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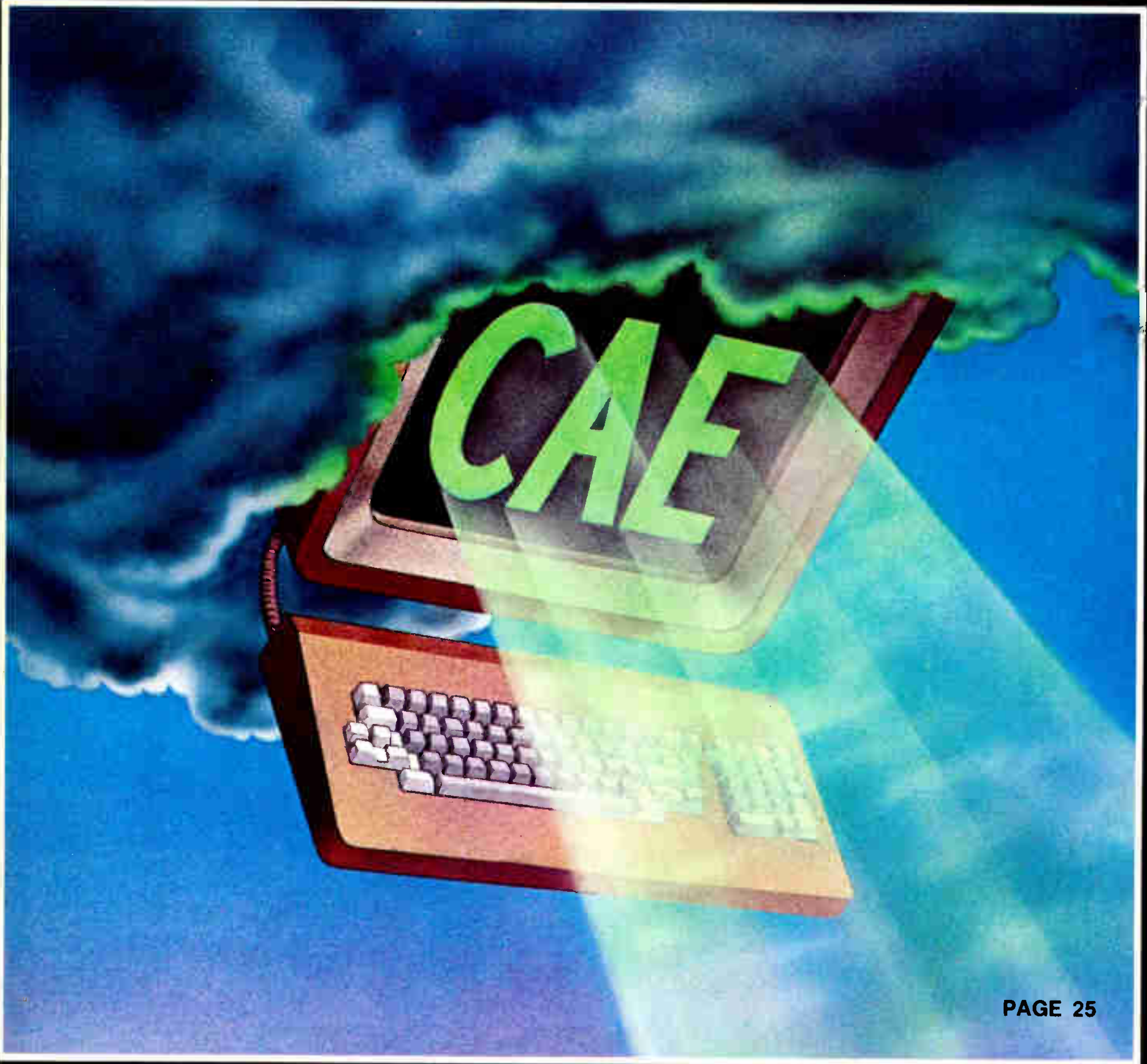
# Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY
JUNE 9, 1986

# HAS CAE LIVED UP TO ITS PROMISE?




PAGE 25

# The only thing small about it is its size!

The RTP-650A is the only portable data recorder that gives you bigger performance than a reel-to-reel.

- **DC to 40kHz frequency response on 14 (or 21) channels** — at a 76.2cm/sec (30 ips) on Beta format video cassette tape. Covers twice the IRIG WBG1 bandwidth on any of the other six tape speeds. WBG1 is selectable for an even better SN ratio.
- **Superior vibration resistance (tested in conformity with MIL-STD-810C)** plus a compact and lightweight design give you a wholly new latitude of applications.
- **FM, DR and PCM recording — three modes in all**
  A first for a desktop data recorder.
- **Optionally available GP-IB port** lets you easily configure a computer-controlled data acquisition and processing system.

And it's easier to use than any other data recorder.....

- **Bright easy-to-read menu style EL display** provides the window for easy access to the multi-microprocessor intelligence.
- **Programmable settings for simpler operation**
  Even an unskilled operator can use it on site.

Learn more about the RTP-650A and its many other exciting features. Write or call:

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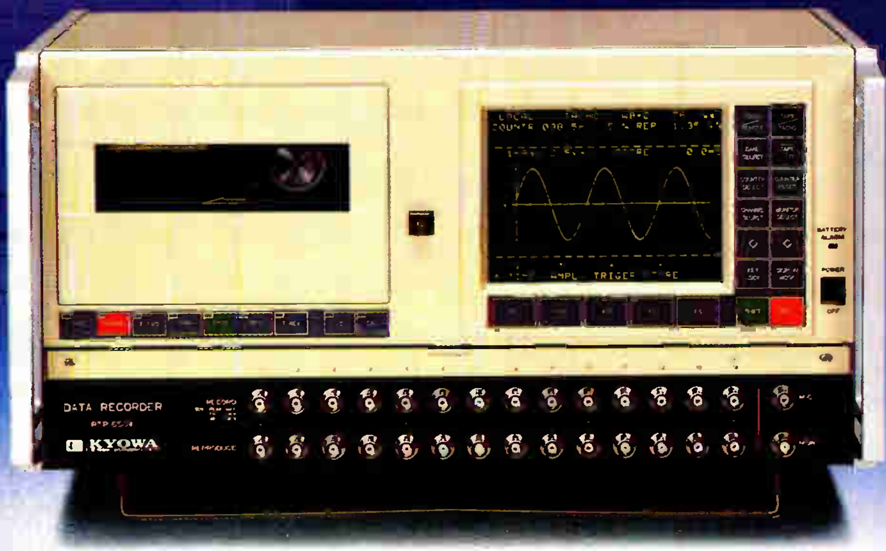
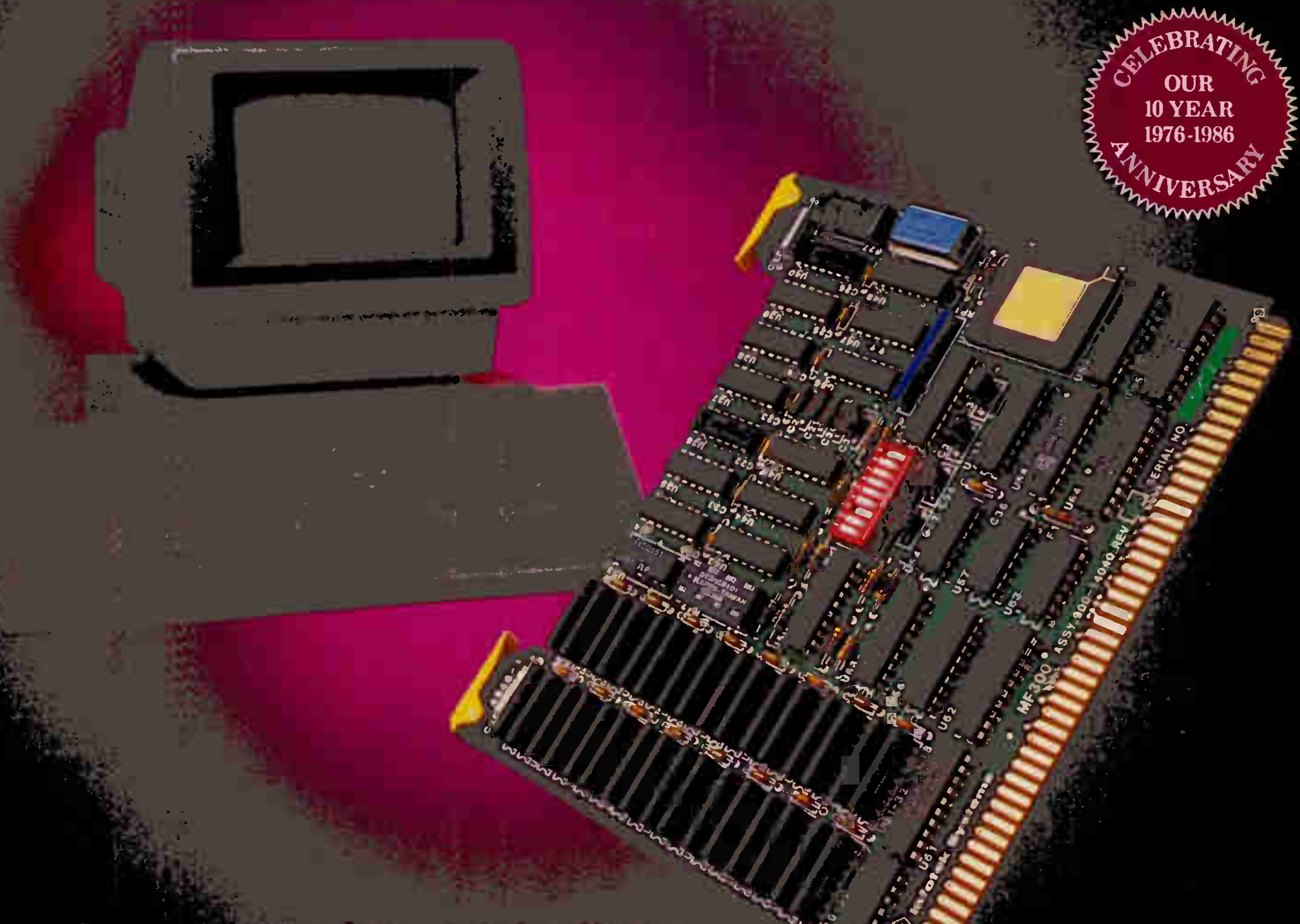



# RTP-650A
## VIDEO CASSETTE DATA RECORDER

Circle 900 on reader service card

# TWO FUNCTIONS ONE CARD

**1 MByte memory + 1 floating point processor on a single board for your HP Series 200/300 computer.**




When you only have two slots—like on your HP 216—or even a few more slots as other HP 9000 computers do, you want the most capability in the least possible space. Now, you can have a full megabyte of memory plus an advanced floating point processor on a single card—the MF 300 from Infotek.

The MF 300 incorporates a powerful floating point processor (based on the Motorola 68881 processor) which significantly increases the speed of transcendental functions as well as arithmetic operations for both BASIC and Pascal. For math intensive applications such as CAD, improvements in speed of three to five times are experienced by most users. Some functions improve by a factor of 30!

The same performance (without the memory) is available in the new FP 881 floating point processor. Or you can choose the Infotek FP 210 floating point processor for BASIC and Pascal. The FP 210 employs the National 32081 processor to increase real arithmetic speed as well as transcendentals. And all floating point boards further enhance real math functions when used with Infotek's BASIC compilers.

As with all Infotek HP enhancement products, the floating point processors demonstrate their exceptional reliability with a full two-year warranty. So give new life to your HP 216 or other 9000 computer! Put maximum performance in a single slot. Call Infotek Systems at (800) 227-0218, in California (800) 523-1682, or (714) 956-9300, 1400 North Baxter Street, Anaheim, California 92806-1201, TELEX 182283.

**INFOTEK SYSTEMS**
A DIVISION OF ALS CORPORATION

*Your Second Right Decision.*

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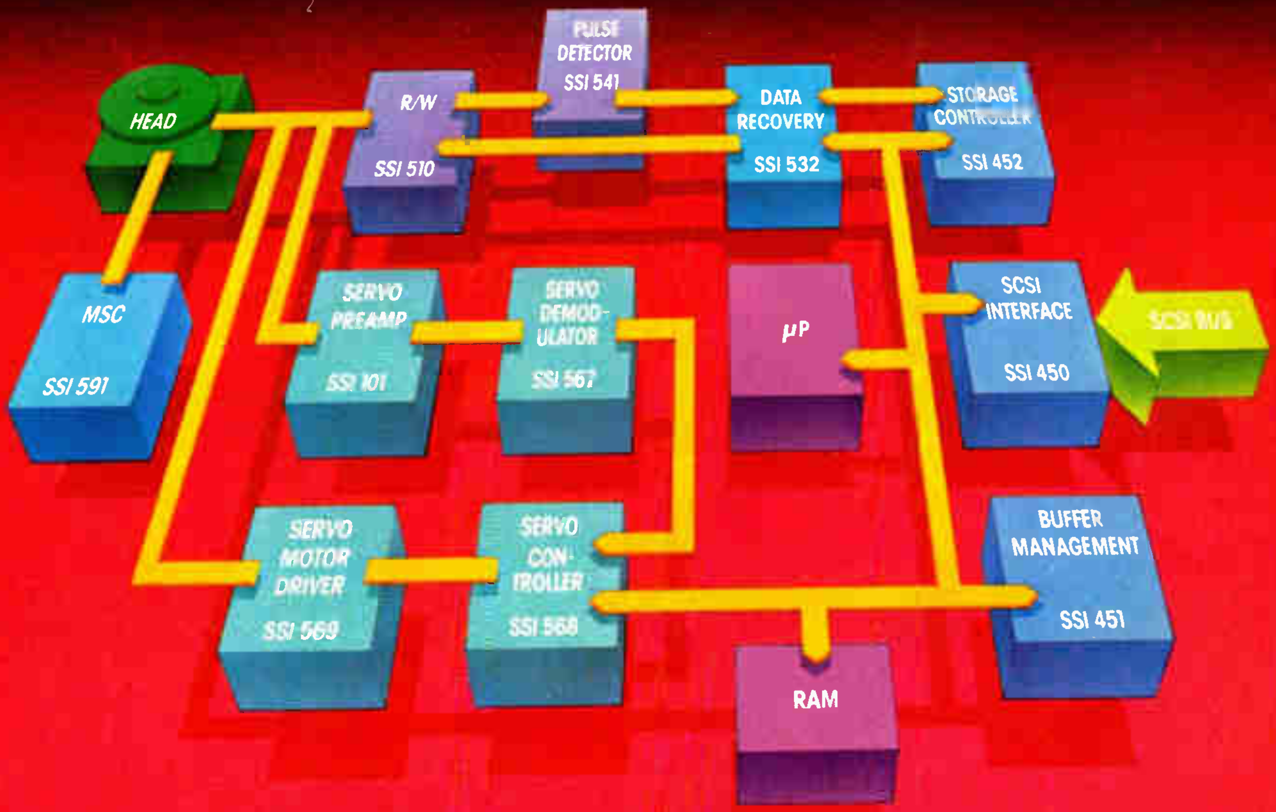
# SILICON SYSTEMS THE NUMBER 1 SUPPLIER OF CHANNEL ELECTRONICS NOW INTRODUCES THE COMPLETE SCSI SOLUTION.




## SCSI CHIP SET

### New Chip Set Provides "Head-to-Host" Solution

The demand for higher capacity Winchester Disk Drives has led to Silicon Systems' introduction of a complete line of small computer system interface (SCSI) products. This exciting new line of 11 ASIC's for intelligent disk drives does it all. The chip set provides silicon solutions for the entire read channel, for the controller and interface electronics, for a dedicated surface servo-head positioning system, and for spindle motor speed control.

### Maximizes Functionality into Smallest Footprint

Silicon Systems' new surface-mounted SCSI chip set enables the customer to reduce the number of passive components in his design, eliminate many board adjustments, and reduce the total board space needed in the end product. This makes it easier and quicker for the SCSI chip set user to design and manufacture his product, thereby giving him a competitive edge in the race to market with new, compact, higher-capacity intelligent disk drives.

### Order Now For Fall Delivery

With many of the new chips already in production, the entire chip set will be available in surface mount packaging this Fall at a cost of less than $60 per set in volume.

For more information, contact Silicon Systems today.

**Silicon Systems,** 14351 Myford Road, Tustin CA 92680, (714) 731-7110, Ext. 575.

silicon systems
INNOVATORS IN INTEGRATION

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63 Career Information

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# Electronics

# How To Stay On Top Of The Charts.

One thing is certain. You have to present a quality image. And you have to maintain it with absolute consistency.

That's why you should look into the new Seiko Hardcopier. You can get a variety of output sizes. With strong vibrant colors and clear, sharp lines on both paper and transparency.

Plus you can get those copies in as little as 45 seconds each. For a lot less money than you thought possible.

The Seiko Hardcopier can make a hundred copies for you off-line. Because its frame buffer holds the image data and frees your terminal. You just set the quantity you want and go on working.

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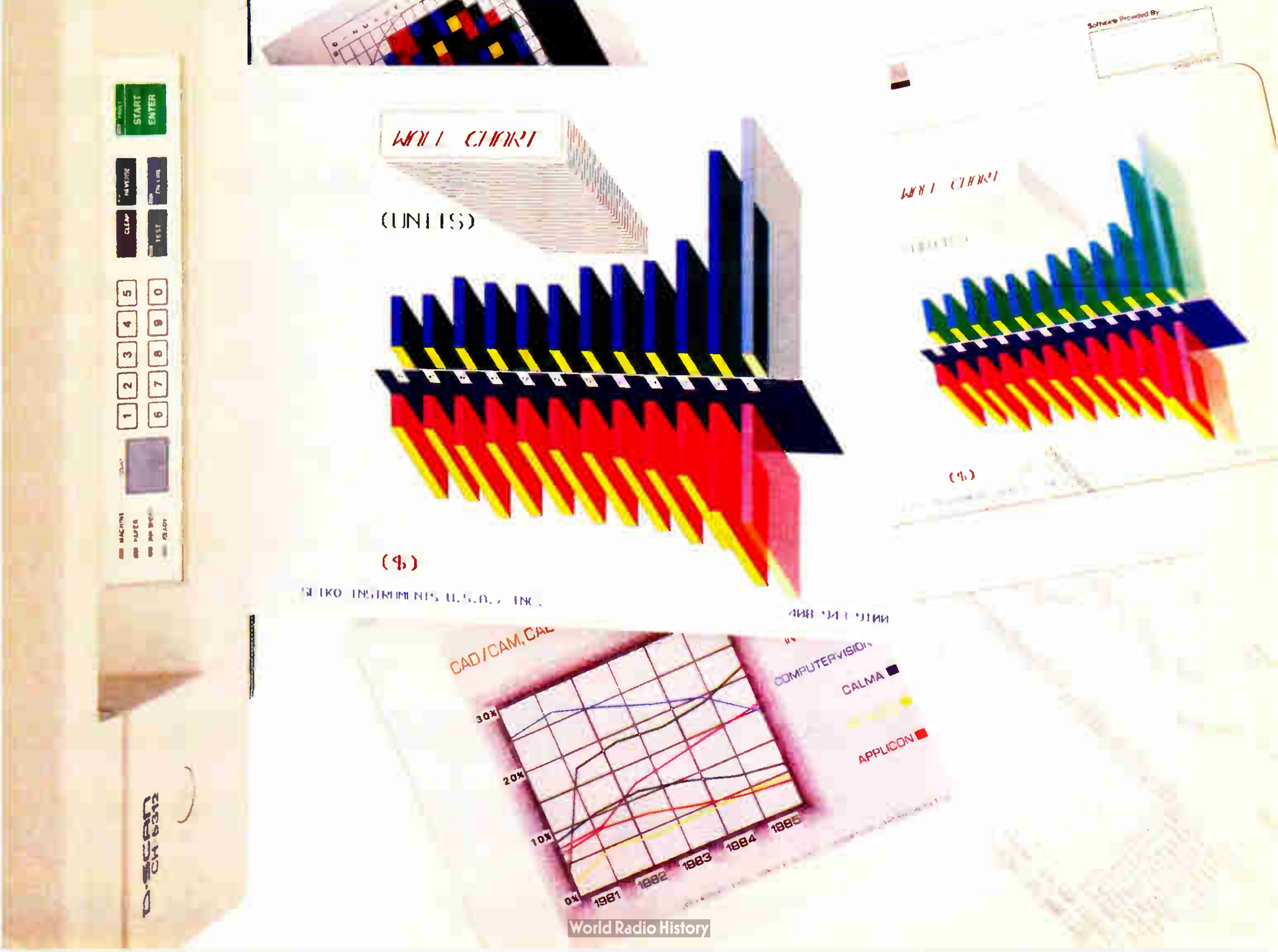
Call Martin Nelson at (408) 943-9100 today.

SEIKO INSTRUMENTS



Circle 4 on reader service card



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An editor setting out to write about technology brings to the job a background of knowledge, which includes certain impressions about the subject. Very often, research and reporting prove those impressions correct; in other cases, the editor learns otherwise.

The latter was the case when Jonah McLeod began to talk to people in the computer-aided-engineering industry as he prepared to write this week's special report, beginning on p. 25, which examines the question of whether the complex and expensive equipment can live up to its promise. Jonah, who works out of our San Mateo bureau and covers the world of test and measurement, says, "I came to this project with the notion that something specific was wrong with the industry and that I could get to the bottom of it. I assumed that there was a cut-and-dried solution to the problem. Instead, I wound up coming to terms with how people accept technology."

**McLEOD:** CAE industry's problems are not that simple.

Jonah says he found the simple answer is that there is no simple or unique reason for the slackening growth that's puzzling the CAE business. "If there was a single reason for the situation, I couldn't find it. The industry is suffering from the same ills as other industries," he says, "with the main pain coming from a contraction of capital spending."

As the money dried up, Jonah found, so did the market. "The target customers came in several stripes. There were those who were in early and couldn't wait to get their hands on CAE equipment. At the other extreme, there were those who said, 'You'll never get me to use this stuff.' And there were those in between saying, 'Maybe we should take the plunge.'"

Then, when the curve started to flatten, the suppliers were caught in a squeeze among those three groups. As Jonah sees it, "The early purchasers already had their equipment and were not in the market. The others were saying, 'All right, show me something new and then we'll talk.' So here were the CAE makers, challenged to come up with new products and beating their heads against the wall because the profits with which they had to finance the development work were minuscule."

This issue is special for more than just McLeod's report. There are two articles in addition to his that complete the CAE package. One is a Technology to Watch, on p. 34, about Teradyne Corp.'s systems that unite the worlds of automatic test and design. The other is a Probing the News, on p. 45, on what the new thrust has done to the company's marketing strategy.


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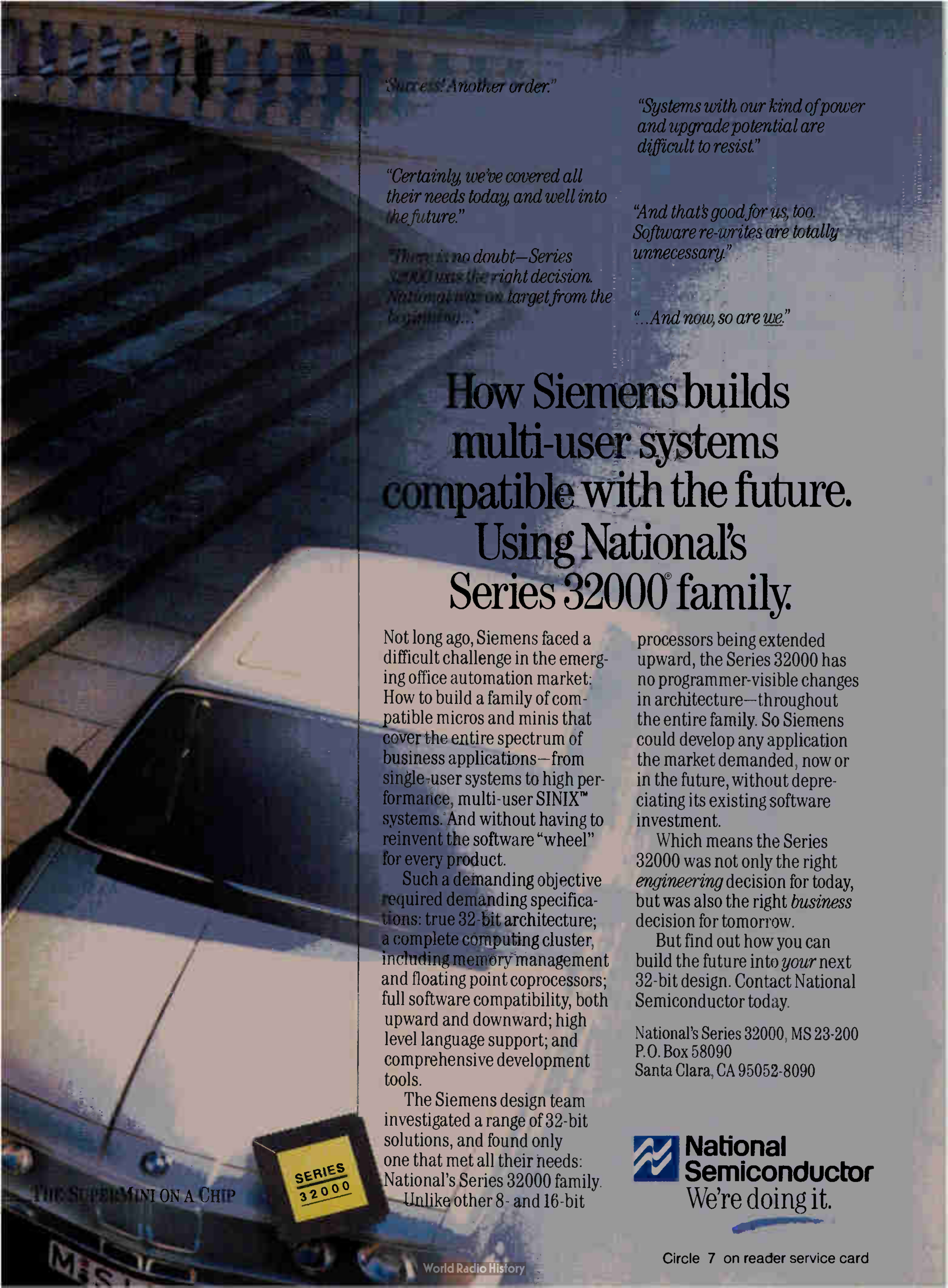
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Such a demanding objective required demanding specifications: true 32-bit architecture; a complete computing cluster, including memory management and floating point coprocessors; full software compatibility, both upward and downward; high level language support; and comprehensive development tools.
The Siemens design team investigated a range of 32-bit solutions, and found only one that met all their needs: National's Series 32000 family.
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## *LETTERS*

### Untruth table

**To the editor:** The table with "At Last: Parallel Engine Benchmarks" [*Electronics*, April 7, 1986, p. 16] is misleading.

The original table—"Performance Measurements for High Performance Computers," published by Argonne National Laboratory—contains many footnotes, which you omitted. They point out that some measurements at the top of the table were made with special software to exploit the parallelism of the multiple engines in certain configurations. Others reflect single-engine performance only.

The IBM Corp. 3090 Model 200 with Vector Facility is represented as a single-engine performance number among a mixture of single and multiengine numbers from other manufacturers; this does not indicate the parallel-performance capability of the machine with or without vectors, as the title of the article implies.

Also, the footnotes show that measurements were made over a long period of time and thus do not reflect accurately the comparative performance of the systems at a given time.

*W. D. Frazier*
*Director*
*Scientific Engineering Processor Products*
*IBM Corp.*
*Kingston, N. Y.*

☐ *We regret any confusion caused by proximity of the article title to the table. The table includes several single-processor machines. The headline was not meant to imply that they were all parallel engines. The article states that measurements were made over a period of time.*

### More ESD reports!

**To the editor:** As a 14-year subscriber, I am disappointed with *Electronics*' coverage of electrostatic discharge control. My experience with component distributors has been scandalous. I have seen high-technology products delivered with poorly packaged spare printed-circuit boards.

Please publish more articles on good practices—like the recent report on Delco [*Electronics*, Jan. 13, 1986, p. 15]. Let's see wrist straps on people handling components and pc boards [*Electronics*, March 31, 1986, p. 53, photo]. Our industry has a problem of perception and attitude. We must ensure that good practices are implemented throughout the manufacturing, distribution, and maintenance cycle.

*Bryan F. White*
*Engineer*
*Atomic Energy Canada Ltd.*
*Deep River, Ontario*

# TECHNOLOGY NEWSLETTER

## CHECKING UNPROCESSED WAFERS FOR DEFECTS AND TRAPS TAKES SECONDS

A technique based on pulsed light and microwaves can cut the time it takes to evaluate unprocessed wafers of silicon or gallium arsenide to a few seconds, says a team of researchers at Rensselaer Polytechnic Institute in Troy, N. Y. Pulsing light from a laser or xenon flash lamp onto a wafer surface excites the surface molecules, increasing the wafer's conductivity and thus its capacity to reflect microwaves, explains professor J. M. Borrego. By measuring how quickly the reflection decays after the light has been shut off, the RPI group gauges the depth of the defect-free region below the surface of silicon wafers. The researchers can also determine the nature and concentration of traps in the GaAs wafers—by using different wavelengths in exposing them—because the traps hold their heightened conductivity longer than the rest of the wafer. Standard techniques for such evaluation require the fabrication of MOS capacitors on the wafer surface and the use of probes to measure capacitance, but that can damage the wafer's surface and take up to an hour to perform, Borrego says. In contrast, the photoconductive method poses no risk to the wafer, can be done in seconds, and could eventually be incorporated into wafer production lines. □

## MAGNETO-OPTIC DISKS SPEED REPLAYS FOR TV BROADCASTS

Magneto-optic disks could well supplant video tapes for inserting replays into sports and news TV broadcasts in the late 1980s. The Science and Technical Research Laboratories of NHK, a nationwide Japanese public broadcasting system, have developed an experimental recording system with two 300-mm disks that can store 10 min of video action, including color pictures and sound. With the disk, TV directors can call up any frame in less than ½ s—faster than with tape decks, because there is no time lost rewinding or skipping ahead in fast forward. Stills, forward and reverse slow motion, high-speed search, and other video tricks are also possible. Editing can also be done at high speed with the system, which can also be used as a memory for computer-graphics processing. NHK put together the experimental system with Nippon Kogaku K.K., Tokyo, the manufacturer of Nikon cameras, and Asaka Corp., a Tokyo manufacturer of broadcast equipment. Production versions could be in broadcasters' studios within two or three years, NHK figures. □

## INMOS ENTERS SIGNAL-PROCESSING MARKET, ADDS A THRUST IN ASICs

In an attempt to shift its market mix, Inmos Corp. is moving into the digital-signal-processing market—and at the same time kicking off a new drive into application-specific integrated circuits. The Colorado Springs company, which is now heavily oriented toward memories, plans to have at least half its business come from transputers and ASICs in five years. It will officially unveil its IMS A100 CMOS digital transversal filter chip at the National Computer Conference next week in Las Vegas. The chip is cascadable and has 16-bit inputs and a 16-bit multiplier-accumulator architecture. It can hold up to 32 separate coefficients, which can be programmed to be 4, 8, 12, or 16 bits wide and reprogrammed on the fly without slowing the chip down. A 16-by-16-bit multiplication takes 12 ns to perform; 32 multiplications and accumulations take 400 ns. The chip comes in an 84-pin grid array and dissipates 1.5 W. Targeted applications include filtering, radar, sonar, communications, ultrasonic equipment, imaging, and speech equipment, which requires the performance of convolutions, correlations, matrix manipulations, waveform synthesis, and digital Fourier transforms. The ASIC department at Inmos's parent company in Bristol, England, is gearing up to do semicustom designs that mix portions of its transputer microprocessors and the new filter chip. □

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# Delivering with the MC68020.

## If you've announced an MC68020-based system and you're not on this list, we're sorry.

Now we know how much you care. We were dismayed recently to discover that we've unintentionally distressed several valued Motorola customers.

A list of companies delivering systems based on the MC68020 32-bit microprocessor to their customers was used in an ad to demonstrate the MPU's popularity, versatility and availability for executive-level decision makers.

The list wasn't intended to be complete, and was, in fact, a somewhat random selection simply to show diversity and suggest our own delivery capability. That's when we discovered just how much some of those omitted wanted it known their systems rely on the MC68020.

Alpha Microsystems is typical, and we're particularly sensitive to their concern because their AM-2075 was one of the systems used to run benchmarks for our very positive MC68020 Benchmark Report last year.

Certainly we had no desire to slight Alpha Micro or any other system manufacturer delivering product based on the MC68020. We may not even be aware of everyone, everywhere, who is.

At any time, there are new MC68020-driven systems in varying stages of design, and we can't run a new ad every time one of them materializes.

But, to amend any inadvertent past offense, here's our best try at a complete list of all the companies who have publicly announced products incorporating the MC68020 as of April 30, 1986. If we missed any we're sorry, and please accept our appreciation for your confidence in Motorola and the MC68020.

If you're a senior executive with responsibility for your firm's MPU business decision and you'd like to be better informed on the microprocessor facts for today and tomorrow, we invite you to call us at 1-800-521-6274 weekdays between 8:00 a.m. and 4:30 p.m., Mountain Standard Time. We'll arrange a one-on-one management-level contact with you.

We're on your design-in team.

**MOTOROLA**

# ELECTRONICS NEWSLETTER

## SHARP EYES HOUSEHOLD 3-D TELEVISION

A new genre of home video entertainment—three-dimensional TV—now is in sight. Sharp Corp. showed up at last week's Summer Consumer Electronics Show with a prototype 3-d method designed for use with a normal TV hooked to a video disk player. Sharp's system, developed jointly with Victor Company of Japan (JVC), does not do away with the need to wear special glasses for 3-d viewing, the hallmark of predecessor 3-d movies in theaters. But Sharp maintains that a high-speed liquid-crystal material used in the system's shutter-lens glasses improves performance in both light blocking and shutter speed. For viewing, the glasses are connected to the video disk player, which signals the lenses to switch between transparent and opaque states 60 times a second to alternate viewing between the left and right eyes. Corresponding images, taken by separate cameras, are flashed on the TV screen at the same frequency, so each eye sees a separate and slightly different view. The human brain combines the images seen by the left and right eyes to form a 3-d image. JVC says that it will start selling a Video Home Disk player for normal and 3-d playback in Japan in October. Matsushita Electrical Industrial Corp., which has joined Sharp and JVC for the project, has scheduled its introduction this autumn. Sharp is seriously considering starting sales in Japan this year as well. □

## SAMSUNG 8-MM/VHS VCR COMBO WORRIES FILM INDUSTRY

Samsung Electronics America Inc. has developed prototypes of hardware that would come down on both sides of the escalating war between the 8-mm and ½-in. Video Home System video formats. But before the Saddle Brook, N. J., affiliate of the South Korean electronics company fires shots in earnest, it has to contend with the powerful Motion Picture Association of America. Samsung drew fire from the MPAA at Chicago's Summer Consumer Electronics Show in early June, where it turned up with a prototype double-deck VHS/8-mm video cassette recorder/player that can dub from one format to the other. Samsung says it could market the machine for less than $1,000, but the MPAA says Samsung will be in for a legal battle if it does. Worried about unauthorized copying of prerecorded cassettes, the MPAA recently swung a deal with the Electronic Industries Association of Japan to limit distribution of a VHS-to-VHS double-deck unit introduced earlier by Sharp Corp. "We were a little surprised. We didn't expect such a strong [MPAA] reaction to a prototype," says Samsung spokesman Richard Leister. He says Samsung has no timetable for introducing the double-deck unit, and that it plans to discuss the issue with the MPAA before making a final marketing decision. □

## JAPANESE HOLD LINE ON PRICES DESPITE IBM CUTS ON MAINFRAMES

The threat of a price war figures to overhang the mainframe market in Japan over the next few months, now that IBM Japan has reduced the prices of its 3090 mainframe computers and peripherals by 9% to 20%. IBM's major competitor, Fujitsu Ltd., says it has no plans to follow suit so far, claiming that 30 orders have been taken for its M-780 top-of-the-line mainframe, which went on sale last fall. Hitachi Ltd. and NEC Corp. are taking the same stance. But all three figure to re-evaluate their positions if IBM's order intake bulges. IBM says lower production costs explain price cuts of 9% on the 3090, 11% on the 3380 magnetic disk drive, and 16% on the 3880 disk-drive controller, all manufactured in Japan. But some industry sources say the weaker dollar may make it attractive to import products from the U. S., and IBM wanted to nip such imports in the bud. Price reductions of 12% on the 3480 tape subsystem and 20% on the 3800-8 laser printer subsystem are mostly credited to foreign-exchange savings on these imported products. □


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# PRODUCTS NEWSLETTER

## RELATIONAL TECHNOLOGY ADDS DATA-BASE SYSTEM FOR NETWORKS

Users of networked computers can now get a relational data-base management system to access data stored anywhere on the net. Relational Technology Inc.'s Ingres/Star uses an open architecture that supports networks from multiple vendors. As a companion to the company's basic Ingres data-base management package, Ingres/Star separately implements the distributed capabilities, allowing the local data-base systems to operate autonomously. Versions for AT&T Co.'s Unix and Digital Equipment Corp.'s VMS operating systems will be available in the fourth quarter from the Alameda, Calif., company. Prices range from $2,000 to $125,000. □

## UNITED TECHNOLOGIES' 1553 BUS CONTROLLER SAVES MONEY AND SPACE

United Technologies Microelectronics Center is entering the MIL-STD-1553 data-bus controller market with a CMOS IC that not only supports 1553 military serial-bus protocols but also has an on-chip memory-management unit. The chip, which will replace hybrids, saves valuable real estate. The MMU will enable the TU1553B chip to offload multiple message processing from host CPUs residing on the bus. The IC prevents CPUs and the MMU from accessing shared memory at the same time. The Colorado Springs company will sell the part for $895; hybrids implementing the same functions sell for about $2,500 and take up about 8 $in.^2$, compared with the TU1553B's 1 $in.^2$. Power usage is also lower than for hybrids—400 mW versus 1.4 W. □

## PC AT ADD-ON CARD HAS MEMORY, GRAPHICS, AND MORE

The Memek from Boca Research Inc. rises above the pack of add-on cards for the IBM Corp. Personal Computer AT by combining up to 2 megabytes of RAM, three graphics-controller formats, a clock-calendar, and serial, parallel, and game ports. The Boca Raton, Fla., company used gate-array technology to emulate the most popular video-display options, including IBM's color graphics format, Hercules' monochrome graphics format, and Plantronics' ColorPlus, which is compatible with IBM's Enhanced Graphics Adapter format. Available now, Memek sells for $647. □

## HERE COME 382-MEGABYTE WINCHESTER DRIVES

Maxtor Corp., San Jose, Calif., has ready a 380-megabyte 5¼-in. Winchester drive with an embedded Small Computer System Interface controller. Competitor Micropolis Corp. is not far behind: at next week's National Computer Conference in Las Vegas, the Chatsworth, Calif., company will unveil a $1,900 382-megabyte model that has an embedded SCSI or Enhanced Small Disk Interface. Maxtor's XT-3380 boasts a byte-wide data-transfer rate of 1.5 megabytes/s. It provides a full SCSI implementation, including arbitration and disconnect/reconnect commands. Price information was not available. □

## DESIGNING A FILTER IN LESS THAN ONE HOUR

With Crystal Semiconductor Corp.'s new system, a filter can be designed in less than one hour instead of in weeks. The system consists of the Austin, Texas, company's CSC7008 digitally configurable filter and the IBM Personal Computer-based Crystal-ICE development system. To develop a filter, the designer specifies the desired type and parameters. The Crystal-ICE then calculates the order of the filter necessary to meet those specifications using a Butterworth, Chebychev, or Elliptic implementation. The development system sells for $3,599, and filters sell for $30 each. □

Electronics

# ISDN STANDARD IS SPAWNING INCOMPATIBLE TELECOM CHIPS

## AMD AND MOTOROLA PARTS SHOW DIVERGING STRATEGIES

**AUSTIN, TEXAS**

Semiconductor makers have an uncanny knack for showing there is more than one way to implement an emerging industry standard. That talent comes into full view as integrators roll out their product plans and silicon renditions for the evolving telephony standard known as ISDN, for integrated services digital network. Motorola Inc. and Advanced Micro Devices Inc., for example, are taking very different tacks, and both unveiled products illustrating their strategies last week.

The very different chips being developed for voice-and-data phone systems, whether ISDN-compatible or not, present phone-equipment makers with some hard choices. The chips they use in their systems will, by their levels of functionality and their interfaces, determine how the equipment is built. It will not be a simple matter to switch to another vendor's chips—once the system is designed and built, the equipment maker is as good as locked in.

End users of the equipment may be affected too, insofar as they find themselves investing in nonstandard voice-and-data exchanges because they cost less or offer more features. Industry observers expect such non-ISDN systems to hold their own in the market for many years to come.

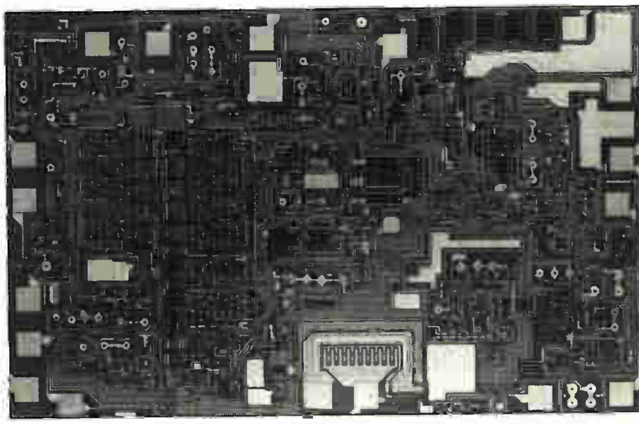
The specifications for ISDN equipment interfaces used at the terminals are firmly spelled out by the International Telegraph and Telephone Consultative Committee. But in the chip world, ISDN specs are only one side of the issue. The other is just how ISDN functions are partitioned on chip and how the chips will interface with the rest of the system.

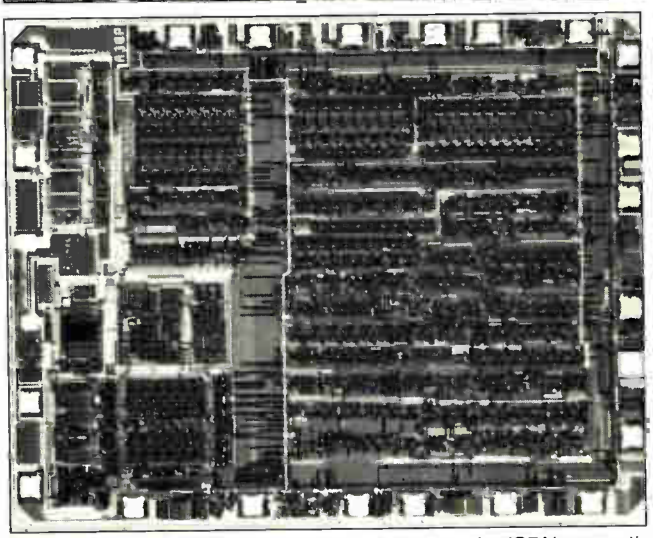
There may be no greater gap among manufacturers' market views and ISDN silicon-implementation strategies than in Austin, where Motorola and AMD are crosstown rivals. While both agree that ISDN compatibility will be a must for their customers, they disagree about how quickly and to what extent the standard will spread through the office.

AMD and Motorola are both rolling out members of a new generation of chips aimed at the integration of voice and data transmission. AMD's Communications Directorate in Austin officially kicked off its much talked-about ISDN line with a bipolar subscriber power controller, the Am7936.

It is among the first ISDN-compatible chips available. John Landau, marketing manager, says it is the only monolithic terminal power device for ISDN. The chip, made from AMD's 90-V bipolar technology, contains a switched-mode regulator that converts an input dc voltage of 15 to 70 V down to an output level programmable from 5 to 40 V. The chip hits the market at $15.75 each in 100-piece quantities. AMD's ISDN-product bandwagon is likely to roll out other ISDN components quickly, with a CMOS digital subscriber controller chip, the 79C30, slated for introduction next quarter.

**CONFORMIST.** AMD's Am7936 subscriber power controller is part of a chip line that hews to the letter of the ISDN specifications.





**NONCONFORMIST.** Although Motorola has plans for ISDN-compatible ICs, its UDLT II implements a nonstandard two-wire interface.

Across town, Motorola pulled the wraps off its second-generation Universal Digital-Loop Transceiver chips [*Electronics*, June 2, 1986, p. 9], which double the speed and channels of its 80-kb/s UDLT. The introduction is part of a multitiered strategy that will allow makers of office voice/data systems to mix ISDN terminal connections with connections made using their own transmission schemes. The UDLT II caters to what Motorola believes will be a persistent desire on the part of telecom houses: to provide low-cost two-wire proprietary interfaces as an alternative to the four-wire interface specified by ISDN.

Motorola is also collaborating with Northern Telecom Inc., Nashville, Tenn., to develop a line of ISDN chips that will support the standard four-wire terminal interface. The MC145474 ISDN S/T transceiver is in design, and samples of the high-speed CMOS chip are slated to become available by November, says Al Mouton, Motorola MOS telecom marketing manager.

"The way I'd like to put it is that the UDLT is not a competitor to ISDN, but rather a complementary product. You could have the UDLT and S/T transceivers serving two applications inside the same office switch," Mouton says. Motorola believes it has outdone the ISDN specs with its new UDLT II master/slave transceivers. The MC145421/25 has one more 16-kb/s signaling channel than the ISDN spec calls for, yet it runs on two wires. "It has a big advantage going for it when customers do not need the ISDN interface," Mouton notes.

AMD engineers, by contrast, argue that strict adherence to the ISDN standard is needed to ensure the kinds of chip volumes that will drive down the cost of four-wire interfaces. AMD intends to be aggressive in driving down the cost of its ISDN S interface after its introduction in the third quarter of this year. One cost-trimming measure will be to shrink chip geometries from 1.6-μm CMOS to—eventually—0.8 μm without major changes in the chip design.

Low cost is also the target of AMD's ISDN chip-integration strategy. The company believes its digital subscriber controller has the majority of functions needed in S-interface terminals.

Motorola is working on what it says is a highly flexible four-line Interchip Digital Link (IDL), which will become a fixture on its future telecom ICs. The company plans to place the IDL interface on its ISDN chips and a future version of the UDLT. The IDL is part of Motorola's collaboration with Northern Telecom; its purpose is similar to different interfaces supported by Intel, Mitel, and Siemens.

Mouton says Motorola spent nine months polling potential customers to be sure IDL covers a broad spectrum of clock speeds—128 kHz to 4 MHz—designed into many existing backplanes. Morton notes that other chip-to-chip interfaces have been derived by PBX manufacturers, which also intend to sell ISDN chips. *–J. Robert Lineback*

*IC PRODUCTION*

# LASER WRITING TAKES A STEP FORWARD

**CONCORD, MASS.**

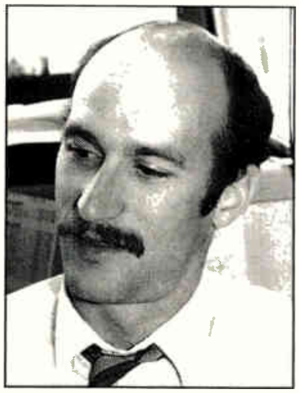
Laser-based direct writing of interconnection lines is moving closer to commercial use in the fabrication of integrated circuits. Researchers at the Massachusetts Institute of Technology's Lincoln Laboratory will report later this month on a better way to use polysilicon for laser-written interconnection by plating tungsten on top of the poly.

Doped poly is an attractive material because it is fast and easy to use in laser writing. The problem with poly is that it has high resistivity compared with metals. Until now, this quality has limited its use to devices with design rules on the order of 5 μm.

But exposing poly to gaseous tungsten hexafluoride lowers its resistivity. This has been reported in the past, but the Lincoln team, which includes Jerry Black, Scott Doran, Daniel Ehrlich, and Jan Sedlacek, is the first to apply it to laser-written poly lines. By exposing devices with laser-written poly interconnections to the tungsten gas in a furnace at 400°C for five or six minutes, the group was able to selectively clad the poly with from 1,000 to 1,500 Å of tungsten. This brought resistivity down to the range of 1 to 2 Ω/square for 400-nm-thick test lines—a twentyfold improvement.

**GATE ARRAYS, GaAs CHIPS.** The group will report on laser writing at 2.5 mm/s and describe a mechanically intricate vacuum cell that allows *in situ* device testing. Their applications work, funded by the Defense Advanced Research Projects Agency and the Air Force Office of Scientific Research, involved adding laser connections to a gate array and restructuring a gallium arsenide IC. It will be reported at the Conference on Lasers and Electro-Optics in San Francisco, June 9-13.

Laser direct writing and pantography [*Electronics*, Jan. 20, 1986, p. 23] are additive techniques in which lasers are used for finely localized control of chemical-vapor-deposition reactions. Unlike subtractive processes, they require no built-in structures such as the fusible links; such structures take up chip space. Also, "by avoiding lithography, we have rapid turnaround on configuring circuits," says Ehrlich, leader of the lab's submicrometer technology group. He says the processes are particularly promising for use in semicustom ICs, wafer-scale integration, and multichip devices.



**EHRLICH:** Laser-writing applications are being opened up.

Meanwhile, research on laser writing with metals continues at Lincoln, Lawrence Livermore National Laboratory, Columbia University, and elsewhere. Metals still offer much lower resistivity than poly and are likely to be the materials of the future for laser writing. Poly "is very nice for demonstrations, and [tungsten cladding] does make it useful, but I think direct metal is the long-term way to go," says Black.

But tungsten cladding does enhance poly's allure, maintains Art Elsea of Burns Research Corp., Santa Clara, Calif. He suggests that some might seek an alternative to metal writing because it is slow and the materials involved are extremely toxic. "Even though the [resistivity numbers] are not as good, this will open up a lot of applications for polysilicon."

Many believe that laser-writing technology is almost ready for large-scale commercial use. Greatest early interest is for customizing gate arrays, says Elsea.

One problem with commercial acceptance of laser writing is the unavailability of laser-writing equipment. But industry watchers report several companies are rushing to produce commercial machines for this type of IC processing; they should be available by the end of 1987. *–Craig D. Rose*

*CONSUMER*

# CES TALK: SHAKEOUT DUE IF PROFITS DON'T RETURN

**CHICAGO**

Manufacturers' plans to make across-the-board price hikes on consumer video and audio gear provided one of the hottest topics at last week's Summer Consumer Electronics Show here. The consensus was that if price increases don't stick soon, the structure of the industry could change.

"The industry has got to return to some semblance of profitability. If it doesn't, you'll start seeing massive shakeouts of some of the major brands. They'll just disappear," warns Anthony Mirabelli, marketing vice president for the Audio Video Division of NEC Home Electronics (USA) Inc., Wood Dale, Ill. Jack Sauter, group vice president for RCA Consumer Electronics in Indianapolis, agrees: "I believe that the higher costs of playing in the consumer electronics game, compounded by the yen/dollar relationship, will shrink the number of participants in the near future."

But many in the industry don't plan to hold their breath until prices actually go up. "We've been hearing about price increases since last December, and we have yet to see the first one," complains John J. Bohntinsky, a buyer of tabletop color TVs for the Sears Merchandise Group in Chicago.

The mass move toward price-hike attempts is driven by the precipitous drop in the value of the dollar against the Japanese yen. By raising the cost on Japanese imports to the U.S. by some 30% since last September, the yen's upward move has put severe margin pressure on the consumer electronics industry's premier Japanese manufacturers.

**HIKES WON'T STICK.** Sony Corp. of America and Zenith Electronics Corp. were among the first to raise prices from 5% to 12% last fall [*Electronics*, Nov. 18, 1985, p. 31], a move that was followed by most major players to some degree. But in the fiercely competitive consumer business—some 70 brands compete in video cassette recorders and more than 40 in TV, for example—the industry has been hard-pressed to make price hikes stick, particularly on popular midrange and low-end products.

"All it takes is for one manufacturer not to go along with the increase or one retailer to say, 'I'm not going to do it,' and the whole thing collapses," as one industry official explains it. In some cases, manufacturers have been forced to rescind announced price hikes; in other cases, retailers have been forced to absorb the difference to be competitive.

At Zenith, where competition on low-end video pricing is largely blamed for losses of $7.7 million in 1985 and $4.4 million in this year's first quarter, marketing vice president Bruce A. Huber confirms the trend. "We implemented increases around Thanksgiving of $10 to $20 at retail on our 25- and 27-in. stereo [TV] line, and the demand is so high on those products that nobody batted an eyelash. But the low end is a different story," he notes, adding that the Glenview, Ill., firm was unable to implement hikes on selected lower-end models announced in February and again in April.

*Consumer trends soon 'will shrink the number of participants'*

"Certainly on VCRs, it's simply remarkable that the yen has escalated the way it has, and we haven't seen price increases," Huber says. "Sooner or later, it's got to break."

Many who attended the Chicago show agree. "Most of the manufacturers have had to sell their low-end models without really raising prices, and the manufacturers, dealers, and retailers are not making money selling these products," says Junichi Egawa, general manager of U.S. corporate planning and development for the Victor Company of Japan Ltd. (JVC), a Matsushita affiliate. As a result, JVC, like others, is emphasizing cost-reduced high-volume products with more value-added features on which a certain amount of profit can be expected, Egawa says. JVC's recently introduced GR-C7 camera/recorder [*Electronics*, June 2, 1986, p. 44] is an example, he notes.

**JAPANESE PLANS.** Japanese manufacturers are also striving to offset the new yen/dollar structure through manufacturing efficiencies. Some have also cut back on advertising and other overhead. The fall of the dollar's value may also accelerate the trend toward more U.S. manufacturing by Japanese firms. It is likewise causing some suppliers to consider buying more components in countries such as Taiwan and Korea, where the currency is tied to the dollar and is thus less affected by the swing relative to the yen, industry sources say.

But most say that such moves won't be enough to stem operating losses without price increases. "The factories have worked hard at finding new manufacturing efficiencies, but there's not a whole heck of a lot more we can do in the factory," says Steve Isaacson, national sales and marketing manager of consumer video products for JVC Company of America, Elmwood Park, N.J.

Isaacson contends that although JVC has raised prices only on selected products during the last few months, the falling dollar has at least led to better price stability across the market than in previous years. And there were signs at the Summer CES that more general price increases could finally be in the offing for this year's second half.

One reason for the market resistance to higher pricing is that many suppliers

## EIA RAISES ITS FORECAST FOR 1986 U.S. CONSUMER MARKET

**Surprising growth** in color TVs as well as strong performance in such products as video cassette recorders and audio Compact Disc players caused the Electronic Industries Association last week to revise its projections upward for the size of the 1986 U.S. consumer electronics market. In figures released at the Summer Consumer Electronics Show in Chicago, the EIA's Consumer Electronics Group now predicts total factory sales of consumer products to U.S. dealers will top $26 billion this year, some 7% ahead of last year's $24.4 billion mark. At the Winter CES in January, the EIA/CEG was predicting a 5% rise this year, to $25.6 billion [*Electronics*, Jan. 20, 1986, p. 19].

Despite a 92% saturation level in U.S. households, color TV sales appear to be headed for another record this year, rising to 17.3 million units compared with 1985's 16.9 million units. In January, the EIA/CEG had predicted a slight downturn for color receivers in 1986 to 16.7 million units. EIA/CEG vice president William E. Boss attributes the uptick to the fact that consumers are replacing their TVs with more fully featured sets that are becoming the central component in connected video and audio systems. In all, color TV sales—excluding projection TV—will account for about $5.6 billion in factory sales this year. About 3 million of the 17.3 million units sold will have built-in stereo capability, Boss says.

VCR sales are also running strong, with the EIA group now projecting 11.8% growth, to 13.2 million units this year. That's a leveling off from 1985, when VCR factory sales rose by about 41%, to 11.8 million units. But it's still ahead of what the EIA expected in January, when it projected 1986 VCR sales at 12.5 million units.

On the audio side, the sales momentum being generated by CD players also continues to outrun expectations. "In January, five short months ago, [sales of] CD players were pegged at 1.5 million units for 1986," says Boss. "From the June vantage point, the number should be more like 1.8 million units, with a factory value of $360 million."

The EIA/CEG also revised upward its 1986 projections for sales of camera/recorders, blank video cassettes, and one-brand audio component systems. But the group lowered its estimates for home computer and home satellite systems.

In home computers, the group now expects modest 2% sales growth this year, to 4.2 million units. That's down from the 4.5 million predicted in January.

Sales of consumer satellite earth-station systems dropped sharply after Home Box Office Inc. announced that it would begin scrambling its signal in January. That development forced the EIA/CEG to lower its projections for the year. Compared with the 700,000 units predicted in January, the group now expects satellite-system sales to fall off by a third, to 400,000. *—W.R.I.*

are still selling products purchased from Japanese vendors when the dollar was priced higher against the yen, some sources say. What's more, Korean manufacturers—accused of leading the recent low-end product price deterioration—are now also joining the price-hike chorus. "You'll see a slight rise in Korean pricing in the second half, depending on the product," says an official for South Korean Samsung Electronics Corp. And Goldstar Electronics International Inc., Lyndhurst, N. J., the U. S. arm of another major Korean supplier, announced 2% to 3% price hikes in April.

At Sony Corp. of America, Park Ridge, N. J., national sales manager for consumer video products R. Jay Sato sees potential for price hikes this year in products such as video camcorders. In that emerging category in particular, many consumers have not done much shopping around yet and so may not object to higher prices. In VCRs, however, competitive pressure from the Koreans will make it much tougher to reverse recent downward price trends, he says. *–Wesley R. Iversen*

***BUSINESS***

# TECHNOLOGY ESCROW BACKSTOPS VENDORS

**NEW YORK**

It's an all-too-familiar story: a vendor closes up shop, and its customers don't have access to the source materials—such as source code for programs and schematic drawings for hardware—that would help them maintain the crucial technology. That's a story for which Data Securities International aims to provide a happy ending with its technology escrow service that covers both software and hardware.

Data Securities seeks to protect the buyer of covered software and hardware by providing third-party possession of source materials, design and maintenance documents, and debugging and testing tools. The San Francisco company will ensure that the source materials are kept complete, correct, and up to date.

Data Securities also offers a similar service for ownership protection of software and other technology. It differs from the escrow service in that its purpose is to provide a neutral party for recording changes made to the technology during development, thus substantiating ownership.

The escrow service has found most of its early business in software coverage, because dependence upon software, especially from outside sources, is growing very rapidly. As the number of licensed programs a business depends on grows, so does the probability of taking a hit—meaning that a supplier will no longer be able to support a product.

"The majority of the end-user community today doesn't seem to recognize its increased dependency on software," says John Noerr, president and co-founder of Data Securities. "Top management and risk managers—except in banks—don't seem to realize the value of the software they use."

The technology escrow service works this way. The vendor agrees to deposit with Data Securities all the source materials for the technology (a software product or a hardware design), to continually supply changes and updates, and to allow the company to release these source materials to a customer under stipulated conditions.

For its part, Data Securities will provide safe physical storage of source materials, verify their integrity, ensure that updates and enhancements are supplied, and help both parties agree on the terms of the escrow. If necessary, it will hand the source materials over to the customer when the vendor fails to adhere to the product-support schedule.

In addition, a vendor can choose to have the escrow company manage its product distribution if it has escrow agreements with a number of customers. The vendor can send one update to Data Securities, which will then notify and distribute the updates to the customers.

Most of the big computer companies have sizable and rapidly growing third-party software-acquisition activities. Noerr expects his business to grow as the management of these companies becomes aware of how much exposure to possible loss this creates.

One Data Securities customer had seen the peril long before it signed up. "Hewlett-Packard has a consistent escrow activity and will not market a product [obtained from a third party] associated with the HP name if it doesn't have either possession of the source materials or an escrow agreement," Noerr says.

**RISC COVERAGE.** The company is handling more hardware agreements now. Prime Computer Inc. has licensed reduced-instruction-set-computer technology from Mips Computer Systems, Sunnyvale, Calif., for use in a future product. The Mips boards that the Natick, Mass., company will use are protected by the escrow service.

To increase its visibility and the awareness of growing liability to loss of technology assets, Data Securities is opening sales offices around the U. S. It now has one in Boston, three in California, one in New York, and is about to open one in Dallas. *–Tom Manuel*

***PACKAGING***

# EMBEDDING ICs IN PLASTIC CUTS INTERCONNECT SPACE

**KAWASAKI, JAPAN**

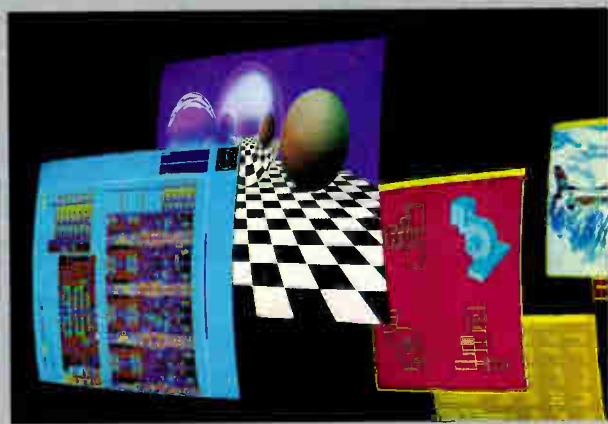
The physical link between large-scale integrated circuits and outside circuits—now generally a wire bond—is becoming more and more of a space problem as electronic products get smaller. Toshiba Corp.'s new wiring scheme may provide one circuit-shrinking solution. It involves printing polymeric conductor patterns on a polycarbonate sheet with one or more chips embedded in it.

As products get thinner and as the pitch of bonding pads on chips decreases, wire bonds start taking up too much height and spacing. Tape automated bonding helps solve these problems, but it is expensive. Toshiba thinks it may have found a good alternative to TAB.

The new wiring scheme is being developed at the Functional Devices Laboratory of the Kawasaki company's Research and Development Center, where it is called printed wiring connection. Senior researcher Hiroshi Ohdaira says that the technology is expected to find application within two years as boards in many small products such as thin radios, card calculators, memory cards, smart credit cards, and the tuners for miniaturized TVs with liquid-crystal displays. Further in the future, it may find its way into larger systems such as small Japanese-language word processors or laptop computers.

Today, the smallest patterns of silver epoxy that can be reliably printed on the plastic sheets have line widths of 100 μm and line spacing of 100 μm for a 200-μm pitch. In the future, it should be possible to halve dimensions of both lines and spaces for a pitch of only 100 μm, the researchers say. Further improvement in the rheology of the inks will be required to achieve these fine pitches because printed lines tend to

# Digital has it now.



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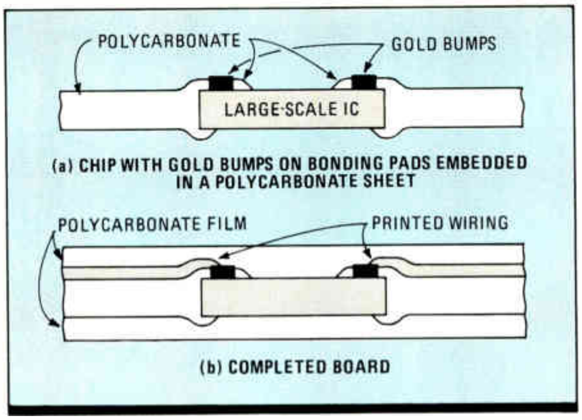
Ohdaira points out that the higher-density connections are needed because chip size for a given function keeps decreasing with time while the number of connections it requires remains constant. A desktop calculator chip measuring 3.2 by 3.2 mm today has 44 bonded leads. In the future, chip size will be down near 2.0 by 2.0 mm, but 44 leads will still be required.




**NO WIRE BONDS.** A low-profile interconnect scheme from Toshiba embeds chips in a polycarbonate sheet.

The new process starts with fabrication of gold bumps on LSI chips' bonding pads. Bumps are needed to provide a stable, low-resistivity contact to the polymeric connections. They also elevate contacts above the surface of the chip to enable the chips to be embedded in the board in a manner that provides insulation between the edge of the chip and the connections. The Toshiba lab is now forming bumps by making a ball bond to a pad and then disconnecting the lead to leave only the ball on the pad. In production, bumps would be made by depositing gold on the pads and then plating—a standard technique.

Board fabrication and the wiring process are relatively simple. Holes slightly larger than chip size are punched in a polycarbonate sheet that is to become the printed-wiring board. Chips are inserted in the holes, and the sheet is compressed at 160° to 180°C. This deforms the sheet plastically so that it fills in the gaps around the chips. Polycarbonate also spreads over top and bottom surfaces of the chips near their edges but does not extend above the tops of the bumps.

**ACCURACY NEEDED.** Conductive interconnections are then printed on the boards. A disadvantage is that there is no way to correct for relative displacements of chips, which automatic wiring machines can do, and therefore high accuracy is needed for chip positioning during board fabrication and screen positioning before printing. Ink is cured at 120°C, and then the board is laminated at 160°C between two 100-μm-thick sheets to seal the structure. The complete laminated board is only 500 μm thick.

Other components, including chip capacitors and chip resistors, can be included in the structure. Initially, this new technology will only be able to handle about three such chips because of the need to position LSI chips precisely, but there is no such limitation on passive components, which have much larger connection pads. Another limitation on the number of chips that can be used practically is the yield figure for the chips themselves, because fully tested chips are unavailable and Toshiba does not envision reworking boards to replace faulty chips. This problem should be solved by developing a method of fully testing chips after dicing.

Another present limitation is the inability to solder external components or connections to the board because temperatures during assembly must be kept below 150°C. Solderless assembly techniques are being developed.

For initial experiments, the Toshiba researchers decided to package a single memory chip to facilitate testing. A 64-K erasable programmable read-only memory was selected because it doesn't require standby voltage. There were no failures, despite high-temperature storage at 120°C, operation at 60°C and 95% relative humidity, low-temperature storage at −25°C, thermal shock test, and a test involving a high applied voltage to check for electromigration of the printed pattern. *–Charles L. Cohen*

*NETWORKING*

# STARLAN ICs ARRIVE, STANDARD NEARS

**SAN MATEO, CALIF.**

Starlan, the twisted-pair local-area network developed by AT&T Information Systems Inc., is beginning to make up some ground on rival low-cost LANs. Last week, two chip makers announced Starlan interface chips. And next month, a draft standard based on Starlan is slated to be circulated to a task force of Committee 802.3 of the Institute of Electrical and Electronics Engineers, the industry's standards body for 1-Mb/s carrier-sense multiple-access nets with collision detection.

AT&T Information Services has placed a couple dozen Starlans in both commercial and academic systems since the network was announced last year. AT&T's boards are built around the Intel Corp. 82586 Ethernet controller, which is a sophisticated processor but needs external logic to perform the Manchester encoding used in the Ethernet/IEEE standard on carrier-sense multiple-access LANs with collision detection.

Now, Chips & Technologies Inc., a Milpitas, Calif., semicustom CMOS house, and Semi-Custom Logic Inc., a San Jose, Calif., startup hoping to catch the Starlan wave, are introducing CMOS gate arrays that perform encoding and other functions, allowing cheaper boards than AT&T's to be put together.

C&T also offers a hub controller chip, which performs timing, jitter control, and several other complex functions on the short bus that contains most Starlan traffic. (What look like the arms of a star in the network topology are actually long drop lines that terminate in a wiring closet, or hub.)

**CHIPPING AWAY.** These chips—the 82C550 Manchester decoder/encoder and 82C551 hub controller from C&T, and the SL4000 from Semi-Custom Logic—will make it possible to replace the AT&T board with a chip set and, presumably, to drive Starlan prices down.

AT&T prices its Network Access Unit at $595 and its hub controller at $579. The quoted prices are misleading because they are for single units, but they are still far from the Starlan target connection price of $100 to $150.

Semi-Custom Logic sells its SL4000 encoder/decoder for $15 in quantities of 100. The comparable C&T product, the 82C550, is $15.60. C&T's hub controller is $56.70, and it performs all of the functions of the AT&T board, according to product marketing manager Sikander Naqvi.

The new interface chips are the first aimed at reducing the chip count on the 586-based Starlan board. Already there is competition: last fall, Redix, a Santa Monica, Calif., supplier of network equipment, introduced several board-level products built around the 82588 controller, tailor-made for Starlan by Intel and introduced after AT&T had already committed itself to the 82586 for its boards.

The 588 is less intelligent than the 586, and so is more taxing for the host processor. But it costs less than the 586 and does its own Manchester encoding to boot, saving more than 50% in overall chip costs. The Redix PC-20 includes an 80188 microprocessor and is priced below $400, including software up to the transport level of the OSI model. (AT&T charges extra for minimal software.)

Another Redix board, the PC-10, does not include the 188 and will sell for less than $300. The PC-10 is producible in volume for well under $100, says Redix chairman Carlos Tomaszewski, "and in the long run, under $50."

So far, Redix is the only U. S. supplier of Starlan boards outside of AT&T. However, Robert Galin, data communications product marketing manager for Intel's Microsystem Components Division in Folsom, Calif., says a number of manufacturers have 588-based products in the wings, and France's Bull has a 588-based board in Europe.

All these products implement an IEEE draft standard known as 1BASE5. Galin has been shepherding this document through a task force of 802.3 since Starlan was made public two years ago [*ElectronicsWeek*, July 30, 1984, p. 11].

Draft E3 of 1BASE5 is about to go out to the task force for final comment before being submitted to the parent 802.3 committee. The final version will set a standard for 1-Mb/s carrier-sense multiple-access with collision detection to which any manufacturer can build, clearing the way for a challenge to the dozens of low-cost proprietary LANs.

The open architecture makes it possible for small firms to jump into the market, points out Idris Kothari, president of Semi-Custom Logic. The SL4000 is the company's only product to date.

Advanced Micro Devices, National Semiconductor, Rockwell International, and Seeq Technology also offer 802.3 controller chips. Within a year, says Tomaszewski, "we will see Starlan components on a motherboard and Starlan ports like RS-232-C ports." Even IBM Corp., which already supports a 1-Mb/s broadband net for its Personal Computer line, has shown some interest in Starlan, he adds. *–Clifford Barney*

**MICROPROCESSORS**

# GaAs RISC PROCESSOR IS IN THE WORKS

**DALLAS**

Chips under development for the Pentagon will combine the emerging trend of reduced-instruction-set-computer architectures with the long-held promise of fast, high-temperature gallium arsenide semiconductors.

Certain aspects of the two embryonic technologies—for example, the current chip-density limitations of GaAs chips—appear to make the match ideal, suggest military-product executives at Texas Instruments Inc. TI is teamed with Control Data Corp., Minneapolis, to produce the GaAs 32-bit RISC-processor chip set for the Defense Advanced Research Projects Agency by early 1987.

CDC is the principal architect of the RISC implementation, while TI is heading up implementaion of the design in HI²L, for heterojunction integrated injection logic. A 32-bit GaAs RISC central processing unit and floating-point coprocessor are now in design, and initial engineering prototypes are expected to be working during the first half of 1987.

TI and CDC plan companion GaAs chips, including a vector coprocessor, a memory management unit (which can be used for either instruction or operand management), and high-speed GaAs memories, says Philip Congdon, manager of the Gallium Arsenide Systems and Components Department in TI's Defense Systems and Electronics Group.

Some of the GaAs memories are likely to be designed with dual ports for high-speed cache applications, but TI is also considering a 1-K-by-32-bit GaAs static random-access memory. A processor interface device will probably be implemented from a GaAs gate array, says Congdon. The first 32-bit CPU, which can also be used as an input/output processor, and the floating-point coprocessor could become available on the market by the first quarter of 1988.

If successful, the radiation-hardened integrated circuits are likely to find a home in a wide range of future intelligent weapon systems, including some proposed for the Strategic Defense Initiative. Work on the GaAs chips recently moved from a year-and-half-long conceptual phase to the first half of a implementation stage, which represents a $4.2 million DARPA contract.

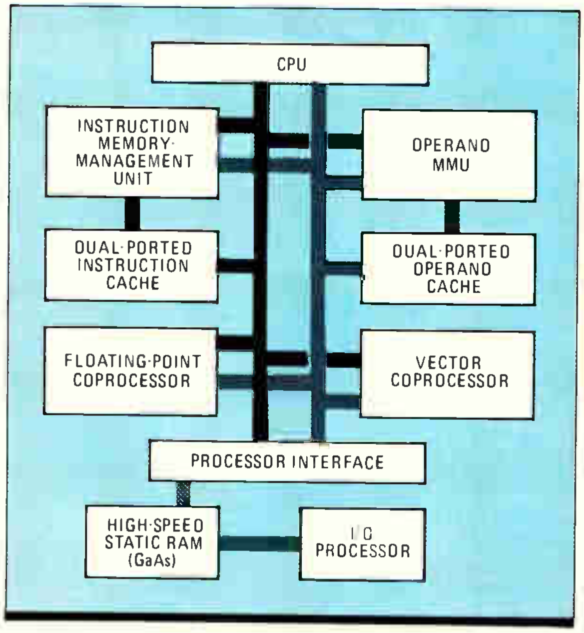
**SHIFTING BUSINESS.** The brief glimpse of the RISC-chip set comes as TI officially announces its entry into the digital and microwave GaAs military IC business. The GaAs components, along with a future line of low-profile high-frequency military power supplies, are the result of TI's recently formed Military Components Intracompany Objective, which aims at transferring new technologies from the exclusive use of the defense equipment group to the company's component-marketing Semiconductor Group [*Electronics*, April 14, 1986, p. 17].

All totaled, the new wave of GaAs chips and standard military power supplies will broaden TI's already extensive defense-component portfolio to address new markets expected to exceed $1 billion by 1990. TI's first GaAs microwave components, which include monolithic power amplifiers, feedback amps, and low-noise and power FETs, are now being offered in sample quantities. Digital GaAs ICs will be available in the second half of 1987.

The experimental GaAs RISC processors are not yet on the new-product roster, but managers heading up the new military product thrust believe RISC's lean nature is a natural fit for GaAs chips, which have lower densities than those built in advanced silicon processes. Integrating a general-purpose 32-bit microprocessor in GaAs is still impractical.

"The RISC architecture allows us to cut out the unneeded features normally contained on general-purpose microprocessors," notes military component manager Robert L. Veal, who is involved in TI's new GaAs product efforts. The GaAs chip set's CPU contains just over 10,000 gates, compared with more than 50,000 for general-purpose CPUs, Veal adds. It will have a set of only 20 to 30 instructions.

A unique six-stage pipelining technique enables a




**IDEAL MATCH.** GaAs and RISC technology underlie the seven chips for a 32-bit processor due from TI and Control Data.

## INSIDE TECHNOLOGY


# HAS CAE LIVED UP TO ITS PROMISE?

### USERS OF THE TECHNOLOGY HAD HIGH EXPECTATIONS; NOW THEY'RE TAKING A LONG, HARD LOOK

*by Jonah McLeod*

Computer-aided engineering began taking off in a big way back in 1981 when the engineering work station arrived on the scene. Sales of CAE systems exploded and started doubling every year until late in 1985. Then they suddenly started slowing down. For many people, this slackening growth raised a crucial question: Was the market slowing because CAE was not living up to its promise?

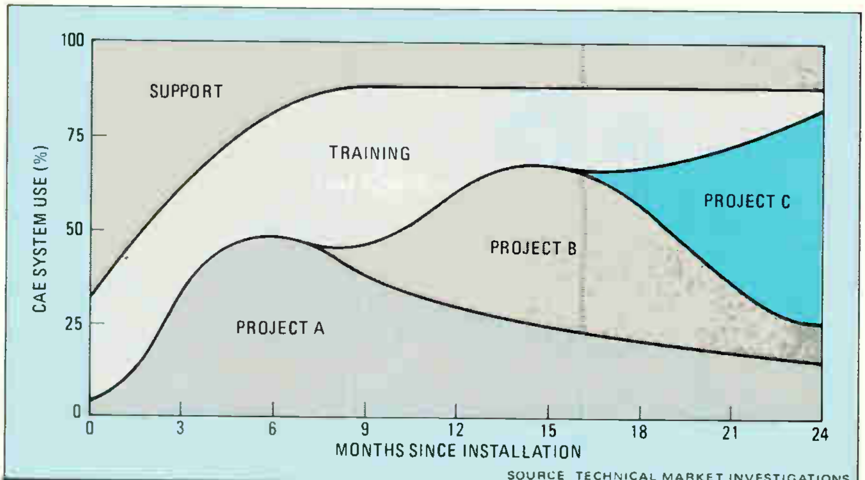
As usual, the answer was not all that simple. Indeed, some customers did not believe that CAE had delivered yet on its promise of greater engineering productivity. Some companies, in fact, have decided not to invest in any more CAE work stations until the equipment they've already purchased makes good on manufacturers' claims. But CAE sales were slowing for at least three basic reasons. Hurting the most was the overall industry downturn; second, the overly optimistic expectations of many CAE customers; and finally, those vendors who promised more performance and faster productivity gains than they could deliver.

In the beginning, technology-driven companies saw CAE as a good solution to their mounting engineering costs and lengthening design cycles of increasingly complex products. These early adopters rocketed CAE from its specialized niche into a large and competitive market with a host of hardware and software suppliers. But there are still technical problems to be solved. Engineers are discovering that systems don't automate as much of the design process as they had expected. Still needing to be developed are the tools for schematic capture and simulation that link directly with layout tools for integrated circuits, printed-circuit boards, and systems.

Engineers are also looking for systems that can handle circuits that have thousands rather than hundreds of gates. Linking existing work stations and larger computers also continues to be a real problem. The problem pressing most CAE equipment vendors is devising workable simulation tools. Many CAE users find they are using their expensive work stations solely for schematic capture, because the simulation software has proven difficult to use and inadequate for the task. Finally, users complain it is difficult to connect different kinds of CAE gear because standards are lacking.

CAE system sales are now growing at about 42% annually, according to Technical Market Investigations, a Thousand Oaks, Calif., market researcher. That's not too shabby by anyone's standards, but it's less than half the 1984 rate. Sales amounted to $408 million last year, up from nearly $300 million in 1984. This dip tended to follow the entire computer market down, but not nearly as far. Computer sales managed only a 15% increase last year, which was down from the 30% annual rate in the early 1970s, Dataquest Inc. says.

"Because of the downturn in the computer and semiconductor industry, decisions on capital expenditures moved up the corporate ladder from the engineering department where they were previously made," says Robert Castellano, author of two CAE-systems market reports from Electronic Trend Publica-




**1. FULLY LOADED.** As users become familiar with a computer-aided-engineering system, they discover that it can juggle more projects than their initial impression led them to believe.

tions, a Cupertino, Calif., research firm. As a result, CAE expenditures have been delayed, postponed, or eliminated.

One researcher recently laid out different growth scenarios over the next three years for CAE equipment sales. William Swift, president of Technical Marketing Investigations, says his most pessimistic scenario calls for a 26% growth rate and assumes no change in demand and no further improvement in equipment functionality. His most optimistic scenario results in a 62% annual growth rate and assumes that new equipment will have greater connectivity with existing hardware.

Swift is one of the industry experts who believe that another fundamental factor affecting the slowdown in growth was that first-generation CAE equipment was simply not the total solution that many buyers expected. Craig Symons, an analyst with the Gartner Group, Stamford, Conn., agrees. He says that delivered systems, which typically cost between $50,000 and $100,000, have fallen short of the marketing hype that accompanied their sale.

"Several large users have told us that systems were originally cost-justified on the marketing claims that indicated the systems were capable of assisting in all phases of the design cycle," Symons explains. "But they use the work stations for schematic capture only," largely because of the complexity of the logic and fault-simulation tools on the market. With several companies offering schematic capture on personal computers at a turnkey price of $25,000, it is unlikely that $50,000 work stations will be bought for the same purpose. Many users are turning to the cheaper, microcomputer-based solutions, even though they do not provide the capability of larger systems. Smaller displays with lower resolution, less powerful central processing units, and other factors combine to reduce the effectiveness of the personal computer approach.

User impatience is also cited as a reason for the perception that CAE is not delivering its promised productivity. Disappointed buyers expected to see an immediately noticeable jump in productivity. "But, given the support and training requirements, the first projects on CAE work stations generally did not proceed to market very fast," says Swift. It has taken time for engineers to learn how to deal effectively with this new design methodology.

Art Lancaster, general manager of the RCA-Sharp Design Center in Vancouver, Wash., agrees. He says that a designer needs six months to become productive with an IC CAE system. What's more, having a CAE system doesn't speed up the most important part of the design process—front-end creativity. In most cases, the value added by a CAE system comes much later in a product's life cycle, even though many companies look for a short-term return. It is becoming apparent that CAE enables a design to be more easily debugged during the design cycle, reducing service costs and facilitating design upgrades. These CAE attributes contribute significantly to the bottom line, though not immediately.

While management looks to CAE for greater productivity, engineers themselves expect it to make their jobs easier. Among the designers Swift interviewed, most did not like the idea that work stations were bought to double or triple their output. "Engineers want to hear that the work station allows them to do a better job on more complex circuits," he says. "One engineer noted that the real benefit of a CAE system is it allows projects to be completed on time by eliminating sources of errors and projected delays."

But there are buyers of CAE equipment who have found that productivity has jumped—and many of them are discovering that they overbought, according to Swift. When systems were first purchased, they showed all the signs of being completely occupied with training, support, and some initial design tasks. This created the illusion that more stations were needed. But very shortly, as users began to understand the equipment, these "fully utilized" systems became available for additional projects (Fig. 1). By Swift's estimates, a typical system can support two projects a year after installation, training, and construction of model libraries. A CAE system is used heavily only during 25% to 30% of a project's life; during the remaining 70% to 75% of the project, the system can support a second and perhaps even a third project, he says.

Another reason some users of CAE systems have slowed their purchases is to cope with the variety of different systems their companies already own. One user says he had bought a large number of work stations from Daisy Systems Corp. and then realized that another group in the company had a large number of work stations from Mentor Graphics Corp. For the two groups to communicate, the company had to purchase a Mentor work station for those using the Daisy systems to transfer schematics between the two systems.

Another reason according to Castellano, is that the buyer has been confused by the plethora of new hardware and software offerings that have come available, in addition to the ubiquitous systems offered by established CAE vendors such as Daisy, Mentor, and Valid Logic Systems. These include IBM Corp.'s new platform for its RT PC and AT&T Technologies Inc.'s recent offering of third-party CAE software on some of its computers. "The buyer is waiting to see what is forthcoming from these new competitors entering the market," Castellano says.

## GETTING USED TO CAE

Despite the early frustrations, novice engineers and experienced designers alike agree that there is no turning back once automation enters the design process. They also agree that all engineers face the same problems when they implement CAE in their design process: CAE equipment was and still is complicated to operate.

Surveys show that initial exposure to CAE systems brings with it a number of problems for design engineers. First, the complexity of some design tools—especially those for logic and fault simulation—discourage many pc-board and system designers from using all but the schematic-capture capability of a work station. For designers of ICs and pc boards, a simulator requires a comprehensive library of IC models, including the latest very large-scale-integration devices. Enter-

*"Decisions on capital expenditures have moved up the corporate ladder"*
*–Robert Castellano*

ing these models by hand is time-consuming, and waiting for the work station vendor to provide them puts the designer at a competitive disadvantage. In addition, simulation is not effective without a high-performance computer. Simulations of complex chips or boards can take several days, even on a mainframe. But these hurdles are not insurmountable. Pc-board designers are confronting the complexity of the CAE tools by automating one task at a time, mastering schematic capture and then moving on to simulation.

New companies are now providing IC-model libraries, not only for readily available components but also for new chips such as Intel Corp.'s 80386 microprocessor. IC designers, who have always had to do simulations, need increasingly higher-performance processors as they learn their equipment and naturally demand more of it. Their needs are being met by new dedicated accelerators that speed up individual tasks such as logic and fault simulation and by parallel processors that speed up many computation-intensive tasks in the design process—in addition to simulation—such as design-rule checking and placement and routing.

# THE BUMPY ROAD TO COMPLETE CAE

Automated design of electronic products involves two processes—functional design, or CAE, and layout, commonly called computer-automated design. The big challenge now is to devise design tools that integrate the entire CAE process as successfully as other tools can integrate the CAD process.

In fact, CAE makers have come up with total solutions: systems that automate the entire process, all the way through fault simulation. But despite the emergence of such systems, another trend has developed: automating one task in the design process at a time and mastering the steps individually. William Swift, president of Technical Market Investigations in Thousand Oaks, Calif., surveyed 99 CAE installations and found that the successful CAE user automates one task in the design process at a time—schematic capture, for example. "Once he had mastered schematic capture, he would proceed to automate the next task, simulation," he says.

Regardless of the approach, the CAE/CAD process (Fig. 2) starts with an engineer capturing a schematic of the circuit in the form of a netlist. He then simulates circuit operation to ensure that it performs all the specified functions. Next, he verifies that the design operates according to the timing specification called for in the design. Finally, he simulates all possible fault conditions to evaluate the design's behavior, to verify performance of a real or emulated breadboard, and to characterize possible malfunctions. The circuit is then ready to be fabricated in silicon or on a pc board.

In the CAD process, the IC or pc-board designer partitions the design into segments that can be implemented readily on a board or a chip. Next, he makes a floor plan that locates each segment on board or chip, and then places the circuit elements by hand or with a tool that does it automatically. Finally, the elements are connected according to the netlist.

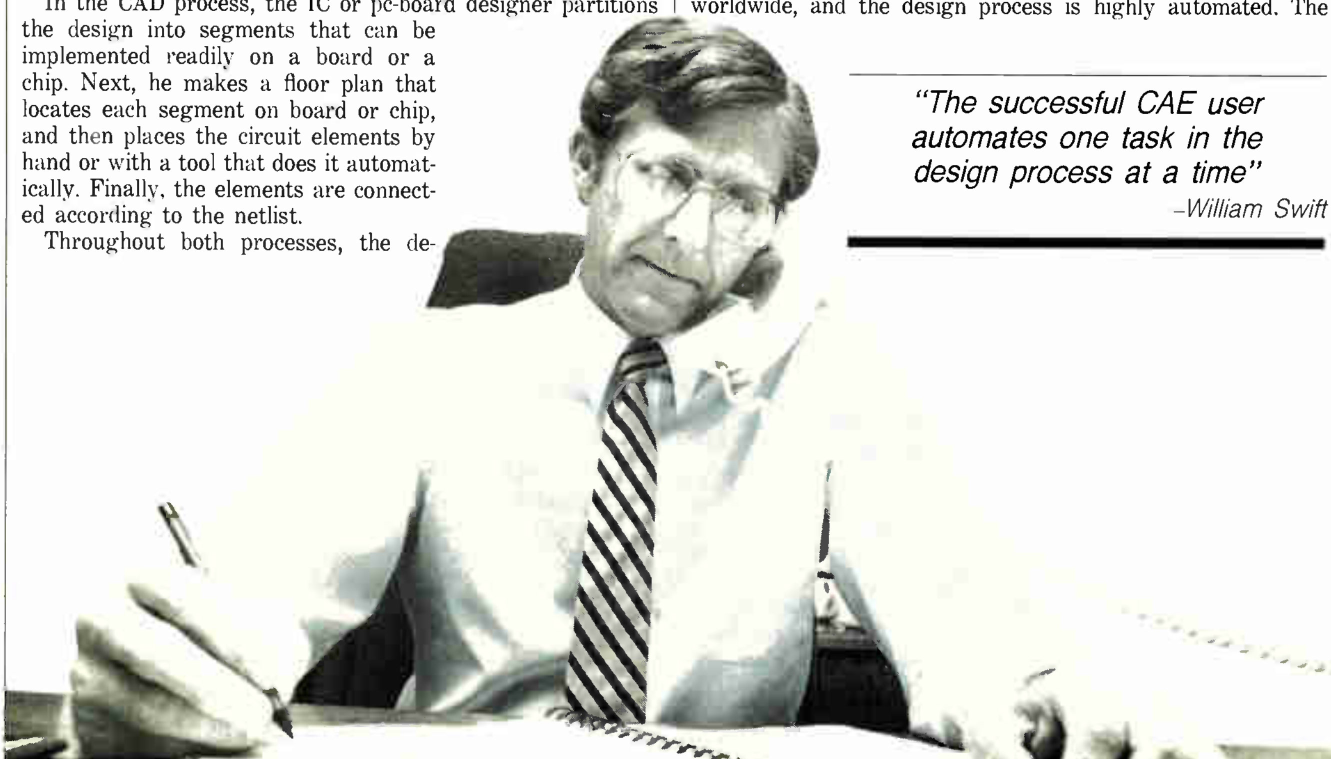
Throughout both processes, the designer or layout engineer operates in a loop—that is, results of one step may necessitate changes in a previous step, which then affects subsequent steps, and so forth. For example, the designer of a floor plan might have to change the schematic to meet timing specifications or to make the logic simulation work. The layout engineer might have to repartition the design to get all the functions within an economical chip size or to keep interconnections short to meet timing specifications. The advantage of current CAE equipment is its ability to perform these iterations automatically and, therefore, with fewer errors.

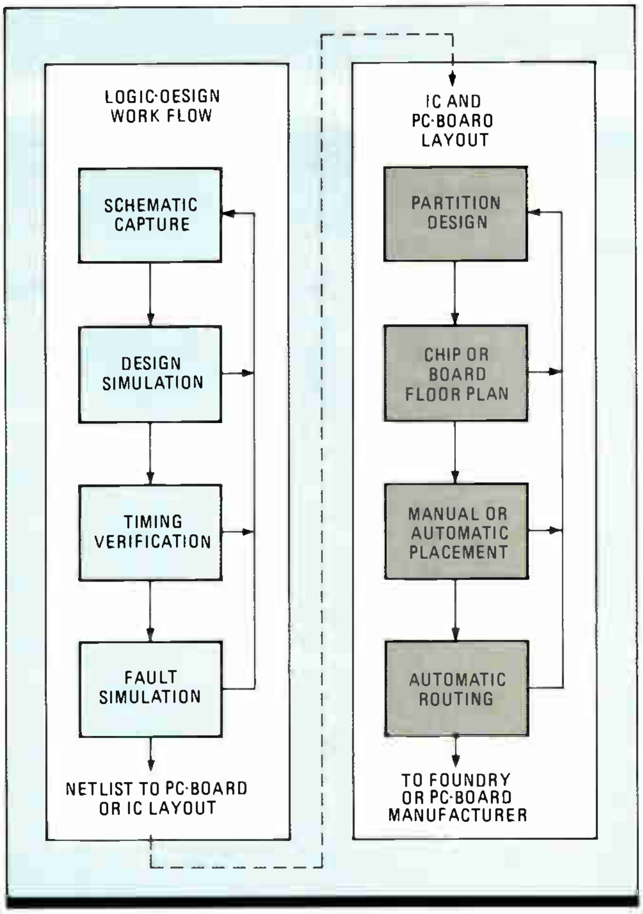
### GOING ALL THE WAY

Most design centers established for semicustom and custom designs are automated from the design-entry stage to chip fabrication. Art Lancaster, vice president and general manager of the RCA-Sharp Design Center in Vancouver, Wash., says his design center has had good experience with CAE work stations. He has 30 such systems, used by 17 designers and 13 layout engineers. The center handles designs with up to several hundred thousand transistors from inception to silicon. Like other design centers, however, RCA provides its own tools to supplement those from the CAE system vendor.

Earl Reinkensmeyer, senior CAD strategy manager for NCR Corp.'s Microelectronics Division in Dayton, Ohio, is in a similar position. His design center is one of 12 that NCR maintains worldwide, and the design process is highly automated. The

*"The successful CAE user automates one task in the design process at a time"*
*–William Swift*






**2. DUPLEX.** Electronic design involves two processes—functional design and layout—whether for a pc board or an IC.

company's setup must be able to handle the 20,000- to 500,000-gate circuits the center produces. As with RCA, NCR has proprietary tools that interact with the standard tools provided on the CAE work stations it bought from outside vendors.

However, even big companies are likely to have reached total CAE by taking the step-at-a-time approach. Hewlett-Packard Co., Palo Alto, offers an example. In designing its Vectra Personal Computer, the project's engineering group decided to buy CAE systems to automate the design. They surveyed the commercially available systems that provided an interface to their existing pc-board layout system. After a month, the group made its choice and took another week to install the system. The company decided to use only the schematic-capture capability of its new system, although other tools were available.

With a team of four designers, the project took only a year to complete; without the system, the job would have taken two years. Because the team did not use simulation for debugging, the design took five layout iterations, typical for a design of this size. But the HP engineers found that each iteration took less time and had fewer errors with the CAE approach.

HP recently announced it was integrating the entire design process in its design-center concept. Designers can now capture a schematic, debug the design, and pass the final netlist to a computer-aided-design work station through a network. The netlist can then be implemented in an IC or a pc board.

But in design labs that are not as fully automated, the notion that a work station is only being used for schematic capture has led many buyers away from the more expensive work stations to those based on personal computers. Among the earliest entrants into this market were Futurenet I/O Data Co., Chatsworth, Calif., which came out with the Dash Schematic Designer, and Personal CAD Systems Inc., Los Gatos, Calif., which introduced CAE-I. Both systems allow schematic capture and some on-line error checking.

Futurenet recently introduced Dash-4. "We've added the ability to rotate parts in a schematic," says Linda Burgess, product marketing manager. In the past, each new orientation of a part had to be redrawn and required its own storage space in memory. This new capability indicates a trend in schematic capture: the user wants more graphics functions.

"We've also extended the data base to contain more data about individual parts," Burgess adds. Previously, a user had to create a different schematic for each postprocessor, simulator, or pc-board layout system he wanted to use. Now, the information needed by various postprocessors is stored in each of the various schematic symbols of one schematic. Finally, the software also does some basic electrical rule checks. It checks to see that the designer has not driven too many inputs from a given output pin.

A more complete implementation of this capability is found in the Visula software from Racal-Redac of Westford, Mass. "Visula has the ability to recognize electrical connectivity rules and specific component characteristics," says company president Gene Robinson. The rules are part of the system's relational data base. Thus the software can advise the designer in real time of any potential electrical error. More recently, the major CAE work-station vendors—Daisy, Mentor, and Valid—have introduced their own schematic-capture products. Daisy Systems Corp. came out with the Personal Logician, and Mentor Graphics Corp. introduced the Entry Station. These products can more easily transfer the schematic-capture data file to a larger work station for intensive logic and fault simulation.

## THE WEAK SPOT

There's no question that automated simulation is the weak spot in CAE, both because designers have difficulty mastering the software and because the simulators turn out to be inadequate. "In the design of the Vectra PC, Hewlett-Packard chose not to use the simulation capability available on the CAE work station because it was a design methodology they were not familiar with," says Swift, who documented the case study. It has taken time to learn the technique and then to develop some of the IC models not in the simulator's own library.

Barry Vaughn, president of QC Graphics Inc., an Addison, Texas, pc-board service bureau, has had similar experience. His customers complain that they have had to build many new ICs into the their simulators before they can handle their particular circuit. The process of adding an IC to a simulator library is both time-consuming and tedious. "It can take an experienced logic designer from six to eight weeks to model a complex IC such as a 2901 bit slice," says Michael Turner, director of marketing at Logic Automation Inc., Beaverton, Ore. "A novice will take twice as long." Turner should know. His company was founded to create a library of IC parts for simulators.

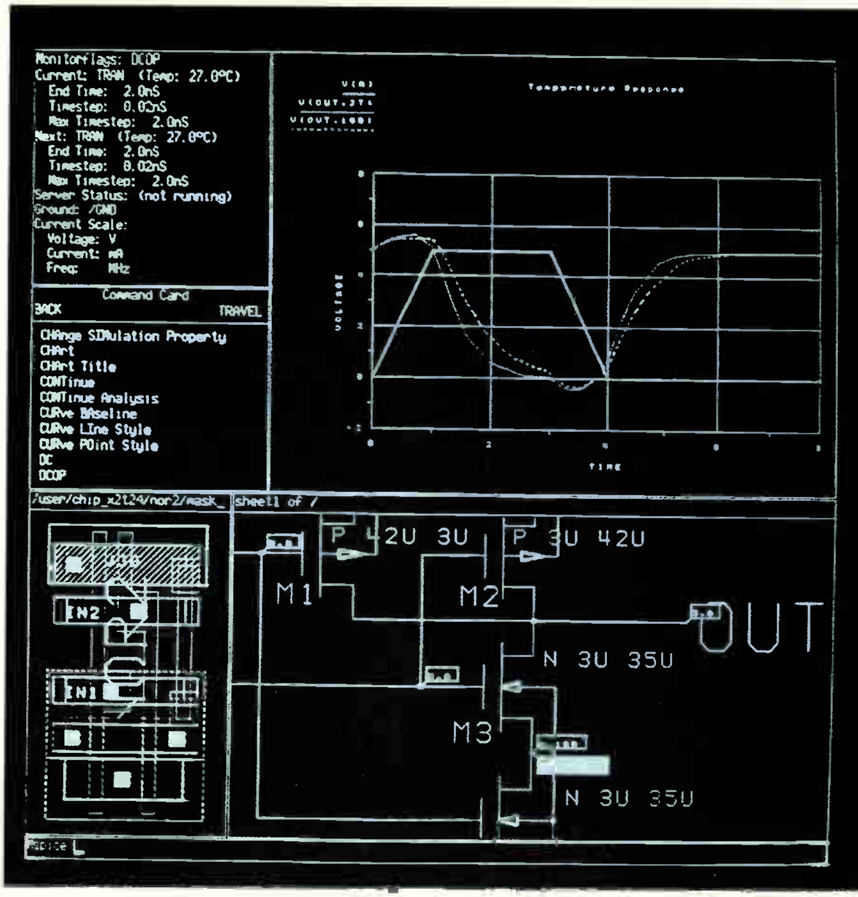
Currently, vendors of engineering work stations supply a library of ICs for their own simulators, but the libraries are not exhaustive and most do not contain the latest components and more complex parts. "The 2901 is about as complex an IC as you'll find readily available in simulator libraries," says Turner. Semiconductor firms are looking favorably on Logic Automation's effort to create a library of simulator models for ICs. Advanced Micro Devices Inc., Sunnyvale, Calif., has signed a deal with the company to collaborate on verified simulation models of AMD ICs for systems designers. Logic Automation has a similar deal in progress with Intel Corp., Santa Clara.

Typical of the complex parts available from Logic Automation are the Am29300 chip set (AMD's family of 32-bit bipolar microprocessor building blocks) and the Intel 80386 microprocessor. Because the models are provided in binary form, they can be installed on almost any CAE system simulator. A semiconductor company having all its VLSI components in such a library will have a competitive advantage when its parts are being evaluated by a designer who wants to simulate his design without having to create models of VLSI components.

Another way around the requirement to model is to use the actual circuit in the simulation run. This concept, embodied in a simulator package called RealChip, was introduced by Valid Logic Systems Inc., Mountain View, Calif. If a design contains a 68020 microprocessor, for example, the RealChip simulator applies the input to a real 68020 and uses the output of the chip to continue the simulation of the model on the work station.

QC Graphics' Vaughn says many designers also believe that simulators cannot adequately account for physical characteristics of a design laid out on a board. For example, propagation delays in high-speed circuits cannot be modeled adequately with existing simulators nor can the effects of crosstalk between parallel signal paths on different layers of a multilayer board.

Another problem with simulation is the cost of long computer runs. In the design of the HP 3000 series 37 Multiuser Professional Computer System, for example, HP ran simulations on an Amdahl Corp. 470V/8 mainframe computer. The series 37 design consisted of five boards. By HP's own account, board-level simulations took up to two days to run, and simulation of the entire system ran for a week. During the design's simulation phase, the group spent $15,000 a month on computer charges and often monopolized the mainframe.




**3. SPICE OF LIFE.** With Spice on a work station such as the Mentor Graphics Idea series, the operator interacts with the schematic of a circuit as though it were an actual circuit.

Another roadblock to total automation is engineers' resistance to simulation, says Vaughn. QC Graphics provides pc-board layouts for customers as varied as companies building IBM Corp. Personal Computer clones all the way up to large defense contractors. Input from his customers can be anything from hand-drawn sketches to a CAE-work-station netlist. "Not a lot of these circuits we lay out have been simulated," he says. "In fact, the pc board we produce, in many cases, is the designer's breadboard."

Another reason that more simulation is not being done, according to Vaughn, is that many of the pc boards are actually second and third generations of existing circuit boards. Hence, the design has been already proven, and the current designer is simply adding new features or capability, none of which involves a large portion of the board.

On the other hand, analog-circuit designers have generally accepted CAE systems for schematic capture and simulation. One contributing factor has been their familiarity with the most pervasive analog simulation program, Spice, which has become easier to use and now runs on a work station.

Formerly, Spice simulations were run as batch processes on a mainframe computer. The user interface required the design netlist to be keyed in manually—tedious and time-consuming on large designs—and the output was a hard-to-read printout. Simulation became much more effective with the advent of Spice 3 from the University of California at Berkeley, on new design work stations such as the Analog Workbench from Analog Design Tools Inc., Palo Alto. Spice 3 on a work station is a much more interactive program.

"With Spice on a mainframe, the designer had to specify each node output he wanted viewed for each simulation. If, after receiving the results, he needed to view another node's output, he would have to run another simulation," says Derek Bray, vice president of analog products at Ferranti Interdesign, Scotts Valley, Calif.

With Spice on a work station such as the Mentor Graphics Idea series, in effect, the operator interacts with a schematic of the circuit in the same way he would with an actual circuit. On the work station, the designer examines each node with a probe, just as he would if he were using a bench instrument on a prototype circuit, and receives a response immediately as a measurement value or a waveform (Fig. 3).

## CUTTING HARDWARE COSTS

But the perennial drawback to simulation—especially on analog designs and many digital ones—is that work stations are too expensive. The user must buy not only a $50,000 work station but also an expensive software package.

However, the advent of coprocessor boards for personal computers, such as the Opus 532.32 single-board computer from Opus Systems Inc., Cupertino, Calif., is changing this. The board contains its own 32032 microprocessor and plugs into the IBM PC's bus. It provides the PC with AT&T Bell Laboratories' Unix V (release 2, version 2). Ted Atlee, president of Opus Systems, says, "Where the Opus board has an application is where an application cannot fit into memory space or runs too slowly on the PC's own central processor."

One of the earliest applications of the coprocessor was to bring to the IBM PC a mainframe version of Cadat, the logic and fault simulator from HHF-Softon Inc., in Mahwah, N. J. In a more recent application, the coprocessor has converted the PC into an analog workbench. In February, Analog Design Tools of Menlo Park, Calif., signed an agreement with Opus to supply the board so its product could be run on the PC.

Engineers at one beta site for the PC-based version of the analog work station say simulations were almost as good as the work station version of the software, but the resolution was not as good and only one window could be used at a time. Operation was a bit slower and so the system was not as convenient to use. However, the user usually works with the larger work station version of the product.

An example of the PC AT with a math coprocessor being used for simulation is the Touchstone 1.4 from EEsof Inc., Westlake Village, Calif. The program allows a microwave designer to design, analyze, and optimize radio-frequency and microwave circuits without an accelerator board. Engineers can perform some 200 measurements, including noise figure, stability, impedance mapping, and differential phase shift. By the fourth quarter, the company hopes to have a user interface comparable to that on the Analog Workbench.

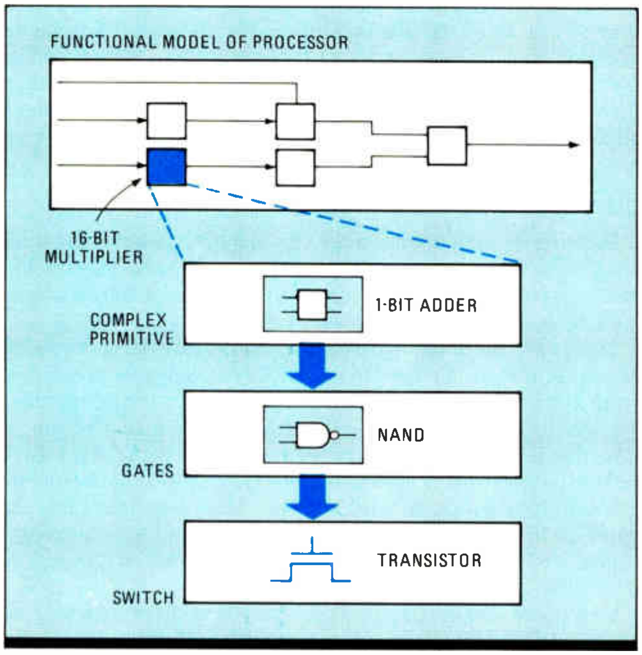
# SIMULATION: THE LAST FRONTIER

Simulation is the final frontier in the quest to integrate the entire process of designing and testing integrated circuits. As IC designs grow more complex, so does simulation, and so one key to the spread of simulation is the accelerator, without which this task can cost a fortune and eat up enormous amounts of computer time. The second key to simulation is standardization—notably a standard file format. Various standards have been proposed, but the battle continues.

Designing an application-specific IC is difficult; for a typical ASIC chip of 100,000-transistor complexity, the designer must break the design down into smaller blocks. For example, a special processor for a process-control application might require an arithmetic logic unit, a control unit, random-access memory, and read-only memory. The designer would divide the larger circuit into these major elements and work on each individually; often, different designers will handle the different elements.

For an ALU, the designer will segment the task into progressively smaller units (Fig. 4), one of which could be a 16-bit multiplier. The multiplier might be built with a collection of 1-bit adders, with the adder consisting of a collection of gates and the gates consisting of a collection of transistors. The 1-bit adder might exist as a standard cell in the CAE work station library of parts. If so, the designer may simply insert the adder cell into his design and design control logic to tie various cells together to form the multiplier.

A CAE system enables the designer to begin by breaking down the design hierarchically and then design and simulate at the lower levels in the hierarchy. Thus the multiplier can be designed and simulated completely apart from other elements of the design. In fact, most CAE systems have multimode simulators, which enable parts of the design to be simulated functionally—the 1-bit adder in the example—while others are simulated at the gate level—such as the logic gates that link the adders to form the multiplier.




**4. HIERARCHY.** In a hierarchical design structure, a 16-bit multiplier design is broken down from adders to gates to transistors.

## PULLING IT TOGETHER

Earl Reinkensmeyer, senior CAD strategy manager for NCR Corp.'s Microelectronics Division in Dayton, Ohio, says that the trend is to put as much of the total design job on the work station as possible. With multimode simulators and the ability to divide the design into smaller, more manageable tasks, a complex very large-scale-integrated circuit could be created on a work station. At some point, however, the entire controller—including the ALU, ROM, RAM, and associated logic—has to be pulled together into a complete circuit and simulated as a whole. If the design is very complex—over 100,000 devices—the job typically must be offloaded to a special accelerator or a mainframe computer for simulation. And after the logic simulation, the designer must perform a fault simulation to ensure that the circuit does not have failure modes that could affect its long-term reliability; fault simulators today operate at the gate level, and so the entire circuit must be simulated at once.

One way of speeding the simulation process is contained in a logic simulator offered by Aida Corp., Santa Clara, Calif. The company uses what is known as a levelized compiled-code simulator, whereas event-driven simulators are currently the predominant form. A levelized simulator evaluates the logic states of all design elements with every change in the input vector applied to the circuit. An event-driven simulator evaluates only elements affected by a change in the input vector. Event-driven simulators can be applied to both synchronous and asynchronous designs, whereas levelized compiled-code simulators work best with synchronous designs, providing 500 to 1,000 times the performance of an event-driven simulator. One reason Aida has adopted the levelized compiled-code technique is that there is a general trend to synchronous designs. "Synchronous designs allow engineers to better cope with more and more complex logic designs," says Edwin Porter, an Aida Fellow. "Today, designers are building ASICs with an entire system on a chip and pc boards with large numbers of VLSI and ASIC components on board."

A problem at this point in the design process is connecting computing power to the work station to perform the simulation. The user can use a mainframe networked to his work station or use a dedicated accelerator connected to his work station or to a node on a network that can be accessed.

In using a networked mainframe computer, there is the large one-time charge to connect the mainframe to the network. The cost is for a controller board to make the hardware connection and for a software package that can communicate with the work station. If more than one manufacturer's work station is

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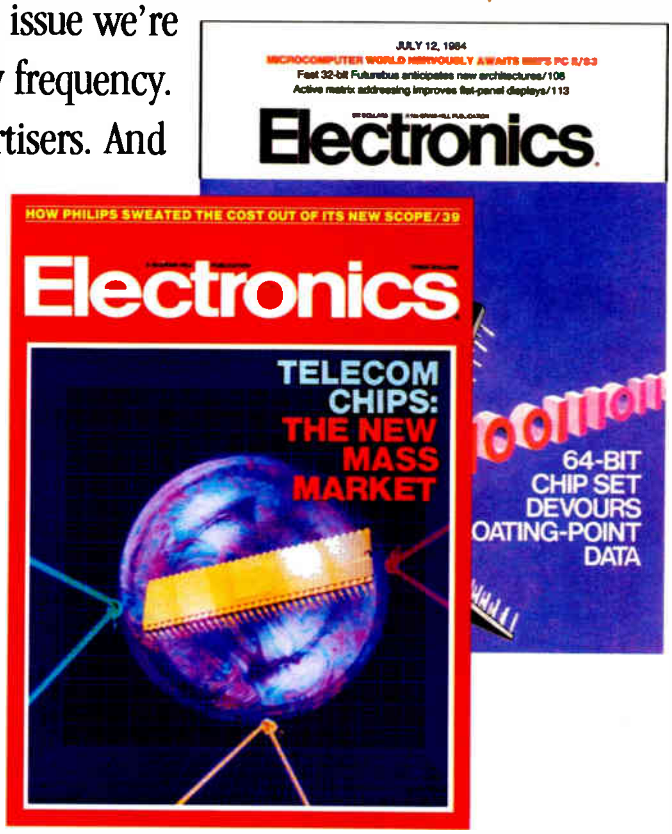
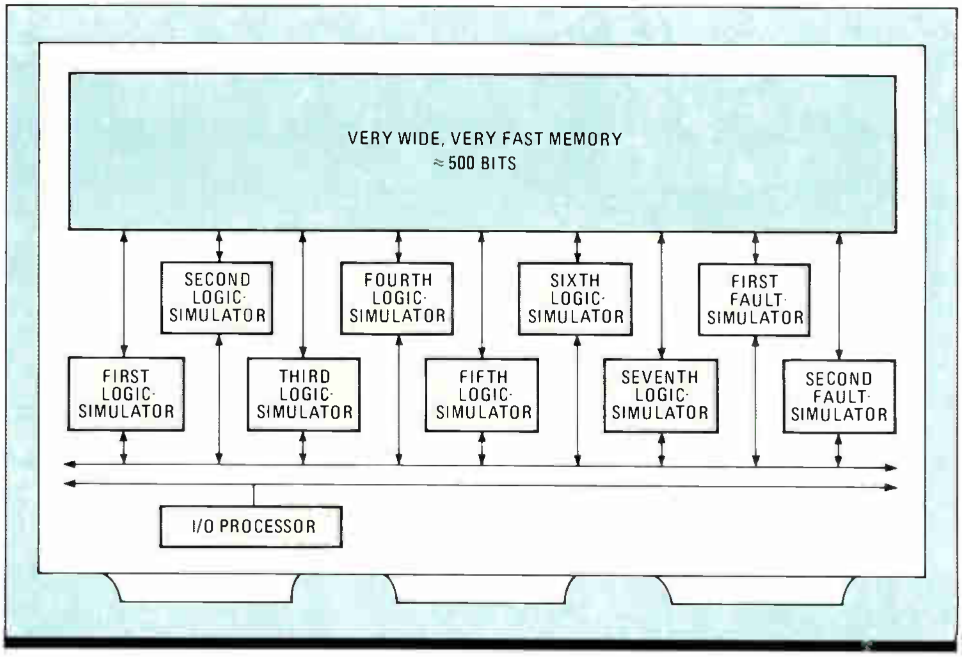



# The job is done.

connected to the computer through the network, each requires its own software driver on the mainframe.

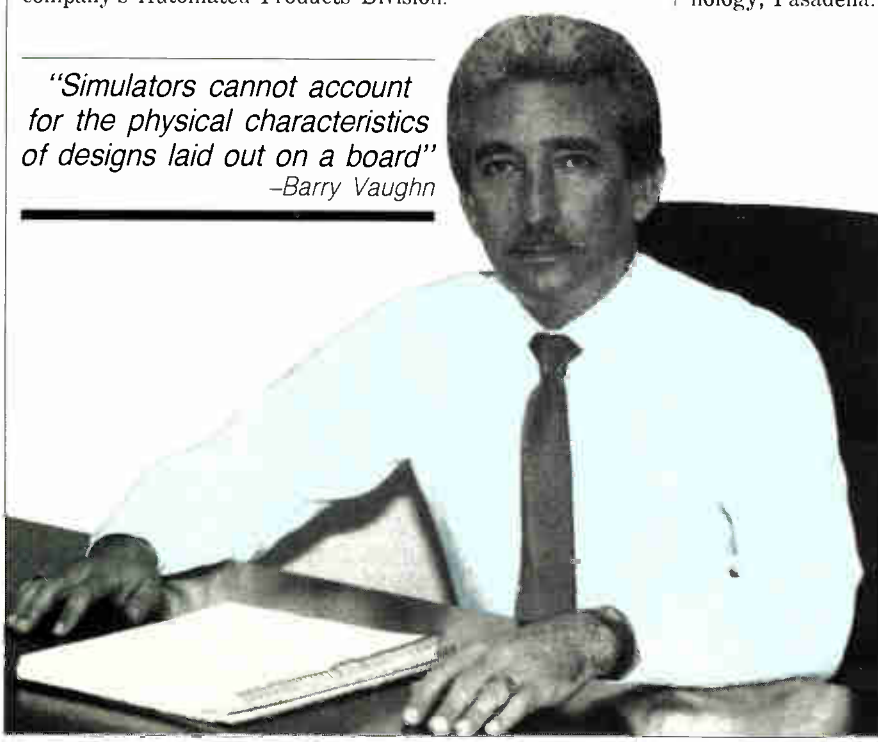
The other approach is to use accelerators. Point accelerators, so called because they address only one task, initially were designed to speed logic and fault simulations. These include systems from Silicon Solutions Inc. of Menlo Park, Calif., and Zycad Corp. of Arden Hills, Minn. Silicon Solutions' newest simulation engine, the Mach 1000, performs high-speed logic and fault simulation of electronic designs at the gate and transistor levels. The company claims the unit runs simulations 1,000 times faster than a minicomputer. It can handle designs with up to 65,000 gates, and it uses parallel-processing techniques to achieve high speed (Fig. 5). The total simulation job is broken up into smaller simulation tasks and executed in parallel by individual processors. Acceleration is also desirable for several other tasks in a design cycle, including placement and routing during the physical layout of a circuit on silicon or a printed-circuit board, design rule checking, and data formatting. Therefore, there is a need for more general-purpose accelerators, which can speed up both simulation and these tasks.




**5. SPEED IT UP.** A point accelerator uses parallel-processing techniques to achieve high speed. The total simulation job is broken up into smaller tasks and executed in parallel by individual processors.

One alternative route is exemplified by the Mentor Graphics Corp. Compute Engine [*Electronics*, Sept. 30, 1985, p. 52]. This box plugs into the work station and offloads the simulation tasks from the central processor. "The Compute Engine addresses the flow of the design processes by increasing throughput on all bottlenecks: simulation, placement, routing, design-rule checking, and data formatting," says Al Jimenez, vice president and general manager of the San Jose, Calif., company's Automated Products Division.

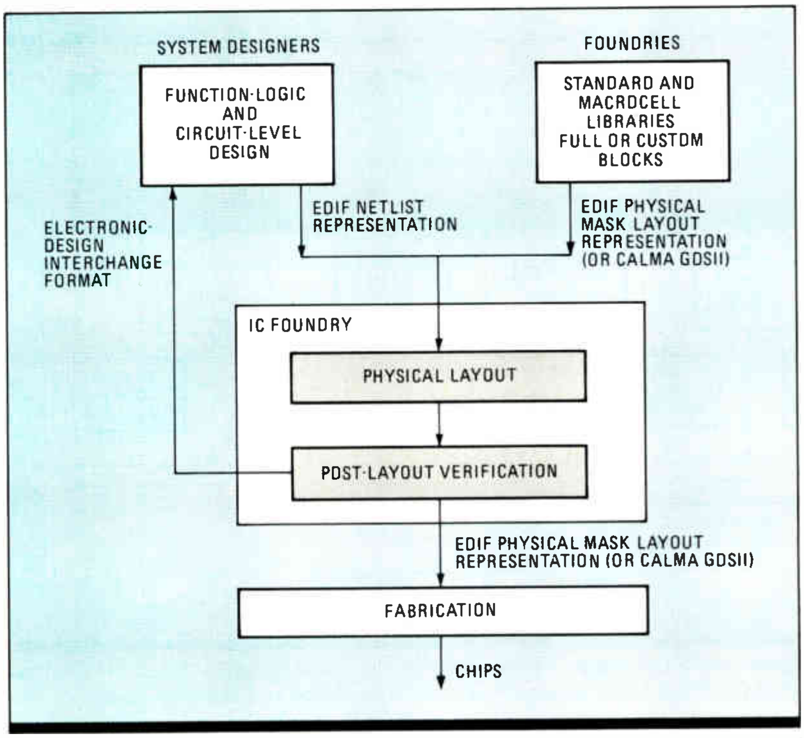
*"Simulators cannot account for the physical characteristics of designs laid out on a board"*
*–Barry Vaughn*



Another solution is the DSP9000 Compute Server, announced early this year by Apollo Computer Inc., Chelmsford, Mass. "The smallest DSP9000 delivers about the same performance as the new Digital Equipment Corp. VAX/8800 for less than half the price," says Eric Hilman, product marketing group manager. It is installed as a node on the company's proprietary network and can be accessed in the same way as any other server or work station. Based on the FX/Series parallel processor [*Electronics*, July 29, 1985, p. 56] from Alliant Computer Systems Corp., Acton, Mass., the Apollo solution is indicative of a trend to parallel processors as a solution for computation-intensive tasks.

Development work on parallel processors was begun at the Jet Propulsion Laboratory of the California Institute of Technology, Pasadena. The work was part of the Caltech Concurrent Computation Project of 1981-82, which produced the Hypercube architecture. The Hypercube architecture connects numerous microprocessors, each of which performs its computations simultaneously yet independently of the others. Experimental parallel processors such as the Mark III from JPL consist of an array of 32-bit microprocessors, each of which forms the node of a concurrent computer. A 32-node system could have the performance of the fastest supercomputer for 5% of the cost. Ametek Inc.'s Computer Research Division, Arcadia, Calif., and JPL have entered into an agreement whereby Ametek will produce and market a commercial version of the Mark III processor late this year. It is likely to be aimed at the accelerator market.

A key question with parallel processors is whether existing simulator software can adapted—"parallelized"—to run on them. "With parallel processors, the application controls how much throughput you can get," says Harvey Goldman, director of marketing at Elxsi,




**6. COMMON SENSE.** EDIF is a common data-interchange format for every aspect of electronic design: design and manufacturing description, layout, and analysis.

the San Jose, Calif., subsidiary of Trilogy Ltd. "Some applications programs can be parallelized, others cannot."

Most CAE software, especially that written in Fortran, can be parallelized. Because nearly 90% of Spice can be parallelized, a Spice simulation that uses four parallel processors achieves a 3.7 to 3.8 times improvement in throughput. The problem is that all the existing applications need to be parallelized, though Goldman says that the conversion is not a large task; converting Spice took less than two days. "Of the 20,000 lines of code in Spice, only 10 to 20 lines had to be rewritten and about 300 lines of code had to be changed," he says. In addition, software suppliers are already beginning to create parallel versions of their software. Managers of design centers are also evaluating parallel processors such as the Ametek product and the System 6400 from Elxsi as general-purpose servers to accelerate computation-intensive tasks.

## THE SEARCH FOR A STANDARD

Perhaps the thorniest problem at this stage in the design process is that of a common file format for the graphical data captured during schematic entry and used for simulation. Each work station vendor has its own file format, incompatible with all others, but this does not affect the data being transferred from the design work station to the layout work station.

Typically, work stations produce a netlist that can be used by a pc-board system or a GDS-II Streams data file from Calma Co., Milpitas, Calif., which can be used by IC-layout systems such as those from Calma and from Applicon, Burlington, Mass. A GDS-II output file comprises variable-length records that can be any number of bytes long. The first two bytes of the record contain a count of the total record length, thus describing where one record ends and another begins. The third byte specifies the record type, and the fourth states the data type. The user needs a common file format to move files from one vendor's work station to another and maintain full functionality between the two. Thus the designer can capture a file on a Daisy work station, transfer it to a Valid work station, and change the file using the new work station.

Art Lancaster, vice president and general manager of the RCA-Sharp Design Center in Vancouver, Wash., says his solution was to require different work station vendors to create translators that would convert their file format over to the format for RCA's Mimic simulator. Once in this format, the file can be transferred between work stations from different vendors.

The ideal solution is to develop an industry-standard file format. One possibility is the American National Standards Institute's Initial Graphics Exchange Specification. IGES is not so much a general graphics interface as it is a standard data-base format for exchanging data between different CAD/CAM systems. IGES sits between the data base and the applications program. Its acceptance by CAD/CAM product suppliers has been considerable, thanks in part to its government and industry backers. In 1979, the U. S. Army, Air Force, Navy, and the National Aeronautics and Space Administration funded the effort to develop IGES; no such backing exists for CAE systems. IGES Version 2.0 does contain a means of handling electronic pc-board product data, but the specification is too oriented to mechanical design to serve the needs of electronic design. There have been efforts—none successful—to make the standard better suited to electronic design.

One alternative with some backing is the Electronic Design Interchange Format. EDIF is being promoted by the companies and university that formed the committee: Daisy Systems, Mentor Graphics, Motorola, National Semiconductor, Tektronix, Texas Instruments, and the University of California, Berkeley; other firms are joining the effort. These companies offer place-and-route software packages and want a standard file format to easily accept files from any design-entry system and provide output to any silicon foundry. EDIF is a common data-interchange format for every aspect of electronic design: design description, physical layout, manufacturing description, and analysis (Fig. 6). In a single logical file, EDIF contains one or more designs and libraries of cell definitions. Libraries contain cell definitions and technology information related to the design and manufacture of each cell. An EDIF description is expressed as a hierarchy that is abstract at the top and increasingly more detailed at the lower levels. The design hierarchy is defined as a nesting of cell instances.

In developing the format, the committee drew heavily from a number of existing interfaces and languages. Texas Instruments Inc. contributed specifications from its Tidal 2.0 design-automation language. Motorola Inc. and Mentor Graphics offered their Technology Definition File format, and National Semiconductor, Tektronix, and Berkeley supplied the Common Interchange Data Format. Currently, version 1.1 of EDIF has been published, and version 1.2 is expected to be published sometime this year, possibly at the Design Automation Conference in June. Henry Alward, manager of connections programs at Tektronix Inc., Beaverton, Ore., says "version 1.1 of EDIF seems adequate for exchanging gate-array design files." A representative for Tektronix on the EDIF committee, Alward says the group is working toward making EDIF adequate to handle file interchange on pc-board and semicustom chips, with the aim of eventually handling full-custom VLSI.

EDIF has gotten one boost that may help get it established as a standard: the Department of Defense is proposing that EDIF be the interchange format for transferring files between computers in the Engineering Information System, a program to define a total computing environment containing an integrated set of CAE tools from different vendors that all work together in creating a design. □

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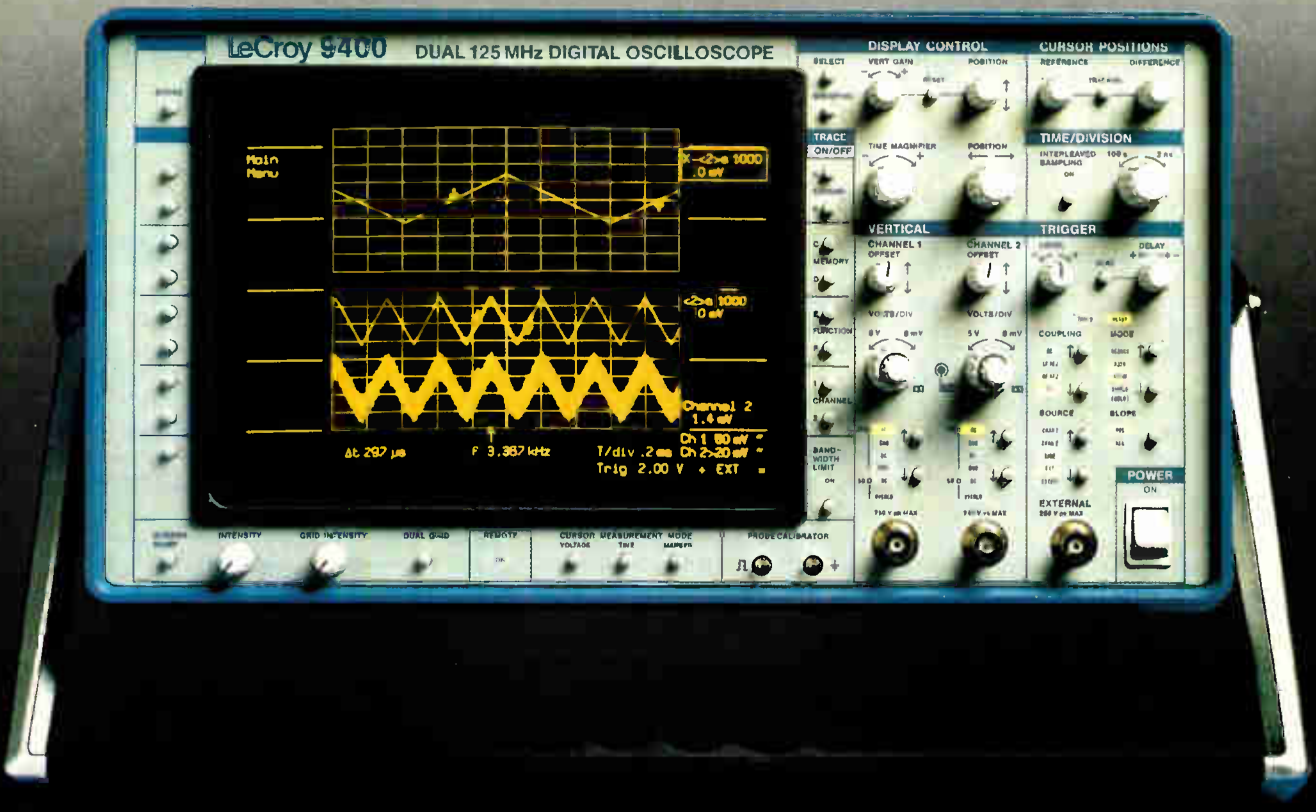


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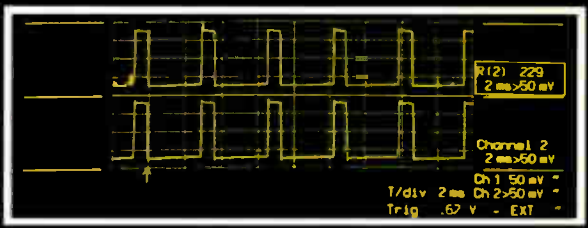


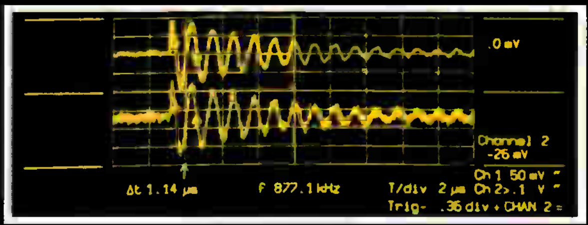


*Top: Summation averaging over 1,000 waveforms, expansion and high resolution frequency measurement all shown in one display.*

*Middle: Extrema Mode shows glitches in digital circuitry, logged over 229 acquired waveforms.*

*Below: Digital filtering with a 9-point filter smooths noisy transient.*

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# UNITING THE WORLDS OF DESIGN AND TEST

## TERADYNE DOES IT WITH A SET OF LOGIC AND TIMING SIMULATION TOOLS

Teradyne Corp. is using a set of powerful internally developed logic and timing simulation tools to unite the previously separate worlds of automated design and testing. In doing so, the manufacturer of test equipment is widening its franchise to include tools aimed at making life easier for designers of boards, systems, and gate arrays.

"There is a natural strategic link between the design and test processes," says Jeff Hotchkiss, general manager of the Design and Test Automation Group. "And we think for a company to be successful in either area requires positioning in both." Accordingly, the Boston company is linking its design-verification and test-generation capabilities for boards and systems—based on its proprietary Lasar version 6 simulation software—with three computer-aided engineering products.

Scheduled to debut at this month's Design Automation Conference in Las Vegas are the DataServer simulation server, DataView integrated design program, and DataSource hardware-modeling system. The DataServer is a multiprocessor that uses parallel processing to accelerate Lasar version 6 simulation operations in multiuser environments.

These additions to the Teradyne stable place the company in three of the four areas of the design and test process—design, design verification, and manufacture and test (Fig. 1). Although Teradyne is staying out of the market for physical layout, its CAE equipment can connect to existing computer-aided design systems for board layout.

In the design stage, a designer electronically creates a schematic for the desired function and then simulates the circuitry. If the simulation proves correct, he sends the data to the next stage for design verification. If the simulation finds an error or fault, the designer must go back through the design process and correct it.

In design verification, the simulated circuitry of the schematic is tested over a wide range of worst-case timing, temperature, and aging conditions. If the simulated circuit meets these specifications, it moves on to manufacture and test, where test patterns for actual boards and particular testers are generated.

Teradyne integrates these steps into a system linking DataView, Lasar version 6, DataSource, and DataServer. One of Teradyne's aims was to use standard computers rather than the custom processors resident in many of today's engineering work stations. These processors often must compromise between graphics and processing capabilities. Teradyne's market research revealed that its customers wanted a standard microcomputer as a system terminal and a powerful but off-the-shelf superminicomputer to perform the actual modeling and simulation.

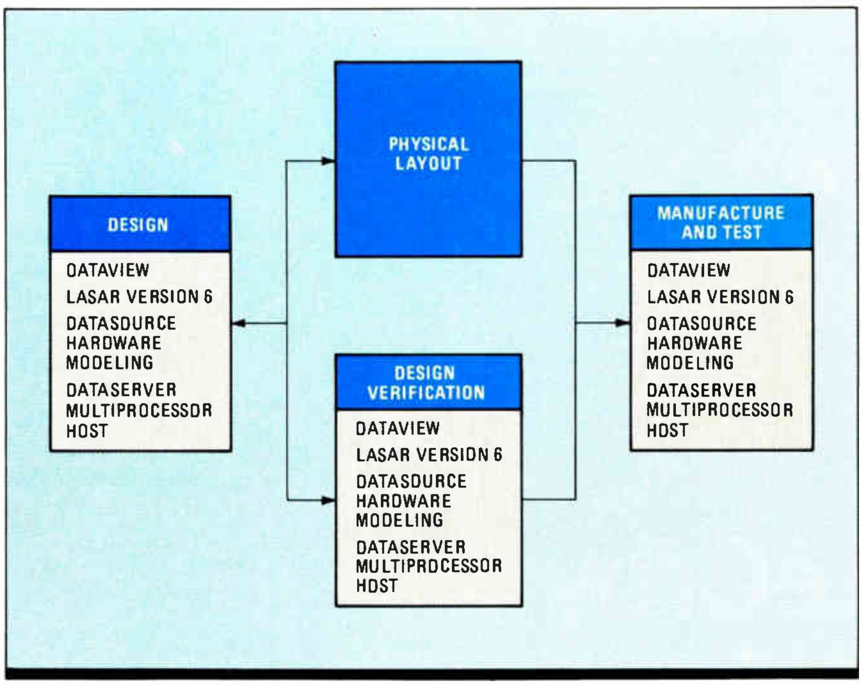
Teradyne decided to use IBM Corp. Personal Computer ATs as engineering terminals. These in turn are linked by Ethernet to powerful VAX superminicomputers or the DataServer multiprocessor host (Fig. 2). This arrangement allows the use of relatively low-cost intelligent terminals that can access tremendous computer memory capacity and computing power.

DataView, a package of software and PC AT-interface hardware, is the designer's window into design and test. Based on the Workview program from Viewlogic Systems Inc., Marlboro, Mass., it provides an integrated PC-based program that sets up a common user interface for schematic entry, simulation, and analysis using Lasar version 6, documentation, and electronic mail. The Teradyne software is a customized package with schematic design data that can be read directly by Lasar to provide the high-speed model compilation necessary for fast simulation response times. Lasar's simulations are run on a VAX accessed by the PC AT over Ethernet.

### MULTIWINDOW DISPLAY

In this design and test system, the engineer at the PC AT initiates Lasar processes such as logic and fault simulation, which run on a VAX. He then views waveform analyses and other simulation results by using the same mouse-driven system of pop-up lookahead menus that DataView employs for schematic entry, documentation, and electronic mail. DataView's multiwindowed displays (Fig. 3) allow easy switching between functions and simultaneous viewing of data from different sources.

Schematics generated using DataView pass along the Ethernet to Lasar's host computer. The Lasar model compiler reads these schematics directly, on a logical page-by-page basis, eliminating most of the data-translation steps usually required. This greatly speeds model compilation, a frequent

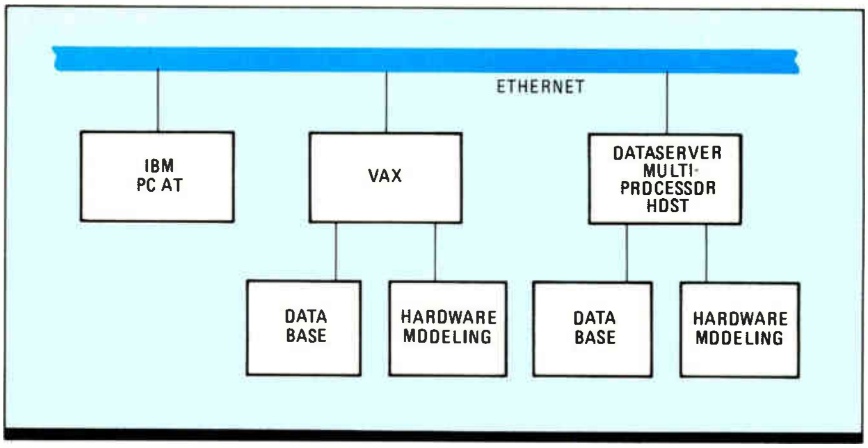



**1. LINKING DESIGN AND TEST.** Teradyne's new design and test environment uses Lasar software as the unifying element in design, design verification, manufacture, and test.

contributor to overall loop turnaround time in an iterative design process.

The simulation results return to the designer's PC work station through the Ethernet. DataView displays the results in a tabular format or as waveforms, showing logic and timing values graphically. Typically, the designer might display a schematic in an adjacent window for easy comparison with Lasar's waveform analyses, timing hazard reports, and other simulation data.

DataView and Lasar share a common, centrally controlled model library that includes schematic symbols and simulation models. The library resides in VAX disk space, avoiding the need to tap the work station's limited storage capacity.




**2. COMPUTER COMMUNICATION.** In the Teradyne system, a PC AT accesses the capacity and power of a VAX superminicomputer for design and simulation work.

The information generated by DataView becomes the input data for physical board or gate-array layout systems. DataView works with layout tools marketed by Racal Redac, Scientific Calculations, and Telesis. It also changes data formats through back annotation to provide a direct path for transferring layout data into Lasar.

In a simulation, signals are propagated to circuit nodes and nodal responses are evaluated. This process is often done completely in software. However, the amount of data required to simulate a circuit as complex as a 32-bit microprocessor can be excessive, requiring as many as $250 \times 10^6$ simulation vectors. In such cases, a model employing the actual IC is more effective.

## PHYSICAL MODELS

DataSource, a multiuser modeling system for very large-scale integrated circuits, lets Lasar use physical parts in board-level simulations. The first hardware modeling system to support high-speed concurrent fault and logic simulation, DataSource works with any VAX, linking to it through a parallel interface that enables high-speed data-transfer rates and ensures fast response from this system each time Lasar accesses a device for simulation.

DataSource comes in a cabinet with hardware-model adapter boards, power sources, memories, and a backplane. It provides a maximum of 2,400 pins, which can be configured flexibly to accommodate multiple parts in any combination of sizes. The system handles parts made in static and dynamic TTL, emitter-coupled logic, CMOS (including gate arrays), and mixed logic, and drives as many as 160 data-input ports simultaneously at a 16.7-MHz maximum pattern rate.

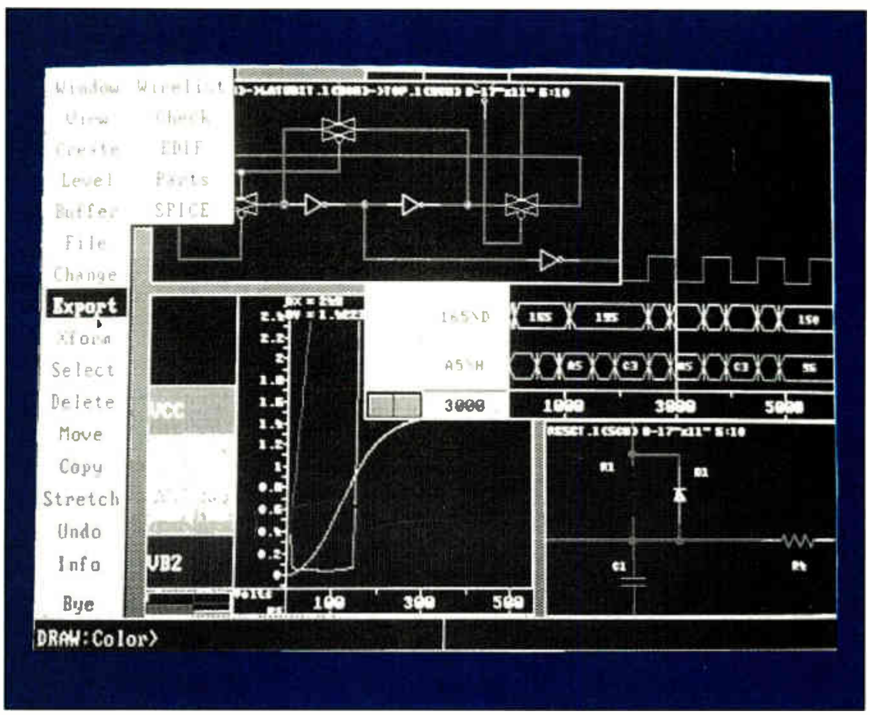
A dynamic memory-allocation scheme assigns DataSource's 80-Mb system memory on an as-needed basis to hardware models. This ability to resize the memory behind each pin on the fly enables DataSource to respond immediately to the demands of various situations: multiple users accessing the same device for simulation; multiple devices in the same simulation; extremely long simulations; and high-speed concurrent fault simulations.

Because dynamic memory allocation permits many simulations to co-reside in memory, it eliminates the time-consuming reloading of memory each time a new simulation must be done. In addition, it enables one hardware model to be used when multiple copies of the device are included in a board design.

To augment the electrical responses provided by the hardware model under simulation, DataSource surrounds each model with a software shell. The shell's behavioral description of the device's operating parameters enables it to act as an interface, screening Lasar's inputs to the hardware model and interpreting the responses correctly in the context of the simulation. Teradyne will initially provide fully programmed behavior shells for about 50 popular 16- and 32-bit microprocessors and peripheral support chips. Users can easily modify the shells' programming.

DataSource's 16.7-MHz pattern rate enables it to drive advanced chips such as 16- and 32-bit microprocessors, digital signal processors, and graphics controllers. Users can add new hardware models to this system by using the interface board of appropriate size and by wiring connections to power, ground, clock, and synchronization points on the chip. Each board includes an uncommitted area that can be used for any special support circuitry required.

The unit's 2,400 pins can be used in 40-pin increments. Device




**3. WINDOWED.** DataView software and the PC AT graphics yield a multiwindowed display of Lasar simulation results, such as waveforms and timing diagrams.

interface boards come in 40-, 80-, 120-, and 160-pin sizes that can be mixed and interchanged as desired. Easily accessible, these boards accommodate dual in-line packages, leadless chip carriers, pin grid arrays, and other common housings. The flexibility afforded by the system's dynamic memory allocation eliminates restrictions on where devices are placed. More than one device can plug into an interface board, as long as the card's pin capacity is not exceeded. By contrast, many competitive hardware modeling systems allow no more than one device per interface board, usually wasting pin capacity.

## SOFTWARE ACCELERATOR

The third component of Teradyne's design and test network is the DataServer. It incorporates optimized processors that run Lasar's logic- and fault-simulation jobs in parallel while multiple general-purpose processors separately handle Lasar's nonsimulation functions. DataServer avoids the inflexibility of hardware accelerator systems, which are limited only to simulation tasks unless users add expensive hardware upgrades.

DataServer executes 10 million to 15 million instructions per second, compared with the VAX-11/780's 1 mips. DataServer lets users realize faster run times in every simulation routine available in Lasar: good-circuit logic simulation, worst-case timing analysis, and concurrent fault simulation. The system also supports any mix of structural, behavioral, and hardware models in simulation.

DataServer is based on Sequent Computer Systems Inc.'s Balance 21000 parallel-processing system. It augments the Balance system with general-purpose processors and Teradyne hardware and software optimized for simulation operations. Multiple optimized processors execute simulation jobs in parallel. The general-purpose processors execute nonsimulation Lasar functions separately within the system and handle routine input/output, operating system overhead, network communications, and the like.

This approach lets Lasar's simulation and nonsimulation features run simultaneously. Extremely computation-intensive logic and concurrent fault simulation receive dedicated processing without draining computer power away from other Lasar functions, such as schematic capture, model compilation, graphics display, and test postprocessing. These nonsimulation tasks therefore operate more efficiently than they would on a single central processing unit and provide faster response as users iterate through designs or develop and postprocess test programs.

DataServer dynamically reassigns its optimized processors to respond moment-by-moment to the needs of multiple users and varying simulation loads. If a single simulation or high-priority job is running, all the simulation processors in the system may be working in parallel on the same task. With an increase in the number of jobs, some of the processors may be assigned to the new jobs. Processors can be added to or taken away while a job is in progress, allowing changing work loads to be accommodated smoothly.

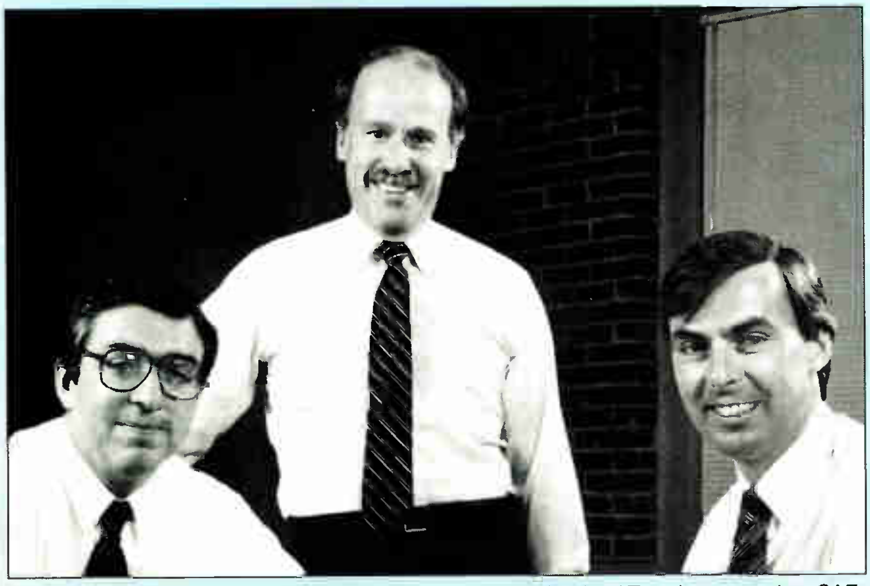
The base DataServer consists of two general-purpose processors, which use AT&T Bell Laboratories' Unix operating system, and four optimized simulation processors. The base configuration includes 16 megabytes of main memory, a 330-megabyte storage disk, and 16 terminal ports. The system can be expanded by plugging additional processor, memory, and other boards into the 16 available backplane slots.

Teradyne says DataView should be installed at a beta test site in July and begin shipping in September. DataSource will be at a beta site in August and have first shipments by the end of the year, and DataServer should ship to its first customer in the last quarter. □

## MOVING A TEST-EQUIPMENT MAKER INTO CAE

**"Culture shock"** is how Jeff Hotchkiss describes the experience of selling in a new market. As general manager of Teradyne's Design and Test Automation (Data) group, he was deeply involved with moving the Boston automatic-test-equipment maker into computer-aided engineering.

"In test, sales calls usually include long discussions of how your product fits into the overall process. With CAE customers, we typically had about 15 minutes to make our pitch and get out." But Hotchkiss, who had been Teradyne's board-test marketing manager, sees that changing. "The first rush of CAE buying, which tended to be on a project-by-project basis, is over," he notes. "Now the trend is to corporate-wide buys, with the buying decisions being made higher up—by people who worry about system integration and want to hear how your product fits into the overall process."



**ATE TO CAE.** Mattison, Hotchkiss, and Parkinson (from left) helped Teradyne move into CAE.

With the new hardware and software products it will demonstrate at the Design Automation Conference in Las Vegas, the two-year-old Data Group aims to fit its flagship product, the Lasar (logic-automated stimulus and response) Version 6 simulation package, more squarely into the design process. "How well a CAE tool such as a simulator links with other design packages is of as much interest to customers as the tool itself," says Andrew Parkinson, Lasar product manager. Parkinson moved to Massachusetts last year from England, where he had managed Teradyne's Northwestern Europe marketing and sales since 1980.

Taking a company with no traditional presence into the design market is a familiar project for Roland Mattison, the Data Group's engineering manager. Mattison spent eight years heading the engineering effort that established computer maker Prime Computer Inc.'s CAD operation. He thinks the design connection is a more natural one in Teradyne's case. "Design software and computer hardware are basically unrelated technologies, but CAE and ATE have many technical issues in common, so your experience in one helps you in the other."

# PROBING THE NEWS

# CAE COULD BE JUST AS BIG AS ATE FOR TERADYNE

## IT AIMS TO BUILD THIS BUSINESS BY LINKING DESIGN AND TEST

*by Craig D. Rose*

**BOSTON**

Alex d'Arbeloff describes computer-aided engineering as a world of sky-high expectations and knee-high reality, which is just the kind of market he likes. "I foresee this for the next few years as a business [that is] technology driven rather than marketing driven," says the president and chairman of Teradyne Corp. "The big problem is to technically solve some very, very difficult problems."

Confident in his company's ability to compete technically, d'Arbeloff is moving to parlay Teradyne's success in automatic test equipment into a new CAE business, concentrating on in-depth solutions for niche markets. "It can be as big as ATE for us," he says of his $336 million company.

This thrust appears to drive the Boston company into headlong competition with dozens of CAE vendors vying for business in a cooled-down market (see story, p. 25). But Teradyne is betting on its ability to link aspects of design and test, thereby smoothing the road from design to production, to give it a competitive edge. And the company believes an offense in CAE may be the best defense for its mainstay business, now threatened by strong competition from Japan.

Other companies—both on the design and the test sides—apparently agree that the future belongs to linkage. Last month, Daisy Systems Corp. and Genrad Inc. announced they would market an interface between their respective design and test systems.

**NEW TRIO.** Teradyne will arrive later this month at the Design Automation Conference in Las Vegas packing three new CAE products (see p. 34). Two of them work with Teradyne's Lasar Version 6 simulation system—DataView, an integrated IBM PC AT-based interface for schematic entry, simulation, and analysis adapted from a Viewlogic Systems Inc. product; and DataSource, a hardware modeling system that permits the use of physical models. The third product—DataServer—is a simulation server. This parallel processor based on Sequent Computer System Inc.'s Balance 2100 computer, optimized with Teradyne hardware and the software-run Lasar.

If the new products revolve around Lasar, so indeed does the origin of the company's CAE strategy. Lasar is a collection of simulation and analysis tools that Teradyne acquired when it bought Digitest Corp. in 1976. The test maker later assembled an engineering team, now numbering 15 people, to create component models for Lasar. It also acquired about 20 key device models through a relationship with Intel Corp. There are now 4,000 in the library.

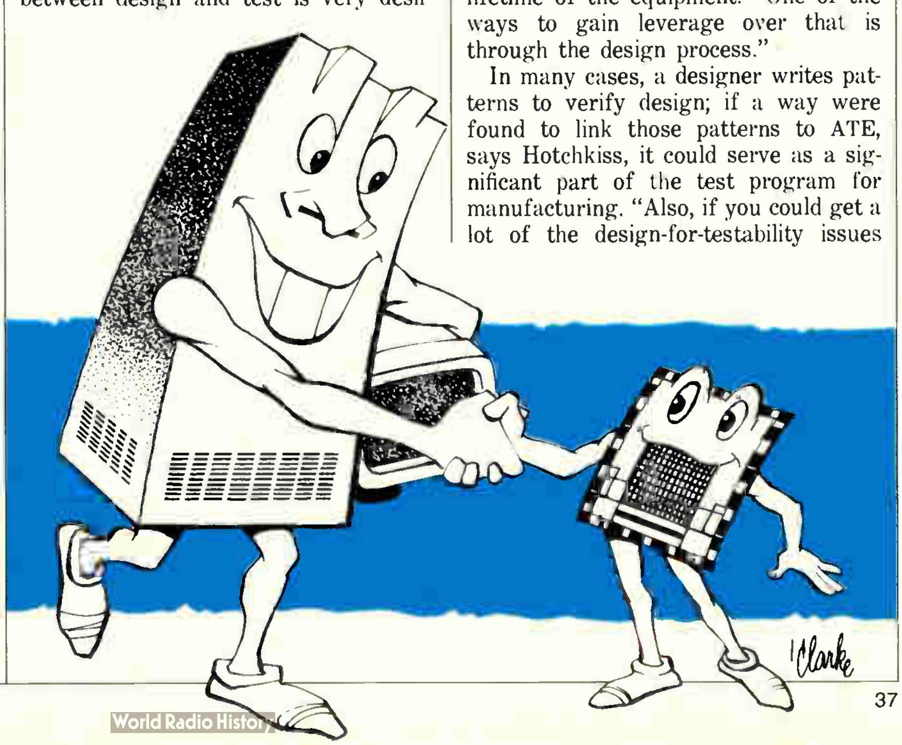
Until now, Lasar has been sold only as an option to Teradyne's board-test equipment, useful in test-program generation. The company has installed the product at 250 sites, half of them in traditional test areas and half in the design end, for simulation and verification. It was the latter application that raised the notion that Teradyne could move successfully into design.

"I think everyone agrees that the link between design and test is very desirable," says d'Arbeloff. "If the same simulation is used in design and test, you have a way to link the two and help in getting test programs written."

The company created a Design and Test Automation Group in early 1984 to lead the charge into the new market. Starting with a team of 20 that has since grown to 75, the unit is led by Jeff Hotchkiss, its general manager. Lasar's success has given them a running start, he says: "That got us an installed base and a sales force that only sells Lasar into the design [area]." The group also has developed the DataServer simulation server, DataView integrated design program, and DataSource hardware-modeling system.

Though emphasizing that the design market is his group's primary focus, Hotchkiss concedes there is a secondary objective. "One of the most important areas in the selection of test equipment is where programs will come from," he says, adding that costs for test-program generation can be two to three times higher than those for hardware over the lifetime of the equipment. "One of the ways to gain leverage over that is through the design process."

In many cases, a designer writes patterns to verify design; if a way were found to link those patterns to ATE, says Hotchkiss, it could serve as a significant part of the test program for manufacturing. "Also, if you could get a lot of the design-for-testability issues



earlier in the design process, you could greatly simplify the test issues," he says.

With competition from Japan growing in the test-equipment business, Teradyne is convinced of the need to expand the competitive front, including competing in Japan itself. But, says Hotchkiss, head-on competition would be tough, likely boiling down to who has the lowest cost of production. So broadening to include design seems the best route for a company with strong technology—such as Teradyne.

But the company had to toe a fine line here. Among the problems it faced in moving into the design-tool market was the suspicion it was trying to sell test equipment via the back door. "That was a big problem the first year in the business," says Joseph Lassiter, vice president of the Manufacturing Systems Division. Partly in response, Teradyne says it is committed to offering design tools that work with any make tester. And in a market that's burned many customers with here-today, gone-tomorrow operations, Teradyne offers a track record of staying power.

Analysts are generally bullish on Teradyne's prospects. Most rate the test maker as among the tightest ships in the industry and give it high marks for turning in a $85,000 profit in the quarter ended March 29, a period awash in red ink for the rest of the industry. Stephen Balog, a senior analyst with Prudential Bache Securities, New York, describes Lasar as a near standard and thinks there could be a big payoff to Teradyne's push to link design and test.

"The work-station products don't completely solve the problem [of moving from design to test and on to manufacturing]," he says. "Teradyne has tremendous capability in the test area, and the test-design link is important... I think they'll pull it together."

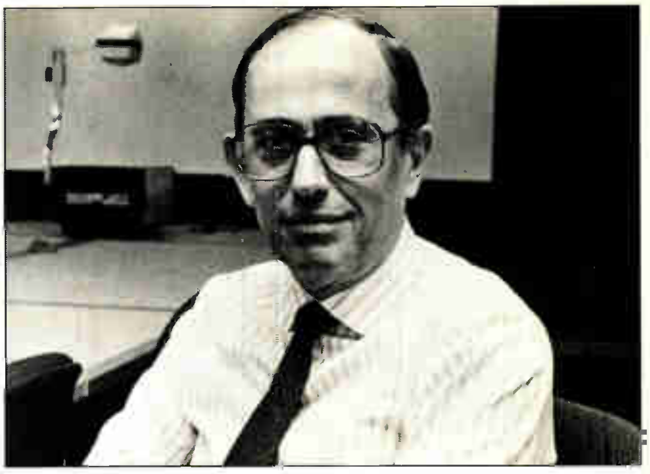
**WRONG APPROACH?** On the other hand, Peter Schleider, senior vice president at L. F. Rothschild Unterberg Towbin Inc. in New York, believes Teradyne has the right idea but the wrong approach. There is a market opportunity, he agrees, but Teradyne would do better going an original-equipment-manufacturer route than trying to compete directly. "There's a lot of service required in this business," he says. "You don't just put it out there with an 800 number and hope the customers are happy."

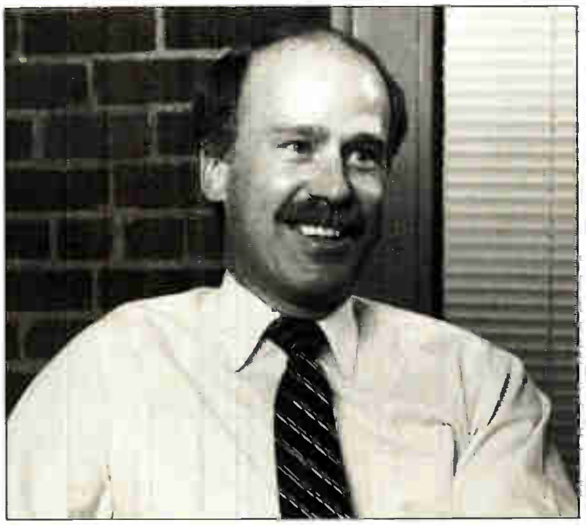
At Teradyne, Hotchkiss says the OEM idea was rejected partly because of the support requirements. "We couldn't get post-sales support that we thought we needed," he says. Besides, he adds, the most logical companies to link up with for an OEM deal already have directly competitive products.

The task now is to reposition Teradyne from a single-tool supplier—Lasar—to a full-fledged CAE company. One trap the company is determined to avoid is trying to cover all bases in CAE. "You get a long to-do list and you have to decide what really matters," says Lassiter. Teradyne is not interested at this time in physical layout; instead, it's focusing on the other three legs of the design-and-test loop: design, including schematic capture and simulation; design verification; and manufacture and test.

The company will concentrate on design tools for printed-circuit boards and systems while also supporting gate arrays. It opted not to target full-custom integrated-circuit design, because, says Hotchkiss, the market is more heavily penetrated and only a tenth the size of the pc-board market. Also, he says, Teradyne's expertise lends itself more readily to board design than chip.

The company designed its products and chose its focus in CAE after careful observations of what design engineers really do. One thing the company learned is the relative unimportance of graphics. "The first thing all of us assumed, going back a few years, was that graphics was going to be real essential," Lassiter says. "But the electrical engineer lives in a simplistic graphics world compared to layout people and mechanical engineers." Thus an IBM PC AT suffices as a platform.





**DRIVERS.** Steering Teradyne into CAE are Joseph Lassiter, vice president, manufacturing systems, above left; Alex d'Arbeloff, president, above; and Jeff Hotchkiss, general manager, design and test automation.

Teradyne designers found that they needed to place greater emphasis on a board's analog parts than they first believed. They also found that customers put a premium on quick simulation and schematics modification, but not on changing test patterns rapidly. In a similar fashion came the decision not to bother with physical layout, because "very few engineers are interested in laying out their own boards," says Lassiter. "The essence of the technology here is getting software simulators to replace the hardware prototype as a way to develop design," he says.

D'Arbeloff offers a detached assessment of all efforts at linking design and test, including Teradyne's. "My perception is that at this point none of these things works extremely well," he says. "I think expectations and true needs will be higher than what we or anybody else can deliver."

But besides assembling and maintaining a team, d'Arbeloff and Lassiter believe the CAE group must also approach the business as an entrepreneurial unit, attempting to pay for its own growth and development. "I'm not sure if you hired an extra hundred engineers and lost a lot of money you'd necessarily solve [these problems]. The discipline of profitability offers the best chance to solve the problem," says d'Arbeloff. □

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# WHY THE PENTAGON WILL SPEED UP IR-SENSOR WORK

## NEEDED: LARGE FOCAL-PLANE ARRAYS FOR SDI AND WEAPON SYSTEMS

*by Larry Waller*

**LOS ANGELES**

The demand for advanced infrared sensors for the newest military gear exceeds by so much industry's ability to build them in quantity that the Department of Defense is poised to make them a top research priority. Such attention from the biggest user underscores the critical need in a host of programs—with the Strategic Defense Initiative heading the list—for large focal-plane arrays that crowd thousands of IR detectors on a chip.

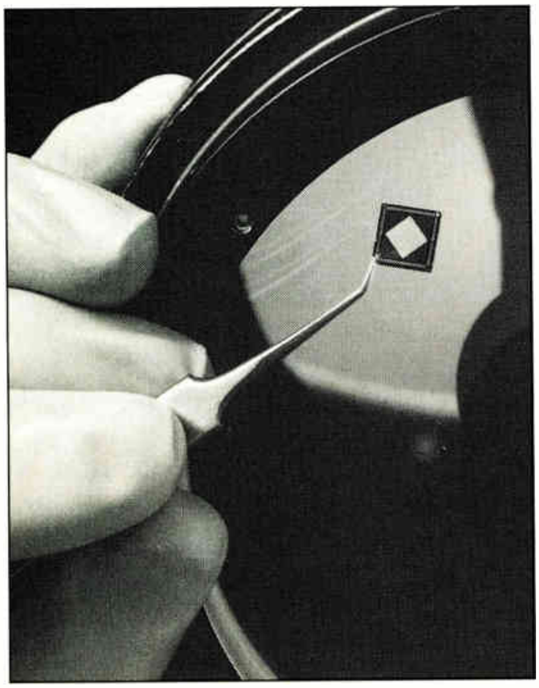
Without these devices, high-performance sensing requirements for SDI and tactical weapons systems cannot be met. But the arrays, far more complex than present IR sensors based on decade-old technology, pose tough materials, fabrication, and signal-processing challenges. The result is that the state of the art for large arrays is a workable laboratory prototype, years away from the volume production stage.

For now, the Pentagon's research and engineering office will say only that it launched an industry survey in April to gauge where array technology stands, with an emphasis on potential problems in the production process. When completed, a spokeswoman says, it is likely that the Pentagon would take some action.

Industry sources are less understated. Defense planners, they say, are poised to press the accelerator on IR array development—possibly as early as fiscal 1988. To offer some perspective, the fiscal 1986 budget for SDI calls for $80 million for IR sensor work. The Pentagon declines specific comment on this question, however.

On the industry side, major suppliers of IR devices such as Texas Instruments Inc. already have undertaken ambitious research and development programs, dipping into their own resources to augment whatever military funding was available. The program has top-level support at TI, says George H. Heilmeier, senior vice president and chief technical officer of corporate research, development, and engineering. "I'm excited about it," says Heilmeier, who considers focal-plane arrays one of TI's prime R&D goals.

That same excitement is the rule at most companies with a stake in sensor technology. It derives from the key role the complex arrays play not only in SDI but also in airborne surveillance and smart—or fire and forget—tactical weapons. In SDI, a key requirement is sensing systems that will accurately track ballistic missiles from launch through atmospheric reentry. For tactical weapons and surveillance, passive IR tracking gear is emerging as the best means to contend with increasingly sophisticated electronic warfare techniques, including jamming and anti-radiation missiles.



**EYES.** Northrop's 16,384-element focal-plane array sensor can see 10 miles at night. It is fabricated with indium antimonide.

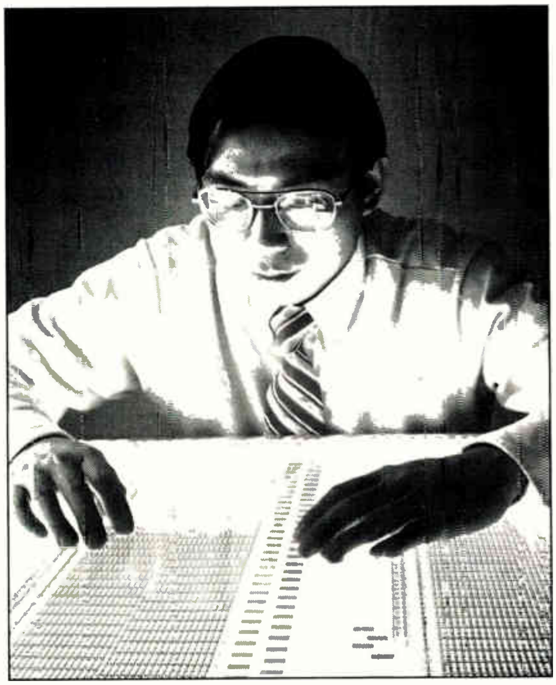
But the IR sensors employed by military users today for night vision and surveillance of aircraft and ground vehicles, among other tasks, need a human operator. And limited as they are to several hundred detectors at most, these arrays can't begin to measure up to the kind of sensitivity, resolution, and, above all, signal processing called for by the new generation of applications. The name of the game now, say designers, is cramming more detectors into the focal plane to raise sensitivity—that is, the signal-to-noise ratio. The rule of thumb is that increasing the number of detectors in a sensor by 100 will improve the sensitivity by a factor of 10.

**COMPLEX.** A further complication is that an IR sensing system needs far more gear than the focal-plane array itself, which works by generating a charge when illuminated by photons. A system needs optics to focus incoming energy on the array and a cryogenic cooler to keep the detectors at an optimum temperature that reduces thermal noise—for example, the principal sensor materials, mercury cadmium telluride and indium antimonide, both need to stay at 80 K. Finally, to get a usable output that clearly highlights target data by eliminating surrounding clutter, the sensor signal must be cleaned up and enhanced

### HOW INFRARED DETECTOR TECHNOLOGY CAN BE USED

| Wavelength (μm) | Materials | Applications: Strategic Defense Initiative | Applications: Other |
|---|---|---|---|
| 1 to 3 | Indium Arsenide, Mercury Cadmium Telluride, Platinum Silicide | Boost<br>Terminal | Laser |
| 3 to 5 | Indium Antimony, HgCdTe, PtSi, extrinsic silicon | Boost<br>Terminal<br>Midcourse<br>Homing | Seeker<br>IR search and track<br>Threat warning |
| 8 to 14 | HgCdTe, extrinsic silicon | Midcourse<br>Homing | Laser<br>Forward-looking IR<br>IR search and track<br>Threat warning |

SOURCE: GENERAL ELECTRIC CO.



**WEI:** The GE materials scientist favors the relatively simple InSb process.

by data-processing circuits.

Although the specific parameters of contemplated arrays and host weapon systems for the most part are classified, their general performance may be inferred by initial results revealed by Northrop Corp., Anaheim, Calif., in testing a prototype InSb array [*Electronics*, May 5, 1986, p. 20]. The 128-by-128-element array, with 16,384 sensors, operates through a telescope in what IR engineers call the midwave sensing region, 3 to 5 μm. It can recognize an aircraft the size of a fighter at distances of 16 nautical miles and detect its presence as far out as 100 nautical miles.

But building arrays in what is known as the staring configuration, which points at a fixed location and has the advantage of not needing electronic scanning gear, has proven tough. The first hurdle for designers is choosing the material and the method of designing the sensors, which means that in effect an IR researcher must become a semiconductor designer.

Which material to use is problematic but critical: the material determines which of the three IR sensing windows, or wavelengths, the device will best address (table, p. 40). The most versatile material is HgCdTe, which can be fabricated to sense all windows by altering the ratio of mercury to cadmium. It has become the subject of intense development throughout the IR community. A big payoff would be to combine both midwave and longwave (8 to 14 μm) sensing windows on one array, which can be done only with HgCdTe and which no one has yet done. The task is well under way at TI.

**TRICKIEST MATERIAL.** At the same time, HgCdTe is by far the trickiest material to work with because it is a three-element compound. Efforts are also hampered by yields said to be as low as 1% in some cases. To raise that number, researchers in HgCdTe are using epitaxial techniques, adapted from semiconductor silicon processing, that deposit a thin film on a cadmium telluride substrate—a method that's also being applied to InSb, gallium arsenide, and sapphire. As TI's Heilmeier points out, "The big challenge is overcoming the vastly different vapor pressures of the different materials."

Although a number of other materials are candidates for IR arrays—including lead salts, extrinsic silicon, and platinum silicide—the chief competitor to HgCdTe is InSb. Northrop Corp.'s prototype and another 128-by-128-element InSb array by General Electric Co., which also works in the midwave 3- to 5-μm range, are the most complex IR arrays yet. No HgCdTe device can boast a similar performance. Hughes Aircraft Co.'s Santa Barbara Center, another major IR-sensing player, built a 16,384-detector array of HgCdTe for the Navy more than a year ago that was sidetracked by temperature-cycle problems. These are now corrected, a company representative says, but he will not elaborate.

The big advantage of InSb is that "its technology is fairly mature, and it's not a complicated process," says Ching-Yeu Wei, a materials scientist at GE's Research and Development Center, Schenectady, N. Y. Although GE also is working on epitaxial HgCdTe arrays, Wei is firmly in the InSb camp and doubts the rival material will soon solve all the IR fabrication problems it faces. "It's always 'a couple of months away,'" he says.

*The state of the art is a lab prototype years from production*

GE's array work in InSb revolves around a silicon-based, charge-injection-device technology developed more than a decade ago for solid-state TV cameras. The new devices have a number of enhancements to improve a longstanding problem with such sensors: charge-transfer efficiency between pairs of collection and injection capacitors. A key change is in the CID cell geometry, says Wei.

Instead of the conventional side-by-side capacitor layout, the improved devices have a concentric design, with one capacitor surrounding the other. This technique cuts the transfer distance for a fixed area of the sensing site, helping to raise efficiency, says Wei. Another advance is a proprietary technique for applying a silicon dioxide insulating layer on the InSb substrate, which results in very low interface-state density, he says.

From the Defense Department's viewpoint, the materials question is "something that might never be settled," observes Samuel Lambert, chief scientist at the Air Force's Weapons Laboratory, Eglin Air Force Base, Fla. More important to Lambert, who is charged with integrating IR sensors into practical weapons, is processing the data from the sensors into something usable. He notes that even the current generation of sensors produces data 60 times a second, which taxes signal processing to the limit.

The heavy signal processing required sets up another roadblock to producing big arrays (128 by 128 elements and up) in the 8- to 12-μm spectral region. In this range, the bandgap narrows to about 0.12 eV (from 0.25 eV in the midwave range), and signal levels come in at a rate about two orders of magnitude higher than at the midwave range. "There's a tremendous saturation of photons," says GE's Wei. Lambert concurs: "There's so much energy coming in, it can overload the detector."

**BUILT-IN STORAGE.** One solution is to build in the storage capacity to integrate the signal and achieve high sensitivity. To this end, TI is pursuing an integrated approach to signal processing, bringing more of this function on board the chip. The company's 64-by-120-element array is structured so that signal integration and multiplexing are in the HgCdTe itself. Such a device—called a charge-imaging matrix—is similar in structure to a dynamic random-access-memory cell, the company says. The approach has the added bonus of allowing a reduction in chip size.

Lambert is in a position to see all aspects of IR sensing activity, and he thinks more funding support is indeed in the cards. But he's grown vaguely skeptical about the technology from years of listening to all kinds of solutions based on techniques not yet in hand. "It's hard to be against large focal-plane arrays if you can get them," he says. But he would still like to see detailed technical justification for their development. And, says Lambert, there's always the danger that too much will be expected because "a lot of generals have the perception that arrays will solve all their problems." □

*Additional reporting was provided by J. Robert Lineback in Dallas.*

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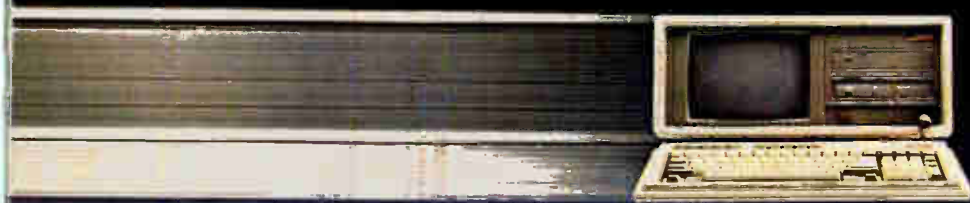

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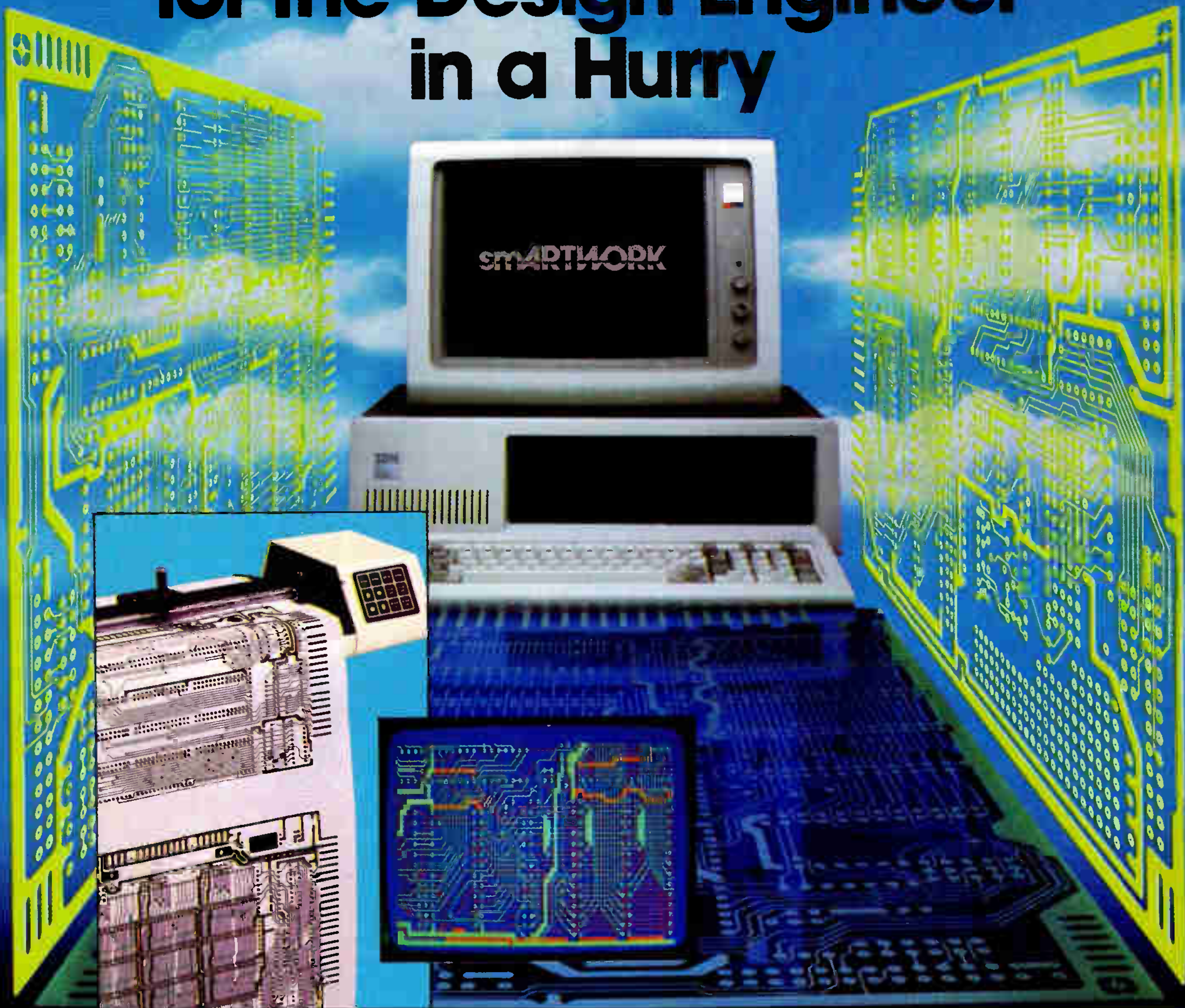


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- ☐ Houston Instrument DMP-41 pen-and-ink plotter
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Circle 44 on reader service card

# THIS COULD BE THE YEAR THAT THE CLONES OUTSELL IBM

## COMPAQ LEADS AS PC COMPATIBLES BATTLE FOR MARKET SHARE

*by Tobias Naegele*

**NEW YORK**

They're called clones because they run the same programs as IBM Corp.'s highly successful line of personal computers. But as more and more of these machines pour into the U. S. market, the struggle intensifies for each manufacturer—large or small, U. S. or foreign—to make its particular product stand out rather than be too close a copy of the others.

Meanwhile, the compatibles are gaining market share. Statistics from Future Computing Inc., the Dallas market researcher that is a unit of McGraw-Hill Inc., indicate that sales of IBM clones are growing faster than sales of IBM-made computers and that the clones should combine to outsell IBM for the first time this year. But analysts aren't worrying about IBM's market position yet. "Compaq [Computer Corp. of Houston] is the most capable of the clones," says Seymour Merrin of The Gartner Group, Stamford, Conn. "They have the best compatibility experts—and they do IBM good. But everybody else is going to lag behind."

Further bloodying the waters are the Korean and Taiwanese makers, which some analysts say could drive prices in the IBM Personal Computer-clone market down into the $500 range. Dataquest Inc., the San Jose, Calif., market researcher, now lists 70 Asian manufacturers of PC clones in its data base, according to analyst Sharon Hashimoto. Precise market-share information is not yet available, but one Asian machine is the popular Model D from Leading Edge Inc. of Canton, Mass., which is manufactured in Korea by Daewoo Ltd. and sells for $1,300 to $1,400.

Price, of course, is the major point of contention, as most players in this market undercut IBM by $1,000 or more—and it will continue to be a major market-driver. But the industry does not live by price alone, and many computer makers try to better the IBM PC in different ways. Compaq, which in 1982 became the first to accept the IBM PC as a de facto microcomputer standard, made its name by putting its first IBM-compatible machine in a portable package. Compaq, as well as others, emphasize higher speed, expanded memory, and improved graphics to try to set their machines apart.

Differentiating themselves from IBM—and the rest of the pack—is the major challenge these competitors face, says Robert Dillworth, president of Zenith Data Systems in Glenview, Ill. Under Dillworth, Zenith has become a major clone producer by competing aggressively for government bids. IBM is not the only competition, he says. Indeed, most of the competition comes from other clone makers hawking nearly identical products. In Dillworth's keynote address at Spring Comdex in Atlanta in late April, he suggested that "what [computer makers] are actually selling are the bells and whistles that make their product different from the rest."

Dillworth said the industry is manufacturing a "standard product, and [Zenith] is treating it much like a television set in that respect." The company has used its experience in the competitive, high-volume TV market to gain an edge, using the parent company's mass to source components from its own plants. With an installed base of 245,000 units, Zenith Data Systems ranks second to Compaq as the most successful of the clone makers (table).

**BIG NICHES.** "Zenith is aiming at large-volume niche markets—federal, state, and local governments, and universities—rather than trying to get broad market coverage," observes Jocelyn Young, an analyst at Future Computing. Through aggressive bidding, Zenith won several major federal contracts over the last year, including a much-coveted Internal Revenue Service contract for 15,000 of its Z-171 portable IBM-compatibles and a much larger $242 million order from the Air Force, Navy, and Marine Corps for 90,000 Z-200 desktop machines compatible with IBM's PC AT.

The leading U. S. price competitor is Tandy Corp. of Fort Worth, Texas. Tandy offers three IBM-compatible models. It matches its 8088-based 1000, designed and built for the home computer market, against the IBM PC, the model 1200 against the PC/XT, and the top-of-the-line 3000 against the PC AT. Using its Radio Shack chain of distributors, Tandy has pushed the model 1000 price lower and lower, and the machine can now be had for as little as $699 with a monochrome monitor or $999 with a color monitor. The pricing has helped Tandy gain its position as the third-largest maker of IBM-compatible microcomputers in the U. S., with an installed base of more than 190,000.

Compaq and others have

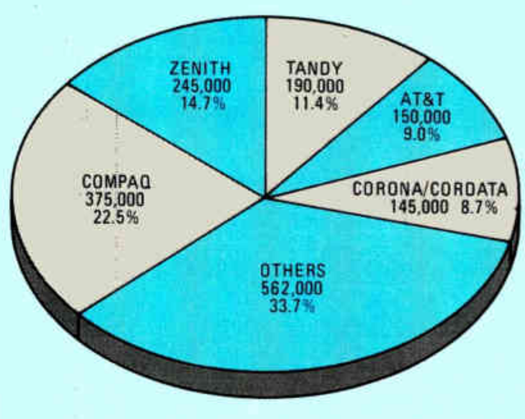
**HOW MUCH OF THE U.S. MARKET IS IBM AND IBM COMPATIBLE?**

| | 1985 (in millions) | % market | 1986* (in millions) | % market |
|---|---|---|---|---|
| Total personal computers sold | 7.182 | | 8.211 | |
| Total IBM PCs, XTs, ATs sold | 1.493 | 20.7 | 1.837 | 21 |
| Total IBM compatibles sold | 1.089 | 15.7 | 2.165 | 24.9 |

*Projected

SOURCE: FUTURE COMPUTING INC

**WHO HAS THE LARGEST U. S. INSTALLED BASE?**




SOURCE: FUTURE COMPUTING INC.

ness," where it had sold more than 23,000 units by 1983.

But fundamental changes in the industry have made the old Wespercorp lines less profitable. For example, small computers that used to need separate tape-drive controllers now generally have this function formatted internally, so that only a coupler is needed to complete the connection to a host. So instead of selling a controller for about $3,000, the company supplies a coupler for $800. Although several products sell well in niches—such as a laser-printer controller for Wang Laboratories Inc. computers—the pressing need is for more up-to-date items with fatter profit margins. But Dashiell rules out internal development of these products. "We need products quickly and can't afford research and development," he says.

**PRODUCT SEARCH.** One solution is to market items produced by other makers. Wespercorp started a search for such products on a crash basis last year and already has four cross-licensed products on the market. Attracting the most attention is the DigiVoice DV-1000, an audio digitizer that converts voice data to digital output and digital data to voice output—a useful product for automated data systems. It comes from a small U. S. company that couldn't afford to carry it on. And Wespercorp has ranged much farther afield—to West Germany for a VME-bus-system disk controller, to England for a Q-Bus streaming-tape-drive controller, and to Australia for a printer controller for IBM Corp. mainframes.

Dashiell's performance in coaxing the company back to profitability wins him kudos from informed observers. "He's making real progress," says market watcher William Y. Richardson in the Portland, Ore., office of brokerage firm PaineWebber Inc., an investor in the company. Wespercorp's earlier troubles are "not at all uncommon in new industries, where management feels it can't make a mistake and tries to grow too fast," Richardson says.

Director Taylor, in close touch with operations, lauds Dashiell's methods: "He's a real straightforward guy, people like to work for him." Taylor says optimism over the company's future is more than idle talk. But he admits much of the outlook "depends on where the FAA contract goes."

Dashiell will continue "building strength quarter by quarter, without risk." The company can withstand whatever comes its way, he says, except "traumatic occurrences," such as losing a lawsuit. *–Larry Waller*

## BOTTOM LINES

### HITACHI RECORDS FIRST DIP IN A DECADE

Hitachi Ltd. has posted its first drop in profits and sales in 10 years. The Tokyo company, reporting its results for the fiscal year ended March 31, says that the decline came from a 28% plunge in semiconductor sales plus a stronger yen, which has slashed export margins. Net profits fell 16.5%, to $374 million, based on average exchange rates during 1985; sales were down 0.7%, to $4.2 billion. The company predicts that the stronger yen will erode net profits another 18.2% for the current fiscal year, based on a per-dollar exchange rate of 165 yen for the first half and 170 yen for the second half.

### ROBOTICS MAKER HAS 1ST PROFITABLE YEAR

International Robomation/Intelligence, a Carlsbad, Calif., maker of artificial-intelligence vision systems, says that 1985 was the first profitable year in its four-year history. Sales for the year, ended Jan. 31, increased 243%, to $10.65 million from the previous year's $4.4 million. Earnings were $536,000, compared with a loss of $3.85 million the previous year. The company says its newest product, a visual-inspection system for printed-circuit boards, has chalked up $2.5 million in orders from such companies as AT&T, Chrysler, Hewlett-Packard, IBM, Lockheed, Rockwell, Texas Instruments, and Zenith.

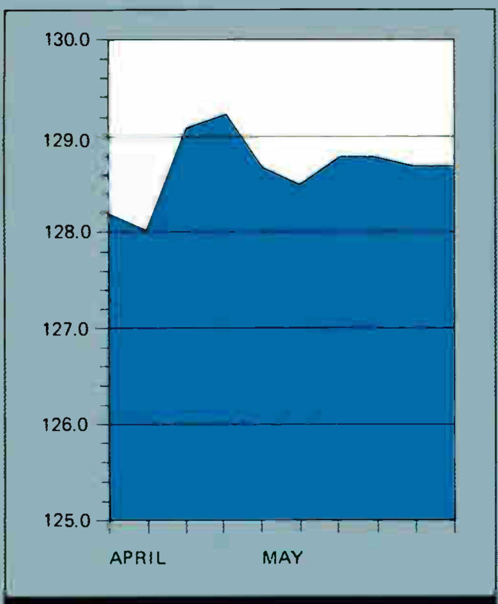
### PLANTRONICS TO BUY HANDSET COMPANY

Telecommunications equipment maker Plantronics Inc., San Jose, Calif., has signed a letter of intent to acquire Walker Equipment Co., Ringgold, Ga. Walker manufactures amplified handsets that complement peripheral telephone equipment from Plantronics' Santa Cruz, Calif., division.

### ZYMOS CUTS LOSS FOR QUARTER BY 66%

Zymos Corp. reports a 66% cut in operating losses, to $879,000, for the second quarter of 1986. That compares with $2.6 million for the same quarter a year ago. The quarter's net loss was $1.3 million on sales of $5.24 million; in the same quarter of 1985, the loss was $2.9 million on sales of $5.3 million. Daewoo Ltd., a South Korean conglomerate, acquired controlling interest in the Sunnyvale, Calif., firm in April. As a result, "we expect revenues to grow," says Zymos president Bert Braddock.

## ELECTRONICS INDEX





| | | |
|---|---|---|
| THIS WEEK | = | 128.7 |
| LAST WEEK | = | 128.7 |
| YEAR AGO | = | 127.8 |
| 1982 | = | 100.0 |

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

## U. S. ELECTRONICS IMPORTS AND EXPORTS ($ BILLIONS)

| | IMPORTS | | | EXPORTS | | |
|---|---|---|---|---|---|---|
| | March 1986 | February 1986 | March 1985 | March 1986 | February 1986 | March 1985 |
| Accounting, computing, and data-processing machines | 476.173 | 364.753 | 342.244 | 630.341 | 555.074 | 783.125 |
| Calculators | 52.437 | 51.253 | 56.763 | 8.832 | 5.807 | 9.460 |
| Parts for data-processing machines and office calculators | 560.664 | 407.673 | 369.056 | 607.665 | 613.935 | 696.167 |
| Telecommunications, sound-recording, and sound-reproducing equipment | 1,807.908 | 1,476.649 | 1,661.969 | 404.876 | 360.760 | 467.097 |
| Electronic or electric instruments | 188.830 | 147.279 | 154.784 | 616.575 | 534.485 | 694.551 |
| Printed-circuit boards | 31.633 | 26.405 | 24.638 | 37.176 | 29.327 | 29.525 |
| Integrated circuits, diodes and other semiconductors, tubes, piezoelectric crystals, parts | 631.552 | 432.516 | 653.302 | 442.529 | 380.863 | 522.980 |
| Fixed and variable resistors | 24.439 | 20.176 | 24.628 | 15.752 | 15.348 | 15.253 |

The weakening dollar, down 23% from a year ago against the currencies of major U. S. trade partners, has done little so far to counter the deficit that U. S. electronics producers now suffer in world markets. In March, electronics imports soared 29% to reach $3.8 billion, with U. S. purchases of foreign-made integrated circuits and other components alone skyrocketing 46% from February.

The trade news was not wholly glum, however. U. S. exports rose nearly 11%, to $2.8 billion, the highest monthly level in the past year. Pacing the growth were calculators, up 52%, followed by printed-circuit boards, which rose 27%.

March marked the third consecutive monthly gain for exports, but the increase fell far short of the heavy hike in imports. The result: a $1 billion electronics trade deficit in March—double the average monthly trade deficit in 1985.

This sharp deterioration in the electronics trade balance could prove to be short-lived. Eventually, the lower dollar should brake imports and boost exports. It's also possible that March's big rise in imports was a one-shot event, spurred by U. S. users stocking up on Japanese memories in the expectation that the U. S. government will slap anti-dumping penalties on Asian chip makers.

# RENSSELAER'S HANIFIN HASN'T LEFT THE FACTORY

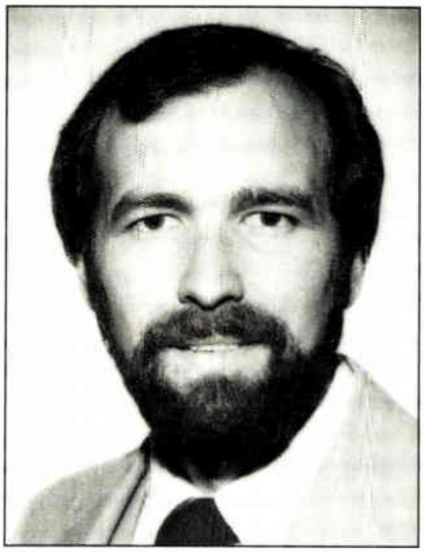
**TROY, N.Y.**

The future of U.S. manufacturing rests squarely in the hands of software engineers who are coordinating automated processes, says Leo Hanifin, director of the Center for Manufacturing Productivity at Rensselaer Polytechnic Institute in Troy. Hanifin also is the new chairman of the Robotic Industry Association's Technology Committee.

"The biggest challenge in manufacturing technology today is integration," says the 39-year-old director, who spent almost 15 years as a manufacturing engineer with Chrysler, Hughes Aerospace, and IBM before moving into his present position. The key to improving U.S. manufacturing is "hooking the hardware together in a way that keeps you from constantly recreating the software for communications control" and other parts of the process. "The actual production technologies available today are very strong," he says, "but they are being held back by these other issues."

One that isn't, he says, is General Motors Corp.'s Manufacturing Automation Protocol. "The MAP standard will be every bit as important as anything that Henry Ford ever did," he says.

Hanifin wants his committee to identify the technological needs of manufacturers and to help stimulate and support research and development efforts in the areas most in need of study. To do this, the committee is distributing a survey in the robotics and manufacturing research community.



**HANIFIN:** Production technologies are held back by integration issues.

"We're looking at areas where we need some new capabilities for robotics technology," he says. "We want to identify areas where we have no proven concept to answer a need." Artificial intelligence, for example, is particularly promising for robot control.

The RIA committee is but a sideline, however, to Hanifin's full-time role as director of Rensselaer's Center for Manufacturing Productivity. Merging the talents of industrial engineers, university professors, and students, the center is dedicated to robotics and the other manufacturing technologies. It was started in 1979 and recruited Hanifin from Chrysler Corp. the following year.

The center has strong backing, and its list of member institutions reads like a who's who of U.S. business. Boeing, Digital Equipment, General Dynamics, General Electric, General Motors, IBM, Kodak, and United Technologies are among the more than a dozen companies financing the center, which also does about $2.5 million a year in funded research to help support itself.

A native of Vestal, N.Y., Hanifin earned his bachelor's, master's, and doctoral degrees from the University of Detroit. His dissertation focused on the modeling of a large manufacturing system at the nation's third-largest automaker. But after eight years at Chrysler, Hanifin felt something was missing. "I was frustrated in industry, not finding people who understood advanced technology and who also understood manufacturing technology."

**SIMILARITIES.** Leaving industry for academia was not easy, but the potential trauma was tempered by the structure of the center itself. Combining the best of both worlds, the group consists of 220 people working at any given time, Hanifin says. Almost 150 of these are students. Instructing and guiding them are about 30 faculty members, 20 industry experts on assignment, and another 20 part-time technical staff members. The diverse professional staff allows Hanifin to say, "I'm definitely part of the academic world, but I haven't really left the industrial world yet either."

Hanifin says that if he could live his career again, he wouldn't change a thing. "Having a university say to me it wanted me for a center that could have a major impact on manufacturing research and education was too important to pass up," he says. "I don't think I could be anywhere doing anything more important for the country or for myself, with my particular skill set." *–Tobias Naegele*

## PEOPLE ON THE MOVE

**DAVID G. FAMILIANT**

☐ Crystal Technologies Corp. has named David G. Familiant president and member of the board. He comes to the Elmsford, N.Y., maker of office work stations with 30 years' experience in information processing, management, and marketing. Most recently, he was vice president of international marketing for Control Data Corp.

**GEORGE W. SARNEY**

☐ Raytheon Co. has created a new post, group executive, and filled it with George W. Sarney, who has also been named a senior vice president of the Lexington, Mass., company. Sarney comes to Raytheon after 25 years at General Electric Co. He will be in charge of the Energy Services Group, four subsidiaries that totaled $720 million in sales in 1985.

**WILLIAM J. ADAMS**

☐ Harris Corp. has appointed William J. Adams vice president and general manager of the company's Digital Telephone Systems Division. The division, in Novato, Calif., is part of the Melbourne, Fla., company's Information Systems Sector. Adams joined the company in 1984 as vice president and general manager of the Mobile Telephone Division. Before that, he spent six years with Northern Telecom Inc. in various management positions.

**RICHARD C. TIPPETT**

☐ Electronic test and measurement systems manufacturer Genrad Inc. has promoted Richard C. Tippett to vice president. He moves from general manager of the Semiconductor Test Division in Milpitas, Calif., a position he has held since October 1985. Tippett joined Genrad in 1984, after 10 years in management positions with NCR Corp. in Wichita, Kan.

**ADRI BAAN**

☐ Philips has appointed Adri Baan managing director of its Electronic Components and Materials Division in Eindhoven, the Netherlands. Baan, 43, a graduate of the University of Amsterdam with a master's degree in experimental physics, joined the company's particle accelerator group in 1969 and spent five years designing cyclotrons. After a stint in the U.S. as a Philips product manager, he returned home, eventually becoming a member of the management board of the company's Science and Industry Division.

# CARAËS'S EUROPEAN STRATEGY BOOSTS MENTOR

**CARAËS:** Direct sales and hardware independence lead to success in the market.

**PARIS**

The notion that history repeats itself is far more than a cliché for Jean-Claude Caraës, managing director of Mentor Graphics (Europe). A year after Mentor began operations in 1983, it stood far behind Daisy Systems Corp., its principal competitor in the market for engineering work stations.

That didn't worry Caraës. After all, Daisy was an established force with a head start of a couple of years in the market. Also, a parallel situation had existed in the U. S. a few years earlier, and he points out that his company overcame that handicap to take the market lead away from the Sunnyvale, Calif., company. He was certain that Mentor's European market share would follow a similar evolution.

Before joining Mentor, Caraës, a graduate of the French Ecole Supérieure des Ingénieurs Electriques et Electroniques, was managing director of VisiCorp Europe from 1982 to 84 and before that manager for systems at the French subsidiary of Intel Corp. He joined Mentor in 1984.

Caraës had to wait only until the following year to be proved right. Mentor's 1984 sales of $10.5 million more than tripled the following year to $32 million, making the company the clear European market leader. according to Dataquest Inc. Daisy now holds second place with $25 million, the San Jose, Calif., market researcher says, and Valid Logic Systems Inc. is No. 3 with some $17 million. Those million-dollar figures correspond almost identically to percentage figures as shares of the $100 million European market.

Caraës points to two reasons for the company's success, one strictly European, the other corporate. Mentor gained an edge on its competition in Europe, he thinks, with a strategy aimed at shunning distributors, setting up its own subsidiaries to attack the market directly, and producing or assembling as much as possible of the systems it sells in Europe.

"In this business, getting a customer is only a small part of the problem. The real issue is keeping him," he explains. "Decisions on which work station to buy used to be made by department heads and then technical managers. But as these choices become more and more strategic, they can even go as far as the president or board of directors. There is no way that you can serve that market using distributors."

The result is that Mentor now has fully owned subsidiaries in all major European countries except Spain, where the company still uses a distributor because it believes the Spanish market does not yet warrant a fully developed subsidiary. The company has a European staff of some 120 people spread among its subsidiaries.

**CENTRALIZED SYSTEM.** Another important feature of the company's European strategy has been to reorganize production. When Caraës joined Mentor in 1984, the company's European assembly was completely decentralized and executed by each of the company's subsidiaries. "Our subsidiaries were so independent that they were each buying hardware from their respective local subsidiaries of Apollo," he recalls. "The reason that we've centralized that function is so that it can be better coordinated and so that we can cut costs by taking advantage of our size on a Europe-wide scale." Production of work stations for European sale is now concentrated in Amsterdam.

The corporate decision that Caraës believes turned Mentor into the market leader is hardware independence. While its major competitors were developing their own dedicated equipment, Mentor was concentrating on software, traditionally sold using Apollo work stations as hardware. This has maintained downward compatibility among all the systems Mentor has thus marketed, an often decisive advantage in a fast-evolving market. *–Robert T. Gallagher*

# NEW PRODUCTS

# AN OFF-THE-SHELF INTERFACE SERVES ANY DEVICE UNDER TEST

## FLEXIBLE TEKTRONIX SYSTEM SUITS JUST-IN-TIME MANUFACTURE

Tektronix has filled in a missing link in automatic test equipment—a standard interface to link the test system and the device under test. The company's Instrument Systems Integration Division has come up with the TSI-8150, an off-the-shelf test-system interface it claims will save ATE-system builders months of design work on custom interfaces.

The TSI-8150 consists of two primary hardware components—the main chassis and the device-under-test adapter. The full family of six switching cards and modules can be mounted in either component. Such flexibility allows the user to move the signal-routing switches close to the device under test when maximum signal integrity is critical.

The range of signal routing for the TSI-8150 goes from low-level dc to 18 GHz. "This is the most complete product of its kind," says Al Schamel, engineering program manager. "Others—the Fluke 2400 and the Hewlett-Packard 3497 among them—have preceded Tektronix into the data-acquisition-ATE market, but we offer the widest range.

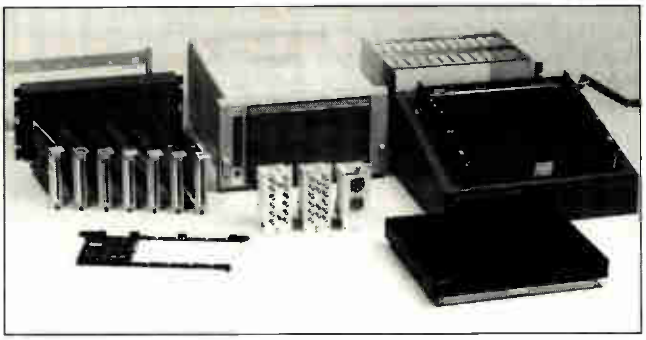
"We're backing the trend to just-in-time manufacturing with flexible configuration and interchangeability of test heads, from vacuum bed-of-nails through custom device fixtures," Schamel says. JIT puts maximum pressure on the test system, he says, with its demand for quick changes from hybrids to components to boards on the line at any given moment.

**SIMULTANEOUS TESTS.** The 8150's flexibility suits it to a wide range of applications, including components, hybrids, wiring harnesses, and pc boards. Also, with two adapters installed, users can perform simultaneous tests—for example, on a device that must qualify under both industrial and military specifications. The adapter accepts custom or commercially available test heads. When the test heads are wired through an internal patch panel to a removable adapter module, the user can construct many adapters without reconfiguring the system for each device being tested.

The TSI-8150 is controlled by the IEEE-488 bus but has enough intelligence to work on its own and stay independent of task allocation on the bus. The developers' aim was to take intelligence as far down into the system as possible, taking switch closures out of the bottleneck on the IEEE-488 bus.

For example, up to 500 sequences can be programmed and stored in a RAM buffer. Thus if 250 test sequences have been preprogrammed, 250 switches can be set on one clock pulse, as opposed to having 250 instructions transfer by way of the bus. All system switches can be set or cleared with a single clock pulse or, when desired, switches can be operated from a variety of trigger sources.

As another example of the interface's flexibility, switches can be as near to the device under test as 6 in. or as far away as 240 ft over cabling. In the latter case, the device can be placed in an environmental chamber while the operator is at a central location.



**WIDE SERVICE.** Tektronix' test-system interface adapts to discrete components, ICs, hybrids, circuit boards, and cable harnesses.

**EASY ACCESS.** The user can configure the system with the low-frequency scanners plugged in from the back or the front and the high-frequency scanners mounted across the front or the back in various combinations. The choice of front or rear signal-routing access makes setting up the system easy, Tektronix says.

Each TSI-8150 function card is coupled to its own shield in the main chassis, and, for additional signal integrity, a 190-W linear power supply minimizes system noise. Because internal bus traffic is held to a minimum, noise from internal digital sources is greatly reduced and ground loops are avoided. The signal relays likewise are quiet, reliable mercury-wetted devices with a long life expectancy. Throughout, the TSI-8150 is a 24-V system.

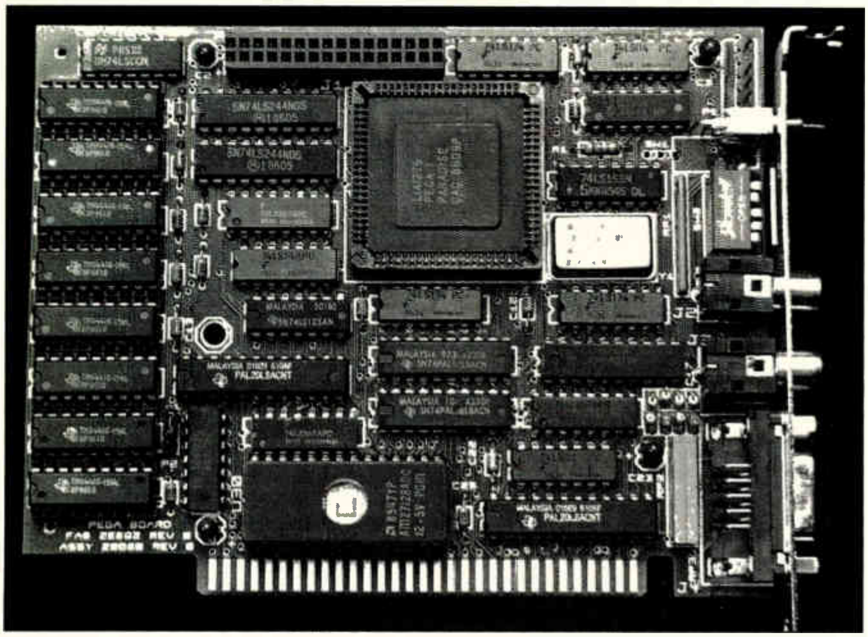
Typical systems run from about $8,000 to $15,000. A system with 12 cards and the adapter costs less than $10,000. Orders are being taken now, and initial deliveries are scheduled to begin in July. *–Ann Jacobs*

Tektronix Inc., Marketing Communications Department, P. O. Box 1700, Beaverton, Ore. 97005. Phone (800) 547-1512; in Oregon, (800) 452-1877 [Circle reader service number 338]

# CARD SWITCHES GRAPHICS FORMATS AUTOMATICALLY

When IBM Corp. streamlined the CRT controller functions in its Enhanced Graphics Adapter (EGA), users lost compatibility with some software that ran on the earlier Color Graphics Adapter and monochrome graphics adapter cards. Paradise Systems is putting back that compatibility with an EGA board that supports all Personal Computer graphics software.

The AutoSwitch EGA card for IBM PCs is transparently compatible with software written for color and monochrome PC graphics cards from other vendors as well as for the Enhanced Graphics Adapter. It automatically picks



**SMART.** Paradise's card automatically switches to the correct graphics format.

the right mode to run the software. Other cards also support all the formats but not automatically, Paradise says.

Because the EGA mates the crisp 7-by-9-pixel characters of the IBM monochrome card with high-resolution (640 by 350 pixels) graphics, it has quickly become a de facto standard. "It's here, it's clear, and anybody who gets in the way will be run over," says Lawrence G. Finch, Paradise's president.

Advanced graphics microprocessors and software standards such as the Direct Graphics Interface Specification are next-generation equipment, Finch says. He adds that until software is written for DGIS, over the next 18 months to two years, EGA is the best bet for text-and-graphics applications, including such interfaces as Microsoft Corp.'s Windows and Digital Research Inc.'s GEM.

EGA solved a problem for users who wanted color graphics but did not like the fuzzy character set of IBM's CGA and monochrome adapters. But these users found that many of their old applications would not run on the EGA card.

**MISSING REGISTERS.** The reason, Finch says, is that in implementing EGA, IBM left out some registers in the CRT controller that were used by the earlier graphics cards. "Well-behaved" applications that march obediently through IBM's Basic Input/Output System are accommodated by the EGA. But applications that attempt to boost performance by writing directly to hardware—most of them, according to Finch—are derailed by the missing registers. When an applications program tries to write to the missing registers, a latch on the AutoSwitch card alerts the BIOS, which contains firmware that switches the card to a CGA or monochrome emulation mode.

Last March, Paradise introduced a single-chip adaptation of the EGA. Rather than reverse-engineer the IBM board, it designed the chip from the bottom up, developing its own BIOS, an extension of IBM's, en route. For that reason, Paradise's board supports software written for the low-resolution color graphics and monochrome adapters even if the software tries to avoid the BIOS.

Some board makers have met this problem by adding to the graphics card a Motorola 6845 controller, which contains the full complement of registers, and switching it in and out either manually or through software. The Paradise PEGA 1 chip, heart of the AutoSwitch board, itself incorporates the 6845 controller functions and the missing registers. The chip is a 10,000-gate array designed by Paradise and built in 2-$\mu$m CMOS from LSI Logic Inc. It displays 16 colors from a palette of 64.

The AutoSwitch board comes with 256-K bytes of dual-ported video RAM that can be read and written to simultaneously. It sells for $599 and is available now.

Paradise Systems Inc., 217 E. Grand Ave., South San Francisco, Calif., 94080.
Phone (415) 588-6000 [Circle 339]

# RISC ENTRY MERGES HP TECHNICAL LINES

Hewlett-Packard unveiled the second computer based on its Precision reduced-instruction-set-computer architecture [*Electronics,* March 3, 1986, p. 39] late last month. The introduction of the new machine, designated the HP 9000 series 800 model 840, makes official HP's cessation of development for HP 1000 A-series machines used for industrial control and the merging of that line with the HP 9000 line of technical computers under HP-UX, the HP operating system derived from Bell Laboratories' Unix.

The company is thus uniting a line of machines targeted for real-time factory automation with a line of machines used for design-automation work. The latter, the 9000 series, had already been pulled in under the HP-UX umbrella and so has software that can be moved

**MERGED.** By merging its technical lines, HP helps integrate design and factory automation.

gracefully to the RISC architecture. The trick will be to extend HP-UX to embrace real-time applications and to bring current HP 1000 customers on board with a minimum of trouble despite the software conversion required.

The company believes the move serves the industry's desires. "In a recent survey conducted among manufacturing companies interested in implementing computer-integrated manufacturing, more than 50% said that integrating design and manufacturing is their first priority," says Brian B. Moore, general manager of HP's Manufacturing Systems Group.

**REAL-TIME UNIX.** For all future technical applications, customers will be steered to a single family, the HP 9000 series. The model 840 is a high-end computer that combines full Unix compatibility with the real-time response and control features needed for the factory floor. It runs at 4.5 million instructions/s and supports up to 24 megabytes of main memory. It delivers up to three times the system throughput of the previous top-of-the-line HP 1000 A-series computers and about twice the throughput of the HP 9000 series model 550.

Users with 9000 series 200, 300, or 500 HP-UX-based systems can easily add the model 840 to the computing environment. Typically, applications need only be recompiled to run on the 840. Users of the HP 1000 family of technical computers will have to work over all their software because the family did not run under Unix. To ease migration, HP is providing a number of software tools.

Port/HP-UX, included in the base system, is a comprehensive set of tools that helps HP 1000 customers retransfer real-time executive software to the model 840. It includes tools to analyze existing code and ease migration of programs and data bases. It also includes routines for HP-UX that emulate most commands in the Real Time Executive used on the HP 1000 A-series computers.

HP offers assistance in writing programs on HP A-series computers to ensure smooth migration to next-generation systems. Also introduced with the model 840 is Solution Creators, a program designed to assist in-house systems designers working on computer-integrated manufacturing applications.

The HP 9000 series 800 model 840 computer sells for $113,500. This includes the main processor, floating-point coprocessor, 8 megabytes of RAM, access-port card set with a six-channel multiplexer, HP-IB interface, and a 16-user HP-UX with C compiler, symbolic debugger, assembler, device library, real-time package, and Port/HP-UX. A $165,075 system comes with a 404-megabyte disk drive and a tape-drive system. Main memory can be added at $6,000 per megabyte. Delivery will begin at the end of the year. *–Steve Zollo*

Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [Circle 340]

## LOGIC ANALYZER HAS 8 400-MHz CHANNELS

The PM 3570 family of logic analyzers offers up to 83 state-analysis channels and 32 transitional-timing-analysis channels at 100 MHz, switchable to 8 channels at 400 MHz. The timing channels can also be used for state analysis, giving a total of 115 state channels.

Performance analysis—essential for optimizing software performance after completion of the hardware-software in-

tegration stage—is standard. With this capability, a complete system can be debugged and optimized before a production commitment is made.

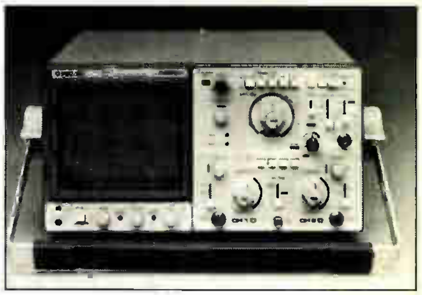
Prices for the PM 3570 start at less than $9,000. An entry-level model, PM 3565, starts at $8,000 and targets 8-bit microprocessor-system testing with up to 59 state channels and 16 transitional-timing channels at 50 MHz, or four timing channels at 300 MHz. Delivery time for either model is 12 weeks.

Philips Test & Measuring Instruments Inc., 85 McKee Drive, Mahwah, N. J. 07430. Phone (201) 529-3800 [Circle 354]

## DIGITAL SCOPE GOES FOR $1,750

The model DSS 5020A digital storage scope is priced at just $1,750. The scope is easy to operate, the company says, because its function-selection controls are identical to those found on an analog scope.

The 20-MHz, dual-channel instrument has a 1-megasample/s digitizer with a sine-interpolation mode that allows waveform storage of frequencies to 400 kHz. Stored waveforms can be magnified 100 times for precise reference measurements. A patented level-lock circuit automatically selects the trigger level of



the incoming waveform, and a built-in jitter-cancel circuit stabilizes the waveform even when it is magnified.

The DSS 5020A, portable at 15 lb, is available from stock.

Kikusui International, 17819 S. Figueroa St., Gardena, Calif. 90248. Phone (800) 421-5334; in California, (213) 371-4662 [Circle 355]

## OPTICAL POWER METER ACCURATE TO 0.15 dB

The HP 8152A optical average-power meter is accurate to within 0.15 dB for both absolute and relative power measurements. The two-channel unit can be used to measure two individual power inputs or to calculate power-ratio measurements. These are useful for checking the insertion loss and attenuation of optical connectors and cables.

In combination with the HP 81521B optical head, the 8152A covers the wavelength range from 850 to 1,700 nm for multimode and single-mode applications. Power levels down to –70 dBm

can be measured with 10 pW resolution.

A flexible optical interface ensures easy and quick adaptation to all common optical connectors. Available in eight weeks, the meter sells for $2,900.

Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [Circle 369]

## SOFTWARE DESIGNS POWER SUPPLIES

The Power Design Module, for designing analog power-supply circuits, is an option for Analog Workbench computer-aided-engineering software. The Power Design Module enables the designer of switching-mode and other power supplies to obtain accurate predictions of how transformer core materials will actually behave, instead of having to rely on ideal simulations, the company says.

The most important component of a Power Design Module is a magnetics model that simulates the nonlinear characteristics of transformer core materials. Typical Spice simulators can't accurately model cores, the manufacturer says, because magnetization characteristics don't follow standard linear curves. The other components of the package are a core-material library and a power-device library that includes complex pulse-width modulator and current-mode controller ICs as well as models for diodes, bipolar transistors, and FETs.

The Power Design Module is based on Spice Plus and is priced at $7,500 for Analog Workbench versions running on Sun, Apollo, and Hewlett-Packard work stations, and at $5,000 for the PC Workbench version. Delivery will begin in the second quarter.

Analog Design Tools Inc., 66 Willow Pl., Menlo Park, Calif. 94025.
Phone (415) 328-0780 [Circle 350]

## VIDA LETS VAX USERS REACH IBM DATA

Vida, a software package, lets users of Digital Equipment Corp.'s VAX computers interactively access data stored on IBM Corp. mainframes running the MVS operating system. Also, extracts of frequently used data can be downloaded to a VAX data base or file, from which they can be accessed by users on the VAX network.

With Vida, the user's application can access and process the data in one step. Then DEC's VAX Datatrieve software can be used to generate a report; then Vida will transparently seek out data stored on the mainframe and use it to produce the complete report.

Vida is priced at $3,500 to $35,000, depending on the size and configuration of the computer system. Vida is available now for delivery.

Digital Equipment Corp., 129 Parker St., Maynard, Mass. 01754.
Phone (617) 493-5489 [Circle 351]

## C COMPILER TARGETS 8051 CHIP

Micro/C-51, version 1.0, is an MS-DOS-based language compiler for the Intel 8051/52/44 family of single-chip microcontrollers. It detects run-time exceptions with default or user-provided exception handling. The results, the company says, are less debugging time and improved product reliability.

Micro/C-51 also provides full pointer support for all 8051 memory maps. It offers expandable pointer access to 250 local or remote devices of 64-K bytes each and performs math and memory-map exception handling. The compiler's output takes the form of an assembly-language source file that is compatible with Intel's MCS-51 relocatable macro assembler. The software requires one disk drive and 256-K bytes of memory. Shipments will begin June 15. The price is $1,495.

Micro Computer Control, Dept. 26, P. O. Box 275, Hopewell, N. J. 08525.
Phone (609) 466-1751 [Circle 352]

## SOFTWARE MODELS QUALITY CONTROL

Quick Quality Analysis software models any eight of a manufacturer's quality-control techniques—including functional specification review and logic specification review. QCA uses an effectiveness data base structured from industry-accepted studies and tools.

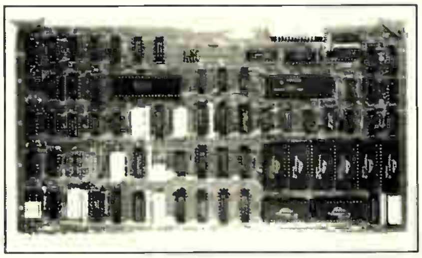
QCA helps project managers use automated decision-making aids in creating companywide software-based management systems. The software will quantify the costs of implementation, calculate potential savings, and display the projected benefits in graphics mode. It runs on an IBM Corp. Personal Computer or compatible machine with 256-K bytes of RAM. QCA is available immediately for $995.

USA/Unlimited Software Associates Inc., 457 Coldstream Dr., Berwyn, Pa. 19312.
Phone (215) 296-2633 [Circle 353]

## MULTIBUS CONTROLLER FOR 24-BIT SYSTEMS

The ZT 87 Multibus controller is compatible with microprocessors having memory addresses up to 24 bits wide. Its on-board 64-K-byte buffer is dual-ported into the host Multibus system to eliminate backplane overhead during direct-memory-access transfers. These data transfers can take place at rates of up to 300-K bytes/s.

Software driver support, for integrating IEEE-488 capability into Intel Corp. development systems, is available as an option. Driver subroutines are also provided in Z80, 8085, and 8088 assembly code as well as in the C language. Important applications for the ZT 87 lie in



test and measurement systems and in the design of Multibus systems.

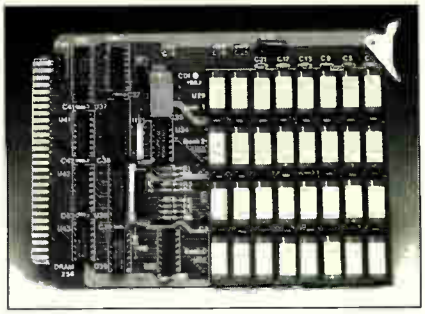
Available now, the ZT 87 is priced at $950 in single quantities.

Ziatech Corp., 3433 Roberto Court, San Luis Obispo, Calif. 93401.
Phone (805) 541-0488 [Circle 364]

## RAM-DISK STORAGE BEATS HARD DISKS

A RAM module that acts like a disk drive for the STD bus lets the user access stored data 10 to 20 times faster than with an actual hard- or floppy-disk drive tystem, the manufacturer says. The package consists of four 256-K-byte dynamic-RAM boards plus the software upgrade for the CP/M operating system. The user gets 950-K bytes of storage, and hardware resets do not erase the contents of the RAM disk.

High-speed data collection, image pro-



cessing, code assembly and compilation, and any program requiring frequent disk access are primary applications for the RAM disk. Its price is $1,550, which includes four boards and software; CP/M is an additional $250. Optional RAM-disk packages can be configured with 256-K bytes to 5 megabytes. Delivery is from stock.

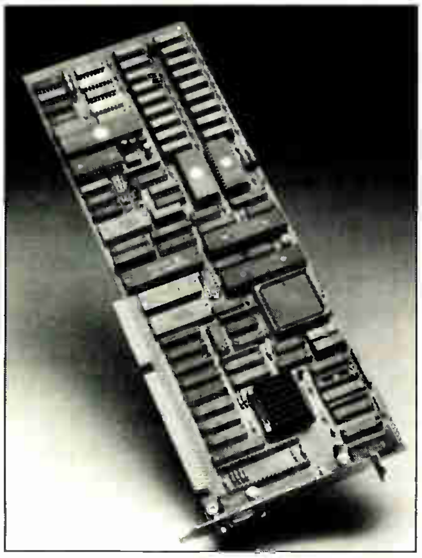
Computer Dynamics Inc., 105 S. Main St., Greer, S. C. 29651. Phone (803) 877-7471
[Circle 365]

## PC AT COMPATIBLE FITS ON SINGLE CARD

The Bus AT is a single-board computer that is fully compatible with the IBM Corp. Personal Computer AT. It includes all of the features of an AT motherboard but on a standard AT expansion card—4.8 by 13.2 in.—and it plugs into a passive backplane.

Ceramic components, heat sinks, and an operating temperature range of 0°C to 55°C suit the card for industrial applications. For example, the Bus AT placed in the same manufacturer's industrial card cage can form a chain of dedicated controllers linked to a remote main computer for data acquisition or process control.

The Bus AT comes with 512-K bytes



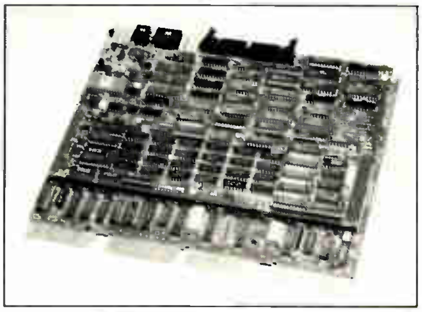
of RAM, a reset port, speaker and keyboard ports, and the manufacturer's Basic Input/Output System. The Bus AT is available with either 6- or 8-MHz processing speed. List price for the 6-MHz version is $1,195; for the 8-MHz version, it's $1,395. Both are available now.

Faraday Electronics, 749 N. Mary Ave., Sunnyvale, Calif. 94086.
Phone (408) 749-1900 [Circle 363]

## Q BUS GETS GEAR FOR IMAGE PROCESSING

Datacube is adding an image-processing board set that works with the Digital Equipment Corp. MicroVAX II computer and any other Q bus product. The model 423 has a 768-by-2,048-by-8-bit video image memory, which digitizes and stores either four 768-by-512-pixel images at 60-Hz or three 768-by-576-pixel images at 50-Hz operation.

The image memory can be further subdivided under software control to store up to 16 images measuring 384 by 256 pixels. The model 423 card set supports hardware-based panning, zooming, scrolling, alphanumeric overlays, and pseudocolor displays. The 423 has advanced dual phase-locked-loop input circuitry that locks automatically onto incoming signals for a high degree of display stability.



Digitized video signals are passed through one of eight software-selectable banks of input lookup tables for image thresholding, gain, offset, linearity control, and other mathematical functions before storing them in memory. The model 423 board set sells for $7,500, with delivery in 30 days.

Datacube Inc., 4 Dearborn Rd., Peabody, Mass. 01960.
Phone (617) 535-6644 [Circle 357]

## FRAME GRABBER NOW STORES TWO IMAGES

Imaging Technology's PCVision plus, a frame grabber for the IBM Corp. Personal Computer, is an enhanced version of the company's PCVision. The new module has a 1,024-by-512-by-8-bit frame memory that accommodates either two 512-by-480-pixel images or an optional 640-by-480-pixel image. The latter supplies a 1 : 1 aspect ratio for users who require square pixels.

Other new capabilities include two software-selectable video inputs, eight input lookup tables to allow for transformation of images prior to storage, programmable gain and offset, and real-time digitization by an 8-bit flash analog-to-digital converter that provides 256 gray levels.

An advanced dual-stage phase-locked loop locks PCVision plus onto unstable video sources such as video cassette recorders, which are typically too noisy to use with image-processing boards. Available 60 to 90 days after ordering, PCVision plus sells for $1,995.

Imaging Technology Inc., 600 W. Cummings Park, Woburn, Mass. 01801. Phone (617) 938-8444 [Circle 356]

## CONTROLLER FLIPS BETWEEN TWO PAGES

The Galaxy GA1024 color-graphics display controller has an option that allows instant switching between two separate pictures on a single monitor. To do this, the company added a second 1,024-by-1,024-by-8-bit memory plane, doubling the total memory of the display subsystem to 2,048 by 1,024.

In addition, the option, called Second Page, comes with a feature that lets users display text on the second screen. The controller, which works with 15- and 19-in. monitors and can display 16 colors from a palette of 4,096, is priced at $2,295. The Second Page option is an additional $300. The controller is available now.

TAT Graphics Group Inc., 1270 Lawrence Station Rd., Building E, Sunnyvale, Calif. 94089. Phone (408) 734-2202 [Circle 359]

## UNIT PUTS GRAPHICS ON SLIDES OR FILM

The Turbograph 2100 processor records computer-generated images on color slides or print film. The unit can accept graphics data from a variety of host computer systems, including personal computers.

Users create graphic images on a host computer with any software package that supports either an industry-standard graphics command language or the Hewlett-Packard Co. Graphics Language. When the image is complete, it is transferred to the Turbograph 2100 over an RS-232-C interface.

The 2100 digital controller converts the image to raster format—with a 2,048-by-2,048-pixel resolution—and then passes it on to a digital film recorder, which prints the image on film. The Turbograph 2100 is priced at $6,995, with delivery 60 to 90 days after ordering.

AMF Logic Sciences Inc., 10808 Fallstone Rd., Houston, Texas 77099. Phone (713) 879-0536 [Circle 360]

## *BOOKS*

### ROBOT VISION

**Berthold Klaus Paul Horn**
**The MIT Press**
**$39.50/509pp**

The core of *Robot Vision*, which grew out of a course in machine vision Horn has taught at the Massachusetts Institute of Technology for the past 10 years, is in chapters on image formation and image sensing; geometrical and topological properties of binary images; reflectance maps, both photometric stereo and shape from shading; extended Gaussian images; and picking parts out of a bin. Chapters on motion field and optical flow plus passive navigation and structure from motion form a foundation for the study of time-varying images.

Horn stresses the need for nontrivial mathematics in the vision disciplines. He also points out that an understanding of image formation is critical to the study of machine vision. Exercises at the end of each chapter lead the reader into in-depth problem solving, including topics still being researched. To succeed in design, the author advises readers to concentrate on a particular aspect of machine vision, such as interpretation of stereo pairs, or on a particular application, such as the alignment of parts for automated assembly. He pinpoints photometric stereo and the extended Gaussian image as the research areas that will most likely lead to future product development.

### ELECTRONIC MATERIALS REPORT

**EMR Corp.**
**$750 annual subscription (12 issues)**

*Electronic Materials Report* contains on-site reporting from Japan and Europe as well as the U. S. The writing focuses on the business side, with technology introduced where necessary, and ranges from basic research to market trends and product introductions. The 20-page April 1986 issue carries articles on the attempt to form an integrated-circuit photomask trade group, the uncertain market in wet chemicals, and the gradual recovery in orders for sputtering targets. Japan coverage includes Dai Nippon Printing Co.'s plans to build a photomask plant in the U. S. and expansion of DuPont-Mitsui's and Merck's Far Eastern operations.

### GALLIUM ARSENIDE DESIGN MANUAL

**Honeywell Inc.**
**$500**

This loose-leaf manual aims to assist designers in preparing a data-base tape in a Calma GDS II format to be submitted to Honeywell's Richardson, Texas, fabrication facility. It is based on Honeywell's GaAs production technology, a 1-$\mu$m, depletion-mode, metal-semiconductor FET process with double-level interconnection. The manual documents minimum geometries needed to yield functional devices; basic structures are also detailed to aid in the construction of circuit elements. The price includes any updates released during the two years after the time of purchase.

### TRANSNATIONAL CORPORATIONS IN THE INTERNATIONAL SEMICONDUCTOR INDUSTRY

**United Nations Centre on Transnational Corporations**
**$41/471pp**

This study explores the international operations of the largest transnational semiconductor corporations by tracking exports, foreign direct investment, licensing activities, and technology-exchange agreements. Developing nations that currently possess substantial assembly and test capacity are likely to continue playing an active role as long as they can remain cost-competitive, the preparers say, predicting that the semiconductor transnationals will consolidate their offshore assembly operations rather than phase them out completely.

The director of the study, Karl P. Sauvant, is a specialist with the U. N. Centre on Transnational Corporations. Copies of the study, Sales No. E86.II.A.1, are available from UN Sales Section, United Nations, N. Y. 10017.

### NETWORKING PERSONAL COMPUTERS IN ORGANIZATIONS

**James R. Weidlein and**
**Thomas B. Cross**
**Dow Jones-Irwin**
**$25/205pp**

Marketing engineers for computer network installations should listen to Weidlein and Cross, who speak for the second generation of personal-computer users—top managers familiar with data management—whose current preoccupations are mainframe access and peripherals sharing. Chapters cover the integration process; design issues, including transmission methods and media, network standards, and communications control; user requirements for a local-area network; and personal computer-private branch exchange networks. Subtler issues such as management style are also taken into account as they affect purchasing decisions.

Weidlein is director of the Information Design Group in Boulder, Colo. Cross is managing director of Cross Information Co. and vice president of Intelligent Buildings Corp., both of Boulder.

## MEETINGS

# FINDING OUT WHAT'S NEW IN DESIGN AUTOMATION

At this year's Design Automation Conference, designers from Japan's Hitachi Ltd. will give their U. S. counterparts a peek into the integrated design-automation system they used to build a mainframe computer. The June 29-July 2 meeting in Las Vegas is devoting 2 of its 44 sessions to the Hitachi team, who will present "a fairly detailed, in-depth look at what the Japanese are doing," says Don Thomas, the conference's program chairman.

"The U. S. computer industry is running scared" of Japan's activities in design automation, says Thomas, "particularly in circuit-level manufacturing and systems-level design. Here the Japanese are willing to talk about it."

Two other new sessions have been added this year, on intelligent systems and on parallel hardware accelerators for computer-aided-design. Thomas says the amount of university research on intelligent systems—which are a means of integrating design tools—led organizers to devote a full session to the topic. In CAD, he says, designers are "picking up on parallel processing" because "CAD offers a lot of opportunity for parallel algorithms." The CAD session will look at four examples of parallel accelerators, which can be used for placement, routing, circuit simulation, and hardware logic simulation.

Recent developments in two relatively new areas—expert systems and very large-scale integrated circuits—will be explored once again this year. Expert systems, the subject of one full session and a few papers at others, are a controversial area because some designers believe they're not needed for design automation, says Thomas.

The application of design automation to production of very large-scale integrated circuits also gets much attention, with placement, routing, and design each getting a separate session.

**Design Automation Conference,** IEEE (J. D. Nash, Raytheon Co., Bedford, Mass. 01730), Las Vegas Hilton, Las Vegas, June 29-July 2.

**FTCS-16:** The 16th International Symposium on Fault Tolerant Computing, IEEE Computer Society (H. Kopetz, Interconvention Hofburg, P. O. Box 80, A-1107, Vienna, Austria), University of Vienna, Vienna, July 1-3.

**International Conference on Radio Receivers,** Institution of Electronic and Radio Engineers (99 Gower St., London, WC1E 6AZ, England), University College of North Wales, Bangor, England, July 1-4.

**Ausgraph 86,** The Australasian Computer Graphics Association Inc. (Ausgraph 86 Secretariat, P. O. Box 29, Parkville, Victoria, 3052, Australia), Queen Victoria Building, Sydney, July 7-11.

**Compass '86**: Computer Assurance Conference, IEEE (Albert W. Friend, P. O. Box 3815, Gaithersburg, Md. 20878), Georgetown University, Washington, July 7-11.

**14th International Optical Computing Conference,** IEEE Computer Society (Joseph Shamir, Department of Electrical Engineering, Technion, Haifa 32000, Israel), Hebrew University, Jerusalem, July 7-11.

**Cable '86:** 4th International Conference and Exhibition on Satellite and Cable Television, Online International Ltd. (Pinner Green House, Ash Hill Drive, Pinner, Middlesex HA5 2AE England), Metropole Centre, Brighton, England, July 8-10.

**PC Expo,** PC Expo (Steven Gross, 333 Sylvan Ave., Englewood Cliffs, N. J. 07632), Jacob K. Javits Convention Center, New York, July 9-11.

**Britec 1986:** British Information Technology Exhibition and Conference on Engineering Software, Computational Mechanics Ltd. (Elaine Taylor, Computational Mechanics Ltd., Ashurst Lodge, Ashurst, Southampton, SO4 2AA, England), Hilton at Colonial Route 128, Wakefield, Mass., July 14-16.

**Net/Comm Security '86,** Computer Security Institute (360 Church St., Northborough, Mass. 01532), Marriott Crystal Gateway, Arlington, Va., July 14-16.

**International Computers in Engineering Conference,** American Society of Mechanical Engineers (ASME, 345 E. 47th St., New York, N. Y. 10017), Hyatt Regency, Chicago, July 20-24.

**7th European Conference on Artificial Intelligence,** European Coordinating Committee on Artificial Intelligence and Society for the Study of Artificial Intelligence and Simulation of Behaviour (Conference Services Ltd., 130 Queens Rd., Brighton, Sussex BN1 3WE, England), Brighton Conference Centre, Brighton, Sussex, England, July 21-25.

**ACM Conference on Lisp and Functional Programming,** Association for Computing Machinery (Robert Halstead, Massachusetts Institute of Technology, 419 Technology Square, Cambridge, Mass. 02139), Massachusetts Institute of Technology, Cambridge, Mass., Aug. 4-6.

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# ELECTRONICS WEEK

## GOLDSTAR UNVEILS TV-VCR COMBO

A 19-in. color TV that houses a built-in Video Home System video cassette recorder was introduced last week at the Summer Consumer Electronics Show in Chicago by Goldstar of South Korea. Shown by its U. S. affiliate, Goldstar Electronics International Inc. of Lyndhurst, N. J., the set is called ViewMax and carries a suggested list price of $650. Though Sony Corp. of Tokyo offers a receiver integrated with an 8-mm VCR unit, combination TV-VCR systems are rare.

## KODAK SENSOR UPS IMAGING POWER

A camera from a Kodak subsidiary, for image processing and machine vision, will use Kodak's new image sensor to capture nearly six times more information than such cameras now on the market. The camera, called Megaplus, is from Videk of Canandaigua, N. Y., and will be available next year. The sensor packs 1.4 million pixels on a 7-by-9-mm chip. Others have the same dimensions but use rectangular pixels larger than the 6.8 by 6.8 $\mu$m of Kodak's.

## ANSA'S SALES HIT $1 MILLION A MONTH

Ansa Software, the Belmont, Calif., software start-up, has announced that it went profitable in March and sold $1 million worth of its Paradox data-base manager in April and May. Paradox uses artificial-intelligence techniques that allow users to query by giving an example of the information they want [*Electronics*, Sept. 23, 1985, p. 63].

## SYMBOLICS DUO IN AI VENTURE FUND

Two executives of Symbolics Inc., the Concord, Mass., builder of Lisp processors, have resigned as officers to form an artificial-intelligence venture fund that will work in cooperation with the computer maker. Andrew Egendorf, formerly vice president and general counsel at Symbolics, and Thomas Farb, formerly treasurer, will lead the effort to fund startups developing AI products. Farb will continue to serve as Symbolics' director of planning and development until January 1987 to complete several projects. The AI Fund, as it is called, will raise money from banks and others.

## XIDEX MELDS DISK OPERATIONS

Xidex Corp., which has gobbled up three manufacturers of hard-disk media in the past 18 months, has consolidated them into a single Data Disc Division, which it claims is the largest single supplier of hard disks in the world. Richard Charlton, founder and president of Charlton Associates, which Xidex acquired in April, is head of the new division. The unit also includes the remnants of Dysan, Oktel, and Trimedia. Xidex, which also makes micrographics products, had record sales of $111 million in the March quarter of fiscal 1986, up 34% over 1985.

## CRAY, CONVEX SWAP PATENTS

Cray Research Inc. and Convex Computer Corp. have agreed to exchange all their issued and pending patented designs. Under the agreement, whose details have not been disclosed, both companies would use their patented technologies in current and future products. The deal indicates that supercomputer leader Cray, with headquarters in Minneapolis, does not plan to compete in the mini-supercomputer market, a niche spotted by Convex, in Richardson, Texas, two years ago. Convex gains legitimization for its niche as well as a competitive boost.

## TRILOGY SELLS LAST CHIP UNIT

Trilogy Ltd. moved last week to abandon the last vestige of its venture into advanced semiconductor processes by agreeing to sell its interconnection and packaging technology for $10 million to Digital Equipment Corp., Maynard, Mass. Trilogy started out six years ago to develop wafer-scale integration and related techniques. But now, the sale to DEC will leave the Cupertino, Calif., company with the Elxsi high-speed computer as its sole line of business.

## PYRAMID FORMS STRATEGY PANEL

Pyramid Technology, the Mountain View, Calif., maker of Unix superminicomputers, has put together a blue-ribbon panel to serve the company as strategic advisers. The members include Domenico Ferrari, associate chairman of the computer science department at the University of California, Berkeley; Angel Jordan, provost of Carnegie-Mellon University; and David Jorgensen, chairman of market researcher Dataquest Inc. Also included are Paul Lego, Westinghouse Electric Corp. vice president; Edith Martin, Boeing Electronics Co. vice president; Eugene Lindstrom, a former IBM Corp. researcher; Stephen Tolchin of Johns Hopkins University; and M. E. Van Valkenburg, dean of engineering at the University of Illinois at Urbana.

## TOSHIBA TO SELL AT&T'S SYSTEM 75

Toshiba Corp. will market AT&T Co.'s medium-size private branch exchange System 75 line in Japan under a new agreement that expands a relationship which began last year, when Toshiba began to market AT&T's DataKit circuit switch in Japan. The new agreement calls for PBXs to be marketed with a double brand label. AT&T's System 75 has a capacity of 200 central lines and 800 extension lines. Toshiba makes its own small-size PBX.

## KODAK GIVES CENTER $3 MILLION

Eastman Kodak Co., Rochester, N. Y., will give $3 million to the National Center for Supercomputing Applications at the University of Illinois at Urbana. The money, to be paid in three yearly installments, will make Kodak the center's first industrial partner. Up to five Kodak scientists will work full time at the center on problems of interest to the company, and Kodak will have access to as much as 1,000 hours a year on the center's Cray X/MP.

## OPTIMEM BOUGHT BY CIPHER

Cipher Data Products Inc., a San Diego maker of magnetic-tape peripherals, will acquire 90% of optical-disk-drive manufacturer Optimem Inc. from Xerox Corp. for $6.3 million in cash, a $3 million note, and future royalties. Based in Sunnyvale, Calif., Optimem was spun out of the Xerox Palo Alto Research Center in 1980 as a product-development house to market optical-drive technology.

## DUTCH CASH PAVES PATH TO EUROPE

Two Silicon Valley firms specializing in application-specific ICs will open European offices in the Netherlands following investments by Mip Equity Fund, a Dutch venture capital firm. Mip put $8 million into Sierra Semiconductor Corp., a chipmaker, and $4.75 million into Silicon Compilers Inc., a pioneer in design automation via silicon compilation. Both companies, with headquarters in San Jose, Calif., will open design and service centers in the Netherlands.

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## for world-class CMOS CSIC!


**On the leading edge and still expanding:** your opportunities in OKI CSIC* product and performance—supplied by the VLSI source with major experience in single-chip logic integration. OKI's been applying the world's most advanced CMOS technology to Gate Array development since 1977; to Standard Cells and Customs since 1979. Today you can count on OKI for full-range CSIC capabilities.

**For quick turnarounds:** very broad predesigned Gate Array options.

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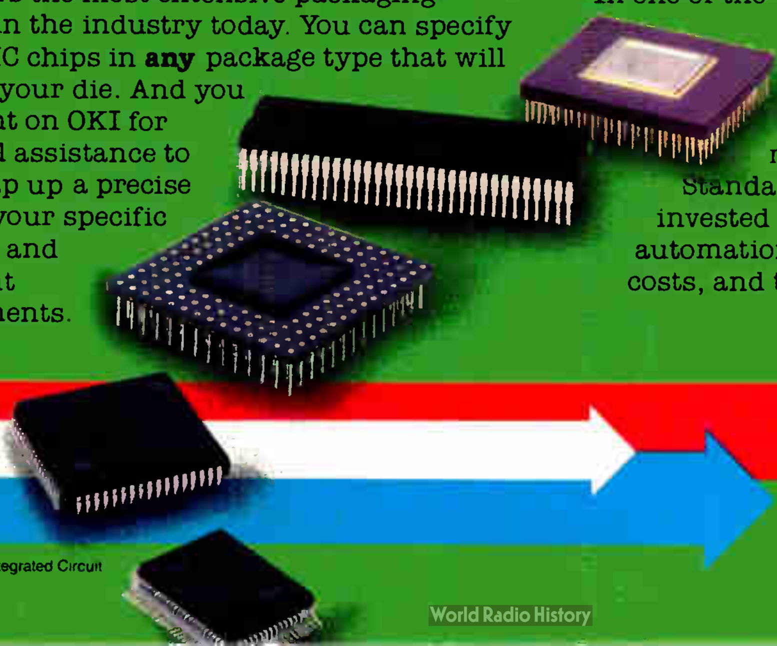
## OKI: world leaders in packaging.

OKI offers the most extensive packaging options in the industry today. You can specify your CSIC chips in **any** package type that will support your die. And you can count on OKI for technical assistance to help wrap up a precise fit with your specific gate-size and pin-count requirements.

## OKI: world leaders in plant automation.

In one of the world's most highly automated facilities, fully robotized CSIC lines are assigned to fabrication, assembly and 100% testing—compatible line-automation dedicated to Gate Array, Standard Cell and Custom runs. OKI's invested over $500-million in plantwide automation to lower production time and costs, and to assure strict quality control.



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# Count on OKI to expand your options in CMOS Gate Arrays.

| 1.5-micron & 2-micron | | | | 3-micron | |
|---|---|---|---|---|---|
| 70V000 Series VERY HIGH SPEED | | 70H000 Series HIGH SPEED | | 70000 Series | |
| # Gates | # I/Os | # Gates | # I/Os | # Gates | # I/Os |
| 700 | 66 | 3289 | 86 | 387 | 44 |
| 1000 | 66 | 4290 | 104 | 720 | 62 |
| 1500 | 66 | 6000 | 130 | 1445 | 88 |
| 2000 | 80 | 8024 | 148 | 2000 | 106 |
| 2500 | 80 | 10008 | 172 | 4205 | 120 |

**Expanded** product families and packaging. For more cost-effective, more flexible single-chip logic integration, OKI supplies more pre-designed Gate Array options, in the most advanced package types: plastic or ceramic through-hole DIPs or pin grid arrays; or plastic surface-mount PLCC or flatpack.

**Expanded** services, plus world-leading production automation. OKI CSIC* design expertise is accessible at any development stage. And OKI's CSIC manufacturing/testing facilities—among the world's most highly automated—assure high quality, high volume fabrication.

## RFQ REQUEST FOR QUOTE — OKI CMOS Gate Arrays

For prompt response to your Request for Quote (returned with complete technical data), please fill out the brief specs needed below:

Name/Title ____________________

Company ____________________

Address ____________________

City ____________ State ________ Zip ________

Tel: (______) ____________________

**My application requires:**

1. Gate count: ________ 2. Pin count: ________
3. **CMOS process:**
   ( ) 1.5 micron ( ) 2 micron ( ) 3 micron
4. **Packaging preferred:**
   Surface-mount ( ) PLCC ( ) Flatpack
   Through-hole ( ) Pin Grid Array ( ) DIP
5. **Anticipated volume:** ____________ pieces/month

☐ Please call me for immediate consultation.

**Request for Data**

Please rush complete technical input on:

( ) CMOS Gate Arrays
( ) CMOS Standard Cells
( ) CMOS Custom VLSI Logic


To return your RFQ to OKI: Remove entire page and fold into thirds. Staple or tape together and mail to: OKI Semiconductor, 650 N. Mary Ave., Sunnyvale, CA 94086. Tel: (408) 720-1900.

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