SN74162N	.89
SN7432N	.29	SN74163N	.87
SN7437N	.25	SN74164N	.87
SN7438N	.29	SN74165N	.87
SN7439N	.29	SN74166N	1.20
SN7440N	.19	SN74167N	1.95
SN7441N	.79	SN74170N	1.69
SN7442N	.57	SN74172N	4.75
SN7443N	.95	SN74173N	.79
SN7444N	.95	SN74174N	.89
SN7445N	.79	SN74175N	.85
SN7446N	.79	SN74176N	.75
SN7447N	.65	SN74177N	.75
SN7448N	.79	SN74179N	1.34
SN7450N	.19	SN74180N	.75
SN7451N	.19	SN74181N	1.75
SN7453N	.19	SN74182N	.75
SN7454N	.19	SN74184N	2.25
SN7459N	.25	SN74185N	2.25
SN7460N	.23	SN74186N	9.95
SN7470N	.29	SN74188N	3.90
SN7472N	.29	SN74190N	1.15
SN7473N	.34	SN74191N	1.15
SN7474N	.34	SN74192N	.85
SN7475N	.38	SN74193N	.85
SN7476N	.34	SN74194N	.85
SN7479N	4.60	SN74195N	.68
SN7480N	.49	SN74196N	.85
SN7482N	.95	SN74197N	.85
SN7483N	.55	SN74198N	1.39
SN7485N	.65	SN74199N	1.39
SN7486N	.35	SN74221N	1.19
SN7489N	1.75	SN74251N	.95
SN7490N	.39	SN74273N	1.05
SN7491N	.57	SN74279N	.75
SN7492N	.45	SN74283N	1.40
SN7493N	.45	SN74284N	3.90
SN7494N	.69	SN74285N	3.90
SN7495N	.65	SN74290N	1.25
SN7496N	.69	SN74298N	.95
SN7497N	2.90	SN74365N	.68
SN74100N	1.20	SN74366N	.68
SN74107N	.32	SN74367N	.68
SN74109N	.37	SN74368N	.68
SN74116N	1.95	SN74390N	1.45
SN74121N	.29	SN74393N	1.90
SN74122N	.39	SN74490N	1.90

CMOS

CD4000	.35	CD4098	2.29
CD4001	.35	CD4099	2.25
CD4002	.35	MC14408	12.95
CD4006	1.05	MC14409	12.95
CD4007	.25	MC14410	12.95
CD4008	1.39	MC14412	12.95
CD4009	.45	MC14415	8.95
CD4010	.45	MC14419	4.95
CD4011	.35	CD4501	.39
CD4012	.25	CD4502	1.65
CD4013	.45	CD4503	.69
CD4014	1.39	CD4505	8.95
CD4015	1.15	CD4506	.75
CD4016	.59	CD4507	.95
CD4017	1.19	CD4508	3.75
CD4018	.89	CD4510	1.19
CD4019	.45	CD4511	1.19
CD4020	1.10	CD4512	1.39
CD4021	1.19	CD4515	2.75
CD4022	1.15	CD4516	1.45
CD4023	.29	CD4518	1.39
CD4024	.75	CD4520	1.25
CD4025	.25	CD4555	4.95
CD4027	.65	CD4556	.99
CD4028	.85	CD4566	2.25
CD4029	1.29	74C00	.35
CD4030	.45	74C02	.35
CD4031	3.25	74C04	.35
CD4032	2.15	74C08	.35
CD4034	3.25	74C10	.35
CD4035	.95	74C14	.72
CD4037	1.95	74C20	.35
CD4040	1.29	74C30	.35
CD4041	1.25	74C32	.99
CD4042	.95	74C42	1.35
CD4043	.85	74C48	1.89
CD4044	.85	74C73	.75
CD4046	1.75	74C74	.75
CD4047	1.25	74C85	1.79
CD4048	.99	74C89	5.95
CD4049	.45	74C90	1.19
CD4050	.69	74C93	1.19
CD4051	1.10	74C95	1.49
CD4052	1.10	74C107	1.19
CD4053	1.10	74C151	2.49
CD4055	3.95	74C154	3.50
CD4056	2.95	74C157	2.10
CD4059	9.25	74C160	1.65
CD4060	1.39	74C161	1.55
CD4066	.75	74C163	1.65
CD4069	.35	74C164	1.55
CD4070	.49	74C173	1.35
CD4071	.35	74C174	1.35
CD4072	.35	74C175	1.35
CD4073	.35	74C192	1.65
CD4075	.35	74C193	1.65
CD4076	1.29	74C195	1.55
CD4077	.35	74C240	2.19
CD4078	.35	74C244	2.19
CD4081	.35	74C373	2.39
CD4082	.35	74C374	2.39
CD4085	1.95	74C922	5.39
CD4089	2.95	74C923	5.65
CD4093	.99	MM80C95	1.50
CD4094	2.95	MM80C97	1.25

74LS00

74LS00N	.26	74LS164N	1.19
74LS01N	.28	74LS165N	.89
74LS02N	.28	74LS166N	2.48
74LS03N	.28	74LS168N	1.15
74LS04N	.35	74LS169N	1.15
74LS05N	.28	74LS170N	1.99
74LS08N	.28	74LS173N	.89
74LS09N	.35	74LS174N	.89
74LS10N	.28	74LS175N	.89
74LS11N	.39	74LS181N	2.20
74LS12N	.33	74LS190N	1.15
74LS13N	.47	74LS191N	1.15
74LS14N	.95	74LS192N	.98
74LS15N	.33	74LS193N	.98
74LS20N	.26	74LS194N	1.15
74LS21N	.33	74LS195N	.95
74LS22N	.33	74LS196N	.89
74LS26N	.33	74LS197N	.89
74LS27N	.33	74LS221N	1.15
74LS28N	.33	74LS240N	1.69
74LS30N	.26	74LS241N	1.69
74LS32N	.33	74LS242N	1.69
74LS33N	.55	74LS243N	1.69
74LS37N	.45	74LS244N	1.49
74LS38N	.39	74LS245N	2.20
74LS40N	.26	74LS247N	1.10
74LS42N	.79	74LS248N	1.10
74LS47N	.79	74LS249N	1.19
74LS48N	.95	74LS251N	1.40
74LS51N	.26	74LS253N	.98
74LS54N	.29	74LS257N	.85
74LS55N	.29	74LS258N	.98
74LS73N	.45	74LS259N	2.95
74LS74N	.42	74LS260N	.65
74LS75N	.59	74LS261N	2.49
74LS76N	.45	74LS266N	.59
74LS78N	.45	74LS273N	1.75
74LS83AN	.79	74LS275N	4.40
74LS85N	1.19	74LS279N	.59
74LS86N	.45	74LS283N	.99
74LS90N	.57	74LS290N	.99
74LS92N	.75	74LS293N	.99
74LS93N	.75	74LS295N	1.10
74LS95N	.88	74LS298N	1.19
74LS96N	.98	74LS324N	1.75
74LS107N	.45	74LS347N	1.95
74LS109N	.45	74LS348N	1.95
74LS112N	.43	74LS352N	1.19
74LS113N	.43	74LS353N	1.19
74LS114N	.43	74LS363N	1.49
74LS122N	.55	74LS365N	.69
74LS123N	1.19	74LS366N	.69
74LS124N	1.35	74LS367N	.69
74LS125N	.89	74LS368N	.69
74LS126N	.52	74LS373N	1.89
74LS132N	.79	74LS374N	1.89
74LS136N	.49	74LS375N	.69
74LS138N	.85	74LS377N	1.95
74LS139N	.85	74LS385N	1.95
74LS145N	1.25	74LS386N	.65
74LS148N	1.49	74LS390N	1.95
74LS151N	.79	74LS393N	1.95
74LS153N	.79	74LS395N	1.70
74LS154N	1.70	74LS399N	2.35
74LS155N	1.19	74LS424N	2.95
74LS156N	.99	74LS668N	1.75
74LS157N	.85	74LS670N	2.29
74LS158N	.75	81LS95N	1.69
74LS160N	1.05	81LS96N	1.69
74LS161N	1.15	81LS97N	1.69
74LS162N	1.05	81LS98N	1.69
74LS163N	1.05		

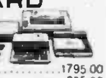
LINEAR

78H05	5.95	MC1358	1.75
78M05	1.49	LM1414N	1.90
78M.G.	1.49	LM1458CN/N	.49
LM105H	.99	MC1488N	.99
LM108AH	2.95	MC1489N	.99
LM300H	.79	LM1496N	.89
LM301CN/H	.35	LM1556N	1.50
LM304H	.98	LM1820N	.95
LM305H	.89	LM1850N	.95
LM306H	3.25	LM1889N	3.10
LM307CN/H	.29	LM2111N	1.75
LM308CN/H	.98	LM2900N	.99
LM309K	1.49	LM2901N	2.50
LM310CN	1.25	LM2917N	2.95
LM311DCN/H	.89	CA3013T	2.19
LM312H	1.75	CA3018T	1.99
LM317T	1.70	CA3021T	3.49
LM318CN/H	1.49	CA3023T	2.99
LM319N/H	1.25	CA3035T	2.75
LM320K-XX*	1.35	CA3039T	1.29
LM320T-XX*	1.39	CA3046N	1.29
LM320H-XX*	1.25	CA3053N	1.49
LM323K	4.95	CA3059N	3.19
LM324N	.95	CA3060N	3.19
LM337K	5.95	CA3062N	4.95
LM338K	6.95	LM3065N	1.49
LM339N	.95	CA3080T	1.29
LM340K-XX*	1.75	CA3081N	1.69
LM340T-XX*	1.25	CA3082N	1.69
LM340H-XX*	1.25	CA3083N	1.55
LM344H	1.95	CA3086N	.80
LM348N	1.20	CA3089N	2.99
LM350K	5.60	CA3096N	3.49
LM358CN	.98	CA3097N	1.99
LM360N	1.49	CA3130T	1.30
LM372N	1.95	CA3140T	1.19
LM376N	3.75	CA3146N	2.49
LM377N	2.75	CA3160T	1.19
LM380CN/N	1.25	CA3190N	1.95
LM381N	1.79	CA3410N	.59
LM383T	1.95	MC3423N	1.49
LM386N	1.25	MC3460N	3.95
LM387N	1.40	SG3524N	3.95
LM390N	1.95	CA3600N	3.39
NE531V/T	3.75	LM3900N	.59
NE555V	.39	LM3905N	1.19
NE556N	.98	LM3909N	.98
NE561T	19.95	LM3914N	3.75
NE565N/H	1.25	LM3915N	3.95
NE566H/V	1.75	LM3916N	3.75
NE567V/H	1.50	RC4131N	2.95
NE592N	2.75	RC4136N	1.10
LM702H	.99	RC4151N	3.70
LM709N/H	.29	RC4194TK	4.95
LM710N/H	.75	RC4195TK	5.40
LM711N/H	.39	ULN2001	1.25
LM715N	1.95	ULN2003	1.50
LM723N/H	.65	SN75450N	.59
LM733N/H	.98	SN75451N	.39
LM739N	1.15	SN75452N	.49
LM741CN/H	.33	SN75453N	.49
LM741CN-14	.19	SN75454N	.49
LM747N/H	.75	SN75491N	.89
LM748N/H	.39	SN75492N	.89
LM760CN	2.95	SN75493N	.89
LM1310N	1.90	SN75494N	.89
MC1330	1.95	TL494CN	4.20
MC1350	1.95	TL496CP	1.65

16K UPGRADE ONLY $24.95 SPECIFY COMPUTER

ADVANCED COMPUTER PRODUCTS

HEWLETT PACKARD

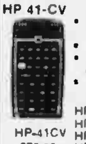


HP-85
$2695.00

HP 7225 Graphics Plotter	1795.00
HP 16K Memory Module	265.00
HP 5 1/4" Dual Master Flex. Disk Drive	2100.00
HP 5 1/4" Single Master Flex. Disc Drive	1295.00
HP Personality Module	700.00
HP ROM Drawer	40.00
HP Plotter/Printer ROM	130.00
HP Input/Output ROM	260.00
HP Matrix ROM	130.00
HP Serial Interface (RS-232C)	350.00
HP-83	$1895.00

HP-41: Powerful. Yet Easy to Use

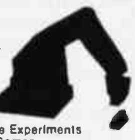
HP 41-CV



- The HP-41 communicates with you in words as well as numbers.
- You can customize the HP-41 to your own design.
- Programming is fast and easy
- Continuous Memory saves everything
- Optional Peripherals allow you to expand capabilities

HP-41CV 275.00	HP-41 System I	398.00
	HP-41 System II	675.00
	HP-Card Reader	178.00
HP-41C 198.00	HP-Optical Wand	105.00
	HP-Plotter/Printer	315.00
	HP-Quad RAM	85.00

Microbot MINIMOVER-5 ROBOTIC ARM



Completely Assembled W/Applications Manual

- Automation or Robotic Assembly
- Education in Robotic Priciples
- Artificial Inteligence Experiments
- Computer Art and Games

$1695.00

Armbasic Software for TRS-80 w/Applications Manual $39.95
Applications/Reference Manual $16.95

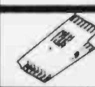
California Computer Systems 2200

SUPER S-100 BUY!

- 12 Slot Mainframe
- 64 Dynamic RAM
- CP/M™ 2.2
- Z-80 CPU 4 MHz w/Serial IO
- Double Density Disk Controller
- Interface to Vista V-1000 Chassis

SPECIAL PACKAGE PRICE FOR COMPLETE SYSTEM 1899.00
with (2) Shugart Double Density Floppys mounted. add 1495.00

Proto Clips



14-Pin Clip	PC-14	$ 4.25
16-Pin Clip	PC-16	$ 4.50
24-Pin Clip	PC-24	$ 9.50
40-Pin Clip	PC-40	$14.95

Proto Boards

PB-6	16.95	PB-104	54.00
PB-100	18.00	PB-203	97.00
PB-101	21.00	PB-203A	149.00
PB-102	25.00	PB-203A-Kit	129.00
PB-103	43.00		

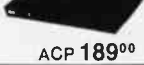
Novation

AUTO-CAT™
Automatic Answer
Direct Connect
0-300 Band

List 279.95
ACP 245.95

CAT™
Answer Originate
List 198.00
ACP 169.00

D-CAT™
direct Connect
0-300 Band.



List 249.00
ACP 189.00

Single Board Computers

AIM 65 w/1K	435.00
AIM 65 w/4K	475.00
8K BASIC ROM	99.00
4K ASSEMBLER ROM	84.00
POWER SUPPLY	64.95
ENCLOSURE	49.95
TOTAL SYSTEM w/4K	669.00
SYNERTEK SYM-1	239.00
SD Z-80 STARTER KIT	367.00
SD Z-80 STARTER KIT A&T	450.00
SD SBC 100 Z-80 A&T	367.00
SD SBC 200 Z-80 A&T	399.00
RCA COSMAC VIP	199.00
CROMEMCO Z-80 SBC	449.00

apple computer Sales and Service

Apple II® 64K Maxi-System

- Z-80 Softcard
- 16K Ram Card
- Disk II w/controller
- Apple II w/48K

Call for more pricing!

Total Value $2719.00 your price $2229.00
save! *For Pascal System add $425.00*

apple II hardware clearance up to 25% off

VISTA COMPUTER		
Datasaver™ Uninterruptable P S	395.00	New
Vocelyzer™ Voice Card	225.00	New
Vision 80™ 80x24 Card	325.00	New
Vision 40™ 40 col enhancement	175.00	New
A 800 Quad Denisty 8" Controller	595.00	New
Microsoft Z-80 Softcard	259.00	
Microsoft 16K Ramcard	169.00	
SSM AIO Serial/Parallel IO	165.00	
CCS Asynchronous 7710 A Serial	139.00	
CCS Parallel Card 7720A	155.00	
Apple Joystick "GESU"	54.95	
Mountain Computer		
Romplus +	169.00	
Rom Writer	159.00	
Introl/X-10	180.00	
Introl/X-10 Remote Conl. Sys.	249.00	
Super Talker	275.00	
Music System	499.00	New
CPS Multifunction	229.00	New
Expansion Chassis	699.00	New
DC Hayes Micromodem II	299.00	New
DC Hayes Smart Modem	189.95	New
Thunderclock	125.00	New
X-10 I/O Option*	49.00	New
Pascal For Above*	29.00	New
Apple Computer		
Apple Hi-Speed Serial I/O	174.95	
Centronics Printer I/O	179.95	
Applesoft II Firmware	159.95	
Apple Clock	244.95	
Apple Graphics Tablet	599.95	
Apple Prototype Card	21.95	
Apple Disk II w/ cont 3.3	559.95	
Apple Disk II	459.95	
Pascal Language Card	425.95	
Parallel Printer Cardd	159.95	
Communications Card	189.00	
Integer ROM Card	159.95	
Calif. Prod Visicalc Keyboard	169.95	
M & R Apple Fan	49.95	New
M & R Sup R' Mod	29.95	
Corvus 5Mb Hard Disk	3699.00	New
Corvus 10Mb Hard Disk	Call	
Corvus 20Mb Hard Disk	Call	New
Corvus Contellation	Call	
Corvus Mirror	Call	
ACP 16K Upgrade Kit	24.95	
Scott Voice Recognition VET-2	895.00	New

apple /// Triple Play!

1. Apple III 128K RAM Information Analysis Pkg. 12" Green Phosphor Monitor 4200.00
2. Apple III 128K RAM Information Analysis Pkg 12" Green Phosphor Monitor Disk II for Apple III 5100.00
3. Apple III 128K RAM Information Analysis Pkg. 12" Green Phosphor Monitor Disk II for Apple III Silentype Printer 5500.00

Buy a System and Save

New apple software

We only offer Apple CPM software which has been evaluated by our software staff.

Visicalc—Now Better Than Ever	169.00
Visiplot—Graph your Visicalc Worksheets	149.00
Visitrend/Visiplot—Visiplot w/Trend Analysis	239.00
Visidex—The Ultimate DBMS Visicalc Compatible	219.00
Visiterm—Communicate w/other Systems	209.00
BPI General Ledger	299.00
BPI Accounts Receivable	299.00
BPI Inventory	299.00
Stockfile Inventory System	349.00
Infolory Inventory System	289.00
Microcom Microcourier	229.00
Microcom Microtelegraph	229.00
Accounting Plus II Biz Pkg.	1250.00
Stoneware DB Master	189.00
Stoneware Utility Pkg (For above)	89.00

WORDSTAR-The Benchmark of Wordprocessing software requires Z-80 & 80x24 349.00

VTS-80 CP/M Wordprocessor has no screen menus uses new keycaps (supplied) to display Key functions 319.00 New

MAIL-MERGE-A Wordstar Enhancement Pkg. allows form-letter generation & chained printing 169.00

SPELLGUARD Will proofread Wordstar & VTS-80 Text files against an expandable 20,000 word dictionary 169.00

SUPER SORT-Will sort, merge, & perform record selection on your CP/M Data Files 169.00

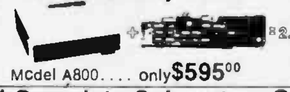
FORTRA 80-By Microsoft 195.00

COBOL 80 By Microsoft 749.00

ACS BASIC ACCOUNTING SYSTEM, Total accounting system includes G/L, A/R, A/P, PAYROLL 699.00 New

Breakthru in Apple II® Mass Storage!

Vista A800 Quad Density DMA 8" Disk Controller



NEW

Model A800.... only $595.00

Special Complete Subsystem Offer

- V1000 w/two Qume Datatrack 8
- Cable, ready to run
- A800 Apple II 8" Disk Controller

Total Value $2939.00 your price $2495.00

ATARI® 800 & 400

Personal Computer System
ATARI 800 $799.00
ATARI 400 $375.00

ATARI 800 Includes: Computer Console, BASIC Lang. Cartridge, BASIC Language Programming Manual. 800 Operator's Manual w/Notebook, 16K RAM Module, Power Supply. TV Switch Box.

Peripherals	
810 Disc Drive	499.00
820 Printer (40 Col.)	295.00
825 Printer (80 Col.)	795.00
8K RAM	49.95
16K RAM	94.95
850 Interface	189.95
Program Recorder	69.00
Software – ROM Cartridges	
Education System Master Cartridge	28.00
Atari BASIC	55.00
Assembler Debug	55.00
Basketball	42.00
Life	42.00
Super Breakout™	42.00
Music Composer	55.00
Super Bug™	42.00
Computer Chess	55.00
Home Finance	55.00
Education System Cassette Programs	
US History	35.00
US Government	35.00
Supervisory Skills	35.00
World History (Western)	35.00
Basic Sociology	35.00
Counseling Procedures	35.00
Principles of Accounting	35.00
Physics	35.00
Great Classics (English)	35.00
Business Communications	35.00
Basic Psychology	35.00
Effective Writing	35.00
Auto Mechanics	35.00
Principles of Economics	35.00
Spelling	35.00
Basic Electricity	35.00
Basic Algebra	35.00
Basic Game and Program Cassettes	
Guide to BASIC Programming	19.00
BASIC Game Programs	19.00
Add-On Memory	
8K RAM Memory Module	110.00
16K RAM Memory Module	225.00
Diskettes	
Blank Diskettes	
Disk File Manager	5.00
Accessory Controllers	
Driving Controller Pair	18.00
Paddle Controller Pair	18.00
Joystick Controller Pair	18.00

RETAIL STORES OPEN MON-SAT

STORE #1 1310 "B" E. Edinger, Santa Ana CA 92705 Showrooms, Retail, Warehouse
STORE #2 542 W. Trimble Road, San Jose, CA 95131 • (408) 946-7010

RETAIL PRICING MAY VARY

P.O. Box 17329 Irvine, Calif. 92713
Direct Order Lines: (714) 558-8813
(800) 854-8230 or (800) 854-8241

DRIVER'S LICENSE # OR MAJOR CREDIT CARD # IS REQUIRED ON ALL CHECKS. MONEY ORDER OR CASHIER CHECK WILL FACILITATE THE SHIPMENT OF YOUR PURCHASE

Circle 6 on inquiry card.

ADVANCED COMPUTER PRODUCTS

FIRST TO OFFER PRIME PRODUCTS TO THE HOBBYIST AT FAIR PRICES!

1. Proven Quality Factory tested products only.

2. Guaranteed Satisfaction

Call For Special School Discounts

SALE 4164 $19.95

V-1000 Vista "V-DRIVE"

Qume. DATATRAK 8

THE LAST WORD IN 8" FLOPPY-DISK ENCLOSURES

THE VISTA V-1000 FLOPPY DISK DRIVE SUBSYSTEM ● Deluxe chassis with internal slide easy access for drive positioning and mounting ● Built to mechanically and electrically accomodate single sided drives—including the most popular 8 inch Winchester and Shugart floppy disk drives, and 8 inch streaming tape units ● Storage capacity from 0.5 to 40 megabytes ● Industrial quality cabinet with die cast front bezel ● Meets all UL and OSHA standards ● Additional Savings! Front and rear retma rail mounts provided at no extra charge (no external slides) ● Desk or rack mountable ● Features modular construction with removeable sub-assembly that allows easy cabinet positioning and mounting ● Drives pull out for easy service and maintenance

DISCOUNT PRICES

CABINET	$ 395
CABINET with (2) single sided drives (including power supply & cable)	$1495
CABINET with (2) double sided drives (including power supply & cable)	$1995

Vista V-80 5¼" DISK

TRS 80® MODEL I, PMC 80, ZENITH H89, S-100, etc.

ONLY 310⁰⁰ ea.

MODEL V-801, 80 TRACKS, SS ONLY 425⁰⁰ ea.

2 DRIVE CABLE 29.95 4 DRIVE CABLE 39.95

MOSTEK MK4015 4K Dynamic RAM

Refresh while supply lasts only .49¢

Pin equivalent to MK4027 except has 1 ms.

S-100 WW

$2.99 each

FIRST QUALITY AT SURPLUS PRICE

2708 EPROMS

PRIME-450 Ms.

8 for $29.95

4K STATIC RAM SELL-OFF

Zilog 6104-4

Same as TMS 4044 but designed specifically for Z-80 based systems. This is full-spec 4K x 1 RAM. 450 Ms.

While supply lasts $1.49 each.

SPECIAL PURCHASE

$59.95 Limited Supply $59.95

16K Altair RAM Boards. Fully Populated as is.

FLOPPY DISK DRIVES

QUME' Datatrack 8
• Double Sided
• Double Density

ACP LOW PRICE $569.95

Tandom TM100-1 5¼" Disk Drive	249.95
MPI 851-5¼", 40 tracks	239.95
Shugart SA400-5¼" 35 tracks	295.00
Shugart 800/801R 8"	449.00
Siemens Shugart Compatible Model FDD-120-8D	429.00
PERSCI Model 277 Dual	1195.00
MPI B52 5¼" Dual	348.00
WANGO/SIEMENS 82	290.00
MPI 91 Double Track Density Single Side, 80 Tracks	375.00
MPI 92 Double Track Density Double Side, 160 Track	475.00

6800 MICROMODULE™ PRICE LIST

MODEL NO	DESCRIPTION	PRICE
9600A	Single Board Microcomputer	$495.00
9609	Advanced Single Bd. Comp (6809)	595.00
9601	16 Slot Mother Board	175.00
9602	Card Cage	75.00
9601	8 Slot Mother Board	100.00
9604	Power Supply	275.00
9605	DC Input Power Supply	325.00
9610	Utility Proto Board	39.00
9611	Arith. Proc Memory Module	495.00
9612	Buffered Utility Proto Board	49.00
9616	32K EPROM/RAM Module	250.00
9617	EPROM Programming Head	250.00
9620	16 Channel Parallel I/O Module	295.00
9622	Serial-Parallel I/O Module	325.00
9627	16K Static RAM Module 470ns	395.00
9629	32K Static RAM 450ns	695.00
9629A	32K Static RAM 200ns	895.00
9630	Card Extender	68.00
9640	Multiple Programmable Timer	395.00
9650	8 Channel Duplex Serial I/O Mod	395.00
9655	Intelligent Tape Controller	550.00
96103	32/32 I/O Module	275.00
96702	Contact Closure Module	350.00

UNPOPULATED BOARDS (Also Available)

$24.95 TRS-80/APPLE $24.95

MEMORY EXPANSION KITS.
4116's. 16K (200/250 ns.)

16K 8 pcs for $24.95 Specify Computer **RAM**

Call For Volume Pricing

CENTRONICS PRINTER

Model 737

• Centronics complete printer
• The 737 has everything. Check and compare the features
• New low price $835.00

32K STATIC RAM BOARD

2 or 4 MHz Expandable uses 2114L's S-100

16K 4 MHz Kit	159.95
16K 4 MHz A&T	217.95
32K MHz Kit	289.95
32K 4 MHz A&T	339.00
Bare Board	39.95
Bare Bd. w/all parts less mem	99.95

NEW! from Zilog

Z-8 CPU comes with Tiny Basic & debug program on the I.C.

$69.95 w/data

BIPOLAR CPU SALE

Signetics 8 × 300 8 bit CPU

While stock lasts 14.95 ea.

UV "Eprom" Eraser

Model UVs-11E $69.95
Holds 4 Eproms at a time
Backed by 45 years experience
Model S-52T... $325.00
Professional Industrial Model

NON-LINEAR SYSTEMS, INC. NLS

TOUCH TEST 20

DIGITAL MULTIMETER $319⁹⁵

BECKMAN DIGITAL MULTIMETERS

AS LOW AS 100⁰⁰

TECH 300 Digital Multimeter	$110
TECH 310 Digital Multimeter	$140
TECH 330 Digital Multimeter	$189
VC-201 Vinyl Carrying Case	$10
DC-202 Deluxe Carrying Case	$24
HV-211 High Voltage Probe	$35
RP-221 RP Probe	$35
CT-231 AC Current Clamp	$42
DL-241 Delxue Test Lead Kit	$10
TL-242 Square Test Leads	$6

INTERSYSTEMS

The Perferred S-100 Box

The new Series II CPU Board features a 4 MHz Z-80A CPU and full-feature front panel. 20-slot actively terminated mother-board, with 25 amp power supply (50/60 Hz operation, incl. 68 cfm fan).

DPS-1, List **$1795**

ACP Price **$1499**

SYSTEM 2A with Z-80A CPU 4 MHz, 64K RAM, I/O Board, 20 slots, front panel, double density disk controller board. Full 1-year warranty.

List **$3795** ACP Price **$2995**

NEC PC-8000 Series Microcomputer System.

NEW INTRO PRICING $1099.00

• Z 80A CPU 4 MHz
• 5 user programmable function keys
• 82 Keys with numeric keypad
• 160×100 resolution
• 80 character screen

PC 8001A Microcomputer w/32K RAM	$1295.00	1099.00
PC 8012A I/O Unit w/32K RAM, Expansion slots	795.00	699.00
PC 8031A Dual Mini-Disk Drive Unit	1295.00	1099.00
PC 8032A Add-On Dual Mini-Disk Drive Unit	1095.00	949.00
PC 8023A Impact Matrix Printer, Tractor/Friction Feed	860.00	769.00
PC 8094A Cable for PC-8023A Printer	49.95	44.95
JB-1201M(A) High Resolution Green Monitor	265.00	239.00
JC-1202DH(A) High Resolution Color Monitor w/RGB Input	1195.00	1049.00
PC 8091A RGB Cable for JC-1202DH(A) Color Monitor	19.95	17.95
Basic Language Learning Guide		19.95
PC 8001A Microcomputer Reference Manual		19.95
PC 8012A I/O Unit User's Manual		14.95
PC 8031A Dual Disk User's Manual		14.95

MICROPROCESSORS

Z8001 16 bit to 8Mb	$189.00
Z8002 16 bit to 64K	149.00
Z80	9.95
Z80A	13.95
F-8 (3850)	16.95
2650	16.95
CD 1802	9.75
8080A	4.75
8080A-4MHz	19.95
SALE 8085	14.95
8008-1	14.95
2901	9.90
2901A	14.95
2903 4-bit Superslice	29.95
TMS 9900JL	49.95
CP1600	39.95
6502	9.95
6502A	16.95
IM6100	29.95
6800	11.75
6800B 2.0 MHz	19.95
6802P	17.95
8035	14.95
8039	19.95
INS 8073N	24.95
8755	49.95
8748	69.95
6809	37.95
8086	69.95

ADVANCED SUPPORT

AM9511 Arith. Processor	175.00
9512 Arith Processor	175.00
9513 Univ. Timing	79.95
AM9517 DMA Controller	18.95
AM9519 Universal Interrupt	18.95

Z-80 SUPPORT CHIPS

Z80-PIO	2.5 MHz	8.75
Z80A-PIO	4.0 MHz	12.95
Z80-CTC	2.5 MHz	8.75
Z80A-CTC	4.0 MHz	12.95
Z80-DMA	2.5 MHz	29.95
Z80A-DMA	4.0 MHz	36.95
Z80-SIO/0	2.5 MHz	35.95
Z80A-SIO/0	4.0 MHZ	39.40
Z80-SIO/1	2.5 MHz	35.95
Z80A-SIO/1	4.0 MHz	39.40
Z80-SIO/2	2.5 MHz	35.95
Z80-SIO/2	4.0 MHz	39.40

8080/8085 SUPPORT

8155/8156 I/O	24.95
8755 I/O with Eprom	64.95
8202 Dyn. Ram Cont.	34.95
8205/74S 138 Decoder	3.95
8212 8 bit I/O	2.75
8214 Priority Int	5.25
8216 Bus Driver	2.75
8224 Clock Gen	2.95
8224-4 (4MHz)	9.75
8228 Bus Driver	2.95
8T26 Bus Driver	2.95
8228 Sys. Control	4.50
8238 Sys. Cont	5.50
8243 I/O Exp	9.50
8250 Asyn. Comm	15.95
8251 Prog. I/O	6.95
8253 Int. Timer	12.95
8255 Prog. I/O	6.50
8257 Prog. DMA	16.95
8259 Prog. Int	15.95
8275 CRT Controller	45.95
8279 Prog. Keyboard	15.95

6800 SUPPORT CHIPS

6810 128 × 8 Ram	4.75
6820	6.50
6821	6.50
6828 Priority Int	10.75
6834-1 512 × 8 Eprom	16.95
6845/HD46505 CRT Cont	29.95
6847 Color CRT	29.95
6850 ACIA	5.95
6852 Serial Adapter	5.95
6860 Modem	10.95
6882 Modulator	11.95
6871A 1.0MHz OSC	25.95
6875	6.95
6880 Bus Driver	2.19
MC68488	19.95
68047	24.95

6502 SUPPORT CHIPS

6520 PIA	7.50
6522 Mult	11.95
6530-002,003,004,005	21.95
6532	19.95
6551	19.95

BIPOLAR PROMS

We do Custom Programming

82S23/6330/5600/74S188	4.25
82S115 (512x8)TS	12.95
82S123/5610/74S288 (32x8)TS	4.25
82S126/5603/74S387 (256x4)OC	4.25
82S129/5623/74S287 (256x4)TS	4.25
82S130/5604/74S570 (512x4)OC	6.50
82S131/74S571 (512x4)TS	6.95
82S137/74S573 (1024x4)TS	12.95
82S141/3624/74S474 (512x8)TS	12.95
82S147/74S472 (512x8)TS	12.95
74S471/6309 (256x8)TS	7.95

MOS PROMS

2764 (8Kx8)TS	89.95
2732 (4Kx8)TS	16.95
2716/2516 5V (2Kx8)TS	8.95
TMS2716, ± 5V, 12V	17.95
2758, 5V, (450Ms)	7.50
2708 (450Ms)	5.75
2708 (650Ms)	5.25
1702A	5.75
MM5203AQ	14.50
MM5204Q	9.95

CHARACTER GEN.

2513-001 (5V) Upper	9.50
2513-005 (5V) Lower	10.95
2513-ADM3 (5V) Lower	14.95
MCM66710 Ascii Shifted	12.95
MCM66740 Math Symbol	13.45
MCM66750 Alpha Control	13.45

UARTS/BAUD RATE

TR1602B (5V 12V)	3.95
AY51013 (5V 12V)	4.95
AY51014A/1612 (5-14V)	6.95
AY51015A 1863 (5V)	6.95
IM6402	7.95
IM6403	8.95
2350 USRT	9.95
1671B Astros	24.95
SALE TR1472B	9.95
MC14411	11.95
4702	14.95
WD1941	9.95
COM 5016	16.95
INS 8250	15.95

KEYBOARD ENCODERS

AY5-2376	13.75
AY5-3600	13.75

STATIC RAMS

SALE 2102 .89

	1-24	25-99	100
21L02 450ns	1.30	1.25	.99
21L02 250ns	1.59	1.55	1.15
2111	3.75	3.65	3.55
2112-1	2.95	2.85	2.65
2101-1	2.90	2.70	2.55
2114N (450 MS.)	3.75	3.50	3.25
2114L-250ns (4045)	6.50	5.95	5.50
2114L-450ns. (4045)	4.75	4.25	3.95
4044 250 ns	8.95	7.50	6.90
4044 450ns.	5.95	5.95	4.75
EMM4200A	9.75	8.75	7.95
EMM4402	7.95	7.25	6.25
AMD9140/41	10.95	10.25	9.25
AMD9130/31	12.95	11.95	10.25
1101	1.95	1.75	1.25
P2125/93425 (45ns)	9.95	8.35	8.25
6518 1K × 1 CMOS	7.95	7.95	7.25
2147 Low Power 4K Static	9.95	8.95	6.95
93415	9.95	8.95	8.50

DYNAMIC RAMS

416/4116 16K (16 Pin)	2.49
Set of 8 416's 200 MS	24.95
4115 8K (16 Pin)	2.49
4050 4K × 1 (18 Pin)	4.95
4060 4K × 1 (22 Pin)	4.95
4096 4K × 1 (16 Pin)	3.95
2104 4K × 1 (16 Pin)	1.75
4027 4K x 1 (16 Pin/UPD 414	4.95

5261	1.95	1103	.35
5262	1.95	4008L	4.95
5270	4.95	6605	7.95
5280	4.95	6604	4.95
		6002	1.50

64K RAMS $19.95

SOCKETS

# Pins	Lo-Pro Soldertail	Wire Wrap 3 Level Tin	Wire Wrap 3 Level Gold
8	.15	.32	.45
14	.19	.36	.59
16	.20	.38	.62
18	.24	.59	.84
20	.29	.69	.99
22	.24	.79	1.10
24	.38	.85	1.20
28	.43	1.10	1.49
36	.58	1.25	1.69
40	.60	1.40	1.89

ZERO INSERTION FORCE

16 Pin $5.50 24 Pin $7.50 40 Pin $10.25

LED READOUTS

Part No	Size	Color	Description	Price
DL704	300	Red	Comm. Cathode	.99
DL707	300	Red	Comm. Anode	.99
FND357	357	Red	Comm. Cathode	.99
FND501	500	Red	Comm. Cathode (+1)	.99
FND503 (500)	500	Red	Comm. Cathode	.99
FND507 (510)	500	Red	Comm. Anode	.99
FND508	500	Red	Comm. Anode (+1)	.99
FND530	500	Green	Comm. Cathode	1.49
FND550	500	Orange	Comm. Cathode	1.49
FND803 (800)	800	Red	Comm. Cathode	1.75
FND807 (810)	800	Red	Comm. Anode	1.75
HP5082-7340	600	Red	4 × 7 Hexadecimal	25.95
HP5082-7300	600	Red	4 × 7 Sgl. Digit RHD	18.95
HP5082-7731	300	Red	Comm. Anode	.75
TIL305	-	Red	Array 5 × 7	7.95
TIL308	270	Red	Numerical Display	10.95
TIL309	270	Red	Numerical Display	9.95
TIL311	270	Red	4 × 7 Hexidecimal	10.95
MAN2A	320	Red	Array	3.95
MAN10A	270	Red	Alpha Numeric	8.95
XAN3061	300	Red	Comm. Anode Right DP	1.25
XAN3062	300	Red	Comm. Anode Left DP	1.25
XAN3063	300	Red	Overflow CA Left DP	1.25
XAN3064	300	Red	Comm. Cathode Right DP	1.25
XAN3051	300	Green	Comm. Anode Right DP	1.99
XAN3052	300	Green	Comm. Anode Left DP	1.99
XAN3053	300	Green	Overflow CA Left DP	1.99
XAN3054	300	Green	Comm. Cathode Right DP	1.99
XAN3081	300	Yellow	Comm. Anode Right DP	2.10
XAN3082	300	Yellow	Comm. Anode Left DP	2.10
XAN3083	300	Yellow	Overflow CA Left DP	2.10
XAN3084	300	Yellow	Comm. Cathode Right DP	2.10

IC SPECIAL PURCHASE

82S09 64x9 Ram	8.95
OP8304 Octal Driver	2.95
DAC86EX D/A Conv.	6.95
MC1650 Hi Speed A/D	7.95
MC6852 SSDA	3.49
MC10145 16x4 ECL Ram	4.50
MK3850/F8 CPU	4.95
MK3853 Static Mem I/O	4.95

SN75136	.46	78M06	.49
MC10210	.89	79M06	.49
LM339	.79	74157	.49
LM710CN	.29	74161	.49
LM711CN	.29	74C74	.39

ICM 7045 Precision StopWatch	23.95
ICM 7207 Oscillator Controller	7.50
Seven Decade Counter 7208	18.95
MC14433P 3½ Digit A/D Converter	13.95
ICL 8211 Voltage Reference	1.95
LM 1850N Ground Fault IC	3/1.00
LM 2900N Quad Amplifier	2/1.00
LM 2917N Freq. to Volt Conv.	2/1.99
AY-3-3550 4½ digit DMM	24.95
AY-5-3507 40MHz DVM	9.95
MEM 4963 Mosfet Smoke Detector	7.95
27S08 32 × 8 Prom (IM 5600)	2.95
ULN 2003A 7 channel Driver	.99
MCM 14505 64 bit Static Ram	6.95
MOC 1003 (4N28) Opto Coupler	3/1.00
SPX33 Opto Coupler	3/1.00
IH 5045 CMOS Switch DBST	4.50
UA 3045 Trans. Array	1.25
TR 1402A UART	1.95
MK 1007 Dyn. Mem. Shift Reg.	3.95
5318 TV Ch. Disp. Circuit	4.50
8080A 8 Bit CPU	4.95
8700 CJ 8 Bit A/D	9.95
MM5280/VPD 411/C2 107/TMS 4060/4Kx1 Dynamic 22 Pin RAM	1.75
6604/VPD 414/4027/2660/MK 4096/4Kx1 Dynamic 16 Pin	1.95

7520/25	.50	LM 387	1.25
1488/1489	2/1.99	LM 4558	3/1.99
LM323K	4.95	RC 4136	2/1.99
MC1372	8.95	RC 4131	2/1.99
MM5298-4A B	2.95	COM 5027	39.95
LM 377	1.25	COM 5037	49.95
LM380	1.25		

VERBATIM DISKETTES

100% CERTIFIED ERROR-FREE!

• 35 TRACKS DOUBLE DENSITY SINGLE-SIDED 5¼"

TYPE	DESCRIPTION	PRICE BOX 10
525-01	Soft Sectored TRS 80 etc	$29.95
525-10	10 Hole Hard NS Apple etc	$29.95
525-16	16 Hole Hard Micropolis	$29.95

• 40 & 77 TRACK DOUBLE DENSITY - SINGLE SIDED 5¼" W/HUB REINFORCEMENT RING

577-01	Soft Sectored TRS 80 etc	$32.25
577-10	10 Hole Hard NS Apple etc	32.25
577-16	16 Hole Hard Micropolis	32.25

• 40 TRACKS DOUBLE SIDED DOUBLE DENSITY 5¼"

550-01	Soft Sectored SA 450 MPI 52	$39.95
550-10	10 Hole Hard BASF WANGCO	$39.95
550-16	16 Hole Hard Microf	$39.95

• 8" 100% CERTIFIED DISKETTES

FD000-01	Soft Single Density 3740	$33.50
FD000-32	32 Hard Single Density Shug	33.50
FD002-01	Soft Double Density 3740	41.80
FD050-01	Soft Double Sided Double Density 3740	49.80

VOLUME DEALER PRICING AVAILABLE
WE ALSO STOCK DYSAN-CALL

FLOPPY DISK I/O

1771-01 8" & Minifloppy	24.95
1781 Dual Floppy	29.95
1791-01 Dual Floppy	36.95
1791-02 Dual Floppy	44.95
1793 DD, DS Floppy	44.95
1797 DD, DS Floppy	54.95
1691 Data Separator	18.95
2143 Clock Gen	18.95

FLOPPY CHIP SET

Double Density
Double Sided Includes: 1797 1691 2143

$79.95/set

A/D CONVERTERS

8700 8 bit Binary	13.50
8701 10 bit Binary	22.00
8703 8 bit TS	13.50
9400 Volt to Freq. Conv	7.25
8750 3½ Digit BCD	13.95
1408L6 6 bit	3.95
1408L8 8 bit	5.95
DAC01 D to A	5.95
DAC08	9.95
DAC 100	9.95

TV CHIPS/SOUND

AY38500-1 6 Games B/W	4.95
AY38515 Color Converter	2.95
AY38603-1 Roadrace Game	8.95
AY38606-1 Wipeout Game	9.50
AY38607-1 Shooting Gallery	8.95
AY38910 Sound Generator	12.95
SN76477 TI Sound Generator	3.95
MM5320/21 TV Synch Gen	9.95
MM5369 Prescaler	3.95
LM1889 RF Modulator	3.95
MM57100 NSC Color TV	6.95
MM57104 Clock Gen	3.75
M&R Modulator	29.95

WAVEFORM GEN.

8038 Function Gen	4.50
MC4024VCO	2.95
LM566 VCO	1.95
XR2206 Function Generator	5.25

SHIFT REGISTERS

2504V	1.49	MM500H	.50
2507V	1.49	MM5056N	2.95
2517V	1.49	MM5060N	2.95
2524V	1.49	2510A	1.95
2525	1.49	2847	4.95
2527	1.49	3341	4.95
2528	1.49	3351	17.95
2529	1.49	3357	6.95
2533	1.49	9403	24.95
3347	5.95	9408	9.95

CTS DIPSWITCHES

CTS206-2	1.75	CTS206-7	1.75
CTS206-4	1.75	CTS206-8	1.95
CTS206-5	1.75	CTS206-9	1.95
CTS206-6	1.75	CTS206-10	1.95

CONNECTORS (GOLD)

DB25P (RS232)	3.25
DB25S Female	3.75
Hood	1.25
Set w/Hood, Sale	$7.50
22/44 W/W S/T, KIM	2.95
43/86 W/W S/T MOT	6.50
50/100 S-100 Connector w/w	4.95
50/100 S-100 Connector s/t	3.95

NAKED PC

S-100 Sound Board	$34.95
8080A CPU	34.95
32K Static RAM (2114)	39.95
8K Eprom (2708)	24.95
2708/2716 Eprom	34.95
ACP Proto Bd	22.95
Vector 8800 Proto	22.20
Vector 8803 11 slot MB	29.95
ACP Extender w/Conn	18.95
13 Slot Mother Board (WMC)	32.95
9 Slot MotherBoard (WMC)	29.95
8 Slot Mother (Expandable)	34.95
Floppy PCB (8" SHUGART)	39.95
S100 (AY5-8910) Sound Bd.	34.95
Apple Sound Bd	24.95

PRINTERS

EPSON

MX-80	$495.00
MX-80 FT	595.00
MX-100	895.00
MX-70	425.00
Centronics 739	799.00
Vista V-300/25 cps	1495.00
V-300/45 cps	1795.00
Malibu 165	1995.00
Anadex 9500/9501	1450.00
Base II 800 MST	549.00

TERMINALS

TELEVIDEO

912C	$799
920C	$849
950C	$995
AddS Viewpoint	$599
Ampex Dialog 80	$1025
Soroc IQ120	$699
IQ135	$899
IQ140	1149.00

MONITORS SANYO

VM4509 9" BW Sale Price	159.95
DM5012 12" B/W	239.00
DM5112 12" Green	249.00
DM6013 13" Color	415.00
NEC Green	259.00
AMDEK/LEEDEX Video 100	149.00
AMDEK/LEEDEX 13" Color	399.00
AMKEK/LEEDEX 12" Green	179.00

TERMS: Use check, M/C, VISA, AMEX, CB or COD. COD requires 25% deposit. Charge Orders please include expiration date. Foreign pay U.S. Funds. Order by phone, mail or TWX. MINIMUM $10.00. Please include magazine issue and phone no. SHIPPING U.S.A. add $2.00 for first 2 lbs. For surface add 30¢ for additional lbs. For air add 70¢ for additional lbs. FOREIGN: Add 10% shipping and handling. COD's $1.85 extra. Not responsible for typos. Some items subject to prior sale. We reserve right to limit quantities, some items subject to precious metal adder. Retail pricing may vary from Mail Order. We reserve the right to substitute manufacturer.

RETAIL STORES OPEN MON-SAT

STORE #1: 1310 "B" E. Edinger, Santa Ana, CA 92705 Showrooms, Retail, Warehouse
STORE #2: 542 W. Trimble Road, San Jose, CA 95131 • (408) 946-7010
RETAIL PRICING MAY VARY

P.O. Box 17329 Irvine, Calif. 92713
Direct Order Lines: (714) 558-8813
(800) 854-8230 or (800) 854-8241

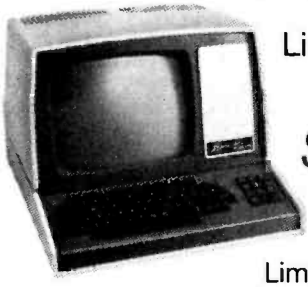
FOR INTERNATIONAL ORDERS:
1310 E. Edinger (714) 953-0604
Santa Ana, CA 92705 TWX: 910-595-1565

Circle 6 on inquiry card.

Terminals and Printers

ZENITH | data systems

Z19 Video Terminal



List $995

OUR PRICE

$799

Limited Time

Intertec

NEW INTERTUBE III

List $995 **ONLY $749**

12" display, 24 x 80 format, 18-key numeric keypad, 128 upper/lower case ASCII characters. Reverse video, blinking, complete cursor addressing and control. Special user-defined control function keys, protected and unprotected fields. Line insert/delete and character insert/delete editing, eleven special line drawing symbols.

TELEVIDEO TVI-912C

Upper and lower case, 15 baud rates: 75 to 19,000 baud, dual intensity, 24 x 80 character display, 12 x 10 resolution. Numeric pad. Programmable reversible video, auxiliary port, self-test mode, protect mode, block mode, tabbing, addressable cursor. Microprocessor controlled, programmable underline, line and character insert/delete. "C" version features typewriter-style keyboard. List $950

CALL FOR PRICE

920C (with 11 function keys, 6 edit keys and 2 transmission mode keys, List $1030

CALL FOR PRICE

950C List $1195 .... CALL FOR PRICE

HAZELTINE 1500

Call For Price

1410 w/numeric keypad, List $900 ...... CALL
1420 w/lower case and numeric pad .... CALL
1510, List $1395 .... CALL
1520, List $1650 .... CALL

SOROC

IQ-120

List $995

SPECIAL

$729

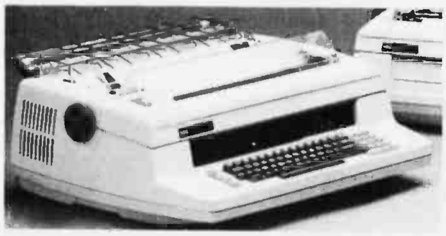
IQ135
$749

IQ-140 List $1495
SPECIAL $1149

CENTRONICS
PRINTERS

730, parallel, friction, tractor $599
NEW 739 w/graphics $819
779-2 w/tractor (same as TRS-80 Line Printer II), List $1350 .... $799
704-9 RS232 150CPS $1595
704-11 Parallel 150CPS $1695

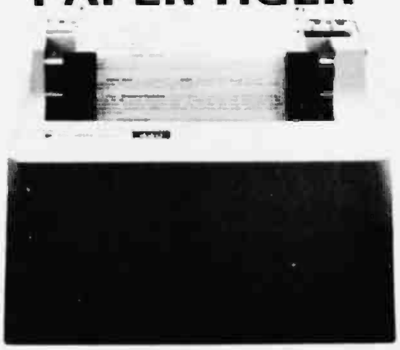
NEC SPINWRITER™



Terminal/Keyboard as well as RO Printer Only models available.

CALL FOR PRICES!

PAPER TIGER®

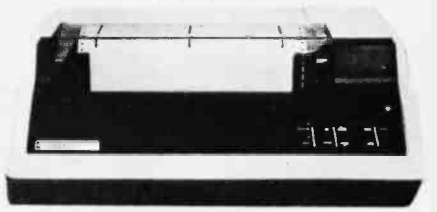


IDS 445 PAPER TIGER $698
IDS 445G PAPER TIGER
Buffer w/graphics option, incl. buffer ... $789

NEW IDS 460/560
QUALITY PRINTING AT MATRIX
SPEED — LOGIC SEEKING
PROPORTIONAL SPACING
w/auto test justification

NEW IDS PAPERTIGER 460 List $1295 .. $1099
NEW IDS PAPERTIGER 460G List $1394 . $1149
NEW IDS 560G List $1794 .... $1499
TRS-80 cable $45

TI-810



TI-810 Basic Unit, $1895 . **$1595**
TI-810 w/full ASCII (Lower case), vertical forms control, and compressed print . **$1795**
TI-820w/lower case List $1995 .... $1645
TI-820w/full ASCII, forms control, compressed print .... List $2150 . $1795
TI-745 Complete printing terminal with acoustic coupler, List $1695 .... **$1399**

ANADEX
DP9500/DP9501 PRINTERS

DP-9500, List $1650 .... **$1349**
DP-9501, List $1650 .... **$1349**

ANADEX DP-8000
80-Col. Dot Matrix..... **$849**

OKIDATA
Microline 80 List $599 **ONLY** $499
Tractor Feed Option $109
Serial interface .... $ 99
Microline 82 List $799 .... $679
Microline 83 List $1260 .... $1069

EpsonMX-80 FTList $745.... $599
EpsonMX-80 List$645......... $499

Above prices reflect a 2% cash discount (order prepaid prior to shipment). Add 2% to prices for credit card orders, C.O.D.'s, etc. Prices are f.o.b. shipping point. Prices are subject to change and offers subject to withdrawal without notice. WRITE FOR FREE CATALOG.

MiniMicroMart, Inc.

VISA · master charge

1618 James Street, Syracuse NY 13203 (315) 422-4467 TWX 710-541-0431

Circle 247 on inquiry card.

If North Star or Cromemco offer it . .

WE HAVE IT!!

Immediate Delivery at Discount Prices

NORTH STAR Horizon® 2

ASSEMBLED

HORIZON 1, DD	$2279	32K, QD, List $2995	2539
HORIZON 2, 32K, DD .	$2619	48K, QD, List $4090	3469
32K, QD, List $3595	3049	64K, DD, List $3830	3239
48K, DD, List $3590	3039	64K, QD, List $4330	3669

NORTH STAR APPLICATIONS SOFTWARE

(Exclusive for use with North Star Disk Systems — specify Double or Quad Density)

NORTHWORD, List $399 .... $339
MAILMANAGER, List $299 249
INFOMANAGER, List $499 419
GENERALLEDGER, List $999 799
ACCOUNTSRECEIVABLE, List $599 499
ACCOUNTSPAYABLE, List $599 499

NORTH STAR HARD DISK HD-18

18 megabytes, plugs into parallel port of North Star Horizon. Utilizes tried-and-proven 14" Century Data Marksman. List $4999. **OUR PRICE $4199**

NORTH STAR MDS-A — Double (or Quad) Density Disk System, Kit, List $799 . **OUR PRICE $669**
Assembled and Tested, List $899 **SPECIAL $719**

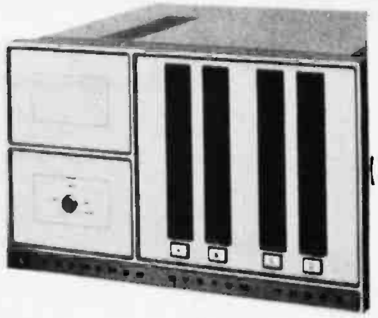
NORTH STAR MEMORY BOARDS

16K Dynamic RAM (RAM-16-A/A), Assembled, List $499 ..... $420
32K (RAM-32/A), Assembled, List $739 .... $620

NorthStar prices going up!!!

Check by phone for prices after May 1, 1981

NEW System 3
by CROMEMCO



Now with Dual Double Sided Double Density (over 2 megabytes of Storage) 64K of RAM
List $7995

LIMITED TIME $6395

CROMEMCO SYSTEM 2 — Now double Density with Double Sided Drives, Quad Capacity mini floppy disc drives. List $4695 .... **Only $3899**

CROMEMCO Z-2H Full 11-megabyte Hard Disk system. Fast Z-80A 4 MHz processor, two floppy disk drives, 64K RAM memory, RS232 special interface, printer interface, and extensive software available.

List $9995
OUR PRICE $8489

Beat the price increase on many CROMEMCO Boards & Software.
ORDER NOW!!!

NEW! Double Density Controller Board from Cromemco w/built-in diagnostics — 16 FDC Controller List $595 .... $505

Cromemco System CS-0/D
Z-80 SCC CPU, 64KZ, 16 FDC $2595

SINGLE CARD COMPUTER — SCC-W 4 MHz. List $450 .... **$382**
NEW COLOR GRAPHICS INTERFACE — SDI List $595 **OUR PRICE $505**
CROMEMCO HDD — 11/22-megabyte Hard Disk for use with existing systems. DMA controller. Transfer rate of 5.6 megabytes/second.
HDD-11. List $6995 .... **OUR PRICE ONLY $5939**
HDD-22. List $11,995 .... **$10,189**

SHIPPING AND INSURANCE: Add $15 or Horizons, $2.50 for Boards and Software. Hard Disk Systems and Cromemco systems shipped freight collect. Advertised prices are for prepaid orders. Credit card and C.O.D. 2% higher. Deposit may be required on C.O.D. All prices subject to change and offers subject to withdrawal without notice.

MiniMicroMart, Inc.

master charge
VISA

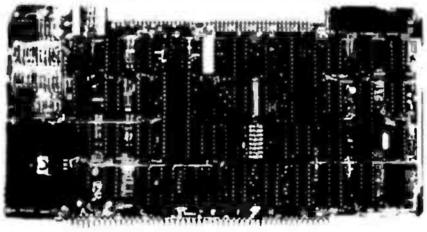
1618 James Street, Syracuse, NY 13203 (315) 422-4467 TWX 710-541-0431

Circle 250 on inquiry card.

Better Products,

JADE Double-D ™

Get the Inside Track



S-100 bus compatible • Reads and writes single or double density • Density is software selectable • CP/M® 2.2 compatible in single or double density • Controls up to four 5-1/4" or 8", single or double-sided drives • Single or double-sided drives may be mixed in the same system • On-board Z-80A to assure reliable operation • EIA level serial printer interface on board, baud rates to 9600 (perfect for despooling operations) • 2K of RAM on-board • Uses IBM standard formats • Designed to meet IEEE signal disciplines • Works with 8080, 8085, and Z-80 CPU's • 4-layer PC board with internal power and ground planes provides very stable, low-noise operation.

IOD-1200B	*Bare board*	$59.95
IOD-1200K	*Kit*	$299.95
IOD-1200A	*A & T for 8"*	$375.95
IOD-1205A	*A & T for 5¼"*	$395.00
SFC-58001200E	*DD boot PROM*	$20.00
SFC-59002001F	*CP/M 2.2 for DD*	$150.00

JADE Memory Bank ™

8 or 16 Bit Dynamic Memory

New, from JADE (naturally), an IEEE S-100 64K dynamic memory that looks toward the future. • IEEE S-100 standard pinout and signal discipline • Expandable to 16 Megabytes via switchable port OR extended address lines • 8 or 16 bit words, automatically, depending on the type of CPU on the bus • 4-layer PC board for extremely low-noise operation.

The new JADE Memory Bank™ is one of the safest places you can store your valuable program information. With its on-board refresh controller, this board allows DMA operations without regard to time factors. It will run reliably at any system clock rate up to 6 MHz--because it is clocked with the system clock itself (no one-shots are used for timing operations). Its unique IEEE design enables it to switch from a 64K by 8-bit board to a 32K by 16-bit board automatically (responds to IEEE's 16 Rqst line and, if enabled, replies with 16 Grant).

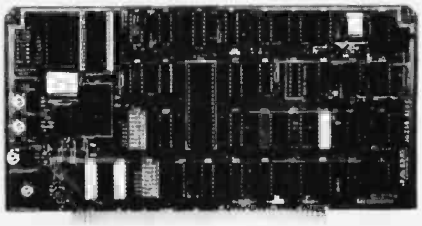
On-board M1 wait-state generator allows the use of slower memory, and a unique on-board precharge extender makes this board run reliably with any manufacturer's 4116 memory chips.

Compatible with Cromemco and other CPU systems – features enough optional strapping to enable it to run with any Z-80/Z8000 system.

MEM-99730B	*Bare Board*	$49.95
MEM-99730K	*Kit, no RAM*	$199.95
MEM-16730K	*16K kit*	$219.95
MEM-32731K	*32K kit*	$239.95
MEM-48732K	*48K kit*	$259.95
MEM-64733K	*64K kit*	$279.95
Assembled & Tested		add $50.00

JADE The Big Z ™

Z-80A Based CPU



S-100 bus compatible • Switch selectable 2 or 4 MHz operation • Serial I/O port • Accomodates a 2708, 2716, or 2732 EPROM in shadow mode allowing full use of 64K RAM • MWRITE signal is generated automatically if used without front panel • On-board 8251 USART controls serial port at baud rates from 75 to 9600 baud • Switch selectable 1K, 2K, or 4K boundary fully buffered • Power-on jump to EPROM

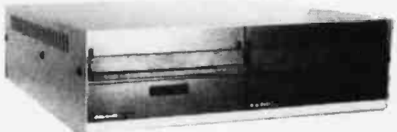
CPU-30201K	*Kit*	$139.95
CPU-30201A	*A & T*	$189.95
CPU-30200B	*Bare board*	$35.00

Memory Chips on Sale

	1-9	10-24	25-49	50+
2114L *4 MHz*	3.35	2.99	2.75	2.49
2708 *2 MHz*	4.90	3.90	3.45	2.90
2532 *2 MHz*	24.90	19.90	15.90	12.90
2716 *2 MHz*	8.90	7.45	6.45	5.75
2716 *4 MHz*	19.90	15.45	13.45	11.75
2732 *2 MHz*	24.90	19.90	15.90	12.90
2732 *4 MHz*	39.90	29.90	24.90	19.90
2758 *2 MHz*	6.90	6.25	5.50	4.50
4116 *200 ns*	3.25	2.99	2.49	1.99
4164 *200 ns*	28.90	24.90	22.90	19.90

JADE Disk Sub-Systems

Shugart, Siemens, Qume



Handsome metal cabinet with proportionally balanced air flow system • Rugged dual drive power supply • Power cable kit • Power switch, line cord, fuse holder, cooling fan • Never-Mar rubber feet • All necessary hardware to mount 2-8" disk drives, power supply, and fan • Does not include signal cable

Dual 8" Subassembly Cabinet

END-000420	*Bare cabinet*	$59.95
END-000421	*Cabinet kit*	$225.00
END-000431	*A & T*	$359.95

8" Disk Drive Subsystems
Single Sided, Double Density

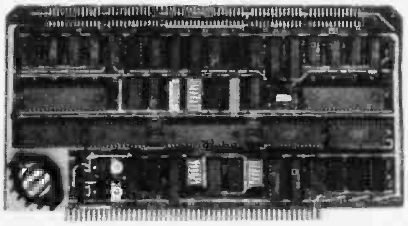
END-000423	*Kit w/2 FD100-8Ds*	$975.00
END-000424	*A & T w/2 FD100-8Ds*	$1175.00
END-000433	*Kit w/2 SA-801Rs*	$999.95
END-000434	*A & T w/2 SA-801Rs*	$1195.00

8" Disk Drive Subsystems
Double Sided, Double Density

END-000426	*Kit w/2 DT-8s*	$1475.00
END-000427	*A & T w/2 DT-8s*	$1675.00
END-000436	*Kit w/2 SA-851Rs*	$1495.00
END-000437	*A & T w/2 SA-851Rs*	$1695.00

JADE S.P.I.C.

Our "SPICy" New I/O Board



New, from JADE, one of the most advanced, technologically sophisticated Serial/Parallel Interrupt Controller systems in the world. On a single IEEE S-100 standard board, JADE has packed two bi-directional parallel ports with full handshaking, four serial channels (asynchronous, IBM-compatible bi-synch, synchronous, HDLC/SDLC) with complete modem control lines, and 16 counter-timer channels.

Utilizing the highly advanced Zilog peripheral chips, (Z-80 SIO, PIO & CTCs), the SPIC board is fully programmable to serve as the foundation for a multi-user multi-tasking system. Although the board can be operated in an 8080/8085 system, we recommend its use with a Z-80/Z8000 system utilizing the powerful Z-80/Z8000 interrupt Mode 2. Each of the seven Z-80 peripheral chips can generate its own interrupt vector, with daisy-chain priority levels. Each counter-timer channel can be programmed to monitor an interrupt vector line on the S-100 bus, to serve as an interval timer or real-time clock, and to operate as a software controllable baud rate generator. Each SIO channel can be driven independently with separate Tx/Rx clocks for each channel, so your peripherals can have varied baud rates, from 110 to 76,800 baud

In addition, this board can serve as a data concentrator link to an IBM, DEC, or Data General mainframe computer, utilizing a high-speed serial channel that is programmable to virtually any protocol.

IOI-1045B	*Bare board & manual*	$49.95
IOI-1045K	*Kit, standard*	$179.95
IOI-1045A	*A & T, standard*	$239.95
IOI-1046K	*Kit w/full chip set*	$219.95
IOI-1046A	*A & T w/full chip set*	$299.95

Jade Business Software

Now, for the first time, at an amazingly low price, CP/M and SDOS users can get an affordable business software package. Just look at these programs! All come complete with basic code (written to run under CBASIC I), for easy customizing and modification. All software is self-documenting. The package price includes a word-processing system. When printed on the system's printer, all files with the extension xxxTOT. constitute a complete manual. No manuals are supplied with the package other than as they appear on the disks. All software is supplied on 8" premium quality JADE Diskettes. Software sold as is. (Sorry, but at these low prices we can not offer our usual friendly support and handholding.)

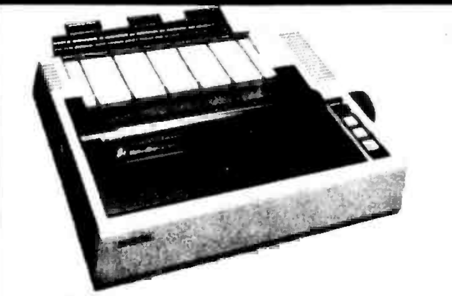
Includes; General Ledger, Payroll, Invoicing, Inventory Controll, Accounts Recievable, Cash Disbursements, Fixed Assets, Cash Receipts, & Mailing List Management.

Special Package Price ***$249.95***

Circle 181 on inquiry card.

Lower Prices,

Printers



BEST BUY in PRINTERS - Epson

MX-70 132 column, 80 CPS, 5 x 7 dot matrix, adjustable tractor feed, & graphics
PRM-27070 *List $459* $399.95

MX-80 132 column, 80 CPS, bi-directional/logic seeking printing, 9 x 9 dot matrix, adjustable tractor feed, & 64 graphics characters
PRM-27080 *List $645* $474.95

MX-80FT same as MX-80 with friction feed and full graphics added
PRM-27082 *List $745* $574.95

MX-100 233 column, correspondence quality, ultra-high resolution graphics, up to 15" paper, friction feed & removable adjustable tractor feed, 18 x18 dot matrix, 80 CPS, programmable forms handling
PRM-27100 *List $945* $795.00

PRA-27084 *Serial interface* $69.95
PRA-27088 *Serial intf & 2K buffer* .. $144.95
PRA-27081 *Apple card* $74.95
PRA-27082 *Apple cable* $22.95
PRA-27086 *IEEE 488 card* $52.95
PRA-27087 *TRS-80 cable* $32.95
PRA-27085 *Graftrax II* $95.00
PRA-27083 *Extra ribbon* $14.95

SPINWRITER - NEC

65 cps, bi-directional, letter quality printer with deluxe tractor mechanism, both parallel and serial interfaces on-board, 16K buffer, ribbon, print thimble, graphics, micro-space justification, data cable, and self test/diagnostic ROM.
PRD-55511 *without 16K buffer* ... $2795.00
PRD-55512 *with 16K buffer* $2895.00

Accessories for TRS-80

DISK DRIVES for TRS-80

23% more storage, 8 times faster, 40 track with free patch, 120 day warranty.
MSM-12410C *Save $125.00 !!!* $325.00

8" DISK DRIVES for MODEL II

2 double density drives with cabinet, power supply, & cables
END-000433 *Kit* $1050.00
END-000434 *Assembled* $1250.00
WCA-5036A *Cable (required)* $29.95

16K Atari ... $359.95

ATARI 800 - Atari

Complete personal computer with high resolution color graphics, built-in RF modulator, 4 controller ports, internal speaker, 16K RAM & 8K ROM
SYO-2080A *16K Atari 800* $759.95
Atari 800 with 32K of RAM $799.95
Atari 800 with 48K of RAM $849.95
SYO-2040A *16K Atari 400* $359.95
MSM-330810 *Disk drive* $595.00
MSM-330815 *Dual drive* $1395.00
IOX-5050A *850 interface* $199.95
MEX-16853K *16K RAM module* $69.95
SFI-241011005 *Visicalc* $184.95

Accessories for Apple

16K MEMORY UPGRADE

Add 16K of RAM to your TRS-80, Apple, or Exidy in just minutes. We've sold thousands of these 16K RAM upgrades which include the appropriate memory chips (as specified by the manufacturer), all necessary jumper blocks, fool-proof instructions, and our 1 year guarantee.
MEX-16100K *TRS-80 kit* $25.00
MEX-16101K *Apple kit* $25.00
MEX-16102K *Exidy kit* $25.00

16K RAM Card - Microsoft

(There is life after 48K)
MEX-16300A *A & T* $174.95

Z-80* CARD for APPLE

Two computers in one, Z-80 & 6502, more than doubles the power & potential of your Apple, includes Z-80* CPU card, CP/M 2.2, & BASIC-80
CPX-30800A *A & T* $279.95

APPLE CLOCK - Cal Comp Sys

Real time clock w/battery back-up
IOK-2030A *A & T* $109.95

DISK DRIVE for APPLE

5¼" disk drive with controller for your Apple
MSM-12310C *with controller* $475.00
MSM-123101 *w/out controller* $375.00

8" DRIVES for APPLE

Controller, DOS, two 8" double densisty drives, cabinet, power supply, & cables
Special Package Price *Kit* $1399.95

PRINTER INTERFACE - C.C.S.

Centronics type I/O card w/ firmware
IOI-2041A *A & T* $99.95

AIO, ASIO, APIO - S.S.M.

Parallel & serial interface for your Apple (see Byte pg 11)
IOI-2050K *Par & Ser kit* $139.95
IOI-2050A *Par & Ser A & T* $169.95
IOI-2052K *Serial kit* $89.95
IOI-2052A *Serial A & T* $99.95
IOI-2054K *Parallel kit* $69.95
IOI-2054A *Parallel A & T* $89.95

A488 - S.S.M.

IEEE 488 controller, uses simple basic commands, includes firmware and cable, 1 year guarantee, (see April Byte pg 11)
IOX-7488A *A & T* $399.95

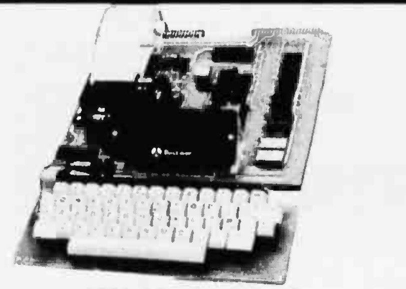
CPS MULTICARD - Mtn. Computer

Three cards in one! Real time clock calendar, serial interface, & parallel interface - all on one card.
IOX-2300A *A & T* $229.95

VISICALC - Personal Sftwr

The ultimate program for your Apple II
SFA-24101005M *Complete package* $139.95

Single Board Computers



AIM-65 - Rockwell

6502 computer with alphanumeric display, printer, & keyboard, and complete instructional manuals
CPK-50165 *1K AIM* $424.95
CPK-50465 *4K AIM* $499.95
SFK-74600008E *8K BASIC ROM* ... $99.95
SFK-64600004E *4K assembler ROM* $84.95
PSX-030A *Power supply* $64.95
ENX-000002 *Enclosure* $54.95
4K AIM, 8K BASIC, power supply, & enclosure
Special package price $675.00

Z-80* STARTER KIT - SD Systems

Complete Z-80* computer with RAM, ROM, I-O, display, keyboard, manual, and kluge area.
CPS-30010K *Kit* $369.95
CPS-30010A *A & T* $459.95

SYM-1 - Synertek Systems

Single board computer with 1K of RAM, 4K of ROM, key-pad, LED display, 20ma & cassette interface on board.
CPK-50020A *A & T* $249.95

Video Terminals

VIEWPIONT - ADDS

Detachable keyboard, serial RS232C interface, baud rates from 110 to 19,200, auxiliary serial output port, 24 x 80 display, tiltable screen, international character set
VDT-501210 *Sale Priced* $639.95

TELEVIDEO 950

Detachable keyboard, split screen with line lock, etched CRT, programmable function keys, on-screen status line, buffered auxiliary port, 14 x 10 dot matrix, self test, serviced nationwide by General Electric
VDT-901250 *List $1195.00* $995.00

Video Monitors

Leedex / Amdek

Reasonably priced video monitors
VDM-801210 *Video 100 12" B&W* .. $149.95
VDM-801230 *Video 100-80 12" B& W* $189.95
VDM-801250 *12" Green Phospor* $189.95
VDC-801310 *13" Color I* $399.95

13" COLOR MONITOR - Zenith

The hi res color you've been promising yourself
VDC-201301 .... $449.00

12" GREEN SCREEN - NEC

20 MHz, P31 phosphor video monitor with audio, exceptionally high resolution - A fantastic monitor at a very reasonable price
VDM-651200 *12" monitor* $259.95

EPROM Erasers

EPROM ERASERS

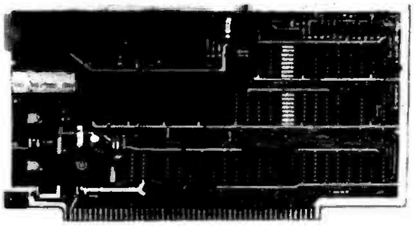
L.S. Engineering UV eraser for up to 48 EPROMs
XME-3200 *A & T* $39.99

Spectronics hi intensity industrial eraser
XME-3100 *Without timer* $69.50
XME-3101 *With timer* $94.50

Circle 182 on inquiry card.

Faster Service.

S-100 PROM Boards



PB-1 - S.S.M.
2708, 2716 EPROM board with built-in programmer
MEM-99510K *Kit* $154.95
MEM-99510A *A & T* $219.95

PROM-100 - SD Systems
2708, 2716, 2732, 2758, & 2516 EPROM programmer
MEM-99520K *Kit* $219.95
MEM-99520A *Jade A & T* $269.95

EPROM BOARD - Jade
16K or 32K uses 2708's or 2716's, 1K boundary
MEM-16230K *Kit* $79.95
MEM-16230A *A & T* $119.95

S-100 Video

VB-3 - S.S.M.
80 characters x 24 lines expandable to 80 x 48 for a full page of text, upper & lower case, 256 user defined symbols, 160 x 192 graphics matrix, memory mapped, has key board input.
IOV-1095K *4 MHz kit* $349.95
IOV-1095A *4 MHz A & T* $439.95
IOV-1096K *80 x 48 upgrade* $39.95

VDB-8024 - SD Systems
80 x 24 I/O mapped video board with keyboard I/O, and on-board Z-80A.*
IOV-1020K *Kit* $399.95
IOV-1020A *Jade A & T* $459.95

VIDEO BOARD - Jade
64 characters x 16 lines, 7 x 9 dot matrix, full upper/lower case ASCII character set, numbers, symbols, and greek letters, normal/reverse/blinking video, S-100.
IOV-1050K *Kit* $99.95
IOV-1050A *A & T* $125.00
IOV-1050B *Bare board* $29.95

Motherboards

ISO-BUS - Jade
Silent, simple, and on sale - a better motherboard

6 Slot (5¼" x 8⅝")
MBS-061B *Bare board* $19.95
MBS-061K *Kit* $39.95
MBS-061A *A & T* $49.95

12 Slot (9¾" x 8⅝")
MBS-121B *Bare board* $29.95
MBS-121K *Kit* $69.95
MBS-121A *A & T* $89.95

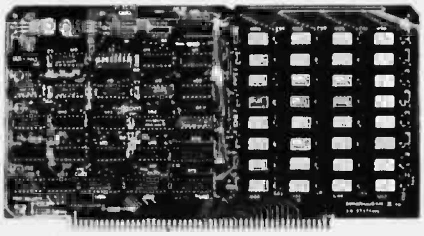
18 Slot (14½" x 8⅝")
MBS-181B *Bare board* $49.95
MBS-181K *Kit* $99.95
MBS-181A *A & T* $139.95

Mainframes

MAINFRAME - Cal Comp Sys
12 slot S-100 mainframe with 20 amp power supply
ENC-112105 *Kit* $379.95
ENC-112106 *A & T* $409.95

DISK MAINFRAME - N.P.C.
Holds 2 8" drives and a 12 slot S-100 system. Attractive metal cabinet with 12 slot motherboard & card cage, power supply, dual fans, lighted switch, and other professional features
ENS-112320 *with 25 amp p.s.* $699.95

S-100 Memory



EXPANDORAM II - S D Systems
4 MHz RAM board expandable from 16K to 64K
MEM-16630K *16K kit* $275.95
MEM-32631K *32K kit* $295.95
MEM-48632K *48K kit* $315.95
MEM-64633K *64K kit* $335.95
Assembled & tested .... add $50.00

64K RAM - Calif Computer Sys
4 MHz bank port / bank byte selectable, extended addressing, 16K bank selectable, PHANTOM line allows memory overlay, 8080 / Z-80 / front panel compatible.
MEM-64565A *A & T* $575.00

32K STATIC RAM - Jade
2 or 4 MHz expandable static RAM board uses 2114L's
MEM-16151K *16K 4 MHz kit* $169.95
MEM-32151K *32K 4 MHz kit* $299.95
Assembled & tested .... add $50.00

16K STATIC RAM - Mem Merchant
4 MHz 16K static RAM board, IEEE S-100, bank selectable, Phantom capability, addressable in 4K blocks, "disable-able" in 1K segments, extended addressing, low power
MEM-16171A *A & T* $174.95

S-100 Disk Controller

DOUBLE DENSITY - Cal Comp Sys
5¼" and 8" disk controller, single or double density, with on-board boot loader ROM, and free CP/M 2.2 and manual set.*
IOD-1300A *A & T* $369.95

VERSAFLOPPY II - SD Systems
New double density controller for both 8" & 5¼"
IOD-1160K *Kit* $339.95
IOD-1160A *A & T* $379.95

Disk Drives

8" DISK DRIVES
Highly reliable double density floppy disk drives

Shugart 801R single sided, double density
MSF-10801R *SA-801R* $425.00
Special Sale Price .... **2 for $790.00**

Shugart 851R double sided, double density
MSF-10851R *SA-851R* $595.00
Special Sale Price .... **2 for $1150.00**

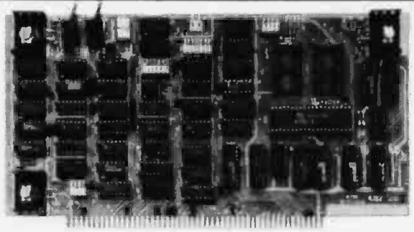
Siemens FDD100-8D2 single sided, double density
MSF-201120 *6 mo warranty* $385.00
Special sale price .... **2 for $750.00**

Qume Datatrak 8 double sided, double density
MSF-750080 *SA-851R compatible* .. $599.95
Special sale price .... **2 for $1160.00**

JADE DISK PACKAGE
Double density controller, two 8" double density floppy disk drives, CP/M 2.2 (configured for controller), hardware and software manuals, boot PROM, cabinet, power supply, fan, & cables
Special Package Price *Kit* $1395.00

5¼" Diskettes *Box of 10* .. **$22.00**
8" Diskettes *Box of 10* **$24.00**

S-100 CPU



CB-2 Z-80 CPU - S.S.M.
2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing, IEEE S-100, front panel compatible.
CPU-30300K *Kit* $239.95
CPU-30300A *A & T* $299.95

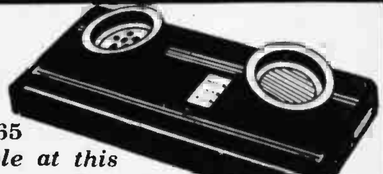
2810 Z-80* CPU - Cal Comp Sys
2/4 MHz Z-80A CPU with RS-232C serial I/O port and on-board MOSS 2.2 monitor PROM, front panel compatible.*
CPU-30400A *A & T* $269.95

SBC-200 - SD Systems
4 MHz Z-80 CPU with serial & parallel I/O ports, up to 8K of on-board PROM, software programmable baud rate generator, 1K of on-board RAM, Z-80 CTC.*
CPC-30200K *Kit* $339.95
CPC-30200A *Jade A & T* $399.95

S-100 I/O

I/O-4 - S.S.M.
2 serial I/O ports plus 2 parallel I/O ports
IOI-1010K *Kit* $179.95
IOI-1010A *A & T* $249.95
IOI-1010B *Bare board* $35.00

Novation Cat Modem



(We have only 265 availible at this special price)

IOM-5200A *List price $189.95* $139.95

D-CAT 300 baud, direct connect modem
IOM-5201A *Special sale price* $189.00

AUTO-CAT Auto answer/origiate, direct connect
IOM-5230A *Special sale price* $239.95

Place Orders Toll Free

Continental U.S. **800-421-5500**
Inside California **800-262-1710**

For Technical Inquires or Customer Service call:
213-973-7707

JADE
Computer Products
4901 W. Rosecrans, Hawthorne, Ca 90250

TERMS of SALE: Cash, checks, credit cards, or Purchase Orders from qualified firms and institutions. **Minimum Order $15.00.** California residents add 6% tax. Minimum shipping & handling charge $3.00. **Pricing & availibility subject to change**

Circle 182 on inquiry card.

MOVING SALE MOVING SALE

MODEM SALE

$129.00

THE STAR MODEM from LIVERMORE

FEATURE
FITS GTE HANDSETS!

2 YEAR WARRANTY

EXCLUSIVE ACOUSTIC CHAMBERS

The exclusive triple seal of Livermore's new flat mounted cups locks the handset into the acoustic chamber yielding superior acoustic isolation and mechanical cushioning. Designed to adapt to most common handsets used throughout the world, the STAR offers the utmost in flexibility and transmission reliability.

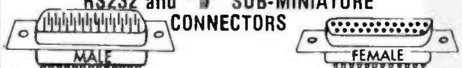
Specifications:
- **Data Rate:** 0 to 300 baud
- **Compatibility:** Bell 103 and 113; CCITT
- **Frequency Stability:** ±0.3 percent. Crystal controlled
- **Receiver Sensitivity:** −50 dBm ON, −53 dBm OFF
- **Modulation:** Frequency shift keyed (FSK)
- **Carrier Detect Delay:** 1.2 seconds ON; 120 msec OFF
- **EIA Terminal Interface:** Compatible with RS 232 specifications
- **Teletype Interface:** 20 milliampere current loop
- **Optional Interfaces:** IEEE 488; TTL; TTY 43
- **International (CCITT) frequencies available**
- **Switches:** Originate/Off/Answer: Full Duplex/Test/Half Duplex
- **Indicators:** Transmit Data, Receive Data, Carrier Ready, Test
- **Power:** Supplied by 24 VAC/150 MA UL/CSA listed wall-mount transformer. Input 115 VAC, 2.5 watts. (A 220 VAC, 50 Hz adaptor is available upon request.)
- **Dimensions:** 10" x 4" x 2"
- **Weight:** 1.74 lbs. (3 lbs. shipping weight including AC adaptor.)
- **Warranty:** Two years on parts and labor, excluding the AC adaptor which carries the manufacturer's warranty

Part No.	Description	List Price	SALE PRICE
LIV-STAR	RS232, TTL, 20 MA Current Loop	$199.00	$129.00

CABLES

Part No.	Description	Price
CND-RS2328F	RS232 8 Cond 8 ft.	$19.95

RS232 and "D" SUB-MINIATURE CONNECTORS



P = Plug, Male Type - S = Socket, Female Type - C = Cover, Hood

PART NO.	DESCRIPTION	PRICE 1-9	10-24	25-99
CND-DE9P	9 PIN MALE	$ 2.10	$ 1.90	$ 1.70
CND-DE9S	9 PIN FEMALE	$ 2.70	$ 2.40	$ 2.10
CND-DE9C	9 PIN COVER	$ 1.50	$ 1.25	$ 1.10
CND-DA15P	15 PIN MALE	$ 2.75	$ 2.45	$ 2.15
CND-DA15S	15 PIN FEMALE	$ 3.95	$ 3.60	$ 3.20
CND-DA15C	15 PIN COVER	$ 1.50	$ 1.30	$ 1.10
CND-DB25P	25 PIN MALE	$ 3.00	$ 2.75	$ 2.60
CND-DB25S	25 PIN FEMALE	$ 4.00	$ 3.75	$ 3.50
CND-DB51212	1 PC. GREY HOOD	$ 1.60	$ 1.45	$ 1.30
CND-P25H	2 PC. GREY HOOD	$ 1.50	$ 1.25	$ 1.10
CND-DB51226	2 PC. BLACK HOOD	$ 1.90	$ 1.65	$ 1.45
CND-DC37P	37 PIN MALE	$ 5.80	$ 5.10	$ 4.45
CND-DC37S	37 PIN FEMALE	$ 8.70	$ 7.70	$ 6.70
CND-DC37C	37 PIN COVER	$ 1.80	$ 1.55	$ 1.30
CND-DD50P	50 PIN MALE	$ 8.75	$ 7.75	$ 6.70
CND-DD50S	50 PIN FEMALE	$11.65	$10.25	$ 8.90
CND-DD50C	50 PIN COVER	$ 2.00	$ 1.80	$ 1.60
CND-D20418	HARDWARE SET 2 PR.	$ 1.00	$ 0.80	$ 0.70
CND-RS2328F	RS232, DB25P, EIA CLASS 1 CABLE 8 CON. 8 FT.	$19.95	$17.95	$15.95
CND-5730360	CENT. 700 SERIES PRINTER CONNECTOR	$ 9.00	$ 7.50	$ 6.00

GOLD S-100 CONNECTORS

SOLDER TAIL PRICE

Part No.	1-9	10-24	25-99	100-249
S100 STG	3.50	3.20	2.80	2.50

WIRE WRAP PRICE

Part No.	1-9	10-24	25-99	100-249
S100 WWG	4.00	3.75	3.50	3.25

2708

450ns 8K EPROM

$8.50 EA.
8/$32.00

2716

450ns 5-Volt only 16 K EPROM

$11.95 EA
8/$48.00

2114-3L
4096 BIT (1024x4) 300ns LOW POWER STATIC RAM
8/$30.00
100 + $3.00

2016P3
2K x 8 200ns L/P STATIC RAM
8/$100.00

TRS-80/APPLE

MEMORY EXPANSION KITS
4116's RAMS
from Leading Manufacturers
(16Kx1 200ns)

100% GUARANTEED — 1,000's SETS SOLD

8 for $24.00

ADD $3.00 FOR PROGRAMMING JUMPERS FOR TRS-80 KEYBOARD

4116's 100 pcs & UP $2.75 each
1000 pcs & UP $2.50 each

POWERLINE INSOLATOR

GOF-IBARW3

SH. WT. 3 LBS.

LIST PRICE $59.95

SALE PRICE $29.95

A MUST FOR EVERY OFFICE WITH DATA PROCESSING EQUIPMENT

PROTECT YOUR INVESTMENT
PROTECT YOUR DATA WITH

ISOBAR

GOF-IBAR46
- Inductively isolated grounds
- Sockets individually filter isolated
- Each socket isolated from power line

LIST PRICE $79.95

SALE PRICE $39.95

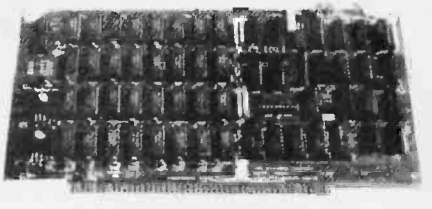
6 OUTLET MULTI USE CORD REEL

THE CONVENIENCE OF AN EXTENSION CORD AND POWER DISTRIBUTION PANEL IN ONE COMPACT, SELF-STORING UNIT!

- SIX GROUNDED 3-PRONG OUTLETS!
- CIRCUIT BREAKER FOR SAFETY'S SAKE — GUARDS AGAINST OVERLOADS ABOVE 10 AMPS

GOF-CR21 22 Ft. - 5 lbs. $24.95
GOF-CR50 50 ft. - 10 lbs. $39.95

THE EXPANDABLE 1™



THE UNIVERSAL IEEE-S100 DYNAMIC MEMORY CARD

THE EXPANDALBE 1 TM 64K Dynamic Ram board provides your S-100 system with 64K of reliable, high-speed dynamic RAM. Compatible with most of the major S-100 systems on the market, including those with front panels, it supports DMA operations and requires no Wait states with current microprocessors.

- *User expandable from 16 to 64 K*
- *2 or 4 MHz operation*
- *North Star compatible*
- *Cromemco Compatible*
- *Designed to IEEE proposed S-100 bus standards*
- *Supports IMSAI-type front panels*
- *Operates with either an 8080 or Z-80 based S-100 system, providing processor-transparent refreshes with both*
- *Bank-select system allows system memory expansion and is compatible with Cromemco products*
- *Bank select port's address is jumper selectable*
- *Any 16K block can be made bank-independent*
- *All 64K can be made bank-enabled on power-on and reset*
- *Configuration as a 16K, 32K, or 48K board without the removal of RAMs*
- *Fully buffered address and data lines*
- *Fail-safe refresh circuitry for extended Wait states*
- *Board configuration with reliable, easy-to-configure Berg jumpers*
- *Supports DMA*
- *Jumper-selectable Phantom input*
- *Uses Popular 4116 RAMS*
- *Assembled & tested*
- *All ICs in sockets*
- *Power supply: Unregulated +8, +16, and −16 volts*
  Maximum power draw: 400 mA at +8 volts
  175 mA at +16 volts
  5 mA at −16 volts
  Dissipation: less than 8 watts
- *Temperature: 0 to 70 degrees Celsius*
- *Humidity: 0 to 90% noncondensing*
- *PC Board*
- *FR-4 glass epoxy*
- *Solder mask on both sides*
- *Gold-plated connector fingers*
- *Silk screen component outlines, reference numbers, and part designations*

PRI-EXP1-16
$299.00

Factory Assembled and Tested 16K Board. For additional memory order 1 set of 8 4116's at the left for each additional 16K. *PRIORITY ONE ELECTRONICS* can supply the board A&T populated to 32K, 48K, or 64K at additional cost, see our catalog or call for pricing.

SPECIAL PURCHASE

GOLD

16 PIN LOW PROFILE I.C. C-95 SOCKETS

TIG-16LP pkg. of 100 $16.00
TIG-16LP pkg. of 1000 $120.00
OEMS Stock up at this LOW PRICE

PRIORITY ONE ELECTRONICS

9161-B DEERING AVE. • CHATSWORTH, CA 91311

Terms: U.S.; VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA. residents add 6% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $2.50 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case...please include your phone no. Prices subject to change without notice. We will do our best to maintain prices thru AUGUST, 1981. SOCKET and CONNECTOR prices based on GOLD, not exceeding $700.00 per oz.
Sales Prices are for prepaid orders only. Credit Card orders will be charged appropriate freight.

MEMBER MITA — NEDA

ORDER TOLL FREE 1-800-423-5922 CA., AK., HI., (213) 709-5464

DETACH OUR CATALOG FROM THE MAY BYTE

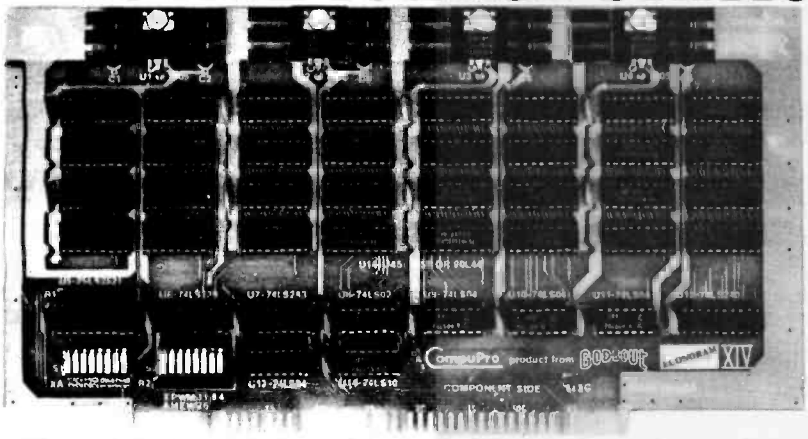
DETACH OUR CATALOG FROM THE MAY BYTE

Circle 315 on inquiry card.

PRIORITY 1 ELECTRONICS

TRUCK LOAD PURCHASE

10 MHZ 16K A&T STATIC S-100 RAM SALE



GBT-143A
List
$349.00

SAVE $180.00

$169.00

or 3 for $450.00

The **RAM 14** provides 16K X 8 of reliable, totally static RAM storage. Conforming fully to the IEEE 696/S-100 bus standard, **RAM 14** not only provides 24 address lines for 16 megabyte extended addressing capability, but also includes a number of features you would only expect to find in memory boards costing considerably more. Here's a partial listing of what makes **RAM 14** your best choice!

- Operates up to 10 MHZ (90 ns RAM Chips)
- Assembled & Tested
- Meets or exceeds all IEEE 696/S-100 specifications (including timing).
- Fully static design eliminates the timing problems associated with dynamic memories.
- Switch selectable choice of 24 address lines conforming to the IEEE 696/S-100 extended addressing specifications, or 16 address lines as used in older S-100 systems.
- Ideal for multi-user installations.
- Board is addressable as one 16K x 8 block on any 4K boundary.
- Switch selectable PHANTOM disable and write protect.
- +5 Volt operation (requires no other supply voltages).
- Low power operation (900 mA typical, 1200 mA maximum).
- 1 year Factory Warranty.

- Don't settle for obsolete boards that use 2114's, draw twice the power, run at only ½ the speed . . . and cost more.
- Buy with confidence when you buy **Godbout** boards from P.I.E. **Godbout** is the world's largest manufacturer of S-100 products. When Priority 1 Electronics — the #1 distributor of S-100 products, teams up with **Godbout,** it makes an unbeatable combination.
- Don't settle for unknown, unproven products from unknown sources.

CompuPro™ division of GODBOUT ELECTRONICS

RDER TOLL FREE
1-800-423-5922
cept CA., AK., HI., CALL
(213) 709-5464

MEMBER MITA

PRIORITY ONE ELECTRONICS

9161-B DEERING AVE. • CHATSWORTH, CA 91311

NEDA

Terms: U.S.; VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA. residents add 6% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $2.50 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case...please include your phone no. Prices subject to change without notice. We will do our best to maintain prices thru AUG, 1981. SOCKET and CONNECTOR prices based on GOLD, not exceeding $700.00 per oz. Sales Prices are for prepaid orders only. Credit Card orders will be charged appropriate freight.

Circle 315 on inquiry card.

PRIORITY [ONE] ELECTRONICS

TOLL FREE 1-800-423-5922

S-100 CPU

CPU-Z - GODBOUT

2/4 MHZ Z80 CPU 24 Bit Addressing

GBT 160U	UnKit	$225.00
GBT 160A	A&T	$280.00
GBT 160C	CSC 3-6 MHZ	$375.00

DUAL PROCESSOR 8085-8088 - GODBOUT

5 MHZ Provides true 16 Bit Power with a standard 8 bit S-100 bus

GBT 1612U	UnKit	$295.00
GBT 1612A	A&T	$399.00
GBT 1612C	CSC	$498.00

BOARD WITH 8085 ONLY

GBT 161U	UnKit	$235.00
GBT 161A	A&T	$305.00
GBT 161C	CSC	$399.00

2810 Z80 CPU-CA. COMP. SYST.

2/4 MHZ Z80A CPU with RS-232C Serial I/O Port complete with Monitor PROM for 2422 Disk Controller

CCS 2810	A&T	$280.00

CB2 Z80 CPU - S.S.M.

2/4 MHZ will accept 2716, or 2732, or RAM RUN/STOP and single step switches

SSMCB2K	Kit	$260.00
SSMCB2A	A&T	$310.00
SSMZ80M	SSM Z80 Monitor	$89.00

CBIA 8080 CPU - S.S.M.

8080CPU, 1K RAM, Holds 1 2708, 1 8 Bit parallel input port.

SSMCB1A	Kit	$183.00
SSMCB1A	A&T	$225.00
SSM8080M	SM 8080 Monitor	$59.00

S-100 RAM

64K STATIC RAM - GODBOUT

RAM 17, 10 MHZ, 2 Watt, DMA Compatable

GBT-175A48	A&T 48K	$950.00
GBT-175C48	CSC 48K	$1050.00
GBT-175A64	A&T 64K	$995.00
GBT-175C64	CSC 64K	$1395.00

64K DYNAMIC RAM - CCS

4 MHZ. on board refresh, DMA compatable. 24 bit address.

CCS-2065A	A&T	$599.00

32K STATIC RAM - GODBOUT

RAM 20 10 MHZ, 4K byte block disable, available 16, 24, or 32K

GBT-164A16	A&T 16K	$319.00
GBT-164C16	CSC 16K	$418.00
GBT-164A24	A&T 24K	$449.00
GBT-164C24	CSC 24K	$539.00
GBT-164A32	A&T 32K	$499.00
GBT-164C32	CSC 32K	$720.00

32K STATIC RAM - CCS

4 MHZ, Bank select, 8/16 bit data

CCS-2032	A&T 32K	$599.00

16K STATIC RAM - GODBOUT

RAM 14, 10 MHZ, 24 bit addressing

GBT-143A	A&T 16K	$199.00
GBT-143C	CSC 16K	$399.00

16K STATIC RAM - CCS

4 MHZ, 8/16 bit data, bank select

CCS-2116A	A&T 16K	$299.00

8K STATIC RAM - GODBOUT

Econoram II 2MHZ. 8K. No doubt, the most popular S-100 RAM ever built.

GBT-114U	UnKit 8K	$99.95

S-100 ROM

PB1 PROM PROGRAMMER - SSM

programs 2708 or 2716's, operates as a 4K/8K EPROM board as well.

SSM-PB1K	Kit	$179.00
SSM-PB1A	A&T	$239.00

ECONOROM 2708 - GODBOUT

16K x 8 EPROM Board using 2708, Power on jump to any 256 byte

GBT 125U	UnKit	$85.00
GBT 125A	A&T	$120.00
GBT 125C	CSC	$175.00

S-100 DISK CONTROLLERS

DISK 1 - GODBOUT

DMA, Soft Sector, Controls 8" or 5¼", single or double density

GBT 171A	A&T	$450.00
GBT 171C	CSC	$555.00
GBT CPM80	CP/M 2.2 for Z80/8085 with Manuals & BIOS 8" S.D. disk	$175.00
GBT CPM86	CP/M for 8086 with manuals & BIOS 8" S/D disk	$300.00

2422A - CA. COMP. SYST.

I/O Mapped, controls 8" or 5¼", single or double density

CCS-2422	A&T with CPM 2.2 8" S.D.	$375.00

DISK JOCKEY 1 - MORROW

Single density disk controller with serial I/O, controls 8"

MDSDJ1108	A&T	$219.00

DISK JOCKEY 2D - MORROW

I/O Mapped, controls 8", single or double density. serial I/O

MDSDJ2208	A&T	$375.00

DISK DRIVES

801R - SHUGART

Single sided double density most popular 8" drive

SHU801R	$425.00 ea. or 2 or more	$410.00
SHUSA801RM	Manual for 801R drives	$10.00

DT-8 - QUME

Data track 8 double sided, double density

QME-DT8	$625.00 ea. or 2 or more	$600.00 ea.

DISK CABINETS

V-100 - VISTA

Dual 8" drive cabinet with power supply. Rack or Desk Mount

VIS-V100	$395.00

SINGLE 8" - Q.T.

Single 8" cabinet with power supply

QTC-DDC8	$195.00

5" CABINETS - VISTA

VIS-9801	Single 5" with P.S.	$75.00
VIS-9802	Dual 5" with P.S.	$95.00

S-100 DISK SUBSYSTEMS

DISCUS SINGLE SIDES MORROW

8" DBL Density drives with cabinet, power supply controller, with CP/M 2.2 and Microsoft Basic

MDSF1218	Single Drive System	$950.00
MDSF1228	Dual Drive System	$1598.00

DISCUS DOUBLE SIDED - MORROW

8" DBL Density/sided drives with cabinet Power supply controller, with CP/M 2.2 and Microsoft Basic

MDSF2218	Single Drive System	$1198.00
MDSF2228	Dual Drive System	$2190.00

26MB HARD DISK - MORROW

Special purchase, limited stock - 26MB formatted hard disk complete with cabinet, P.S., Controller, CPM 2.2 and Microsoft Basic

MDS-M26S	26 MB Subsystem List	$4995.00

SALE

★ $3950.00 ★

SAVE $1,045.00!

MICROPOLIS

Priority 1 Electronics is the worlds largest distributors of MICROPOLIS disk sub Systems

CALL FOR PRICES

NEED MORE INFORMATION? SEE OUR 60 PAGE CATALOG IN MAY BYTE

S-100 I/O BOARDS

SYSTEM SUPPORT 1 - GODBOUT

Serial port (software prog baud), 4K EPROM or RAM provision, 15 levels of interrupt, real time clock, optional math processor

GBT-162U	UnKit	$295.00
GBT-162A	A&T	$360.00
GBT-162C	CSC	$460.00
GBT-9512	Math Chip	$195.00

MPX CHANNEL BOARD - GODBOUT

I/O Multiplexer, using 8085A-2 cpu on board

GBT-166A	A&T	$450.00
GBT-166C	CSC	$550.00

INTERFACER I - GODBOUT

Two Serial I/O

GBT-133A	A&T	$219.00
GBT-133C	CSC	$298.00

INTERFACER II - GODBOUT

Three parallel, one serial I/O board

GBT-150A	A&T	$219.00
GBT-150C	CSC	$298.00

MULTI I/O - MORROW DESIGNS

Three Serial, Two parallel

MDSMB3200	A&T	$309.00

SWITCHBOARD-MORROW DESIGNS

Two serial I/O, four parallel I/O, one status port, one strobe port

MDSSB2411	A&T	$239.00

I/O2 - SSM

One parallel input, one parallel output, proto work area

SSMI02K	Kit	$69.00
SSMI02A	A&T	$89.00

I/O4 - SSM

Two serial I/O, two parallel I/O

SSMI04K	Kit	$210.00
SSMI04A	A&T	$260.00

SBI-SSM

Music synthesizer board

SSMSBIK	Kit	$249.00
SSMSBIA	A&T	$310.00
SSMSBIS	Software	$ 25.00

S-100 VIDEO BOARDS

SPECTRUM - GODBOUT

Color Graphics board with Parallel I/O.

GBT-1440	UnKit	$299.00
GBT-144A	A&T	$349.00
GBT-2D	Sublogic Software	$ 35.00

VB - 3 S.S.M.

80 x 24 or 48 character video display Memory Mapped, Parallel Keyboard port

SSM-VB3K24	Kit 80x24	$359.00
SSM-VB3A24	A&T 80x24	$450.00
SSM-VB3K48	Kit 80x48	$425.00
SSM-VB3K48	A&T 80x48	$495.00
SSM-VB3UP	Upgrade Kit	$ 50.00

VB2 - SSM

I/O Mapped Video Board, with Parallel Keyboard port. 64x16

SSM-VB2K	Kit	$169.00
SSM-VB2A	A&T	$229.00

VBIC - SSM

Memory Mapped Video Board 64x16 character display or 64x16 graphics dislplay

SSM-VBICK	Kit	$169.00
SSM-VBICA	A&T	$229.00

S-100 MOTHERBOARDS

MOTHERBOARD - GODBOUT

Active termination, 6-12-20 slot

GBT-153U	Unkit 6 slot	$ 89.00
GBT-153A	A&T 6 slot	$119.00
GBT-154U	Unkit 12 slot	$129.00
GBT-154A	A&T 12 slot	$149.00
GBT-155U	Unkit 20 slot	$174.00
GBT-155A	A&T 20 slot	$189.00

WUNDERBUSS - MORROW DESIGNS

Active termination, 8-12-20 slot, peripheral power outputs (5V@1A, 12V @ 500ma, − 12V @ 500ma)

MDS0800K	Kit 8 slot no connectors	$ 54.00
MDS1200K	Kit 12 slot no connectors	$ 65.00
MDS2000K	Kit 20 slot no connectors	$ 76.00
MDS0800A	A&T 8 slot	$129.00
MDS1200A	A&T 12 slot	$149.00
MDS2000A	A&T 20 slot	$199.00

S-100 MISC.

CKO17 ACTIVE TERMINATOR-GODBOUT

GBT-106U	Kit	$ 34.95

2520 - CCS

Extender/terminator, Active and/or passive

CCS2520AK	Kit	$ 59.00

EXTENDER/LOGIC PROBE-MULLEN

MUL-CK004	Kit	$ 59.00

OB1 VECTOR JUMP - SSM

with prototyping area

SSM-OB1K	Kit	$ 65.00
SSM-OB1A	A&T	$ 90.00

PRIORITY [ONE] ELECTRONICS

9161-B DEERING AVE. • CHATSWORTH, CA 91311

ORDER TOLL FREE (800) 423-5922 CA, AK, HI CALL (213) 709-5464

Terms: U.S.; VISA, MC, BAC, Check, Money Order,, U.S. Funds Only. CA residents add 6% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $2.50 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case . . . please include your phone no. Prices subject to change without notice. We will do our best to maintain prices thru August, 1981. SOCKET and CONNECTOR prices based on GOLD, not exceeding $700.00 per oz. Sales Prices are for prepaid orders only. Credit Card orders will be charged appropriate freight.

Circle 316 on inquiry card.

CompuPro™ division of **GODBOUT ELECTRONICS**

TEAMS UP WITH PRIORITY ONE ELECTRONICS TO INTRODUCE THE NEXT GENERATION OF IEEE/696 S-100 COMPUTERS

8 BIT

There are still a lot of 8 bit machines out in the world, matched with plenty of 8 bit software — but very few of these machines are working up to their peak capacity. We want the "Big 8" system to change all that, and bring professional level computing power to all the owners of older S-100 machines. And if you're assembling an 8 bit system from the ground up, "Big 8" gets you off to the best possible start . . . regardless of price.

Here's what you get

1. CPU Z, our high speed, high performance Z80* based CPU board. Includes a 6 MHz CPU for maximum throughput and highest operating speed.
2. Disk 1 DMA floppy disk controller.
3. 64K of *fast* static RAM with 24 bit extended addressing.
4. Interfacer 1 — Dual Serial I/O card *or* Interfacer II 3 Parallel 1 Serial I/O Card.
5. CP/M*-80 2.2.
6. All documentation and manuals.

It all adds up to $2712.00

TOTAL PACKAGE PRICE

$1950.00

YOU SAVE $762.00!

ORDER PART NO. GBT-SPEC-C
Big 8 System with Interfacer I
ORDER PART NO. GBT SPEC-D
Big 8 System with Interfacer II

SAVE EVEN MORE, when you add 2 Shugart 801R disk drives, and a dual Vista Cabinet with Power Supply.

This package adds up to $4062

TOTAL PACKAGE PRICE

$3095.00

YOU SAVE $967.00

GBT-SPEC-EV with Interfacer I
GBT-SPEC-FV with Interfacer II

16 BIT

A second chance, we offered a limited number of these "BIG 16" packages 2 months ago and quickly sold out, leaving many customers disappointed. We had so many customers who wanted to get a second system, and many more who just wanted a chance to get one system, that we went back to GODBOUT, and convinced them to make another production run just for us. (They can't ignore our requests when we purchase boards by the 1,000's.) Here is your second chance to step up to the World of 16 Bit Computers and save hundreds, even thousands, of dollars if you act right now.

Here's what you get

1. 16 bit/8 bit Dual Processor (w/6 MHz 8088)
2. System Support 1 with Serial I/O. Real time clock, Interval Timers & More!
3. Disk 1 DMA Floppy Disk Controller (w/BIOS for CP/M *2.2)
4. 64K of fast static RAM (w/IEEE 24 bit extended addressing)
5. Sorcim's powerful PASCAL/M*-8086 software on disk
7. I/O and Disk Controller cables, plus full documentation on all hardware and software

*PASCAL M is a trademark of Sorcim: CP/M is a registered trademark of Digital Research

It all adds up to $3430.00

A) TOTAL PACKAGE PRICE

$2495.00

YOU SAVE $935.00

ORDER PART NO. GBT SPEC-A

SAVE EVEN MORE, when you add 2 Shugart 801R disk drives, and a dual Vista Cabinet with Power Supply.

This package adds up to $4780.

B) TOTAL PACKAGE PRICE

$3650.00

YOU SAVE $1130.00

ORDER PART NO. GBT-SPEC-BV

Ciarcia's Circuit Cellar

Micromouth for use on Apple II or other parallel ports A&T Featured in June BYTE

MMMI-94VOAPL $149.00

Micromouth for use of TRS-80 Model I complete with cable, AC Adapter, less enclosure A&T.

MMI 94VOTRSI $169.00

Expansion Interface for TRS-80 Model 1 with DATA SEPARATOR. 32K of RAM, and Centronics Printer port. A&T. Featured in MARCH BYTE.

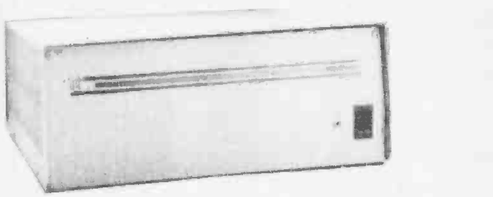
MMI-DISK80 $429.00

Ciarcia's Circuit Cellar

I/O Interface for TRS-80. Features 50-19200 baud RS-232C Serial port and Centronics printer port. Connect up to 16 COMM-80's to either Keyboard or Expansion Interface. Featured in June 80 BYTE.

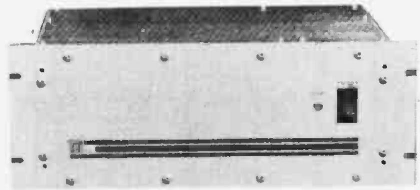
MMI-COMM-80 $179.95

TEI MicroFrame®



From the power supply through the sturdy chassis, TEI constructs and assembles each mainframe with great care. Every TEI mainframe utilizes a constant voltage transformer (CVT) which delivers clean, regulated power at the proper level, reducing the heat in the computer cards. The output voltage on the transformer remains nearly even with the input voltage varyng from approximately 85V to 140V. This means the mainframe will never notice voltage variations or even a brownout. It lso provides 100 dB noise rejection to protect the computer from voltage spikes and line noise.

No need for a dedicated line or expensive noise filters. TEI was the first manufacturer to offer the CVT in its complete computer product line and is still one of few manufacturers to offer the CVT as standard equipment.



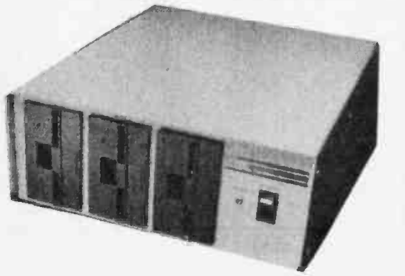
TEI 22 slot and 12 slot mainframes offer a S-100 motherboard which is grounded, shielded and actively terminated for high speed operation now or for later upgrading. Each mainframe is shipped completely assembled, tested and burned in, with fan, washable filter, all connectors and card guides. Rackmount models are available in both 22 and 12 slot mainframes. The combination of the lowest noise bus, a regulated CVT power system and a rugged chassis produces a mainframe without equal.

S-100 MAINFRAMES		LIST PRICE	OUR PRICE
TEI-MCS 112	12 Slot Desk	$685.00	$615.00
TEI-MCS 122	22 Slot Desk	$845.00	$760.00
TEI-RM 12	12 Slot Rackmount	$800.00	$720.00
TEI-RM 22	22 Slot Rackmount	$945.00	$850.00

Shipping Weight: On 12 Slot Mainframes 35 lbs.
On 22 Slot Mainframes 50 lbs.

12 slot: +8V @ 17A, ±16V @ 2A; 35 lbs.
22 slot: +8V @ 30A, ±16V @ 4A; 50 lbs.

Shipping Weight: On 12 Slot Mainframes 40 lbs.
On 22 Slot Mainframes 55 lbs.



S-100 MAINFRAME WITH 12 SLOT MOTHERBOARD AND CUTOUTS FOR 3 5¼" FLOPPY DISK DRIVES
WITH INTERNAL POWER CABLES

		LIST PRICE	OUR PRICE
TEI-TF12	12 slot desk	695.00	625.00
TEI-RF12	12 slot rackmount	795.00	715.00

DUAL 8" DISK DRIVE CHASSIS

For Shugart 800/801R with internal power cables provided		LIST PRICE	OUR PRICE
TEI-DFDO	Desk Top	669.00	599.00
TEI-RFDO	Rack Mount	819.00	749.00

*Priority 1 Electronics is a master distributor for T.E.I. Dealers & O.E.M.'s. Call for quantity pricing.

PRIORITY ONE ELECTRONICS
9161-B DEERING AVE. CHATSWORTH, CA 91311
ORDER TOLL FREE (800) 423-5922 CA, AK, HI CALL (213) 709-5464

Terms: U.S.; VISA, MC, BAC, Check, Money Order., U.S. Funds Only. CA residents add 6% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $2.50 for the first 3 lbs., plus 25¢ for each additional pound. Orders over 50 lbs. sent freight collect. Just in case . . . please include your phone no. Prices subject to change without notice. We will do our best to maintain prices thru August, 1981. SOCKET and CONNECTOR prices based on GOLD, not exceeding $700.00 per oz. Sales Prices are for prepaid orders only. Credit Card orders will be charged appropriate freight.

Circle 316 on inquiry card.

7400

SN7400N	.25	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104	.89	SN74184N	2.49
SN7426N	.29	SN74105	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.29	74LS112	.45	74LS240	1.95
74LS09	.35	74LS113	.45	74LS241	1.95
74LS10	.29	74LS114	.49	74LS242	1.95
74LS11	.35	74LS122	.49	74LS243	1.95
74LS12	.35	74LS123	1.25	74LS244	1.95
74LS13	.59	74LS125	.89	74LS245	2.95
74LS14	.99	74LS126	.55	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.29	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	1.49
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.99
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.29	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	1.19	74LS273	1.95
74LS33	.59	74LS156	1.19	74LS279	.75
74LS37	.45	74LS157	.89	74LS283	1.09
74LS38	.49	74LS158	.99	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.25	74LS365	.75
74LS51	.29	74LS165	1.25	74LS366	.75
74LS54	.29	74LS168	1.19	74LS367	.75
74LS55	.29	74LS169	1.19	74LS368	.75
74LS73	.45	74LS170	2.49	74LS373	1.95
74LS74	.45	74LS173	1.19	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.45			81LS95	1.95
74LS90	.59			81LS97	1.95

74S

74S00	.50	74S124	2.49	74S243	3.25
74S02	.50	74S133	.55	74S244	3.25
74S03	.50	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.50	74S140	1.15	74S280	2.95
74S11	.50	74S151	1.35	74S287	4.95
74S15	.50	74S153	1.35	74S288	4.95
74S20	.50	74S157	1.35	74S373	3.49
74S22	.50	74S158	1.35	74S374	3.49
74S30	.50	74S160	1.95	74S387	5.95
74S32	.55	74S174	1.59	74S471	19.95
74S38	.69	74S175	1.59	74S472	19.95
74S40	.55	74S188	4.95	74S473	19.95
74S51	.50	74S194	1.95	74S474	21.95
74S64	.50	74S195	1.95	74S475	21.95
74S65	.50	74S196	3.95	74S570	7.95
74S74	.79	74S240	2.95	74S571	7.95
74S86	.79	74S241	2.95	74S572	19.95
74S112	.79	74S242	3.25	74S573	19.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

CA–LINEAR

CA3010H	1.07	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.48	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD–CMOS

CD4000	.39	CD4041	1.49	CD 4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	14.95
CD4028	.89	CD4078	.55	MC14410	14.95
CD4029	1.49	CD4081	.39	MC14411	14.95
CD4030	.49	CD4082	.39	MC14412	11.95
CD4034	3.49	CD4093	.99	MC14419	4.95
CD4035	.99			MC14433	13.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

OIP/IC INSERTION TOOL WITH PIN STRAIGHTENER

Inserts both 14 and 18 pin packages. Narrow profile permits work on closely spaced items. Pin straightener built into handle.

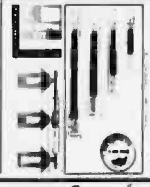
Part No.	Function	Price
INS-1416	14-16 pin	$3.49
MOS-1416	14-16 pin CMOS safe	7.95
MOS-2428	24-28 pin CMOS safe	7.95
MOS-40	36-40 pin CMOS safe	7.95

Vacuum Vise

Vacuum-based light-duty vise for small components and assemblies. ABS construction. 1½" jaws. 1¼" travel. Can be permanently installed.

VV-1 ..... $3.49

Wire Wrapping Kit WK-2



Contains WSU-30 wrap tool, 50 feet of Kynar 30 AWG white wire, 50 pieces each pre-stripped wire in 1", 2" 3" and 4" lengths, stripped 1" both ends.

WK-2 ...... $12.95

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1

6 VOLT MINI LAMP

— INCANDESCENT —

800-147 Clear w/5" leads 8/$1
80620 Red w/10" leads 9/$1

RCS14 RED LED, METAL MTG. HDW. 1-4" LEADS.
RL-2 ... $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode C.C. — Common Cathode

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	1.25	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	1.25	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL746	C.A.—red ± 1	.630	1.49
MAN 72	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DL750	C.C.—red	.600	1.49
MAN 82	C.A.—yellow	.300	.49	DLO847	C.A.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DLO850	C.C.—orange	.800	1.49
MAN 3620	C.A.—orange	.300	.49	DL338	C.C.—red	.110	.35
MAN 3630	C.A.—orange ± 1	.300	.99	FND358	C.C. ± 1	.357	.99
MAN 3640	C.C.—orange	.300	.99	FND359	C.C.	.357	.75
MAN 4610	C.A.—orange	.400	.99	FND503	C.C. (FND500)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	FND507	C.A. (FND510)	.500	.99
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.75
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 sgl. dig. RHD	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7302	4x7 sgl. dig. LHD	.600	22.00
MAN 6780	C.C.—red	.560	.99	5082-7304	Overnge. char. (±1)	.600	19.95
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol.Triac Driver		1.25

SOCKETS — Test Sockets — RECEPTACLES

ZERO INSERTION FORCE

SOCKETS:
- Nickel Boron Plating
- G.F. PSF Plastic Body
- For testing IC's

RECEPTACLES:
- Nickel Boron Plating
- G.F. PSF Plastic Body
- Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75
218-3341	18 pin	7.95	228-3345	28 pin	11.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95

Part No.	Pins	Price	Part No.	Pins	Price
214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3593	16 pin	9.95	224-3597	24 pin	12.75
218-3594	18 pin	10.95	228-3598	28 pin	13.95
220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm 27 Ohm	12 Ohm 33 Ohm	15 Ohm 39 Ohm	18 Ohm 47 Ohm	22 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 180 Ohm	82 Ohm 220 Ohm	100 Ohm 270 Ohm	120 Ohm 330 Ohm	150 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 1.2K	560 Ohm 1.5K	680 Ohm 1.8K	820 Ohm 2.2K	1K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 8.2K	3.9K 10K	4.7K 12K	5.6K 15K	6.8K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 56K	27K 68K	33K 82K	39K 100K	47K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 390K	180K 470K	220K 560K	270K 680K	330K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 2.7M	1.2M 3.3M	1.5M 3.9M	1.8M 4.7M	2.2M 5.6M	50 pcs.	$1.95

ASST. 8R Includes Resistor Assts. 1-7 (350 pcs.) $10.95 ea.

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage – Add 5% plus $1 Insurance

Spec Sheets – 25¢
Send 52¢ Postage for your FREE 1981 JAMECO CATALOG

NEW 1981 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE

1355 SHOREWAY ROAD, BELMONT, CA 94002

PRICES SUBJECT TO CHANGE

8/81

INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	22.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	9.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	11.10
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.50
8212CPA	Volt Ref/Indicator	2.50

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.89
74C20	.39	74C161	1.60	74C903	1.15
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.49
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.39	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.49
LH0070-OH	6.05	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N/H	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N/H	.79
LM300H	.99	LF351N	.60	LM748N/H	.59
LM301CN/H	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN/H	.45	LM359N	1.79	LM1489N	1.25
LM308CN/H	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1877N-9	3.25
LM311H/CN	.90	LM381N	1.95	LM1889N	3.20
LM312H	2.49	LM382N	1.79	LM1896N	1.75
LM317MP	1.15	LM384N	1.95	LM2002T	1.49
LM317T	1.75	LM386N-3	1.29	LM2877P	2.05
LM317K	3.95	LM387N	1.45	LM2878P	2.25
LM318CN/H	1.95	LM389N	1.35	LM2896P-1	2.25
LM319N	1.95	LM392N	.69	LM3189N	2.95
LM320K-5	1.35	LF398N	4.00	LM3900N	.69
LM320K-12	1.35	LM399H	5.00	LM3905CN	1.25
LM320K-15	1.35	TL494CN	4.49	LM3909N	1.15
LM320T-5	1.25	TL496CP	1.75	LM3914N	3.95
LM320T-12	1.25	NE510A	6.00	LM3915N	3.95
LM320T-15	1.25	NE529A	4.95	LM3916N	3.95
LM323K-5	5.95	NE531H	3.95	RC4136N	1.25
LM324N	.99	NE536H	6.00	RC4151NB	3.95
LM329DZ	.65	NE540H	6.00	RC4194TK	5.95
LM331N	3.95	NE544N	4.95	RC4195TK	5.49
LM334Z	1.30	NE550A	1.30	KB4428	4.25
LM335Z	1.40	NE555V	.39	KB4429	5.95
LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

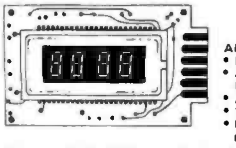
+20% DIPPED TANTALUMS (Solid) CAPACITORS

.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. instru.
- Portable/battery powered instrumnts.

Features: Bright 0.3" green display. Internal crystal time-base. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module $16.95

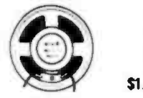
CLOCK MODULES

MA1023	.7" Low Cost Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Low Cost Digital LED Clock/Timer	6.95
MA1002	.5" LED Display Dig. Clock & Xformer	9.95

TRANSFORMERS

102-P20	Xformer for MA1023 Clock Modules	3.49
102-P22	Xformer for MA1026 Clock Modules	3.49
102-P20	Xformer for MA5036 Clock Modules	3.49

8 OHM SPEAKER

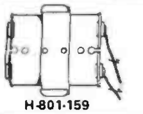


A0201

2¼" – 8 Ohm – .25 watt

$1.25 ea. 2/$1.95 ea. 10/$7.95 ea.

BATTERY HOLDER

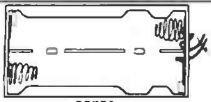


H-801-159

- Holds 2 ea. C cells
- Aluminum Case
- 5" leads

$ .45 each 10/$3.95

BATTERY HOLDER



82721

- Holds 4 ea. C cells
- Plastic case
- 9" leads

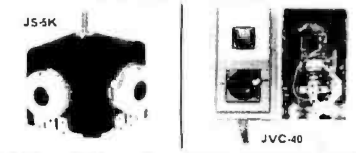
$ .49 ea. 10/$4.25

EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch.
- Special conductive foam liner eliminates static build-up.
- Built-in safety lock to prevent UV exposure.
- Compact — only 7-5/8" x 2-7/8" x 2"
- Complete with holding tray for 4 chips.

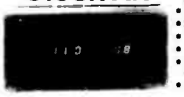
UVS-11E $79.95

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$5.95

6-Digit Clock Kit



- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 .... $19.95

NEW! JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200	Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205	Adapter Brd. (to JE200) ±5, ±9 & ±12V.	$12.95
JE210	Var. Pwr. Sply. Kit. 5-15VDC. to 1.5amp.	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	6.50
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	7.95
DP8253	Prog. Interval Timer	14.95
DP8256	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog. DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	49.95
DP8279	Prog. Keyboard/Display Interface	19.95
DP8300	Octal Bus Receiver	6.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	13.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	15.95
CDP1802	CPU	19.95
2650	MPU	16.95
IOM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC56507	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	16.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128bytes RAM)	19.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402	256-Bit Dynamic	1.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.89
MM5034N	Octal 80-Bit	0.95
MM5035N	Octal 80-Bit	0.95
2504V (1404A)	1024-Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Pass Filter	19.95
AF122-1CJ	Touch Tone Low Pass Filter	19.95
LM308AH	Super Gain Op Amp	1.00
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	4.95
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	5.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	5.95
2114L	1024x4 Static 450ns Low Power	6.95
2114-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16,384x1 Dynamic 560ns (house marked)	4.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	3.95
4164	64K Dynamic 250ns	49.95
MM2147J	4096x1 Fast 70ns	19.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	5.25
MM5298J-1A	8K Dyn. 200ns (lower ½ of MM5290J)	4.95
MM5799NAA/N	Controller Oriented Processor	9.95
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	14.95
TMS4045	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	5.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716Intel(2516)TI	16K EPROM (Single +5V)	10.95
2732Intel(2532)TI	32K EPROM	19.95
2758	8K EPROM (450ns) (Single +5V)	7.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	4.95
82S115	4096 Bipolar PROM	19.95
82S123(74S288)	32x8 Tri-State Bipolar PROM	4.95
82S185	8K PROM	29.95

ROM'S

2513(2140)	Character Generator (Upper Case)	9.95
2513(3021)	Character Generator (Lower Case)	9.95
2516N	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	1.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	1.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53130N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

ELECTRONIC TOY MOTORS

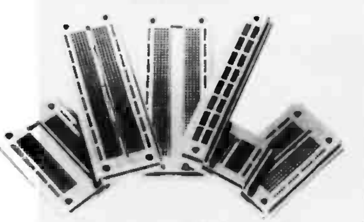
Typical Power Source	Operating Voltage Range	Voltage	No Load Speed RPM	No Load Current AMP	At Maximum Efficiency Speed RPM	At Maximum Efficiency Current AMP	At Maximum Efficiency Torque OZ IN	At Maximum Efficiency Output W	At Maximum Efficiency Eff. %	Small Torque OZ IN
DRY CELL	1.5-6.0	3.0	9,200	0.20	6,750	0.90	0.260	1.30	57.0	0.97

.937 O.D. X 1.201 Length

MABUCHI RE280 $ .99 each . . .10/$7.50 . . .100/$50.00

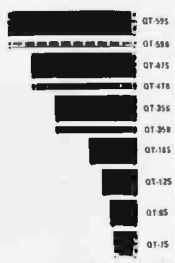
GLOBAL SPECIALTIES

EXPERIMENTOR SOCKETS



Model	Length	Width	Center Channel	5 Tie Point Terminals	Bus Strips	Price
EXP4B	6.0"	1.0"	n/a	n/a	4(160)	$ 4.75
EXP300	6.0"	2.1"	.3"	94(470)	2(80)	$12.00
EXP325	1.8"	2.1"	.3"	22(110)	2(20)	$ 3.50
EXP350	3.6"	2.1"	.3"	46(230)	2(40)	$ 6.75
EXP600	6.0"	2.4"	.6"	94(470)	2(80)	$14.75
EXP650	3.6"	2.4"	.6"	46(230)	2(40)	$ 8.75

Quick Test Sockets & Bus Strips



	Length	Hole to hole	Term. Pts.	Unit Price $
QT-59S	6.5"	6.2"	118	$12.25
QT-59B	6.5"	6.2"	20	$ 2.75
QT-47S	5.3"	5.0"	94	$ 9.75
QT-47B	5.3"	5.0"	16	$ 2.50
QT-35S	4.1"	3.8"	70	$ 7.25
QT-35B	4.1"	3.8"	12	$ 2.25
QT-18S	2.4"	2.1"	36	$ 4.50
QT-12S	1.8"	1.5"	24	$ 3.75
QT-8S	1.4"	1.1"	16	$ 3.00
QT-7S	1.3"	1.0"	14	$ 2.75

$10.00 Min. Order – U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage—Add 5% plus $1 Insurance

Spec Sheets — 25¢
Send 52¢ Postage for your
FREE 1981 JAMECO CATALOG

NEW 1981 CATALOG

Jameco ELECTRONICS

PHONE ORDERS WELCOME (415) 592-8097

MAIL ORDER ELECTRONICS – WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

8/81

POWER CORD SALE

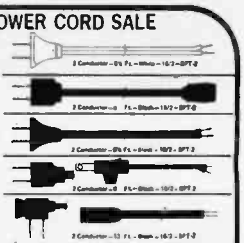
842-812 1-9	10-99	100
.35	.30	.25

362-812 1-9	10-99	100
.39	.35	.30

473-862 1-9	10-99	100
.45	.39	.35

468-828 1-9	10-99	100
.49	.45	.39

435-802 1-9	10-99	100
.59	.55	.49



AC and DC Wall Transformers

Ideal for use with clocks, games, power supplies or any other type of AC or DC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	$3.95
AC 500	117V/60Hz	12 VAC 500mA	$4.95
AC1000	117V/60Hz	12 VAC 1 amp	$5.95
AC1700	117V/60Hz	9 VAC 1.7 amp	$6.95
DV 9200	117V/60Hz	9 VDC 200mA	$3.25
DC 900	120V/60Hz	9 VDC 500mA	$3.95

CONNECTORS

DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
★ Documentation for Conversion

TRS-16K2 *150NS $39.95
TRS-16K4 *250NS $29.95

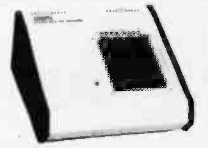
JE610 ASCII Encoded Keyboard Kit

The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V @ 10 mA for operation. Features: 60 keys generate the 128 characters, upper and lower case ASCII set. Fully buffered. Two user-define keys provided for custom applications. Caps lock for upper-case-only alpha characters. Utilizes a 2376 (40-pin) encoder read-only memory chip. Outputs directly compatible with TTL/DTL or MOS logic arrays. Easy interfacing with a 16-pin dip or 18-pin edge connector. Size: 3½"H x 14½"W x 8½"D

JE610/DTE-AK (After assembled as pictured above) ... **$124.95**
JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) ..... **$ 79.95**
K62 62-Key Keyboard (Keyboard only) ..... **$ 34.95**
DTE-AK (case only – 3¼"Hx11"Wx8¾"D) **$ 49.95**

NEW! JE212 – Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT Kit/ Provides -12VDC from incoming 5VDC . . $9.95

JE600 Hexadecimal Encoder Kit



FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¾"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**
JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) .. **$59.95**
K19 19-Key Keyboard (Keyboard only) **$14.95**
DTE-HK (case only – 3½"Hx8¾"Wx8¾"D) **$44.95**

WHAT'S NEW FROM CONSUMER COMPUTERS

Consumer Computers announces it's lowest prices ever.

Apple Cards and Hardware

Language System w/Pascal	379
Silentype Printer w/Interface	349
Hayes Micromodem II	299
Novation Apple-Cat II	339
Videx videoterm 80 w/graphics	269
Z-80 Microsoft Card	269
16K Ram Card Microsoft	159
ABT Numberic Keypad (old or new kybrd)	110
ALF 3 Voice Music Card	239
ALF 9 Voice Music Card	169
Heuristics Speechlink 2000	249
Alpha Syntauri Keyboard System	1399
Corvus 10MB Hard Disk	CALL
Lazer Lower Case Plus	50
Micro-Sci Disk Drives (A-40 & A-70)	CALL
SSM A10 Serial/Parallel Card A&T	189
Sup-R-Terminal 80 Col. Card	329
SVA 8 inch Floppy Disk Controller	345
Versawriter Digitizer Pad	229
Digisector Camera I/F	299
ThunderClock Plus	CALL
Symtec Hi-Res Light Pen	210
Integer or Applesoft II Firmware Card	145
Graphics Tablet	619
Parallel Printer Interface Card	135
Hi-Speed Serial Interface Card	135
Smarterm 80 Column Video Card	299

We have many more accessories in stock for the Apple II Please call toll free 800-854-6654 for a price list.

Mountain Computer, Inc.

Music System (16 voices)	479
A/D + D/A Interface	289
Expansion Chassis	599
Introl/x-10 Cont. Card	169
Clock/Calendar Card	225
Supertalker SD-200	239
Romplus+ Card	135
Romwriter Card	149

CCS California Computer Systems

Clock/Calendar Module	99
GPIB IEEE-488 Card	249
Asynchronous Serial Interface Card	129
Centronics Parallel Interface Card	99
Arithmetic Processor Card	299
We carry all CCS hardware	CALL

Apple II Entertainment Software

Raster Blaster	29
Alien Rain	23
Adventrue by Microsoft	27
Sargon II Chess	32
Reversal	34
Pool 1.5	34
Creature Venture	23
Hi-Res Adventure #0	19
Hi-Res Adventure #1	24
Hi-Res Adventure #2	32
ABM By MUSE	32
Zork	35
Pulsar II	29
Phantom Five	29
Space Eggs	29
Snoggle	24
Flight Simulator	34
Warpfactor	39
Olympic Decathalon	24
Prisoner	29
Alien Typhoon	24
Missle Defense	29
Autobahn	29
Operation Apocalypse	55
Interlude (X-rated)	19
Odyssey	30
Space Raiders	29
Cosmos Mission (Space Invaders)	24

TELEX 695-000
ANS: BETA
REF: CCMO

OPEN 7 DAYS

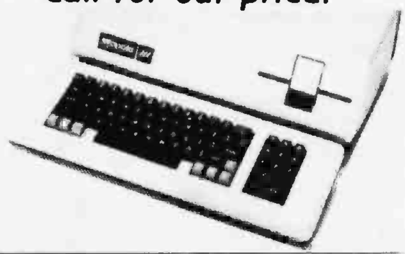
Apple II Plus Computer

The versatile Apple Computer for home or business. Unmatched in flexibility.

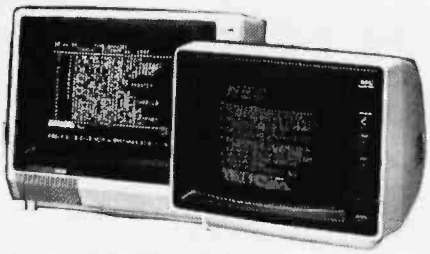
16K **$1025**

48K **$1129**

We carry the Apple III Call for our price.



Save on Video displays.



Highlights of our fine line of video monitors.

Amdek/Leedex Video 100 12" B&W	139
Amdek (Hatachi) 13" Color	359
NEC 12" P31 Green Phospher	CALL
NEC 12" RGB Hi-Res Color	CALL
Panasonic 13" Color	449
Sanyo 9" B&W	159
Sanyo 12" B&W	239
Sanyo 12" P31 Green Phospher	279
Sanyo 13" Color	419

Happy Birthday Leslie!

Solution Software for the Apple II.

Visicalc 3.3	169
CCA Data Management	85
DB Master	169
Word Star (Apple 80 col. ver.)	299
Super Text II	139
Desktop Plan II	169
Applewriter	65
Infotory	225
Landlord Apt. Mngmnt	649
Stock Tracker H&H	175
Easywriter	225
ASCII Express	59
Appleplot	60
BPI General Ledger	CALL
PFS	85
Apple Pie (specify version)	119
Super-Scribe	79
Data Factory	139
Peachtree Business	1200
Applesoft Compiler	185
Visiterm	129
Visitrend/Visiplot	219
Real Estate Analyzer	89
Tax Preparer	89
Request	199
DOS Toolkit	65
Tax Planner	99
Dow Jones Portfolio Evaluator	45
Dow Jones News & Quotes Reporter	85
Apple Fortran	165
Apple Pilot	129
Controller gen. Bus. Package	519
The Analyzer Dakin 5	519
Music Theory	45

CALL TOLL FREE
800-854-6654

Apple Disk Drives

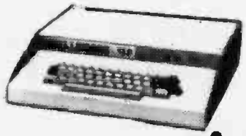
With Controller **$519**

Without Controller **$439**

16K Ram Cards by ConComp Industries

Atari 800 Card	89
Apple II Card	130

Ohio Scientific Challenger computer.



4P **$549**

1P MODII **$399**

Circle 90 on inquiry card.

WHAT'S NEW FROM CONSUMER COMPUTERS

Buying Mail Order saves time, money and energy!

Atari Personal Computer

Now the personal computer offering from the acknowledged leader in video arcade technology . . . ATARI.

ATARI 800 16K

$749

Atari Accessories

410 Program Recorder	59
810 Disk Drive	449
815 Dual Disk Drive (Dbl. Den.)	1295
820 40 col. Impact Printer	349
822 Thermal Printer	349
825 80 col. Impact Printer (Cent. 737)	699
830 Acoustin Modem	159
850 Interface Module	159
Atari Light Pen	65
16K Ram Memory Module	149

Atari Software

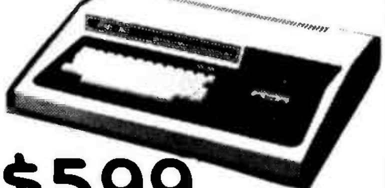
Missile Command	35
Asteroids	35
Space Invaders	19
Star Raiders	35
Sunday Golf	9
Star Trek 3.5	14
Sands of Mars	39
Microchess	19
Checker King	19
FastGammon	19
Fantasyand 2041	55
Family Expenses	24
Imperial Walker	29
Galactic Empire	19
Lunar Lander	14
Cypher Bowl	29
Star Warrior	39
Wizard and the Princess	32

Exidy Sorcerer II

Please Call for our price.

S-100 Unit	449
Word Processing Pac	179
Development Pac	89

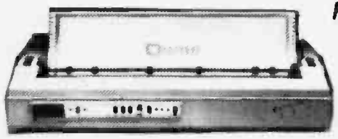
PMC-80 Micro Computer



$599

See Pages 164-165 for more discounts

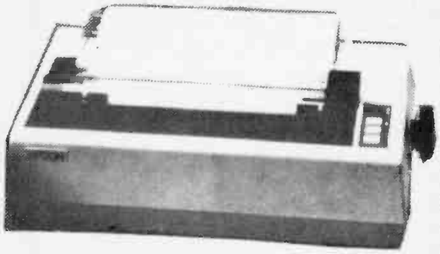
Printers, Etc.



Qume
Sprint 5145

$2495

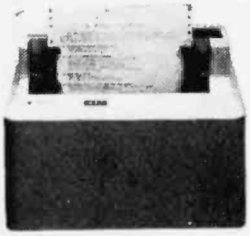
Anadex DP-9500/1 w/2K Buffer	1349
C. Itoh Starwriter 25 CPS	1649
C. Itoh Starwriter 45 CPS	2249
Centronics 737	699
Epson MX-70	339



Epson
MX - 80

$499

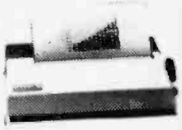
Epson MX-80 F/T	649
Epson MX-100	829
Paper Tiger IDS-445	729
Paper Tiger IDS-560	1450
Watanabe Digiplot	1149



Paper Tiger
IDS - 460

$1099

Silentype w/apple II
Interface



$349

AVAILABLE NOW. . .

The NEC Microcomputer

Please call for more details

TOLL-FREE ORDER LINE
800-854-6654

Use your Mastercharge, Visa, American Express, Carte Blanche, or Diners Club card to charge your order by phone.

SSM S-100 Cards at Lowest Prices Ever

The following is our fine line of S-100 cards. We will beat any currently advertised price.

	Kit	Assm & Tested
Z-80 CPU CB-2	219	279
104 2 P + 2 S I/O	189	249
VB-3 80 x 24 VIDEO	329	379
VB-3 80 x 48 VIDEO	369	429
BV-2 VIDEO	159	219
PB1 PROM PRGMMR & EPROM BOARD	139	199

CCS Calif. Comp. Systems

Z80 CPU 2810	n/a	229
64K Dynamic RAM card	n/a	499
16K Static RAM 2 MHz	n/a	249
16K Static RAM 4 MHz	n/a	269
Dbl. Density Floppy Disc Controller	n/a	299
12 Slot S-100 Mainframe	n/a	349

We carry much more than listed. Please call our toll free order line to request our complete price list.

How to Order

Ordering Information: Phone Orders invited using VISA, MASTERCARD, AMERICAN EXPRESS, DINER CLUB, CARTE BLANCHE, or bank wire transfer. Credit cards subject to service charge, 2% for account number (include expiration date), cashiers or certified check, money order, or personal check (allow 10 days to clear.) all funds must be in US dollars. Shipping, handling and insurance in US add 3% (minimum $4.00). California residents add 6% sales tax. We accept COD's OEM's, Institutions & Corporations please send for written quotation. All equipment is subject to price change and availability without notice. All equipment is new and complete with manufacturer warranty (usually 90 days). Showroom prices may differ from mail order prices.

Send orders to:

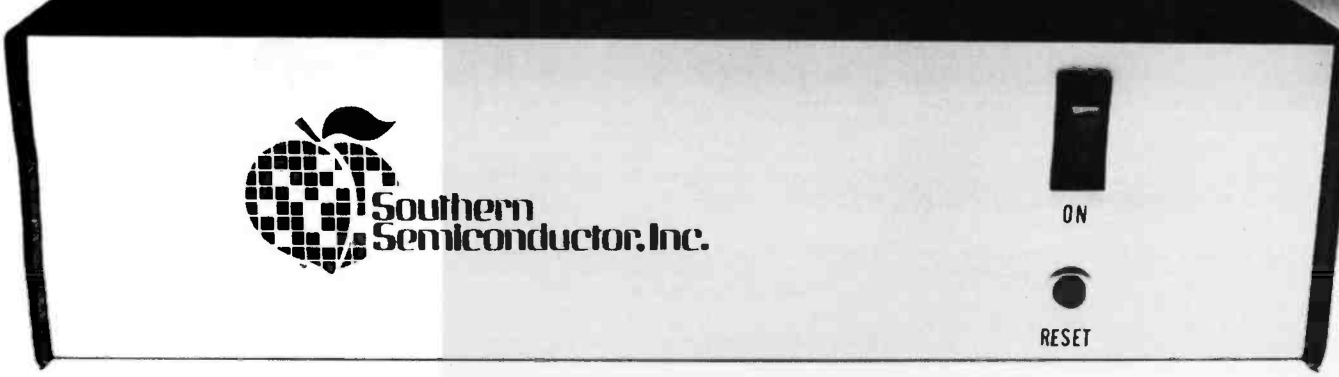
consumer computers
Mail Order

8314 Parkway Drive
La Mesa, California 92041

Circle 90 on inquiry card.

If your printer is using more of your computer's time than you are...

you need the "Fast Spooler."



Remember the last time you waited for your printer to complete a printout so you could get down to business with your computer? Well now you can untie your computer with Southern Semiconductor's "Fast Spooler". Large blocks of data can be transmitted at high speed to the "Fast Spooler" so your computer is available for more important functions. Long printouts can be handled entirely by the spooler — a real timesaver for word and data processing.

Easy to interface, the "Fast Spooler" can be connected by either a RS-232 serial interface or a Centronics parallel interface. These interfacing capabilities provide service for virtually any computer and printer.

With it's own power supply, cabinet and necessary software, the "Fast Spooler" is a complete unit. So why keep waiting. Visit your nearest Southern Semiconductor dealer today or contact us for complete details.

Southern Semiconductor, Inc.™
6030 Unity Drive, Suite J, Norcross, Georgia 30071 (404) 449-6666

Circle 356 on inquiry card.

Unclassified Ads

FOR SALE: IMSAI 8080: $560. Tarbell interface with two PerSci 70 8-inch disk drives, case, and power supply: $1400. VDM-1: $190. 16 K static programmable memory: $180. IMSAI MIO: $100. Selectric I/O: $650. BYTE, Kilobaud Microcomputing, and Interface Age: write for details. T Tai, 115 Bonny Ln, Collegeville PA 19426.

FOR SALE: Digital Group Z80 dual Phi-Deck system with 34 K memory. Godbout memory board can be expanded from 16 K to 32 K. The system has a 64 by 16 display, BB-cab, and Phi-cab. A Sanyo 9-inch monitor and two keyboards are part of the package. A large amount of software is also included (Phimon, Hi-Phi, Business BASIC, Sargon, Super Games, etc). $1250. D Reavis, 4355 Morris St, Salt Lake City UT 84119, (801) 966-0065.

FOR SALE: 9-inch video monitors. No case, in factory carton. 100% prime tested, but never used. Green-phosphor display, requires composite video and 13 thru 16 VDC inputs. Schematic included. I can ship COD, but I will pay shipping if you send a money order for $60. Chris Kalmbach, 422 S Florida Ave, Joplin MO 64801.

FOR TRADE OR SALE: BYTE: Vol. 6, #4-1, Vol. 5, #12-3, Vol. 4, #8, Vol. 3, #11, 4. Walter Jeffries, RFD 1, Readfield ME 04355.

WANTED: Apple II with 16 K. Must be in good to excellent condition. Marc Lenburg, 14 Meadowbrook Dr, Hadley MA 01035.

FOR SALE: Ohio Scientific C4P small-business computer. Includes 52 K, dual 8-inch floppy drives with 600,000 K bytes of storage, OS-65D and OS-65U operating systems, full line of related manuals, and monitor. All for $2500. UCSD Pascal development package available at $300 (includes FORTRAN). John F Dutcher, RD 1, Oxford NY 13830, (607) 843-9206.

FOR SALE: SOL-20/16 K programmable memory microcomputer, 9-inch Sanyo monitor, Diablo Hy-Type tractor-feed letter-quality printer with keyboard, cassette recorder, Electric Pencil I and II word-processing software, BASIC/5 software, debugging tape, supplies, and manuals. Asking $4000. Pete Pennington, 580 Gregory Ln, Devon PA 19333.

FOR SALE: Wave-Mate 6800 64 K computer, dual 8-inch floppy-disk drives, and Infoton 80-column video display. Includes software: Dynamics editor, assembler, and BASIC compiler. Asking $3000 or best offer. Will consider selling separately. Scott Joslyn, 5411 El Jardin St, Long Beach CA 90815, (213) 597-1749.

FOR SALE: Seales 8 K memory board for SS-50 bus: $100. SwTPC MP-A processor board less ICs: $20. Conrac 21-inch black-and-white monitor: $25 (pick-up locally only). Joe Dubner, 865 S Haskett St, Mountain Home ID 83647, (208) 587-9383.

FOR SALE: Diablo Hy-Type I/Hy-Type II or IBM Selectric printer interface. The input is Centronics-compatible (parallel). The unit is stand alone and has a 16 K FIFO print buffer. Ted Warn, POB 526, Knightdale NC 27545, (919) 266-9411.

FOR SALE: Quest Super ELF 1802 system in cabinet, 4 K expansion board, monitor and Tiny BASIC read-only memory, power supply, RF modulator, ASCII keyboard, manuals, magazines, and tapes. $300. Richard Moffie, 20121 Leadwell St #3, Canoga Park CA 91306, (213) 341-6098.

HELP: I have an INFO 2000 with TDL monitor and piggyback intelligent controller to PerSci drives. I lost the first EPROM on the S-100 board. Need DUMP or will buy copy of the chip. Company no longer has the information. If anyone has a similar system, please write or call collect. Edgar Alberding, POB 382, Salem IN 47167, (812) 883-2644.

FOR SALE: Cromemco Z2 chassis, Cromemco ZPU, Central Data 64 K twin-port SIO programmable-memory card, IMSAI twin-port SIO, Morrow second disk controller, and two Shugart 801 floppy drives. The above is up and running under CP/M 1.4 with a Hazeltine 1500 terminal. $4200. Rick Pugsley, 1911 W Callender, Peoria IL 61604, (309) 674-4343.

FOR SALE: Nine female Pin D connectors: $1.50 each. Retaining clips and mounting screws: $0.50/set of two each. Strain-relief cases for 15-pin D connectors: $3 each. 30-pin card-edge connectors, solder-eye, 0.156-inch spaces, gold-plated, bifurcated contacts: $2.50 each. Limited quantity, first come, first served. 10% for shipping and handling. Money order or cashier's check only. Kurt A Schultz, 115-1 Roxanne Ct, Walnut Creek CA 94596.

FOR SALE: Complete set of BYTE. Make offer on any or all issues. John Cowan, 613 Navarra Dr, Scotts Valley CA 95066, (408) 438-5116.

WANTED: Our nonprofit college radio station desperately needs the donation of a video terminal or Teletype. Working or nonworking is okay. We need the terminal fairly soon to secure an I/O port on the new college computer. Your donation is fully tax deductible and will be acknowledged by a Swarthmore College receipt. Steve Podell, WSRN-FM, Swarthmore College, Swarthmore PA 19081, (215) 447-7340. May thru August: 90 Terrace Ln, Moss Beach CA 94038, (415) 728-3248.

FOR SALE: Printer: 165 cps, excellent condition, variable character size, double-width characters, graphics can be added, same mechanism as the IDS printers. Best offer. S Levine, 1802 Melville St, Ocean NJ 07712, (201) 531-8305 after 6 PM.

FOR SALE: Apple Silentype printer. As new and complete. $450. Al Coombe, 807 Neal Dr, Gurley AL 35748, (205) 776-2378 after 6 CT.

FOR SALE: S-100 memory: SDS Expandoram II with 32 K of 4 MHz memory. Bank select, expandable to 64 K. Certificate of performance by Jade. Novation CAT acoustic modem, nearly new, RS-232C compatible. Guaranteed working. $350 and $150. Nick Reiber, 11458 Benton St, Loma Linda CA 92354, (714) 825-7942.

WANTED: Daily stock prices on Pet cassettes. One cassette per issue. Hi, lo, close, volume, date. 1960 to present. Don Nyre, 305 LaJolla Dr, Newport Beach CA 92663.

FOR SALE OR SWAP: TRS-80 Model I with upper-case/lowercase modification in keyboard. Complete with 48 K expansion interface, RS-232C and modem, Percom drives, and Centronics 730 printer. Only one year old; selling to do major hardware upgrade. Software: NEWDOS/80, Miller-FORTH and Datahandler, Pascal, FORTRAN, VisiCalc, Disk Ed/Asm, Stockpak, Scripsit, etc. $5000 investment. Want S-100 or STD bus Z80 equipment with 8-inch drives. Alan Wilcox, POB 151, Archbald PA 18403, (717) 586-8515 before 9 PM.

FOR SALE: Televideo 920C terminal with second-page memory option. Used for only three months and in mint condition in its original shipping container. Will send UPS postage paid to the first person submitting a $700 certified check or money order. G D Kaplan, POB 1462, Laguna Beach CA 92652, (714) 499-2724.

WANTED: Poor student in need of any and all S-100 (preferred) computer boards, peripherals, software, and electronic components. Need not work. Send list of equipment and price. Jonathan A Chandross, 14 Hunterdon Blvd, Murray Hill NJ 07974.

FOR SALE: Brand-new unused Apple communication card. Best offer. R J Crafts, POB 262, Ocean Heights, Edgartown MA 02539, (617) 627-4707 days, 627-8867 evenings.

FOR SALE: Digital Group computer. Factory wired, less than five hours running time. Z80A processor, 32 K static programmable memory, keyboard, and dual Phi-Deck (early board). Complete documentation, showroom condition. $700 or best offer. FOB Los Angeles. J Zubrecky, 328-A Russell Ave, Monterey Park CA 91754, (213) 571-1554.

FOR SALE: Heath H-89 all-in-one microcomputer. Less than ten hours use, looks and works perfect. Single floppy-disk drive, 48 K programmable memory, cassette interface, cassette player, HDOS 2.0 disk operating system, and Extended Benton Harbor and Microsoft BASIC. Full documentation plus miscellaneous software. $3000 value for $2000. Will ship anywhere. Thomas F Arnold, 6961 Island Rd, Clay NY 13041, (315) 699-5310.

FOR SALE: IMSAI MIO board and Processor Technology 3P+S board. Assembled and tested with all IC sockets and guaranteed working. MIO contains one serial port, two parallel ports, and a Tarbell cassette interface for S-100 bus systems. 3P+S contains three parallel ports and one serial port for S-100 bus systems. $100 each plus shipping. Will ship COD. John Dunning, 1395 Main St, Waltham MA 02154, (617) 899-7244 days only.

FOR SALE: Heath H-11: 32 K, two serial and one parallel boards, two extra LSI-11/2 processor modules, extended arithmetic chip, WH-27 factory-assembled floppy disk, DEC VT100 video terminal, DEC LA36 DECwriter II Accelwriter (600 bps) equipped, Heath computer desk, super software package, all accessories, many extras, running and ready to go. Will accept any bona fide offer over $5000. Will separate. Greg Krzyzowski, 5223 Main St, Downers Grove IL 60515, (312) 963-0250 days, 964-4429 evenings.

FOR SALE: Apple II peripherals: Hayes Microcomputer Products micromodem and Videx 80-column board. Free interface EPROM for modem; spare EPROMs and programmer for video board. Also, Mountain Hardware clock. Everything 1/3 off current price or trade for Apple Graphic Pad. James Leatham, RD 2, Box 198, Chester NY 10918, (914) 469-4092.

FOR SALE: BYTE, complete set to present, in excellent condition. SwTPC 6800 complete system, cassette-based with terminal. New RS/Centronics 779 in unopened box. Make offers. John French, 8045 Alida St, La Mesa CA 92041.

WANTED: Bare printed-circuit board for D C Hayes 8-103A modem. D Reinebeck, 899 Fairfield Rd, North Vancouver British Columbia, V7H 2J4 Canada, (604) 929-5759.

FOR SALE: Assembled and working Heathkit H-8 with 8 K memory, H-8-5 serial interface board, Extended BASIC and regular BASIC tapes, tape recorder, and manuals. $350 or best offer. Micro-Term serial keyboard: $350. Sanyo 9-inch monitor: $125. RF modulator (used with Apple computer): $20. Bill Lofton, 5840 Sun Valley Way, Sacramento CA 95823, (916) 393-0154.

FOR TRADE: A Leslie Model 145 organ amplifier/speaker and preamplifier for a computer of comparable value. Like-new condition. I will deliver within a 250-mile radius. Marlin Meier, 801-J Patterson Rd, Dayton OH 45419, (513) 299-7156.

FOR SALE: APF Imagination Machine. Only two months old. Excellent condition. Paid $599, will sell for $450 or offer. Also, interested in buying used Apple II with 48 K. Steve Grabarczyk, 4921 W Midland Dr, Greenfield WI 53219, (414) 543-7989.

UNCLASSIFIED POLICY: Readers who are soliciting or giving advice, or who have equipment to buy, sell or swap should send in a clearly typed notice to that effect. To be considered for publication, an advertisement must be clearly noncommercial, typed double spaced on plain white paper, contain 75 words or less, and include complete name and address information.

These notices are free of charge and will be printed one time only on a space available basis. Notices can be accepted from individuals or bona fide computer users clubs only. We can engage in no correspondence on these and your confirmation of placement is appearance in an issue of BYTE.

Please note that it may take three or four months for an ad to appear in the magazine.

Reader Service

To get further information on the products advertising in BYTE, fill out the reader service card with your name and address. Then circle the appropriate numbers for the advertisers you select from the list. Add an 18-cent stamp to the card, then drop it in the mail. Not only do you gain information, but our advertisers are encouraged to use the marketplace provided by BYTE. This helps us bring you a bigger BYTE. The index is provided as an additional service by the publisher, who assumes no liability for errors or omissions. *Correspond directly with company.

Reader Service

BOMB
BYTE's Ongoing Monitor Box

Article #	Page	Article	Author(s)
1	14	Introducing the Smalltalk-80 System	Goldberg
2	36	The Smalltalk-80 System	Xerox Learning Research Group
3	50	Build a Z8-Based Control Computer with BASIC, Part 2	Ciarcia
4	74	Object-Oriented Software Systems	Robson
5	90	The Smalltalk Environment	Tesler
6	147	User-Oriented Descriptions of Smalltalk Systems	Reenskaug
7	168	The Smalltalk Graphics Kernel	Ingalls
8	200	The Japanese Computer Invasion	Miastkowski
9	230	Building Data Structures in the Smalltalk-80 System	Althoff
10	286	Design Principles Behind Smalltalk	Ingalls
11	300	The Smalltalk-80 Virtual Machine	Krasner
12	322	Building Control Structures in the Smalltalk-80 System	Deutsch
13	348	Is the Smalltalk-80 System for Children?	Goldberg and Ross
14	369	ToolBox: A Smalltalk Illustration System	Bowman and Flegal
15	378	Virtual Memory for an Object-Oriented Language	Kaehler
16	398	Microsoft Editor/Assembler Plus	Carlson
17	401	BOSS: A Debugging Utility for the TRS-80 Model I	Mitchell

May BOMB Results: Printers Top List

By one of the largest margins in BOMB's history, Kevin Cohan's article "The Epson MX-80 and MX-70 Printers" swept first place in the May contest. The $100 first prize will be donated to charity in Kevin's name. (Kevin Cohan, a technical editor at BYTE, was killed in an automobile accident April 22.)

Steve Ciarcia's "DC Motor Controls: Build a Motorized Platform" captured second place and the $50 prize. Third place went to senior editor Gregg Williams for his article "The Commodore VIC 20 Microcomputer: A Low-Cost, High-Performance Consumer Computer," and fourth place went to technical editor Stan Miastkowski for his article "Extended Color BASIC for the TRS-80 Color Computer."

The Dynabyte Difference: Unequalled price/performance with total expandability.

Buying the powerful Dynabyte 5615 isn't only smart, it's cost efficient.

The 5615 is the sure way to get the system you need. With more power for the price. You can select memory to 400 KB on our S-100 bus architecture. Choose from 3 sizes of Winchesters to 45 MB and have diskette back-up to your system also. If it's tape back-up you need, then choose our 5700. If you need less storage, our 5¼" floppy 5200, our 8" floppy 5300 or our 5400 system using both floppies, with up to 3.6 MB capacity, can be yours.

The 5615 system is available with either single user CP/M or our enhanced MP/M for multi-user applications. Our MP/M operating system supports up to eight terminals, with a separate or shared spooler, and up to sixteen printers with no required partition space. Add to this multi-tasking, bank switching, record lockout, type-ahead and DMA and you have an MP/M operating system that supports a host of existing languages and meets minicomputer standards.

No multi-user applications library is so responsive to your needs. The 5615 features Business Manager,™ the fully integrated, menu-driven, well documented, easy to install accounting system that gives you file/record protection, HELP commands, multi-level security, keyed data access, internal disk management, available source code and more.

System expandability, power and price/performance are further enhanced by on-hand availability, quantity discounts, 180-day warranty and a national WATS line for support.

Whether you use or sell computer systems, you should ask about the microcomputer that puts minicomputer capability in your hands. That's the 5615. That's the Dynabyte Difference. Call Mike Seashols, V. P. Marketing (800) 227-8300. In California (415) 329-8021. Dynabyte, 115 Independence Drive, Menlo Park, California 94025.

DYNABYTE
Business Computers

Business Manager is a registered trademark of Dynabyte. CP/M and MP/M are registered trademarks of Digital Research Corp.

Circle 124 on inquiry card.