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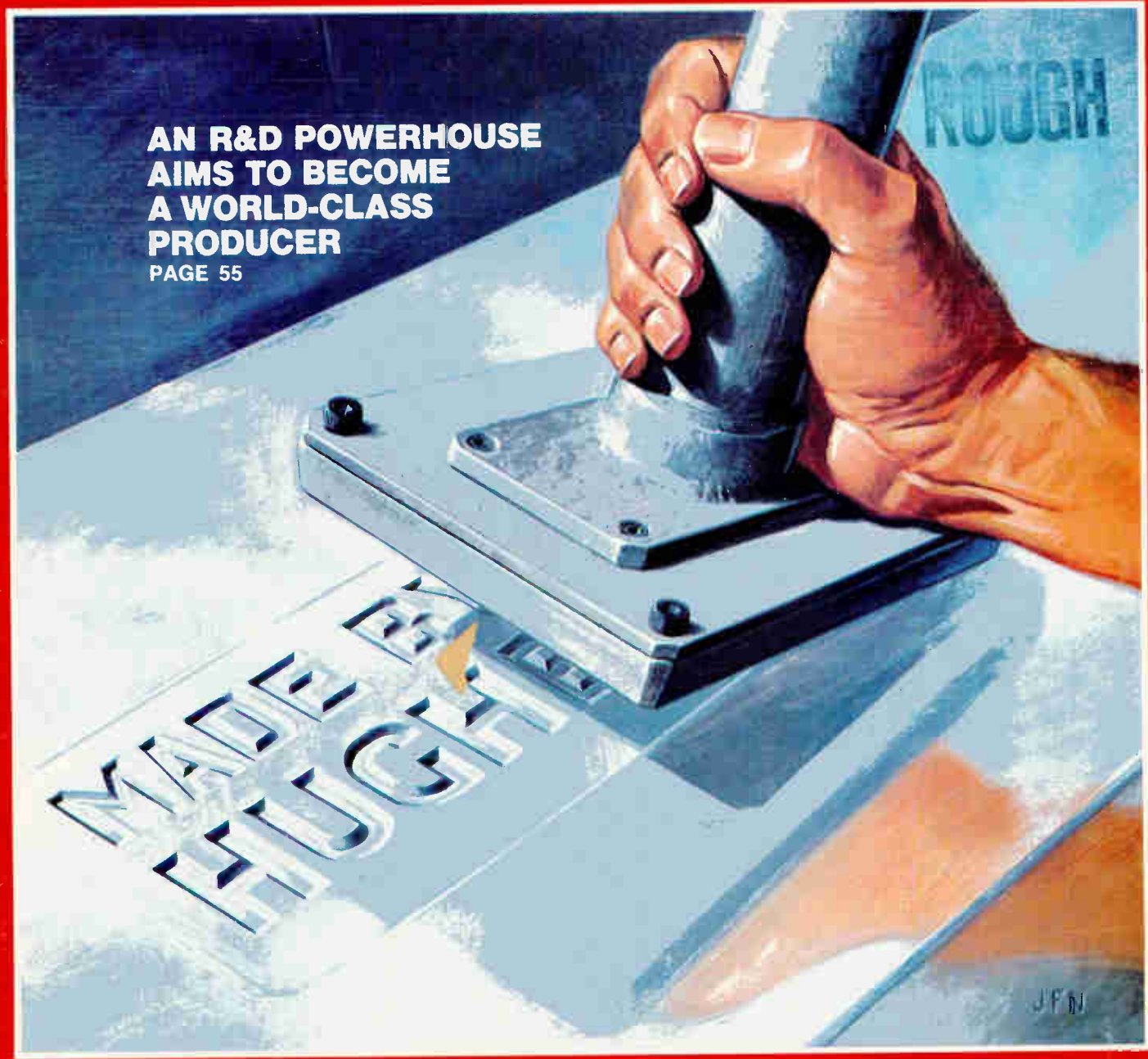
Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

MARCH 24, 1986

HOW HUGHES WILL CHANGE UNDER GM

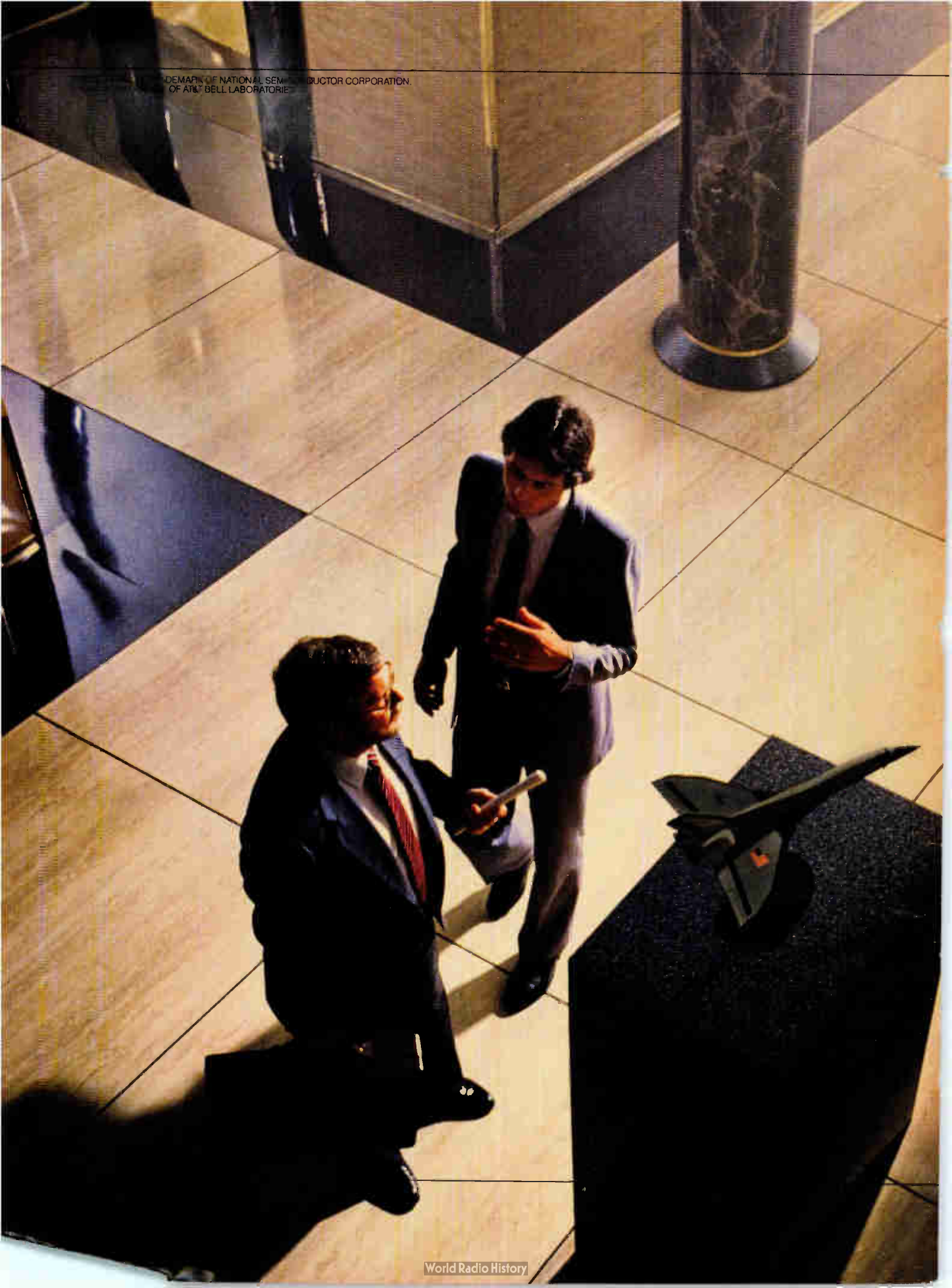


AN R&D POWERHOUSE AIMS TO BECOME A WORLD-CLASS PRODUCER

PAGE 55

SPECIAL REPORT: HOW THE PC IS CHANGING TESTING/31

ELECTRON-BEAM TESTING OF VLSI CHIPS GETS PRACTICAL/



"We did it!"

"I knew we'd close that sale. Did you see their faces?"

"It's our competitors' faces I want to see. We've really cracked this market now."

"Looks like we made all the right decisions at the right times."

"Like National's 32-bit microprocessor family?"

"You can't build a system out of data sheets and promises. National had it, they delivered it, and they got us here first."

While you're still dreaming about success, Sequent is delivering it. With National's Series 32000 family.

On January 17, 1983, eighteen people started a new company called Sequent Computer Systems. They had no product, no plan, no backing. Only a dream.

Two years later, that dream came true. They delivered their first system—a sophisticated parallel processing computer. A full year ahead of their competitors.

How'd they do it? Hard work. Calculated risks. Belief. And a critical decision. They chose the Series 32000™ microprocessor family.

It offered them a *complete* 32-bit microprocessor family, including demand paged virtual Memory Management, Floating Point, and other peripherals with full UNIX™ support.

But the Series 32000 wasn't just the right engineering decision, it was the right *business* decision. It helped Sequent get their system to market fast. First.

Sequent hit their window of opportunity. And that window is still open—for now. So find out how the Series 32000 can help you build your own success story. Contact National Semiconductor today.

National's Series 32000, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor
We're doing it.

Circle 1 on reader service card

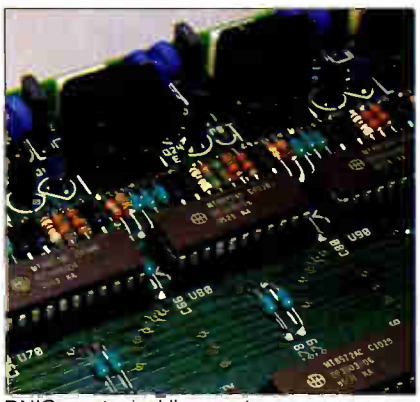
MITEL SEMICONDUCTOR

ISDN

COMPONENT NEWS

Vol. 1

ISDN Means "In Silicon, Deliverable Now" At Mitel



DNICs on typical line card.

While other semiconductor manufacturers debate the meaning of ISDN, Mitel Semiconductor is marketing its MT8972 Digital Network Interface Circuit (DNIC); a complete "U" interface conforming to the CCITT specification for the ISDN.

The MT8972 DNIC delivers the required 144 kb/s in a 2B+D channel format (*Basic Rate Access*) over existing twisted copper pair wiring. Moreover, the DNIC alone successfully incorporates the Echo Cancellation Hybrid (ECH) technique recommended by T1/D1.3 committee. ECH allows full duplex 144 kb/s operation over a single twisted copper pair, while compensating for any impedance variations along the loop.

Loop lengths vary with data rates: up to 4 km at 80 kb/s; or up to 3 km at 160 kb/s over one 24 AWG twisted-pair. At 160 kb/s the DNIC supports: two 64 kb/s "B" channels for PCM encoded voice and/or data; one 16 kb/s "D" channel for signaling and low-speed packet-switched data; plus one 16 kb/s channel that conveys loop framing and housekeeping information. At 80 kb/s, the DNIC offers one B channel, an 8 kb/s D channel, plus a housekeeping and framing channel.

Clock and frame extraction can be derived from the line or generated by internal circuitry. ISO-CMOS fabrication minimizes power consumption to 50 mW (typical) permitting the network interface to be line-powered. The MT8972 DNIC also can be used as a 160 kb/s high-speed, limited-distance modem. Its Serial Telecommunications Bus (*ST-BUS*™) architecture simplifies intercomponent, interprocessor and multiprocessor communications on-board, on-premises or at the network interface.

Other ISDN support circuits *now* available from Mitel are:

- T1/DS-1 and CEPT trunk interfaces (MT8975, MT8978).
- Digital Crosspoint Switch ICs (MT8980/81).
- T1/CEPT Digital Trunk Phase Locked Loop ICs (MT8940).
- PCM Filter/Codec ICs (MT8960).
- HDLC Controller ICs (MT8952).

While others joke that ISDN means "I Still Don't Know", Mitel Semiconductor is producing silicon that makes ISDN happen.

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Circle 2 on reader service card

MARCH 24, 1986 VOLUME 59, NO. 12

Electronics

NEWS

INSIDE TECHNOLOGY

PROBING THE NEWS

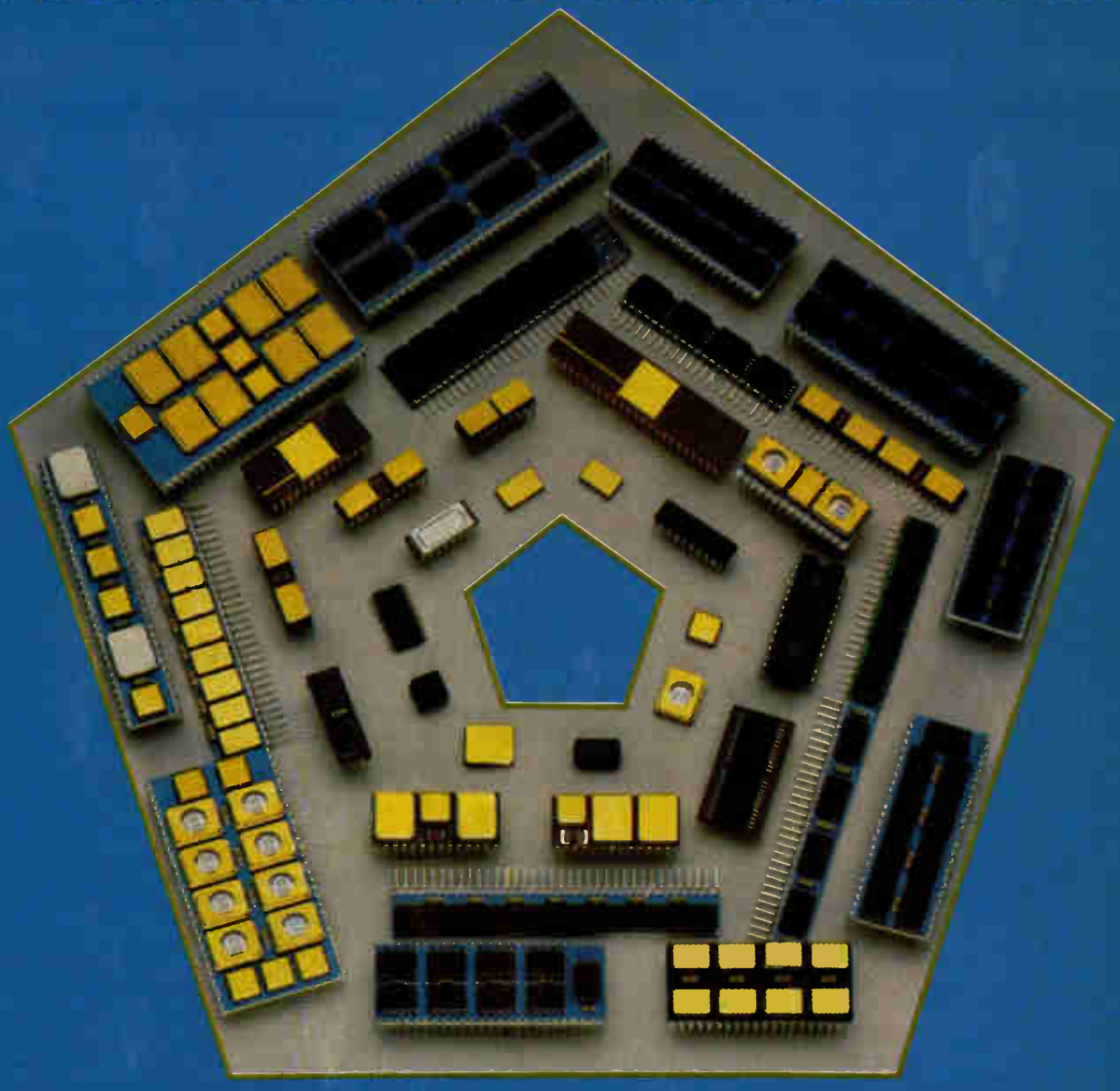
COVER

Cover illustration by Joel F. Naprstek

NEW PRODUCTS

DEPARTMENTS

MILITARY
MODULES AND MONOLITHICS



MILITARY CERDIPS/LCC's
Static RAM

SIZE	P/N	SPEED
16Kx1	DP9167	35ns
4Kx4	DP9168	35ns
2Kx8	DP9116	35ns
64Kx1	DP9267	35ns
16Kx4	DP9288	35ns
8Kx8	DP9264	65ns
1Kx8	DP9130*	85ns
2Kx8	DP9132*	85ns
32Kx8	DP92256	65ns
64Kx4	DP9186	35ns

*Quad Pinout

Dynamic RAM

SIZE	P/N	SPEED
64Kx1	DP9164	100ns
256Kx1	DP91256	100ns
1Mx1	DP9001	100ns

EPROMS, EEPROMS and MI-REL
M68000 (-55 to +125°C)
now available

Circle A on reader service card

Dense-Pac currently supplies over 80% of the top 25 defense contractors in the United States with their military MIL-STD 883 semiconductor requirements.

Dense-Pac continues to offer the widest range family of high density million bit memory modules. The technologies included in the above modules are SRAM, EEPROM, EPROM, DRAM, VIDEO RAM and NOVRAM.

Dense-Pac also provides complete form, fit and function compatibility with existing memory modules from IDT and EDI. CMOS CPU modules are currently being designed for the **80C31, 80CX86, 9450** and **290X** families which include memory and support chips. Challenge the Future - Join the Family!

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The changes at Hughes Aircraft Co. are important in a number of ways. For one thing, it is now a public company and part of GM Hughes Electronics Corp. And, as Los Angeles bureau chief Larry Waller points out, the manufacturing expertise that will flow from the General Motors side of the shop can only help the defense giant, which has been deficient in that area.

But for a journalist, the changes go even deeper, says Waller, who wrote the five-page report beginning on p. 55. To an old pro like Larry—he has reported on Hughes's engineering and technology since the early 1960s—the changes in corporate culture and attitudes are profound. And they are going to enable the people who cover Hughes for newspapers and magazines to do a more comprehensive job.

"In the past," says Larry, "I often experienced firsthand the problems of reporting about a company whose top officials wanted to keep its business affairs private. When you consider that Hughes easily qualifies as a heavyweight in many technologies, you can understand how important it is to me as a journalist to be able to report about it." Not only that, but the company, with upward of 75,000 people and a gross of $6.2 billion last year, is Southern California's biggest employer, so it's not exactly the kind of place that is likely to be tucked out of sight down some little side street.

WALLER: Now he can use the front door.

At the old Hughes Aircraft, it was common practice for Larry and other reporters to try to go in the back door and get past the executives. And if a journalist managed to talk directly to the engineers and scientists—Larry calls them "the heart of the company"—he still had to convince them to put themselves on the line. "Many were forthcoming with information, just like their counterparts elsewhere who like to discuss what they are doing," Waller recalls. "Now there are already solid signs that the flow of information will be improved still further."

Larry says that Hughes's new headquarters is a symbol of its new openness and visibility. "The building is a striking high-tech complex set into a bluff overlooking the Los Angeles marina," says Waller. "It is in sharp contrast to the cramped headquarters a mile or so inland that Hughes occupied for years. Gone too is the bilious green that identified all Hughes buildings until several years ago. And even the security people have a friendlier appearance—instead of the grim-looking guards there are now blazer-clad young men. Now, 10 years after his death, Howard Hughes wouldn't recognize his once supersecretive company."

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WEEK 22

The improved features of our new AmPAL18P8 IMOX™ PAL* device are the result of some very careful reasoning.

Why not, for example, allow designers to plug increased logic power into their designs, without the extra cost of a 24-pin package? So the 20-pin AmPAL18P8 comes loaded with 8 bidirectional I/O pins (not 6), 18 inputs (not 16), and an additional product term per output (a total of 8 plus OE). The perfect foundation for more complex logic functions.

And why not mix outputs—both active high and active low—on the same chip? So the AmPAL18P8's output polarities are user programmable. Eliminating outboard inverters and extra circuitry.

AmPAL18P8

There's a lot of logic in this.

Finally, why not give this advanced logic the speed, power and reliability benefits of our most advanced technology? So the AmPAL18P8 is implemented using platinum-silicide fuses and our exclusive IMOX process.

The AmPAL18P8. Choose it because of all the logic that went into it.

*PAL is a registered trademark of, and is used under license from, Monolithic Memories, Inc.

WEEK 23

Just a quick reminder. Now that our Am2970 Dynamic Memory Timing Controller is in volume production, you've got everything it takes to refresh dynamic memories without robbing the CPU of valuable processing time.

That's because the Am2970 can be programmed to initiate refresh cycles independently, while the CPU is busy with other tasks. This "hidden refresh" technique will give your system higher throughput without extra cost or design penalties.

But even if you can't always use hidden refresh, the Am2970 is something to remember.

Am2970

We'll refresh your memory in no time.

After all, unlike other controllers, the architecture of the Am2970 allows you to schedule timing signals when they're really needed, instead of when the system clock thinks they're needed. And that, in turn, means you have the unique ability to balance refresh, CPU and DMA requests for maximum memory performance.

Keep in mind, too, that the Am2970 is the perfect companion for our popular Am2968A Dynamic Memory Controller. And with the upcoming Am2969 Controller (which supports error detection and correction), the Am2970 is part of the most flexible 256K dynamic memory controller family on the market.

The Am2970. Use it once and it will stay in your memory forever.

WEEK 24

We're proud to announce our new 1 million bit CMOS EPROM, the Am27C1024. For the first time there's a single EPROM chip that stores over a megabit of operating system and applications code in a convenient 64K by 16-bit word format that's ideal for 16- and 32-bit designs.

Am27C1024

We just made our first million.

Now you have your first million.

With 16 bits of data, all at once, every 200ns. And 2 minute programming so, in spite of its size, it won't cramp your manufacturing flow.

In a 40-pin DIP, with 44-pin LCCs on the way. (You can wire 16 of them into your system and wind up with a 2M byte disk storage capacity in a very tight space.)

It's all yours, right now, from AMD. All you have to do for your first million is pick up the phone.

Circle 151 on reader service card

Circle 152 on reader service card

Circle 153 on reader service card

WEEK 25

Design with our new Am29525 Dual 8-Deep Pipeline Register and your pipelined system will never work better. That's because the Am29525 is the only pipeline register that also lets you dip into the data in any order, at any time.

To start with, the Am29525 is a pipeline register that is dual 8-byte deep. Or single 16-byte deep. It's programmed to hold, shift or load data via microcode instructions. And, while the I/O is three-state TTL-compatible, the innards are straight ECL. So its access time is a swift 21ns.

Am29525

Out of order.

On the other hand, the Am29525 is also a random access register file, with all 16 internal registers instantly available. Instead of the confines of first-in, first-out rules, you can grab an arbitrary 8-bit word whenever you want. So system performance is significantly improved.

What's more it's available in space saving, .4" wide 28-pin DIP packages.

The Am29525.

It's unlike any pipeline register you've ever used. Because it's more flexible than any pipeline register you've ever used.

Sometimes you improve things by not following orders.

Circle 154 on reader service card

On October 1, 1985, Advanced Micro Devices committed to deliver fifty-two new products in one year. One a week. Every week. On the shelf. In volume.

After 13 weeks, our customers could reduce networking costs, modernize old state machines, revive fading memories and see graphics in a whole new light.

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BOOKS

U. S. MILITARY COMMUNICATIONS: A C³I FORCE MULTIPLIER

Fred J. Ricci and Daniel Schutzer
Computer Science Press
$39.95/263pp

In an area where little recent information is available, *U. S. Military Communications* is a timely overview. Both strategic and tactical systems are described, and the present and future U. S. Defense Communication System and North Atlantic Treaty Organization systems are discussed in the context of how they connect with each other and with other major systems.

Although defense communications requirements do not mirror commercial systems, the authors describe many instances in communications in which commercial developers have led the military and will probably continue to do so.

Ricci is vice president of Ramcor Inc.'s Telecommunications Division, where he is in charge of the design of Defense Department and commercial networks. Schutzer is a vice president of Citibank's North American Investment Bank.

STRATEGIES FOR ELECTRONIC TEST

Craig Pynn
McGraw-Hill Inc.
$19.95/174pp

Construction, function, and longevity remain the basic issues of printed-circuit-board manufacture—they have only become more complex over time, says the author, a vice president of corporate marketing for Zehntel Inc., a manufacturer of test and production systems. Pynn examines two basic digital functional test philosophies—simulation and emulation—and their respective advantages and limitations. The approach is pragmatic as well as historical.

Because testing is typically performed under conditions where a production line mixes a number of pc-board types, the author guides the reader to a strategy that accommodates the largest number of boards. Pynn's writing is clear but not oversimplified, and key steps are illustrated throughout the book.

VLSI SIGNAL PROCESSING SYSTEMS

Earl E. Swartzlander Jr.
Kluwer Academic Publishers
$36.95/179pp

For managers who don't work on the chip level, Swartzlander's book summarizes very large-scale architecture and signal processing. The author, who is manager of the Digital Processing Laboratory for TRW's Electronic Systems Group, presents case studies of a finite-impulse-response digital filter and a frequency-domain filter with a minimum of mathematics and a maximum of clearly drawn diagrams and charts. The book concludes with a chapter that introduces networking. As more signal-processing systems become distributed, both physically and logically, the author predicts that networks and signal processing will merge in much the same way that very large-scale integration and signal processing have merged in the last decade.

UNDERSTANDING COMPUTER SCIENCE APPLICATIONS

Texas Instruments Inc.
$14.95/280pp

TI's Understanding Series has grown since its introduction last year [*Electronics*, Feb. 11, 1985, p. 91] to include this and a number of other titles, which cover such topics as artificial intelligence, automation systems, telephone electronics, and digital troubleshooting. Each volume is self-contained, with illustrations and review questions, and can be recommended for self-teaching or for training groups. Formerly available from the Dallas chip maker, the series is now being distributed by Howard W. Sams & Co., Indianapolis.

ADHESIVES, SEALANTS, AND COATINGS FOR THE ELECTRONICS INDUSTRY

Ernest W. Flick
Noyes Publications
$39/197pp

This book lists more than 1,600 products in adhesives, sealants, coatings, and related categories, based on manufacturer descriptions. Each listing contains the company name and product category, trade name where applicable, and product number and description. The table of contents is also a subject index, and addresses of manufacturers—44 in all—are given.

DIGITAL FILTERS: THEORY AND APPLICATION

N. K. Bose
Elsevier/North-Holland
$44.95/488pp

For advanced engineering students and practicing engineers, *Digital Filters* looks at discrete-time methodologies and analyzes computational schemes for discrete Fourier transforms. The author, a faculty member in engineering and mathematics at the University of Pittsburgh, discusses basic design procedures as well as such special topics as filtering over a finite field. Fifteen Fortran programs support the text.

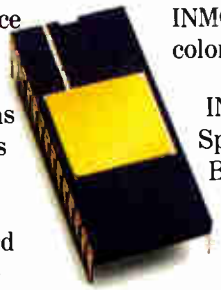
If your system is only using this many colors,

isn't it time to grow up?

The INMOS IMSG170 Color Look-up Table offers a grown-up solution to video display color enhancements. It lets you and your RGB analog display advance to a palette of more than a quarter million colors.

This programmable DAC conforms to RS170A standards with pixel rates up to 50 MHz, in a 28 pin package.

And to simplify things, the table integrates the functions of a 256 word x 18 bit color mapping table, three 6-bit DACs, 75 ohm drivers and microprocessor interface into a monolithic CMOS device. The result? Reduced board space and power consumption at a lower cost.



The Color Look-up Table from INMOS. Designing with thousands of colors just became child's play.

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inmos

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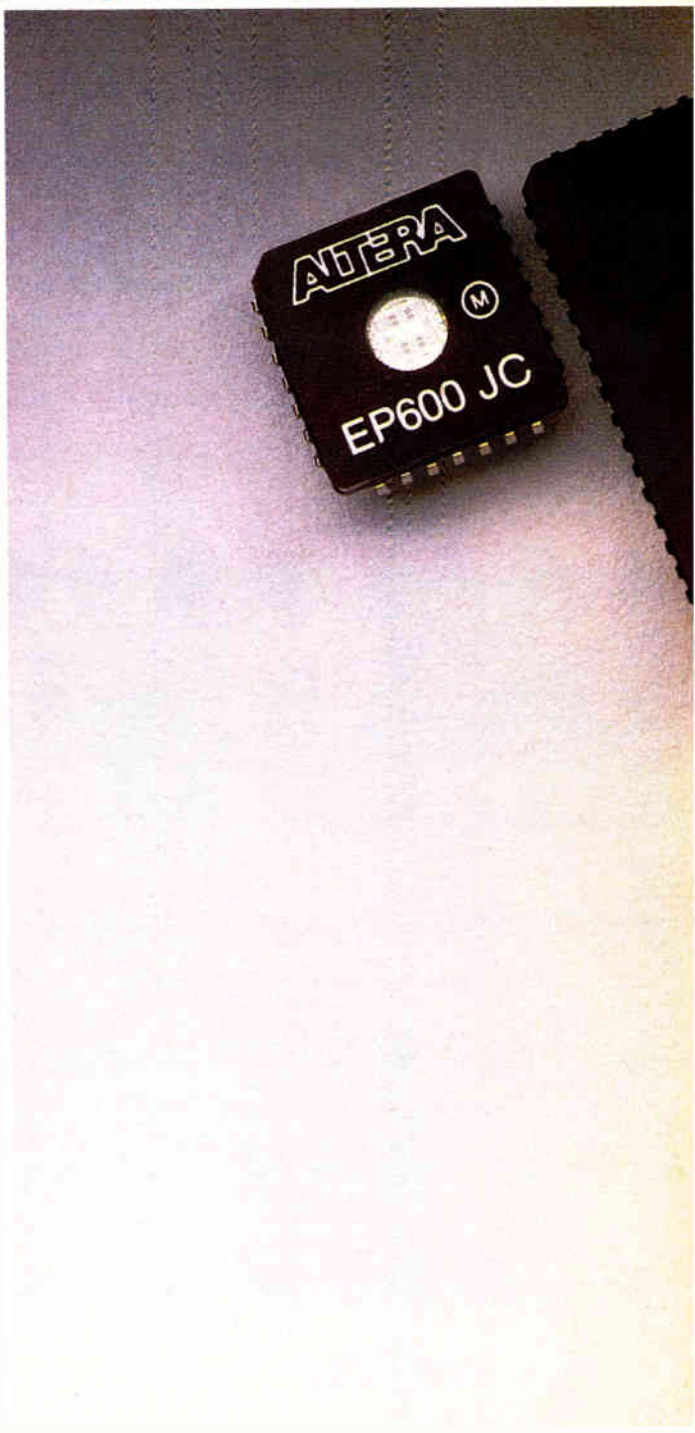
Immediate



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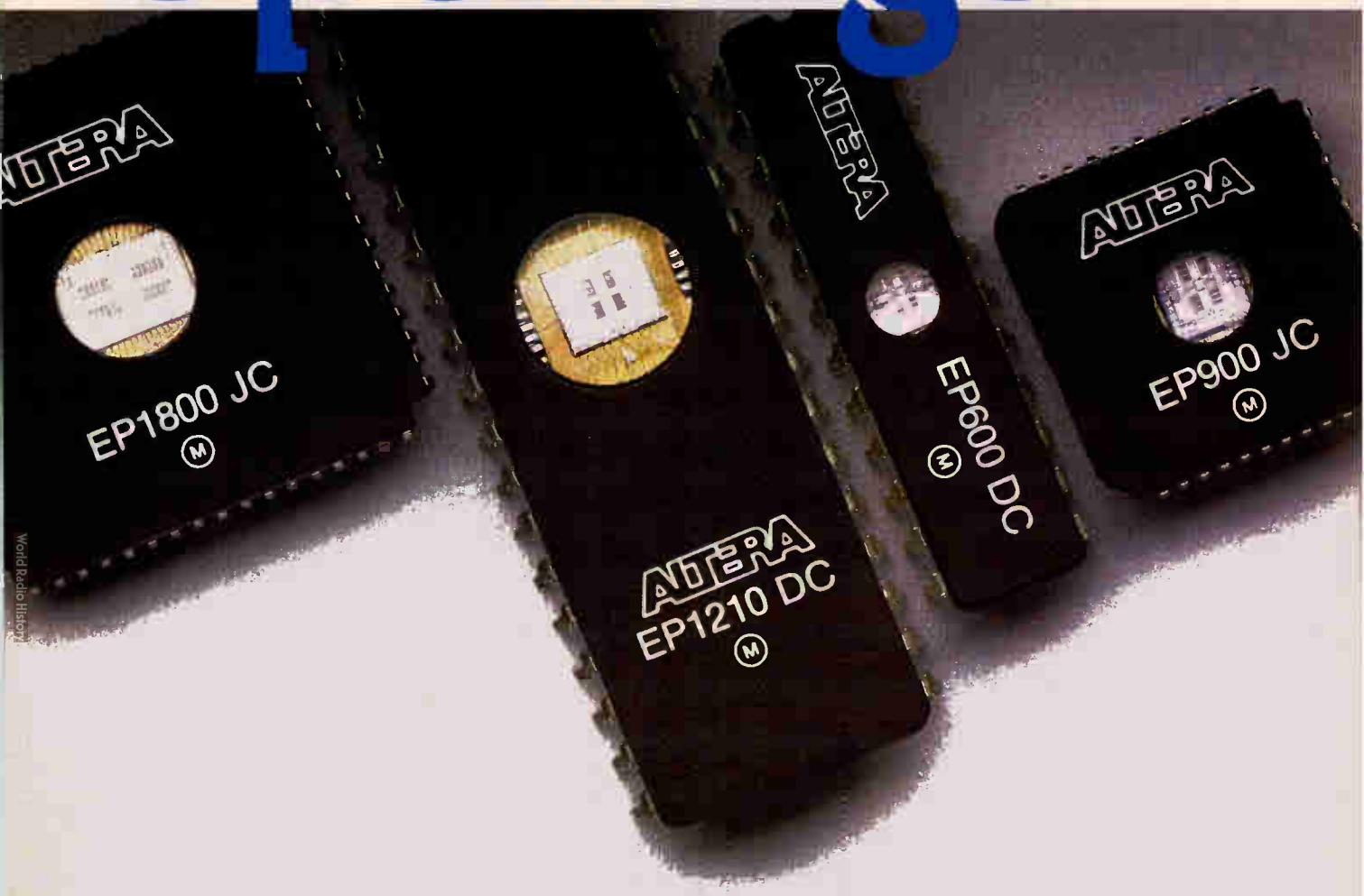
Openings.



Put your finger on intelligence!

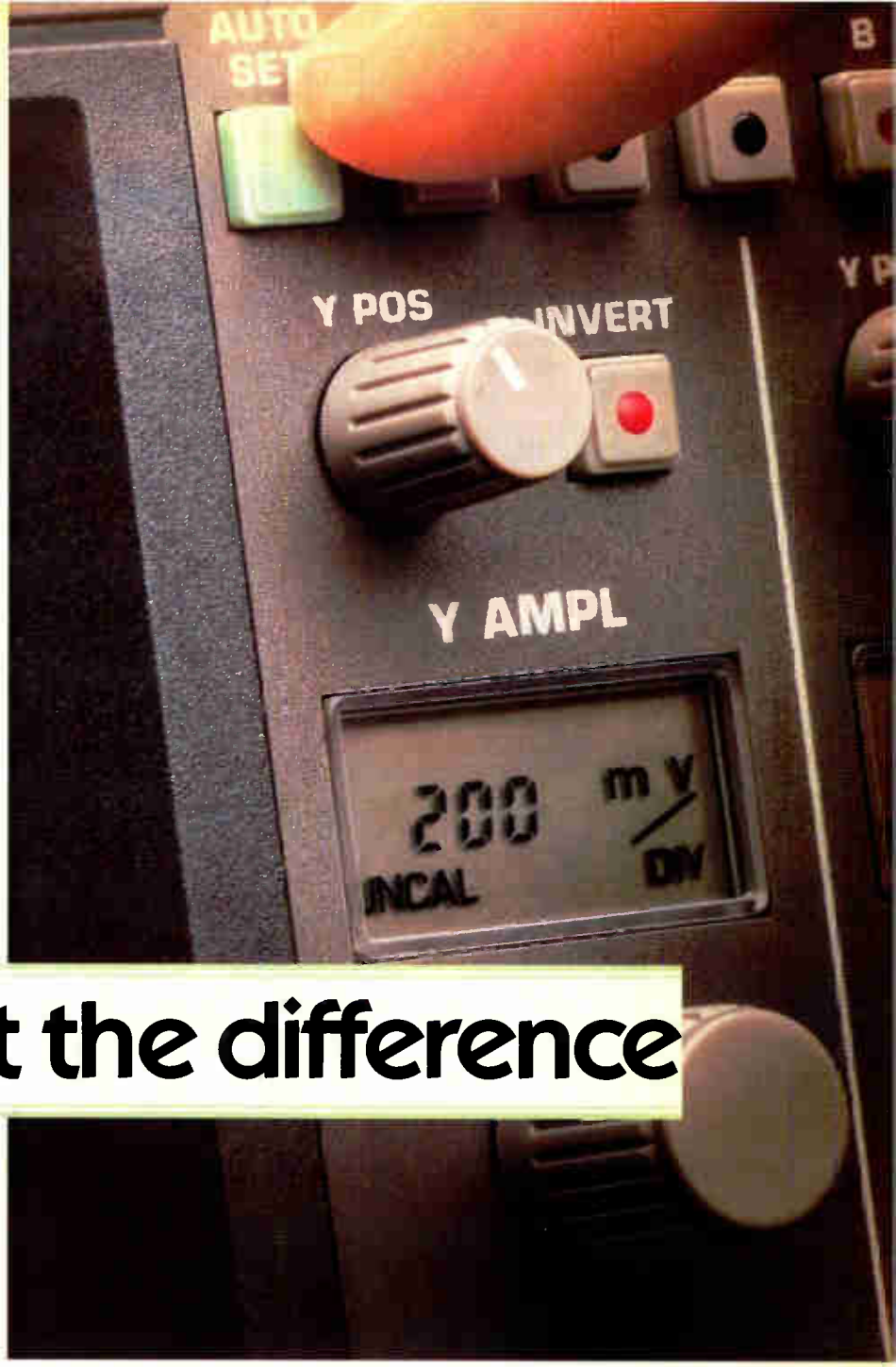
Intelligence is truly the hallmark of the Philips family of 350 MHz oscilloscopes.

Intelligent beam finding, for example. A finger-tip touch of the Auto-Set button and every parameter for all initial measurements is displayed – immediately; amplitude, timebase, trigger functions and screen positioning.

Other intelligent benefits include:

- **Current status read-outs** thanks to buffered switching.
- **'At a glance' status** is indicated on LED/LCD displays, while voltage/time cursors simplify direct signal measurement.
- **Ultra-fast writing speed** of 4 div/ns for secure capture and full waveform display of single-shot and low-repetition signals.

Moreover, the Philips 350 MHz family is backed by the vast corporate resources of one of the world's largest electronics companies. So Product Credibility in technology, technique, quality and service is assured.



Test the difference

Test the difference and you'll also agree that Philips wins on price and performance!

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Building HKF/55, 5600 MD Eindhoven,
The Netherlands.
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In the UK call 0223-358866
In France call 01-8301111
In the USA call 1-800-631-7172
or write to: PTMI, 85 McKee Dr.,
Mahwah, NJ 07430

350 MHz SCOPES

PHILIPS Test & Measurement

PHILIPS

Circle 12 on reader service card

TECHNOLOGY NEWSLETTER

IBM'S PC-BASED PROTOTYPE SYSTEM RECOGNIZES 20,000 WORDS...

The latest word regarding advances that IBM Corp.'s Thomas J. Watson Research Center is making in large-vocabulary speech recognition will be heard at the early April International Conference on Acoustics, Speech, and Signal Processing in Tokyo. Although the computer giant will not bring the hardware to Tokyo, Gideon Shichman, manager of speech engineering at the Yorktown Heights, N. Y., facility, will talk about an IBM PC-based machine that can recognize 20,000 words in real time. Its forerunner, a dictation-taking prototype machine that was first demonstrated in October 1984 [*Electronics-Week*, Oct. 15, 1984, p. 14], recognized only 5,000 words and required an entire IBM 4341 mainframe system and three Floating Point Systems 190L array processors. □

...AND NATURAL LANGUAGE ADDS ITS LILT TO VOICE RECOGNITION

Data bases will be coughing up information on voice command if a prototype system from Artificial Intelligence Corp. catches on. The Waltham, Mass., company has combined 1,000-word voice-recognition hardware from its neighbor Kurzweil Applied Intelligence Inc. with its own widely used natural-language data-base interface software, Intellect. The combination makes it possible to access a data base through Kurzweil's speaker-dependent KVS3000 machine. Three major corporations—John Hancock Mutual Life Insurance, E. I. Du Pont de Nemours, and General Motors—are evaluating prototypes of the AI system. □

CHANNEL PROCESSOR LINKS UNIX COMPUTERS WITH IBM'S MAINFRAMES

A Multibus-based channel processor from four-year-old Mitek Systems Corp. (of which AT&T Co. owns 32%) will let computers running AT&T Bell Laboratories' Unix operating system tap directly into IBM Corp.'s mainframe environments. Mitek, of Carrollton, Texas, successfully demonstrated the high-speed channel processor, which AT&T designates CP1, in stress tests this month. The CP1 handles a variety of mainframe communication standards, including Systems Network Architecture, licensed through Communications Solutions Inc. The channel unit works with a range of IBM operating systems, including VM, VS, and VCS. AT&T will be offering the CP1 and a second CP2 remote gateway processor to customers of its 3B minicomputers and 3Bnet local-area network. The 1.8-megabyte/s channel processor is based on a Motorola 68000 microprocessor. Later this year, Mitek will enhance its technology by using the 32-bit 68020 processor and improved software so that its processor will run faster than IBM's current 3-megabyte/s channel speeds and therefore handle future IBM upgrades. □

MOUNTAIN BELL TO TRY OUT AN ALL-DIGITAL RADIO-BASED PHONE SYSTEM

Looking for an economical way to provide service to remote locations, Mountain Bell will begin a 120-day trial of an all-digital radio-based telephone system this summer. Called Ultraphone, the system can multiplex four conversations onto a single radio channel in the 450-MHz range. In addition, its end-to-end digital design offers significant security and data-handling improvements over cellular mobile telephones and other analog radio-based systems, according to Kris Shelton, manager of market planning and product development at Mountain Bell. Ultraphone was developed by International Mobile Machines Corp., a Philadelphia telecommunications company. A base station with a 40-mile radius will be installed at the telephone station in Glendo, Wyo., where calls from trial customers will be transferred onto the telephone network using conventional switching gear. □

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ELECTRONICS NEWSLETTER

FRENCH ELECTRONICS FIRMS MAY REMAIN UNDER GOVERNMENT CONTROL

An unexpectedly narrow two-seat victory by the right-wing coalition in France's March 16 Assemblée Nationale elections could mean that any or all of the country's principal electronics manufacturers will remain under government control. The conservatives had planned to return the nationalized industries to the private sector—including Thomson-CSF, Bull SA, the Compagnie Générale d'Electricité, and the Compagnie Générale des Constructions Téléphoniques [*Electronics,* Feb. 24, 1986, p. 79]. Prime minister-designate Jacques Chirac, leader of the coalition's largest single party, the Rassemblement Pour la République, claims that his government of "cohabitation" will move quickly to put into effect the proposed privatization. However, most observers expect that Chirac will be forced to compromise on most key issues. □

OTA: CHIP MAKERS DEPEND INCREASINGLY ON U. S. FOR R&D FUNDS

U.S. microelectronics companies increasingly are turning to Uncle Sam for research and development funds as international competition and fluctuating markets drain the industry's R&D budget, according to a congressional study to be released this week. The report comes just as industry R&D groups and government agencies are beginning to explore cooperative R&D efforts [*Electronics*, March 17, 1986, p. 52]. The Office of Technology Assessment says companies are seeking federal assistance through either direct funding or federal policies that promote private support, such as R&D tax credits and intellectual-property protections. Because an estimated 80% of direct federal R&D support comes from the Pentagon, however, the study warns that commercial needs may not be met. Moreover, OTA found disagreement on the issue within the industry. Some favor a program modeled after those set up by Japan's Ministry of International Trade and Industry; others say the commercial sector must carry out its own R&D to ensure industry access. □

DYNAMIC RAMS MAY SOON BEAR 'MADE IN EAST GERMANY' STAMP

Dynamic random-access memories made in East Germany may be offered on the Western market in the next few years, according to industry observers and semiconductor-house officials in West Germany. Later this year, VEB Kombinat Mikroelektronik in Erfurt will begin fabricating 64-K DRAMs based on n-MOS technology. The memories have a maximum access time of 200 ns and a cycle time of 330 ns. The DRAMs will be sold to other Eastern bloc countries, with sale to the West a distinct possibility. East Germany's foray into electronics also includes a plan to produce 16-bit personal computers this year at VEB Kombinat Robotron in Dresden. When production starts, East Germany will be the only Soviet bloc country other than the USSR that manufactures 16-bit microcomputers. □

JAPANESE PRINTER WILL TURN OUT COLOR PHOTOS FROM VIDEO SIGNALS

Japanese video fans will be able to capture fleeting images from their screens on paper starting this summer. Hitachi Ltd., Tokyo, will offer the domestic market full-color printers that can produce—on the spot—high-quality photographic prints from video signals supplied by a TV, video cassette recorder, personal computer, or videotext terminal. Hitachi will offer three models, all printing images equivalent to 468 TV lines, with 512 pixels per line. In some 80 seconds, the machine can print a picture about 3 by 3.8 in. on paper measuring 4 by 5 in., with a resolution of 152 dots/in. Hitachi will also offer a video disk drive capable of storing 50 still images on a 2-in. floppy disk. □

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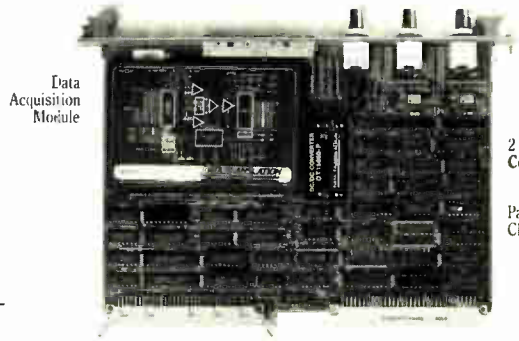

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PRODUCTS NEWSLETTER

TEXAS INSTRUMENTS TO DELIVER ITS 32-BIT MINICOMPUTER

Texas Instruments Inc.'s Data Systems Group will start shipping its promised 32-bit minicomputer—the Business System 1500—in the third quarter of this year. The computer is built around multiple Motorola 68020 microprocessors, which the Dallas company selected for the system's CPU before it decided in 1984 to second-source National Semiconductor's 32-bit 32020. The 1500 is built on the same NuBus chassis as TI's Lisp-based Explorer work station. The 1500, which has 4 gigabytes of memory, will support up to 128 users. The computer will be priced from $70,000 for a system with two processors to more than $400,000 for systems with four processors. □

INTEL WILL ADD C-EXECUTIVE TO ITS 80386 MICROPROCESSOR

Look for Intel Corp. to include the newest version of the C-Executive real-time operating system in the Santa Clara, Calif., company's 32-bit 80386 microprocessor. Version 2.1 of the operating system, which comes from JMI Software Consultants Inc., Spring House, Pa., runs faster than its predecessors because the company rewrote the context-switching code in assembly language. JMI will complete the adaptation by the end of April. □

SOFTWARE WILL MAKE SUN WORK STATIONS COMPATIBLE WITH OTHERS

Sun Microsystems Inc., Mountain View, Calif., will be making its work stations compatible in multivendor environments by introducing the SunLink OSI networking package. SunLink OSI supports all seven layers of the open-systems interconnection reference model of the International Organization for Standardization. The package is based on the Technical and Office Protocol and has already been tested for compatibility by the General Motors Manufacturing Automation Protocol Laboratory and by 20 computer vendors, including AT&T, Hewlett-Packard, and IBM. Sun says it is also making its own Network File System operate with the OSI network, but that capability will not be available when the $950 SunLink OSI ships in May. □

OUTPUT-ENABLE FEATURE SPEEDS UP TOSHIBA 16-K STATIC RAM

Toshiba America Inc.'s new 16-K static RAM, which boasts a 35-ns access time, has an output-enable feature that enhances speed at the system level. The Tustin, Calif., company says the output-enable scheme turns the RAM on or off faster than the ordinary way of changing address inputs, thereby reducing cycle-time delays caused by bus contention. The TMM2078D-35's output-enable feature is suitable for high-speed applications, such as in cache, buffer, and video memories. The RAM also has a standby mode in which maximum current is 20 mA; maximum operating current is 150 mA. The RAM is available now for $7.35 each in lots of 1,000. □

MICROSOFT'S LATEST XENIX IS COMPATIBLE WITH AT&T'S UNIX SYSTEM V

The latest version of Microsoft's Xenix operating system, Release 2.0, is fully compatible with AT&T Bell Laboratories' Unix System V version. The Bellevue, Wash., company's Xenix System V is upwardly compatible with Microsoft's earlier Xenix System III. In addition, it has all the features of Unix System V that are needed for the multiuser, commercial microcomputer market, including all Unix System V calls and library routines. At the same time, IBM Corp., Microsoft's largest customer, is introducing a development system, a text-formatting system, and operating-system extensions for its line of Personal Computers that are compatible with Release 2.0. Licensing fees for Xenix System V were not available at press time. □

Electronics

U.S. GOVERNMENT IS WAKING UP TO THREAT IN X-RAY LITHOGRAPHY

IT MAY FUND WORK TO COMPETE WITH JAPAN AND WEST GERMANY

UPTON, N.Y.

The U.S. government may be waking up to the foreign threat posed by the large amount of subsidized development work going on for applying high-energy synchrotron-radiation-based X-ray lithography. Government-funded programs for this new type of lithography in West Germany and Japan [*Electronics*, March 17, 1986, p. 46] are proof positive that these countries see it as vital to fabricating the submicron integrated circuits of the 1990s.

Earlier this month, the Department of Energy took the first step toward U.S. support of such development work when it called a meeting at Brookhaven National Laboratory in Upton to see if the synchrotron technology developed at the lab's National Synchrotron Light Source Department could be transferred to industry. A transfer could be accomplished through either a cooperative program involving industry alone or one backed by the government.

A select group of about 60 potential lithography users, lithography machine manufacturers, storage-ring manufacturers, and government agencies participated in the conference. They were briefed on the the IBM Corp. effort on the vacuum ultraviolet storage ring at Brookhaven and on the worldwide situation in compact-storage-ring technology. IBM has been conducting synchrotron research and development on Brookhaven's vacuum ultraviolet ring since the early 1980s. At least two speakers sounded notes of alarm about the lack of progress in advanced X-ray lithography in the U.S.

All the X-ray lithography work in progress in the U.S. originates with private-sector players such as IBM, Micronix, and Perkin-Elmer. Micronix Corp., Los Gatos, Calif., recently announced a commercial X-ray stepper based on a standard stationary-anode source [*Electronics*, March 17, 1986, p. 41]. And Perkin-Elmer Corp., Norwalk, Conn., will soon deliver the same type of unit to contractors on the Pentagon's Very High Speed Integrated Circuits program.

The throughput of these units is very much limited by the sources' low energy levels and the sensitivity of the special resists used. Synchrotrons, however, have none of the energy-level limitations of the standard-source aligners.

HIGH INTENSITY. The high-intensity X-ray beam put out by the synchrotron can be used with standard, less-sensitive photoresists that do not have the process-compatibility problems of the special X-ray resists. The high intensity also leads to a big boost in production-throughput potential. Furthermore, the collimated nature of the synchrotron's X-ray beam makes possible the fabrication of somewhat smaller device features than can be made using standard X-ray sources.

"Somebody has to do something cooperative in the U.S. to survive in this business or we will lose in the soft-X-ray technology race," noted Michael Knotek, chairman of Brookhaven's National Synchronous Light Source Department, in his introductory speech. (Soft X rays have a spectrum of 4 to 40 Å.) It's time to move now, Knotek emphasized, because Japan and Germany are already building dedicated storage rings; in fact, he said, the West German program is quite advanced.

A second speaker sounded an even more urgent note of alarm. "Whoever rules in ICs dominates the supercomputer field," said Norman Kreisman, DOE's technology-transfer chairman. And domination of the IC field requires leadership in advanced lithography.

Kreisman also noted that because Japan's X-ray lithography effort is so advanced, a U.S. company could eventually have its proprietary supercomputer chips manufactured in Japan. Some of the Japanese IC manufacturers—NEC and Hitachi, for example—would also be the main rivals of U.S. supercomputer makers—not the best arrangement for protecting proprietary designs.

Synchrotron technology itself is not proprietary, Knotek pointed out; building a unit dedicated to synchrotron X-ray lithography is more a matter of resources than developing new technology. The technology for two other vital links is also ready: Micronix supplies bo-

IN THE LAB. The vacuum ultraviolet synchrotron at Brookhaven spins off X rays for lithography.

ron nitride masks, and IBM has developed a vertical stepper in-house. Perkin-Elmer and Micronix, which have developed horizontal steppers, could certainly develop vertical types for commercial use.

Conference attendees split into applications and machine-technology working groups to prepare recommendations on transferring Brookhaven's technology to industry. The report will not be ready until late next month. But Gwyn Williams, a physicist at Brookhaven and coordinator of the meeting, says one preliminary conclusion is that the U. S. needs a dedicated synchrotron by 1991 to be competitive, and that such a facility could clearly be finished in time if the U. S. starts now.

The working groups approximated specifications for the synchrotron, but the big question remains: who will pay for it? Nor did the conference settle the issue of whether to build a normal ring with proven technology or invest in a costly, unproven, superconductive storage ring with a theoretically higher throughput.

It is unlikely that any storage ring for a cooperative effort will be built without government help. In view of this, the working groups will draft a statement to lobby in Washington, pointing out the problems and drawing the government's attention to the problem. *–Jerry Lyman*

URGENT. Brookhaven's Knotek says U. S. must move now or be left behind by West Germany and Japan.

DATA COMMUNICATIONS

TOSHIBA MULTIPLEXES FIVE BEAMS ON ONE FIBER

KAWASAKI, JAPAN

Despite their high capacities, current fiber optic systems won't be able to carry the large amounts of data that telecommunications systems will be choking on in the 1990s. Wavelength multiplexing—putting several light beams on a single fiber—could be the answer, and one company taking this route, Toshiba Corp., has taken a big step forward.

Toshiba has been able to demultiplex five closely spaced—only 50 Å apart—optical signals emerging from a fiber. Because the five signals are so near each other in wavelength and all in the low-loss 1.3-μm band, they can travel long distances together in a practical long-haul data-communications system. Work continues on showing that it can be done in practical systems and extending the results to the 1.55-μm band, where signal losses in the fiber are even lower.

At present, large numbers of signals are multiplexed electrically to modulate lasers at rates up to about 1 Gb/s. These high bit rates and the even higher ones that will follow require more-costly logic and laser-modulation circuits. These circuits cost more because of increasing fabrication difficulty. Yet such systems provide only a fraction of the potential transmission capacity of the optical fibers.

To demonstrate a quintupled fiber capacity, the Toshiba team multiplexed five signals with a wavelength spacing of only 50 Å onto a single fiber. This spacing was selected because it is 10 times the wavelength accuracy to which the lasers can be fabricated, says Takeshi Ozeki, manager of the Electron Devices Laboratory in Toshiba's Research and Development Center and head of the research team.

The most difficult aspect of this work is the fabrication of the integrated transmitter and of the receiver demultiplexer, which has not previously been done for channel spacing this narrow, and the integrated transmitter laser chip. The transmitter multiplexer and the receiver's integrated p-i-n photodiode chip are more straightforward.

The integrated transmitter chip has five distributed-feedback laser diodes that produce the five beams with wavelengths staggered at 50-Å intervals. A corrugated diffraction grating located above the active region of each laser sets its output wavelength.

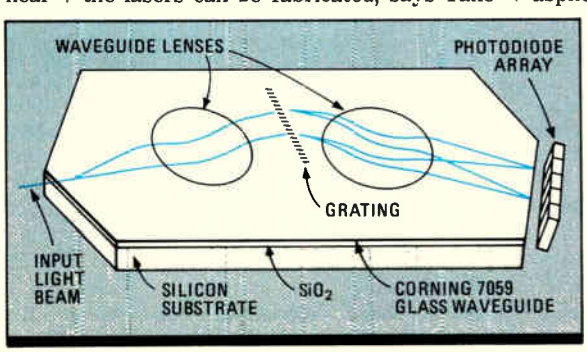
REPETITIVE PROCESS. A holographic technique that uses interference between two laser beams provides photolithographic patterning for fabrication of the grating. The process must be repeated five times for the five diodes on each chip. However, the patterns for lasers of the same wavelength are exposed simultaneously at the wafer level.

Toshiba uses conventional fabrication techniques for the gallium indium arsenide phosphide/indium phosphide lasers for the 1.3-μm band. Threshold current is in the 20- to 30-mA range and power output is 5 mW. The wavelength achieved is typically within 5 Å of design value.

The integrated optical multiplexer is fabricated on a lithium niobate substrate. Waveguides of diffused titanium, which oxidizes, form directional couplers that multiplex the beams from the five lasers on the laser array onto a single optical fiber. Loss in the multiplexer is about 10 dB.

The demultiplexer (figure) is a novel passive device fabricated on a silicon substrate. A thin layer of Corning 7059 glass overlying a silicon dioxide film on the surface of the substrate forms an optical waveguide. The chip also holds an aspherical geodesic lens for collimating the beam coming in from the optical fiber, a diffraction grating for dispersing the beam into its five constituent wavelengths, and another aspherical geodesic lens for focusing the five beams onto a single-chip array of five p-i-n diodes. The diffraction grating is fabricated by ion-beam milling. The loss figure for the demultiplexer is about 7 dB.

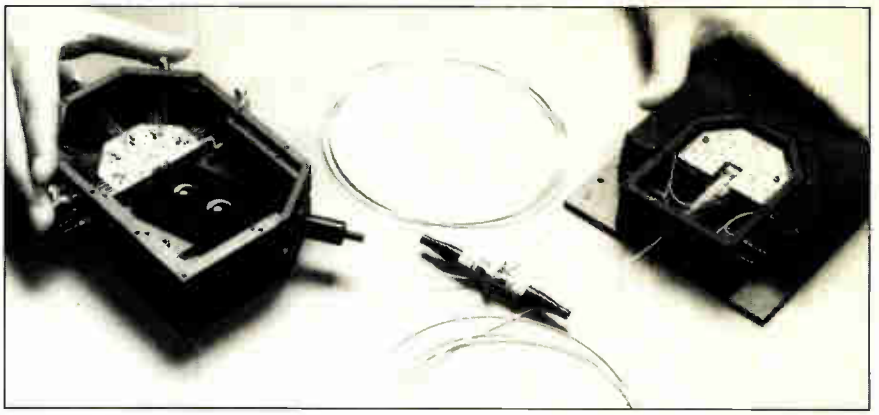
Wavelength-multiplexed optical transmission systems have already been built, but wavelength



GRATE DEMULTIPLEXER. Toshiba uses a grating and two lenses to separate light of different wavelengths.

spacing was on the order of 1,000 Å. Systems of this type are used mainly for short-haul jobs because attenuation and dispersion characteristics are different at each wavelength, which limits data rates and distance.

Toshiba's work was carried out at the data rate of 32 Mb/s per beam to show the feasibility of optical integration. However, the company hopes to extend the data rate to the gigabit region. The effort was part of the large-scale project set up by the Agency of Industrial Science and Technology of the Ministry of International Trade and Industry for the development of optical measurement and control systems. *–Charles L. Cohen*



ADVANCED. Toshiba's experimental fiber-optic system has new technology at both ends.

MATERIALS

IBM FUNDS RESEARCH AT 12 SCHOOLS

YORKTOWN HEIGHTS, N. Y.

IBM Corp. plans to give $24 million in money and equipment to a dozen U. S. universities over the next five years to fund basic research and help create graduate programs in advanced electronic materials and packaging technologies. The fields are crucial to next-generation integrated circuits and "critical to the future of the information industry at large," the computer giant says.

"It was apparent that a large number of departments wanted to get into areas of science that would be best for our industry but couldn't because of the high cost," says Praveen Chaudhari, vice president of the Sciences Research Division at IBM's Thomas J. Watson Research Center in Yorktown Heights. The result was the program unveiled this month, by which each of the 12 schools selected will receive up to $1 million in cash and up to an additional $1 million in equipment.

The schools were selected from a field of 47 that submitted comprehensive proposals, following preliminary proposals from 100 schools in December 1984. They are Brown University, Carnegie-Mellon University, Columbia University, Cornell University, Massachusetts Institute of Technology, Pennsylvania State University, University of Chicago, University of Illinois, University of Massachusetts, University of Minnesota, University of Pennsylvania, and the University of Washington.

By funding the work, which will focus on polymers, processing technologies, and packaging, IBM hopes to create "a sea of knowledge that industry can extract from when it needs to," says Chaudhari. The program is not only likely to produce basic materials advances that can be used for future generations of devices, he points out. It will also boost the supply of graduates with advanced electronics materials expertise.

"Why can't we make something 10 times denser or faster than what we've now got? The answer isn't that there is a new physical phenomenon that determines how the device will operate, but that we don't have control over the materials and processing sciences that are required," Chaudhari declares.

The 12 universities agreed to invest their own money and create at least one permanent tenured faculty position devoted to the fields, Chaudhari notes. The proposed programs will bring together faculty from a variety of disciplines, including ceramic engineering, chemistry, electrical engineering, and metallurgy.

NEW MATERIALS. Carnegie-Mellon, for example, will look into thin films, in particular the development of new materials, such as magnetic thin films on polymers, says Subhash Mahajan, professor of materials science. The Pittsburgh university will study the thermal stability of thin films, the origin of internal stresses in them, and the effect of those stresses on electromigration, among other areas.

IBM laid out examples of areas where long-term research is needed in the three target areas. Polymer work might focus on creation of new insulators for use between ultrathin layers or new bonding materials, for instance, or on plastic materials with new or "custom-made" properties. A material that would react to X rays or ultraviolet light in the way photographic film responds to light, for example, could permit fabrication of 0.3-μm-thick line geometries, IBM says.

In the processing area, future technologies that require deposition, removal, or diffusion of discrete numbers of atoms or molecules could benefit from work in ion implantation, ion etching, and molecular-beam epitaxy. And in packaging, IBM says new kinds of insulators, ceramic substrates, and other materials will be needed to bind and separate the numerous elements in the ultradense chips of the future.

With the program, IBM hopes to create a basis from which to view the problem, says Chaudhari. He hopes other corporations and national funding agencies will follow. "My only regret is that we couldn't fund more than 12," he says. *–Wesley R. Iversen*

OPTICS

EUROPEANS DESIGN A WAY TO LINK CHIPS OPTICALLY

VIMERCANTE, ITALY

The faster that chips run, the bigger the propagation delays imposed by standard printed-circuit-board technology. Now three European research laboratories have teamed up to replace copper connections with fiber optics.

First results are encouraging: the team has already worked out two possible schemes for optically linking chips and has also completed a detailed evaluation of the optoelectric technologies necessary to realize components. Under their new method, fibers replace copper traces on a circuit board, and optoelectric interfaces substitute for the pads by which a standard integrated circuit communicates with the outside world.

The work is being done as part of the European Communities' Esprit program

by three companies—GEC Research Ltd., the research and development arm of Britain's General Electric Co. plc, Telettra SpA, the telecommunications subsidiary of Italy's Fiat group, and the UK's University of Southampton.

Conventional metal interconnections cannot keep pace with the fastest chip technologies available because at rates higher than 100 Mb/s, design and test difficulties arise. Transmitting an acceptable pulse, for example, requires a bandwidth of three times the bit rate. At such frequencies, pc-board traces exhibit unacceptable inductive impedances as well as high crosstalk.

Even the use of microstrip transmission techniques is limited to distances shorter than a couple of centimeters because the source and load impedances of logic are not matched or constant. This causes problems with reflection, or standing-wave, effects.

GaAs MODULE. The approach the three Esprit partners are taking is to integrate a gallium arsenide module onto silicon logic circuits. This small block would integrate one or two light-emitting diodes or diode lasers and a corresponding number of photodetectors. The diodes would replace the output pads of a standard logic board, and the detectors would take the place of the input pads. These would be used to send and receive, respectively, a multiplexed optical signal corresponding to the circuit's inputs and outputs.

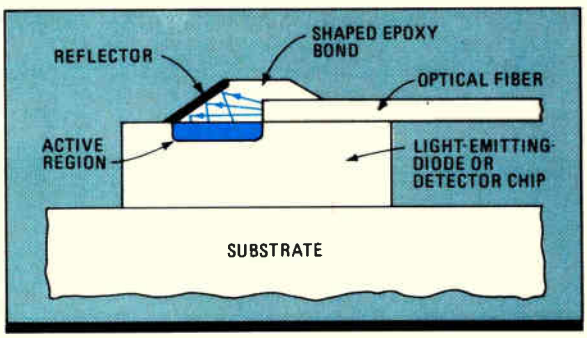
Multiplexing and demultiplexing circuitry would also be integrated in the GaAs section. The only standard pads needed would be for connecting such devices as power supplies, external oscillators, and timers.

This concept presents several difficult engineering problems. Still, say the project's participants, some such scheme will be necessary by the 1990s, when many current research programs (such as numerous supercomputer projects) produce their desired circuits. Otherwise, users will run into serious transmission problems when they try to integrate those circuits into systems. The only currently available alternative is the costly and cumbersome possibility of using a high-power line driver with impedance-matched termination.

The project's most daunting task is integrating the necessary GaAs circuitry and optoelectronic components on a silicon chip. As unlikely as that may appear, Giorgio Guarini, manager for Telettra's Components and Technologies Division, points out that there is no theoretical reason why it cannot be done. The solution would be to grow a layer of germanium on the IC's silicon substrate on which it is possible, in turn, to grow GaAs and other III-V materials. The addition of indium and phosphorus makes laser fabrication feasible.

The project's work so far has centered on LEDs because they can be produced simply and with sufficient reliability. The only drawback is that their transmission rates are limited to a maximum of 1 Gb/s, a figure Guarini considers the lower limit for effectiveness of this technology.

Another problem with lasers is that their operation is currently limited to a lifetime of 5 to 10 years at 25°C, a figure that drops to only one or two years at 50°C. The project participants reckon that for practical use, they have to be able to count on lifetimes of 20 years at 50°C, an order of magnitude greater.



MIRROR, MIRROR. A drop of metal on shaped epoxy changes the optical index to reflect light to or from an optical fiber.

The researchers have worked out two possible schemes for connecting the chips. The simpler uses plastic fibers and welds them to the active region of the emitter or detector using thermal compression. This method, which is fast and inexpensive, mounts the fiber at right angles to the board's plane. There are drawbacks, however: transmission losses can occur because of microbending, and the finished product is not planar and is therefore cumbersome.

The second solution is more complex (figure) but overcomes the drawbacks of thermal compression. The end of a fiber, which runs parallel to the pc board, is laid on the active region of a diode or detector and covered with transparent epoxy. The side of the epoxy to which the fiber end points is then shaped to intersect with the plane of the optoelectronic component at a 45° angle.

REFLECTED LIGHT. When a drop of molten metal is deposited on this surface, it changes the optical index so that light reflects into the fiber from an LED or laser or out of the fiber into the active region of a photodetector. Connecting fibers are laminated to the pc board.

Guarini points out that Telettra, the company responsible for this portion of the project, has demonstrated through a pilot operation that the process can be easily automated. So far, the companies have developed the tools for automating the connection processes and laminating the fibers to the boards. They have tested these connections and found that their methods ensure transmission with small enough losses that these schemes can already be used for their final objective: optically multiplexed input/output signals for very large-scale integrated circuits.

The partners' objective for this year is to develop a prototype board that works at a rate of 1 Gb/s. For their prototype, they'll use a version in which optoelectronic components simulate the I/O pads of ICs. *–Robert T. Gallagher*

SEMICONDUCTORS

MODEL MAY HELP SOLVE CHIP-RELIABILITY PROBLEM

CHAMPAIGN, ILL.

As integrated circuits move toward submicron geometries, semiconductor researchers are stepping up efforts to understand and deal with the potential for device reliability problems caused by hot-electron effects. Now, researchers at the University of Illinois say they have effectively modeled the atomic mechanisms that cause the problems, and they are beginning the next step toward merging their model into commercially available computer-aided-design simulation software.

Still two to three years away, such a package could provide IC designers with a way to predict more precisely the operating life of a device and aid in the design of more reliable transistor structures, says C. T. Sah, a professor of electrical engineering and chief researcher on the effort.

Though known for years, the hot-electron effect is of increasing concern as device geometries get smaller. If supply voltages remain constant while dimensions shrink, the electric field created inside a working device gets stronger, accelerating the electrons and increasing their kinetic energy. Though the atomic mechanisms that cause transistor aging are not thoroughly understood, what is known is that hot electrons can affect device threshold volt-

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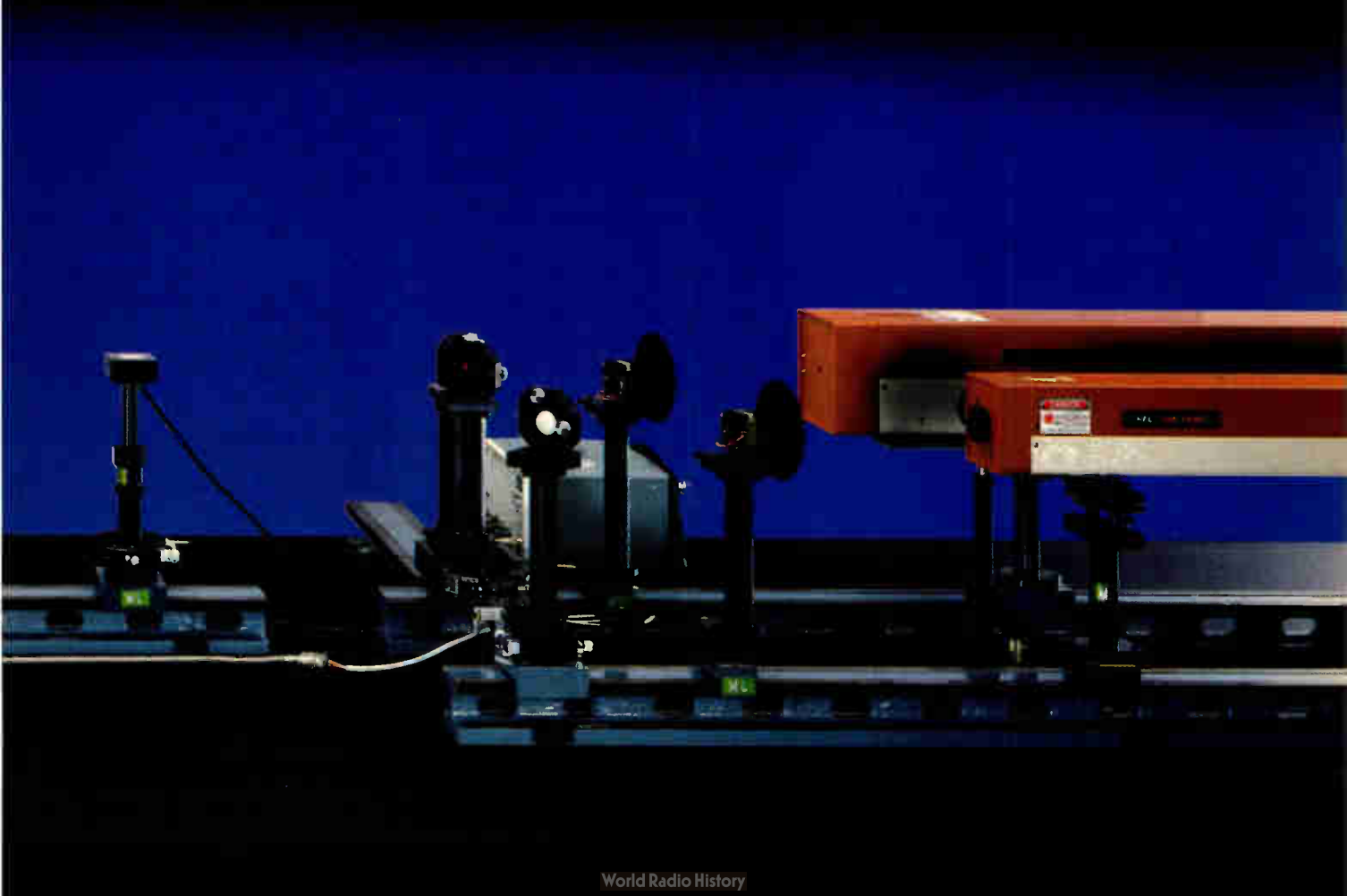
the Laser Beam Picture?



ages, subthreshold currents, and breakdown voltages, causing transistors to deteriorate and eventually fail.

"People have already seen the problem" in the 1-μm device geometries of today's advanced ICs, says Leo D. Yau, a principal engineer for technology development at Intel Corp. in Aloha, Ore. At 1 μm, the industry has overcome potentially deleterious hot-electron effects with various processing techniques, such as giving the source and drain regions of an n-type structure a phosphorus-arsenic doping that is selectively lighter than in the channel area, Yau notes. But if the industry doesn't come up with some new processing tricks, says Yau, supply voltages around 3 V probably will be necessary for next-generation ICs. "When the electrical channel lengths get into the 0.5-μm range, we'll definitely have a problem with 5 V."

MODEL BUILDER. The University of Illinois' Sah is working to incorporate models of hot-electron effects into CAD software.

Sah says his model, developed over three to four years with the aid of about 10 graduate students, could help solve the problem. Designers could try different doping profiles and structure dimensions, for instance, and see how well they counteract hot-electron effects.

"We've got pretty good verifications of a variety of experiments [about 200 in all] on the model, on the mechanisms," he says. Now Sah has several of his students at work transforming the model into software. In about a year, Sah expects the group to complete a software package that models along a single physical dimension of the device at a time and that incorporates the results of verifying lab experiments. Another year or two after that, he says, experimental results will be incorporated into a two-dimensional modeling program, which could then be quickly worked into commercially available simulation packages, such as Spice from the University of California at Berkeley.

OVER TIME. The result, Sah notes, will be a program that will not only simulate the design but will also provide time-dependent reliability predictions. This could help engineers tweak designs for longer operating life and could also help in developing new ways to fend off hot-electron phenomena, he says.

Not all researchers in the field are convinced such software can be developed. "It would be very useful, but whether you can effectively model to the point where it would be good enough to be useful, there's some question," says Donald R. Young, manager of interface physics at IBM's Thomas J. Watson Research Laboratories, Yorktown Heights, N. Y.

Sah believes otherwise. The Illinois model consists of three basic parts, one of which device makers have known of for years. The other two parts have been modeled and verified over the past four years at the university, he says. All are related to water that gets into the device at levels of about one part per million in most production furnaces.

The relatively well-known phenomenon with which the model concerns itself is the energizing of previously neutral traps in silicon dioxide layers and the oxide-silicon interface by hot electrons in a high electric field, leading to threshold-voltage changes.

The model's more novel portions deal with water-induced hydrogen that bonds with the oxygen and silicon in the oxide and at the oxide-silicon interface. When the hydrogen atoms are knocked loose by highly energized electrons, they leave behind "dangling traps" that had previously been neutralized by the hydrogen. These traps can grab electrons and holes, causing performance deterioration in the transistor, Sah says.

The third part of the model mimics the mechanism whereby the loose hydrogen atoms can bond with boron acceptors in p-type doped silicon, eventually causing the p-type silicon to become intrinsic.

Sah says most of the experimental work was done with MOS FET test structures, but these could easily be modified for use with gallium arsenide and other FET types. *–Wesley R. Iversen*

TELECOMMUNICATIONS

FASTEST DIAL-UP MODEM CLOCKS IN AT 18 kb/s

ALPHARETTA, GA.

A dial-up modem with instantaneous data-transmission speeds nearly twice that of current 9.6-kb/s modems is on the way from Digital Communications Associates Inc. and Telebit Corp.

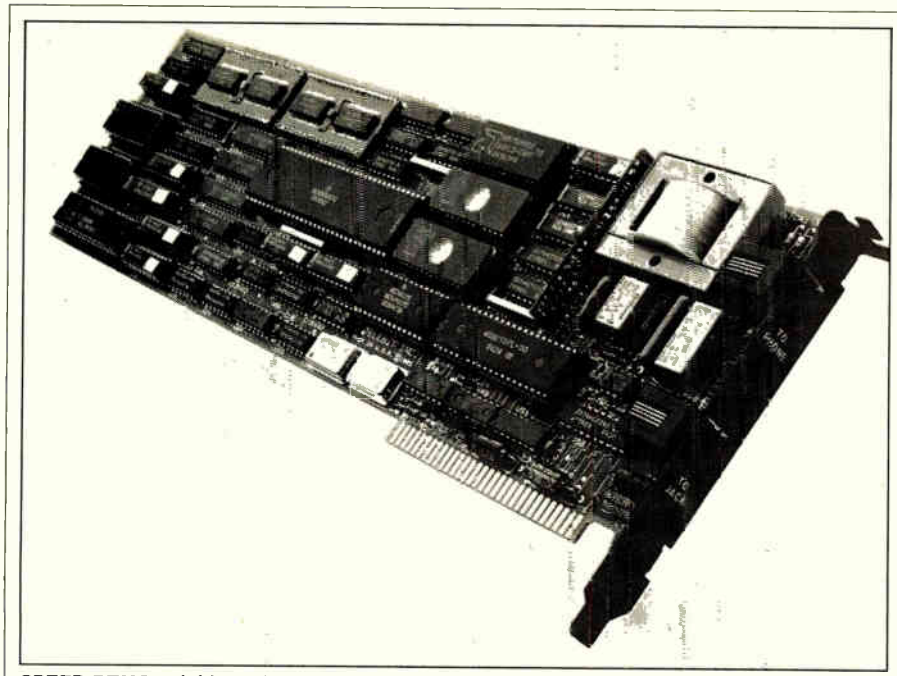
Higher data rates are important, but it is the actual throughput that really counts, says Mary Schaller, Telebit's director of marketing. The modem has a 14-kb/s throughput rate that includes error correction and protocols, yielding "an efficiency factor of about 80% of the data rate," Schaller says. In addition, the partners stress, the high-speed modem will improve interactive applications over phone lines.

The key to the 18-kb/s asynchronous modem, an enhanced version of a Digital Communications product dubbed Fastlink, is a design that combines a multicarrier modulation scheme, digital signal processing, and new packet technologies.

"We see it as a breakthrough in data communications," adds Dodge McCord, Fastlink technical specialist at DCA, Alpharetta. One reason, he says, is that the enhanced Fastlink makes high-volume file transfers more feasible over unpredictable regular phone lines, eliminating reliance on costly dedicated lines.

A market for this sort of device is fast developing. Consumption of personal computer work stations and high-speed modems are projected to grow dramatically in the next few years, according to market researcher Dataquest Inc., San Jose, Calif. Personal computer work stations will jump to 33.7 million units installed by 1988 from 8.7 million in 1984, and associated growth in high-speed modems is expected to grow at a compound annual rate of 73.4% through 1989, estimates Dataquest.

With these projections in mind, the two companies joined forces—as DCA/Telebit Data Systems—shortly after Telebit researchers received a patent in early 1984 for a technique called dynam-



SPEED DEMON. A Motorola 68000 microprocessor in DCA/Telebit's 18-kb/s modem helps it analyze and adapt to line quality in real time. It uses up to 400 carrier frequencies simultaneously.

ically adaptive multicarrier quadrature amplitude modulation, or Damqam. An earlier version of its Fastlink modem was introduced last July with data rates of 15 kb/s and a throughput rate of 10 kb/s without data compression.

Earlier this month, DCA/Telebit Data Systems introduced two new versions of the Fastlink with higher data rates: a stand-alone modem and a personal computer modem card. Telebit, Cupertino, Calif., is also marketing the new versions to original-equipment manufacturers under the name Trailblazer.

Fastlink "departs from the widely accepted evolution of modems," says McCord. The evolution of conventional modem technology has led to the use of single- or dual-carrier modulation techniques at modulation rates as high as 2.4 kb/s. These modems, he argues, have now become heavily dependent on higher transmission quality.

MORE BANDWIDTH. By contrast, Fastlink's packetized ensemble protocol, which uses Telebit's Damqam technique, enables the enhanced modem to analyze and select up to 400 out of 512 available carriers at rates as low as 7.3 baud to speed error-free transmissions. Hence, the technology uses a 3.1-kHz-wide band, about 50% more bandwidth than is used by conventional modems.

Carrier signals can be spaced every 7.9 Hz and encoded with up to six bits of error-free data per carrier. The number of encoded bits per carrier is determined by the signal-to-noise ratio, among other factors; the S/N ratio is measured when the modem analyzes line quality, which it can do in real time. McCord says that allows carriers to be spread out, regardless of transmission quality, without wasting bandwidth.

To increase the interactive capabilities of computer networks, the modem also incorporates a short/long data-packet technique. Short packets are used to maximize the response to interactive applications—something McCord and Schaller both say the desktop-computer market needs—and large packets are used to speed large-volume data transfers. The modem automatically determines the optimum packet size.

Along with current applications, such as microcomputer-to-mainframe links, file transfers, information-retrieval services, and electronic mail, new dial-up applications include high-resolution graphics capabilities, videotext, software distribution, and local-area-network gateways to public switched networks.

Fastlink is also compatible with slower modems and many transmission standards, including the Bell 103 standard for 300-b/s transmission, the CCITT V.22 and Bell 212A standards for 1.2-kb/s transmission, and the CCITT V.22 bis standard for 2.4-kb/s transmission. Bundled communications software also allows Fastlink to operate with IBM Corp.-compatible PC-DOS microcomputers, along with Digital Equipment Corp. and Texas Instruments Inc. terminals.

The partners will also offer upgrade kits ($99) and factory upgrades ($250) to the original Fastlink. They involve changing four programmable read-only memories, two of which are connected to a pair of Motorola 68000 processors. The enhanced PC-card version is priced at $1,995; the stand-alone version goes for $2,395. Depending on daily data-transmission needs, Telebit's Schaller estimates that users could pay for the enhanced modem in as little as six months. *–George Leopold*

COMPUTER-AIDED DESIGN

EXPERT SYSTEM CUTS CHIP DESIGN TIME BY UP TO 50%

MOORESTOWN, N. J.

Engineers are racing to incorporate artificial-intelligence technology into the next generation of computer-aided design systems, though some experts say that such tools will not reach maturity for some time. An undeterred group of young researchers at RCA Corp.'s Advanced Technology Laboratories, taking a near-term approach, may be the first to have developed a knowledge-based expert system for use with existing very large-scale-integration design tools.

Building on RCA's Multi-Port Two-Dimensional automatic standard-cell placement and routing program, known as MP2D, the group developed an expert system that it says could cut design time for the complex program by 5% to 50%, depending on the user's experience. Used in conjunction with MP2D, which is still being developed and enhanced after 17 years of use, MPECS (for MP2D Expert Consultation System) helps inexperienced users get the most out of the powerful design program.

The MPECS program does not directly interact with MP2D, says principal researcher Nicholas Straguzzi, but rather works as an "adjunct consultation system." Users must first run MP2D; in cases where special requirements—such as chip size or shape, critical path, or interconnection length—require further refinement of the program's output, the user can then run MPECS to aid the improvement process, much as the user might call in an expert designer for advice.

NOT BROKE, BUT FIXED. The advantage of this approach goes beyond maximizing an expert's time by sparing the person from a slew of bothersome questions, according to Straguzzi. Unlike most research into AI-based CAD systems, which focuses on incorporating AI rules into brand-new design tools, the RCA approach does not trash available CAD systems but builds on them instead. "MP2D is a very old-time pro-

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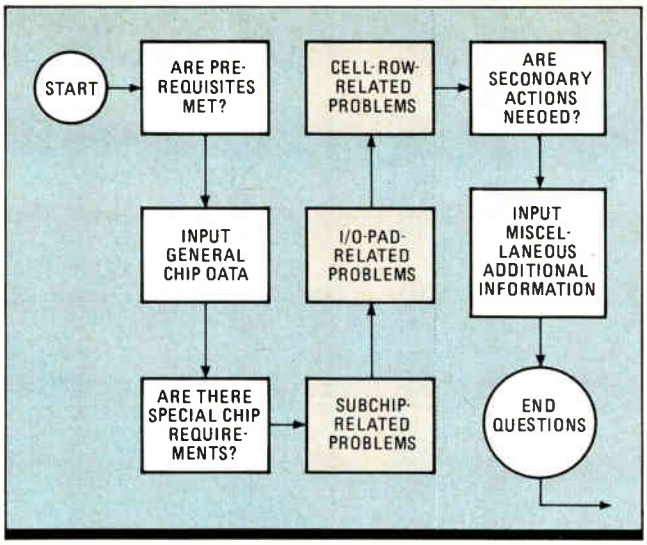
gram, but it works very well," Straguzzi says. "You can get to the point where you say, 'If it ain't broke, don't fix it,' but by nature these are very difficult programs to use." So while the program wasn't "broke," its difficult nature offered room for improvement.

MPECS asks users questions of increasing complexity concerning general chip data, special requirements, and whatever potential problems they can identify. The program then responds with an interpretive analysis, identifying problems and their locations in order of importance, and recommending treatment. In addition to strict recommendations, the program will also occasionally generate trial-and-error suggestions that it "thinks" could help the design. These suggestions are accompanied by a warning that the user should revert to the original design parameters if the suggestions fail to work.

Running the program then becomes somewhat like playing a game of Twenty Questions. Built around Expert, an expert-system-building shell developed at Rutgers University in New Brunswick, N.J., the system represents its knowledge as a series of if-then rules. Stephen Kennedy, an MP2D expert who played a major role in the development of the MPECS program, says the consultation session takes five minutes at most to complete. "MPECS only asks about 15 or 20 questions," he says. "You don't want your designer sitting there for two hours answering questions."



20 QUESTIONS. MPECS's questioning strategy takes the place of a consultant in the use of the MP2D placement-and-routing program.

The system is an "iterative process," according to Kennedy. "You don't run it just once." Because it is based on "expert knowledge," it relies on the same thought process used by expert MP2D users. Designers optimize layouts gradually, he explains. They run MP2D, examine their checkplots, change relatively few parameters, and run the program again. MPECS does the same. Once a designer is pleased with a checkplot, the process is complete. If still not pleased, the designer can take another run through MPECS, which will indicate whether the layout can be further improved.

Straguzzi and Kennedy, who were assisted on the project by Todd Rockoff, a PhD candidate at Carnegie-Mellon University, are now aiming to improve their system. Future versions of MPECS will concern other parts of RCA's Caddas design system, and eventually the researchers would like to find a way to run MP2D's output directly into the expert system. That would minimize user errors in interpreting data, thereby streamlining the consultation process. *–Tobias Naegele*

BUSINESS ABROAD

TIMES GET HARD FOR ISRAELI FIRMS

JERUSALEM

Israel's electronics industry, nurtured by the government in an all-out drive to build exports, can't seem to pull out of its current decline. Things have gotten so bad at one major company, Elscint Ltd., that the goverment has had to step in and bail it out. And though another big player, Scitex Ltd., has not yet had to go to the government for a handout, it has just posted record annual losses.

Elscint, a Haifa maker of medical imaging equipment, has been trying hard to recover from fiscal 1985 losses of $33.7 million on sales of $147.6 million [*Electronics*, Sept. 2, 1985, p. 36]. But it has continued to lose money in recent months. Those results have not yet been announced; in its latest quarterly report, for the period that ended last June, the company lost $15.4 million on sales of $31.4 million.

Elscint's continuing losses have led to a major restructuring program, which was given the blessing of Israeli prime minister Shimon Peres. Under the plan, Israeli banks will cancel $80 million of debt out of a total of $180 million owed by Elscint. Another $50 million in debt will be converted from a short-term loan to a four-year loan.

A new president and chief executive officer has also been brought in to help turn Elscint around. Taking over is Benjamin Peled, former head of Elbit Computers Ltd., a profitable maker of commercial computers and military electronic systems. Both Elscint and Elbit are partly owned by Elron Electronics Ltd., a holding company with a stake in more than a dozen local high-technology companies.

Peled, a former Israeli air force commander, has his work cut out for him. He plans a major reorganization and streamlining of Elscint, a move that is expected to entail the firing of several hundred of the company's 2,000-odd workers. This follows last year's layoff of almost 1,000 workers.

All Elscint's product lines will be evaluated for possible abandonment, according to company executives. While they have not ruled out dropping any of the five lines of medical imaging products, the company is not likely to dump any of its magnetic resonance imaging and computerized axial tomography lines. Elscint has recently introduced new products in both these areas.

Scitex, which produces computerized imaging systems used mainly in printing and publishing but also in such other fields as printed-circuit board production and seismic exploration, reported a $13.3 million loss on sales of $132.5 million in 1985, the first red ink in more than a decade. The company attributes its losses to several causes. The government's decision to reduce export subsidies under its July emergency economic program cut into its profits, for one.

Scitex also says its efforts to diversify in automation and seismic-evaluation markets fell short of expectations. In addition, it has had disappointing sales for its Insight system for the transfer of printed-circuit artwork. The company's Japanese subsidiary, a joint venture with Toyo Inc. called Nihon-Scitex, has also failed to hit its sales targets.

BETTER NEXT YEAR. Company officials stress they have not asked for any government aid or restructuring of debt. Chairman Efraim Arazi predicts the losses will continue into the first two quarters of 1986, after which he expects Scitex to be profitable.

Sales for the current year are expected to grow about 20% to $160 million. That is somewhat below last year's 27%

sales increase and far less than the 40% to 50% annual growth the company has experienced in the past.

Officials at Scitex expect a new generation of products—developed over the past 3½ years at a cost of $25 million—to help it move back into the black. These include engineering graphics computers, work stations, and laser-beam recorders. Scitex also has new solid-state color scanners and high-speed laser plotters, improved versions of its existing Vista and Response lines for the publishing and printing industries. They will be introduced in May.

Other measures have been taken to strengthen the company. Arazi says 230 employees were dismissed, bringing the work force down to 1,570.–*Neal Sandler*
McGraw-Hill World News

PERIPHERALS

CHIP HERALDS NEW GENERATION OF POINTERS

OAKLAND, CALIF.

By integrating all the control functions for its Puck pointing device in a single CMOS circuit, an Oakland company has developed a generalized controller chip that addresses points on a cathode-ray-tube screen. The chip, a Motorola 6805-family microcontroller with proprietary firmware, puts out signals that directly control mice, trackballs, joysticks, and tablets as well as the Puck, a typing-key control for moving a cursor [*ElectronicsWeek*, July 23, 1984, p. 26].

The chip heralds a new generation of pointing devices that can be tailored for application requirements and human ergonomics, according to Victor B. Kley, founder and president of Lightgate Inc. Current-generation pointing devices can work only one way. But by using the new chip, a pointer can be dynamically shaped, Kley explains. In other words, the controller and the application software running on the computer can change the operating parameters of the pointer on the fly to make it easier and faster to use. Changing the scaling factor that converts hand movements into larger or smaller cursor movements to suit certain situations would be an example.

When connected to a pointing device, Lightgate's chip translates large hand movements, on the order of 10 mils, into on-screen movements that can be on the order of microns. It works with all Apple computers, including the Macintosh, as well as with Commodore's Amiga and Atari's recent entries.

Lightgate, a metamorphosis of the KA Design Group, which developed the Puck, will market the chip. And it continues to push the Puck as a standard item of computer control. Last week, the company announced a $3 million, three-year agreement with Honeywell Inc.'s Micro Switch Division to put Pucks on Micro Switch keyboards.

Each type of pointing device has its own characteristic output, Kley explains. Optical tablets use an absolute X-Y coordinate system, trackballs and mice use delta signals, and joysticks require a rate mode, in which the cursor attains a velocity and keeps moving when the joystick reaches the limits of its travel.

But a pointing device and associated hardware must also address certain human characteristics, such as fatigue and the limits to the accuracy of small hand movements, says Kley. "To do this effectively, we need to interpose additional commands between the device and the machine, allowing the device to change its characteristics so that the interface is kept optimal."

As another example, Kley suggests that an IC designer might want a sketchpad type of pointer, optimized for freehand movement, for entering a schematic, and then later a rate-type device when performing logic analysis on the same work station. "In that situation, the software would tell the pointer to be a sketchpad when interacting with a schematic and then to be a rate device when the logic comes up."

The changes are implemented on chip with single-byte control, which tells a hardware driver how to shape data from the microcontroller, Kley says. A supplier of hardware to original-equipment manufacturers could implement the control as part of a command system; application-software packagers would use the same command in their software.

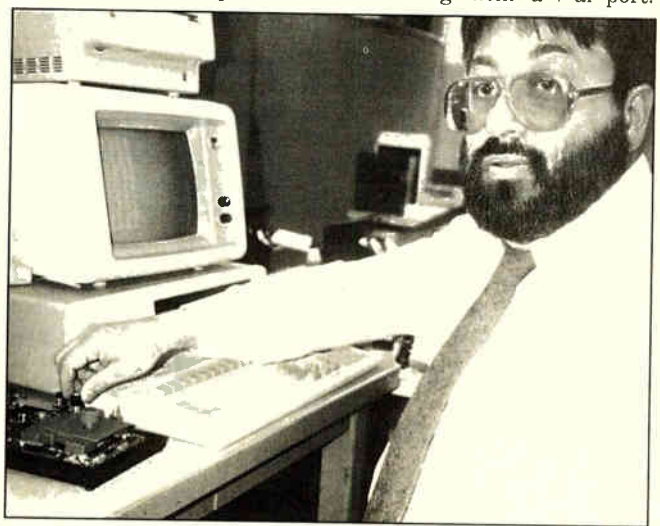
The Lightgate chip is based on a Motorola Inc. 68HC805C microcontroller with 4-K of on-board electrically erasable programmable read-only memory that made it possible to configure and reconfigure controller operation through software during the development process. "Simulation would have been impossible because the system is so time-critical," Kley says.

With EEPROM technology making it possible to test a number of configurations with no cost or time penalty, design of the finished chip took four months, he says. Motorola will act as a foundry for production of the programmed device.

MEMORY SECTIONS. Lightgate divided the EEPROM into eight sections of memory. These sections interpret commands, restructure data from absolute to delta values, determine cursor position from the phase-modulated quadrature signals generated by optical encoders, provide step and rate mapping from the pointer to the cursor, and perform other programmable controls applicable to each class of pointer.

The Motorola chip is a midrange, multipurpose processor with a 2.1-MHz bus speed and 4,160 bytes of EEPROM in two arrays, so that one can be written to as the other is read. An on-chip pump cell generates the 19 V necessary for reprogramming. The chip has three general-purpose parallel ports and one serial port. (Lightgate uses the latter for RS-232-C output.) Motorola charges $100 for a single chip and comes down only $10 for lots of 1,000. For that reason, Lightgate will use the mask-ROM version of its own controller, which sells for $25.

The chip supports 14 bits of resolution (1 part in 16,384) in three axes—though Kley admits that little use has been made of the Z axis so far. "There is an emerging need in work stations for a three-dimensional controller," he says. Beyond that, he sees applications in mechanical design, for rotating coordinates; in paint programs, to vary line thicknesses; and in games, because "you need a Z axis to fly an airplane." –*Clifford Barney*



KEY MAN. Victor Kley founded the company that put control functions for its Puck and other pointers on a single chip.

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INSIDE TECHNOLOGY

SPECIAL REPORT: HOW THE PC IS CHANGING TESTING

THE PERSONAL COMPUTER IS BECOMING THE TEST CONTROL CENTER

by Jonah McLeod

Low-cost computer power, mainly in the form of the personal computer, is dramatically changing the whole world of testing. An entirely new computer-based instrumentation architecture is being created by combining single-board computers with such high-speed standard computer buses as the 50-MHz VMEbus. Tektronix Inc. and Keithley Instruments Inc., for example, are already using this combination to build automatic test equipment for testing high-speed circuit designs.

More and more, the ubiquitous personal computer is turning into a test control center. It's being connected to a chassis full of individual board-level instruments, such as digital voltmeters, oscilloscopes, and pattern generators. The separate chassis ensures a noise-free environment for taking measurements, while a high-speed parallel bus provides a tight coupling with the computer. With this technique, the computer's CRT display becomes the control panel for each instrument.

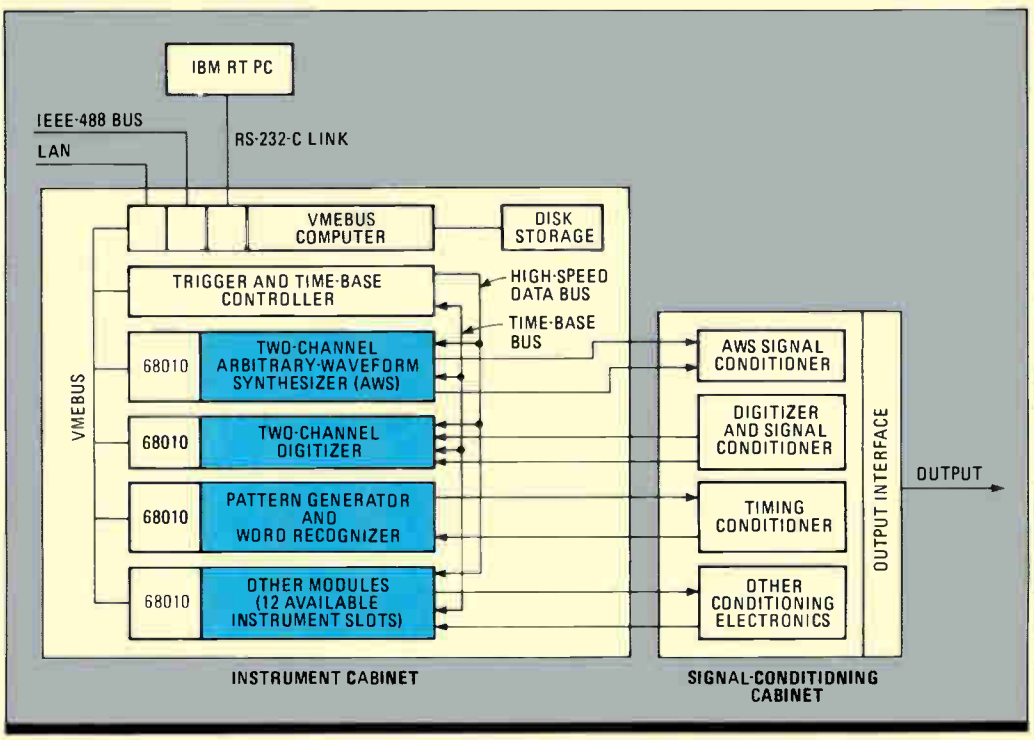
A less radical approach is also taking hold. Stand-alone instruments such as pattern generators, oscilloscopes, and counters are being connected to personal computers through the IEEE-488 bus and RS-232-C serial links. The personal computer does more extensive postprocessing of the data gathered by counters and oscilloscopes as well as provides a more productive environment for creating stimulus patterns for such instruments as pattern generators. But when the computer acts as a central controller and control panel for a chassis filled with board instruments, it can far more effectively coordinate the operation of stimulus-and-response instruments than can a computer tied to discrete instruments through an IEEE-488 bus.

These two approaches to computer-based instrumentation are covered in the first article of this three-part special report.

The second article explores new developments in computer software that are moving hand in hand with the increasing reliance on the personal computer as an instrument controller and data processor. Application programs such as the Lab Tech Notebook from Laboratory Technologies Inc. have greatly simplified instrument data collection. Other programs—Lotus's 1-2-3, for example—have been plucked from their original context and adapted to improve the engineer's ability to analyze data collected from his instruments. And more specialized engineering applications programs such as Asyst and RL/1 are enabling engineers to do detailed statistical analysis—performing fast Fourier transforms on the collected data, for example.

Despite a proliferation in off-the-shelf software, some engineers still prefer to write their own programs. To satisfy these users, new languages are becoming available and old languages are being improved. Aside from Basic, the engineer can now choose from Fortran, Pascal, and C. In addition, new dialects of Basic are emerging—Engineering Basic, for instance—that better serve the needs of the test engineer.

The third article in this package delves into the growing relationship between personal computers and logic analyzers. Matchmakers intent on marrying the two point out that the connection gives the analyzer a direct link to computer-aided engineering systems that contain simulation data used in designing the device under test. The result of this pairing is that the simulation data that is developed for verifying the design



MOD EXAMPLE. Typical of today's computer-based instrumentation is a Tektronix CBI modular instrument system that uses a VMEbus computer to control a variety of plug-in instrument boards.

can also be used to debug the actual hardware.

Using a personal computer as the front end of a logic analyzer means that peripherals such as disk drives and printers that can be connected to the computer now can just as easily be linked with the instrument. In addition, the computer front end makes the logic analyzer easier to use. Programs in the computer direct the operator through elaborate setup sequences that are often forgotten because they are used so infrequently. The connection also gives the test engineer the means to transfer data from the instrument to the personal computer for more detailed postprocessing.

Some engineers, however, are not so optimistic about the success of the computer-analyzer marriage. These detractors say that the analyzer itself is powerful enough to do most of the information gathering and analysis a test engineer needs. The logic analyzer has its own ports for connecting the disk drives and printers typically required by the debugging process. If the test engineer really needs to move data between the two, RS-232-C and IEEE-488 ports on the instrument make the transfer possible.

HOW INSTRUMENTS ARE LINKED TO A PC

As recently as five years ago, instrument automation meant tying stand-alone units to a $10,000 special-purpose computer through the IEEE-488 general-purpose interface bus. Today, thanks to fast-changing computer, instrument, and bus technologies, the test engineer can get a lot more performance for a lot less money.

Now an engineer can follow several paths. He can combine a proprietary bus with a chassis full of instrument boards, controlling the whole setup with an IBM Corp. Personal Computer or a compatible model. Alternatively, he can control stand-alone instruments with an IBM PC, which replaces the costly IEEE-488 controller. Instrument makers have been responding to the increasing popularity of this approach by incorporating enough intelligence into their instruments to take advantage of the personal computer's capabilities.

A variation of the instrument-board approach—Tektronix Inc.'s computer-based instrumentation, or CBI—links a single-board computer (which also eliminates the IEEE-488 controller) and a VMEbus to a chassis full of instrument modules.

In addition, the growing importance of the PC as a controller has yielded a proliferation of controller cards to link it to the IEEE-488 interface.

Instruments tied to personal computers provide the appropriate sequencing and any synchronization needed to make a measurement. The personal-computer-based system provides the intelligence to coordinate the state and timing events, and split screens on the computer's display show the behavior of two different circuits at the same time.

These systems are available for designing both digital and analog electronic systems; in both types, the personal computer provides a common control and display panel and a user interface for single-board instruments that do not have displays and controls of their own. Putting to use a collection of instruments, all controlled by a personal computer, means that the computer can do many of the engineer's time-consuming routine jobs, increasing his productivity.

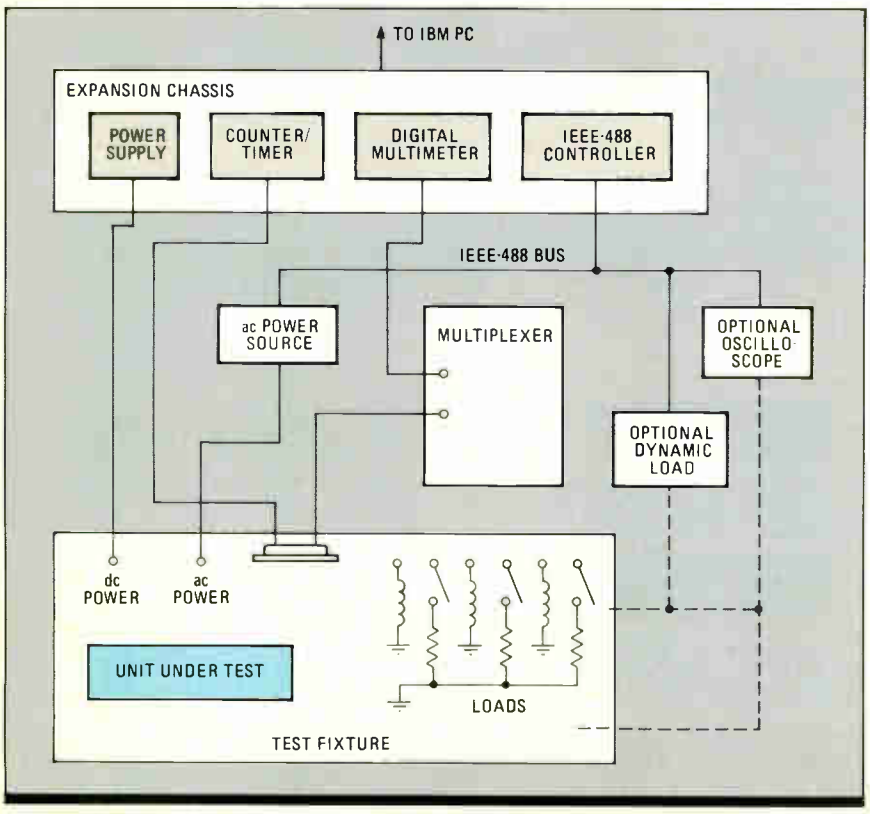
THROUGHPUT UP, COST DOWN

Most personal-computer-based instrument systems have a similar architecture: a personal computer connected to an instrument cluster in a separate chassis through a proprietary bus. Such a bus reduces the $100 price of adding an IEEE-488 connection to each instrument. A plug-in controller card for the personal computer connects the proprietary bus directly to the computer's bus. The connection increases throughput because data is transferred directly from the instruments to the computer's memory.

This idea is not new. Ever since the personal computer first became a common fixture in the laboratory, instrument makers have built chassis with proprietary buses to connect discrete modular instruments to each other and to a separate personal computer. One of the first with such a system was Northwest Instrument Systems Inc., Beaverton, Ore. "We take advantage of the personal computer's low cost and general-purpose processing power," says the company's executive vice president, Michael Maerz. "The computer is used to provide information displayed in a time-correlated way for presentation of the raw data in a form more meaningful to the designer—for example, using a split screen to display two different measurements aligned in time."

Before such systems were available, an engineer debugging a digital system design would use separate instruments that could not trigger one another. In Northwest Instrument's modular system, all the instruments—an emulator, a logic analyzer, software analyzers, state analyzers, timing analyzers, and pattern generators—can be cross-triggered, and the information they generate can be correlated and then displayed on the PC's screen.

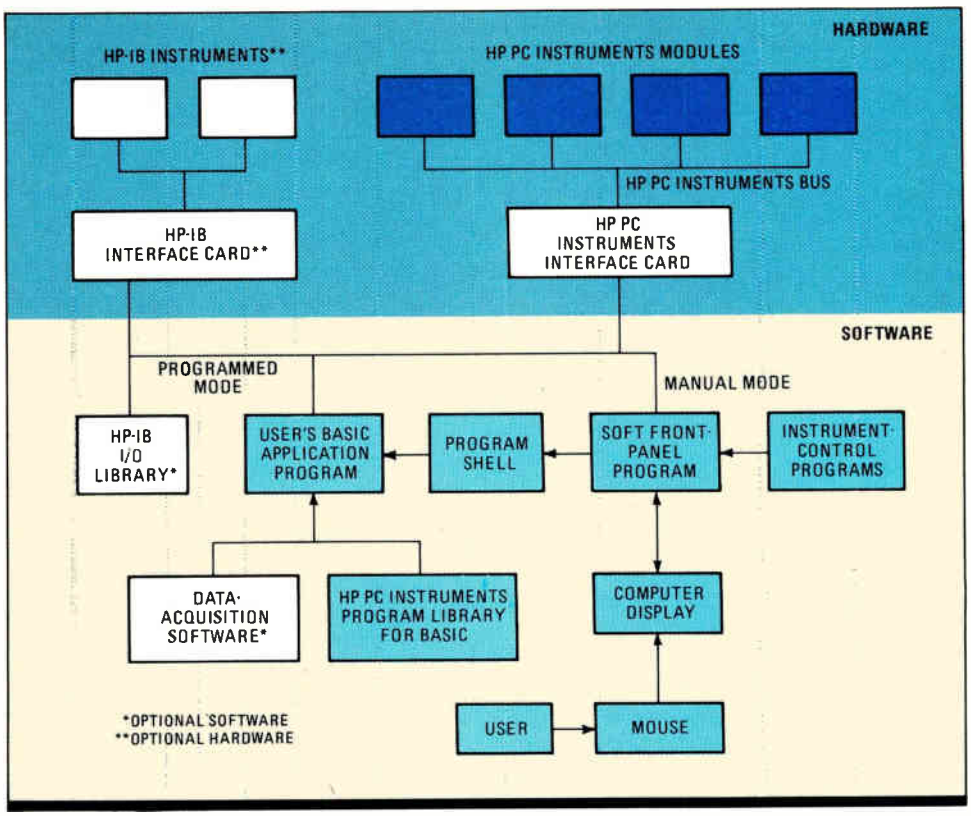
One potential benefit of this capability is that when debugging a microprocessor-



1. POWER PLAY. Vistar's power-supply test set, the series 1000 PC, has a programmable triple-voltage power supply and an expansion chassis for instruments and controllers.

based system, the state analyzer might be attached to the microprocessor bus of the system being debugged. The timing analyzer might be attached to a combination of the microprocessor bus and some of the input/output circuits. In this case, the engineer is trying to correlate which instructions are being executed when certain inputs are coming into the system or certain outputs are being created by the system under test. The test system has two cursors that are displayed on the screen in time alignment. One of them, on the state analyzer, shows the instruction sequence being executed. The other one is on the I/O circuit looking for an interrupt. The designer can see what is occurring in the I/O circuits and the instructions being executed concurrently.

The Northwest Instrument system is mainly for digital design, but there are also systems for the analog designer. The series 1000 PC from Vistar Corp., Tampa, Fla., comes in a seven-slot chassis with a programmable triple-voltage power supply. The chassis holds a low-distortion oscillator, an 11-MHz function generator, a 120-MHz universal counter/timer, and several other instruments and controllers (Fig. 1). Last year, Hewlett-Packard Co., Palo Alto, introduced its PC Instruments line of nine modules (Fig. 2), including a 50-MHz oscilloscope, a 100-MHz universal counter, an 8-channel relay multiplexer, a 4½-digit digital multimeter, and a 5-MHz function generator. The products from both companies connect to IBM PCs.



2. POTPOURRI. Hewlett-Packard's PC Instruments product line has nine instrument modules, including an oscilloscope, a universal counter, a relay multiplexer, a digital multimeter, and a function generator.

For production testing, the HP setup could be used for go/no go tests; the computer, instead of an operator, would make the comparison between the measured waveform and an ideal waveform in computer memory. "PC-based instruments will impact the way measurements are made in a lab automating routine work," says HP product manager Max Trescott. Frequently, an engineer must make a measurement every minute for a certain length of time; formerly, he would make the measurement manually and write the results in his notebook. "Now he can write a program in a few minutes that will free him for more productive work."

NO-NOISE STRATEGY

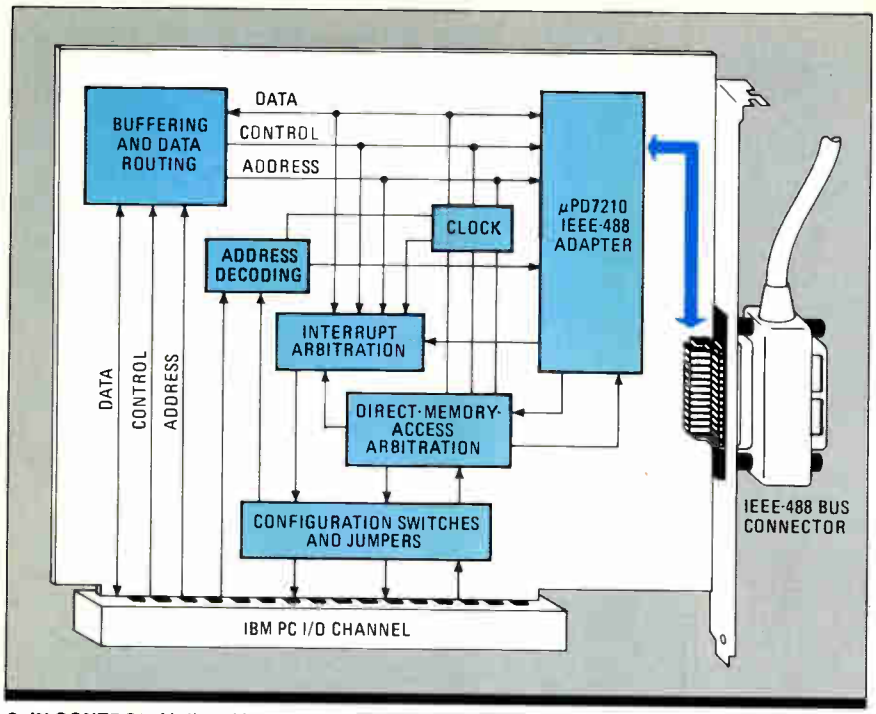
In instrument systems built around the PC, it is valuable to have a separate chassis for the instruments because it creates a controlled environment in which noise cannot affect the measurement. "In an external chassis, instruments are not affected by the power supply inside the PC, nor is the number of instruments limited by the available slots inside the PC," says Scott Goodlisse, sales engineer with Vistar. Instrument systems within a chassis can operate close to the device under test, and there is no need for test cables running from the PC to the device under test. Probes from the instrument chassis close to the device under test are used instead. Connecting the chassis and computer is a high-speed bidirectional parallel proprietary bus. The controller's processor, which is inside the instrument cabinet, has a map into the PC memory.

On the series 500 Scientific Workstation from Keithley Instruments Inc., Cleveland, the bus is an extension of the PC bus. Though primarily a data-acquisition system, the series 500 architecture is similar to PC-based instruments. A plug-in interface card connects the instrument chassis to the PC bus with a ribbon cable.

The HP PC Instruments use a similar ribbon cable between PC and instruments. HP is calling the cable the PC IB. "PC IB is an optimum combination of cost and performance for personal computers," says Trescott. Instrument cost is reduced by the amount saved by not having to add power-hungry chips and cabling to implement the IEEE-488 interface. "For a $650 instrument, adding $100 for a cable and another $200 or so to connect to the IEEE-488 is not practical," Trescott says. "In designing our product, we looked at the other low-cost alternatives—RS-232-C and HP IL [an HP interface loop], but the speed of the HP IL was prohibitively low for the application, and RS-232-C does not provide the isolation required between PC and instrument. We created the PC IB, which is cost-effective but still provides high data rates as well as isolation from the computer."

In the PC Instruments system introduced early last year, an interface card plugs into one slot of the PC. On the interface card is a standard 25-pin connector. A ribbon cable attaches to the connector and runs to the first instrument. From there, the ribbon cable forms a daisy-chain connection to as many as eight other instruments. There are two links on the PC IB bus—a high-speed parallel link and an isolated slower-speed serial link. Depending on the instrument being used, one or the other of the links is active, transferring data. The computer determines which of the two links to use.

Despite the power and economy of these personal-computer-based instrument systems, there is still a big market for stand-alone instruments controlled by personal computers. IEEE-488 controller cards inside the personal computer are replacing dedicated IEEE-488 controllers in three out of four systems, and a cornucopia of third-party hardware and soft-



3. IN CONTROL. National Instruments' GPIB-PC2A is a typical IEEE-488 instrument controller that supports up to 14 instruments on the bus. It also has an IBM PC input/output channel.

ware and more powerful personal computers such as the IBM Corp. RT PC ensure that the trend away from dedicated controllers to general-purpose machines will continue. Most instrument makers, therefore, have begun to build in accommodations for the PC. Some write PC-compatible floppy disks, and others are adding more intelligence to the instrument to facilitate interaction with the computer.

PLENTY POWERFUL

When Northwest Instrument got started, the PC was criticized as not powerful enough to be an effective instrument controller. But with such computers as the PC AT and the reduced-instruction-set RT PC, that argument is no longer valid. Only about 7% of instrument systems used an IBM PC as a host in 1984, says instrument industry consultant Gary Brock, Menlo Park, Calif.; in 1985, that figure rose to 60%. "The instrument supplier in this environment is faced with a problem," he says. "Should he build his own intelligent controller or build his equipment to work with the PC? Using a 68000 microprocessor chip, most instrument makers could build a controller more powerful than the IBM PC AT, but it would cost more than the AT." Moreover, the instrument supplier could not match all the third-party software and hardware offerings now available for the PC.

For example, the RS-670 word generator from Interface Technology Inc., Glendora, Calif., combines RS-232-C communications capability with an IBM-compatible floppy-disk drive. This allows the designer to program a stimulus pattern for the word generator on the PC, store it on the floppy disk, and load the disk into the word generator's drive.

The Model 320 oscilloscope from Nicolet Instrument Corp., Madison, Wis., accepts ideal waveforms from the PC through either RS-232-C or IEEE-488 communications links for comparison with actual waveforms being measured. In addition, the scope can become the digitizing front end to a data-analysis system. The computer can arm the oscilloscope, and the scope can grab the desired data and return it to the PC. After processing the data, the PC can send a waveform to the scope display for the test engineer to examine. A similar capability exists in the new VP-5704P digital oscilloscope from Panasonic Industrial Co., Secaucus, N.J. The scope comes with three 10-K-word memories to accommodate waveform storage.

The PM 3360 waveform analyzer from Philips Test & Measuring Instruments Inc., Mahwah, N.J., has five on-board microprocessors. With that much processing power, it can perform extensive analyses, such as fast Fourier transforms, correlations, integrations, and differentiations, without an external controller. After local processing, the results can be sent to a computer for further processing; because only results are sent, communications time between the smart instrument and the computer is shortened considerably.

Communications time is also being reduced by simplifying the command string between the PC and the instrument. On earlier instruments of this type, a long string of commands was needed to initiate some operations; on the Keithley model 194 digital multimeter, for example, the command string has been reduced to a command word and one variable. On the model 1998 1.3-GHz frequency counter from Racal Dana Instruments Inc., Irvine, Calif., there is a single-key nulling capability that can be transmitted through the IEEE-488 bus. The null capability is useful for establishing standard frequencies for highly accurate monitoring of frequency drift.

At the very high end of the price/performance spectrum is Tektronix' CBI approach, which combines a VMEbus and a single-board computer. This system can simultaneously trigger every instrument in a cluster with 100-ps accuracy, whereas IEEE-488 instruments can be triggered with only millisecond accuracy. In addition, using the 50-MHz VMEbus means data transfers are 50 times faster than on the 1-MHz IEEE-488 bus. Significant intelligence on each instrument and controller means that much higher-level commands can be issued, which eliminates the tedious setup and coordination required of the test engineer using the IEEE-488 standard.

"The advent of the VMEbus has revolutionized the way automatic test equipment is being built," says Ron Ruiz, general manager of Keithley's Data Acquisition & Control Division. "In a large aerospace company such as Grumman Aerospace, the instruments used to check out the avionics in an aircraft are contained in many racks of test equipment." These large users have wanted instruments on boards that can be plugged into some kind of standard architecture so the racks of equipment can be reduced in size and cost. The VMEbus promises to do just that. Keithley has an ATE system built on the VMEbus that tests semiconductor wafers.

Tektronix' proprietary CBI architecture contains a VME computer as a controller and several instrument modules such as a digitizer, an arbitrary waveform synthesizer, a pattern generator, and a word recognizer. The VME computer's function is to run an operating system and applications software. It maintains the file system, accepts commands from the user, sends the commands to the right instruments for execution, and performs data processing on data going to an instrument module and on data coming from a module.

Part of the CBI architecture defines the TTC (trigger and time-base controller). It consists of three connectors to three buses. One is a dual 50-MHz buffered VMEbus. The on-board intelligence of the various instruments can be programmed over this bus. Trigger signals and the time base for all the instrument modules are sent from and received by the TTC through the second connector and the 50-MHz time-base bus.

The TTC triggers and sequences the instruments on the timebase bus with a 100-ps timing resolution. On the third connector is an optional high-throughput data bus, also managed by the TTC. It is a 32-bit 50-MHz bus with 200-megabyte/s throughput, and it is implemented only on modules, such as a digitizer, that require real-time data. The TTC can send data between modules or give all modules access to the same data.

Tektronix wants to make CBI an open systems architecture, but it hasn't published its command set yet: "We might have to modify some of the command syntax," says Arnie Frisch, general manager of computer-based instrumentation. "If we published the set now and had to modify it later, we would end up with a whole set of incompatible versions, just like IEEE-488 did." For now, the company has given the command set to parties who can help get the bus adopted as a standard.

With CBI, Tektronix is trying to establish a more functional high-level interface than IEEE-488, which is only a communications bus with no established protocol. The user issues a command in the high-level language to make a measurement, and the instrument takes the command apart and does all the low-level operations automatically. The commands in this protocol automatically generate the delays needed by each instrument to set up before each measurement is made. Firmware in each instrument handles this protocol.

CONTROLLER CARDS IN DEMAND

One fallout of the trend away from dedicated controllers and toward personal computers is the growth in demand for controller cards, such as those made by National Instruments, Austin, Texas, that connect the PC bus to the IEEE-488 interface. "One reason that the PC is replacing a dedicated controller is that the $2,000 to $5,000 price tag of a PC is in the sign-off range of most engineers," says Ron Perry, national sales manager of Pulse Instruments Co., a bench-instrument maker in Torrance, Calif. "Purchasing a $10,000-plus controller needs the approval of higher management." The controller plugs into the PC bus and acts as a talker and listener on the IEEE-488 bus. Thus commands from the PC to set a digital multimeter range get sent to the DMM's controller card. Data from the instruments moves through the controller to the PC memory, where it is processed.

The IEEE-488-controller market will be worth $207 million this year and is growing 30% annually. At an average price of $5,000, about 41,400 units will be shipped in 1986. Don Nadon, vice president of sales and marketing at National Instruments, says that 75% of those units will be personal computers.

A typical instrument-controller card, such as National Instruments' GPIB PC (Fig. 3), will include an NEC Corp. μPD7210 GPIB monolithic talker/listener controller chip, which supports up to 14 instruments on the IEEE-488 bus. This, and similar IEEE-488 cards from Tecmar Inc., Solon, Ohio, and Metra Byte Corp., Stoughton, Mass., implement the full range of talker, listener, serial and parallel polling, service requesting, and remote programming functions.

Though it may appear that a test engineer cannot get along without a computer tied into his instrument, there is no reason to believe the computerless stand-alone instrument is dead. Claude Roux, national sales manager of Interplex Electronics Co., New Haven, Conn., puts it this way: "There is always going to be a need for a test engineer to make one simple measurement, and he isn't going to want to set up a computer system to do it. He's going to pull out an instrument, stick the probes at the appropriate test point, and make the reading. So much for computer-controlled instruments."

SOFTWARE SPEEDS AUTOMATED TESTING

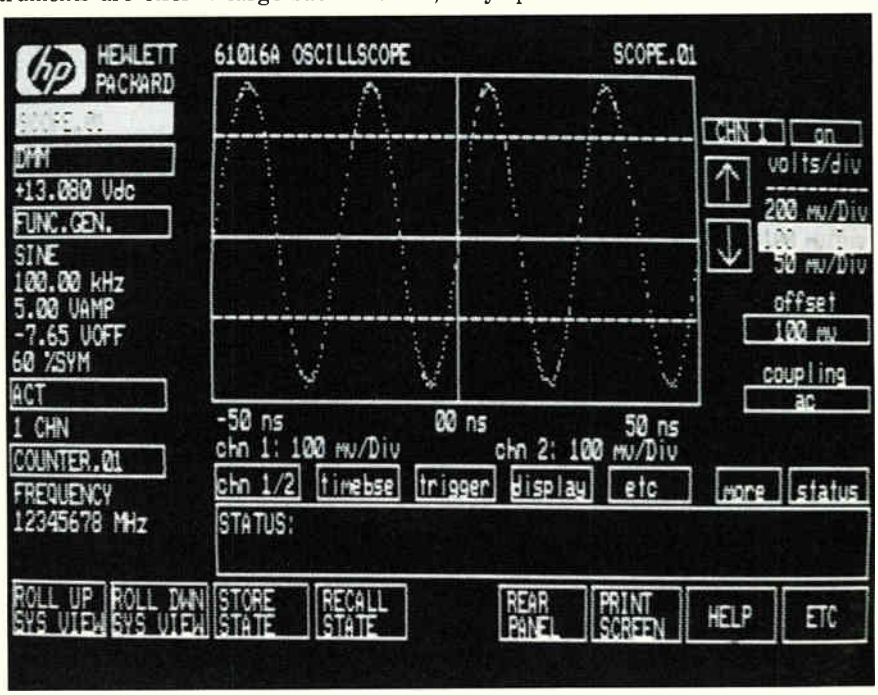
A tidal wave of new software products is making personal-computer-controlled instrument systems smarter than ever. Even popular and readily available business software such as 1-2-3, the spreadsheet program, is now being used in measurement analysis. The users of personal-computer-controlled instruments can also draw upon a flurry of new data-acquisition programs. If they want to write their own applications software, some makers of smart instruments are offering more programming languages than the usual Basic.

Also showing up now are instrument-control handlers and packages that make the add-on instruments to a personal computer easy to use. Another significant improvement in data-acquisition and -analysis systems is the addition of multitasking software to manage simultaneous foreground and background processing.

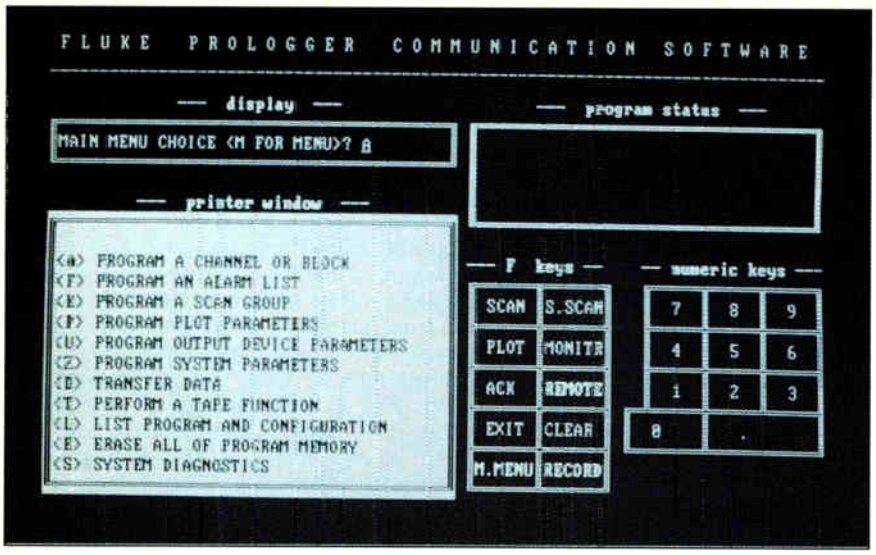
Now that computer-based instruments can gather large amounts of data, engineers need help in manipulating the data. To help meet this demand, the newest data-acquisition software provides data in formats that can be easily used by such personal-computer programs as 1-2-3 from Lotus Development Corp., Cambridge, Mass., and Asyst from the Macmillan Software Co., New York.

The software package most often accommodated is Lotus's 1-2-3. It can manipulate data, format reports, and create graphs, and these attributes are just as useful in the lab as they are in the office.

One well-known data-acquisition program that was adapted to 1-2-3 is Lab Tech Notebook from Laboratory Technologies Inc., Cambridge. "We decided to develop a user interface that was similar to 1-2-3 because it was familiar to a large base of users," says president Fred Putnam. Now the



1. THROUGH THE WINDOW. The user-interface software on HP's PC Instruments is based on windows. For example, the main window can display a waveform from an oscilloscope.



2. EASY DOES IT. Fluke's ProLogger communications software on a PC makes it easy to program the 2280 Data Logger. Part of the screen matches the instrument's front panel.

data acquired in Lab Tech Notebook can be moved over to 1-2-3 for data analysis.

Another example is the LTN488 from National Instruments of Austin, Texas. This utility program processes raw data into a form that 1-2-3 can use. Soon, the two programs will be merged into one package, enabling a test engineer to acquire data, do analysis, and write reports using 1-2-3.

A similar package, called Lotus Link, is available from Northwest Instrument Systems Inc., Beaverton, Ore. The information that its instruments gather is reformatted so that it can be used by Lotus's 1-2-3 and Symphony, a spreadsheet that integrates data-base management and communications capabilities. A user preparing documentation using a word-processing package on the IBM Corp. Personal Computer can now incorporate instrument-acquired data directly into reports. Or he can use the Symphony data-base manager to do selective query and retrieval of the information. He can also write his own program to process the collected data in any way he chooses.

Another analysis package finding favor on instrument systems is Macmillan Software's Asyst, based on keywords that call up subroutines. For example, the Autoplot command takes data from the computer and displays it on the screen, complete with correctly labeled axes. Asyst also performs fast Fourier transforms, three-dimensional plotting, and other engineering math functions.

Part of its power comes from using an 8087 or 80287 coprocessor on either the IBM PC, the PC AT, or the Hewlett-Packard Co. Vectra personal computer. "With this combination of hardware and software, the test engineer has the power of a minicomputer in a package priced at much less," says Rick Van Ness, HP product manager for test software for the New Jersey Division in Rockaway. HP sells the combination for less than $7,000, whereas a minicomputer setup would cost about $20,000, Van Ness says. "The designer can do a 1,024-point FFT in just over 2 seconds," he says. "It might take over 30 seconds on a personal computer without Asyst and the coprocessor board."

The company has contracted with Macmillan to distribute a version of Asyst tailored for some of HP's products—including PC Instruments, a collection of instruments that tie into the Vectra. "Asyst is strong on the analytical side, strong on data analysis, statistics, graphics, and instrument control for both PC Instruments and GPIB instruments," Van Ness says.

Before data can be analyzed by programs such as Lotus's 1-2-3 and Asyst, it has to be gathered from the measuring instrument. Several programs for data acquisition are available—including Lab Tech Notebook, which now supports instruments from 21 hardware suppliers.

With this program, a string of characters making up a single reading from the instrument is presented to the instrument controller. The string of characters is placed in the controller's memory in one transfer, and thereafter the Notebook software parses the string, extracts the relevant data, and puts it in a buffer, which is then accessed by the application program, such as Asyst.

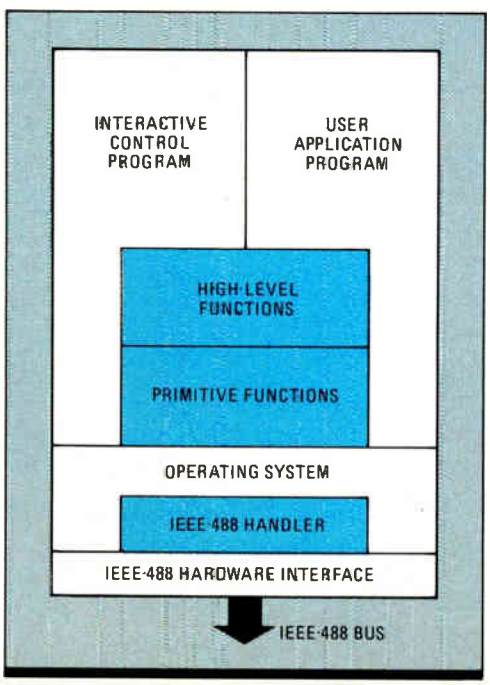
Another easy-to-use application program comes with the Series 500 data-acquisition system from Keithley Instruments Inc., Cleveland—the Soft 500 data-acquisition software, which runs on personal computers. Soft 500 is available to the programmer through about 40 commands that are invoked as subroutine calls in Basic. Each subroutine is a single command—for example, Acquire—and a parameter list that specifies which input/output port to use to collect data, how many samples to take, how fast to take the readings, and so on. The commands are compiled down to machine code for faster execution.

Instrumentation software may be available in abundance, but some engineers still prefer to write their own. If they are working with personal-computer-based systems, they find that the language most commonly offered is Basic, because it is the one programming language always provided on the IBM PC.

"The problem with standard PC Basic is that it is not oriented toward engineering applications," says Don Nadon, vice president of sales and marketing at National Instruments. The company recently began offering Engineering Basic, a version of the language with capabilities that engineers will find useful, such as trigonometric functions and plotting.

In addition, National and rivals such as Metra Byte Inc. of Stoughton, Mass., are offering other languages as standard with their IEEE-488 controller boards. Fortran, C, Pascal, and assembly language are common, with Turbo Pascal and a Basic compiler also available.

Another class of programs that makes personal-computer-based instruments easier to use is control software. It



3. PC 488. Typical of instrument software to make a PC an IEEE-488 controller is the GPIB PC-DOS package from National Instruments.

comes in the form of what are called handlers—routines that control specific instruments—and interface routines for high-level-language programs.

For example, the system software for HP's PC Instruments presents the user with a control system based on a multiwindow display on the screen of the Vectra or IBM PC. The main window in the display (Fig. 1) shows the data being collected from one of the instruments in use. A system view occupying the leftmost window of the display summarizes the activities of other instruments being used. Across the bottom of the display are system-control soft keys, activated by function keys on the computer.

Another example of a handler is the ProLogger from the John Fluke Manufacturing Co., Everett, Wash. This communications software lets a personal computer control the company's 2280 Data Logger instrument. The operator can program applications in Basic or have the software provide prompting messages on the display that will lead him through direct program generation without the use of Basic (Fig. 2). In this mode, the personal computer's screen resembles the Data Logger's front-panel display.

Manufacturers of plug-in boards are providing cards that convert the IBM PC into an IEEE-488 controller, and add-on instrument manufacturers are tying their instruments to the PC. Now these companies are providing software on the PC to make their hardware easy to use.

A typical product is the GPIB PC-DOS package from National Instruments, which provides communications and bus-management functions (Fig. 3). The IEEE-488 portion of the software implements the 30 or so IEEE-488 functions, such as input, ouput, set range, and power break. Interface subroutines link the GPIB PC-DOS handler to the application program written by the test system designer or to standard data-collection software. The high-level and primitive functions on top of the operating system automatically handle most of the communications protocol needed to manage devices on the bus. The interactive control program allows the test-system operator to issue IEEE-488 interface commands from the keyboard.

DOING DOUBLE DUTY

One trend in instrumentation software is to perform more than one function at a time. "One of the significant additions we made to the Lab Tech Notebook product was to add foreground/background capability," says Fred Putnam of Laboratory Technologies. "It's a two-task multitasking system, driven by real-time interrupts, with the background task having the highest priority in the system." In the background, the engineer can start collecting data. He can then go into foreground mode and start executing another application. Data collected in the background can be moved into the foreground task, and analysis can begin on the newly arrived data.

Keithley's Soft 500 software package also has a foreground/background mode. As in Lab Tech Notebook, data acquisition occurring in the background is tied into a nonmaskable interrupt on the personal computer. Thus it has top priority on the system. In the foreground, the data is being processed—displayed on the screen, manipulated on the personal computer, and graphed on screen.

PC EXPANDS THE USE OF LOGIC ANALYZERS

One of the more popular mergers to develop so far in automated testing is between the personal computer and the logic analyzer. Pairing the two makes sense for several reasons. It makes the analyzer easier to use, peripherals such as disk drives and printers can be added to the analyzer, and the logic analyzer can be connected to a computer-aided-engineering system.

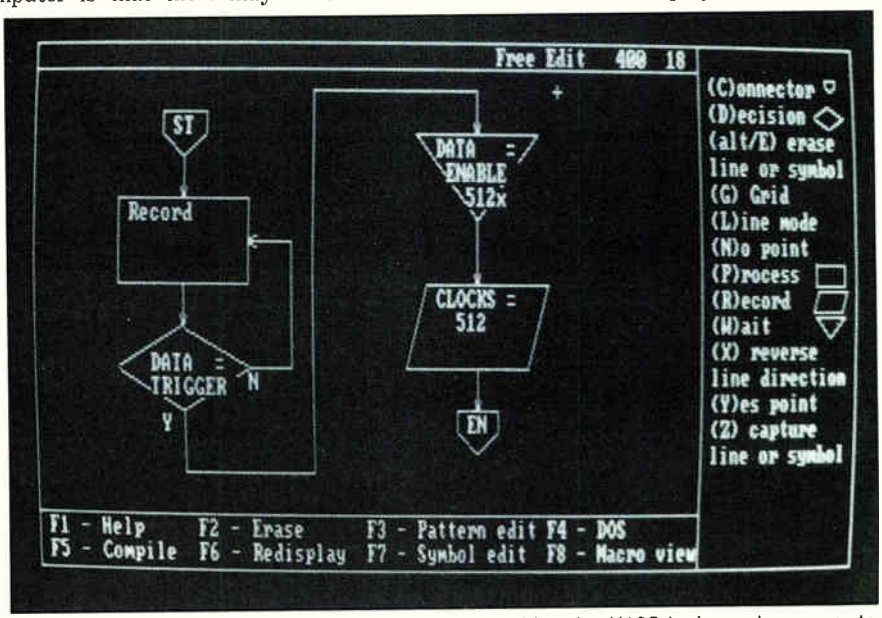
The personal computer is a good way to simplify logic-analyzer operation and to overcome one of the greatest barriers to wider use of these instruments. "A plus in controlling the logic analyzer from the personal computer is that the engineer has become familiar with the personal computer screen," says Mike Maertz, vice president of marketing at Northwest Instrument Systems Inc., Beaverton, Ore. "He does not have to learn the logic analyzer interface to be productive."

Being productive with a logic analyzer means processing the data gathered by the instrument to determine how and where the circuit, system element, or software program under test is failing. Even a personal computer can do extensive postprocessing of data captured by a logic analyzer.

However, this marriage is not without its detractors. Some engineers maintain that the link is unnecessary for many applications (see "Some don't want to link PC with analyzer," p. 38).

For example, the perspectives capability of the Series III logic analyzer from Kontron Electronics Inc., Mountain View, Calif., allows the operator to display on the personal computer screen combinations of synchronous, asynchronous, and high-speed data. A synthetic timing diagram that is based on a previously recorded time stamp can be overlayed on the analyzer's display in order to correlate the different perspectives.

"Once the logic analyzer captures data from a design being debugged, it can disassemble the code," according to Paul Hoy, applications engineer at Kontron. As an alternative, the designer can move the data to the personal computer for disassembly and for other postprocessing that is not implemented on the logic analyzer. "For example, he may need to reformat the data to display it in a more



SETTING UP TESTS. Gould's Smartpak software enables the K105 logic analyzer user to generate flow charts on a personal computer to depict the analyzer triggering function.

convenient form for him, to tie in symbols with the data."

Another data-reduction task comes in searching for errors in instructions. With a personal computer, the designer can search the state listing for words or sequences of up to 16 words. He or she will quickly find multiple-byte instructions, even in very long data streams.

In addition, a personal computer can run performance-analysis programs or logic analyzer data to determine what part of a program is used most often. The results can be shown as a histogram, a help in pointing out bottlenecks in software design.

SETUP AID

The personal computer also can help the engineer set up the logic analyzer for various measurements. "The instrument manufacturer can write sophisticated software routines to help the test engineer perform trigger setup" using a personal computer, says Marvin Russell, digital test equipment product marketing manager of Philips Test & Measuring Instruments Inc., Mahwah, N.J.

A personal computer can help with even the simplest of logic-analyzer operation. "Our market research showed that test engineers perceive logic analyzers as difficult-to-use specialized tools," says Jiten Kumar, marketing manager at Gould Inc.'s Design and Test Systems Division, Cupertino, Calif. "We determined that 'difficult to use' meant difficult to set up for making a measurement."

Gould once used English mnemonics to help the designer master a setup sequence. The designer would use English terms to describe the flow data and mnemonics of up to five characters to specify a trace sequence. Now, however, Gould uses symbols instead of words to describe the flow of data. "We found that engineers are familiar with the symbols commonly found in flow-charting a problem," Kumar says. "We decided to use the symbols instead of menus to set up the logic analyzer."

This capability is offered by Gould in a personal-computer software product, called Smartpak, for its K105 logic analyzer. Smartpak is designed to simplify the development of custom test procedures. When the engineer initiates the program, he sees a collection of symbols on the screen that resemble flow chart blocks (Fig. 1). He connects symbols to perform the triggering needed to isolate his design bug. When the flow chart is complete, he sends it to the logic analyzer through an RS-232-C or IEEE-488 link. The instrument decodes the flow chart into the appropriate setup commands.

A good reason for coupling a logic analyzer to a personal computer is to add peripherals to the system. A personal computer is ready-made for this purpose because there are many printers, plotters, and other peripherals available for them. The two peripherals that the designer usually needs to connect to the logic analyzer are a printer and a mass storage device, such as a floppy- or hard-disk drive.

One important application in which the peripherals connection comes into play is when an engineer is troubleshooting a design bug. For such detective work, he may find it advantageous to view a series of events collected over time. With the personal computer and instrument set up in a "baby-sit" mode, a mass-storage device can collect a series of machine states over time, and a printer can be used to record the information. With the data listed on a printout, the designer can see elements interacting in various parts of a large program.

MAKING CONNECTIONS TO CAE SYSTEMS

Design engineers find it useful to connect logic analyzers to a CAE system. When it is time to debug a hardware design, the engineer may want to transfer to the analyzer data from the CAE system's simulator. The analyzer compares the actual hardware's performance to the simulator's ideal representation of the output of the circuit with a certain stimulus applied. Once he has captured the behavior of the circuit from the logic analyzer, he may want to transfer that back to the computer for further analysis.

Such a connection is not commonly supported on the logic analyzer, however. But nearly every CAE system interfaces to a personal computer. To make the connections with a logic analyzer requires special software drivers for each different brand of logic analyzer.

In fact, "the primary application for our connection with personal computers is to download files containing stimulus test patterns created on a CAE system or upload files from the analyzer to the CAE system's computer for postprocessing," says Bob Delp, applications manager for Dolch Logic Instruments Inc. The San Jose, Calif., company's Atlas 9600 logic analyzer mainframe has IEEE-488 communications capability that allows the designer to connect the logic analyzer to a personal computer. Dolch offers software called Move-it that allows the user to transfer data between the personal computer and analyzer.

Many logic analyzer users want a link between their instruments and the mainframes or minicomputers on which they develop CAE software, says Charles Wiley, operations manager for Tektronix Inc.'s Logic Analyzer Division in Beaverton. "Using a personal computer as a large interface port to other computers might appear to be overkill," he says. "But the low cost of a personal computer and the fact that the interface between it and most any other computer system already exists, makes it very cost-effective." Also, the engineer can use the personal computer for any of the available personal computer applications he desires. □

SOME DON'T WANT TO LINK PC WITH ANALYZER

Some instrument manufacturers see no need to tie personal computers to logic analyzers. "Most of our logic analyzers are sold into research and development labs, and they are not controlled by computers," says Doug Fryman, product manager for logic analysis at Hewlett-Packard Co., Palo Alto. HP customers find a stand-alone instrument can handle their analysis tasks without any help, he says.

Also, it's harder to share a logic analyzer that must be tied to a personal computer than it is to share a stand-alone analyzer. "From our market research, we found that three to four users use each logic analyzer sold," says Jiten Kumar, marketing manager at Gould Inc.'s Design and Test Systems Division in Cupertino, Calif. Switching such an instrument from one user's computer to another is cumbersome.

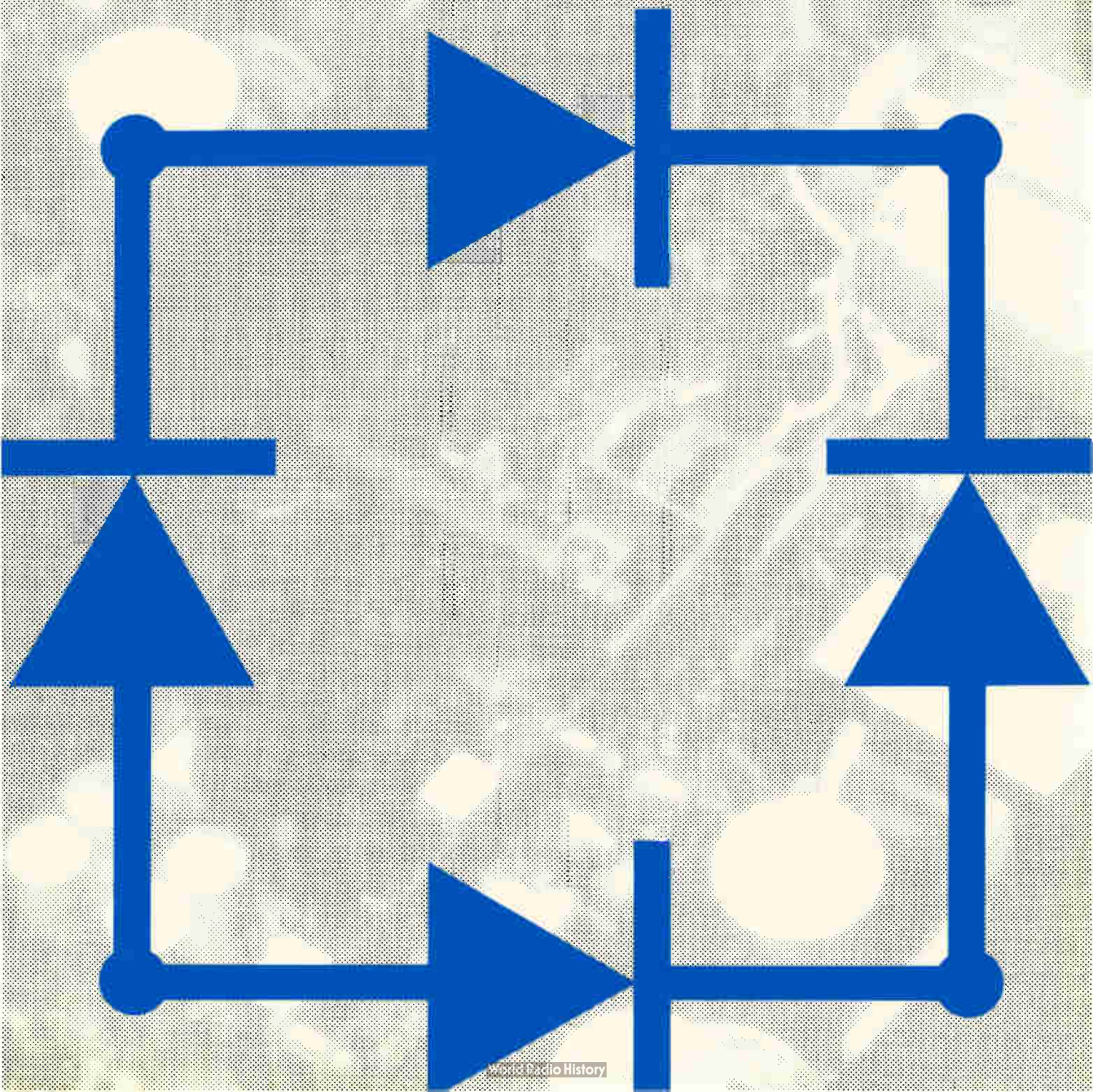
HP's Fryman agrees it is important to connect peripherals to the logic analyzer but says it can be done without adding a computer. "The HP logic analyzer family already has an IEEE-488 port and support software that enables the instrument to use any peripheral that can be attached to the IEEE-488 bus."

A number of peripheral devices can be connected to a logic analyzer, such as a disk drive for data and instrument-setup configurations. Disk storage can also be used for disassemblers employed when the instrument is debugging a computer-based system. The results of the disassembly can be shown on the analyzer's screen. HP's disassemblers are on 3½-in. disks; other manufacturers, such as Tektronix, put the disassembler for a particular microprocessor in read-only-memory packs.

On many analyzers, a printer can be linked to the same IEEE-488 port as the disk drive. The logic analyzer produces a setup menu for the operator, who uses it to tell the instrument that a disk drive and a printer are attached to the port. He can print either the contents of the analyzer's screen or the entire contents of the instrument's memory.

Electronics SPECIAL ADVERTISING SECTION

POWER SUPPLIES



POWER SUPPLIES

SUPPLY MANUFACTURERS ADD FEATURES, BROADEN LINES TO MEET RENEWED DEMAND

An increase in demand from makers of communications and military equipment this year should get the market for power supplies soaring again. U. S. noncaptive consumption of switching power supplies will jump 11.5%, according to the 1986 *Electronics* Market Report, and the result will be a $649 million market. A longer term study published in 1985 by Salzer Technology Inc., Santa Monica, Calif., projects a market for noncaptive switching power supplies of nearly $2.84 billion by 1989. About half those sales will be standard off-the-shelf products, the study indicates; the other half will be custom-designed items.

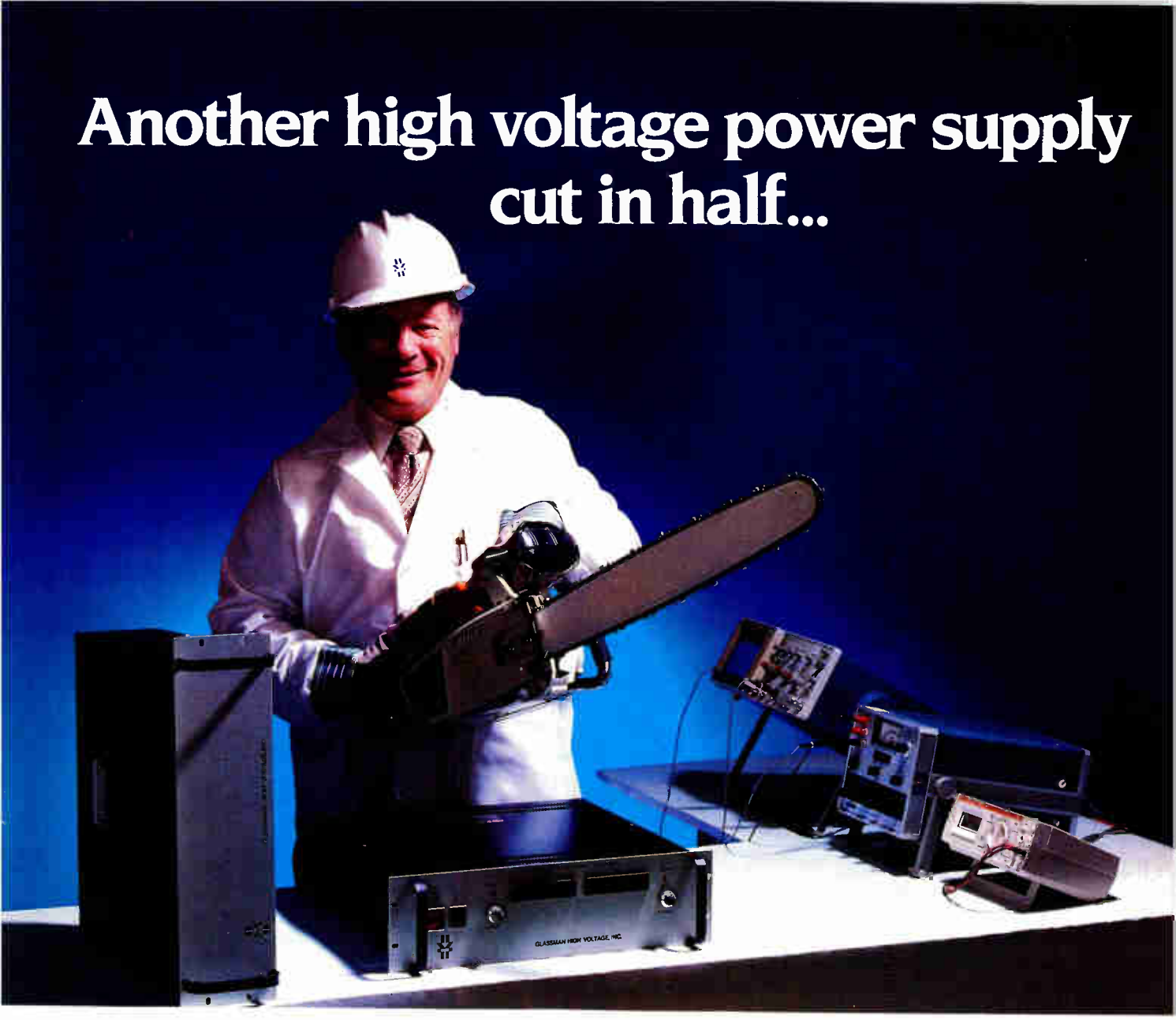
Among linear power supplies, programmable and industrial products (those rated at over 1 kW with regulation no better than 0.1%) will grow in dollar sales to reach a combined 1986 market of $166 million, according to the *Electronics* survey. Overall, the market's linear segment should rack up sales of $386 million in 1986.

One of the biggest buyers of power supplies is the military. Frost & Sullivan, the New York market researcher, projects sales to the military alone of $1.38 billion in fiscal year 1988, more than twice 1983's value. Aircraft is the largest subsidiary market, and military aircraft made in the U. S. then sold to foreign countries accounts for much of these sales.

The military is more than a very large market for power supplies—it is also a stable one. The commercial market has

Kepco's talker-listener device uses the high-level Control Interface Intermediate Language to communicate with up to 16 of the company's ATE Power Manager or BOP programmable power supplies at once. The parts are linked through an IEEE-488 bus.

Another high voltage power supply cut in half...



The WH Series...500 watts, 1/2 the space, 1/2 the weight, and we even cut the price!

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Circle 41 on reader service card

seen price reductions from time to time, but in the military segment prices have remained fairly strong. Power supplies must meet stringent standards for safety and electromagnetic radiation. As a result, high reliability with value-added features are becoming more common among new products.

Power-supply designers can choose from a number of application-specific integrated circuits geared to improving the reliability of the product, including soft-start chips, overvoltage and overtemperature devices that combine MOS and bipolar technologies, pulse-width modulators, input-isolation circuits, ac-to-dc converters, and a variety of voltage and current regulators.

Lots of products

Kepco Inc., a longtime manufacturer of precision programmable dc power supplies, has a broad range of products, including an interface for mating controllable power supplies to computer controls. The talker-listener device, called the TLD, communicates with computer controllers using the high-level Control Interface Intermediate Language (CIIL) over an IEEE-488 bus. CIIL, which uses commands given in English, has been chosen by several makers of automatic test equipment and is being used in the U. S. Air Force's Military Automatic Test Equipment program.

In the TLD, communication in CIIL contains verbs forms such as "set volt" and queries such as "status" that elicit a response if the power supply cannot execute the command. The device recognizes and responds to CIIL commands using a built-in Intel Corp. 8088 central processing unit to drive field-installable analog cards, each of which handles up to four independent power supplies.

In turn, the TLD accommodates up to four of these plug-in cards, so the entire system can issue commands to and receive information from up to 16 of Kepco's programmable power supplies at once.

Kepco initially introduced the TLD for use with the unipolar models in its ATE series of Power Manager linear supplies—40 products ranging from 50 to 1,000 W and from 0-6 to 0-150 V. The addition of a plug-in card adapts the device for use with the company's bipolar power supplies, which range from 50 to 400 W.

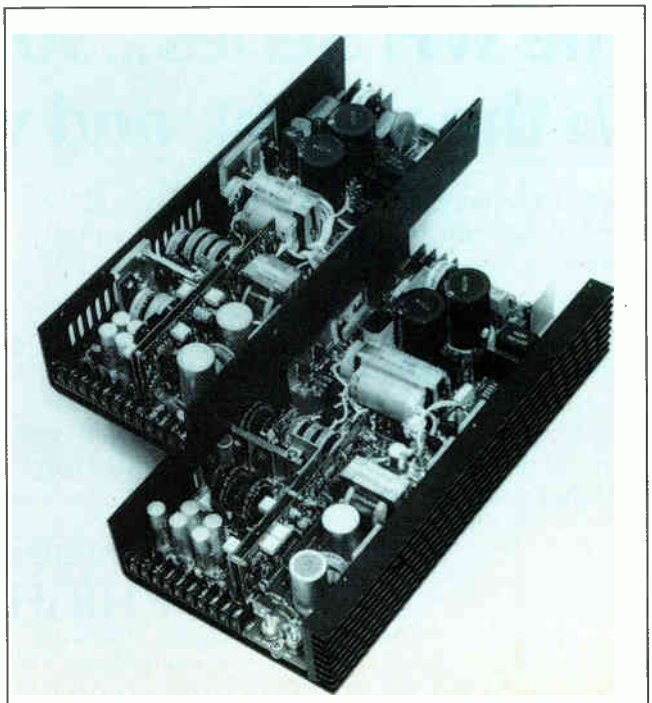
The Flushing, N. Y., company is also keeping up with demand for power supplies with very tight specifications. Like the rest of the Power Manager family, the ATE 325-0.8M offers full external control over both voltage and current, with automatic crossover. This product, however, puts out 0-325 V, 0-0.8 A dc. Its entire voltage and current range is programmable, either locally through front-panel rheostats or remotely through a fixed-gain amplifier scaling from an input of 10 V to the rated voltage. Digital input with an IEEE-488 bus is possible with a Kepco digital interface programmer.

In addition, users of the ATE Power Manager series can select either a slow or a fast mode of operation. In the slow mode, large output and feedback capacitors reduce output noise to stabilize voltage. In the fast mode, those capacitors are eliminated so the unit can follow rapidly changing voltages and deliver a constant current.

Kepco has also beefed up its BOP line of four-quadrant, bipolar power amplifiers. The brawn comes from models offering 400 W of stable power from dc to 4 kHz in the voltage range from ±20 to ±100 V. The series comes ready for rack mounting, but the user can remove the panel mounting brackets for benchtop use.

With sources in two quadrants and sinks in two quadrants, models in the line are suitable for simulation, modeling and test applications. The 400-W unit can be used either as a bipolar voltage stabilizer with current limiting or as a bipolar current stabilizer

Putting the emphasis on thermal characteristics, acdc electronics has come up with a series of open-frame multiple-output switching supplies in several configurations offering different power levels.



Glassman High Voltage's new 500-W high-voltage dc supplies, the WH series, come in 24 models with a wide power range. Line and load static regulation is better than 0.005%.

What can go from zero to 3500 Volts and back in 2 smooth millisecond leaps?

A Kepco high voltage Power Manager.™

And nothing else. At least, nothing else that you can buy for controlling high voltages. Everything else has to creep between those voltages, usually in 500V steps.

Because nobody but Kepco uses, for the crucial series pass element, a remarkable invention called the vacuum tube. While solid state technology has, for the most part, made the vacuum tube a relic, it is still the only device around that can handle a high voltage, and make it take big jumps linearly, in one step, at high speed.

The function of the series pass element in a linear power supply is to absorb, and remove from the output, all variations, transients, and noise. It is consistently subjected to excess currents, voltage, and power dissipation, which strain the resources of semiconductor junctions. To protect their transistors, others do things like supplying auxiliary feedback to limit current, using switching techniques to limit dissipation, and connecting transistors in series to share high voltage stresses. These tricks work fairly well, but they're slow. And they reduce dependability because they add enormously to the number of components required.

By using vacuum tubes, which are much more tolerant of overloads, we can use far fewer protectors, greatly reducing the number of components, and make voltage jump around at microsecond speeds. Our Power Managers OPS IXB and OPS X produce outputs from 0-500 Volts to 0-5000 Volts (including the 3500V model whose output is illustrated). Their voltage can be slewed faster than 1V/μsec. Kepco's bipolar models BOP 500-M and BOP 1000-M have fast programmable outputs up to $\pm$1000 Volts. And can be controlled as fast as 3V/μsec. As with all Kepco Power Managers, you can go from one end of the voltage range to the other, in one leap, at any load current within the unit's current range. And from one end of the current range to the other, at any load voltage within the unit's voltage range.

The Kepco Power Managers, of course, do a lot more than just control voltage and current (which is why we call them Power Managers). You can use them as feedback stimulated current or voltage stabilizers, as self-powered oversized op amps, or as servo amplifiers. With the help of our SN digital interfaces, you can control the 500 and 1000 Volt models with a computer. All the details are in a brochure we've prepared called "The Kepco Power Managers," which we'd be delighted to send you.

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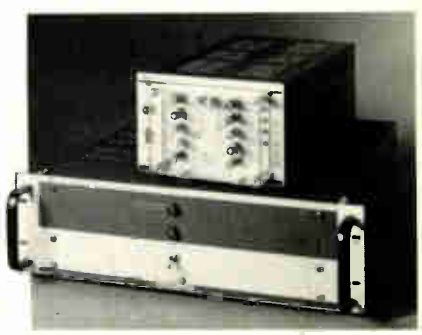

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Circle 43 on reader service card

Bertan has enhanced the versatility of its power-supply line with remote 16-bit digital binary programming of the high-voltage output. The new option can be installed in the Bertan 205A/210 series of regulated precision high-voltage power supplies.

with voltage limiting. The settings and limits are controlled by analog signals. The line also includes 100- and 200-W models. Supplies ordered with an optional built-in IEEE-488 interface can be connected directly to an instrumentation bus.

High-voltage systems

For manufacturing systems, such as spraying, ion implantation, fault detection, and precipitation and deposition, Glassman High Voltage Inc., Whitehouse Station, N. J., is delivering a new line of 500-W high-voltage dc power supplies. The WH series consists of 24 products that range from 0-5 kV at 100 mA to 0-75 kV at 5 mA. Line and load static regulation is better than 0.005%.

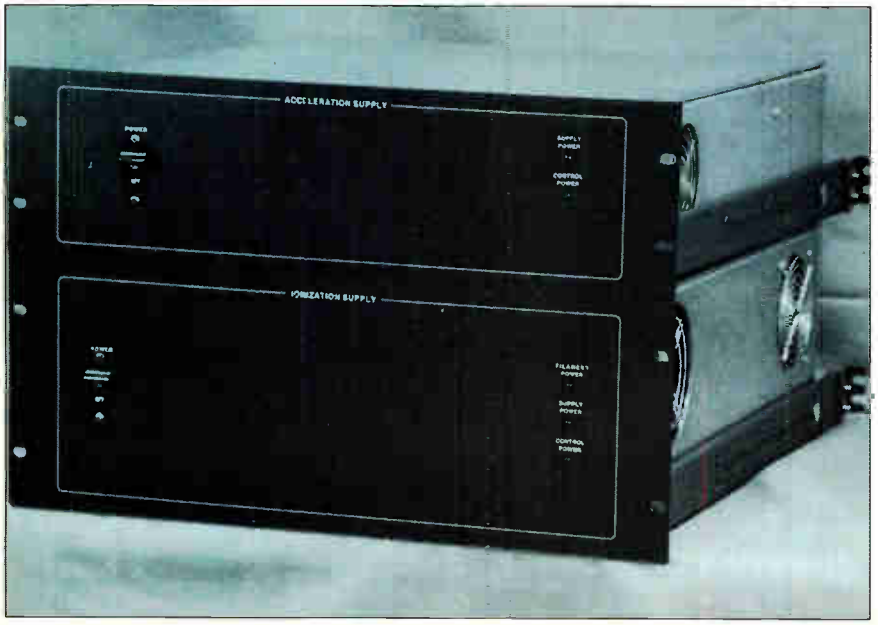
Like other power supplies from the company, the WH series is insulated with air, rather than with oils or potting compound. The units, which weigh less than 25 lbs, are designed for mounting on a standard 19-in. rack and require only 5¼-in. of vertical space—half the space needed by the series' predecessor. Standard input is 105 to 125 V ac, single phase, at 6 A.

The power supplies offer both voltage and current regulation with automatic crossover to voltage or current mode as required by the size of the load. Other standard features include remote voltage and current programming and monitoring, low ripple, and a recovery time of less than 3 ms from a 50% load transient.

Also from Glassman is the PH series, a family of 3,000-W, off-the-line switching power supplies. These high-voltage models have a power range of 0-300 kV at 10 mA to 0-3 kV at 1 A. Each unit has up to four interconnecting modules, depending on desired voltage. Each module takes up only 5¼-in. of vertical panel space when mounted in a standard rack. All models have both voltage and current regulation, with automatic crossover to voltage or current mode.

Glassman's MX series of power supplies can yield as much as 60 kV dc at 0.8 mA. Units measure only 4 3/4 by 5 3/16 by 11 in.—about one third the size of comparable units. Voltage and current regulation are better than 0.01%. Moreover, because the modules are insulated with air, they weigh less than 9 lbs. Thanks to the design of the power-drive circuitry, products in the MX series operate off a standard 120 V ac input, eliminating the need for an auxiliary low-voltage dc power supply. The 20 models in the series range from 0-5 kV at 10 mA to 0-60 kV at 0.8 mA, with a wide variety of voltage and current relationships.

For industrial applications, Kaiser Systems has a high-voltage line that is short-circuit proof and designed to limit surges of stored energy into the loads being driven. Several models feature microprocessors as communications and control elements.



Thermal characteristics

Placing heavy emphasis on thermal characteristics, acdc electronics, Oceanside, Calif., has come up with a family of open-frame multiple-output switching power supplies. The RMV and RMC product series come in several configurations and power options. All the parts have up to four

acdc's 750-1500 watt power supply operates today... the next day... 2,773 more days in a row...

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The demonstrated MTBF for acdc's 750–1500 Watt supplies is in excess of 7½ years! Already.

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And burn-in at acdc is harsh.

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acdc's new JF Series offers more than rugged reliability. Advanced technology such as Current Mode Control allows superior Transient Response:

- <100 mv output excursion following a 50% load step (<400mv following a 100% load step)
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Features:

- VDE 0806 licensed by TUV
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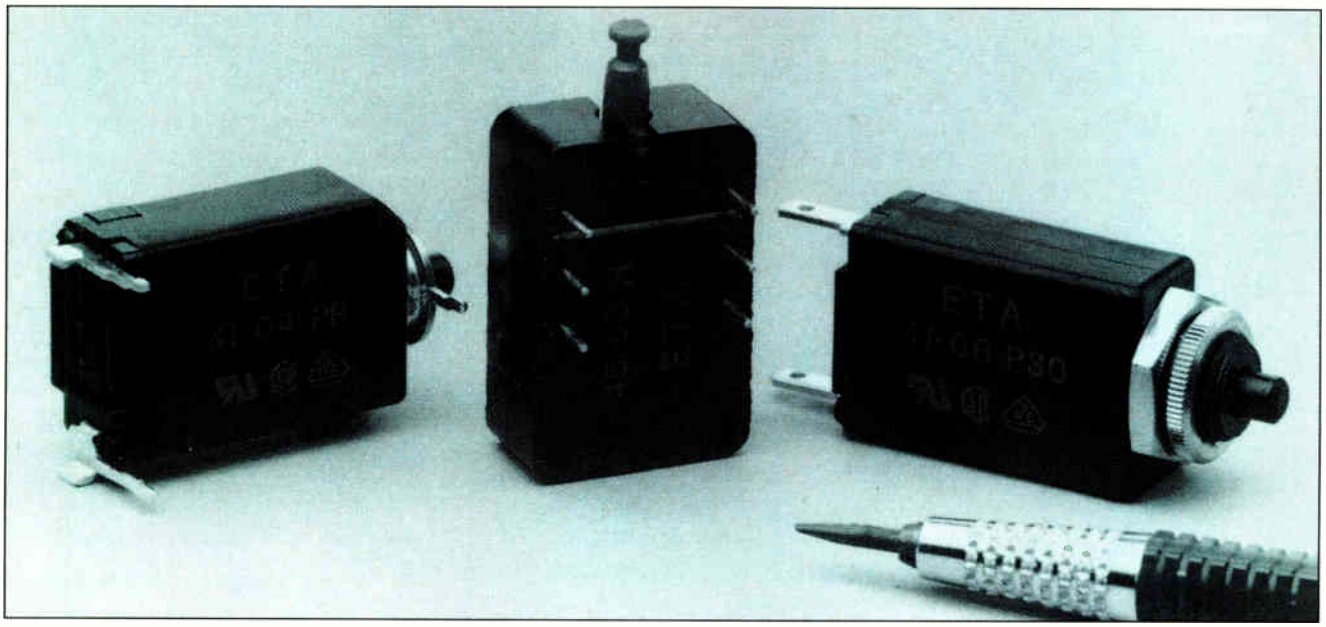
Circle 45 on reader service card

outputs. The RMV 22X is a 220-W convection-cooled supply. The RMC 30X puts out 300 W with fan cooling. The 300-W RMV 30X is convection cooled. The RMC 40X is a 400-W fan-cooled unit.

When air is applied to the 220-W unit, it can put out a full 300 W of regulated power; the convection-cooled 300-W unit produces 400 W with air, says the company, a division of Emerson Electric Co.

All the units have MOS FETs on the primary channel and saturable reactors on the secondary. Use of the reactors allows post-regulation of all channels, which is unique to the RMC and RMV product series and enables the supplies to handle high peak current on auxiliary channels—up to 6 A, regulated. Other standard features include a 2½-in. profile, field-selectable 115/230 V ac operation, soft-start circuitry, and protection circuits. These

E-T-A Circuit Breakers' series 41-04-PR of miniature circuit breakers can be mounted either vertically or horizontally on printed-circuit boards. Their current ratings range from 0.1 to 10 A, and their maximum voltage ratings are 250 V ac, 28 V dc.



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This extensive product line includes single and three phase AC input power supplies and DC-DC converters in single and multiple output power ratings to 1KW.

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*U.S. Navy/Industry Power Supply Ad Hoc Committee Estimates for Time and Cost.

Circle 47 on reader service card

Miniature transformers from Avel-Lindberg incorporate an internal positive-temperature-coefficient device that automatically breaks the primary circuit if the transformer becomes overloaded. Normal operation resumes when the transformer cools down.

acdc supplies are designed for such major market segments as data-processing, communications, industrial, and medical equipment.

For industrial applications, Kaiser Systems Inc. has a line of high-voltage power supplies that are short-circuit proof and designed to limit surges of stored energy into the load being driven. With output power ranging from a few hundred watts to over 100 kW and voltage levels from 1 to 200 kV, equipment from the Beverly, Mass., company is suited for use in computerized control systems.

Many of the models employ microprocessors as communications and control elements. Kaiser Systems' high-frequency switch-mode and vacuum-tube linear power supplies are suitable for applications ranging from ion implantation to medical and industrial lasers to X-ray, deposition, and electron-gun systems.

New option

Most of the emphasis at Bertan Associates Inc., Hicksville, N. Y., has been on enhancing its power-supply line to allow remote 16-bit digital binary programming of the high-voltage output. Bertan's new CBNY option can be installed in the company's 205A/210 series of regulated precision high-voltage power supplies, which put out up to 75 kV, as well as in the Bertan series of cathode-ray-tube and X-ray-tube test sets. The CBNY option—consisting of the installed card, a programming connector mounted on the rear panel, and the mating connector—works with any computer or microprocessor.

Bertan also has announced the 700 series for the operation of CRTs and X-ray, electron-beam, and ion-beam sources. Specifications for the line include ripple and regulation of 0.01%. Input voltage is +28 V dc, accurate to ±5%. All units are short-circuit and arc protected. Remote digital programming of the high-voltage output is optional.

Two series of high-voltage dc-to-dc converters for use with photomultipliers, CRTs, electron- or ion-beam systems, X-ray sources, and related applications are available from

Bertan. The 605C puts out up to 10 W, and the 606C puts out up to 30 W at high voltage. The units come with maximum output voltages of 1,500, 3,000, 5,000, 10,000, and 15,000 V dc.

For design engineers in need of an extremely compact circuit breaker, E-T-A Circuit Breakers has developed its 41-04-PR series. These miniature parts, which can be mounted vertically or horizontally on printed-circuit boards, are trip-free, cannot be held closed against an overload, and will not cycle. Current ratings are from 0.1 to 10 A. Maximum voltage ratings are 250 V ac, 28 V dc. The Chicago company's devices also are available for snap-on or panel mounting.

A new design feature of a line of miniature transformers from Avel-Lindberg Inc., Danbury, Conn., is an internal positive-temperature-coefficient device that automatically breaks the primary circuit if the transformer becomes overloaded. The advantage of this system over traditional fuses is that the transformer reverts to normal operation as soon as it has cooled enough to allow the positive-temperature-coefficient device to return to its conducting state.

Avel-Lindberg's devices have a dual primary winding for operation at 120/240 V, 50/60 Hz. Single secondary windings of 6, 8, 9, 12, 15, 18, and 24 V and dual windings of 6, 8, 9, 12, 15, and 18 V are available. The transformers, which are designed to be soldered directly on the pc board, are rated from 4.5 to 30 VA. The use of the positive-temperature-coefficient device enables regulation to be kept to a minimum and makes the transformer suitable for full-wave and bridge-rectifier circuits, particularly as the dual secondary windings can be operated in series or in parallel.

Military-specification dc-to-dc converters, using power MOS FETs at 100 kHz, are the specialty at Rantec Power Systems, a division of Emerson Electric Co. The Chatsworth, Calif., company has a line of standard supplies designed for military applications. This family of products includes the 4000 series of single-output converters, available in 74-, 150-, and 300-W ratings; the 5000 series of 180-W dual-output converters; and the 6000 series of 175-W triple-output parts. The line is an alternative to Rantec's custom military designs.

Rantec designs are based on single-ended forward converter topology to reduce the number of circuit components required, which improves reliability. The mean time between failures for the 4000 series is 71,400 hours; for the 5000 and 6000 series, it

is 72,000 hours, per MIL-HDBK-217C.

All models in the Rantec line include soft-start circuitry, low-line lockout, output foldback current limiting, and shutdown overvoltage protection. Converters in the Rantec 4000, 5000, and 6000 series are qualified in accordance with MIL-E-5400 Class 2, MIL-E-16400 Class 1, MIL-E-4158, MIL-STD-461A Notice 3, MIL-STD-704D, MIL-STD-1275A Notice 2, and MIL-T-27.

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ELECTRON-BEAM TESTING OF VLSI CHIPS GETS PRACTICAL

SIEMENS EXPECTS A NEW BREED OF TESTERS IN THE NEAR FUTURE

Electron-beam testing of very large-scale integrated circuits has long sounded like an appealing idea to many chip designers. Such test methods offered strong potential advantages: contactless probing, nondestructive testing, nonloading of circuits, and the ability to handle small line widths.

But basic limitations of electron-beam testing made it difficult, if not impossible, to use in many important applications. It did not work in testing circuits that carried high-frequency signals, those that operated asynchronously, ones with very narrow interconnections (1 μm and below), or chips with interconnections covered with insulating layers.

Now researchers at Siemens AG have gotten rid of the stumbling blocks that have limited the effectiveness of electron-beam testing. They did it by applying new tricks to the dynamic electron-beam test techniques that the West German company pioneered at its Central Research Laboratories in Munich in the early 1980s [*Electronics*, July 14, 1981, p. 105]. Siemens researchers came up with novel measuring schemes that "will lead to a new breed of electron-beam test equipment in the near future," predicts Fred Fox, leader of the Siemens research team.

Siemens has made it possible to use electron-beam probes to check out VLSI circuits carrying signals in the gigahertz range. What's more, it has brought electron-beam test methods to the probing and testing of asynchronously operating circuits, to measuring interconnections as narrow as 1 μm, and on interconnections that lie deep inside the circuit and are covered with layers of insulating material. Two basic techniques—frequency tracing and logic-state tracing—can, depending on the circuit under test, be used in any of these test applications. However, logic-state tracing cannot be used for testing narrow interconnections. A third test technique, frequency mapping, functions as an aid to frequency tracing.

Investigation of these techniques began in April 1984 by a Siemens team that included Fox and researcher Hans-Detlef Brust. Now they have developed them to the point where they can be used in practical applications. The techniques are about to be used for testing the 1- and 4-Mb dynamic random-access memories that Siemens is developing as part of the Mega project [*Electronics*, Dec. 23, 1985, p. 17].

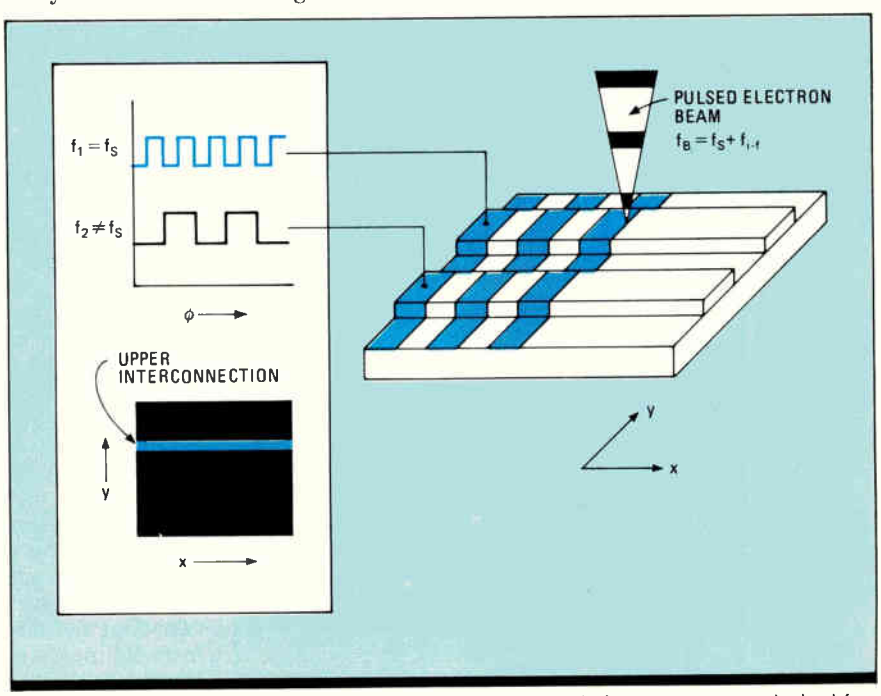
The Siemens researchers were driven by the fact that testing VLSI chips was a highly difficult task no matter what method was used. To measure high-frequency signals on an IC, traditional test methods use very short primary-electron pulses to get a sufficiently high time resolution. Such pulses are not only difficult to generate, but also contain only a few electrons per pulse. To obtain a good signal-to-noise ratio and therefore a high-enough measuring accuracy, a large number of measurements must be taken to get an average value. "That, however, is a time-consuming process," Fox points out.

Furthermore, the use of sampling and averaging schemes presupposes that the electron-pulse generation is synchronized with the signals to be investigated. Where this is not possible, as is the case with ICs whose components operate asynchronously with the external signals, other electron-beam test methods fail.

Measuring voltages on small spots requires that the primary electron beam be focused sharply and that it have very low drift so that the beam does not move away from the interconnection. Keeping the beam positioned exactly on very narrow, micron-sized interconnections is very tricky, especially when long measuring times are involved, explains Brust. "We hope to be able to eventually probe lines that are well in the submicron region," says Fox.

Finally, insulating layers on top of the interconnections make it difficult to measure signals because the secondary electrons originate at surface layers only a few nanometers thick. Multilayer metalization is becoming increasingly important in IC fabrication. This means that many points that must be probed lie at the deeper levels covered by oxide or nitride insulating layers.

The basic idea behind frequency tracing and logic-state tracing is to show all circuit structures that carry a desired



1. FREQUENCY TRACE. Siemens uses voltage-contrast techniques to trace a desired frequency as it passes through a circuit.

TECHNOLOGY TO WATCH is a regular feature of Electronics *that provides readers with exclusive, in-depth reports on important technical innovations from companies around the world. It covers significant technology, processes, and developments incorporated in major new products.*

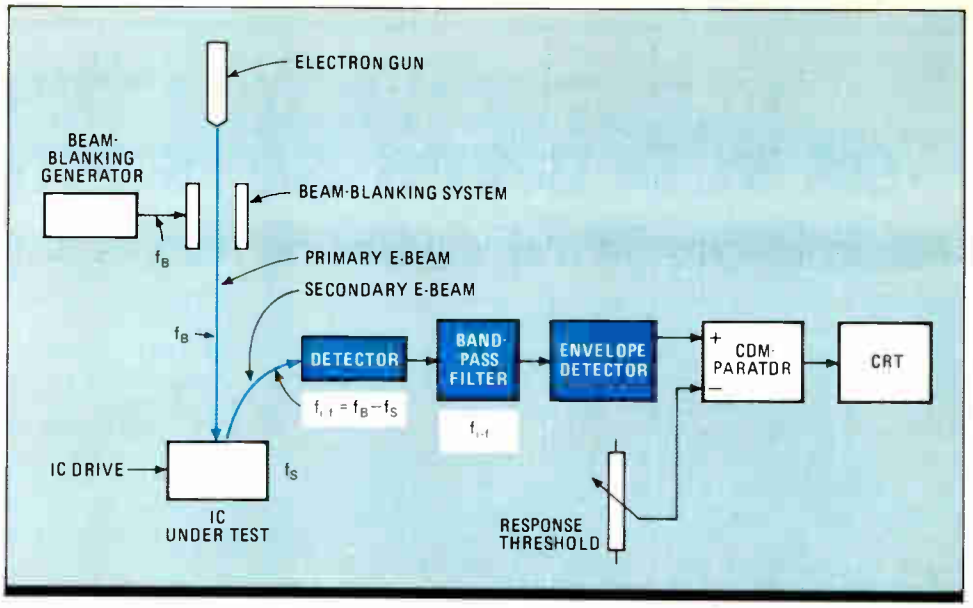
signal. For functional analysis of an IC, it is often necessary to trace the path of the correct signal within the IC. A significant characteristic for a periodic signal is its frequency.

Using this characteristic, the frequency-tracing method displays all interconnections carrying the correct signal (Fig. 1). The IC is represented on a displayed micrograph by two symbolic interconnections. These have signals of different frequencies—f_1 and f_2, with f_1 corresponding to the correct signal of frequency f_S.

In frequency tracing, the primary beam scans the entire circuit line by line. At each measuring point, the secondary electron current is modulated by the signal frequency at that point by the voltage contrast mechanism. Frequency tracing shows the result of this procedure. Only the upper interconnection, which carries the correct frequency $f_1 = f_S$, appears bright. The lower one, with a frequency different from that of f_S, remains dark.

To obtain this result, it should be enough to simply extract the correct signal f_S from the secondary electron current, Fox explains. But secondary electron detectors used in scanning electron microscopes to record this current have an upper frequency limit of 5 MHz. In practice, this means that signals above 5 MHz cannot be investigated because of the detector's limited bandwidth.

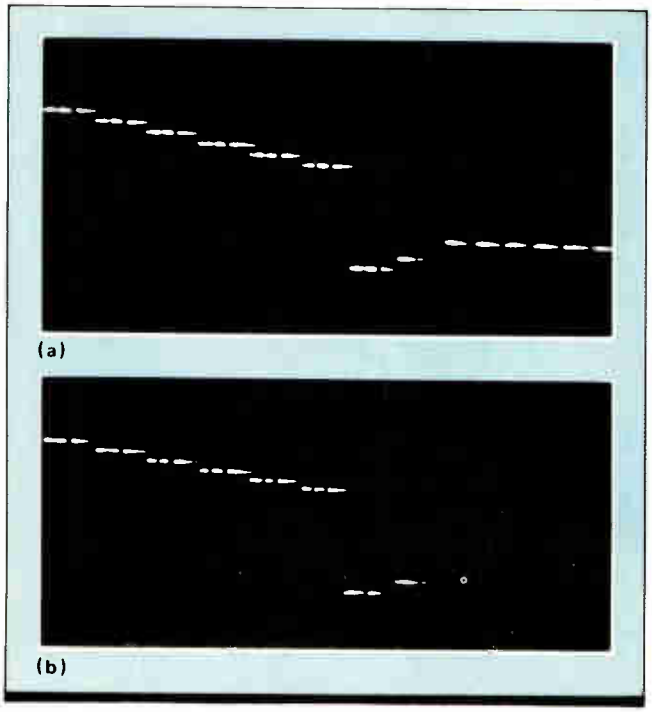
To get around that problem, Brust and Fox resorted to an old idea—the heterodyne principle used in radio receivers for roughly 60 years. Applied to frequency tracing, the principle entails mixing the correct signal, whose frequency may have a very high value, down to a signal with a lower, fixed intermediate frequency, f_{if}. The new signal is fed to the secondary-electron detector, which can cope with this lower-frequency signal.



2. HETERODYNE PRINCIPLES. The experimental equipment the Siemens team has developed for frequency tracing resembles a superheterodyne receiver.

The experimental equipment the Siemens team has developed for frequency tracing resembles a superheterodyne receiver (Fig. 2). The actual mixing process in frequency tracing must take place before the secondary electron detector. The mixing process involves multiplying the measured signals by the output signal of the mixing oscillator. A superhet receiver uses a mixer for this process. But in frequency tracing, multiplication is done by voltage contrast, because the measured secondary electron current is proportional to the primary electron current and also depends on the signal at the measuring point.

The pulsed electron beam does the mixing. The primary electron beam is pulsed with frequency f_B, which is shifted with respect to the correct frequency by the value of the correct intermediate frequency f_{if}. In this case, the correct frequency f_S is mixed down to an intermediate frequency that is equal to the difference between f_S and f_B. This low i-f, typically 50 kHz, can easily be detected and amplified by the secondary electron detector, extracted by a bandpass filter, and demodulated by an envelope detector. The demodulator output is then compared with an adjustable response threshold and used to control the brightness of the recording beam of a cathode-ray tube. The beam's movements across the CRT screen follow the movements of the primary electron beam.



3. TROUBLESHOOTING. Micrographs of a frequency trace show a pipeline multiplier operates perfectly at 3.8 V (a) but fails at 3.5 V (b).

NO SYNCHRONIZATION

The upper limit of the frequency tracing depends only on the pulsing frequency of the primary electron beam. Because beam-blanking systems are available for frequencies into the gigahertz range, frequency tracing can be used for measuring signals of such frequencies. What's more, just as a radio receiver need not be synchronized with the transmitting station, the frequency-tracing method need not be synchronized with the circuit operation to carry out the measurements. This opens the possibility of investigating asynchronously operating circuits using electron-beam testing by frequency tracing.

Finally, experiments by Siemens researchers have shown "that frequency tracing is eminently suited for

probing signals on interconnections covered with layers of insulating material," Brust says. That's because the signals set up electrical fields that pass through the layers. They can then be measured on the circuit's surface with a small detection bandwidth and therefore with an excellent signal-to-noise ratio.

In a typical frequency-tracing application, a micrograph displays the secondary electron image of a fast pipeline multiplier operating at a 50-MHz clock frequency and with one of its data inputs switched at 5 MHz. The frequency-tracing method makes visible all circuit structures carrying this 5-MHz switching signal. The results at normal and at slightly reduced operating voltages are displayed in the micrographs. In the application, the circuit functions perfectly at 3.8 V (Fig. 3a), but fails at 3.5 V (Fig. 3b). The design weakness is located at that position.

LOGIC-STATE TRACING

In certain applications, the frequency criterion for distinguishing two signals is not enough. Fox likens this situation to differentiating people in a crowd: "In a large crowd of people, the criterion 'date of birth' is not enough to unmistakably characterize single individuals." Consequently, if a circuit carries several signals of the same frequency but with different profiles, it is difficult for the frequency-tracing method to tell one signal from another. Here, logic-state tracing comes in. This method makes visible all circuit structures carrying digital signals with a certain bit pattern.

In operation, the IC is again represented by two interconnections carrying the signal corresponding to the wanted signal—that is, the signal whose bit pattern is to be traced. As is the case with frequency tracing, the primary electron beam scans the circuit line by line. Wherever the beam strikes, the secondary electron current is modulated by the IC's signal at that point. Thus the correct, or desired, signal can simply be extracted from the secondary electron current.

The extraction is done with the aid of an electronic correlator in which the test bit pattern is stored. The correlator compares the measured bit pattern with the test bit pattern and controls the brightness of the CRT, with the CRT's recording beam again positioned synchronously with the movement of the primary electron beam. The correlator contains a "template" of the correct signal, and only a bit pattern that fits this template can unblank the CRT beam.

In a logic-state-tracing application, seven interconnections in a test circuit carry different bit patterns, with the two connections marked by arrows carrying the correct pattern (Fig. 4a). To make the patterns visible, the clock frequency for the voltage-contrast micrograph was reduced to 2 Hz. The clock was subsequently increased to 500 kHz and the circuit investigated with logic-state tracing. Whereas the voltage-contrast micrograph seems to show the signals ending at the contact holes in the upper part of Fig. 4a, the logic-state-tracing micrograph reveals that the wanted signals in reality continue along polysilicate interconnections, which in this case are covered by oxide (Fig. 4b). Thus it is also possible to use logic-state tracing to investigate interconnections covered with insulating layers.

FREQUENCY MAPPING

To apply the frequency- and logic-state tracing methods, the user first must have sufficient information about the correct signal. For frequency tracing, the signal frequency, and for logic-state tracing, the bit pattern must be known. But if this information is not available, something else must be done.

For frequency tracing, the answer is simple. Just as with a radio receiver when the correct transmitter frequency is unknown, a transmitter search is initiated. In the case of a radio, the local oscillator frequency is continuously tuned until the desired frequency is found. Similarly, in frequency tracing, the frequency of the beam-blank-

ELECTRON-BEAM TESTING BLUNTS MECHANICAL PROBING

For the functional analysis of very large-scale integrated circuits, on-chip measurements are often necessary during the design phase as well as for failure testing. But using mechanical probes "is like a surgeon operating on a patient with a blunt kitchen knife," says Hans-Detlef Brust, a graduate student of the University of Saarbrücken and now working on the Siemens electron-beam test project as part of his doctoral thesis. A mechanical probe, he points out, is difficult to position on narrow interconnections and can damage the circuit. Also, the probe's capacitance can induce false measurements, especially of high-frequency signals.

To avoid these problems, circuit design and test engineers increasingly are turning to electron-beam testing, in which the sharply focused beam of a scanning electron microscope scans the surface of a circuit in operation and functions as a noncontacting measuring probe. When the beam's scan rate is synchronized with the clock pulses of the device under test, the signals—either digital pulses or analog waveforms—traveling along the interconnections can be displayed on a cathode-ray tube as logic-state maps superimposed on the circuit image.

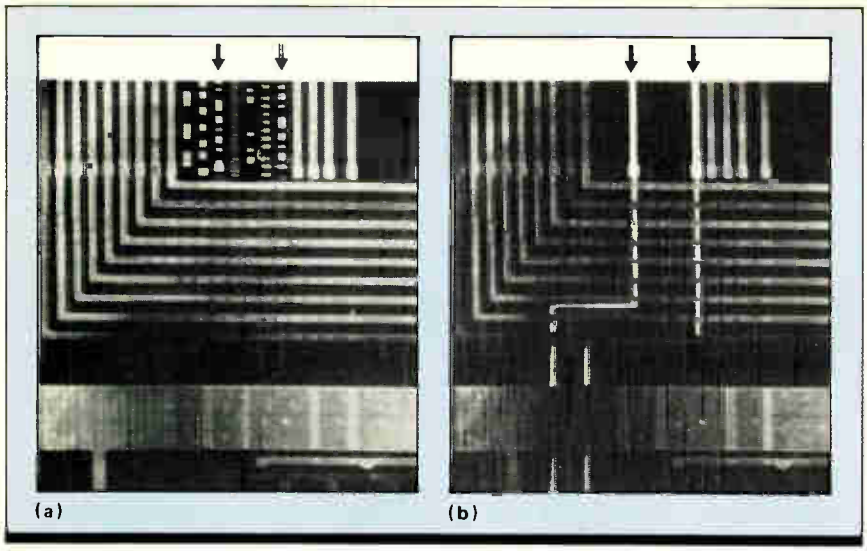
Siemens researchers implemented this dynamic test technique in experimental equipment for the company's own use about five years ago. The nondestructive and nonloading test method is based on the fact that the scanning electron microscope's primary electron beam—between 1 and 2.5 keV—strikes the interconnections of an IC placed in the microscope and knocks out low-energy secondary electrons from the surface. Electric fields set up by the voltages applied to the interconnections attract the secondary electrons to interconnections carrying positive voltages.

More secondary electrons produced at grounded, or negative, segments leave the interconnections than those produced at positive segments. Secondary electrons leaving the surface are registered by a detector that produces a signal whose amplitude depends on the voltage at the point struck by the primary electron beam. This is known as voltage contrast.

The method is nonloading because the electron beam induces no current. This is because a charge balance exists—for each electron hitting the circuit, an electron leaves it. Also, because electron-beam testing is contactless, there is no capacitive loading of the circuit.

Traditional methods of electron-beam testing such as voltage coding, logic-state mapping, and waveform measurement can be used to measure voltage profiles at individual nodes of a circuit and to show an IC's logic states on a CRT. For high time resolution, stroboscopic techniques and a pulsed primary electron beam are usually employed. The underlying principle is comparable to that of a sampling oscilloscope.

Perfected electron-beam testers based on Siemens's technology are now sold by Integrated Circuit Testing GmbH, a German startup that Siemens helped finance and which is run by former Siemens researchers [*Electronics Week*, Sept. 10, 1984, p. 61]. Though the experimental equipment that Siemens is now building is, like the earlier systems, intended for in-house use only, there is a good chance that Siemens will eventually license the technology.



4. LOGIC-STATE TRACING. The two interconnections marked by arrows carry the wanted bit pattern (a). Logic-state tracing detects the signals on oxide-covered interconnections (b).

ing oscillator is tuned over the frequency range of interest. Siemens calls this procedure frequency mapping.

To display the result of the frequency-mapping procedure on a two-dimensional screen, however, one spatial dimension must be omitted. So in frequency mapping, the primary electron beam does not scan the entire IC surface but only a line over the interconnections of interest. The CRT's recording beam is deflected synchronously with this movement in the Y direction. The frequency f_B, which modulates the primary electron beam, is varied simultaneously and compared with the movement in the Y direction.

Next, the CRT beam is swept simultaneously in the X direction and synchronized with the frequency f_B. Whenever the frequency at the measuring point is mixed with the frequency f_B down to the fixed intermediate frequency, f_{IF}, a bright bar appears on the screen. This is the case when f_B lies above or below the signal frequency by the value f_{IF}.

This is similar to amplitude modulation, in which there are upper and lower sidebands. Two bright bars are obtained for every unknown frequency that corresponds exactly to the value of f_B midway between both bars. When the unknown frequency has been determined, the signal investigations can be continued with frequency tracing.

A typical application of frequency mapping is a multistage frequency divider with a 16-MHz signal applied. The primary electron beam continuously scans the lines, and the beam's frequency is simultaneously varied between 100 kHz and 8.1 MHz. The frequencies of the individual divider stages (such as 8, 4, 2, or 1 MHz, or 500 kHz) can simply be read from the frequency-mapping micrograph.

To determine an unknown bit pattern, logic-state tracing can still be used. All that need be done is to direct the primary electron beam onto the desired measuring point, feed the signal obtained at that point to the correlator, and then use the signal derived as the correct bit pattern in the logic-state-tracing procedure. The signal at the desired measuring point is thus used to define the template for the correct bit pattern.

The new Siemens methods are effective approaches to current VLSI electron-beam test techniques, Fox and Brust say. They are bound to become more important as new IC fabrication technologies make higher complexities and greater densities possible. □

RESEARCHERS SHARPEN SIEMENS'S FOCUS ON ELECTRON-BEAM TESTING

Solving several problems that have plagued electron-beam testing of VLSI circuits was not a massively difficult undertaking, says Fred Fox, a member of the research team at Siemens AG's Central Research Laboratories. The work built on the company's already extensive experience in electron-beam testing—Fox and his team simply improved the system further. Fox has been at Siemens for over 25 years, with much of that time spent working on electron-beam technology.

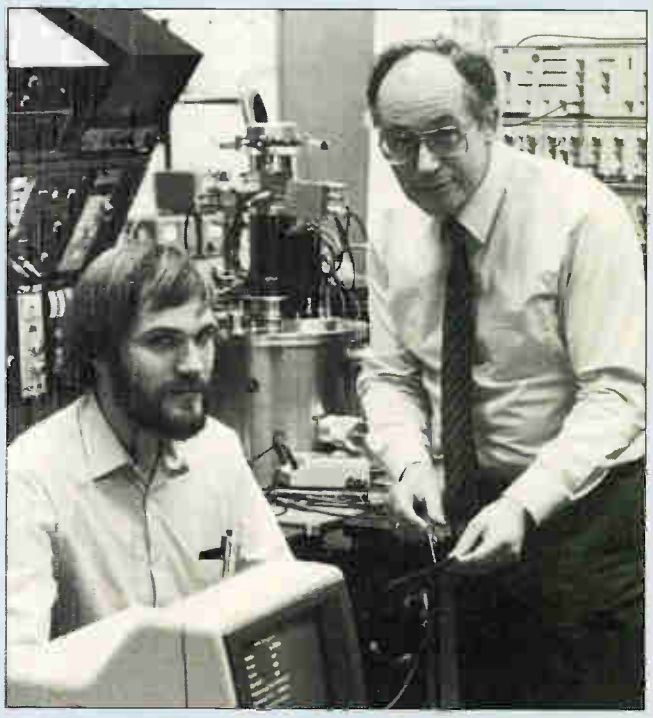
Despite his Anglo-Saxon name, Fox is a native German. His ancestors emigrated from England and settled in Berlin.

Fox, 54, studied at the Technical University in West Berlin, earning his master's degree in electrical engineering in 1957. He got his first practical electronics experience as a designer of precision instruments at AEG AG and then, starting in 1959, at Siemens. There he developed digital controls for electron-beam microscopes.

In 1971, Fox moved to the Munich labs to work on superconducting lens systems. Since 1980, he has been the principal researcher in a 10-person group engaged in electron-beam test methods.

Hans-Detlef Brust officially is at the University of Saarbrücken, where he is a candidate for a PhD in electrical engineering. But because his thesis is on electron-beam test methods, Brust, 24, is actually at the Siemens labs in Munich to get practical experience.

Brust is no stranger at Siemens, however. While studying at Saarbrücken he has had summer jobs at the Munich labs. After getting his doctorate, Brust says he may stay at Siemens.



STUDENT AND MENTOR. Hans-Detlef Brust and Fred Fox collaborated on Siemens's electron-beam developments.

PROBING THE NEWS

HOW HUGHES WILL CHANGE UNDER GENERAL MOTORS

AN R&D POWERHOUSE AIMS TO BECOME A WORLD-CLASS PRODUCER

by Larry Waller

LOS ANGELES

Howard Hughes would never believe it. Hughes Aircraft Co., the Southern California electronics giant that the reclusive billionaire started just three decades ago, is suddenly and radically changing, in what most likely will end up being one of the most fundamental shifts ever experienced by a major U. S. corporation. The $6.2 billion company is being transformed from a super-secret, privately owned operation into a public business whose shares are traded on the New York Stock Exchange. It all started last June when General Motors Corp. purchased Hughes, fused it with its Delco Electronics Division, and formed a subsidiary called GM Hughes Electronics Corp.

What GM gets for its $2.7 billion cash payment and GMHE stock, ultimately to be valued at an additional $3 billion, is the breadth and depth of Hughes's defense-related technologies and systems-management experience. Hughes is the nation's sixth-largest defense contractor, its sales accounting for 4.4% of the U. S. defense budget. Besides providing the automaker with major market diversification, Hughes will also go a long way in supporting GM in its core business. A major intent, according to GMHE president Donald J. Atwood, is "to tap Hughes's technologies for autos."

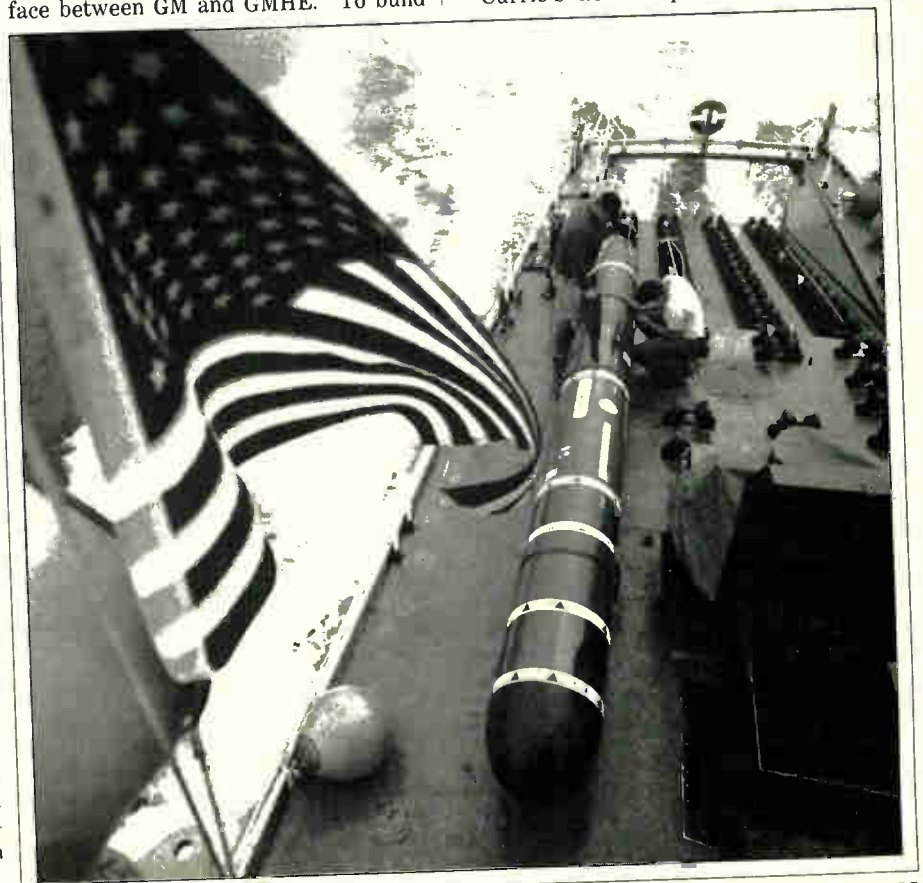
Hughes, surprisingly, could gain far more out of the merger. It expects to obtain significant manufacturing savvy from GM, skills that the defense electronics company has decidedly lacked in recent years. Donald H. White, president of the Hughes segment, doesn't duck the issue. "It's no secret that while we're known as a first-rate research and development house, we can do a lot better at low-cost manufacturing," he concedes. Toward that end, GM is lending Hughes top manufacturing people and expertise. " 'Tell us how we can help' is what GM says," according to White. Hughes's manufacturing problems made national headlines two years ago when its prime customer, the Department of Defense, uncovered major shortcomings at its Missile Systems Group's Tucson plant.

In the two months since the official takeover, top-level executives have been shuffled by GMHE amid a flurry of other activities. Atwood comes to the new subsidiary after 27 years with GM; he was named executive vice president and a corporate director in 1984, titles he retains along with responsibility for the Electrical Components, Mechanical Components, and Power Products Groups.

Atwood's first order of business is to devise channels for the flow of information. He defines his role as "the interface between GM and GMHE." To build and oversee this function, Atwood last month assigned Malcolm R. Currie, Hughes's executive vice president for advanced programs, additional duties as president of Delco in Kokomo, Ind. "His full-time job is the focal point for transferring technology," says Atwood.

Hughes and GM are moving quickly to identify technology areas where they can help each other. In the first months of the year, they set into motion intensive discussions on more than a dozen programs where Hughes's scientific and engineering know-how can be used. "Quick-start" committees of Hughes and Delco officials are studying such needs as technology content in automotive instrumentation and integrated-circuit requirements for each operation.

Currie's next step is to create the



IN PRODUCTION. Hughes has a $200 million DOD contract for the Mark 48 torpedo.

formal organizational framework and funding for the joint ventures. But exchanging information in the 100-odd technologies in which Hughes excels is only the beginning, Currie says. "If any technology is simple to transplant, then GM doesn't need to acquire a company to do it." Rather, he says, the thrust is in "the systems approach, or the integration of technology, management, and engineering" for the long-haul payoff in automobiles.

Atwood and Currie single out the following as high-priority programs:

- A push into ICs, because "GM has a tremendous demand for them in car electronics," says Atwood. Delco itself is a major fabricator, supplying nearly 40% of GM's chip consumption (see "Delco plays the high-volume game," p. 62). But Delco cannot keep up with IC advances without outside help, and phasing in new processes is Hughes's forte. Also, Hughes is a participant in such Pentagon research as the Very High Speed Integrated Circuits program and so has expertise as both "a design and manufacturing source," says Atwood. A Hughes-Delco team is at work making computer-aided design software tools compatible.
- A cooperative venture between Hughes Communications Inc., a subsidiary that operates a satellite network, and Electronic Data Systems Corp., the GM subsidiary in data-processing management. Electronic Data Systems already is designing hardware and software to link all parts of GM and has brought Hughes into the project in the communications satellite end. Initially, it is leasing portions of two channels on Hughes's Galaxy satellites; after a working system for GM is developed, a turnkey product will be sold to outside customers.
- Trading information on automated production. The first exchange on the nuts-and-bolts working level brought nearly 200 Hughes employees face to face with a team from the GM Technical Center, Warren, Mich. The mission was to brainstorm on the Manufacturing Automation Protocol, which is being adopted throughout GM and its vendor community. More workshops are planned.
- Developing digital displays and instrument panels, a field where Hughes boasts vast military experience. Researchers from its Malibu Research Laboratories already have helped improve resolution of an experimental GM head-up display.
- More efficiency—and less cable—for new auto multiplexing systems. Currie believes Hughes's engineering experience will help on this project. One goal is development of a data bus that is economical enough to tie together the proliferating electronics gear of cars.

Atwood points out that the electronics content of autos, now at about $400, will more than double within 10 years as microcomputer controls pervade more functions. Thus, he says, auto systems could be the sleeper of the future. It is likely that Delco's in-house share of device production will increase as GM pursues the value-added payoffs of vertically integrated manufacturing for these critical components.

Though such joint programs are in the spotlight, Hughes's bread-and-butter defense operations are getting even closer attention. Particularly important, as is clear from changes already in place, is the need to improve lagging manufacturing quality, which still plagues most of the company's operating groups. The impetus for this work is coming from Hughes itself, which seems determined to set its house in order with no prodding from GM.

If the automaker is not prodding, it's definitely involved. GM has dispatched its experts to California, led by James M. Hall, who as the new director of product operations is the key corporate official overseeing manufacturing. Hall previously was general manufacturing manager at Delco, and before that ran Delco's semiconductor production.

Among other things, Hall will concentrate on applying Delco manufacturing techniques to Hughes's production lines. Five other Delco specialists in areas such as materials-control and quality systems management have already been pegged for temporary duty of three to eight months at Hughes.

Hall succeeds Blaine Shull, who takes over as president of Hughes's largest unit, the Ground Systems Group, in a move intended to beef up manufactur-

WHO DOES WHAT AT HUGHES

GROUND SYSTEMS GROUP
Fullerton, Calif.
1985 estimated sales: $1.3 billion
Mainly produces automated command and control systems for tactical air defense. The group has installed most of the U.S. and North Atlantic Treaty Organization's tactical equipment. It is also the chief supplier of electronics to the Navy. Typical is the AN/UYQ-21 weapons-control display: it has delivered more than $1 billion worth since the late 1970s. In the group's ship-based surface-radar and active and passive sonar systems line, the major new product is the Mark 48 Adcap (advanced capability torpedo), which features new homing sensors and digital signal-processing gear.

RADAR SYSTEMS GROUP
El Segundo, Calif.
1985 estimated sales: $1.1 billion
Manufactures radar equipment for military aircraft, along with airborne weapons-control systems and data links. Three of the four U.S. fighters in production have Hughes radar—the Navy/Marine F/A-18 Hornet, the Air Force F-15 Eagle, and the Navy F-14 Tomcat, which also has a weapons-control unit. About 77% of its revenue in the five years ended Dec. 31, 1984, came from supplying the fighters.

SPACE AND COMMUNICATIONS GROUP
El Segundo
1985 estimated sales: $1.1 billion
Has built more than half the communications satellites in commercial service, and in 1963 built the first geosynchronous-orbit satellite. Since 1980, this group has manufactured the second-generation model HS 376; it is developing a next-generation satellite, the HS 393, for 1987 launching. It is constructing five units for Intelsat, and through its subsidiary, Hughes Communications Inc., it leases satellite services to the Navy under Leasat and to commercial customers under the Galaxy program. Some 43% of its revenue comes from defense customers, 57% from commercial.

ELECTRO-OPTICAL AND DATA SYSTEMS GROUP
El Segundo
1985 estimated sales: $1 billion
Makes surface-, air-, and space-based electro-optical sensors and weapons-control systems. Its laser rangefinders are used widely, including in the M-1 tank and Bradley Fighting Vehicle. It also makes the control computer for the Trident submarine and guidance electronics for its missile.

MISSILE SYSTEMS GROUP
Canoga Park, Calif.
1985 estimated sales: $960 million
Makes tactical guided missiles, notably the armor-piercing TOW, air-to-surface Maverick, and long-range air-to-surface Phoenix for the F-14. The most important product on the boards is Amraam (advanced medium-range air-to-air missile).

INDUSTRIAL ELECTRONICS GROUP
Torrance, Calif.
1985 estimated sales: $635 million
Makes parts and equipment not readily available elsewhere, primarily for in-house use but also for contractors and commercial customers. It makes microwave and millimeter-wave components, hybrid circuits, image sensors, storage and display devices, and solar cells.

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Circle 57 on reader service card

Robert Penn
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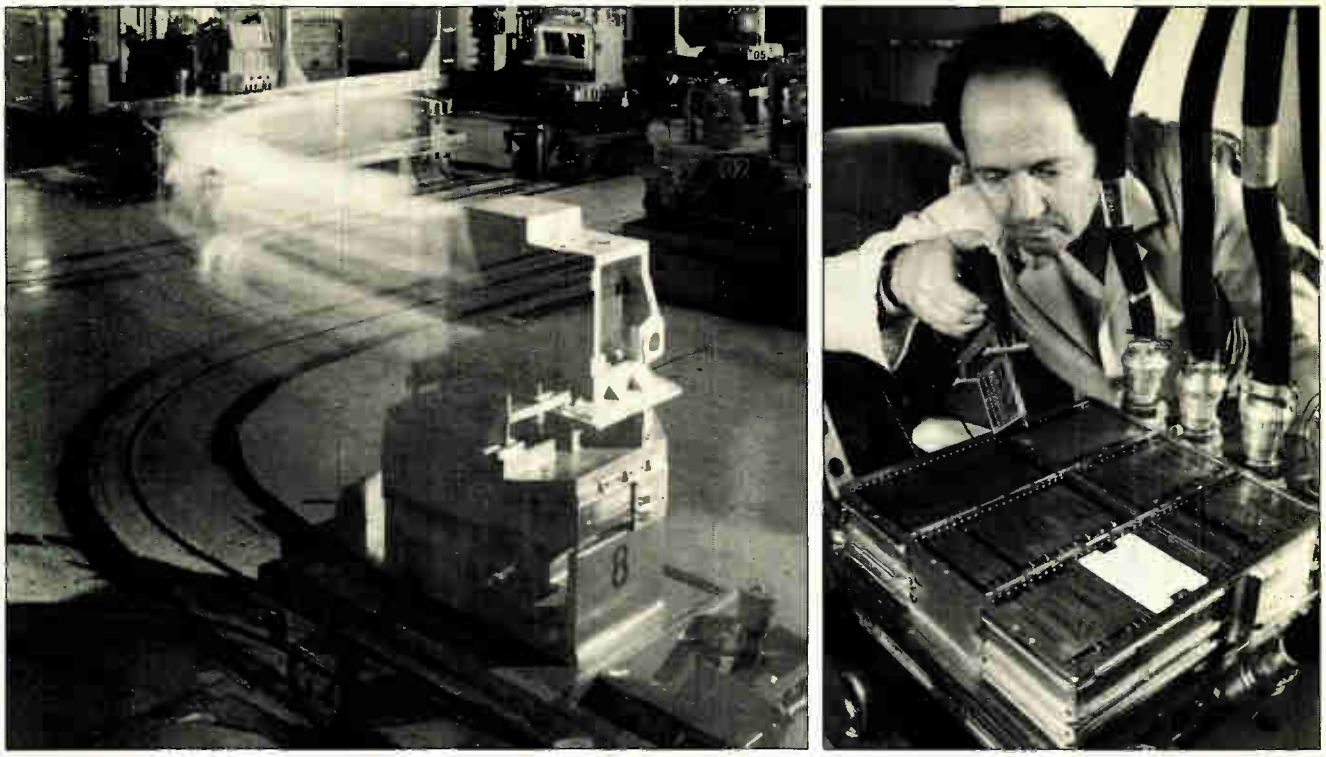

AT WORK. Left: Electro-Optical and Data Systems Group uses flexible fabrication system. Right: technician works on Trident I.

ing there. Shull played a major role in correcting the well-publicized Tucson situation, which for months soured company relations with the Pentagon.

DAMAGING BLOWS. Those problems, in three long-running missile contracts, recently dealt especially hard blows to Hughes's reputation in the defense community. Facing government criticism was hard on a company that had long enjoyed a smooth relationship with the Pentagon.

The problems at the sprawling Tucson plant did not come as a total surprise, however. For years, labor questions had caused headaches for group managers located some 600 miles away in Southern California, though corrective measures by Hughes were thought to be working. But in spring 1984, the military took action after getting reports of defective missiles made at Tucson [*Electronics Week*, Sept. 3, 1984, p. 42].

The Navy started the investigation by asking for a minute disassembly inspection of its Phoenix missiles. The defects that came to light caused the Air Force to do likewise with its Maverick and the Army with the TOW (tube-launched, optically tracked, wire-guided) missile, both built bu Hughes. Hardware defects on all three ranged from such minor items as poor wire splices to serious problems of bad workmanship on solder joints, which could cause the missiles to fail, according to Hughes. Many examples cropped up, too, of Hughes workers not following specifications, or deviating from engineering drawings.

In August 1984, all three services stopped accepting the three Hughes missiles and suspended payments. The pressure to clean up the situation was intense. Officials of the Howard Hughes Medical Institute, then 100% owner of Hughes Aircraft, were trying to decide whether to get rid of the company by selling it or going public, and they were particularly displeased. The result was a plan to improve quality and an agreement to foot the bills for inspections.

The plan was expensive. It cost $68 million in 1984 and $20 million in 1985, not counting revenue lost from closing the plant for five months and cutting production for nearly another year.

There was other fallout as well. Within months, the military began performing "quality audits" of at least two programs at each Hughes group, and turned up further problems. Although these flaws didn't suspend product acceptance, several—including faulty printed-circuit boards in the FA/18 Hornet aircraft radar system, the kingpin Hughes defense contract—were serious enough to stop production until fixed.

Hughes officials now regard the quality problems as largely behind them, a stance confirmed by the Navy and Air Force. Willis Willoughby, the Navy's executive director for reliability, maintainability, and quality assurance, estimates the overhaul in Tucson is within six months of being complete. "They've responded well and stayed on the fulfillment curve set up a year ago," he says. Thomas S. Amlie of the Air Force's financial management office concurs that Hughes has made "a lot of progress. But they're still not as good as they could be."

PROCEDURES FAULTED. The lapses in manufacturing quality indicate to Hughes watchers that companywide management control procedures were either not in place or not working well. One reason lies in Hughes's mushrooming growth since the late 1970s. Sales soared from $2.2 billion in 1979 to $6.2 billion last year, and personnel and plants kept pace. Another cause is the structure of the company. Many important decisions are made in the nearly autonomous operating groups formerly headed by strong-willed veterans (many now reaching retirement age). The groups have often seemed to resemble a loosely tied confederation.

This is a problem common in large companies, where it is often difficult to effect smooth exchanges of technology among divisions or programs. To help, Hughes established a corporate office for technology in 1984. Since GM's arrival, the informal monthly meetings of all operating heads that have been a practice for years have continued, but too many cases of duplication still exist, many executives believe. That's where GM—a leading example of a centralized corporate vehicle—can help, they add.

To more smoothly coordinate the freewheeling Hughes groups, Albert D. Wheelon, who now heads the Space and Communications Group, has been selected. He is highly regarded as an effec-

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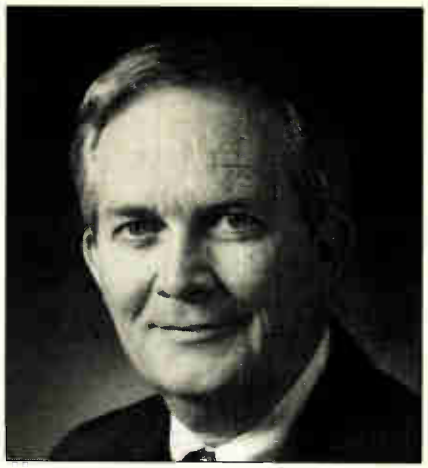
DONALD J. ATWOOD: GMHE president wants Hughes technologies for autos.

MALCOLM R. CURRIE: Hughes vice president is now also president of Delco.



DONALD H. WHITE: Hughes president wants to improve manufacturing.

tive executive, perhaps the hardest driving in Hughes's top ranks, and sources inside and outside the company say his own tightly run group reflects it. Under him, Space and Communications has become a world leader in commercial satellites. Wheelon holds an advanced technical degree, a PhD in physics, regarded as a necessity in riding herd on the company's diverse technological interests.

Regardless of who heads the company, one of the toughest calls Hughes and GM have to make is how to handle R&D. When the company was private, management was free of the compulsion for short-term success and could take the long view. It also could spend more for research, as a percentage of sales, than public companies customarily do. "That [was] the advantage of Hughes, the source of its technical sophistication," says aerospace and electronics industry analyst James Jeffs of Siedler Amdec Securities Inc., Los Angeles. "Are they going to lose it? It's a real worry." Don't fret, says the company. Though it won't break out R&D figures, it says spending in 1986 will be higher than it was in 1985.

GMHE president Atwood also takes pains to dispel concerns about R&D. GM's consistent theme is its regard for Hughes's technology, especially as it affects autos, he says. This means keeping R&D levels high, he emphasizes. Furthermore, steps are already being taken to coordinate programs at Hughes's Malibu labs and the GM equivalent, its Technical Center. The intention is not to reduce activities, "but to cut out the overlap and cover a greater number of areas," he notes. Even with the stepped-up concentration on upgrading GM products, Hughes's "main thrust still is directing technology into defense and space."

But in this, its principal business, Hughes joins the ranks of defense-related companies in general, which foresee few new major programs and growth receding from the 23% compound rate of the early 1980s. The solution in such periods always has been to play the enhanced-products game: with sales spread over about 1,500 programs, Hughes has started offering improvements on equipment already installed. The hope is that any federal cutbacks will have little effect.

Also important, says White, is that "we have some insulation by diversity alone." No single contract bulks large, with some 10 projects representing about 35% of sales in 1985.

Forecasts for the company are murky because of GMHE's business mix and the fact that detailed combined financial data does not yet exist, analysts say. However, the $10 billion in 1985 combined sales of Hughes Aircraft and Delco Electronics would have made GMHE, had it existed then, the 36th largest U.S. industrial company. Even with the consensus that defense sales will grow about 10% annually—a figure that could be altered by federal budget cutting—the picture is clouded by the variable of Delco production levels that are tied to the auto business.

Also, the synergy of combined Hughes-GM talent lies far in the future. In fact, Los Angeles analyst Jeffs thinks GMHE financial results will not be meaningful for at least a year. "There's not enough data yet to analyze by traditional methods," he says. Adds Larry Lytton, who follows Hughes for New York's Drexel Burnham Lambert Inc., "It's a difficult situation to follow."

As for the outlook concerning the

IT WAS PUCKETT WHO SET HUGHES ON ITS UPWARD COURSE

PUCKETT: Hughes's driving force.

Company watchers credit Allen E. Puckett as the driving force behind Hughes Aircraft Co.'s meteoric surge of recent years. He became chairman and chief executive officer in 1978, when sales stood at $2.2 billion, and led the company to $6.2 billion in revenue in 1985.

But Puckett, 66, is said to be contemplating retirement after overseeing the transition of Hughes into a component of the new GM Hughes Electronics Corp. A formal announcement likely will not come before next year, however. Speculation about his successor centers on two questions: whether GM will fill the job from within Hughes, and whether the new boss will have a heavy scientific background, which is usual for Hughes.

Puckett joined Hughes in 1949 and moved into the chairman's seat after the retirement of Lawrence A. Hyland. Hyland held the top post from 1954 to 1978, a period when the company's management was in turmoil because of the eccentricities of sole owner Howard R. Hughes. He is credited with elevating Hughes's research and development arm to its current level of esteem.

Hyland took the reins with the approval of Hughes Aircraft's principal customer, the U.S. Air Force, which was concerned about maintaining a stable source for important missile and electronic equipment. *–L. W.*

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Jerry DaBell
Manager, ASIC Design Tools & Methods
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technology flow from Hughes to GM, there is some skepticism. "It won't work for them; there is no successful precedent for buying a company only to get technology," states the top executive of one longtime supplier to Hughes, who declines identification. Analyst Lytton's opinion is representative of the New York financial community. "Talk is the easy part. Actually getting into production is difficult," he says.

But Jeffs sees "exciting potential, a real possibility it will work. Hughes is too well positioned on all sides with all the right technologies." In fact, he maintains, purchase of GMHE shares is practically risk-free.

That brings up an unusual financial payout provision in GM's acquisition agreement with Hughes Medical Institute. If the price of the Class H stock issued for the new subsidiary is less than $60 a share on Dec. 31, 1989, GM must make up the difference. Thus, it is important to GM that the new subsidiary get off to a strong start, because GM's potential liability for the stock, recently selling for about $45, is $2 billion.

Analysts believe GM will take whatever measures are necessary to reach or exceed this price. They also are convinced that many changes will take place this year as Hughes reorients itself as part of a public company. But officials have not altered the way they want the company to be perceived: simply, says White, "as the best high-tech house in the country—and as a good, low-cost defense supplier, too." □

HOW ALMQUIST WILL BLEND IN DELCO

As vice president and general manager of the reorganized Delco Electronics Corp., Donald J. Almquist faces challenges on two fronts.

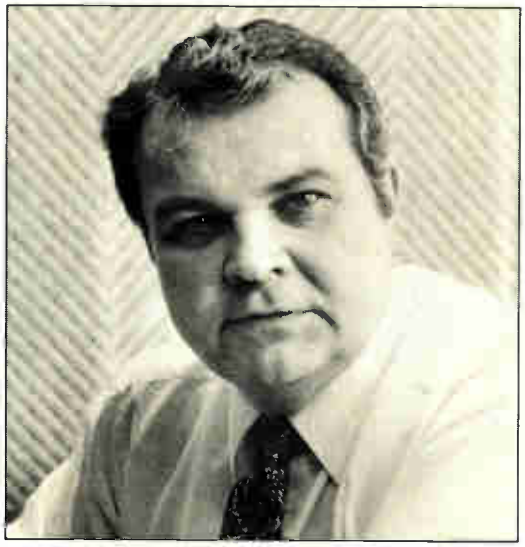
On one, he is the Kokomo, Ind., unit's point man in ensuring a smooth exchange of manufacturing and technology capabilities between Delco and Hughes Aircraft Co. following General Motors Corp.'s acquisition of the aerospace giant last June. And he also must focus on how best to blend previously separate GM entities into a new Delco organization.

Delco Electronics has been paired with Hughes to make up GM Hughes Electronics Corp. (GMHE), itself a wholly owned GM subsidiary. Besides Delco's Kokomo operation—previously GM's Delco Electronics Division—the new Delco Electronics also includes a portion of GM's AC Spark Plug Division in Flint, Mich., and GM's previously separate Delco Systems Operations, a military and commercial avionics supplier in Santa Barbara, Calif.

As the core of the new Delco Electronics, the Kokomo operation brings low-cost high-volume manufacturing expertise to the GMHE combine. During 1984, the last full year for which figures are available, GM's Delco division racked up more than $2 billion in business, selling radios, engine-control modules, and other semiconductor-based systems primarily to GM's automotive divisions. This year, Delco will manufacture about 30,000 radio systems per day and a like number of engine controllers; its three in-house semiconductor fabrication lines will churn out some 112 million integrated circuits for use in GM systems.

DIFFERENT GAME. "It's obvious that with our volumes, we play in an entirely different game than Hughes," says Almquist. "I'm satisfied that we probably have far better production and material controls than they do, for example, and we can help them with that." In fact, James M. Hall, Delco's former general manager for manufacturing, has already been transferred to Hughes.

At the same time, Almquist notes that Delco is looking to Hughes for new technologies and expertise in systems engineering that can be useful in its automotive products. Hughes people have already joined a GM task force developing an electronic antilock brake system. "With the growing amount of electronics in the automobile, we're making a major effort to pursue what Hughes can do to help us provide more reliable systems at a lower cost," he says.



ALMQUIST: Looking to Hughes for new technology.

Hughes's systems engineering expertise could prove helpful in merging the Instrumentation and Display business, previously part of AC Spark Plug, into Delco's Kokomo operations. AC Spark Plug's sales of instrumentation systems, including speedometers, tachometers and gauges for temperature, pressure, voltage, and fuel level, amounted to about $500 million in 1984, with most going to GM's automotive divisions.

"We've got a lot of people at work right now trying to carve that part of the business out of AC Spark Plug," says Almquist. The change will likely include the merging of marketing, engineering, and, eventually, manufacturing functions of the two formerly separate GM organizations, Almquist says. And once the transition is complete, officials plan to take a more top-down, systems-oriented approach to instrumentation system design. "Hughes will help us come up with designs that are going to make us more competitive," Almquist predicts. "They'll help us look at the total system."

Bringing in the third part of the new Delco—the Delco Systems Operation—will be more straightforward, because the Santa Barbara business was a stand-alone operation. A maker of avionics, guidance, and navigation systems for military and commercial markets, Delco Systems did some $207 million worth of business in 1984.

In all, Almquist figures the total integration of the three GM entities into the new Delco organization could take about three years to complete. "We want to think fast about all of the things that we need to do and then maybe we'll act slowly, because we don't want to charge into some major change without understanding all the impact," he says.

NEW BUSINESS. Some observers have suggested that to boost GMHE fortunes, GM could eventually channel into Delco additional business now handled by its other divisions. "I haven't participated in any discussions along those lines, but there probably would be businesses within GM that could more properly fit within GMHE," Almquist allows. For example, businesses such as cruise-control and mass-airflow systems now handled within AC Spark Plug could fall into that category.

"Any of the electronics businesses might be more cost effective and better managed if it were part of Delco, and I imagine they [GM management] will look at that at some point," Almquist concludes. *–Wesley R. Iversen*

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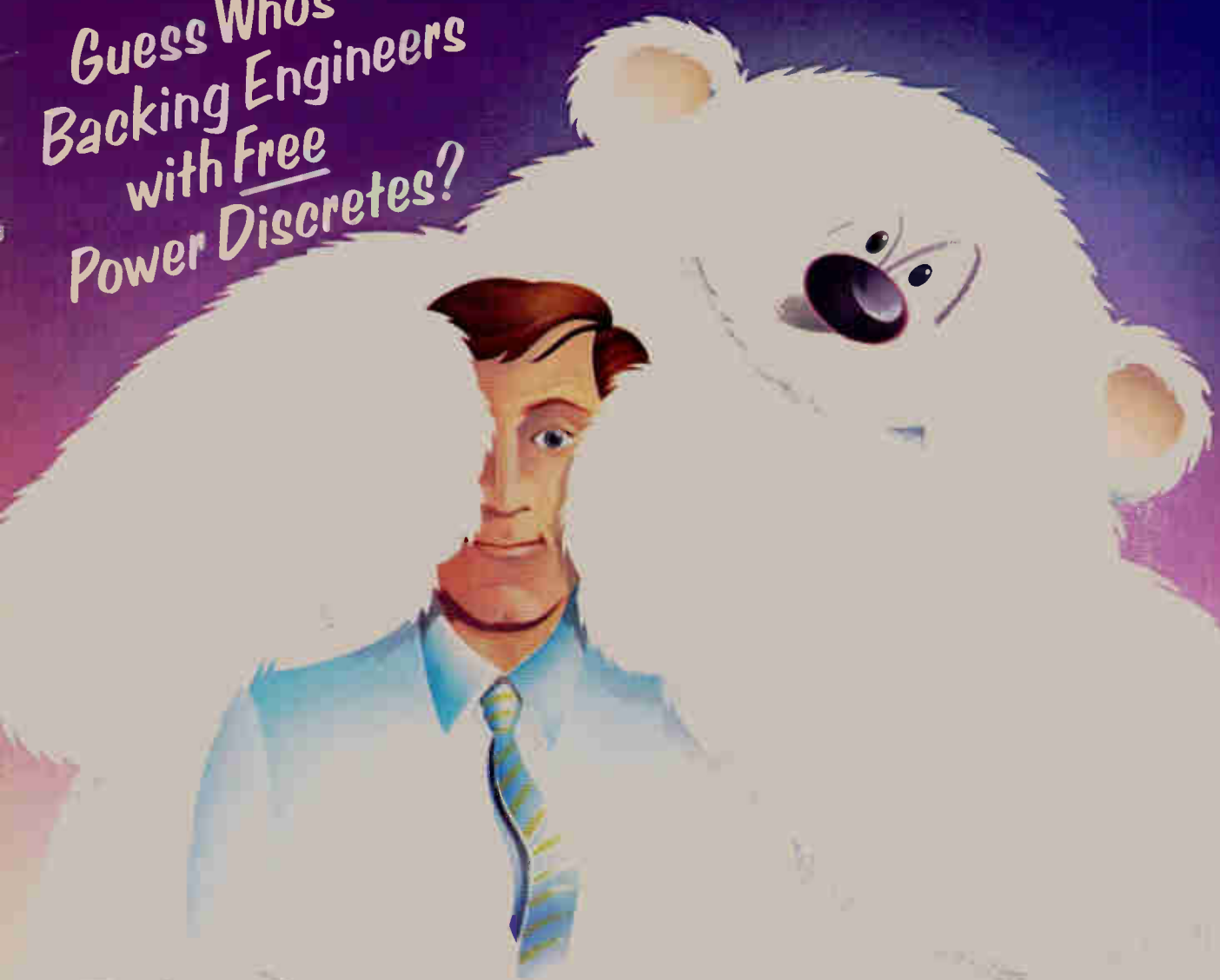

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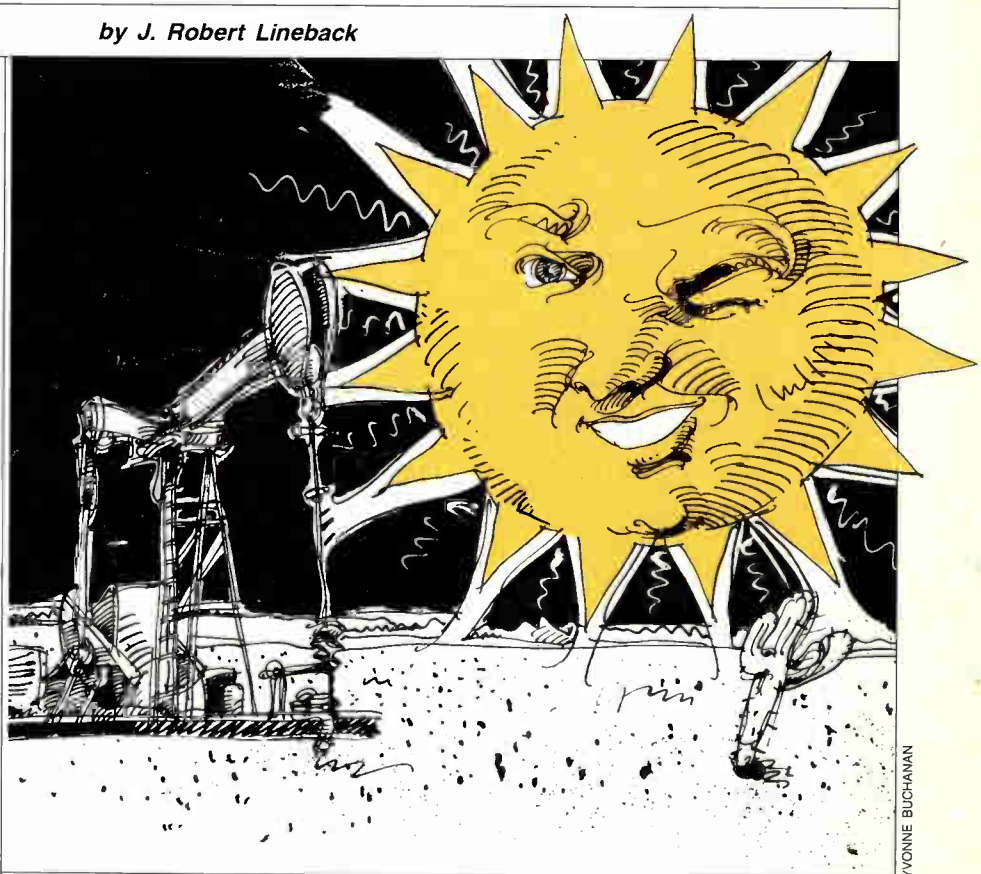
CAN PHOTOVOLTAIC RESEARCH FIND A NEW PLACE IN THE SUN?

OIL GLUT DOUSES TAX INCENTIVES AND SHRINKS RESEARCH DOLLARS

by J. Robert Lineback



YVONNE BUCHANAN

GOLDEN, COLO.

Plunging oil prices have removed much of the urgency—and the financial incentive—from research in photovoltaics, once deemed the last best hope of an energy-hungry world running low on fossil fuels. But low oil prices won't last forever, so photovoltaic technology lives on in the materials research labs of companies hoping to capitalize on what could be a $10 billion industry by the year 2000.

Suppliers are switching from the across-the-board panic mode adopted in the early days of the 1970s' oil crisis to a focused search for more efficient techniques for converting sunlight to energy. In doing so, researchers increasingly look for near-term profit potential.

The shift from oil shortage in the 1970s to oil glut in the '80s has doused tax incentives and scrapped government-backed crash research projects. But that's not all bad, claims Jack Stone, director of the Solar Energy Research Institute's Solar Electric Research Division, a branch of the Department of Energy in Golden, Colo. "We look forward to doing our research in a period of calm rather than one of crisis.

"One problem back in the '70s was that we were doing everything in a crisis, and it is very hard to quickly develop a new energy technology when a 10- to 15-year time lag is normally involved," Stone adds. As the industry waits for conventional energy costs to rise again, it is taking the time to find more stable near-term markets, such as in the Third World.

EFFICIENCY CLIMBS. Experimental multijunction photovoltaic cells, fabricated from amorphous thin films and semiconductor compounds, aim at capturing 35% of the sun's energy. More conventional single-crystal and polycrystalline silicon cells have already cleared the 10%-efficiency hurdle, making solar arrays a practical alternative to diesel-driven electrical generators in impoverished, remote locations.

Sun-powered applications on the horizon include remote electrical generators for consumer entertainment electronics, navigation systems, and pumping stations. Many product planners want to put a solar panel atop every car. Others hope to glaze office towers with low-cost thin-film photovoltaics. But these days, few talk about wholesale replacement of electrical power grids.

In addition, few researchers talk about unlimited funding for their work. The DOE's budget for photovoltaics research projects has tumbled from a high of $149.6 million in 1981 to $43.1 million in fiscal 1986. Moreover, tax credits for solar energy ended last year [*Electronics*, Sept. 23, 1985, p. 32]. "Domestically, the tax-credit issue will hurt the business," predicts David Gorin, executive vice president of the Solar Energy Association in Washington.

The erosion of domestic technological efforts has some photovoltaics leaders concerned. Aggressive Japanese photovoltaics producers continue to leverage new systems off volume shipments to the island nation's handheld calculator business—the largest consumer of solar power panels today. In 1985, Japan took over the volume production lead from the U. S. for the first time, Gorin says.

The new activity in advanced photovoltaics has become a rare case of leading-edge technology having its best opportunity in the world's underdeveloped regions. "It is an odd market in that respect," says Robert Steele, who tracks photovoltaics for market researcher Strategies Unlimited, Mountain View, Calif. With large government demonstration projects ended and utility-oriented power systems at least 10 years away, he says, "in the intermediate period, the remote market will carry the industry. And that will start out in the Third World, which has poorly developed electricity networks."

Steele estimates this segment will continue to grow 30% to 40% a year. Strategies Unlimited says the worldwide market for photovoltaics modules has grown from $35 million in 1980 to $140 million last year. By 1990, sales will cross the $400 million mark.

"Industry is now concentrating [R&D] on the near term and, hopefully, the

profitable projects, while government programs are more focused on taking part of the risk of long-term research activities," notes Stone. His DOE branch will give solar-energy scientists from industry, university, and government labs a chance to compare notes in May at the seventh annual review meeting of the Photovoltaic Advanced Research and Development Project in Denver.

SPLITTING SUNLIGHT. At the meeting, solar-energy advocates expect to get another dose of encouragement about the long-term future of photovoltaics and prospects of eventually plugging into a huge energy market now served exclusively by electric-utility grids. One of the most promising projects is research on multijunction stacked cells, which split light into multiple band gaps to use more of the sun's energy than conventional silicon photovoltaics. Multijunction cells are being developed for thin-film materials, single-crystal structures, and gallium arsenide-based alloys under a number of privately financed and government sponsored projects, both in the U. S. and overseas.

Mutiple-band-gap cells are made from optically and electrically connected layers of semiconductor materials, each containing different mixtures of alloys. The material content of the layers gives each layer different spectral-response characteristics, enabling it to absorb only a limited band gap of sunlight. Conventional single-junction cells have a single band gap, and wasted solar energy is given off as heat.

Using a variety of materials and processing techniques, the multiple-band-gap materials are arranged such that the shorter wavelengths of high-energy green and blue light are absorbed by top layers of stacked cells. Low-energy long-wavelength red light passes through the top layers and is absorbed by the bottom material.

Theoretically, the more layers, the greater the potential for high efficiency. Most researchers agree, however, that three junctions are likely to be the practical limit, as each additional band-gap layer increases manufacturing complexities with diminishing gains in energy.

"There are several other key areas of promise in photovoltaics. But there is certainly starting to be a consensus that if we are ever going to reach the energy-significant markets—particularly the utility markets—we need a combination of low cost and high performance," says Stone. "Right now, the tides are pulling toward multijunction thin films. Because you have the inherent potential from thin films and because it is multijunction, you also have the potential for high performance and efficiency."

Stacked-cell, multiple-band-gap technology is being readied for its first commercial uses. Energy Conversion Devices Inc. claims 13% power-conversion rates with a new triple-junction amorphous solar cell in its labs. The Troy, Mich., company, which is exploring photovoltaics markets through a partnership with Standard Oil Co. (Sohio), Cleveland, is designing prototype panels for the new spectrum-splitting cell.

The Third World may have to carry the market

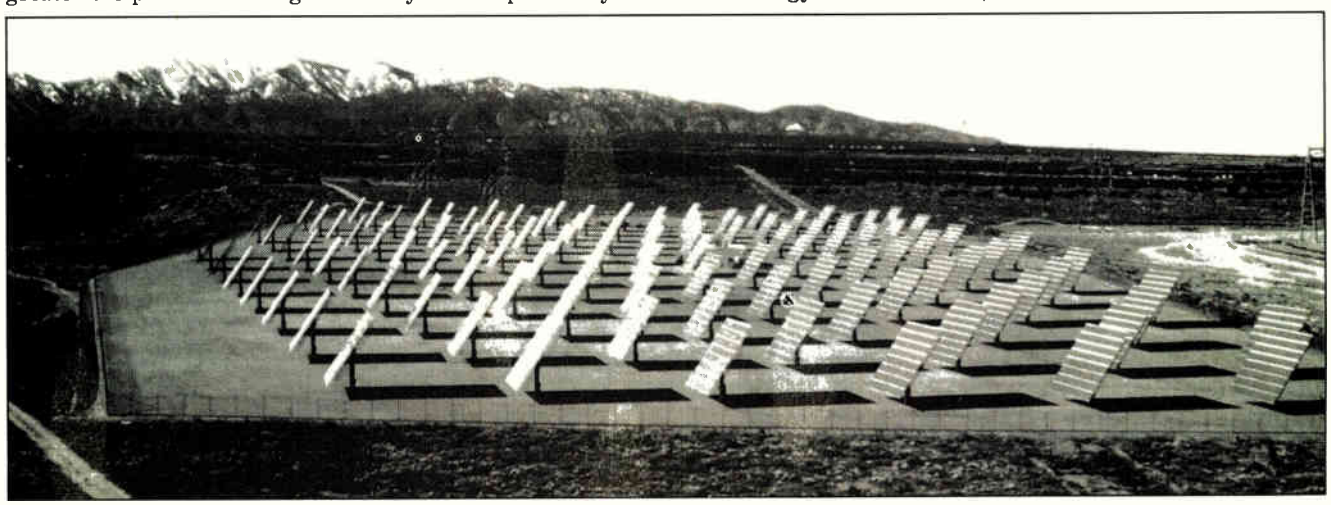
Energy Conversion Devices and its Sovonics Solar Systems partnership with Sohio were the first to market a tandem-junction solar cell made from fluorinated amorphous thin-film silicon. The tandem-junction photovoltaics, which are used in Sharp Corp.'s calculators and other power-generating products from Sovonics, do not split sunlight into different band gaps, however. Instead, Energy Conversion Devices uses the stacked cell layout to improve the stability of amorphous thin-film photovoltaics, says R&D vice president Stephen J. Hudgens.

Both layers of the tandem-junction cell are made from the same amorphous silicon alloy. Stacking the redundant amorphous layers allows Energy Conversion Devices to produce thinner, more sensitive elements while avoiding degradation effects that plague thin-film solar cells. To boost efficiencies from the 10% obtained from the tandem junction, Energy Conversion Devices adds a fluorinated silicon germanium alloy to the bottom of its multijunction sandwich to catch the low-band gap of infrared light and raise efficiency to 15%.

Solarex Corp., an Amoco subsidiary in Rockville, Md., has also fabricated experimental spectrum-splitting stacked cells in its thin-film photovoltaics lab and is preparing its first commercial prototypes for a soon-to-be-announced joint venture. David E. Carlsen, deputy general manager and director of R&D at Solarex' thin-film division in Newtown, Pa., says studies indicate double-stacked junctions will boost the theoretical limit for thin-film photovoltaics to over 30%, versus 25% for single-junction amorphous cells.

Arco Solar Inc., which industry sources estimate holds more than 30% market share in photovoltaics shipments, is working on a tandem cell constructed from amorphous silicon for the top band-gap layer and a second alloy, such as copper indium diselenide, for the lower level. Laboratory results also indicate efficiencies in the 13% range, says James H. Caldwell Jr., president of the wholly owned subsidiary of Atlantic Richfield Co. in Chatsworth, Calif. "We are looking to achieve commercial-device efficiencies in the 18% range in the next three to five years."

Caldwell sees the photovoltaics challenge in the last half of the decade as one of product packaging and market development. "There is much more focus today on real transaction and real business and less focus on demonstrations aimed at the dream of covering half of the Southwest desert with photovoltaics," he adds. □



ABSORBING THE RAYS. The sight of large arrays of solar panels, such as those at a test site in Colorado, could become rare.

HALLEY'S COMET SPACE ENCOUNTER SET FOR MARCH.

The ultimate space encounter is about to begin. Halley's comet, making a brilliant comeback after 76 years, will soon provide scientists with a once-in-a-lifetime opportunity to shed new light on the origins of the solar system.

As part of a global research effort, Japan's Institute of Space and Astronautical Science, the Ministry of Education, has sent out a welcoming mission of twin interplanetary probes—SAKIGAKE (Pioneer) and SUISEI (Comet)—which are due to intercept Halley's comet in March '86 soon after its closest approach to the sun.

The two deep space explorers will obtain invaluable new data on solar wind—waves of plasma emitted by the sun—and its effect on the comet. Simultaneously, SUISEI will reveal the 3-dimensional structure of the hydrogen cloud surrounding the coma with an ultraviolet TV camera and beam the image data to the earth up to 170 million km away.

For its part, NEC's involvement in these space probes included system design, system integration and the manufacture of major subsystems for telemetry and command, the antenna, power, data processing, attitude and orbit control.

With 20 years of experience in space development NEC has contributed, as a prime contractor or system integrator, to 20 of the 32 satellites placed in space by Japan since 1970.

Photos courtesy of the Institute of Space and Astronautical Science, the Ministry of Education, Japan.

NUMBER 134

KUWAIT CHOOSES NEC CELLULAR MOBILE TELEPHONE.

NEC will install an integrated cellular mobile telephone system in Kuwait by the 3rd quarter of 1986, paving the way for truly high-grade services nationwide.

NEC's total access communications system featuring 25kHz frequency spacing in the 900MHz band will initially serve up to 25,000 subscribers, and can be expanded to accommodate up to 100,000 subscribers.

Awarded by the Mobile Telephone Systems Company (MTSC) of Kuwait, the full turn-key contract calls for NEC to manufacture and install all key equipment, including an advanced digital switching system plus radio equipment for 21 base stations and 15,000 mobile telephones. MTSC is a shareholding company, 49% Government and 51% public, established to run all mobile communications in the State of Kuwait.

Moreover, NEC will also provide the latest microwave radio and fiber optic links to interconnect the central switching system and base radio equipment, and a medium-scale computer for message accounting and communications traffic control.

This massive project is well under way, drawing upon the integrated computer and communications technology of NEC and expertise of all concerned companies.

Upon completion, the new system will provide sophisticated services such as "Call Transfer", "Call in Absence" and "Privacy".

NEW TTC & M EARTH STATIONS FOR ARABSAT.

An advanced NEC satellite control network is now providing complete tracking, telemetry, control and monitoring (TTC & M) services for the Arab Satellite Communications Organization (ARABSAT) which is comprised of 22 Arab League countries.

The ARABSAT Satellite Control Network analyzes and processes satellite telemetry and tracking data, and commands and monitors operating conditions of the Arab world's first series of communications satellites—the ARABSAT-1A and ARABSAT-1B.

This integrated control system consists of a primary earth station at Riyadh, Saudi Arabia, and a secondary station at Tunis, Tunisia. All necessary equipment including computer hardware and software systems, were developed and installed by NEC on a turn-key basis to assure optimum system performance and long-term reliability.

NEC's contribution to the growing ARABSAT network also includes the completion of three earth stations—one each in Jordan, Bahrain and Tunisia—and it is now manufacturing 7 more for use in other Arab countries.

The ARABSAT system can accommodate 8,000 simultaneous telephone circuits, seven television channels and a community television channel for isolated rural areas. It can also provide telex and data transmission services, and other specialized services.

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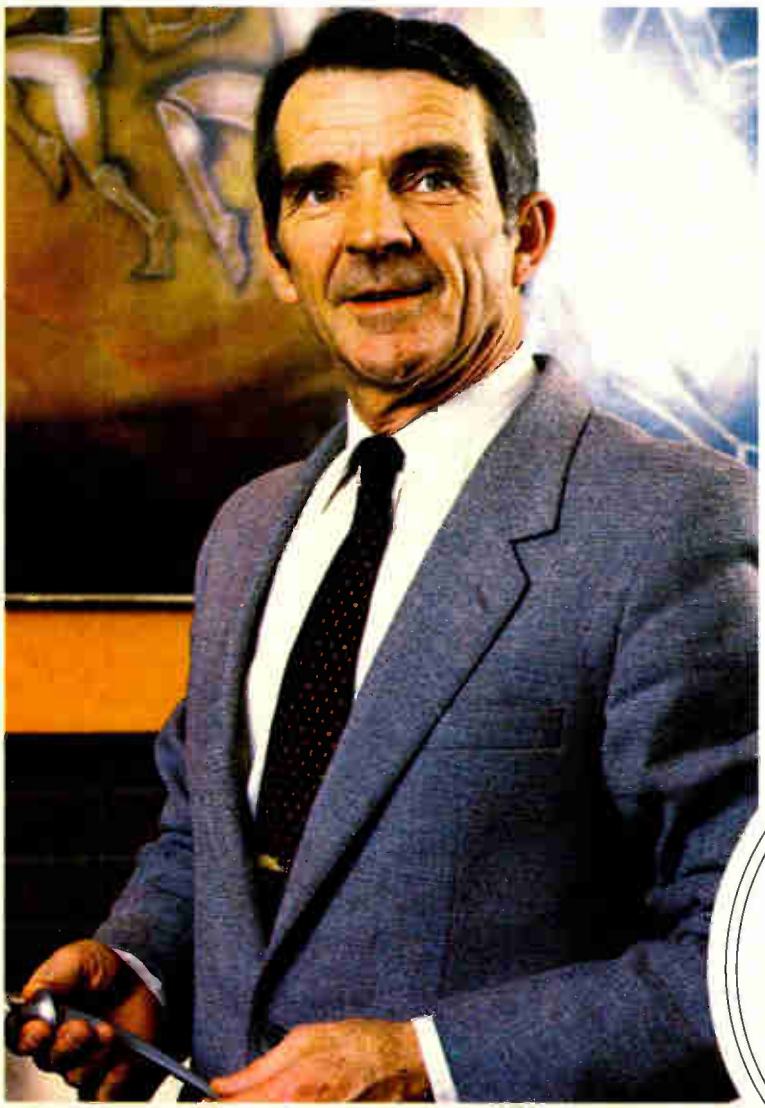
Managing Director, Howmedica International Inc. Ireland.
Division of Pfizer Chemical Corp.



In 1971, Howmedica International Inc. centralised all ex-US distribution of its range of orthopaedic implants and instruments at Shannon International Airport, Ireland. From Shannon, Howmedica profitably and effectively supports its distributors, not only in Europe, but in the Far East, Japan and Australia.

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SHANNON, IRELAND

VTI's ASIC STRATEGY SHOULD BEGIN PAYING OFF

WITH ORDERS INCREASING DRAMATICALLY IN RECENT MONTHS, REVENUE SHOULD BREAK THE $100 MILLION MARK THIS YEAR

SAN JOSE, CALIF.

It has taken VLSI Technology Inc. almost seven years, but now the company is set to see its long-term strategy in the application-specific integrated-circuit business pay off. VTI is emerging from the 1985 semiconductor recession with a stronger emphasis on its proprietary products and is expanding into both new product and geographic markets.

The San Jose company, which began by offering custom and programmable devices and design services, now has a base of mature design tools and a broad selection of specialized memory products and standard logic to complement custom and semicustom designs. It is also relying on joint ventures and second-source agreements to give it momentum in the rapidly expanding ASIC market.

"I think it has the best position of any small company in the industry," says Paul Johnson, an analyst at New York's L. F. Rothschild, Unterberg, Towbin Inc. "They'll do very well."

PICKING UP. Business is already starting to improve. "Order rates have turned up pretty dramatically in the last three to four months, and the design business has really picked up," says George W. Jones, director of marketing for application-specific products.

That should help VTI rebound from last year. Revenue rose 13% to $78.7 million from 1984's $69.5 million, but VTI barely broke even—its net income was only $16,000, versus $7 million in 1984. "The company's earnings have been mediocre because they've invested so much in research and development," says Michael Stark, a research analyst at San Francisco's Robertson, Colman & Stephens. Overall, revenue should break the $100 million barrier this year, says VTI president Henri A. Jarrat (charts).

PLEASED. VTI chairman Alfred J. Stein (left) and president Henri A. Jarrat are seeing their strategy pay off.

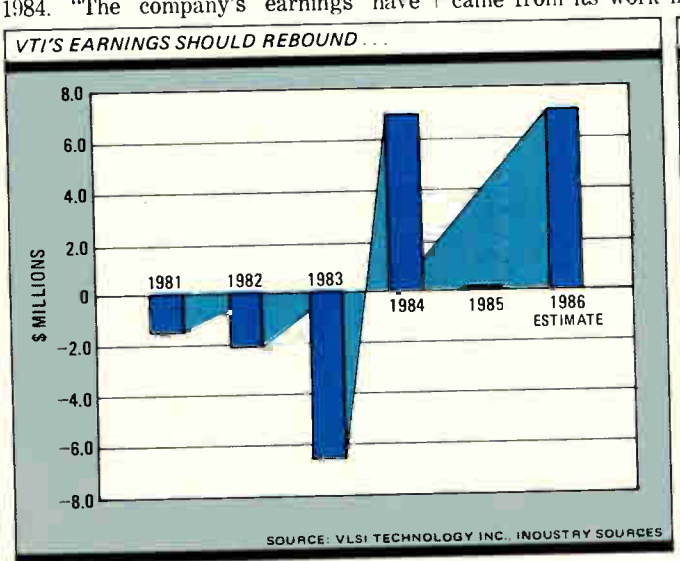
Much of VTI's 1985 revenue gain came from its work in standard cells, a $235 million market last year that Dataquest Inc., the San Jose market researcher, sees growing to $2.4 billion by 1989. In 1985, VTI was second among U. S. standard-cell design companies with $43 million in revenue, up from 1984's $16 million, Dataquest estimates.

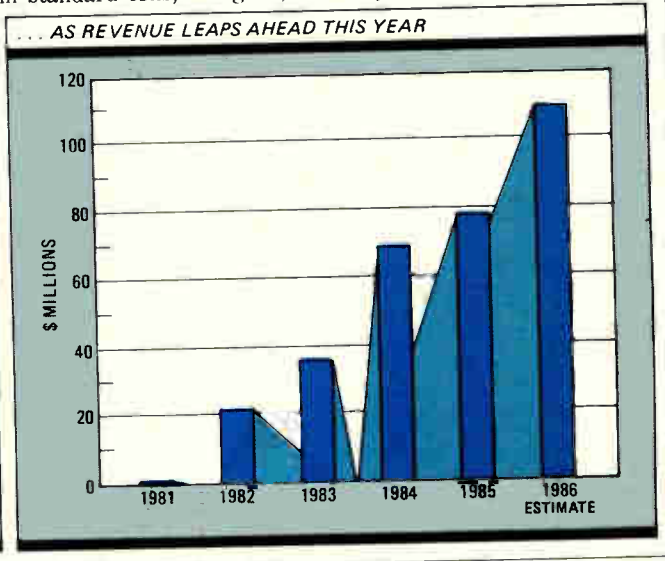
VTI's main business groups are user-defined products and the tools to design them, memory products, and application-specific logic products. These groups build on a common set of cell-based design tools, available at VTI's design centers or through work-station licenses, and on state-of-the-art process technology that includes 1.0- to 1.5-μm CMOS. "Design and process are the driving strategy" for VTI, says Jarrat. "What VLSI Technology brought to the industry was design tools," he claims.

VTI operates five design centers in the U. S. and one in Europe. This year it expects to open three or four more centers in the U. S. and in London, Paris, and Tokyo. Distributor Arrow Electronics Inc.—which VTI chairman Alfred J. Stein once headed—is setting up three centers for the company's tools.

Jarrat says VTI's approach helps develop designer loyalty. "Once customers have completed their first design with our software, they're more likely to use our software for the next design because they invested the time to learn it," he notes. "We want to be there with the product capabilities the designers need so there is no reason for them to look to another supplier."

VTI gets high marks for its tools. "Their CAD system seems to be pretty good, and they have a lot of experience





with their silicon-compiler technology," says Andrew Prophet, senior industry analyst with Dataquest. "Some of the other standard-cell people, such as some of those on the second and third tier, don't have the tools available yet to capture their designs," Prophet adds. "Their strategy with design tools is coming around quite nicely," says Stark of Robertson, Colman.

Partnerships have played a big role in VTI's development. With Fairchild Semiconductor Corp., VTI exchanges its silicon-compilation methods for gate-array process expertise. VTI does much of Lattice Semiconductor Corp.'s fabrication work and in return has second-sourcing rights to some of Lattice's products. The company second-sources Sierra Semiconductor Corp.'s 1,200-b/s single-chip modem, and Sierra's analog-cell library enhances VTI's design library, while Sierra uses VTI tools. Zilog Inc. also uses VTI tools; in exchange, VTI is converting some Zilog products—in particular, the Z80 microprocessor—to megacells.

VTI is No. 2 in standard cells, Dataquest says

MORE PARTNERSHIPS. VTI will depend on more partnerships in the future. As the company moves into Japan this year, it will look for local manufacturing support, says Jarrat. A joint venture involving a prototyping facility tied to the new design center is likely at first, and "eventually we will have our own manufacturing in Japan. Similarly in Europe, down the road we are looking at a manufacturing presence."

At least one analyst thinks VTI could be taking the wrong tack. Stark of Robertson, Colman criticizes VTI's deal making. "Some of the deals are interesting, but they aren't VTI's main mission. They can't be all things to all people. I wish they would focus more on their design tools instead of diluting their efforts by getting into other areas."

VTI still relies heavily on its memory-product business, and it underwent a major transition last year, says Lou Williams, memory marketing manager. "Prior to last year, we were only in ROMs. We've moved to SRAM, EPROM, and E^2 technologies." VTI plans to mix technologies on the same chip and combine logic and memory for smart memory products.

And this year, VTI plans to offer samples of some 30 proprietary logic products based on megacells developed in the ASIC group. The most hotly anticipated product is the company's first digital signal processor, expected for sampling in the early fall. *–Eve Bennett*

BOTTOM LINES

ZYMACOM GETS MONEY FROM GENERAL SIGNAL

Zymacom Inc. has received $2.5 million in financing from General Signal Corp., Stamford, Conn., bringing the diversified electronics company's investment to about $8 million. Zymacom, founded in February 1984, says General Signal plans to invest another $2 million as part of a July 1984 financing agreement. The Westford, Mass., company plans to soon introduce an office communications system that integrates existing computer and telephone systems to provide messaging and voice/data communications. It will use the new funds to build its sales and marketing forces.

LAN-TEL FINANCING YIELDS $4 MILLION

Lan-Tel Inc. has raised $4 million in its first round of venture financing. The Orleans, Mass., company plans to develop an integrated and multinodal private branch exchange/local-area network business communications system. The company says it will use the new capital to develop its prototype products into commercial systems. Lan-Tel demonstrated a single-node system in February 1985, a double-node system in April, and a triple-node product in June. Lan-Tel plans to move to the Boston area in May.

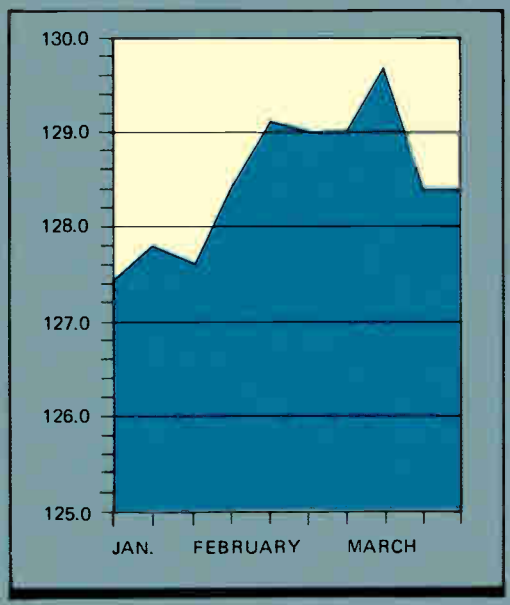
WALKER ACQUIRES ROCKWELL'S RECTICON

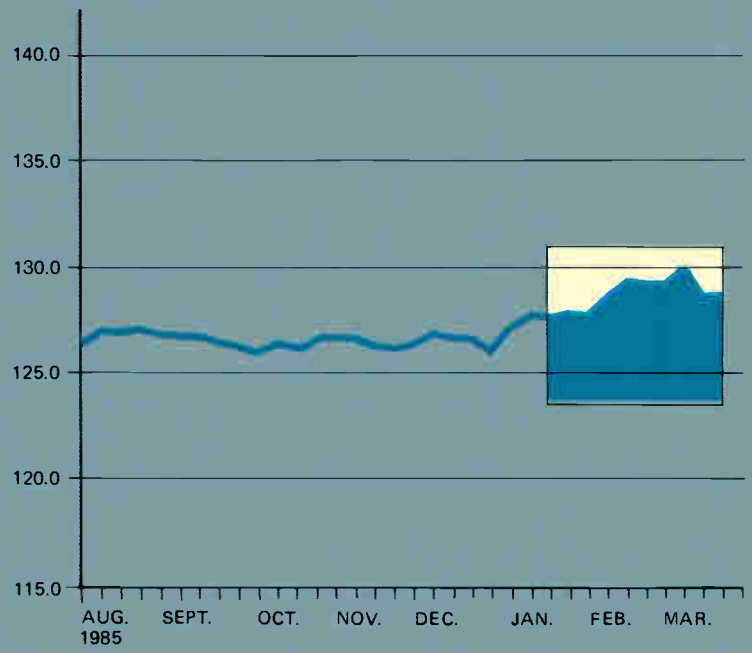
Chemical supplier Walker International Industries Inc., Elmsford, N.Y., has purchased Recticon Corp. from Rockwell International Corp. for an undisclosed amount. Recticon, a silicon-wafer maker, has been in business for over 12 years and had revenue in 1985 of about $5 million. The Pottstown, Pa., company will be operated as a wholly owned subsidiary of Walker International.

NBI BUYS OFFICE SUPPLIES COMPANY

NBI Inc., the Boulder, Colo., supplier of office and technical computer systems and a distributor of office products, said it has acquired Kershaw's Inc., Spokane, Wash., for an undisclosed amount. According to NBI, Kershaw's had revenue in 1985 of more than $5 million and is a source of office supplies, machines, and furniture. Kershaw's is the fourth office-supplies company that NBI has acquired in the past 15 months. Kershaw's, NBI said, will become a unit of its Yukon Office Supply Inc. operations.

ELECTRONICS INDEX





THIS WEEK	= 128.4
LAST WEEK	= 128.4
YEAR AGO	= 129.1
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 & EXPORTS ($ MILLIONS)

	IMPORTS			EXPORTS		
	January 1986	December 1985	January 1985	January 1986	December 1985	January 1985
Accounting, computing, and data-processing machines	460.671	355.004	416.511	522.626	531.869	669.750
Calculators	50.398	37.852	67.697	4.492	5.377	8.066
Parts for data-processing machines and office calculators	388.006	359.227	392.508	523.361	504.004	611.387
Telecommunications, sound-recording, and sound-reproducing equipment	1,599.495	1,553.283	1,741.332	351.683	339.748	361.749
Electronic or electric instruments	148.128	157.187	131.984	540.149	517.525	567.128
Printed-circuit boards	17.105	20.845	21.428	26.259	23.775	28.822
Integrated circuits, diodes and other semiconductors, tubes, piezoelectric crystals, parts	473.515	420.821	630.816	345.358	289.587	527.517
Fixed and variable resistors	26.057	26.558	23.364	11.971	10.733	15.117

Although the value of the U. S. dollar has fallen against the yen and most European currencies, the drop has yet to stem the tide of imports of electronic goods or to restore exports of U. S. goods to historical levels. Imports of foreign electronics products rose 8% in January. Exports increased by nearly 5%, but this was not enough to prevent the trade deficit in electronics products from growing 18%, to $838 million. Imports were down almost 8% from January 1985, but exports were off by more than 16%. Nonetheless, the deterioration in January of the U. S. trade situation was not large enough to damage the *Electronics* Index.

Components cast the one ray of light on this gloomy picture. Imports of printed-circuit boards dropped 18% from December 1985, while exports grew 10%. Though integrated-circuit imports were up 21%, exports rose 19%—almost offsetting that increase. And imports of resistors fell 2% as exports advanced 12%.

On the equipment side, imports of instruments dropped 6% and exports increased 4%, while a 4% gain in exports of telecommunications equipment exceeded a 3% rise in imports of these products. But exports of data-processing gear slipped 2%, while imports surged 30%.

BACK FROM ITT, SMITH PUSHES AT&T SOFTWARE

WILLIAM SMITH: Aiming to boost AT&T software writers' productivity 300% by 1989.

HOLMDEL, N. J.

William Smith, the newest—and at 42, the youngest—executive director at AT&T Bell Laboratories, became a media sensation early this year with his surprise resignation as chief technical officer for ITT Corp. But now that he's back at Bell Labs, he is eager to put the hoopla behind him.

Smith's dramatic return to AT&T, where he began his career at the age of 18 in 1962, sparked instant speculation on Wall Street that ITT was about to abort its $150 million project to convert the System 12 digital switching system to the U.S. standard. Smith and ITT immediately denied the rumors, but the company nevertheless canceled the project just two weeks later.

The peripatetic Smith—who took his PhD from the University of Pennsylvania at age 24—returns to Bell Labs with broad responsibilities in software development and network planning. He is supervising groups charged with boosting software-development productivity by an unprecedented 300% in three years and with analyzing potential new services and changes for AT&T's long-distance net.

Smith is most excited about the productivity project, calling software "the key ingredient in high technology." With about 40% of Bell's engineers dedicated to software development, the payoff could be staggering.

Smith was executive director for Bell Laboratories' Toll Switching and Operator Services Division when it developed AT&T Co.'s highly successful No. 5 ESS electrical switching system. Then ITT lured him away in 1982 for the post of general technical director of European operations. Late in 1985, he returned to the U.S. as chief technical officer for ITT worldwide.

But Smith soon grew weary of long flights and longer business trips. He thought ITT took him too far away from research and that his time and abilities were wasted on heavy administrative tasks. An engineer at heart, he again has direct contact with the labs.

RECYCLING CODE. Smith says he will emphasize a modular approach to software development in an effort to create writing tools that researchers can call upon to save time. Reusable sections of code can be stored for other projects, and Smith adds that designing a method where software writers would have easy access to a library of software

PEOPLE ON THE MOVE

NAPOLEONE CAVLAN

☐The inventor of field-programmable logic arrays, Napoleone Cavlan, is moving from Signetics Corp., Sunnyvale, Calif., to Monolithic Memories Inc., Santa Clara, Calif. As the new product planning manager for PLAs, he will work on combining PLA methods with the advantages of gate-array logic in a new category of semicustom devices. Before joining Signetics, where he spent 10 years, he was a strategic manager for programmable logic devices at Fairchild.

JAMES H. MOORE

☐The new director of Ford Aerospace & Communications Corp.'s Sunnyvale, Calif., operation is James H. Moore, who before this appointment was deputy director of network support programs. He began his career with Ford Aerospace as a field engineer in Okinawa, Ryukyu Islands, in 1952. Among the projects he will direct are engineering services and support for the U.S. Air Force's Satellite Control Network, survivable space-mission support systems, and engineering analysis programs for the Strategic Defense Initiative.

HOY Y. CHANG

☐Zenith Electronics Corp. has named Hoy Y. Chang president of its Zenith/Inteq Inc., a Herndon, Va., subsidiary that specializes in design and marketing of Tempest microcomputers for the military and other high-security markets. Chang, 44, moves up to the post following five years as vice president of engineering for Zenith Data Systems Corp. He replaces Winfree P. Tuck, who resigned Feb. 28. The holder of a bachelor's degree in electrical engineering and mathematics from Michigan State University and an MSEE from Princeton University, Chang has 20 years experience in the computer industry, including a stint with Burroughs Corp.

GUY RABBAT

☐The new manager of General Motors Corp.'s electronics research is Guy Rabbat, named head of the Electronics Department for the General Motors Research Laboratories, Warren, Mich. Rabbat comes to GM from Tektronix Inc., where he served as vice president of engineering in the CAE Systems Division of the company's Austin, Texas, operations. He began a 10-year tenure at IBM Corp.'s General Technology Division in 1974, serving in such posts as manager of very large-scale integration exploratory circuits and program director for technical development. Rabbat has a BS, MS, and PhD in electrical engineering from Queens University, England.

JOHN PENNEY

☐The fastest-growing group in Mitsubishi Electric UK Ltd., the Electronics Division, is getting a restructured management to add to its strength. John Penney, previously general manager of telephones and personal communications at STC Telecommunications Ltd., has been named the division's managing director. Initially, he is working with his predecessor, Hisao Okada, who has been appointed to the company's board. This move follows last year's promotion of division director Takeo Iinuma to group joint managing director. The division, which comprises mainly computer hardware and components and telecommunications, grew 40% in 1985, hitting sales of $75 million.

JAMES JOHNSON

☐GTE Corp., Stamford, Conn., has reshuffled its top management. James Johnson becomes president and chief operating officer after 37 years with the company, the last three as corporate senior vice president and president of GTE's Telephone Operating Group. Industry observers say the change is an effort to groom a successor to chairman and CEO Theodore Brophy.

modules may be the most important step in increasing productivity. But he also stresses needs to improve communications among software developers working concurrently on separate segments of the same program and to formulate an organized plan of attack during development.

The other major part of Smith's job is to oversee the move to a nonhierarchical strategy for long-distance switching. AT&T began the change last year and will continue efforts over the next 18 months. Smith says the system allows AT&T to route long-distance calls faster and more efficiently.

Ironically, it was software development delays that kept the System 12 project from ever getting off the ground, and while Smith hedges when discussing his former employer, he does allude to a lack of organization for the project. His comments about his labors at ITT are cryptic: "the job was never dull," he says. "It was an interesting experience." *–Tobias S. Naegele*

HOW A DROPOUT GOT A BOOST FROM HONEYWELL

VISTA, CALIF.

When he dropped out of high school, William L. Grivas probably didn't think he would ever become the owner of a company that does $50 million in annual sales. But after staking out a claim in the mushrooming manufacturing subcontractor business, that's what he is—and at the ripe old age of 31.

Grivas's Southwest General Industries Inc., started in a garage in 1977, is really moving into the fast lane. It just landed a big deal with Honeywell Inc.'s Large Computer Products Division. Under the agreement, Honeywell sold Southwest General the means—factory and equipment—and provided the personnel to build computer cables and subassemblies that the Minneapolis company needs but doesn't want to produce itself. The deal calls for purchases by Honeywell of "more than $100 million over the five years it covers." That's quite a coup for Grivas, whose initial layout was $5 million.

EVERYBODY WINS. Grivas, an ex-marine who attended the University of Pittsburgh once he finally picked up his high school diploma, will not reveal all the terms of the Honeywell contract. But he claims that it puts his company "among the top five in the country" in the subcontracting business. He adds that Honeywell also benefits from this approach, because "it allowed Honeywell to restructure how it does business."

One Honeywell official explains how his company will benefit from this subcontracting deal. "It is often more cost-effective to buy components from outside vendors, such as Southwest General, that specialize in manufacturing limited items. This is a growing industrywide practice," says James R. Bloom, vice president and general manager of the Honeywell division.

A key goal on the Honeywell side was to ensure that as many workers as possible would keep their jobs by having an opportunity to transfer to Southwest General, according to Bloom. Of the total 250 former Honeywell workers, 130 will now perform their duties at Grivas's company. The operation will remain in Phoenix, Ariz., he says.

With the time, effort, and out-of-pocket cash put into the Honeywell deal—some six months and $250,000—Southwest General has learned how to make acquisitions. Next, it will buy the warranty service and repair division for cable TV converters from Oak Communications Inc., Rancho Bernardo, Calif., and it expects to make another key acquisition next month.

An avid reader who gets through a half dozen books a week and as many as 30 magazines a month, Grivas says he is a history buff and that he owes much of his philosophy about business tactics and acquisitions to the books he has read on the Roman Empire, though he doesn't say exactly how he plans to divide and conquer. *–Ellie Aguilar*

WILLIAM L. GRIVAS: Staking out a claim in the mushrooming subcontracting business.

NEW PRODUCTS

A CHEAPER WAY TO ANALYZE MOTION WITH HIGH-SPEED VIDEO

$57,000 KODAK EKTAPRO GRABS 1,000 IMAGES PER SECOND

Events that occur too fast for the human eye to detect—such as the operation of a high-speed assembly line—are easily captured by a low-cost portable motion-analysis system now available from Eastman Kodak Co.'s Mass Memory Division. The videotape-based Ektapro 1000 motion analyzer can record up to 1,000 pictures/s for instant playback and analysis in a variety of slow-motion modes.

In addition, as many as six images can be recorded on a single frame for 6,000-picture/s split-screen display. This enables users to record and play back an event that is too fast for the 1,000-picture/s rate. Normal playback is at 30 frames/s, but the system can display one frame at a time or at a slow continuous rate of one to four frames/s.

"Motion analysis can be used to reduce machine downtime, increase productivity, improve quality assurance, and shorten research and development cycles," says Peter Giles, vice president and general manager of the San Diego division. "If you can see the problem, you can solve it faster. It is important for companies investing in robotics, computer-aided design and manufacturing, and automated assembly methods to be able to record, study, and understand events that occur at high speeds."

During the 1970s, video systems emerged as an alternative to the high-speed movie cameras then being used for motion analysis. Video didn't replace film, but opened up new applications and offered certain advantages, such as instant replay. But applications were limited because the video recorders modified for this use could record only 200 images/s, compared with the thousands of frames per second that film-based systems could capture. The breakthrough came in 1980, when Kodak introduced the EP2000, which could capture 2,000 pictures/s.

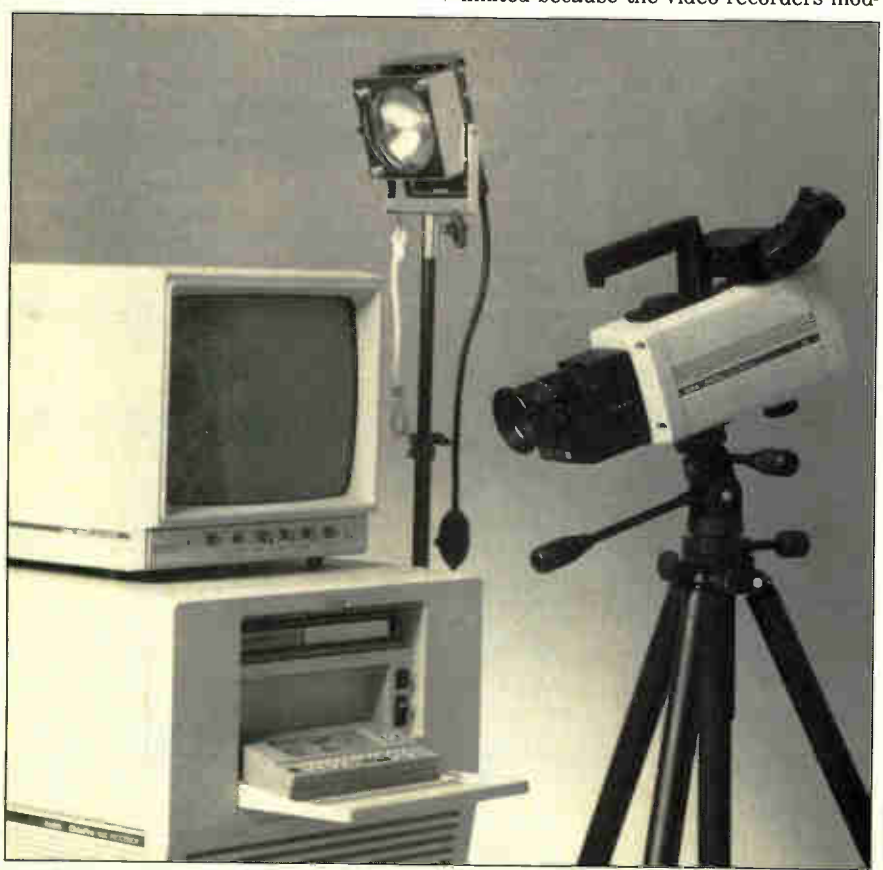
The Ektapro, which is priced at $57,000, is a scaled-down version of Kodak's much larger and more expensive SP2000 system. According to the company, the Ektapro takes advantage of breakthroughs in electronic imaging and computer interface technologies. "The Ektapro 1000 is priced for broad market acceptance. This modular unit will establish motion analysis as a productivity tool for a wide range of applications," says John F. Bloomfield, general manager of the Spin Physics Division, a part of the Mass Memory Division.

To capture and process its high-speed video images, the system uses a menu-driven console built around a 16-bit 68000 processor, an imager (or camera), and a control keypad. The imager contains a solid-state image sensor developed by Kodak that produces good images under normal lighting conditions.

This sensor is a photocapacitor array with an image area and resolution of 192 by 240 pixels, enabling the Ektapro to record 46,080 spatial points. Each point can represent up to 64 levels of gray as rapidly as 1,000 times per second. In addition, the sensor is free from image lag and ghosting, and is not damaged by bright light, problems that typically plague TV tubes.

The imager, which weighs 5 lb, comes with a removable electronic viewfinder, a gamma control for adjusting contrast, a removable handle, standard tripod mounts, a video jack, and an audio jack for operator communications in noisy or remote situations up to 100 ft from the processor.

The processor weighs 80 lb and can be rack-mounted or transported on a cart. Two imagers can be used with one processor to allow simultaneous recording from two different angles, such as from the front and rear of an assembly line. The processor can link with computers over an optional RS-232-C inter-



INSTANT. Ektapro's sensor captures 1,000 images per second, storing them on videotape.

face so that users can digitize images and send them to computers for further analysis. Computers can also be used to enhance the images or to recognize variations from set processes or patterns.

Images are recorded on high-density ½-in. cassette-loaded instrumentation tape at 30, 60, 125, 250, or 1,000 images/s. Information can be downloaded to a video cassette recorder.

Optional features add to the system's flexibility. A reticle can be electronically positioned to provide accurate X and Y coordinates for each image. By combining this with a digital readout of elapsed time, the system can make time-referenced spatial measurements.

The Ektapro 1000 uses standard C-mount lenses and can therefore be used with a broad range of photographic accessories, such as tripods and lighting kits. Other accessories include an automatic exposure-control lens with remote power zoom and focus and a strobe lighting kit. With the strobe light, the Ektapro can record events that occur at 5-μs intervals, compared with the system's 1-ms exposure time under normal lighting conditions. *–Steve Zollo*

Eastman Kodak Co., Spin Physics Division, 11633 Sorrento Valley Rd., San Diego, Calif. 92121. Phone (619) 481-8182 [Circle reader service number 338]

SENSOR TESTS FOR STATIC IN CIRCUIT-BOARD BAGS

Electrostatic discharge has a devastating effect on chips, and combating it is a never-ending battle for chip makers. Much of the blame can be traced to a mundane source: the plastic bags in which printed-circuit boards are packaged for shipment.

Now, a quick and simple method to determine the electrostatic propensity and static bleed-off characteristics of the bags and pouches is at hand. The product, called EZ Test, can be inserted into a bag or pouch to determine whether it's suitable for packaging pc boards.

Such bags often trap static charges, later inflicting the charges upon chips they are supposed to protect, says P. S. Neelakantaswamy, director of the Electrostatic Discharge/Electrical Overstress Research Center at the Rochester Institute of Technology Research Corp. Neelakantaswamy established the center early this year [*Electronics*, Feb. 3, 1986, p. 24] to develop methods to fight static damage.

The EZ Test is a virtually raw pc board, with a smooth back and rounded corners to minimize damage to the bags it tests. The unit consists of a static sensor made from a proprietary IC and a static pickup. It is mounted on a small board with an LED and a buzzer.

SHAKE IT UP. Users can test bags and pouches in either of two ways, Neelakantaswamy says. By inserting the EZ Test board into a bag and then "zapping" it with a static gun, he explains, the user can tell if a bag resists static penetration. If the static charge penetrates the plastic, the sensor responds by activating the LED and buzzer alarm. The second test is performed by putting the board inside the bag and shaking; the alarm goes off if the friction between the board and the plastic bag causes a static discharge.

Because some chips are less susceptible to static-induced damage than others, the tester has a built-in, adjustable sensitivity control that allows users to choose an acceptable static-shielding level for a given device. Powered by on-board flat lithium batteries, EZ Test measures 4 by 3 in.

Neelakantaswamy says RIT Research, a wholly owned, for-profit subsidiary of the RIT, Rochester, N. Y., will design and build the tester, and is currently handling distribution. The group is negotiating with Quality Packaging Supply Corp., a Rochester maker of the plastic packages that EZ Test was designed to check, for marketing and sales support.

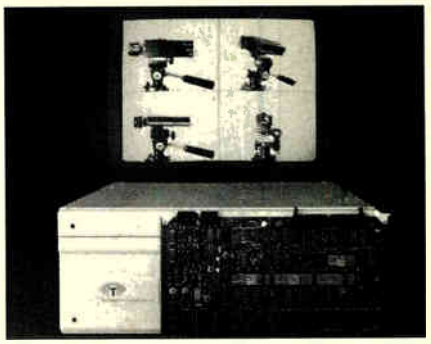
EZ Test is available now and sells for less than $200; delivery takes about four weeks. *–Tobias Naegele*

RIT Research Corp., Electrostatic Discharge/Electrical Overstress Research Center, 75 Highpower Rd., Rochester, N. Y. 14623.
Phone (716) 475-2308 [Circle 339]

MEMORY BOARD HOLDS 512 BY 512 IMAGES

The DS-541M is a memory-mapped Multibus memory board that holds four 512-by-512-pixel images. Applications include automatic inspection and quality assurance where machine-vision algorithms require on-line access to multiple images or repeated access to immediate results in a chain of calculations.

Image-acquisition hardware is organized as 1-K by 1-K by 8 bits; a ninth bit plane in the memory can be used for



plane and pixel protection or for graphic overlays. For applications requiring more than 8 bits of resolution, two units can be combined to provide an image-memory space organized as 1-K by 1-K by 18 bits.

On-board pan and scroll hardware activates any window for video input or output at any time. The image size is compatible with most machine-vision systems. The DS-541M sells for $3,495; delivery is from stock.

Recognition Technology Inc., 335 Fiske St., Holliston, Mass. 01746.
Phone (617) 429-7804 [Circle 353]

VIDEO CAMERA WORKS IMMERSED IN WATER

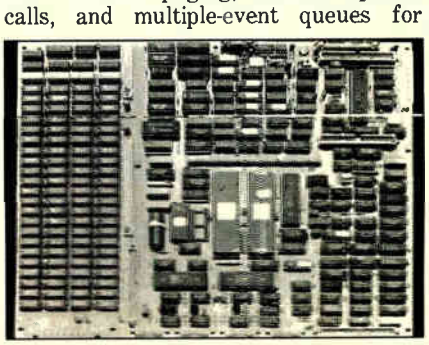
An immersible subminiature video camera weighing just 2½ oz is designed for imaging systems in unusually harsh conditions. The MC-6 camera is also shielded against radio-frequency and electromagnetic interference.

The camera delivers resolution of 330 lines with automatic white-balance adjustment. Its price is $9,500. Delivery information was not available at press time.

M. P. Video Inc., 3 Huron Dr., Natick, Mass. 01760. Phone (617) 655-3311 [Circle 354]

COMPUTER CARD RUNS UNIX OR RTIX

A single-board computer for real-time applications, the model 712G can be used either with AT&T Co.'s Unix or Xenix System V or with the manufacturer's RTIX operating system. RTIX offers demand paging, no-wait system calls, and multiple-event queues for



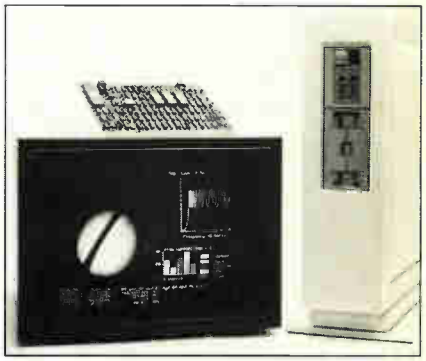
such applications as large data bases.

The 712G comes in several configurations and clock speeds. For example, at a volume price of $1,890, the board contains a 68010 processor, 2 megabytes of no-wait-state RAM expandable to 4 megabytes, demand paging, two Small Computer Systems Interfaces, four direct-memory-access channels, an interface for 5¼- and 8-in. floppy disks, four RS-232-C ports, battery-backed clock-calendar, and a socket for a floating-point coprocessor.

Isotron Inc., 140 Sherman St., Fairfield, Conn. 06430.
Phone (203) 255-7443 [Circle 350]

GRAPHIC CONTROLLER OBEYS 90 COMMANDS

The QG-1280 graphics controller board features a high-level instruction set of over 90 commands that lets the onboard graphics processors do the drawing and at the same time frees the Q-bus CPU to run the application program. The board offers a resolution of 1,280 by 1,024 by 8 bits/pixel and a drawing rate of 20,000



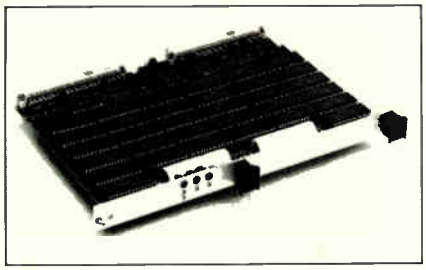
vectors/s. It turns a Digital Equipment Corp. MicroVAX II into an engineering work station.

The QG-1280 plugs into the Q-bus, eliminating serial links between the host CPU and the graphics-output device. It sells for $4,995 and will be available in the second quarter.

Matrox Electronic Systems Ltd., 1055 St. Regis Blvd., Dorval, Quebec H9P 2T4. Phone (800) 361-4903; in Canada, (514) 685-2630 [Circle 351]

MEMORY CARD IS SAFE FROM POWER LOSS

Two on-board redundant fused nickel cadmium or lithium batteries on the MM-6700C memory board for the VME-bus support nonvolatile operation in case of a power loss. Data is retained for up to four years with the nonrechargeable lithium batteries or up to two months with the rechargeable nicad batteries. LEDs on the front panel report the batteries' status. The host com-



puter can also monitor battery status.

Cycle and access time for the MM-6700C is 150 ns, and standby current is 1 A. The board supports 8-, 16-, and 32-bit data transfers. All boards are burned-in and temperature-cycled during memory diagnostics and operate in the commercial temperature range.

Delivery time of the MM-6700C is from stock to four weeks. Prices vary.
Micro Memory Inc., 9540 Vassar Ave., Chatsworth, Calif. 91311.
Phone (818) 998-0070 [Circle 352]

ADA COMPILER RUNS ON IBM PC AT

A compiler for the IBM Corp. Personal Computer AT creates large-scale Ada application programs, overcoming the 640-K limitation imposed by the DOS operating system and accessing the PC AT's up to 16 megabytes of extended memory. The compiler generates 8086 executable object code for the PC/XT or 80286 code for the PC AT. It also offers a proprietary multistep error checker and on-line Help facility.

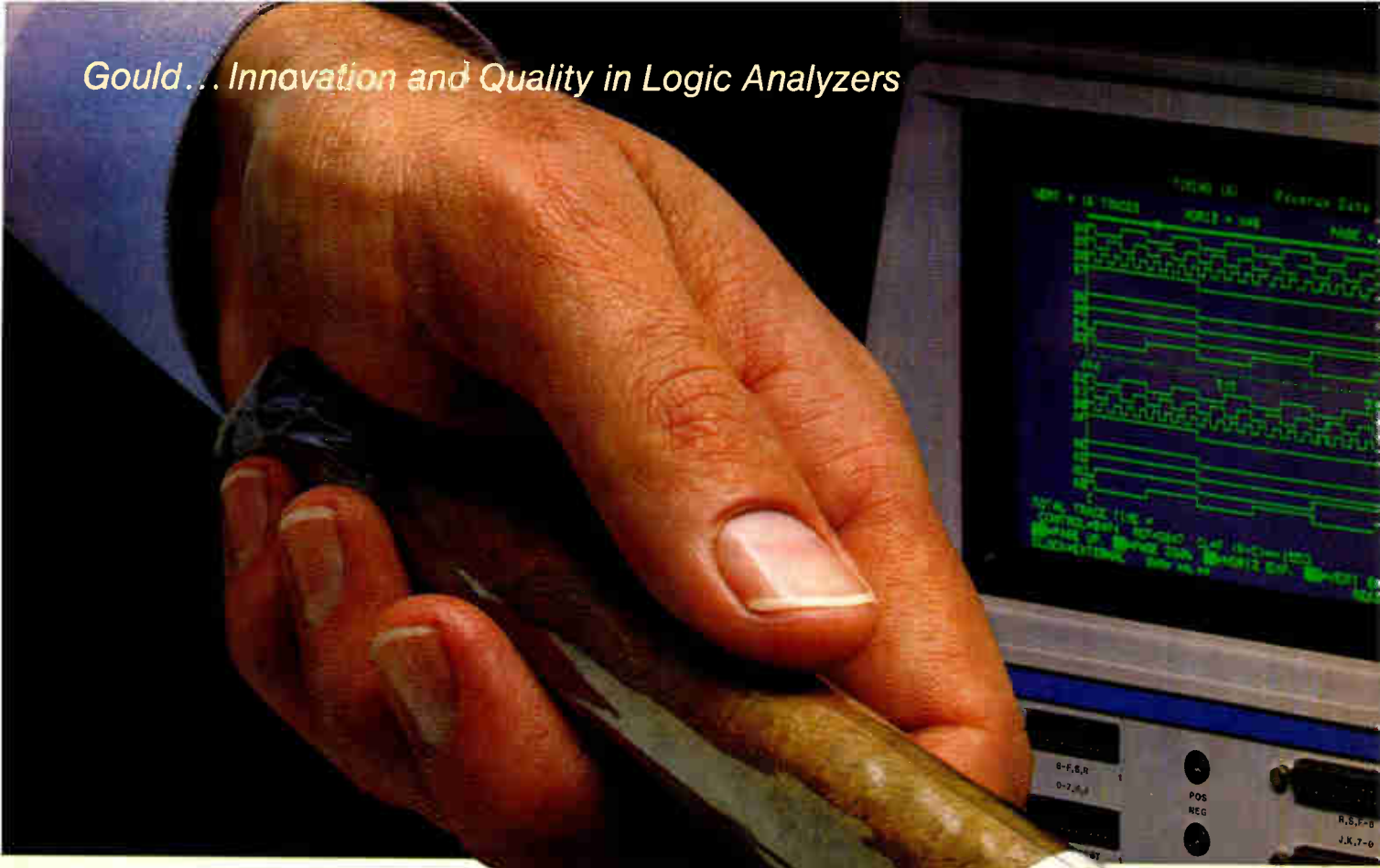
The compiler contains a memory board, library manager, unit manager, binder, run-time executive, and predefined packages. It should receive Department of Defense validation by April 1. Priced at $3,000, the Ada compiler is scheduled for customer shipments immediately.
Alsys Inc., 1432 Main St., Waltham, Mass. 02154. Phone (617) 890-0030 [Circle 356]

LIBSIM CHECKS PLA FUSES AND BOARD

Version 8.1 of Libsim, a simulation package, simulates the individual fuses of programmable logic arrays as well as the entire pc board. Fully interfaced to Jedec fuse maps, the logic-simulation system reconfigures the array's architecture to reflect the blowing of the fuses as defined by the Jedec files.

The multiwindow, interactive user interface is menu-driven, and graphic waveform display is part of the software. Libsim's 18 node states model all technologies, including CMOS, n-MOS, TTL, ECL, and Schottky logic.

It supports batch processing for large simulation runs. The minimum hardware



Gould proudly announces six new additions to its family.

A proud lineage continues.

Gould knew a good thing when they saw Biomation and its precedent-setting K100 logic analyzer. We've built on that heritage to bring you the industry's most comprehensive line of logic analyzers.

One Gould Logic Analyzer is exactly the right tool for the job you're doing. Why pay for more analyzer than you need? Or settle for too little? Also, you can trade up for more sophistication without trading away ease of use.

And now, six new models extend and enhance our line.

The new K20 and K40 make Gould performance affordable for service and repair applications, as well as jobs where portability is important.

The new K115 and K450 models set new performance standards. The K115 may well be the best μP logic analyzer around. And the K450 has all high-speed channels for complex multi-μP and VLSI problems.

The new K125 may look plain, but it's a beauty below the surface. Handles up to 80 channels per mainframe. It makes CAE/CAD faster, more productive and leverages your engineering investment into ATE production.

And yes, there is a doctor in the house – the PG110. It checks up on our logic analyzer family – including the well-known K100/T12, K105, K205 and K500 units – to keep them up and running.

For details on Gould's New Generation in Logic Analyzers, call *TOLL-FREE (800) 538-9320, in Calif. (800) 662-9231.* Or simply write: Gould Inc., Design & Test Systems, 19050 Pruneridge Ave., Cupertino, CA 95014. Because a family that stays together pays.

The New Generation in Logic Analyzers

"Congratulations, it's a GOULD!"

NEW K450. All high-speed channels: 10ns resolution across 48 channels at 100 MHz or 5ns across 24 channels at 200 MHz. 5ns glitch capture on all channels with no loss of memory. 4K memory depth. Unique Auto Save for saving failures in unattended mode.

NEW K115. "The μP analyzer." Up to 72 channels for state/timing, 200 MHz on up to 8 channels. All key software/hardware integration tools, noise margin analysis, tolerance compare. Trace Control. Multi-level "Help." Disassemblers for all popular μPs, incl. 68020.

NEW PG110. Pattern generator has 96 data channels with 1.5ns data skew. Built-in patterns for ease of use.

NEW K20. Low cost. Weighs only 9 lbs. 8-ch. timing analysis. 24-ch. software debug. 3-level triggering. "Help" key. Easy to use.

NEW K40. 32-ch. software or timing analysis. 4-level triggering. Setup/compare memories. Plus μP option.

NEW K125. Use with CAE/CAD/ATE. 80-ch. capacity up to 200 MHz. ATE software packages, IBM PC controlled. Expand with multiple mainframes.

GOULD
Electronics

Circle 79 on reader service card

required is an IBM Corp. Personal Computer with 256-K of RAM and one floppy-disk drive. The package also runs on the PC/XT and PC AT. Priced at $955, Libsim version 8.1 is available now; a demonstration disk costs $35.
American Computer Automated Systems Inc., P. O. Box 20127, San Jose, Calif. 95160. Phone (408) 997-3333 [Circle 357]

SOFTWARE DESIGNS PROTOTYPE BOARDS

Using Pen-Entry-PC, developers of wrapped-wire or discrete-wired prototype boards can work directly from a schematic or from net files created by such packages as FutureNet or PCad. The software also accepts data created on popular computer-aided design and engineering work stations.

Pen-Entry lets the user create a graphic facsimile of the panel, then lay out components and interconnections while progressive on-screen messages report schematic or program errors. The software handles gate arrays, surface-mounted devices, restricted area or via routing, and twisted-pair cables. Its output comes in the format of the user's wiring machine.

The add-on Pen-Entry PC package for the IBM Corp. Personal Computer, PC/XT, or PC AT and compatibles costs $5,999 and is available now.
Wire Graphics Inc., 95 Sherwood Ave., Farmingdale, N. Y. 11735.
Phone (516) 293-1525 [Circle 358]

HIGH-LEVEL DEBUGGER RUNS ON IBM PC

DOS Pscope is a high-level-language symbolic debugger that runs on IBM Corp.'s Personal Computer, PC/XT, or PC AT. With it, users can observe program execution at the source-code level by working with high-level procedure and variable names.

They can then set breakpoints and tracepoints to suspend program execution and display or change a variable's value. The software is available now for $995; two packages sell for $795 each.
Intel Corp., Literature Department W280, 3065 Bowers Ave., Santa Clara, Calif. 95051 [Circle 355]

LETTERS

University of Texas work

To the editor: The verification of the Viper processor described in "Designing a 32-bit processor that's 'fail-safe'" [*Electronics*, Jan. 27, 1986, p. 53] parallels work at the University of Texas at Austin. We have verified a microcoded microprocessor named FM8501. The Viper was apparently specified in a mix of Ella and LCF-LSM [Logic of Computable Functions-Sequential Logic Machines]; the correctness proofs were constructed by hand. In contrast, FM8501 was specified entirely within a formal mathematical logic and the correctness proofs were constructed with mechanical aids and certified mechanically.

The FM8501, which is similar in complexity to a PDP-11, has two specifications. The instruction-level specification is an instruction interpreter for the abstract machine and describes the effect of every instruction with respect to three abstract data types—Boolean bit-vectors, natural numbers, and integers. The gate-level specification describes gates, registers, and microcode. The final circuit description contains about 2,000 gates (excluding registers), although its formal description is quite compact because most of the combinational logic is described with recurrence relations rather than given explicitly.

Both specifications are expressed in the Boyer-Moore logic, a mathematical logic similar to Pure Lisp. The logic is supported by several mechanized tools, including a compiler and a mechanical theorem prover. Thus our specifications can be executed on concrete or symbolic data to test whether the machine meets the functional requirements.

Warren A. Hunt, Jr.
J. Strother Moore
Institute for Computing Science and Computer Applications
The University of Texas
Austin, Texas

What engineer shortage?

To the editor: Spare us, please, from fears the U.S. is facing an engineering shortage [*Electronics*, Jan. 27, 1986, p. 65]. The facts are that layoffs of U.S. engineers continue; that salaries of American engineers are static because of the large influx of foreign engineers; that the College Placement Council reports that the jobs offered to the engineering class of 1985 are down by 5%; and that even the anti-engineer American Electronics Association agrees that there is no engineering shortage.

Irwin Feerst
Committee of Concerned EEs
Massapequa Park, N.Y.

WIN $1,000 CASH ADVERTISER AUDIT

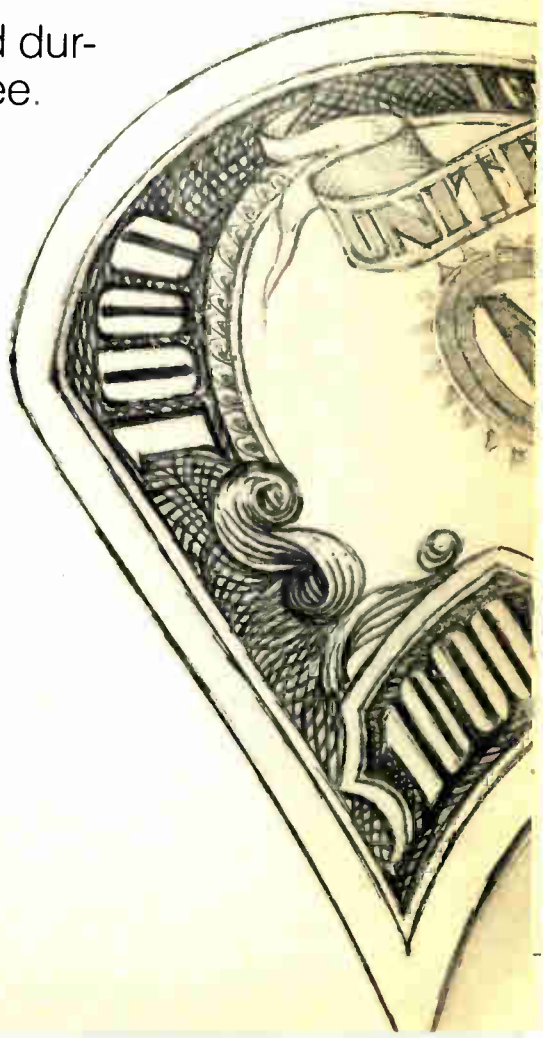
Electronics' unique new contest makes it easy to win big.

The rules are simple. Each issue this month contains a ballot asking you to select your three favorite ads in the issue. All you do is fill in your choices and drop it in the mail. Your returned ballot or reasonable facsimile is automatically entered in the prize drawing at the end of the month. If your name is drawn at random, you win one thousand easy dollars.

Ads receiving the most votes each week and during the course of the contest will be rerun for free.

You can win money *and* let advertisers know what you think of their selling messages. Advertisers can win extra insertions.

So watch for contest ballots and rules in each March issue. And get ready to win big this month.

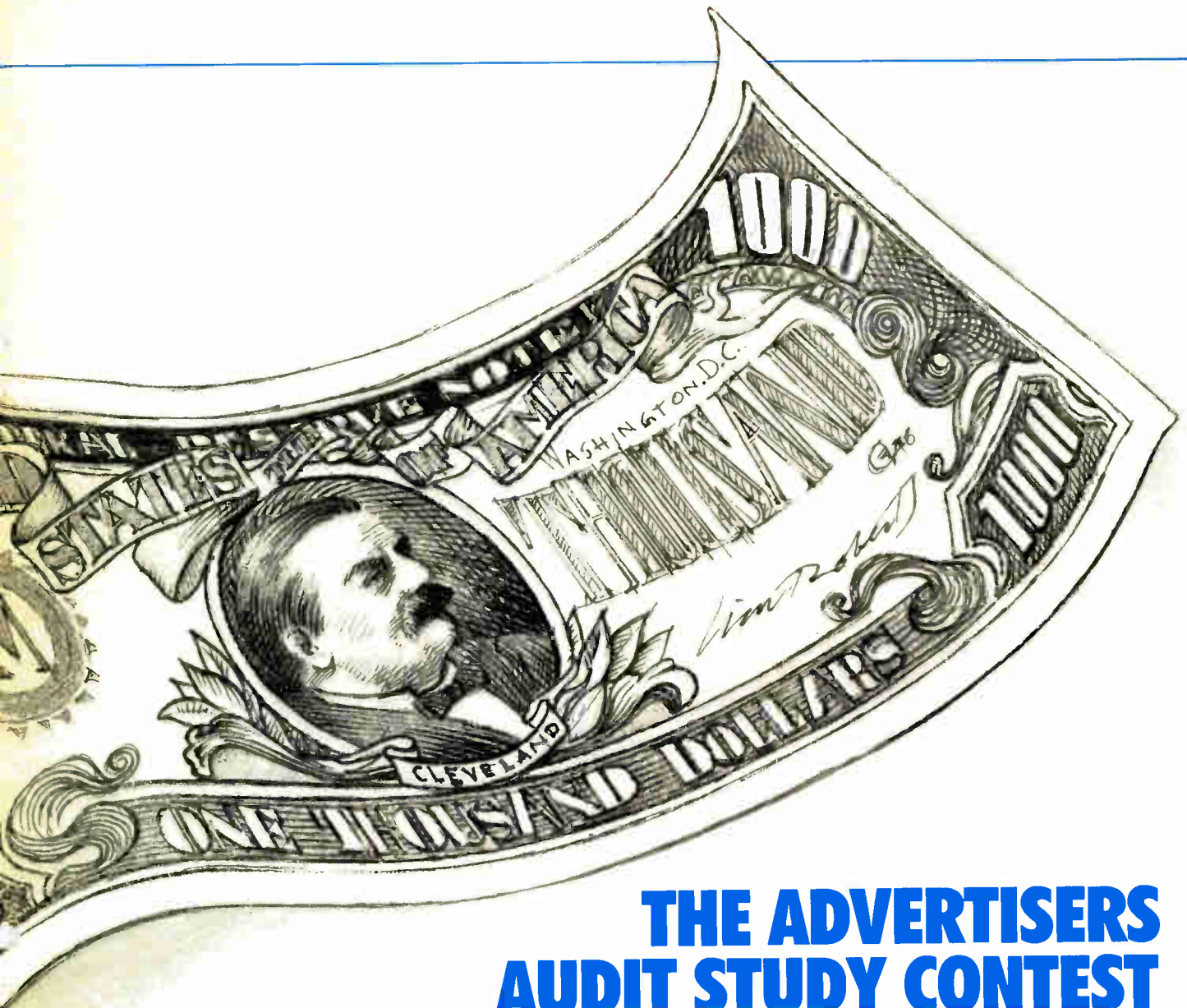


ADVERTISERS: YOU CAN WIN $1,000, TOO!

All advertising and marketing personnel in companies and agencies are invited to participate along with our readers by filling out a special Advertisers Ballot included in each March issue. Whoever comes closest to picking the 15 winning ads for the month (3 from each issue) in this special Advertisers Contest will receive an award for skill in evaluating advertising, plus a free ad insertion for his or her company, and $1,000 cash!

ONLY IN MARCH

IN ELECTRONICS' STUDY CONTEST



THE ADVERTISERS AUDIT STUDY CONTEST

Only this month in

Electronics

Electronics

THE ADVERTISERS AUDIT STUDY CONTEST

Enter a drawing for $1,000 cash by selecting your favorite ads in the March issue of *Electronics.*

Reader Contest Rules

1. After you have examined this issue of *Electronics,* pick your three favorite ads and enter your selections on the entry blank bound in this issue or on a 3" x 5" index card. Your entry should include: 1) the name of the advertiser; 2) the advertiser's Reader Service Number; 3) the page number the advertisement appears on; and, 4) if you would like, your comments explaining what you like most about the ads you selected. Ads placed by McGraw-Hill, Inc. should not be considered in this contest.

2. Check the box on the entry blank marked "Reader Contest." No more than one entry *per issue* may be submitted by any one individual. All entries must be postmarked no later than midnight, April 18, 1986. The winner will be notified in May, 1986.

3. The winner of the $1,000 cash prize will be selected in a random drawing from among all eligible entries. Winner will be notified by mail. Odds of winning depend on the number of entries received.

4. No purchase necessary. Contest void where prohibited or restricted by law. Liability for any taxes on the $1,000 cash prize is the sole responsibility of the winner. Employees of McGraw-Hill, Inc., its advertising agencies, and their families are not eligible to participate.

Advertiser Contest Rules

1. All advertising and marketing personnel in companies and agencies (other than McGraw-Hill, Inc. and its advertising agencies) are invited to participate in a separate contest for advertisers. All rules for the Reader Contest will similarly apply for this contest, with two exceptions: 1) the winner of the Advertiser Contest will *not* be selected in a random drawing from among all eligible entries; and 2) the box on the entry blank marked "Advertiser Contest" must be checked.

2. Examine the March issues of *Electronics* with extra care. Choose the three ads in each issue that you think readers of *Electronics* will pick as their favorites and enter your selections on the entry blanks bound in each issue or on a 3" x 5" index card. No more than one entry *per issue* may be submitted by any one individual.

3. All entries must be postmarked no later than midnight, April 18, 1986. Each individual's qualifying entries will be matched against the winning ads as determined in the Reader Contest. Whichever individual in this Special Advertiser Contest comes closest to picking the 15 winning ads for the month of March, 1986 will receive: 1) $1,000 cash; 2) one free full-page ad in *Electronics* for their company or client; and 3) a plaque acknowledging their skill in evaluating advertising. McGraw-Hill, Inc. reserves the right to schedule the free ad at its discretion.

4. This special Advertisers Contest is open to all advertising and marketing personnel in companies and agencies (other than McGraw-Hill, Inc. and its advertising agencies), whether or not their companies or agencies have an advertisement in the March, 1986 contest issues.

5. No purchase necessary. Contest void where prohibited or restricted by law. Liability for any taxes on the $1,000 cash prize is the sole responsibility of the winner. Employees of McGraw-Hill, Inc., its advertising agencies, and their families are not eligible to participate.

Winning Advertisers Earn Free Ad Reruns

The three advertisers receiving the most votes in each March 1986 issue of *Electronics* will receive a free rerun of their winning ads and a plaque commemorating their achievement. Since there are five issues of *Electronics* in March, there will be a total of 15 winning ads.

After all the March Reader Contest ballots are received, the three ads that scored the highest over the course of the entire contest will be determined and announced in May, 1986. These three Grand Prize Winners will receive a special plaque, plus a free rerun in *Electronics* of *all* the ads they ran in *Electronics* during the entire month of March.

All reruns will be made from existing plates or negatives. If the advertisement qualifying for a free rerun is an insert, the winner may run up to a four-color, two-page spread on R.O.P. stock from existing plates or negatives. McGraw-Hill, Inc. reserves the right to schedule reruns at its discretion.

CONFERENCE TO COVER SPEECH TECHNOLOGY

Speech Tech '86 will reflect the rapidly growing interest in the application of voice synthesis and recognition products. Exhibits and technical sessions will be bigger than ever at this third annual conference; attendance is expected to hit 2,000 this year, up from 1,000 last year and 500 in 1984, says Stanley Goldstein, president of Media Dimensions Inc., conference sponsor. It will cover a wide spectrum of applications, from consumer and military to the factory and office.

A core session will discuss the application of the second generation of digital signal processors, which "constitute the most important event ever in the history of speech technology," according to session chairman Thomas P. Barnwell III, vice president of Atlanta Signal Processors Inc. The emphasis is now shifting from fixed-point to floating-point implementations and from single to multiprocessor systems, Barnwell says.

One topic getting plenty of attention will be large-vocabulary speaker-independent recognition of natural continuous speech. The current system configuration of a new recognition system called Angels, as well as some early operating results, will be given by Ronald A. Cole of Carnegie-Mellon University.

Texas Instruments Inc. has a grammar-driven connected-word recognition system that will be described by Michael L. McMahan, speech-systems engineer. He says it solves the two most serious problems of current systems: the user can speak in a natural unconstrained manner, and sentence recognition is improved dramatically. And the status of IBM Corp.'s project to develop a voice-actuated typewriter will be given. Speech Systems Inc. will also report on its voice typewriter driven by a phonetic engine.

Eurocon '86: 7th European Conference on Electrotechnics, IEEE (L. J. Libois, IEEE French Section, c/o Society of Electronic Engineers, 49 rue de la Procession, 75724 Paris, Cedex 15, France), Palais des Congrès, Paris, April 21-23.

34th National Relay Conference, National Association of Relay Manufacturers and Oklahoma State University (School of Electrical and Computer Engineering, 202 Engineering S., Oklahoma State University, Stillwater, Okla. 74078), Oklahoma State University, Stillwater, April 21-23.

Electronic Printer Industry Conference, Dataquest Inc. (1290 Ridder Park Dr., San Jose, Calif. 95131), Hyatt Regency Hotel, Fort Worth, Texas, April 21-23.

Robots 10, Robotic Industries Association (Robotics International/Society of Manufacturing Engineers, 1 SME Dr., Dearborn, Mich. 48121), Chicago Hilton & Towers, Chicago, April 21-24.

Quality Expo TIME: Test, Measurement and Evaluation, *Quality* magazine (Quality Expo TIME, 2400 East Devon Ave., Suite 205, Des Plaines, Ill. 60018), O'Hare Expo Center, Rosemont, Ill., April 22-24.

TCC '86: Tactical Communications—the Next Generation, Defense Advanced Research Projects Agency (TCC '86, Systematics General Corp., Brinley Plaza, Route 38, Wall Township, N. J. 07719), Marriott Hotel, Fort Wayne, Ind., April 22-24.

Fiberoptics Venture '86, Kessler Marketing Intelligence (31 Bridge St., Newport, R. I. 02840), Westin Hotel, Boston, April 24.

17th Modeling and Simulation Conference, University of Pittsburgh (William G. Vogt, Modeling and Simulation Conference, 348 Benedum Engineering Hall, University of Pittsburgh, Pittsburgh, Pa. 15261), University of Pittsburgh, April 24-25.

Optical Mass Memories, Institute for Graphic Communication (375 Commonwealth Ave., Boston, Mass. 02115), Holiday Inn, Monterey, Calif., April 27-29.

Speech Tech '86, Media Dimensions Inc. (Stanley Goldstein, Media Dimensions Inc., 42 E. 23rd St., New York, N. Y., 10010), Waldorf-Astoria Hotel, New York, April 28-30.

Avignon '86: 6th International Workshop on Expert Systems (Jean-Claude Rault, Agence de l'Informatique, Tour Fiat, Cedex 16, 92084 Paris-La Défense, France), Palace of the Popes, Avignon, France, April 28-30.

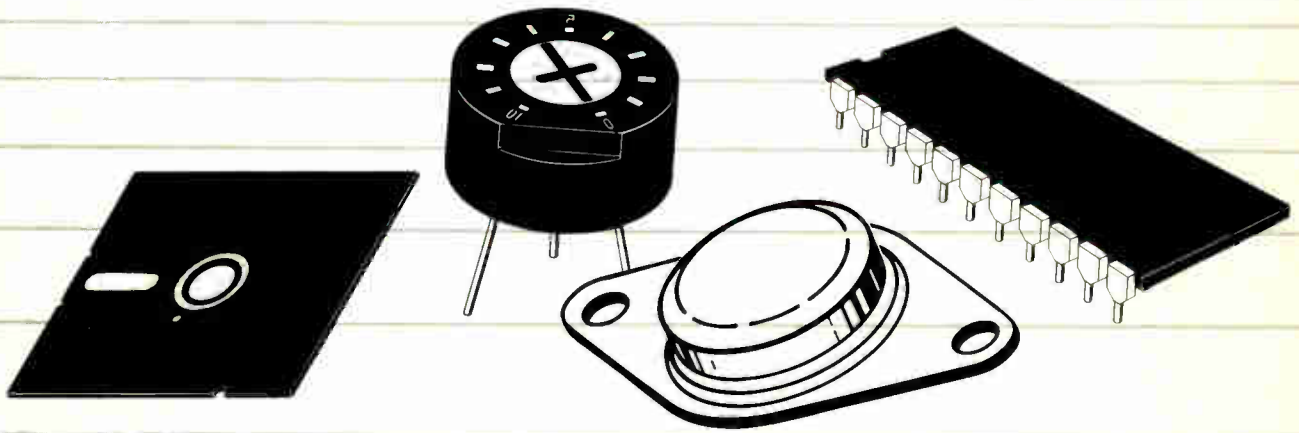
Comdex/Spring, Interface Group Inc. (300 First Ave., Needham, Mass. 02194), Georgia World Congress Center *et al.*, Atlanta, April 28-May 1.

IEEE Applied Power Electronics Conference and Exhibit, IEEE (Melissa Widerkehr, Conference Manager, APEC '86, 655 15th Street, N. W., Suite 300, Washington, D. C. 20005), Fairmont Hotel, New Orleans, April 28-May 2.

Artificial Intelligence and Advanced Computer Technology Conference/Exhibition, Society for Computer Simulation *et al.* (Murray Teitell, Department of Computer and Information Science, Northrop University, Inglewood, Calif. 90306), Long Beach Convention Center, Long Beach, Calif., April 29-May 1.

The industry's leading coverage of technology news.

In Electronics.



Electronics is back–with the industry's best reporting on technology. In the first half of 1985 alone, Electronics featured hundreds of important articles with news and analysis that leaders in the field can't afford to be without:

- Full coverage of computer technology, with 86 articles on computer systems, 50 on software, 33 on boards and peripherals, and 28 on CAD/CAM
- 140 articles on international technology
- 30 articles on military technology
- 27 articles on the latest developments in test and measurement equipment
- Over 100 articles on communications technology
- 40 articles on components technology
- More than 100 articles on worldwide events in semi-conductor technology.

Readers depend on us for this full scope of technology coverage worldwide. Shouldn't your selling message be in Electronics' environment of pivotal technology reporting and analysis?

Put your advertising where the electronics attention is. Call Electronics today, at 212/512-3140 (U.S.), to reserve your ad space. Outside the U.S. contact your sales representative.

Electronics is back. Shouldn't you be back as well?

Advertisers Index

Classified and employment advertising

For more information of complete product line see advertisement in the latest Electronics Buyers Guide
* Advertisers in Electronics International
‡ Advertisers in Electronics domestic edition
□ Advertisers in Special Laboratory Power Supplies Advertising Section

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[617] 262-1160
633-0155 Mobil Phone
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[312] 751-3738
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Cleveland, Ohio 44113:
[216] 496-3800
Costa Mesa, Calif. 92626: Fran Cowen
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[713] 462-0757
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3333 Wilshire Blvd.
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Carol Gallagher
Production Manager
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Production Manager Related Products
[212] 512-2044

Classified and Employment Advertising

[212] 512-2556

ELECTRONICS WEEK

NORTHROP SHRINKS SENSOR ARRAY

Northrop Corp. has developed a focal-plane array-sensor chip that it says packs more sensors in a smaller area than has been possible up to now and can provide well-defined TV images of aircraft operating at night at ranges exceeding 10 miles. The Los Angeles company says the array could replace larger night-vision systems on the Navy's F-14 Tomcat fleet defense fighter and the Hawk antiaircraft missile. The chip houses 16,384 sensors, each 0.001 $in.^2$, in a cluster that is linked to a microprocessor. Infrared radiation absorbed by the array is converted to a picture.

FOUR SUPPORT VME SUBSYSTEM BUS

Four major corporations are lining up behind the new VME Subsystem Bus. The VSB, which runs in conjunction with the VMEbus, is being supported by Plessey Microsystems, Philips/Signetics, Thomson Components Mostek, and Motorola Semiconductor Products. The VSB originated in a special working group of the International Electrotechnical Commission. Motorola, which originated the VMEbus, will introduce several VSB-compatible board-level products, including processor boards, random-access memory, intelligent mass storage, and graphics controllers, with initial shipments of the products planned for the second half of 1986. The other three companies will announce product details in the next few weeks.

GOULD BUYS PSC, AI SYSTEMS FIRM

Gould Inc., seeking to strengthen its position in artificial intelligence and the integration of large software programs, has purchased PSC Inc., a Fairfax, Va., computer- and systems engineering company that is doing work in AI. PSC employs more than 150 engineers and scientists. As part of the deal, terms of which were not disclosed, PSC will become part of Gould's Defense Systems Business Section. James F. McDonald, president of the Rolling Meadows, Ill., company, says the purchase is in line with Gould's goal of becoming a total systems supplier of defense electronics.

TOSHIBA, SIEMENS IN IC PACT

Two of the world's leading electronics companies, Toshiba Corp. of Japan and Siemens AG of West Germany, have agreed to jointly develop libraries of standard-cell integrated circuits. The companies will use their CMOS processes and computer-aided design tools and will market the libraries under a common name. The two will serve as alternate sources for the standard-cell ICs. The first products will use 1.5-μm design rules; design tools and services based on the libraries will be available by the end of 1986. Then, expanded by more complex functions and macrocells, 1.2-μm CMOS technology will be available by the end of 1987 or the beginning of 1988.

HITACHI, SPERRY NEAR ACCORD

Hitachi Ltd., Tokyo, says it is working out final details of an agreement with Sperry Corp. involving the New York company's Univac 1100 mainframe computers. Under the deal, which has been in negotiation since November, Hitachi would contribute its component or production technology, possibly through a licensing agreement. The two also are negotiating an original-equipment manufacturer deal in which Hitachi would produce Sperry's computer-peripheral equipment.

FUJITSU BUYS BURROUGHS UNIT

Fujitsu Ltd. last week acquired the North American operation of Burroughs Corp.'s Imaging Systems Division, Danbury, Conn., for $20 million. The move was based on a desire by the Kawasaki, Japan, company to begin building closer ties to the U.S. market. A Burroughs spokesman says his company is getting out of the facsimile business so it can concentrate on its main activity: providing integrated hardware and software computer systems for businesses. The agreement takes effect April 1.

FAIRCHILD MOVING INSOUTH DIVISION

Troubled Fairchild Industries Inc. will move its Insouth Microsystems unit from Auburn, Ala., to Germantown, Md., by the end of July, and lay off 38 of 50 employees. Fairchild, whose aerospace business based in Chantilly, Va., has been reeling since last year, acquired a 51% interest in the company in 1983 and has since raised its share to more than 90%.

VCR SALES OUTRUN FORECASTS

Video cassette recorders and projection TVs are both off to a hot start in 1986. Factory sales of VCRs through February are running 13.4% ahead of the same period last year, at 1.8 million units, reports the Electronic Industries Association's Consumer Electronics Group. Projection-TV shipments hit 49,074 units for the two months, 41.1% ahead of last year's rate. VCR sales continue to run ahead of predictions, even though sales in the U.S. are expected to slow this year as the increasingly ubiquitous video machine finds its way into more and more homes. The EIA Consumer Electronics Group expects the 1986 overall growth rate to dip to 5.5%, resulting in sales of about 12.5 million machines, compared with a growth rate of 41.7% for all of 1985, when VCR sales reached 11.8 million units [*Electronics*, Jan. 20, 1986, p. 19].

KOREA TO TRIPLE EXPORTS OF CHIPS

South Korea's Ministry of Trade and Industry says exports of semiconductors will triple to an estimated $3 billion this year. The ministry also says it plans to organize semiconductor research projects with the private sector as well as with the government's Korea Electrotechnology Telecommunications Research Institute.

TRANSDUCER SALES SEEN DOUBLING...

Sales of pressure transducers and transmitters will double by 1990, spurred by dramatic increases in factory and process automation and by technological refinements—especially in price-performance ratios and digital technology. According to a report from Venture Development Corp., a Natick, Mass., market research outfit, almost $1.2 billion worth of the devices will be sold by the beginning of the next decade. This follows a seven-year period, 1978 through 1985, in which revenues tripled to $573 million from $183 million.

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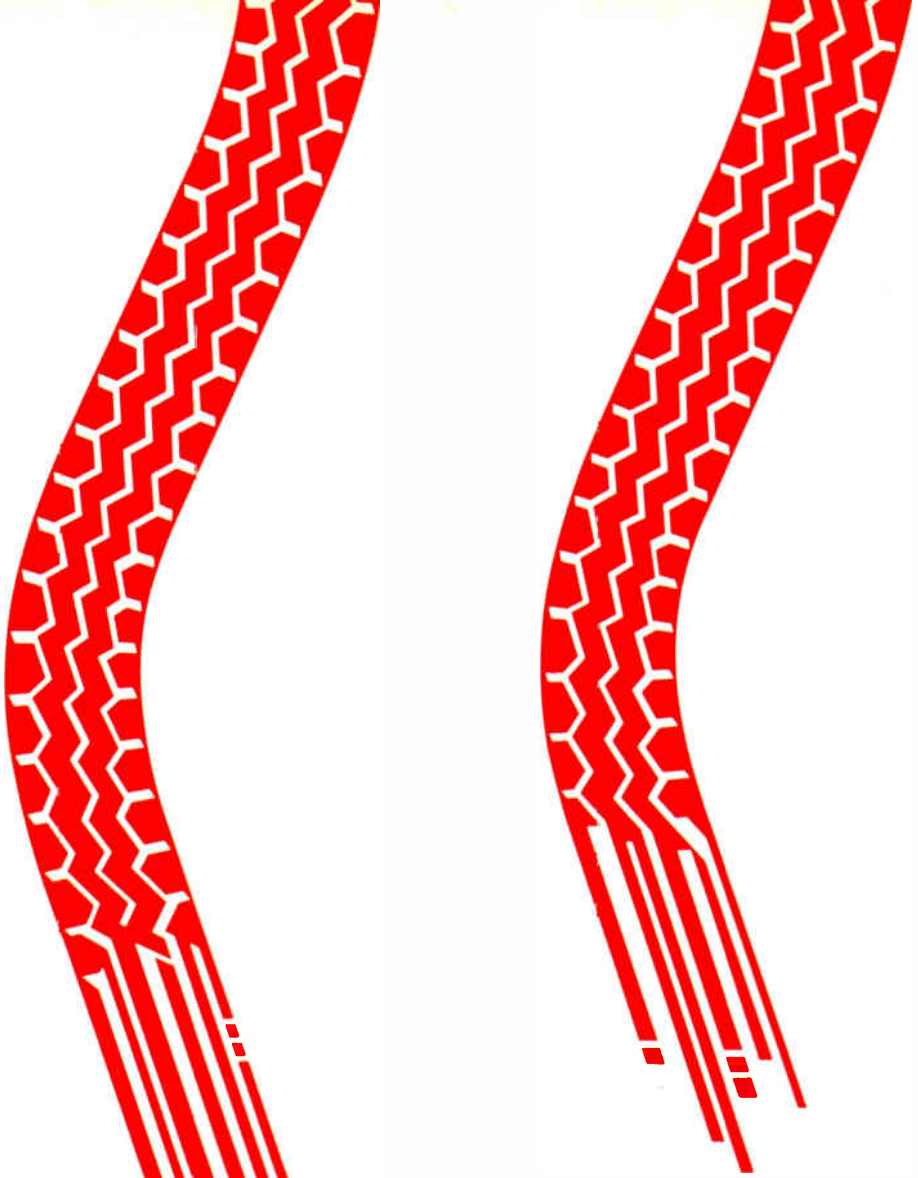
Venture Development says the most prominent technological advances in pressure transducers have come in the diffused semiconductor technique used to embed strain-gauge elements into a silicon pressure-sensing diaphragm. The result is a low-cost sensor that has found wide use in the medical and automotive industries.



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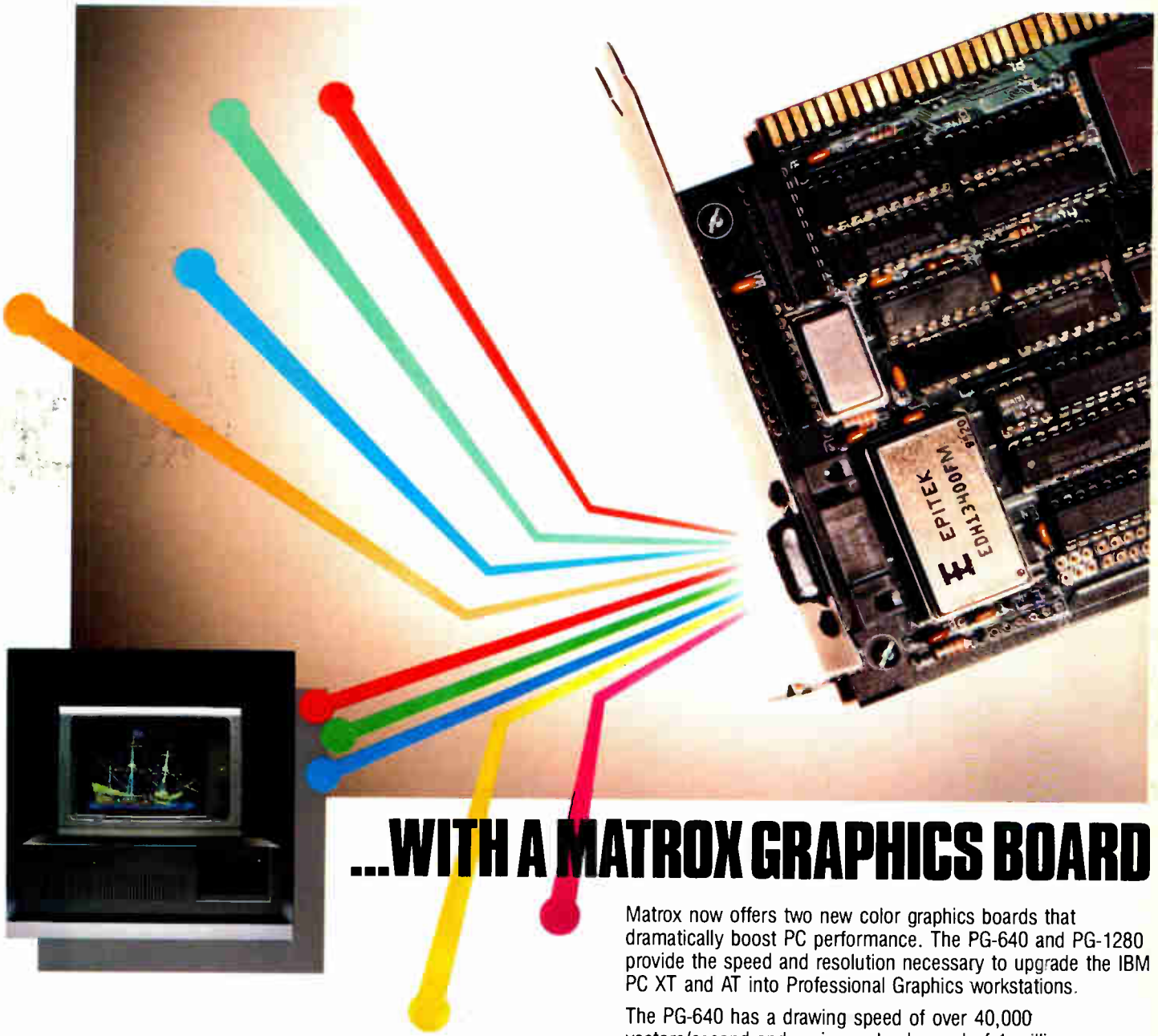

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