May 31, 1983

BRITAIN PAVES WAY FOR ITS FIFTH-GENERATION COMPUTER/101

Tester gives VLSI chips first look at real world/155

Computer courses crowd engineering curriculum/145

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Electronics

A SPECIAL REPORT

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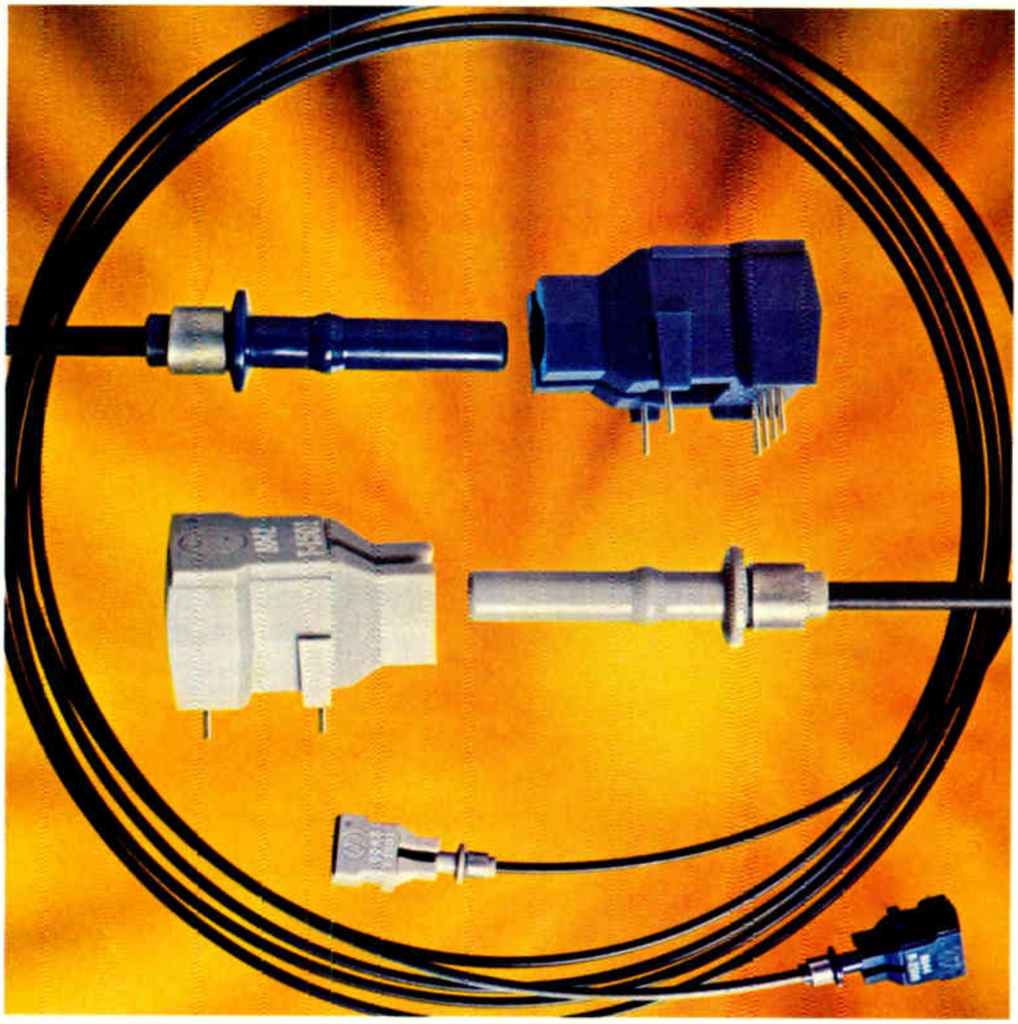

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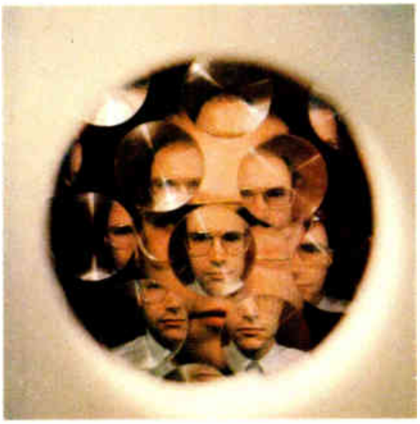
01202

Electronics

The International Magazine of Electronic Technology and Business



Cover designed by Art Director Fred Sklenar.

The Cover Story

The changing face of engineering, 125

Complex semiconductor chips, low-cost computing power, and software are moving the workaday world of electronics engineers toward systems rather than circuits and toward management rather than design. The results of Electronics' *survey of its readers yields interesting insights into who and what is changing in the workplace.*

Major New Developments

VLSI tester adds functionality

As more and more engineers design systems around large semiconductor elements, their companies' test needs are growing faster than test department capacity. A new tool for the task handles integrated circuits with high, 20-MHz speed and up to 256 pins by using a pattern processor to cut programming time and effort, 155

Midwest's industrial states pin hopes on high tech

With the smokestack-industry base of such states as Ohio and Michigan eroded by recession and imports, Midwesterners are looking to electronics for salvation. At a new show, Ohmcon, they are told that they need a "focused strategy," 108

Changing the game

Reusable cartridges that can be reprogrammed with new games by a terminal at neighborhood electronics entertainment stores will make their debut at the June Consumer Electronics Show in Chicago, 49

Two-screen work station

A designer at a computer-aided–design work station with two cathode-ray tubes can modify the schematic on the monochrome CRT and view the effect on the chip's layout on the color CRT, 165

NEWSLETTERS

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Vol. 56, No. 11 • May 31, 1983

Electronics Review

Electronics International

Probing the News

Technical Articles

New Products

Highlights

No one knows better than electrical engineers that electronic technology is the source of sweeping advances and that their profession has radically changed in the past decade. But what does it all mean; what is the big picture for EEs? *Electronics* has mounted a months-long global effort to answer these questions by talking to the men and women on the front lines of this revolution. The results are reported in the following four articles.

The magic of integrated circuitry, in its ever-denser manifestations, has created a host of new applications for electronics and new jobs for EEs. One importance difference, of course, is the switch in emphasis from component to system and the emergence of software as a leading discipline. By and large, engineers around the world feel they are meeting the new challenges.

This liberally illustrated section takes at look at the varied pursuits of four representative EEs: an East Coast military electronics engineer in mid-career, a young Silicon Valley software engineer who switched from her intended career in neurobiology, a Japanese project planner who was a digital-audio researcher until six months ago, and a Coloradan who has found that his interest in computer-aided engineering has changed his career.

The biggest change in the way EEs work stems from the mounting use of computer-aided design and engineering, with more sophisticated tools appearing regularly. By and large, working engineers welcome the new tools, as do their bosses. In fact, there may be no better example of the impact of abundant computer power than CAD and CAE.

A radically changing profession entails a like response from the schools that prepare its members. Yet U. S. educators find they are running a desperate race to keep up, with money, staffing, and time all in short supply.

To meet the testing needs of very large-scale integrated circuits, a new system expands the range of functional tests with a new high-speed pattern processor and supports 256 data channel—twice as many as its predecessors did.

Coming up . . .

Mainframe researchers push work on a radically new parallel-processing architecture: a special report . . . a seeing robot with a deft touch . . . a monolithic data converter that achieves high resolution without trimming.

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Publisher's letter

Look hard enough, and you can usually discern a cycle for almost everything that people do more than once. Every six years or so, for example, our editors feel a need to delve in great detail into the ways the jobs of electronics engineers are evolving.

We did our first major special report on career prospects in mid-1971, when EEs started finding out that the lush days when companies kept their rosters of engineers overstocked had ended. We followed up with another special in mid-1977, when the electronics industries had just come out of a serious downturn. Now, with some signs that the industries once again are on an uptick, we have taken another reading on how engineers feel about their jobs and their career prospects in the special report that starts on page 125.

"Cheap computer power has begun to revolutionize the way engineers work, expanding enormously, in effect, the intelligence they can bring to bear on a problem," says Senior Managing Editor Arthur L. Erikson, who organized the report and wrote most of it. "Yet some attitudes of engineers about their jobs and perceptions of themselves actually haven't changed a whole lot over the past six years."

Art points out that in the 1977 survey of engineer readers made for us by the McGraw-Hill Research Dept., 32.6% rated themselves "very satisfied" and 51.5% "reasonably satisfied." The 1983 version, done for us by the same McGraw-Hill organization, resulted in figures of 33.7% and 51.0%, respectively.

Interestingly enough, the shift in opinion was only slight for another crucial career question: "Do you feel there is discrimination against older (age 40 or above) engineers?" Six years ago, 55.4% felt there was and 16.6% felt there wasn't. This time around the ayes had slipped into a slight minority—47.7%—and the nays had edged up a couple of points to to 18.5%.

However, the figures suggest that there has been a noteworthy—and welcome—increase in the number of companies that have dual-ladder promotion schemes so that engineers who want to stay in engineering can do so without taking a really heavy financial hit. Only 37.5% of the engineers surveyed in 1977 reported their companies had dual ladders; over the past six years, the number has climbed significantly to 50.9%.

However, many engineers feel their ladder still does not have enough rungs. "My next level is chief scientist, and then I would have to switch to management which has four or five more tiers up," says a senior systems engineer at a West Coast aerospace company (the questionnaires did not ask people to identify themselves or their companies).

At the same time, salaries in current dollars have moved up, the mean going from \$23,000 to roughly \$38,000. That works out to an average annual increase of slightly more than 8.7%. But the figure is deceptive: actually, the salary of the average engineer—if there is such a person—has not kept pace with the rise in the consumer price index for the same six years.

Even so, there has been a turnabout in the past six years in the way engineers regard accreditation—that is, having engineers qualify by examination, much the way doctors, dentists, and lawyers do. In 1977, 61.4% of those queried said they believed that accreditation would be beneficial. In the 1983 poll, the figure dropped to 29.6%.

There is no clear reason for this turnabout. The comments scribbled in after the question ranged from "Engineers are artists compared to doctors and lawyers" (from a reliability engineer at a computer company in Silicon Valley) to "I see no useful purpose; engineers are hired amd hold their positions by their on-the-job performance" (from the head of a planning group on very large-scale integration for a components maker in Pennsylvania).

Paul W Brin


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Readers' comments

Tantamount to treason

To the Editor: I am so furious I can hardly write. In light of what has happened to our other industries, I often wonder why are we not yet buried in $60 computers from Japan, Korea, Taiwan, Hong Kong, and China. The answer is that producers have not been able to copy our software know-how the way they can easily copy our hardware—that is, not until the sellout by Microsoft described in the Electronics newsletter on page 41 of your March 24 issue, ["Microsoft, Japanese plan standard low-end home computer"].

I do not believe that Bill Gates is as incredibly naive as portrayed in the report when he says, "the computer will not be available in the U. S. . . ." This deal will cut the heart out of the information revolution in this country. It will result in a drying up of sources of investment capital and talent required to continually pioneer new hardware, software, and applications here. And it will throw off the track the potential the computer had to improve the quality of life worldwide.

The Japanese will not create new hardware, or software, or applications. They will make what they can copy in volume and kill the prospect for return on investment that drives the creative process here so well.

How can someone who contributed so much and benefited so richly from our system—and who has such an important stake in the exponential future growth of the markets he helped create—sell us all out, lock, stock, and barrel?

Robert H. Norman
San Diego, Calif.

Corrections

In "Motorola adopts revised pin-grid array" (April 7, p. 52), one of the socket makers backing the package should have been identified as Robinson Nugent Inc. Also, the MRF966/7 gallium arsenide field-effect transistor noted in that issue's Products newsletter (p. 253) is being introduced by the Motorola's Semiconductor Products Sector in Phoenix, Ariz.

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Circle 9 on reader service card

This new programmable sweep generator uses distributed microprocessor architecture.

CW accuracy can be held to ±10 Hz or better by phase locking to external frequency counter or lock box.

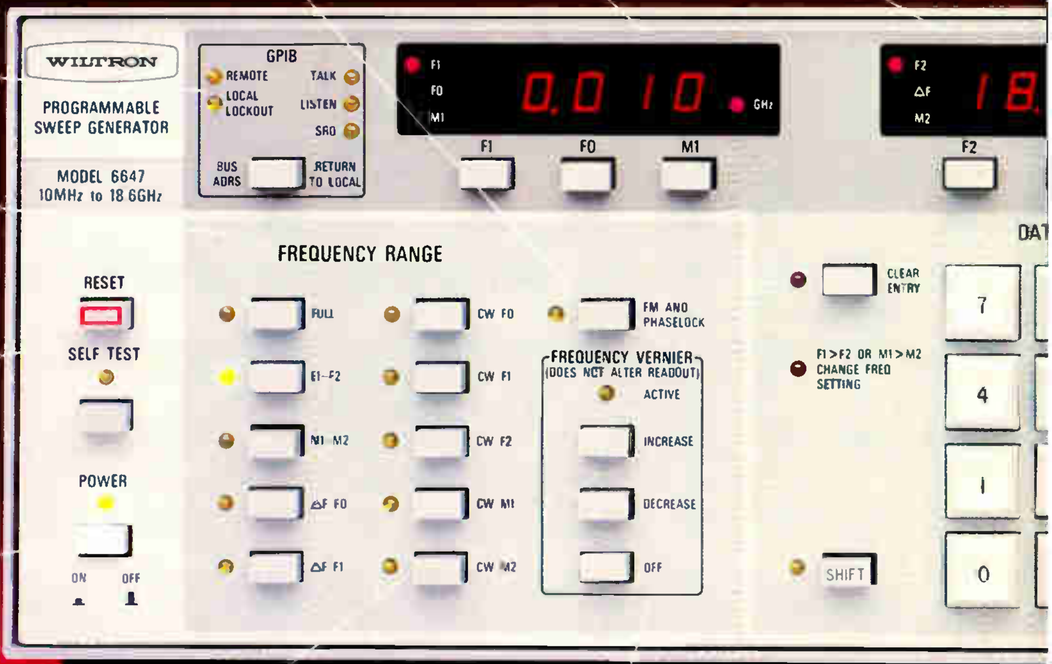
Both F1 (start) and F2 (stop) sweep frequencies, or M1, M2 marker frequencies or any combination can be displayed simultaneously.

GPIB (IEEE-488) bus messages include serial and parallel poll, group execute trigger and SRQ.

Five sweep modes provide broad or narrow band control for unprecedented measurement flexibility.

Self-test and automatic fault diagnosis occur every time the instrument is turned on; a diagnostic code is displayed on the front panel.

SAV and RCL commands can be used to store test setups. Non-volatile memory holds controls and readings at previous setting for 20 days or more.



Remarkably clean and stable CW signals are available with 1 MHz resolution at five pushbutton-selected frequencies or program-selected values.

Frequency Vernier with 100 kHz resolution allows precise adjustment of CW or center of ΔF sweep frequency.

Digital convenience and accuracy are part and parcel of the new Wiltron 6600, an eminently easy-to-use family of instruments which combines new RF technology with microprocessor control. With 10 MHz to 40 GHz coverage, the 6600 group is expressly designed to meet your ATE needs too. There are, quite simply, no more advanced sweeper/signal sources at any price.

A look at the features

Here in one compact 33 pound unit we give you a virtually self-explanatory pushbutton controlled front panel. All pushbutton controls can be programmed via the IEEE-488 interface bus. We give you a sweeper using fundamental oscillators avoiding the substantial errors generated by the harmonic products of multiplier type oscillators. We give you modular construction without the disadvantages of RF plug-ins. We give you a fast unit using distributed microprocessors and a display preprocessor to reduce bus loading and measurement times.

The result, broadband coverage with the lowest harmonic content (>40 dBc, 2-20 GHz), lowest residual FM and greatest stability on the market today. We give you a unit with the best frequency accuracy (±10 MHz up to 20 GHz) because it uses a ROM to correct non-linear residual frequency characteristics of YIG oscillators.

Programmable parameters include stepped sweep with selectable step size, start and stop frequencies, sweep width, marker frequencies, sweep time, output power level and optional attenuation.

Other features of note include high spectral purity, modular construction, self-test, 82 dB power control range with 0.1 dB resolution and power sweep.

So easy to operate

Multiple microprocessor design and human engineered panel controls make it easy for even the least experienced to use—on or off the bus.

It's a Wiltron.

Optional attenuator provides bus or front panel control of power level over 82 db range.

All frequencies, sweep times, power levels and their units are displayed when selected on the corresponding pushbutton or commanded over the bus.

Three markers provide easy identification of swept frequencies, center frequency of ΔF sweep and M1-M2 sweep limits.

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Excellent source match (<1.4 up to 20 GHz) reduces measurement errors.

Wiltron super-flat leveling components hold variations in output power to <±0.6 dB from 10 MHz to 20 GHz.

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6637	2 GHz to 18.6 GHz	>10 mW (+10 dBm)
6638	2 GHz to 20 GHz	>10 mW (+10 dBm) at ≤18.5 GHz >5 mW (+7 dBm) at >18.5 GHz
6647	10 MHz to 18.6 GHz	>10 mW (+10 dBm)
6648	10 MHz to 20 GHz	>10 mW (10 dBm) at ≤18.5 GHz >5 mW (+7 dBm) at >18.5 GHz
6636	18 GHz to 26.5 GHz	>3.1 mW (+5 dBm)
6640	26.5 GHz to 40 GHz	> 1 mW (0 dBm)

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Editorial

The EE faces change with equanimity

The people who have been most instrumental in developing the profound changes in the way our society goes about its everyday life and who themselves face profound changes in the way they do their work appear generally satisfied with the profession they have chosen. We refer to electronics engineers and the way that the technologies they have pioneered, particularly the computer, are revolutionizing their own work modes.

As shown in "The Changing Face of Engineering," our special report beginning on on page 125, not even the advent of the engineering work station, the flagship of computer-aided engineering, has unduly ruffled the feathers of those who would use it. Perhaps it is because the EE is professionally dedicated to change and so welcomes its excitement, or perhaps it is as simple as the fact that the stations have still not made their appearance in many of the less volatile specialties of engineering. Whatever the reason, many of the readers of *Electronics* who responded to our survey on job satisfaction wrote that they would welcome this next generation of work tool; some expressed impatience with what they saw as the reluctance of management to install such systems quickly.

But perhaps more to the point is the fact that, in the face of revolutionary change, some two thirds of the respondents say they would do it all over again if they were just starting college—and 85% would encourage their children to study engineering.

To be sure, there are anguished and angry comments from a number of working EEs about exploitation, pay, working conditions, and the like. These are real problems and should not be ignored. That a profession as multifaceted as electronics engineering should be the perfect pursuit for all people is not a realistic expectation. However, most of those who chose it agree that it is at least as much as they could hope for.

There is nothing to fear but fear

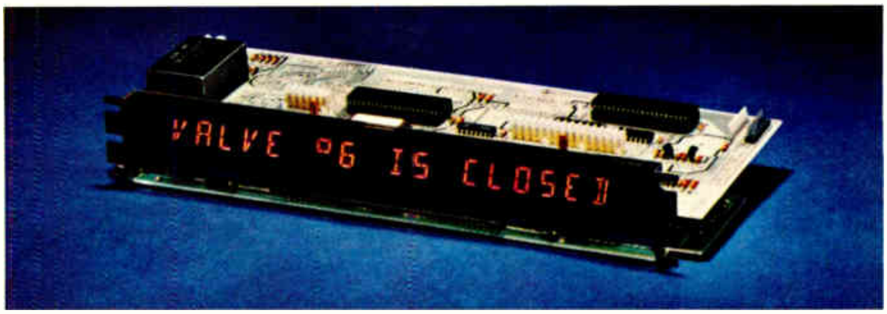
Meanwhile, as EEs consider a future fashioned around computer-aided engineering, thousands of blue-collar workers contemplate one of bleak joblessness. The culprit already has been selected: automation. A group of business leaders in the so-called smokestack industries—autos, steel, and the like—has said that, even if there is a complete economic recovery, they would not rehire thousands of laid-off workers whose jobs have been automated.

If it is true that those who fail to learn from history must repeat it, then we are in danger of reliving the excesses of the industrial revolution, complete with machine-smashing Luddites. At least part of the prevention of that scenario is a realization that automation creates jobs: systems must be designed, made, sold, installed, and repaired, and many of those out-of-work blue-collar employees can be retrained to do those jobs. Business and governmental leaders must get to work now in order to sell the benefits of automation.

New PC display system reduces down-time, increases productivity

F. A. Amendola
Cherry Electrical Products Corp.
Waukegan, IL

Cherry unit adds diagnostics and operator prompting in understandable printed messages to any programmable controller. Cost: less than $300



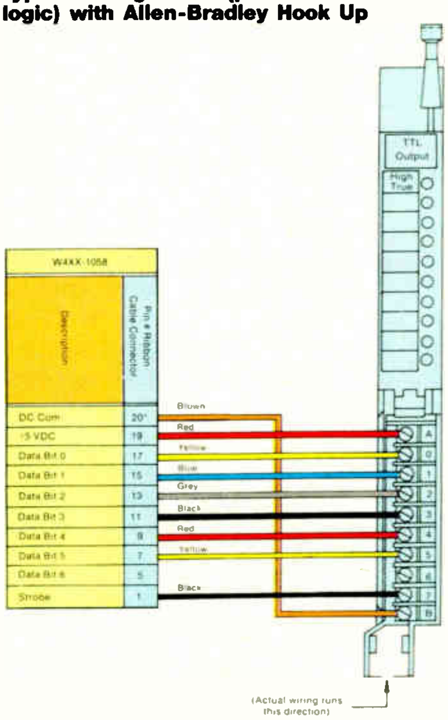
Cherry No. W420-1058, 20 character display system complete with all on-board electronics.

If your programmable controller is not equipped with a serial ASCII output port, you may not be realizing all of its potential productivity. In its present state it is unable to output information for operator prompting or provide diagnostic information in immediately understandable messages for your maintenance staff. Of course the information is being supplied by your PC, but in the form of signals or shut-offs or complicated codes.

The new Cherry display system literally adds literacy to any programmable controller with TTL output drivers, 5 VDC. Instead of using cumbersome look-up tables to translate output codes, your operator is given any of up to 64 messages of up to 32 characters each, spelled out on a bright, easy-to-read display panel. A flashing mode attracts attention to potential trouble such as slipping belts, stuck valves or overheating. Your operator is constantly and instantly supplied with pertinent, *understandable* information about all critical phases of production under your host system's control.

At a cost of less than $300 in OEM quantities this new unit compares with others costing over $1000. It is estimated that the addition of this Cherry display system to your host system will pay for itself in just a few months by decreasing frequency of down time, in improved maintenance and increased machine efficiency.

Typical configuration (positive logic) with Allen-Bradley Hook Up



Easy to install—a complete message center

You just connect two color-coded cables (one power and one signal) and the Cherry unit is ready to take the PCs output drivers and provide output decoding of up to 64 easily programmable messages...anything from "BIN 4 EMPTY" to "ET PHONE HOME." No hardware changes or additions.

This new Cherry unit is a piece of straight-forward engineering consisting of complete on-board electronics and a flat gas discharge display panel of 16, 20 or 24 half-inch high characters in bright orange easily readable in any ambience. (Longer messages may be scrolled.) Unit has built in capability for longer scrolled messages and a flashing mode.

Sample Program (message: VALVE #6 IS CLOSED) Starting location HEX 000

HEX CODE	DESCRIPTION
10	Blank Display—all messages must start with this
0A	Line Feed—clears display
0D	Carriage Return—puts cursor to far left
12	Display Recall—turns on display
56	V
41	A
4C	L
56	V
45	E
20	Space
23	#
36	6
20	Space
49	I
53	S
20	Space
43	C
4C	L
4F	O
53	S
45	E
44	D
89	All messages must end with this

Complete information and specs available

Cherry will send you an 8-page instruction booklet that includes typical connections to various PCs plus application notes on sample programs and ribbon cable connections and Hex Number Addresses for messages in user's EPROM. Send for it today.

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Circle 13 on reader service card

People

Entrepreneur von Meister sees games as videotex key

He is technically savvy, well-connected, and perennially optimistic—qualities he exploits to the fullest to gain his ends. William von Meister, inventor of The Source, winner of $20 million from entrepreneurial ventures and loser of two thirds of that, is riding full tilt again, this time as founder, president, and chief executive officer of Control Video Corp. of Vienna, Va.

Master entrepreneur. William von Meister expects to gross $100 million within three years. Then he will retire.

The new company's maiden service, GameLine, is a scheme that gives at-home access over telephone lines to a well-stocked, frequently updated library of video games [*Electronics,* May 5, p. 42]. Says von Meister: "We see this as a way of getting into the home. I'd like to see this become the videotex system for the average family."

Before The Source, his biggest hit, von Meister in 1972 founded Telecommunication Industries Inc., now known as Western Union Electronic Mail Inc., and then TDX Systems Inc., a computerized long-distance telecommunications system acquired in 1977 by the British government. As a consultant for GTE, he helped draft the videotex standard known as the North American Presentation-Level Protocol Specification.

Not all is well at The Source, however. The sports, news, and financial data base, acquired in 1980 by the Reader's Digest Association Inc., has fallen some 15,000 subscribers short of its 50,000 goal.

"It's missed the boat by not marketing more to business users," says von Meister. "I would do two things over: waive the $100 registration fee and allow on-line registration." However, it still has "the best electronic-mail system in the business," and co-owner Control Data Corp. "just may have the technical expertise and the marketing clout to bring it around."

Von Meister backed into the idea for GameLine last June on the rebound from a stunning defeat with his Digital Music Co. venture, which was to offer digital transmission of master recordings to homes with cable. But "the retailers pressured the record companies, and they reneged on their agreements" to supply the tapes. "There went $2 million down the tubes," he says.

Ups and downs of this magnitude are the stuff of life for von Meister, 41, who never received an undergraduate degree (though he does hold an MBA from American University): "It's like being a cowboy or exploring the Amazon. You're still living within the rules, but you're up against tremendous challenges. Plus, it's the only way to make any real money."

He looks for Control Video to rake in $100 million within three years. Two years after that, he will "retire and become a consultant and venture capitalist."

McKnight says time is ripe for Orion's satellite plan

"It's right, timely, and fair, and of tremendous value to heavy communications users." That is how Thomas K. McKnight, president of the recently formed Orion Satellite Corp. of Washington, D. C., describes his company's $215 million plan to orbit satellites with transponders for sale to private transatlantic customers with their own earth stations [*Electronics,* March 24, p. 63].

Recognizing that Orion is an underdog before the Federal Communications Commission, McKnight is

Hewlett-Packard on low-budget data logging...

Here's a system that goes wherever you go... and it goes for less than $3100.*

This low-cost traveler can help bridges, forests, telephones, automobiles, schools, pipelines, solar systems...and you.

Now there's a sensible answer for small data logging projects. Whether they take you to the engineering lab, a plant, or the field. It's a portable system based on HP's new 3421A Data Acquisition/Control Unit. We combine this portable powerhouse with HP's 41CV handheld computer and peripherals to give you a low-cost data logger that offers surprising performance.

For example, this system can automatically scan up to 30 channels, measure ac or dc volts, make 2- or 4-wire resistance measurements, monitor digital inputs, and even provide digital outputs.

Sensitivity of 1 μV and 300,000 count resolution let you detect small signals from transducers such as RTD's, thermocouples and thermistors. High accuracy (0.01% full scale), excellent noise rejection (120 dB), and electronic calibration mean you get answers you can trust... even in noisy industrial environments. What's more, reference junctions and software programs simplify measurements by giving you results directly in engineering units.

But you also need flexibility in a portable data logging system. That's assured by the convenient HP-IL interface and 3421A adaptability. With the 41CV, you can easily program the system to do your measurements your way. HP's Digital Cassette Drive lets you store programs for easy recall. And you can also store data for later analysis in the lab. With HP's Thermal Printer/Plotter, you can see measurement results immediately. With the 3421A, you can trade accuracy for speed. Choose 5½-digit resolution to detect small changes. Or, if you're interested in speed, select a fast 30 readings per second with 3½-digit resolution. When ac power is available, you can plug into an outlet, but if power fails you have battery backup for uninterrupted operation. In remote locations, you can operate totally from battery power. A "sleep" mode conserves power by putting system components on standby until needed. With HP-IL you can even upgrade to the more powerful HP85 personal computer for tougher data-logging tasks.

We're into applications you wouldn't have dreamed of.

This new system opens the door to countless data logging tasks you'd have previously tackled manually...if at all. For example, in the electronics lab you can check PC-board temperature profiles. In process plants you can quickly do spot checks on levels, pressures, temperatures, and flow rates. Civil engineers can do life tests on structures such as bridges by measuring the galvanic effect on reinforcing rods.

A data logger in a fish hatchery? Yes, this system can monitor water level, flow rates, and temperature to produce the best mixture of stream and well water for optimum fish growth. The forest industry could even put this system to work in studying the effects of clear cutting on seedling mortality by monitoring soil temperature in various locations.

Whether you're in a manufacturing plant, research lab, solar powered building, ship, airplane, or balloon... HP's new portable data logging system can give you precision measurements at low cost. A complete system, including the 3421A, 41CV, Digital Cassette Drive, Thermal Printer/Plotter, and HP-IL interface, goes for less than $3100.* So pack this system up in its convenient carrying case and take it along... wherever you go.

Get all the details by calling your local HP sales office listed in the telephone directory white pages. Ask for a sales engineer in the electronic instruments department.

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* Prices shown are suggested USA list prices

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Circle 15 on reader service card

People

still convinced he will triumph. Noting the Reagan Administration's inclination to deregulate space activities, politically canny McKnight says the issue boils down to public ownership versus free enterprise.

One of many. In fact, he predicts, 10 years from now the International Telecommunications Satellite Consortium will be just one player among a host of foreign-flag systems operating between the U. S. and Europe. He also submits that FCC denial of his application would result in no U. S. participation in that arena—a prospect he believes will not wash on Capitol Hill.

McKnight attributes his strong pro-American stance to his two years in the marines. Later, as a brand-new attorney with a bachelor's degree from Ohio State University and law diploma from Miami University in Ohio, he joined the FCC Office of Policy and Planning in 1973 when the skies were just opening to satellite communications. There he began acquiring a taste for challenging the *status quo*, developing alternative perspectives on controversial issues. In 1976, he moved to the White House's Office of Telecommunications Policy.

Seeking to gain hands-on business experience, he joined the legal staff of Combined Communications Corp., Phoenix, Ariz., in 1977. After that and a brief second stint at the FCC, McKnight became vice president for telecommunications development at Gannett Satellite Information Network.

Then, with a close friend from his FCC days, he formed Orion Telecommunications Ltd. in March 1982 to advise industry on regulatory strategy. That venture was to prove short-lived for the 38-year-old Cincinnati native; some seven months later, Orion Satellite Corp. was born.

Should the FCC rule in Orion's favor, McKnight says, there is enough money pledged by investors to proceed with the construction of the satellite system. If the proposal is shot down, he says he has a number of contingency plans that also are provocative and will rock the existing order. □

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MV 5354	.087		
MV 5453	.087		
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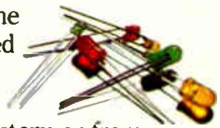

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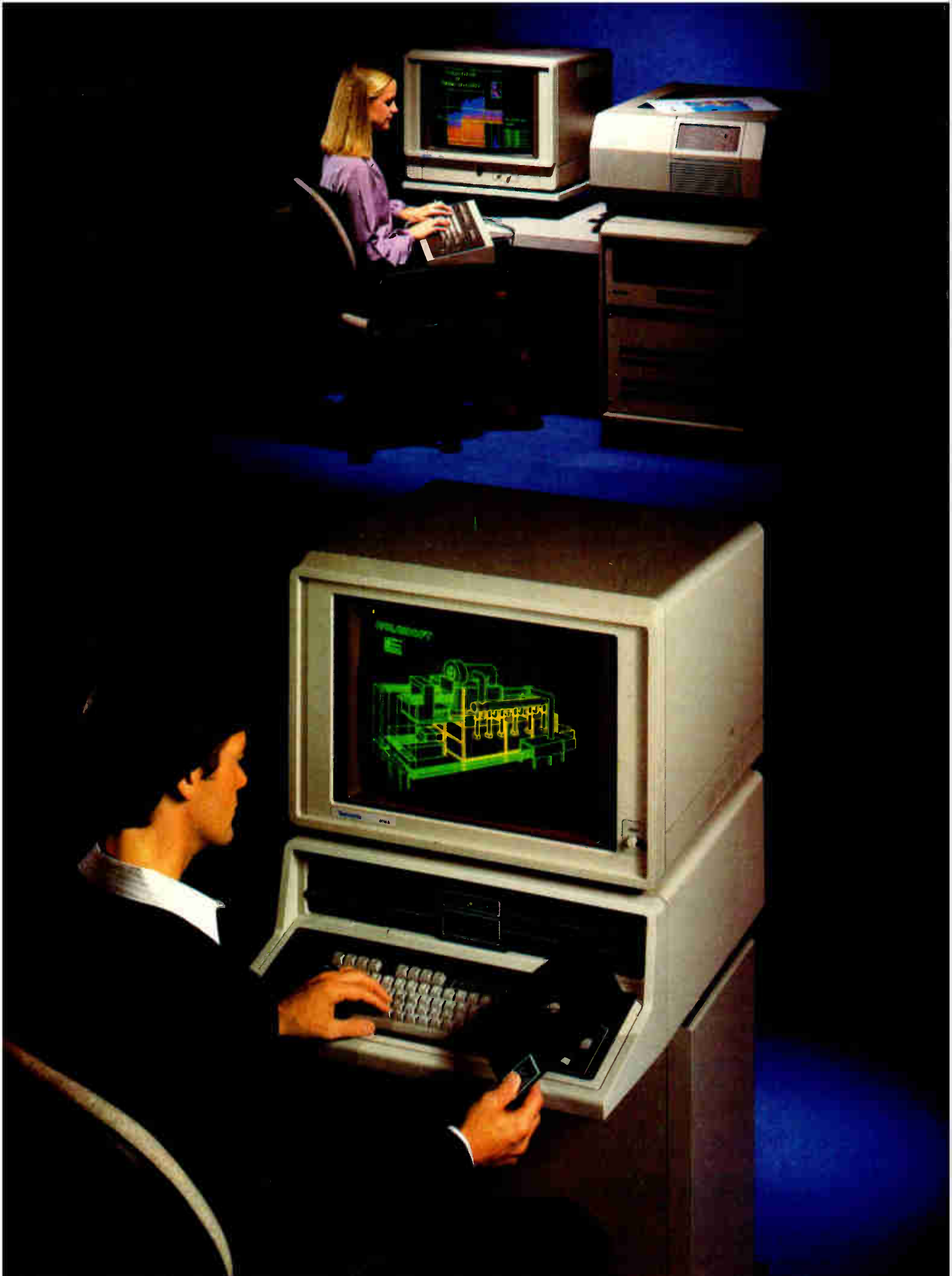
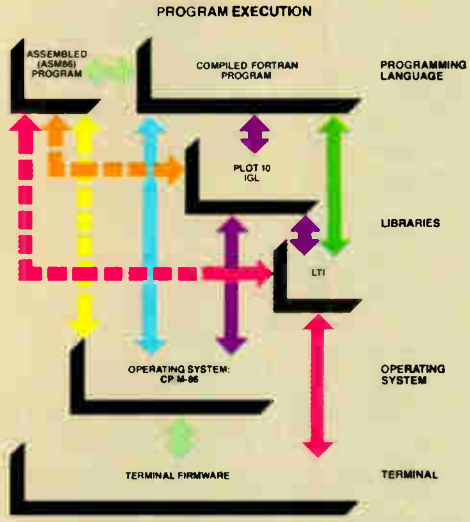


Host power only when you need it: introducing standalone computing for Tek 4110A Series terminals.



(Left) Local Programmability is compatible with all Tek 4110A Series terminals, including the high-resolution 4114A and color raster 4113A, shown. (Right) Illustrated: relationships of software modules for a terminal with Local Programmability. User-written FORTRAN or assembly language programs can be linked via the CP/M-86 operating system to Tek LTI and PLOT 10 IGL libraries. (Above) Local Programmability lets you locally control peripherals like the new 4691 Color Graphics Copier, engineered compatible with the Tek 4113A color raster terminal for outstanding color copy quality.

Tektronix 4110 Series Local Programmability combines the best elements of standalone computing and host-based data management. Add Local Programmability to any Tek 4110A Series terminal to enjoy the execution speed of a mini. To access the processing power of a mainframe. And to utilize the resident capabilities of Tek's advanced color raster or DVST graphics terminals, on-line or off.

Local Programmability can dramatically raise output and reduce the cost of data communication. It can eliminate line delays and other obstacles to true graphics interactivity, without changing the way you work.

Armed with Local Programmability you can develop and run programs locally, while exploring the full graphics potential of the 4110A Series.

The package includes an industry standard CP/M-86®* operating system. Your choice of a FORTRAN-86®** compiler or ASM86®** macro assembler. Plus a library of powerful Low-level Terminal Interface (LTI) subroutines providing a quick path to resident terminal features, such as segments manipulation or 2-D transforms, at a minimal expense of memory.

A local version of PLOT 10 IGL, the world's most-utilized SIGGRAPH "core" software, is also available. With Local IGL, you can run your host resident IGL programs at the terminal level, by downloading and recompiling them locally.

Local Programmability lets you do pre- and post processing tasks—such as tablet digitizing, on-screen rotation and scaling, and plotter output—with complete independence.

Finally, it frees the mainframe to service more users by doing only what it does best: the most intensive processing and data base management tasks.

Local Programmability is the latest dividend of Tek's commitment to easy evolution and upgrade of its graphics. The tools, documentation and support are in place to allow easy implementation on all of Tek's wholly-compatible 4110A Series terminals.

Talk to your Tek Sales Engineer soon. For literature and the address and phone of the nearest Tek sales office, write or call:

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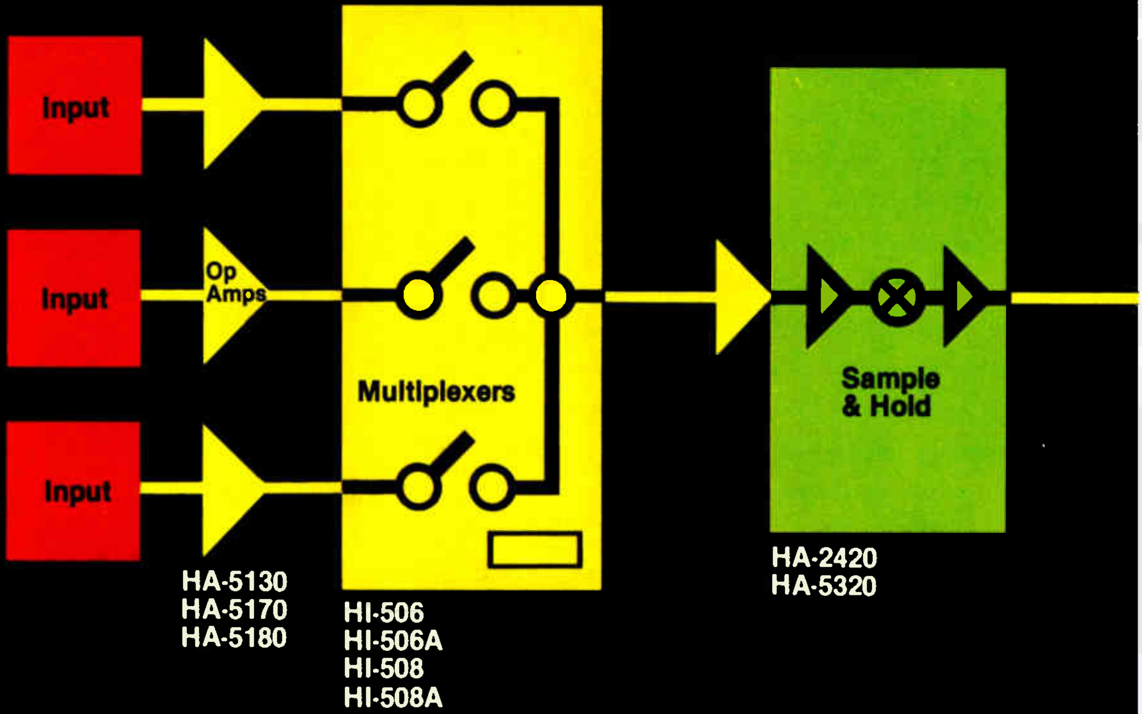

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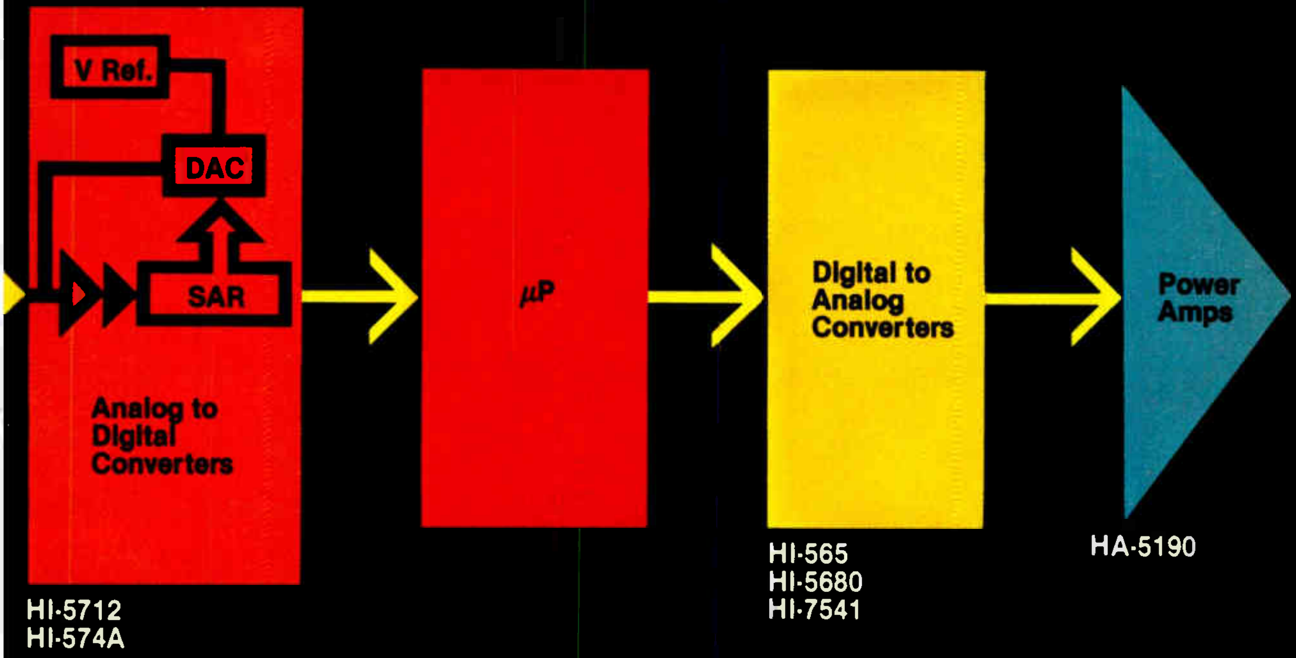

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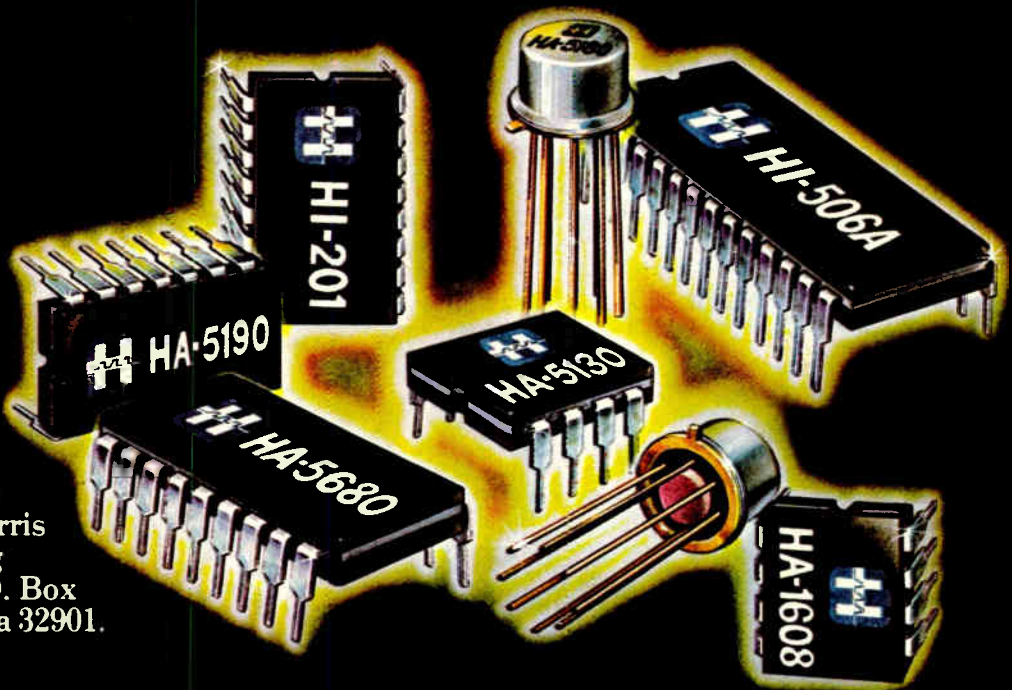

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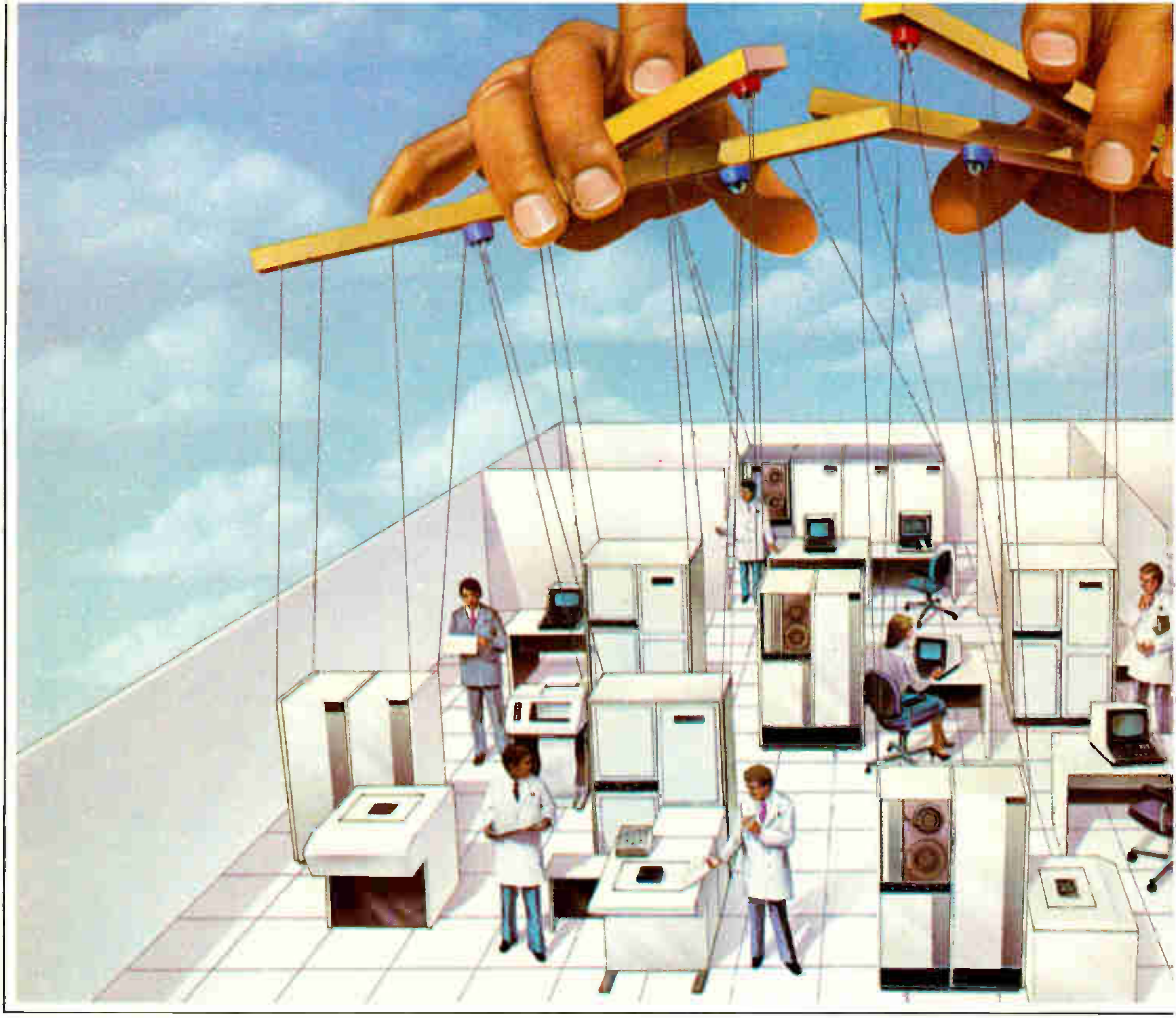

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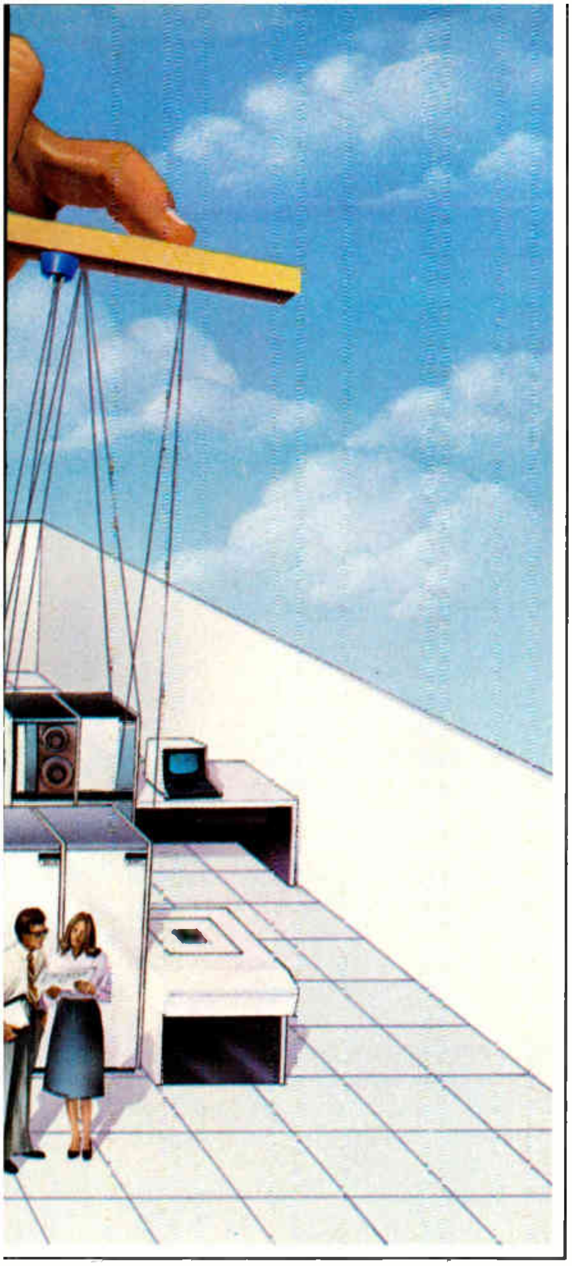

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For more information about our new Test Area Manager solution, call or write: Fairchild Digital Test Systems, 1601 Technology Drive, San Jose, CA 95115. (408) 998-0123, Ext. 2296. Regional sales offices: New Jersey (609) 784-2000 Texas (214) 422-7200 California (408) 947-3601. Fairchild Camera and Instrument Corporation.

Circle 23 on reader service card

Limiting liability for computer malfunctions

by **Marc E. Brown,** *patent attorney practicing in Los Angeles*

Businesses today depend upon their computers. When they fail, computer vendors are often asked to pay for the damages caused.

Generally, vendors can be held liable, not just for the expense of repairing the computer, but for all damages that were "reasonably foreseeable" to them at the time the computer was sold. These usually include injuries to persons and property and, most importantly, consequential damages such as lost profits, harm to reputation, and liabilities that the customer itself incurred because of the computer failure.

Disclaimers. One of the most effective methods of limiting this liability is to place a disclaimer clause in the sales contract. Each type of injury that the vendor refuses to cover can be expressly excluded.

The most common exclusion is for consequential damages. Often, the vendor does not object to repairing the equipment, and the likelihood of personal injury or property damage is remote. Still, few vendors want to accept liability for lost profits and other types of remote and often unbounded injuries.

Another common disclaimer is of the "Implied Warranty of Fitness for a Particular Purpose." When the user has relied upon the vendor's expertise in selecting a computer to solve his problems, an implied warranty is created that the computer will solve those problems. Unless this implied warranty is disclaimed, therefore, the vendor may be liable for damages even though the computer, as a technical matter, functions perfectly.

The most encompassing disclaimer is of the "Implied Warranty of Merchantability." This warranty is implicit in every sales contract and assures the buyer that the computer is fit for the ordinary (as opposed to the specific) purposes for which it may be used. To be effective, however, any disclaimer of it must explicitly mention the word "merchantability" or state that the goods are being sold "as is."

One caveat: disclaimers will not be enforced unless they are placed in a conspicuous position in the sales contract. They will also not be enforced when personal injury results from the malfunction.

Functional specifications. Users often demand compensation when the computer fails to solve all of the problems for which it was purchased, regardless of whether it is operating properly from a technical standpoint. If the user relied originally upon the vendor's expertise in selecting the computer, such a claim is likely to succeed in court. And although liability could probably be cut off by a disclaimer of the "Implied Warranty of Fitness" discussed above, the presence of such a disclaimer might well kill the sale.

The compromise solution is for the buyer to be required to provide a detailed and comprehensive list of the problems the computer must solve. These functional specifications can then be incorporated into the sales contract and identified as the only specifications the computer has been selected to meet. The more detailed and comprehensive they are, the less room there will later be for legal dispute.

Merger clauses. After the sales contract is executed, users often claim that the computer does not measure up to the oral assurances they previously received. To minimize the chances that such claims will be respected, vendors often insert "merger clauses" into the sales contract. These clauses typically state that the buyer of the computer is not relying upon any representations or promises other than those expressly set forth in the sales contract and that no such additional representations or promises have been made.

Shortening claim time. In most states, the buyer has many years (typically four) following a computer failure in which to file a lawsuit for damages. This leeway is often a source of frustration to vendors who, after having devoted literally years to solving the buyer's problems without charge, find themselves a defendant in a lawsuit.

To minimize this risk, a clause can be placed in the sales contract that shortens the time in which the buyer must file a lawsuit for breach of contract. In most states, however, the time may not be shortened to less than one year.

Insurance. Even the most carefully drafted liability limitations may be ineffective in certain circumstances. Next month's column will explore these circumstances. For now, however, vendors should realize that they can protect themselves by obtaining insurance. Not only can this indemnify them for losses, but most policies pay for the insured party's legal defense.

This column sets forth basic principles of law and is not intended as a substitute for personal legal advice. Questions and comments are invited and should be sent to Mr. Brown in care of Electronics.

"Thanks to our Fluke Troubleshooters, we don't send boards back to the factory for repair."

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And because Fluke Micro-System Troubleshooters support over 30 microprocessors — including the new 16-bit designs — they give you flexibility to meet change.

But the bottom line for John Dedich is this:

"With help from the 9010A, we are finding it easier to maintain Collins' high standards of after-sale support. Our service techs are able to be more productive, and customers get more value from our avionics systems."

For more information on Fluke 9000-Series Instruments, microprocessors supported, and seminar programs, contact your Fluke Sales Engineer, use the coupon below, or call toll free: **1-800-426-0361.**

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For technical data circle no. 25

Meetings

20th Design Automation Conference, IEEE (Paul Losleben, DARPA/IPTO, 1400 Wilson Blvd., Arlington, Va. 22209), Fontainebleau Hilton, Miami Beach, June 27–29.

Fourth International Conference on Integrated Optics and Optical-Fiber Communication, IEEE *et al.* (Melvin I. Cohen, Room 60325, Bell Laboratories, 600 Mountain Ave., Murray Hill, N. J. 07974), Keio Plaza Intercontinental Hotel, Tokyo, June 27–30.

13th Fault-Tolerant Computing Symposium, IEEE (Michele Morganti, Teletra SpA, Via Mattel 20, 1-20064 Gorgonzola, Milan, Italy), Jolly Hotel, Milan, June 28–30.

Microcomputer Show '83, Japan Electric Industrial Development Association (3-5-8 Shiba Koen, Minato-ku, Tokyo 105), Osaka Merchandise Mart, Osaka, June 29–July 2.

Office Automation Show, Nihon Keizai Shimbun (1-9-5 Otemachi, Chiyoda-ku, Tokyo 100), Tokyo Ryutsu Center, July 4–7.

The Fifth Generation: Dawn of the Second Computer Age, Systems Programming Ltd. (The Fifth Generation Computer Project, SPL International Research Centre, The Charter, Abingdon, Oxfordshire, England), London, July 7–9.

Siggraph '83—10th Annual Conference on Computer Graphics and Interactive Techniques, Association for Computing Machinery *et al.* (ACM/Siggraph, 111 E. Wacker Dr., Chicago, Ill. 60601), Cobo Hall, Detroit, Mich., July 25–27.

Hi-Tech Osaka '83, Marcom International Inc. (Akasaka Omote-cho Building, Room 705, 4-8-19 Akasaka, Minato-ku, Tokyo 107), Osaka Minato Exposition Center, Minato-ku, Osaka 552, July 27–29.

VLSI '83 International Conference, International Federation for Information Processing (Pat Ueland, VLSI '83, The Norwegian Institute of Technology, N-7034 Trondheim—NTH, Norway), Trondheim, Aug. 16–19.

10th International Conference on Amorphous and Liquid Semiconductors, Physical Society (3-5-8 Shiba Koen, Minato-ku, Tokyo 105), Federation of Economic Organizations, Tokyo, Japan, Aug. 21–26.

National Conference on Artificial Intelligence, American Association for Artificial Intelligence (Claudia Mazzetti, AAAI, 445 Burgess Drive, Menlo Park, Calif., 94025), Washington Hilton Hotel, Washington, D. C., Aug. 22–26.

International Conference on Parallel Processing, IEEE *et al.* (P. O. Box 639, Silver Spring, Md. 20901), Shanty Creek Lodge, Bellaire, Mich., August 23–26.

10th International Conference on Amorphous and Liquid Semiconductors, Physical Society of Japan (3-5-8 Shiba Koen, Minato-ku, Tokyo 105), Federation of Economic Organizations, Tokyo, Aug. 30–Sept. 1.

Seminars

Fundamentals of Control, Instrument and Control Technology, Introduction to Process Computers, and other one- and two-week applications courses in measurement and control are being given during the summer and fall in Foxboro, Mass., Houston, and other U. S. and Canadian cities. For more information, write to the Registrar, Educational Services, The Foxboro Co., Foxboro, Mass. 02035, or call (617) 543-8750.

Engineering Work Stations will be studied at Andover Inn, Andover, Mass., June 21–23, followed by **Advances in High-Definition TV,** July 10–12, and **Optical and Video Disc Systems,** July 24–26, both at the Holiday Inn, Monterey Bay, Calif. For more information, write to the Institute of Graphic Communication, 375 Commonwealth Ave., Boston, Mass. 02115, or phone (617) 267-9425.

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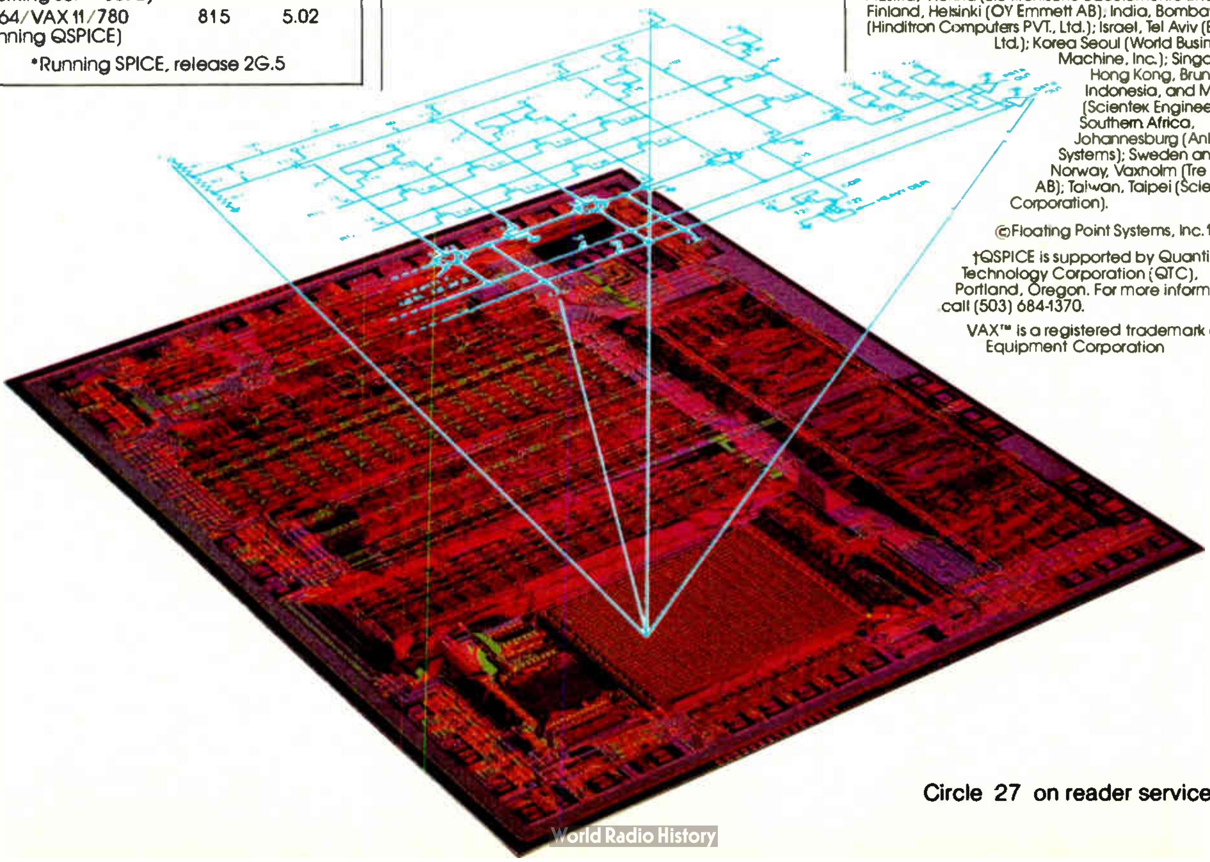

†QSPICE is supported by Quantitative Technology Corporation (QTC), Portland, Oregon. For more information, call (503) 684-1370.

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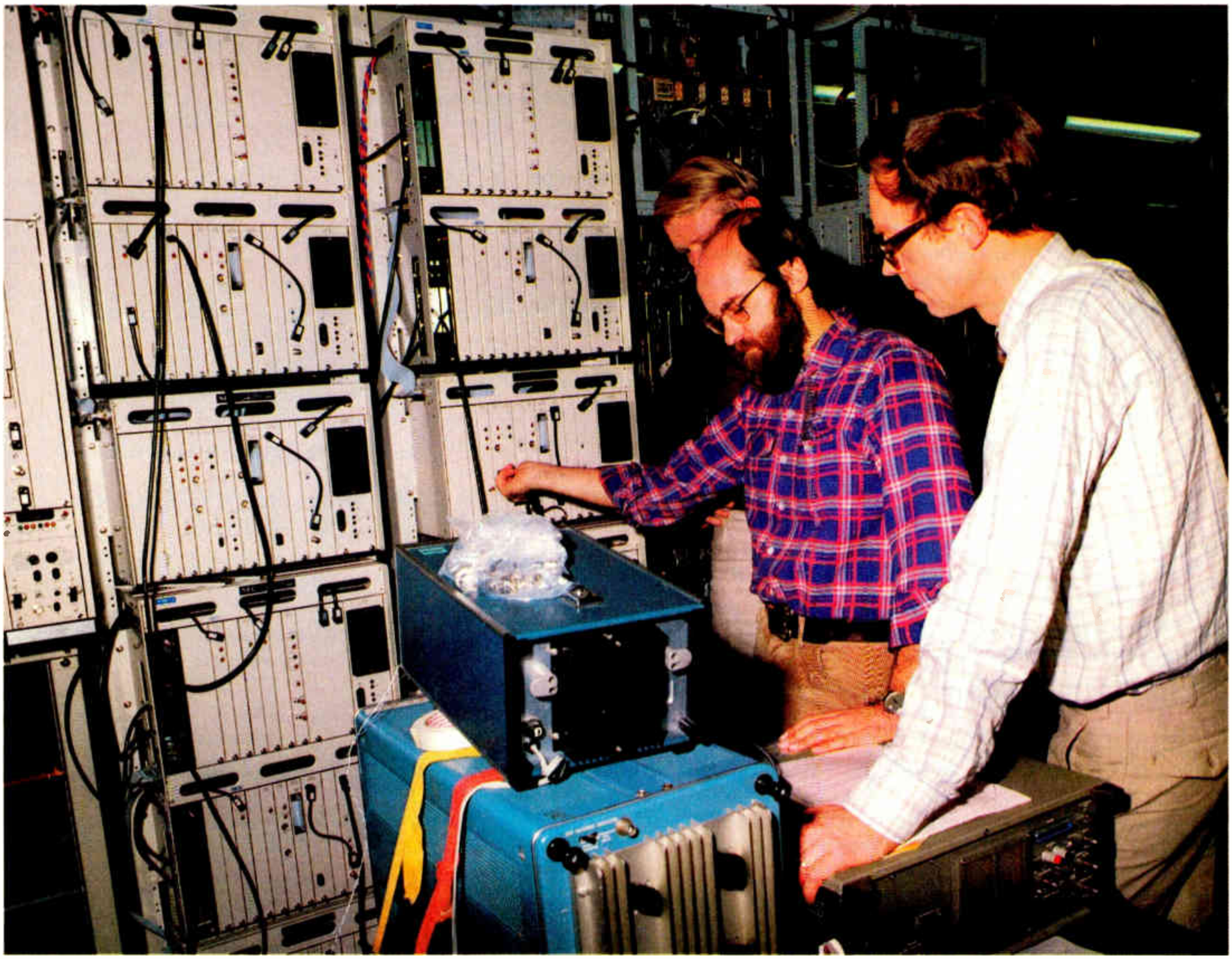


140Mbps DIGITAL MICROWAVE SYSTEMS TO SERVE SCANDINAVIA

As part of a drive to digitalize their telecommunications networks, Denmark, Sweden and Norway will employ 16QAM-140Mbps digital microwave systems from NEC.

Each country's link will provide high quality transmissions between its capital and other major cities. The combined length of these links is about 2,400 kilometers.

NEC's 16QAM-140Mbps digital microwave system has the highest bit rate recommended by CCITT and CCIR, and accommodates 1,920 communications channels.

Outside of Scandinavia, eight other countries around the world are using or have decided to use the same equipment.

Photo: Danish engineers test 16QAM-140Mbps digital microwave transmitter-receivers at NEC.

NUMBER 128

SINGAPORE INMARSAT STATION IN FULL OPERATION

Since the inauguration of its Sentosa coast earth station, the Telecommunications Authority of Singapore has been operating INMARSAT maritime telecommunications service.

The new station provides high-grade telephone and telex communications as well as facsimile and data transmission between land subscribers and ships in the Pacific Ocean.

For access, control, and signalling, the station uses a NEAX61 digital switching system capable of handling telex and data in addition to voice.

NEC, the world's leading manufacturer of INTELSAT earth station systems, completed the Sentosa coast earth station just 14 months after the contract was awarded.

The C/L dual band 13m diameter antenna, with an NEC-built INTELSAT Standard A earth station antenna in the background.

TWO TERMINALS FOR VOICE INPUT/OUTPUT

Verbal man/machine interface is offered by two compact, economical terminals—NEC's SR-100 and AR-100.

To program the SR-100 Voice Input Terminal, the user just speaks each word once. Almost any word, in any language, can become part of the SR-100's vocabulary. With its unique internal dynamic programming method, the SR-100 recognizes up to 120 words with over 99% accuracy. It is ideal for "no hands" situations.

Quick registration is also a feature of the AR-100 Voice Output Terminal. Built-in analysis circuitry lets vocabulary be changed in the field. The AR-100 uses NEC's bandwidth compression technology (adaptive differential pulse code modulation) for high-quality voice output. It takes up to 120 seconds of messages and has a built-in speaker, making it valuable in such applications as warning, instruction, or announcement systems.

Both the SR-100 and AR-100 interface with computers, numerical control machinery, medical equipment, and more. In combination, they become an efficient voice-operated control system that lets the user work away from the keyboard and display terminal area.

Circle 29 on reader service card

3-CHIP LSI OBEYS 512 SPOKEN COMMANDS

NEC is now marketing a 3-chip LSI that incorporates all the functions necessary for voice recognition and subsequent processing.

Consisting of the MC-4760 analog processor, μPD7761D recognition processor, and μPD7762G controller, the LSI is extremely easy to program. Voice patterns are registered when the operator speaks word-by-word through a microphone Recognition is achieved by referring sounds to these voice patterns. There is no need for an analog input circuit. The LSI holds up to 512 words using a 16K byte memory for every 128 words. Its recognition accuracy is over 98%, with an average recognition speed of 0.7 second per 2-second long word.

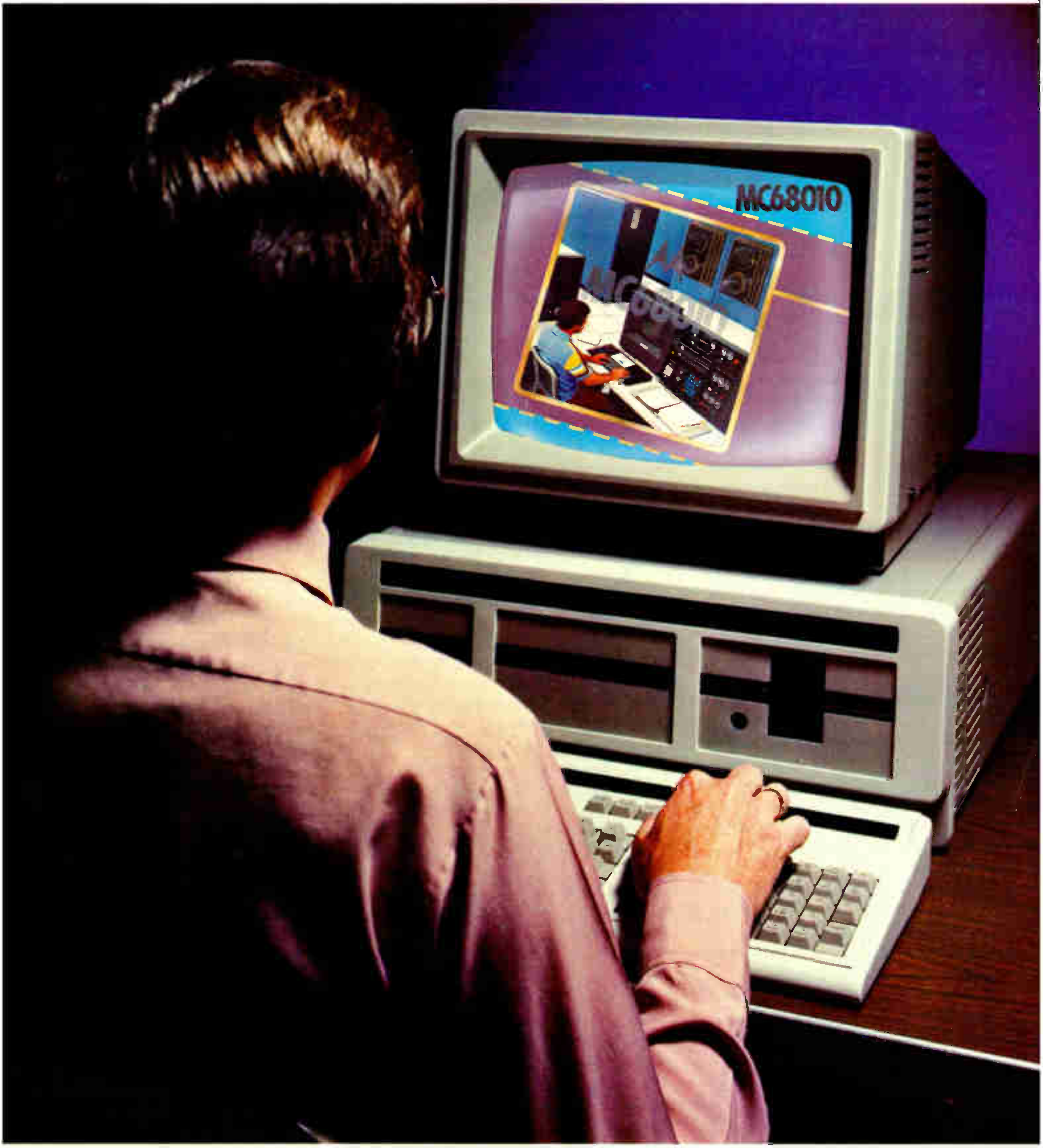
NEC's voice recognition LSI is easily interfaced with the main system host processor, either in parallel or in series. A special serial interface port is also available.

NEC

NEC Corporation

P.O. Box 1, Takanawa, Tokyo, Japan.

Motorola's virtual memory 16-
mainframe capabilities for



bit MC68010 provides your microcomputer systems.

Now you can design powerful mainframe capabilities into your 16-bit microcomputers with the latest of Motorola's M68000 Family microprocessors.

The MC68010 fully supports virtual memory/virtual machine/virtual I/O techniques in microprocessor based systems. This allows a system to operate as if it has many times the amount of physical memory it actually has, and makes it tolerant of faults.

Faults on any bus cycle can suspend any instruction and begin a controlled correction. The MC68010 doesn't try to predict faults; it responds to them intelligently. No segmented architecture offers these features.

The MC68010 tolerates failures of memory cards to make proper transfers, cleanly, regardless of cause.

It handles faults caused by hardware failure and the software protection faults that a memory manager finds.

MC68010 systems don't care whether faults are due to protection violation, non-existent memory, circuit failure, bad RAM or a watchdog timer. Even memory errors during important operating system procedures are tolerated routinely.

The MC68010 provides capabilities that once were confined to mainframe and minicomputer systems, and extends the leadership characteristics which have made the MC68000 so popular in new designs.

Applications programmers should love the MC68010.

Applications programmers don't have to code around, or even know about memory management. That's handled by the operating system. Many memory management techniques can be implemented, including demand paging, to make the bank-switching schemes of segmented architectures obsolete.

And, don't forget the MC68010 gives you the same 16 megabyte linear memory space as the MC68000.

For systems designed with error detection and correction (EDAC), the MC68010 helps you improve the design of systems with slower memories.

Enhanced instruction timing results in execution of MC68000 instructions up to 50% faster by the MC68010, at the same clock speed. The MC68010 runs all MC68000 user code identically, so your existing system is upgraded simply by placing the MC68010 in the MC68000 socket.

M68000 Family: 32-bit architecture makes it the only practical 8/16/32-bit migration path.

From the time the MC68000 was introduced it claimed the leader's mantle. One of the most significant reasons is its 32-bit architecture. It's not an 8-bit architecture stretched to 16, but 32 bits confined to a 16-bit bus. It's now also available in 8-bit form as the MC68008. That's a 32-bit architecture on an 8-bit bus. Full 32-bit power will soon be unleashed in the MC68020. From the MC68000 and MC68010, in both directions to the MC68008 and the MC68020, the M68000 family becomes the very definition of code compatibility . . . the only practical migration path along the 8/16/32-bit route.

Advanced tools assist fast, accurate system development.

Advanced MC68010 support is provided by the EXORmacs™ system: the first 8-/16-/32-bit multiuser development system.

An MC68010 Macro Assembler that runs on the EXORmacs will be augmented by the user-friendly HDS-400 Hardware/Software Development Station, which will provide real-time emulation to 8 MHz with no wait states.

When you need a variety of logic analysis and system performance histogram features, the Bus State Analyzer adapts to the MC68010 through a unique personality module.

Basic and C will soon be offered with existing Pascal and Fortran compilers, and symbolic debug is available. A broad and rapidly expanding base of development and applications software also is available from independent, third-party vendors.

M68000 family peripherals, memories, discretes, linear and logic meet your broad system needs.

M68000 MPUs are supported by a growing family of Motorola-developed peripherals. Contributions from our worldwide major second sources are adding even greater breadth and depth to the family.

Motorola memories from ROMs and PROMs to Static RAMs and state-of-the-art dynamic RAMs are available in chip, board or box form. And, Motorola is one of the few suppliers dedicated to bubbles.

Our discrete products are legendary for breadth of line and quality. Every significant logic form is available, and the Motorola linear line is among the world's leaders.

For direct M68000 Family assistance, call your local Motorola office or distributor. For information on the MC68010, send to Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix AZ 85036.

INNOVATIVE SYSTEMS THROUGH SILICON.

MOTOROLA INC.

TO: Motorola Semiconductor Products Inc., P.O. Box 20912, Phoenix, AZ 85036.
146ELEX053183

Please send me more information on 16-bit MPUs.

Name ____________________

Title ____________________

Call me: ( ) ____________________

Company ____________________

Address ____________________

City ____________ State ________ ZIP ________

News update

■ When GenRad Semiconductor Test Inc. of Milpitas, Calif., was formed in late 1979, president Brian Sear had high hopes that the company would lead the field in introducing a VLSI test system [*Electronics*, Feb 14, 1980, p. 14]. Not having to worry about compatibility with earlier generations, he and system designer Robert Albrow figured they could also get a leg up using a modular architecture offering the high pin counts and frequencies needed for very large-scale integration.

Barely a year later, the company unveiled its first two systems—the GR16 and the more powerful GR18. The GR16, a 144-pin, 20-megahertz tester for less complex VLSI chips [*Electronics*, January 13, 1981, p. 187] came off with nary a hitch. Not so the GR18, which at 40 MHz with 288 test pins was to have been the fastest, largest tester on the market. Its high-speed ambitions [*Electronics*, March 24, 1981, p. 292] have simply not been met.

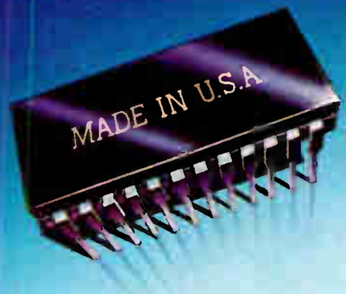
Slow. The first systems delivered ran only at about 25 MHz, marginally faster than the GR16. Problems with fabricating the high-speed emitter-coupled-logic circuits were cited. With decreasing demand as the semiconductor industry's business turned sour, the company was granted a breathing spell. It reworked the ECL-related electronics, moved the tester's speed up to a solid 30 MHz, and began shipping in mid-1982. But competitors, such as Tektronix (see p. 155), also announced VLSI testers.

This month, speaking to security analysts in New York, Sear said that this is the year: "In 1983, we have the technology in hand to deliver systems of 40 MHz and up to 288 pins." Shipments should begin toward the year's end. Further, a company will expand its line with a production-line tester from its TEL-GenRad joint venture in Japan.

Although the company's learning experience may pay off in a stronger base of design experience, its first-in edge gets duller by the month. Fairchild and others will introduce VLSI testers in the same range later this year. —**Richard W. Comerford**

FAIRCHILD

A Schlumberger Company



THE STATE OF THE ART IS NOW MAINE.

Fairchild, the people who brought you FAST,™ now bring you the first high-volume, fully-automated robotics assembly line for plastic IC logic. Right here in South Portland, Maine, U.S.A.

We've achieved greater capacity. Reduced cycle time. Better control. Improved lot traceability. And increased quality. In wafer fabrication, diffusion, assembly and testing.

So if you've always liked FAST for its high speed and low power, now you have one more reason: its address. Fairchild Digital Division, 333 Western Avenue, South Portland, Maine 04106.

THERE'S A FAST IN YOUR FUTURE.

1978: Fairchild introduces FAST.

1980: Over 1 million units shipped.

1981: Second source announced.

1982: 2,000,000 units shipped in one month.

1983: Manufacturing technology innovation.

FAST

FAST is a trademark of Fairchild Camera and Instrument Corporation for Digital Products. Fairchild Camera and Instrument Corporation

Circle 33 on reader service card

300kHz Per Channel Data Acquisition

High-Speed Data Acquisition

With Neff's new High-Speed ADC (620543), you can take data at rates to 300,000 samples/second/channel and directly acquire and record low-level dynamic or transient signals. Built on a single card that plugs into Neff's Series 500 I/O System, the High-Speed ADC is a high performance data acquisition system in itself. It features a high quality, programmable, differential amplifier with 12 input ranges from 5mV to 10.24V fullscale; a precision sixth-order pre-sampling filter with programmable bandwidth to 80kHz and a 12-bit analog/digital converter that accommodates the high programmable sample rates.

Converted data is stored in an on-board memory and accessed by the computer using standard Neff software programs and computer interfaces.

Versatile Recording Techniques

Because all functions are programmable, you have complete control over recording start times and rates. Recording can be timed to occur at any point or points before or after an event. You can even change sample rate during a recording interval so that signals with fast rise time and slow fall time can be efficiently recorded.

Find Out More

Full specifications and other details of the High-Speed ADC are covered in our new 1983-84 System 620 catalog. If your application calls for fast data acquisition, you should have a copy. Send for yours today or, for faster response, call toll free: (800) 423-7151; in California (213) 357-7151 collect.

NEFF
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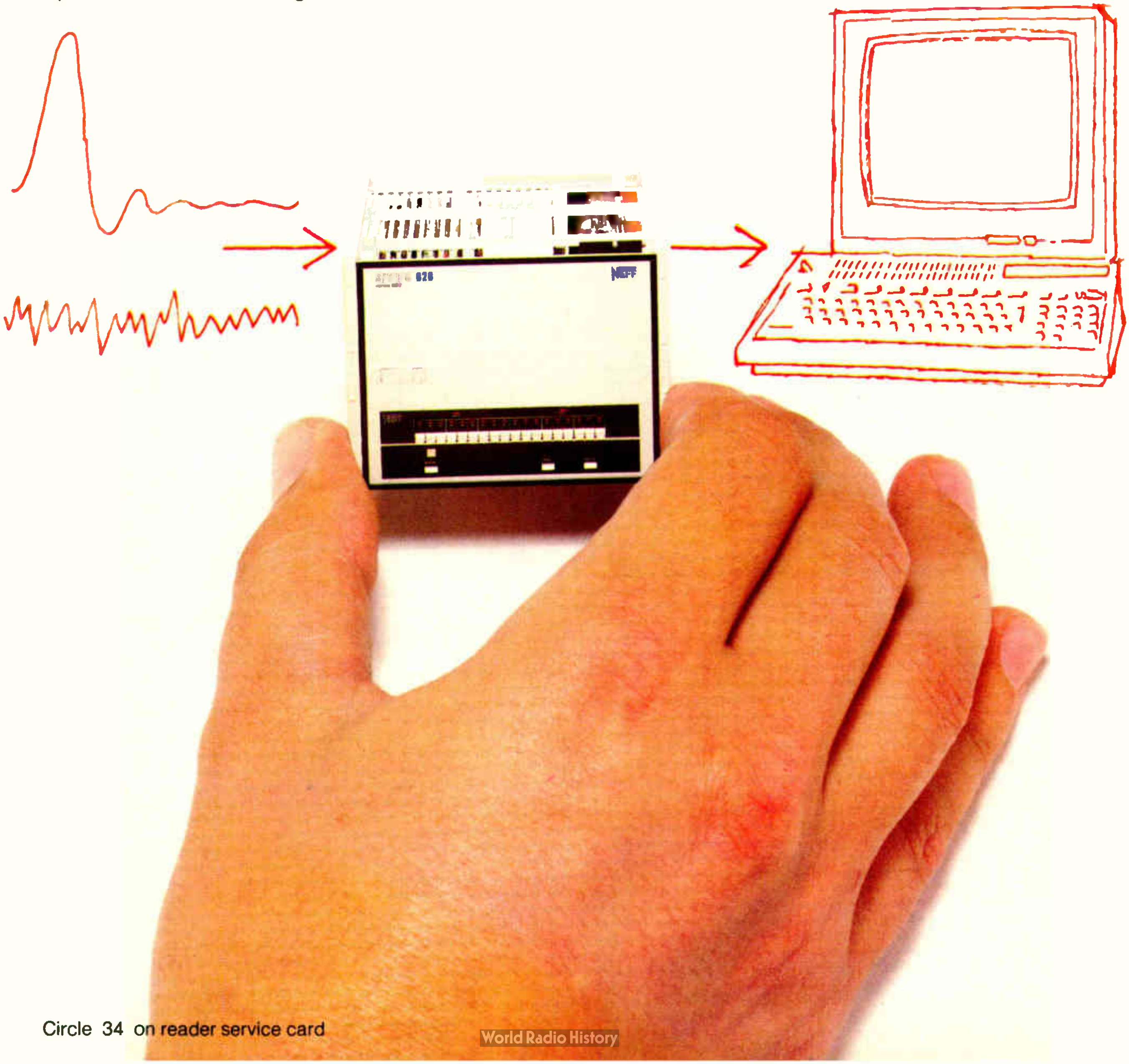
700 South Myrtle Ave., Monrovia, CA 91016
TWX 910-585-1833



Circle 34 on reader service card

Business activity

The Canadian electronic equipment market started growing again in the final quarter of 1982, according to the latest data released by Statistics Canada, when both the consumption and the production of equipment outpaced the year as a whole. For those last three months, the total consumption of equipment, defined as the apparent domestic market, grew to $2.171 billion (Canadian), up 5.4% from the $2.059 billion of the third quarter. Total shipments, or domestic production, on the other hand, rose 10.9% to $1.455 billion from the previous quarter's $1.312 billion, the government reports.

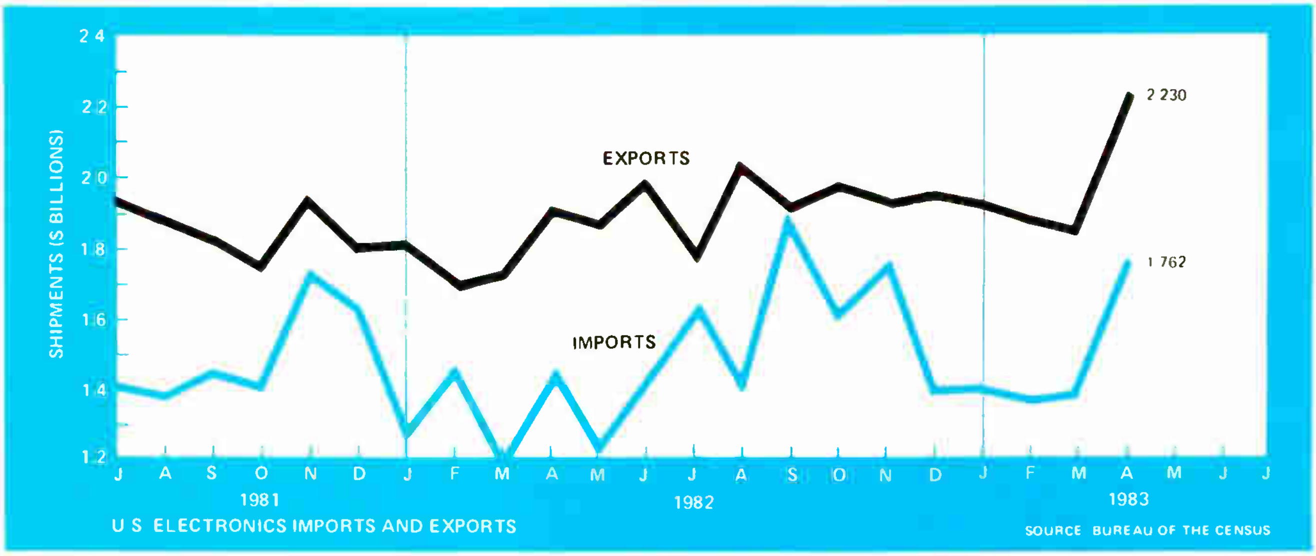
Exports of equipment, which includes communications equipment, office machines and computers, instruments, and radio and television gear, grew 8.7% to $813 million in the fourth quarter from $748 million, while equipment imports rose 2.3% to $1.529 billion from $1.495 billion. The electronic equipment trade deficit in the fourth quarter fell 4.1% to $716 million from $747 million in the third quarter.

"Whereas growth was restrained [in the Canadian industry] overall, relatively," Statistics Canada reports of the fourth quarter, "shipments did better than domestic demand and exports much better than imports, all of which reduced the trade deficit" to its lowest since the 1980 fourth quarter "and well down from $942 million in the first quarter of 1982."

Communications equipment "had a firm and stable period" in the final three months, adds the Ottawa-based government operation. Demand for office machines "weakened for the third successive quarter and again kept a damper on imports. Shipments, nonetheless, turned stronger to give a significant push to exports, which led to a fall of $35 million in the trade deficit." Instruments and radio and television equipment, though, were two market segments that underwent little change in the final quarter.

For the full year, Canadian electronic equipment consumption was up 3% to $8.821 billion in 1982 from 1981's $8.567 billion. Shipments by Canadian manufacturers, on the other hand, gained 6.1% to $5.553 billion from $5.235 billion. Of this amount, Canadian companies exported $3.019 billion worth of equipment, an increase of 5.5% over the $2.862 billion sent abroad in 1981. Equipment imports, on the other hand, were up only 1.5% to $6.287 billion, compared with the $6.194 billion registered in 1981. As a result, Canada's 1982 trade deficit in electronic equipment inched downward 1.9% to $3.268 billion from 1981's $3.332 billion. Commenting on the year as a whole, Statistics Canada notes that "the high growth rates of recent years were absent and the industry barely managed a holding position. If there was a favorable side, it was that the trade deficit, at $3.3 billion in 1981 and expected to soar, remained unchanged following increases of $796 million in 1981 and $547 million the year before." **–Robert J. Kozma**

Business activity



U.S. ELECTRONICS IMPORTS AND EXPORTS[1] (MILLIONS OF DOLLARS)

	IMPORTS			EXPORTS		
	March 1983	February 1983	March 1982	March 1983	February 1983	March 1982
Accounting, computing, and data processing machines	125.474	88.574	69.984	490.650	413.259	424.782
Calculators	33.028	34.500	39.443	8.653	6.140	9.005
Parts for data-processing machines and office calculators	197.672	157.800	110.551	440.751	352.224	345.984
Telecommunications, sound-recording, and sound-reproducing equipment	813.349	683.163	755.326	357.322	269.831	318.066
Electronic or electric instruments	82.974	66.660	72.082	524.454	455.959	434.870
Printed circuit boards	21.339	15.749	16.913	15.249	10.791	9.865
Integrated circuits, diodes and other semiconductors, tubes, piezoelectric crystals, parts	473.475	322.977	355.195	382.122	326.340	353.628
Fixed and variable resistors	14.649	13.059	15.130	11.271	10.073	11.868

U. S. ELECTRONIC COMPONENTS PRODUCER PRICE INDEX[2] (1967 = 100)

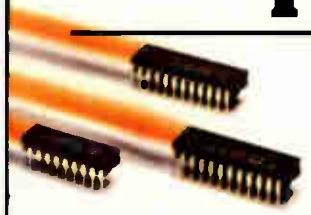
	March 1983	February 1983	March 1982
Digital bipolar integrated circuits	48.8	48.6	49.7
Digital MOS ICs	41.1	41.2	46.4
Linear ICs	60.6	60.7	56.9
Capacitors	191.4	192.0	197.3
Resistors	183.0	182.9	174.0
Relays	232.0	232.0	234.4
Connectors	222.6	221.4	219.0

GENERAL U. S. ECONOMIC INDICATORS

	April 1983	March 1983	April 1982
Average prime rate (%)[3]	10.50	10.50	16.50
Retail sales ($ billions)[4]	94.219	92.741	88.468
Unemployment rate (%)[2]	10.1	10.1	9.2

SOURCES [1]Bureau of the Census [2]Bureau of Labor Statistics [3]Federal Reserve Board [4]U. S. Department of Commerce

INTRODUCING THE WORLD'S FASTEST ECL RAMs.



And the next fastest.
And the next to the next fastest.

Address access times of 7nsec. Maximum. And block access times of 4nsec. Maximum!

These specs belong to the world's fastest ECL RAMs. Fujitsu's new MBM10422A-7 and MBM100422A-7. Both are results of our patented DOPOS (Doped Polysilicon) and IOP-II (Isolation by Oxide and Polysilicon) manufacturing processes. Both give you low power dissipation (0.7mW/bit) and 256 x 4 organization. And both are fully compatible with their respective industry standard 10K and 100K families. Plus, our 100K series gives you on-chip voltage compensation for improved noise margin.

When higher density is a must, but speed records aren't, look into our fully decoded 1K x 4 MBM10474 and MBM100474. Ideal for high speed scratch pad, control and buffer storage tasks, they deliver access times of 15nsec and low 0.7mW/bit power dissipation.

For main memory, control and buffer storage applications, our MBM10480 and MBM100480 give you the highest densities available anywhere. They're 16K x 1 products of an entirely new cell technology using the active pull-up (PNP) technique. They give you access times under 25nsec, extremely low power dissipation (0.04mW/bit) and very small cell and chip sizes.

Each of our ECL RAMs is fully compatible with industry standard 10K or 100K families. And if you're thinking about switching to an MOS part, you'll be happy to know these second-generation ECL RAMs deliver far lower cost per bit than the ECL products you've probably been dealing with.

For literature, call 800-556-1234 (ext. 82). In California, call 800-441-2345 (ext. 82). For samples, contact your nearest Fujitsu sales office. We'll set speed records to deliver the ECL RAMs you want.

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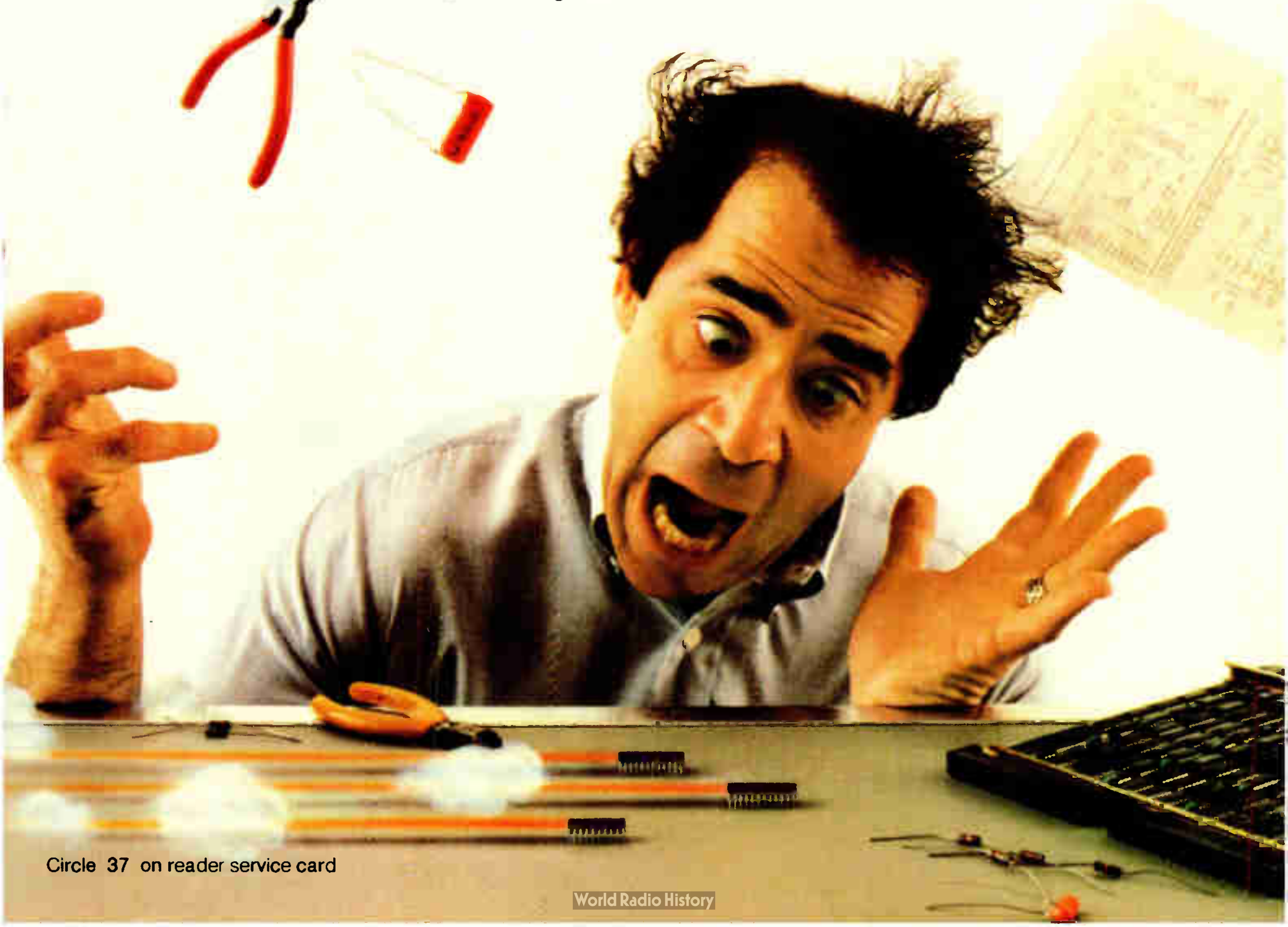

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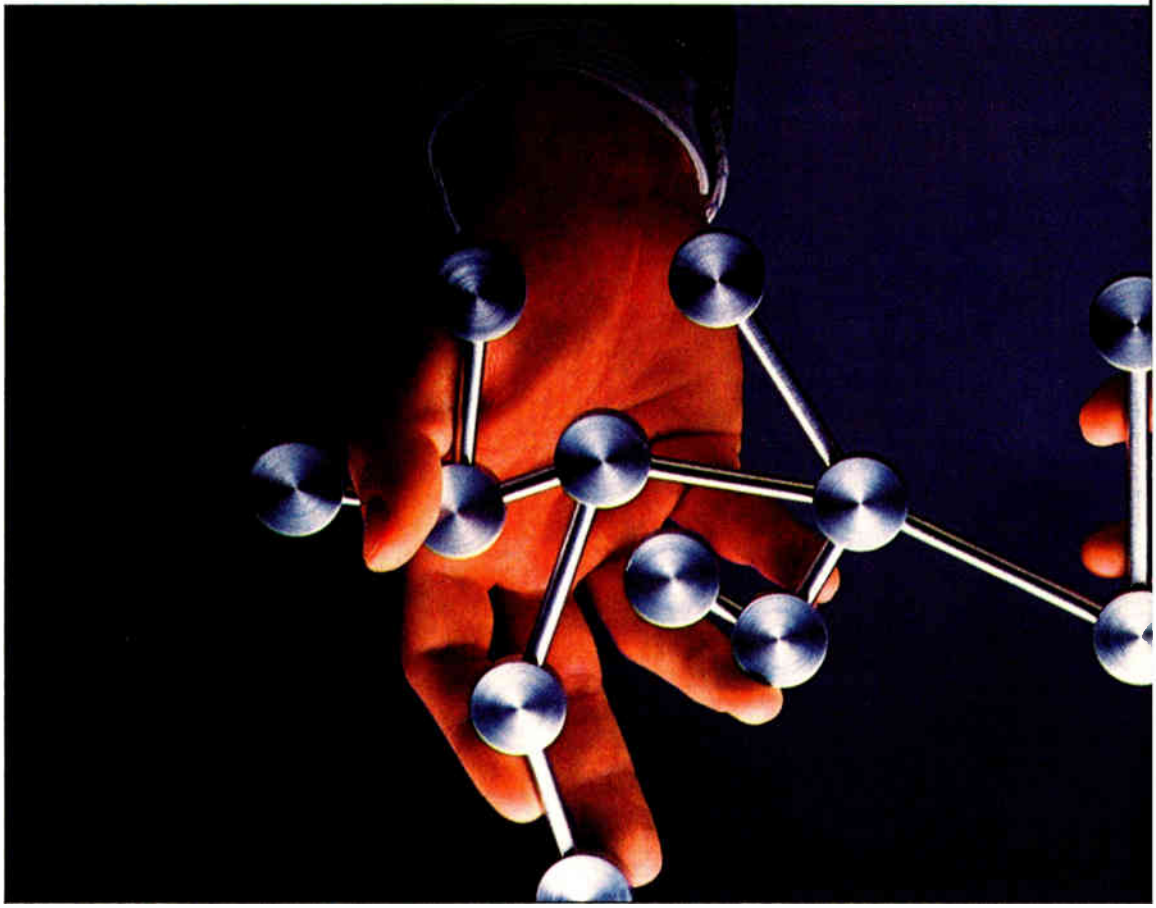
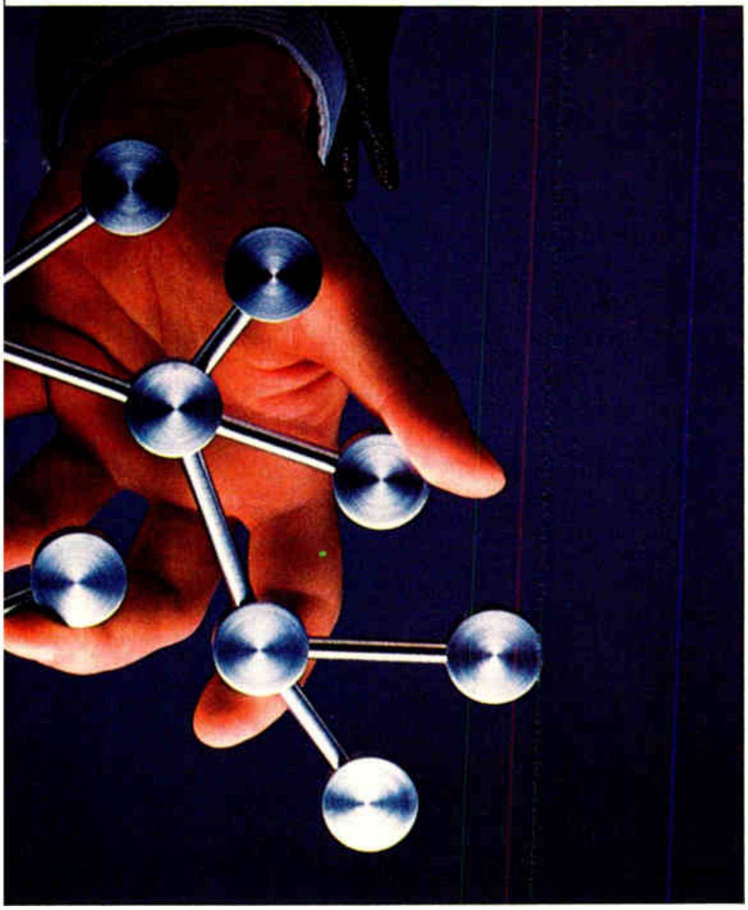


Quality and productivity demand control. Control of resources, procedures, and data.

It's popular to think that networking will fill that demand. But networking alone won't enable you to exercise this control. You need a networking *system*. TERANET.

In addition to communication tools, TERANET includes powerful software, a second-level computer and test systems. Together, they do much to help you boost productivity and quality.



First, by improving the use of production resources through better test system monitoring and operator supervision.

Second, by reducing the time required to prepare new test programs, managing job plan libraries and keeping the cost of each programming station low.

And third, by allowing better yield management through more efficient data collection, analysis and reporting.

TERANET will benefit both semiconductor and equipment manufacturers. The system's one megabaud communications link and ISO 802 implementation support our memory, logic and analog device test systems, laser trim products and discrete device test systems. TERANET will accommodate all future Teradyne products as well.

TERANET is the natural evolution of our long experience in ATE networking technology. Because it's a system, it can help you achieve a greater degree of control. And what manager doesn't want that?

For a copy of our brochure, *Distributed Industrial Management Systems,* write Teradyne, 183 Essex Street, Boston, MA 02111.

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We measure quality

Bubble Machine.

This Nicolet digital scope can put a waveform in your pocket.

The two-channel 3091 offers the traditional advantages of a Nicolet digital storage oscilloscope in a compact portable package. The quartz crystal timing, precise A/D conversion and alphanumeric display combine to overcome the accuracy limitations of the analog oscilloscope. Its high resolution and 1MHz digitizing rate make it ideal for field calibration, fault diagnosis or transient analysis in mechanical, electrical, acoustical and biological applications.

Signals can be viewed live, stored for closer examination or compared in real time to previously stored references. Waveforms can be expanded, interrogated by cursor, output to pen recorders or even transmitted to a computer at the touch of a button. Important data can be stored on the optional magnetic bubble cassette for instant recall in either your 3091 or someone else's.

The 3091 is a digital storage oscilloscope, a transient recorder and a chart recorder all in one, easy-to-use instrument.

To find out how you can put digital precision in your pocket, call 608/273-5008 or write: Nicolet Oscilloscope Division, 5225 Verona Road, Madison, Wisconsin 53711.

In Canada: call 416/625-8302.

$4300.00*

Nicolet

* U.S. domestic list price. Bubble cassette option additional at $1,500.

Circle 40 for more information

Electronics newsletter

Data General completes revamped supermini line with midrange model . . .

Completing a total revamping of its superminicomputer line in little more than six months, Data General Corp. will soon unveil a new midrange model. To be rated at approximately 1.26 million Whetstone operations per second, the new model will fall between the low-end MV/4000 introduced last November and the MV/10000 announced in March. The Westboro, Mass., company **is also expected to introduce a high-performance Winchester disk,** with the highest capacity and speed ever offered by the company.

. . . as archrival DEC adds muscle to Q bus

Look for Digital Equipment Corp. to unveil a flurry of new products later this year that support substantially enhanced capabilities for its popular Q bus. The Maynard, Mass., systems giant is poised to introduce block-mode direct-memory access, **which will permit memories to increment their own address counters and thereby dramatically reduce address-transmission requirements.** According to one well-placed source, the technique will allow a tripling of Q-bus data-transfer rates to about 2 million words per second. DEC is also known to be working toward processors, disks, and memory boards that can handle bus-parity data.

HP starts ATE push with two new systems

Hewlett-Packard Co. is pushing harder in the automatic-test-equipment markets dominated by such companies as Fairchild, GenRad, and Teradyne. Executive vice president William Terry told New York security analysts last week that two new systems will be shown at the ATE East show in Boston June 13–16. Joining two printed-circuit–board testers introduced earlier this year [*Electronics,* Feb. 24, p. 147], the 3065A will sell for about $250,000, support up to three test heads and as many programming stations, **and check out a board, including its memory chips, in less than 20 s.** About 30 on-board ICs can be tested each second. The roughly $40,000 4062A, for production semiconductor testing, will perform ac and dc tests using an HP 1000.

X-ray lithography unit for production work has submicrometer resolution

Two-year-old Micronics Corp. of Los Gatos, Calif., introduced at last week's Semicon West conference an X-ray lithography system with submicrometer resolution and accuracy developed for full production printing of very large-scale ICs. **The high-resolution X-ray source has a stationary palladium target,** a 6-kW power level, and a 0.4-mm spot. Optical resolution is 2 to 0.5 μm, adequate for most of today's VLSI circuits, as well as for 256-K and 1-megabyte dynamic random-access memories. An automatic alignment system built around piezoelectric motors, helium-laser illuminators, and fresnel zone plates ensures accuracy to ± 0.1 μm at 2 standard deviations. The machine will sell $750,000 when it becomes available in six months.

CP/M's author plans new operating systems to fight Unix, MS/DOS

Digital Research Inc., whose popular CP/M operating system for microcomputers is in danger of being eclipsed in the 16-bit arena by Bell Laboratories' Unix and Microsoft's MS/DOS, will fight back with two new operating systems and some CP/M upgrades. A joint effort with Hitachi Ltd., the program may result in what the Pacific Grove, Calif., company calls the next generation of operating systems: **a high level of**

multitasking, including multiple windows and interprocess communications. Like Unix, the systems, for the Motorola 68000 and the Intel iAPX 286 microprocessors, will have a hierarchical file structure.

Two distributors to sell Motorola's semicustom ICs

The move toward distributors' selling semicustom ICs, expected soon to become an important source of revenue to chip makers as well, is picking up speed. In the latest deal, Motorola Corp.'s Semiconductor Sector has named two leading firms to handle its line of Macrocell gate arrays. **Both Hamilton/Avnet of Culver City, Calif., and Schweber Electronics of Westbury, N. Y.,** will install the computer-aided design equipment necessary for them to customize the chips to customers' specifications at three locations. The first distributor to get into this niche was Wyle Distribution Group of Irvine, Calif., with NCR Corp.'s semicustom parts.

Pentagon to fund GaAs pilot lines

Eager to pull gallium arsenide chips out of the laboratory, the Department of Defense is set to fund one or more GaAs pilot production lines this fall. The goal for the three-year program, to be administered by the Defense Advanced Research Projects Agency, is **a capability of a hundred 3-in. wafers per week for each pilot line by early 1986.** Target device types are gate arrays of at least 6,000 gates and static random-access memories of at least 16-K density. At least two bidding teams are known: Texas Instruments Inc., of Dallas, with McDonnell Douglas Corp. of St. Louis; and Honeywell Inc., Minneapolis, with Rockwell International Corp., headquartered in Pittsburgh. The cost for each pilot line funded is expected to be $20 million to $40 million.

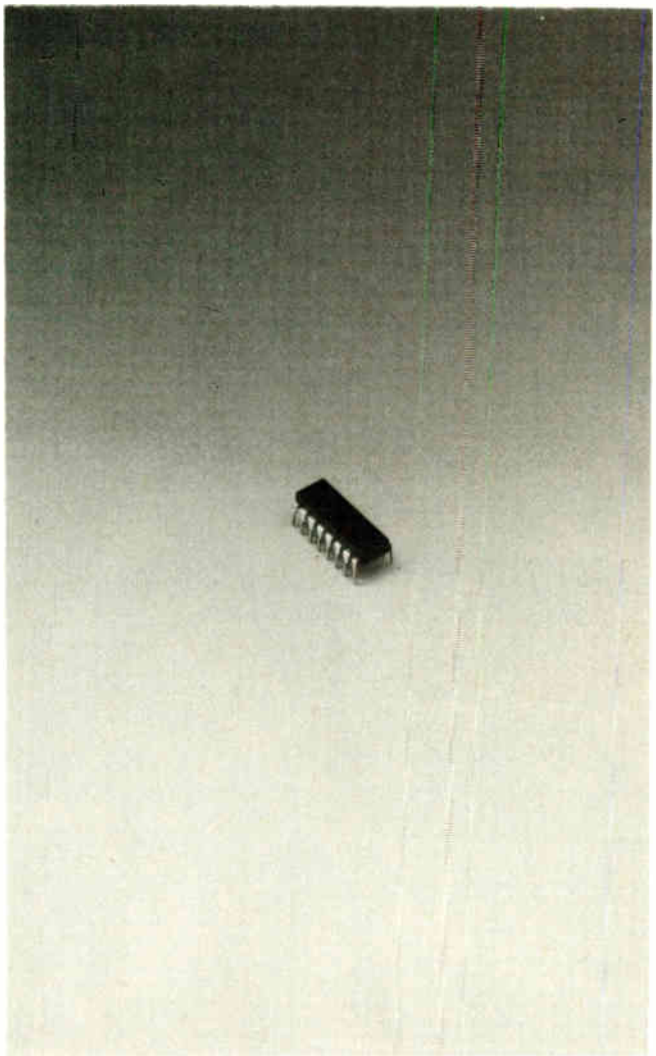
Video teleconferencing rates squeezed to 56 kb/s

A new technique that cuts data rates for color motion video to just 56 kb/s from around 1.5 Mb/s should give the market for teleconferencing a big boost. Developed by Widergren Communications Inc. of San Jose, Calif., it will show its paces on video tape at the annual International Communications Association meeting in Anaheim, Calif., June 1–3. **The company has a $770,000 contract with the Pentagon for a system to be delivered in January 1984.** Commercial sales are also planned for 1984 with target prices of about $85,000, compared to $100,000 to $200,000 for existing versions.

Addenda

Hewlett-Packard Co., Palo Alto, Calif., has signed a letter of intent to form a joint venture with Genentech Inc. of nearby San Francisco **to develop instrumentation and information systems for biotechnology and genetic engineering.** Initial plans call for a budget of about $10 million to $20 million to cover five to seven years. . . . Add Zilog Inc. to the firms cooperating with Western Electric Co. to provide **a generic version of Bell Laboratories' Unix System 5 operating system** for its 16- and 32-bit microprocessor products. The Campbell, Calif., firm joins Motorola, Intel, and National Semiconductor. . . . **The rash of semiconductor start-ups continues unabated.** The latest is Lattice Semiconductor Corp. in Portland, Ore. A founder is Rahul Sud, a designer of Inmos Corp.'s high-speed static random-access memory. To be a broad-line supplier of ultrahigh-performance parts, it is scheduling samples of its first design for February 1984.

ANOTHER SEMI SUCCESS



Our semiconductor memory designers have done it again. Thanks to their ingenuity, we've invented a new manufacturing process known as LD³*. And it's a major breakthrough. Because now, we're producing significant volumes of ultra-fast computer memories – 64K dynamic RAMs with operating speeds of less than 80 nanoseconds.

Equally impressive, these new 64K's require no more power than their slower equivalents. Nor is there any compromise in reliability.

In addition, we've developed reliable thin oxides to improve electrical storage characteristics. And we've added other enhancements that are being used to develop our even higher density one-megabit RAM.

What does it all mean? Simply this: Our ultra-fast semiconductor memories complete the technology picture for a whole new generation of computers – a generation that condenses mainframe computer speed into desktop systems.

And that's why our latest innovations truly are a "semi" success.

*Patent-pending

UNITED TECHNOLOGIES
MOSTEK

E-PROM cartridges change the action in games people play

by Stephen W. Fields, San Francisco bureau manager

Through special terminals at retail stores, dealers will program new video games into reusable cartridges for $10

Video-game retailers are in for a pleasant surprise at the Consumer Electronics Show next week in Chicago: game cartridges are now available with erasable programmable read-only memories, instead of with ROMs. Henceforth, for a mere $10, games that do not sell or that have outlived their popularity can simply be reprogrammed in the retail store at a special terminal. New game cartridges carry price tags of anywhere from $29 to $49.

The cartridges' maker, Romox Inc., of Campbell, Calif., plans to have 2,500 terminals at major retail outlets in time for the Christmas season, says its president Paul Terrell. "There are tens of thousands of our customers out there with programmable cartridges. This is a substantial customer base, and I expect it to grow to millions as we sign up other software publishers. Electronic software distribution is here; it works; and it is going to totally change the way software is distributed."

Others appear to agree with Terrell. Currently, a few software developers and publishers are downloading programs to users over telephone lines. Grid Systems Corp., Mountain View, Calif., a personal-computer maker [*Electronics*, Jan. 13, p. 49], offers to download business-application packages from a central computer over the phone. Source Telecomputing Corp., of McLean, Va., downloads programs for one of its user groups, and newly launched Control Video Corp., of Vienna, Va., sends games to subscribers over the phone. There are also electronic distribution systems involving fm carrier channels and cable TV. But so far, the numbers of programs involved are not nearly as significant as the market Terrell envisions.

CES debut. Romox has "shipped tens of thousands of cartridges for Atari 400 and 800 computers, as well as for Commodore's VIC-20 and model 64 and Texas Instruments' 99/4A," according to Terrell. At the Chicago show, he will unveil the programming terminal to be installed in the retail outlets.

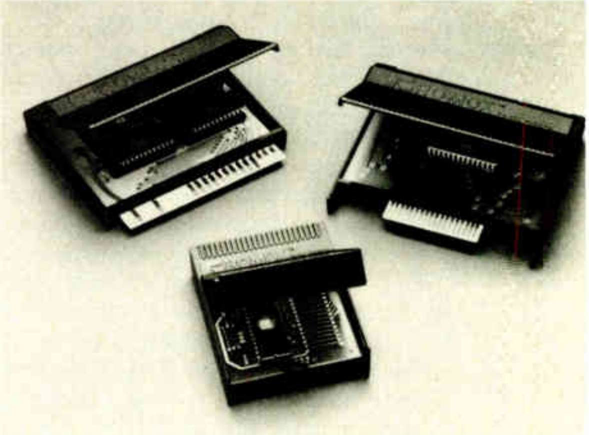
Linked over 1,200-baud modems and telephone lines to a mainframe computer in Santa Clara, Calif., each terminal will store the top 10 games of the week in random-access memory and 100 more titles on a floppy disk. "We have hardware and software locks built into the system, and so there is no way a cartridge can be programmed without us knowing about it," explains Terrell. "The retailer gets the $10 on the spot [from the customer], and we bill him monthly and pay any royalties due."

Terrell has been in the personal-computer business since late 1975, when he founded the first computer store, the Byte Shop in Mountain View, Calif. When he got the idea for reprogrammable cartridges, in March 1982, he limited them to games played with computers, convinced the market for growth was in personal computers rather than game consoles. Moreover, he had electronic software distribution in mind for other things besides games and was willing to pay "the couple of dollars more for the PROMs."

Explains Terrell, "There is no reason why non-game software can't be distributed in the same way." It would eliminate one of the biggest problems software retailers face, which is not having the right software in stock when the customer asks for it.

EE-PROMs to come. The cartridges themselves come in several different sizes, ranging from 4- to 16-K bytes, and will be sold as blanks for $15 to

On the spot. With a new programming terminal designed for use at retail outlets, customers can have new game software downloaded from a mainframe into reusable E-PROM-based cartridges for Atari, Commodore, or TI personal computers.



$25. In practice, since ultraviolet-light–erasable PROMs are used, the customer will have either to exchange a cartridge for a blank one or buy a new blank. The Romox cartridges have a snap-open case, so the dealer can open the returned units and erase them for resale. "In the future, as electrically erasable PROM prices fall, we can eliminate the UV erase step," Terrell says.

Terrell has applied for several patents on his E-PROM-based edge-connector cartridge and on the technique of programming the E-PROMS through the edge connector. He is also licensing titles from several game companies and talking to several major software houses about non-game products.

Memories

Novel oxide makes disks 10 times denser

If interest by potential users is a tip-off, Eastman Kodak Co.'s dense new magnetic recording medium should have a big impact on rotating memories for computers. Called Isomax, it can boost the capacity of 5¼-inch floppy-disk drives from the current 1 megabyte to 10 megabytes, and it is the first commercially available medium to support vertical recording techniques, according to its manufacturer, the Spin Physics operating unit of Kodak in San Diego, Calif.

"Isomax is not a curiosity. Prototype disks already have been evaluated and will be available in volume later this year," says William L. Kroon, director of marketing, magnetic media division. In the last six months, 10 disk makers have put Isomax through its paces, he says.

Kodak unveiled Isomax at the National Computer Conference earlier this month at Anaheim, Calif. Inquiries surpassed expectations, officials claim. The medium was developed by Kodak researchers in France and the U. S. So far, it has been used for magnetic tape in the video-frame storage portion of a motion-analysis system built by Kodak.

The new oxide derives its advantage over conventional cobalt-doped oxide media from a proprietary chemical process that produces magnetic particles of a smaller, more compact shape and a different crystal structure. Instead of resembling needles, Isomax particles, which are only 0.2 micrometer long, are egg-shaped and can therefore be packed more closely together. They also exhibit complete isotropy, which means they can be magnetized equally well in any direction. It is this characteristic that lends itself to either the vertical or conventional horizontal recording format, explains Kroon.

High densities. Floppy disks made with Isomax can have densities of up to 40,000 flux changes, or bits, per inch, yielding capacities of 5 and 10 megabytes for disks with track densities of 96 and 200 tracks/in., respectively, Kroon says. In perpendicular recording formats, densities could exceed 100,000 b/in., he claims.

The only barrier to converting to Isomax from present media is its need for a recording head with a smaller gap between its poles—20 μm instead of the present 50 μm. Such heads already exist in prototype. One head supplier, Applied Magnetics Corp., of Goleta, Calif., reportedly showed its favored customers one at the NCC in a locked-door hotel suite.

Drive manufacturers, however, are not saying much about Isomax, a caginess typical of a competitive market like floppy disks. Seagate Technology Inc., Scotts Valley, Calif., acknowledges it thoroughly evaluated the medium but as yet has no plans for it. A spokesman points out that the higher density also poses a need "for a whole new mechanism for error control." Tandon Corp., Chatsworth, Calif., a leader in floppy production, declines to comment.

Potential. A consultant on data storage, Raymond C. Freeman Jr. of Freeman Associates, Santa Barbara, Calif., agrees Isomax has potential. "It will permit a major advance in recording. It's precisely what is needed," he says. But in his view, an old problem looms ahead: disk suppliers are reluctant to commit themselves to a sole supplier, even a heavyweight like Kodak. The firm has no plans to license Isomax, but will sell only disks and media.

Kodak's Kroon notes that while floppy disks are targeted first, rigid disks may be next as production gets up to speed. And he predicts, "You'll see the first Isomax products at next year's NCC." –**Larry Waller**

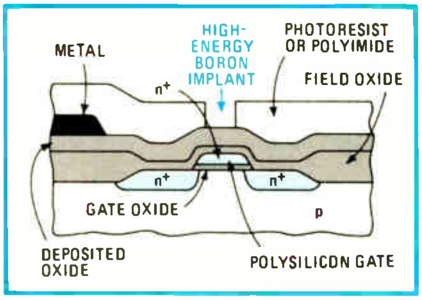
Memories

Late implant turns ROMs around fast

First conceived for suppliers of video-game cartridges, a technique that promises turnaround times as short as two weeks from order to shipment has been developed for programming read-only memories.

Known variously as late-mask, last-step, or after-metal programming, the technique puts the programming step after final metalization, rather than halfway through the fabrication process. Several ROM makers have hit upon the technique independently and will soon be shipping from stocks of tested wafers.

The process has three main advantages over present technology. First, chip makers can keep an inventory of almost-processed wafers on hand, so that supplies are ready for urgent orders. Second, some believe that with turnaround times down to around two weeks, equipment makers now opting for the flexibility of erasable programmable ROMs will be



Late implant. A photoresist or polyimide mask blocks the high-energy implant that penetrates a finished wafer to program read-only memory cells in Mostek's late-mask process for fast turnaround.

persuaded to switch to ROMs, which cost anywhere from one half to two thirds as much as E-PROMs. Finally, because the wafers can be tested before they are fixed with a customer's code, producers can select performance grades for further economies.

Promising the swiftest turnaround so far is American Microsystems Inc., Santa Clara, Calif., a subsidiary of Gould Inc. "You're out of fab on the day you program and can ship volumes in two weeks, compared with four to six," says Dick Norby, marketing manager, Memory Products group. "We will have samples of a post-metal-programmed 256-K ROM in the last part of July."

Others may already be shipping. "We will be able to ship samples this quarter of 64-K and 256-K ROMs with late-mask programming," says Jeff Schlageter, vice president in the Memory Components division at Mostek Corp., the United Technologies Corp. subsidiary in Carrollton, Texas. Mostek's fastest turnaround now—four to five weeks—will drop to three to four weeks.

Implanter. Programming after metal requires a high-energy implanter to send boron ions all the way through the insulating oxide, polysilicon gate, and gate oxide into the channel region of the transistors (see figure). A photoresist or polyimide mask blocks the other regions from the implant. After programming, the only remaining step involves adding the final passivation layer.

The technique is not without its risks, however, warns Peyton Cole, director of marketing at Texas Instruments Inc.'s MOS Memory division, in Houston. He worries about the integrity of a gate oxide after a high-energy implant through it. As yet, Cole appears unruffled by the prospect of competitors' fast-turnaround chips even though TI's ROM business is almost entirely with video-game makers—they have special needs, he says. He is confident, too, that if a market for late-mask programming emerges, TI can speed up its development of the technique.

Besides addressing the needs of game software, fast-turnaround ROMs are likely to woo some users away from E-PROMs. Once merely a prototyping tool, E-PROMs are now routinely shipped in final products. This is because it takes time to get ROMs with new code, and time is precious when new products are rushed out the door. Mostek's Schlageter, for one, projects that late-mask-programmed parts will take as much as half of the E-PROM business by 1986: a total of some 6 trillion bytes. –**Roderic Beresford**

Solid state

Ultrathin wafer promises ultrafast transistors

In the world of semiconductors, as in that of fashion, thin is in. A gossamer silicon wafer, merely 1,000 angstroms thick, has been fabricated at Cornell University's National Research and Resource Facility for Submicron Structures, in Ithaca, N. Y. What's more, scientists there say a gallium arsenide version could be the basis of a millimeter-wave transistor more than twice as fast as current devices.

One major stimulus, says Charles Lee, a Cornell professor of electrical engineering who took part in the research, was the desire to make silicon devices that operate at as high a frequency as does gallium arsenide. Silicon, he points out, is cheaper, and the technologies and properties surrounding it are "more varied and powerful."

Intrigued by the potential, the Semiconductor Research Corp., Research Triangle Park, N. C., has offered to support further research into

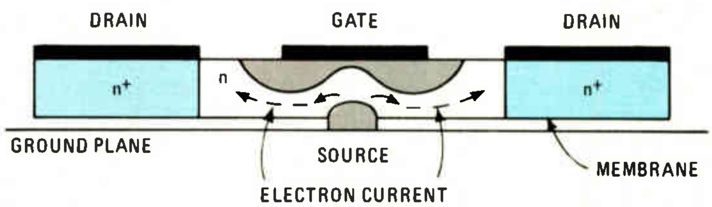
Superthin FET halves channel length

In the opposed-gate-source transistor being developed at Cornell University, the source and gate are opposite each other, on either side of a superthin gallium arsenide membrane (see figure), in effect reducing the channel length to just half the gate length. In operation, electrons from the source diverge in two groups about a quarter of the way through the wafer, making right or left turns toward one or the other drain.

Carriers thus travel half the length of the gate, says Cornell's Charles Lee, giving a delay equivalent to that of a conventional metal semiconductor field-effect transistor just half as long. Using conventional electron-beam lithography, gate contacts slightly more than 0.2 micrometer long will be formed. Drain contacts are placed on either side of the gate.

In addition to the reduced delay, another advantage of the structure is that transmission lines are readily formed from parallel wires on either side of the membrane, so that signals propagating down the gate line are coupled in phase with those propagating down the drain line. Thus, the transistor's output power can be boosted by making the gate wider.

Moreover, adds Lee, moving the source to the bottom of the membrane, right atop the ground plane, reduces inductance to a minimum. A similar reduction of inductance might be achieved, he says, in the permeable-base transistor [*Electronics*, Dec. 15, 1982, p. 138] developed by the Massachusetts Institute of Technology's Lincoln Laboratory. –**Marilyn A. Harris**



devices made on superthin silicon. At 1,000 Å, the membranes are about 1/250 as thick as the usual 10-mil silicon wafer.

Pacing the effort now, however, is a fast millimeter-wave GaAs transistor conceived by Lee and his Cornell colleague, G. Conrad Dalman, along with former student and present TRW engineer John Berenz, while the two were consulting for TRW Inc.'s Electronics Systems Group in Redondo Beach, Calif. Called an opposed-gate-source transistor and sporting a novel structure (see "Superthin FET halves channel length," p. 51), the device is built on a 1,500-Å-thick GaAs membrane, a dimension that Lee says his etching process is approaching for this material.

The new transistor should be able to operate at 94 gigahertz, Lee says, a frequency where there is an atmospheric window with small attenuation. The fastest devices to date, he adds, work at about 40 GHz.

Silicon membrane. To obtain a superthin membrane, a standard 10-mil silicon wafer is implanted to a depth of 1,000 Å with any common dopant—Lee and co-researchers John Silcox and graduate student Kevin Lee (who is Lee's son) have successfully used neon, boron, phosphorus, and hydrogen. The wafer is then annealed by heating it to between 900° and 1,000°C.

Then, anodic etching, which depends on the wafer's being conductive to work, is used to thin the wafer. A positive potential is put on the wafer, and a negative potential on an electrolytic bath—for silicon, a buffered solution of hydrofluoric acid. The bath etches the semiconductor from the back of the doped wafer, dissolving all but the doped layer, which is relatively nonconductive.

Handling such a delicate wafer requires extra care. The etching is done selectively, so as to leave a supportive ring. Moreover, the wafer must be put on a supportive surface—one method the Cornell group uses is to set it in paraffin.

Lee and his co-workers are attempting to measure the resistivity of the completed transistors before making ohmic and rectifying contacts and diodes. The SRC has promised some $35,000 to Lee's group to help them pursue the silicon wafer's applications, as well as the amenability to analysis of its fabrication techniques by an electron-transmission microscope. –Marilyn A. Harris

Information processing

Xerox extends reach in office automation

Xerox Corp., long a powerhouse in the office-automation business, isolated itself from much of the market by restricting access to its high-level protocols. But now the company's Office Systems division, in Dallas, plans to ease the restrictions by providing a general interface that will make it possible for office-automation networks to mix the IBM Personal Computer (PC) with Xerox equipment. It is the first time Xerox has made such an interface available, according to division vice president John Shoch.

For the medium that will link it to the rest of the office-automation world, Xerox has joined in a loose consortium with 3Com Corp. of Mountain View, Calif., and VisiCorp. of San Jose. The trio announced at the mid-May National Computer Conference in Anaheim that Xerox would provide a software interface between its network-server protocols and Viscorp's bit-mapped VisiOn environment for the PC. The IBM machine and Xerox work stations will thus be able to communicate over an Ethernet system provided by 3Com.

Xerox previously offered all comers its low-level Ethernet protocols and some transport and internet protocols, but it kept as proprietary its advanced network servers for high-speed printers, file management, and electronic mail. The deal, then, marks a change in the company's marketing strategy.

Enticed. More than anything else, what lured Xerox on was the PC. An insider reports that Xerox salesmen were finding themselves shut out of potentially major accounts because PCs could not be tied into a new Xerox system. Shoch notes that some 20 Xerox network products will now be able to work with PCs. Other interfaces may be expected. VisiOn has already been mated to the Wang personal computer, which would need only a link to the Xerox network servers and an Ethernet interface to join the party.

VisiCorp, meanwhile, gains powerful application software, to be developed by Xerox and others, for its yet-untested VisiOn user interface. Announced last November, it will be available next October. VisiOn provides windowing software, so that users have a relatively easy way to manipulate many files simultaneously. Moreover, the product becomes more versatile, since 3Com's Etherlink card lets up to four IBM machines operate with a single hard disk. Normally, VisiOn requires a hard disk for every PC. And 3Com, which has become the leading suppli-

Doing away with floppy disks

As it pursues its group effort with Xerox and VisiCorp, 3Com Corp., of Mountain View, Calif., is also working on ways to spare IBM Personal Computer users on Ethernet local networks the delays and errors of floppy-disk-based software. According to 3Com founder Robert Metcalfe, the firm's new "low-end" network server—based on the IBM XT Personal Computer with a 10-megabyte Winchester disk and the MS-DOS 2.0 operating system—can download software to 10 PC-based work stations. Because the XT would also handle the work-station booting, no floppy-disk drive would be needed. Along with this saving in hardware, further economies may be made because multiple disk copies of software would become unnecessary. Moreover, the software would be more secure, since only the server would have it. –Harvey J. Hindin er of hardware and software for Ethernet, finds both Xerox and VisiCorp marketing its products.

The agreement is "very logical" for all three companies, says Robert Metcalfe, founder of 3Com after inventing Ethernet while a Xerox employee. Xerox will develop the network applications; VisiCorp will market them through its sales force and distributors; and 3Com will provide the connections to the network. Xerox will also implement VisiON on one of its own personal computers and will sell the systems through its own sales force.

Hybrid system. The resulting product will be something of a many-layered hybrid. The Xerox network servers will be linked to a network of IBM PCs and Xerox work stations through VisiON software, the 3Com networking interface, the IBM machine's MS/DOS operating system, and a 3Com Ethernet.

Each of these elements already exists and all were on display at the computer conference. However, the question of who has ultimate responsibility for packaging them was politely ducked by the three partners.

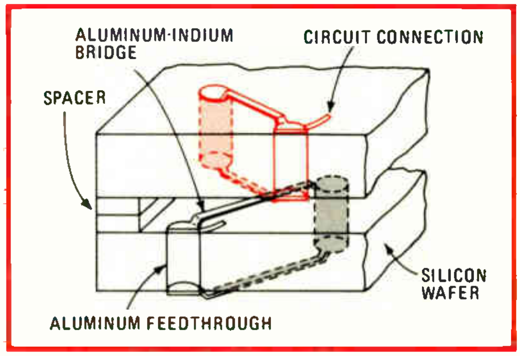
Shoch would not commit his firm to having a product out before "next NCC," but VisiCorp president Terry L. Opdendyk said he would be disappointed if one was not on the market in six months. **–Clifford Barney**

Computers

Stacked wafers form dense machine

For all the runaway improvement in circuit density stemming from crowding ever-smaller devices onto very large-scale integrated chips, the chips are most often packaged in a time-tested but limiting way: they cover the two dimensions of printed-circuit boards. Going one dimension better, scientists at Hughes Aircraft Co.'s Research Laboratories are experimentally boosting density by stacking the chips vertically—or, rather, stacking the wafers on which the chips are fabricated.

The big problem with that technique has been connecting one wafer to the next. To carry signals vertically from one side of a wafer to the other, Hughes has developed "feedthroughs" produced by the thermomigration of aluminum through the silicon. Then, for interconnecting one wafer to its near neighbor, Hughes uses a spring-like structure called a Microbridge, which both supports the wafers and distributes signals. So far, researchers at the laboratories in Malibu, Calif., have demonstrated a two-wafer stack with enough devices and interconnects to prove feasibility. They plan to start shortly on a five-wafer stack.



Well-fed. Aluminum dots deposited on a wafer migrate to the other side and form a feedthrough. A Microbridge connects two wafers. A stack of seven wafers would hold 1,024 microcomputers working in parallel.

Goal. The goal is ambitious. In three years, with funds from the Pentagon's Defense Advanced Research Projects Agency, they hope to build a stack for a cellular-architecture computer suited for chores like signal processing and image analysis, says Graham Nudd, head of the Hughes labs' information sciences and computer architecture section.

Other companies are also working on cellular computers, Nudd points out. "What is radically different about our approach is the degree of integration employed and the three-dimensional organization of the processing circuitry," he says. The basic structure will also accommodate a wide range of applications, he continues, and its massively parallel nature will allow rates of 10^4 million instructions per second.

Each wafer in the stack measures 640 mils on a side and contains similar computer elements in a 32-by-32 array. Each computing element is 20 by 20 mils, with wafers 20 mils thick and kept about 5 mils apart. Seven types of wafers are enough to perform most algorithms studied so far, Nudd says.

A microprocessor-controller wafer would be at the bottom of the stack, and other wafers would hold memory, accumulators, counters, comparators, and input/output circuits. A replicator layer, as it is called, would speed the broadcasting of data constants needed in the algorithms being executed. A "wafer stack" would contain 1,024 complete microcomputers. They would operate under stored-program control, first from an external source, later integrated into a bottom control wafer.

This controller communicates with array hardware via address and control buses passing through the stacked wafers. The architecture is "word-parallel, bit-serial"—that is, individual processor logic uses serial arithmetic, but all processors operate simultaneously. This characteristic produces the high speed, says Nudd, and data may also flow laterally into processing elements that are not adjacent.

Thermomigration. The vertical feedthroughs are formed by placing dots of aluminum at points on the wafer and heating the surface of the n-type silicon to 1,000°C. Simultaneously, a thermal gradient of about 150°C per centimeter is applied to the wafer. In this proprietary process, says Nudd, the dots move down through the silicon "much like earthworms through the ground," leaving droplet trails of highly conductive p-type material that become the feedthroughs.

The Microbridge interconnect, shown in the figure, is of aluminum and coated with indium, which, when heated, acts as solder. It is flexible enough to compensate for any warping of the wafer. Also, its very low parasitic impedance minimizes propagation delays and power dissipation. The resistance of a pair of interconnects is less than 2 ohms, according to Nudd.

As for power dissipation, which plagues designers of supercomputers, the Hughes machine "sidesteps this problem in a number of ways," says Nudd. The extensive parallel nature of computations permits low clock speeds of about 10 megahertz, and very low parasitic impedances of interconnects allow small, low-power complementary-MOS devices to drive data and control lines. What's more, an average of only 2½ wafers would be active in each bus cycle at any one time, further cutting power. Nudd puts dissipation for his machine at 3 to 5 watts.–**Larry Waller**

Optical memories

Library of Congress eyes optical storage

Public officials and private citizens alike will get access next year to the precious documents housed in the Library of Congress in Washington, D. C. But no one will be leafing through fragile pages; instead they will be looking at copies stored in a sophisticated optical storage and retrieval system based on optical disks.

Called Image Link, the $1.7 million system is being assembled by Integrated Automation Inc., which has combined its own image-digitizing and cathode-ray-tube hardware with direct read-after-write laser-scanned disks and drives from France's Thomson-CSF. With it, the library will be able to scan, digitize, and store on a disk the information on an 8½-by-11-inch page in 2 seconds with a resolution of 300 by 300 picture elements per inch. That works out to 8 million pixels per second. After writing, the disks are scanned by a laser and their contents displayed on a cathode-ray tube.

Cost cutter. Integrated Automation, a five-year-old maker of microfiche systems based in Berkeley, Calif., put a demonstration optical-disk installation through its paces this spring and intends to start installing the full-fledged version in October. Such systems, says company president David L. Fain, sell for roughly half what a comparable microfiche facility would cost. As a result, he expects to see heavy competition from both U. S. and Japanese firms emerging by early next year.

For the library, major hardware in the system will include two charge-coupled–device (CCD) scanners, one for printed pages and the other for microfiche, eight custom CRT displays that will present pages with a resolution of 150 by 300 pixels/in., and two laser printers.

One Thomson-CSF disk drive will handle recording and another playback. Further, there will be a jukebox-type device that selects one disk from among 100 and loads it for playback. The disks are 305 millimeters in diameter; one side stores 1 gigabyte (see "Optical disk stores a gigabyte," below).

Despite their vast capacity, the 100 disks will hold only about 1 million of the collection of some 10 billion pages, points out John Ragsdale, a systems analyst at the library. The high resolution is needed for two reasons, he explains: the documents have a lot of fine 4- or 6-point type, and many images have faded and blurred with the years.

Enhancements. To sharpen the images, Integrated Automation has designed a two-dimensional image-enhancement system based on a gray-scale algorithm. After the CCD scanner has captured the image with a 4,096-pixel detecting element, each pixel and its surrounding eight points are digitized to 8 bits of gray scale. This pixel area is buffered and fed in parallel to three processors: an edge processor, a point processor, and a level processor.

The edge processor looks at the brightness of pixels within the area to determine if an edge, or sharp transition from one tone to another, exists. If it detects such a transition, even though blurred, it will select the binary output of the point processor to form a sharp edge. If, on the other hand, the edge processor should find that the area is of uniform brightness, the level processor output will be chosen in order to form a smooth

Optical disk stores a gigabyte

A two-layer structure consisting of a polymer and a metallic recording material in a plastic support layer makes up Thomson-CSF's Gigadisc laser-scanned optical disk. According to François Le Carvennec, general director of the French company's optical-disk department in Le Plessis-Robinson, a Paris suburb, the recording material—whose composition he will not reveal—stands up better to abrasion, oxidation, and moisture than does the tellurium alloy generally used for disks. The plastic serves both as a protective covering and as a substrate for the recording material.

For the Library of Congress disks, one side is grooved with 40,000 tracks and divided into 25 radial sectors that format it for tracking, addressing, and focusing. Each track sector stores 1-K byte of data, for a total of 1 gigabyte. Le Carvennec predicts a disk will sell for less than $50 and the disk drive for less than $5,000 by 1988, if not sooner. In that year, he also believes the worldwide market for disks and drives alone will total $8 billion.

To write into the disk, the metallic layer is heated by the beam of a 15-milliwatt solid-state diode laser. The polymer decomposes locally and, as it does, the resulting gas pressure forms bumps about 0.8 micrometer wide in the metallic layer. These bumps are read by a 1-milliwatt laser spot beam as the disk spins at 1,200 revolutions per minute. Thompson is also working on a disk that stores data on both sides.

Thomson will produce disks both in France and the U. S. As part of a 1980 technology-transfer agreement, the Optimem division of Shugart Inc. in Sunnyvale, Calif., will begin shipping drives next year. The French firm is negotiating with a U. S. supplier as a second source for the disks. –**Karen Berney**

News Briefs

MCC to set up shop in Texas

Once considered a long shot by even top Texas officials, Austin will wind up as the home of the much-sought-after Microelectronics & Computer Technology Corp. Set to operate on an annual budget of $50 million to $100 million, the nation's second electronics-industry research cooperative is sponsored by a dozen U. S. companies [*Electronics*, March 10, 1982, p. 97].

Ultimately, MCC will hire 300 to 400 scientists, engineers, and staff support personnel, says Bobby R. Inman, president and a native Texan who went to college at the University of Texas in Austin. Among the incentives that lured the research cooperative to Austin were a 20-acre headquarters site and a $20 million office-laboratory facility.

NCC exhibitors decry in-tents heat

Soaring temperatures at the National Computer Conference provoked a near-revolt among several hundred exhibitors housed in six tents outside the Anaheim, Calif., Convention Center. Their angry complaints to show sponsor American Federation of Information Processing Societies stemmed from temperatures up to 115°F inside the tents, keeping out visitors and forcing shutdown of sensitive machines. AFIPS officials refused to respond to demands for refunds and threats of lawsuits but did say the giant show probably would not return to Anaheim, which cannot accommodate it on one site. Next year's locale is Las Vegas, Nev.

Western Electric plans to be first off the mark with 256-K RAM

Western Electric Co. hopes to propel its 256-K dynamic random-access memory into the commercial marketplace this fall. The AT&T subsidiary first showed the chip, fabricated in Allentown, Pa., at last May's National Aerospace and Electronics Conference [*Electronics*, June 2, 1982, p. 56] and has been providing samples since January. It expects to be the first company in the world in commercial production.

transition from one pixel to the next.

To display these enhanced images, Integrated Automation has developed a CRT with an 8½-by-11-in. screen. Its resolution is very high—2,496 by 1,644 lines. To keep the image refreshed at 30 frames per second, the video transfer rate is 160 million pixels/s. —**Karen Berney**

Medical

Ultrasound treats cancerous tumors

Ultrasound has joined electromagnetic radiation as a viable energy source for the promising though experimental cancer therapy of hyperthermia. In hyperthermia (sometimes called thermotherapy), rf, microwave, or ultrasound sources are applied to heat cancerous tissues and destroy them.

Dr. Padmakar P. Lele, professor of experimental medicine at the Massachusetts Institute of Technology, says ultrasound produces deep within the body powerful and highly focused antitumor effects that cannot generally be achieved with electromagnetic radiation. Lele reports his findings on May 31 at an all-day hyperthermia workshop at the International Microwave Symposium sponsored in Boston by the Institute of Electrical and Electronics Engineers.

Hyperthermia works because cancer cells are more sensitive to heat than normal tissue [*Electronics*, April 26, 1979, p. 88]. Moreover, cells at the periphery of tumor masses are often resistant to ionizing radiation but not to the effects of heating. Preliminary results indicate thermotherapy also has milder side effects, for it does not produce the bone marrow depression, hair loss, nausea, and vomiting often associated with chemotherapy and radiation therapy.

Highly focused. Ultrasound thermotherapy uses piezoelectric transducers, of either quartz or less expensive ceramic, to convert an electrical oscillator output into sound waves in the 300-kilohertz-to-10-megahertz range. Single- or multiple-transducer outputs are focused through plastic acoustic lenses onto the tumor.

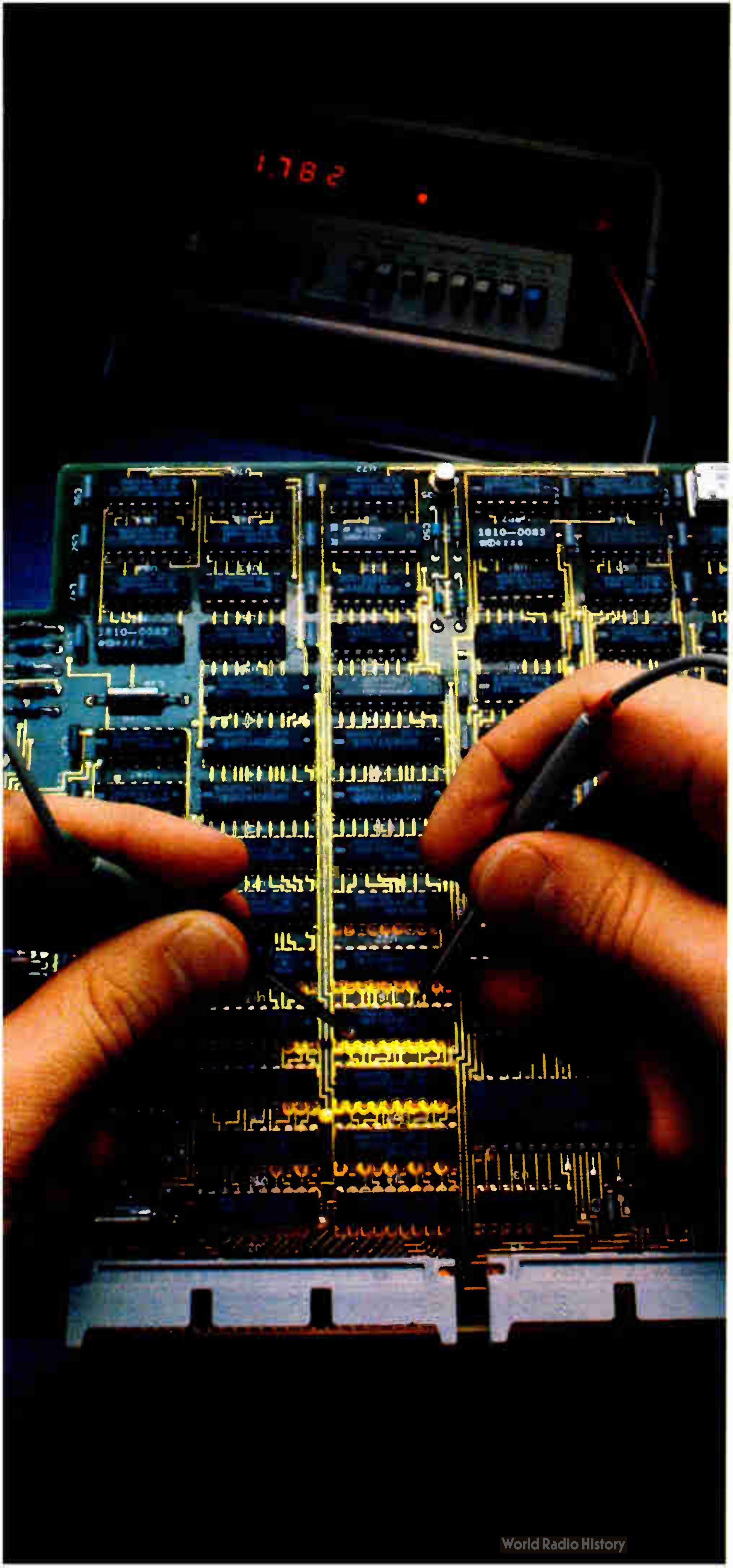
The chief advantage of ultrasound is the sharp focus it achieves at a great depth within the body, says Lele. He cites pancreatic, liver, bladder, and urinary-tract cancers as prime candidates for its use. For hyperthermia with electromagnetic sources of energy, the microwave range must be used to penetrate to internal organs. But these long-wavelength sources are harder to focus and control, often overheating adjacent, noncancerous tissues.

Transducers. Early ultrasound systems using stationary transducers sometimes produced skin irritations and overheated normal tissues overlying the targeted tumors. To circumvent these problems, Lele built what he calls a synthetic-aperture system. Computer-controlled movement of the transducers in effect enlarges the system aperture and allows energy to be focused at depth while being distributed more safely over a larger area of skin and intervening tissues. Thus, sufficient energy can be directed at the tumor without damaging the skin or overheating intervening noncancerous tissues. Lele uses as many as three transducers, depending on tumor size and depth.

Of 36 patients with highly metastasized cancers unresponsive to other treatments, 26 (72%) responded to ultrasound hyperthermia, with tumor reductions of 50% or more, according to Lele. Total tumor regression was reported in six (17%) of the patients. A phase 1 study such as this is designed to establish treatment safety, not survival figures, since the cancers are already so widely spread. Lele is beginning phase 2 studies, with less metastasized patients, in order to establish the treatment's efficacy. —**Norman Alster**

When Texas Instruments and Hewlett-Packard team up, quality in technical computers goes up.

- **TI device quality is so high**, Hewlett-Packard's Desktop Computer Division will greatly reduce incoming testing *(Page 2)*.
- **TI's Quality Improvement Program** assures consistently high-quality standard semiconductors for all TI customers *(Page 3)*.
- **More than 100 quality TI Advanced Low-power Schottky/Advanced Schottky devices** offer still greater performance *(Page 4)*.



◀ **Board-level test results,** in addition to data from incoming parts inspection, are passed on to TI from HP's Desktop Computer Division to further improve IC quality.

The high technical

Incoming bipolar digital and linear integrated circuits from Texas Instruments rank among the highest quality ever received by Hewlett-Packard's Desktop Computer Division.

Result: The extra quality built into each TI device helps HP design technical computers noted around the world for performance and reliability.

An example is the new HP Series 200 Model 16 Personal Technical Computer shown on the previous page. This powerful 16-bit computer is designed for the most demanding technical and scientific applications.

HP technical computers, in fact, include a wide range of TI bipolar digital components: Advanced Low-power Schottky. Advanced Schottky. Low-power Schottky. Schottky TTL. And regular TTL. Quality TI linear circuits and interface devices also are incorporated.

TI/HP team effort achieves best PPM quality levels

Three years of close cooperative teamwork between TI and HP have reduced the number of total electrical defects in parts per million (PPM) to well under 500 (see graph).

The quality of incoming TI devices is so high, HP will significantly reduce incoming testing.

Crucial to achieving these unprecedented quality levels has been the formation of a "Quality Team" made up of members from both TI and HP. The team regularly meets to exchange information, establish goals, and measure progress.

Higher quality TI devices speed HP products to market

The superior quality of TI ICs pays off for HP. In several ways.

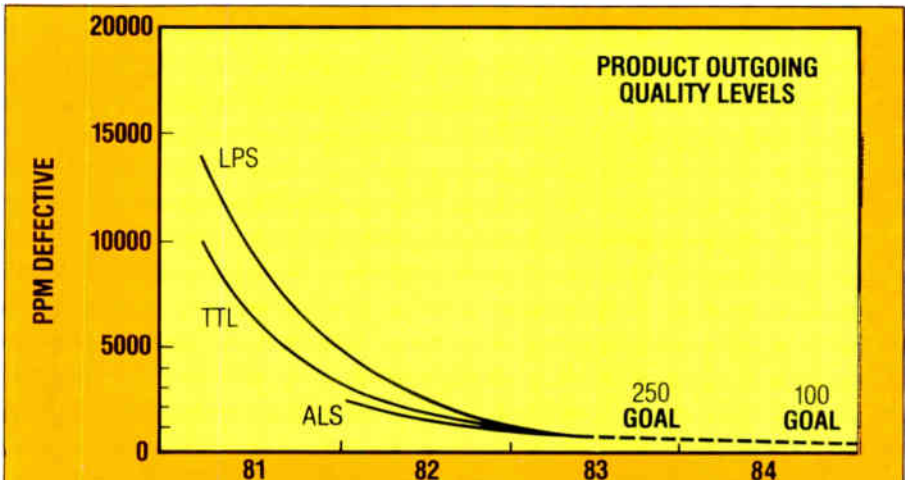
First, without exceptionally reliable components, HP could not build increasingly powerful scientific computers. Equipment reliability simply would not be good enough.

TI quality that helps improve computers for HP also helps you.

In fact, the extra quality built into each TI device has helped HP's Desktop Computer Division achieve product improvement goals. Compared with its 1980 units, HP's comparable products now offer triple the reliability at one-third the price.

Second, the extra quality built into advanced TI logic functions (74ALS and 74AS) enables HP to incorporate leading-edge technology into its products — without having to wait for years for the technology to prove itself.

The bottom line is this: Quality TI devices help HP get innovative products into production and to market faster.



New standards for quality are being set every year by TI bipolar logic ICs. Unlike many suppliers who quote only 25°C Average Outgoing Quality (AOQ), TI rigorously measures AOQ at full-temperature DC and room-temperature AC. By 1985, our goal is fewer than 100 total electrical defects in parts per million (PPM) at outgoing inspection.

You get the same higher quality TI semiconductors

The standard TI semiconductor devices your local distributor stocks are *exactly* the same — up to symbolization — as those we ship to HP and all other TI customers. The ICs come off the same production line. Receive the same processing. And are 100% DC tested.

The TI approach to quality is simple: Do it right the first time. At TI, quality/reliability is designed and built into every device, rather than just testing out defects.

Testing of TI devices at HP's Incoming Quality Audit will be substantially reduced because ICs are of such high quality.

A quality program that works for you

The close teamwork between TI and HP is just one aspect of the TI Quality Improvement Program. A comprehensive program designed to lower the cost of TI components to all our customers by reducing defective ICs. By eliminating the need for incoming testing. By minimizing board-level failures. And by preventing even more costly equipment failures in the field.

To achieve this, TI's 100% testing of all standard devices is followed by rigorous QA sampling (see table). Advanced multitesting as well as automated handling, fabrication, and inspection also are utilized to push quality levels higher.

The bottom line? When you want the highest quality, most cost-effective components, do what HP does. Specify standard TI bipolar digital and linear ICs.

Built-in TI quality can save you money

Higher quality TI parts can cut your costs substantially.

The cost of defects to you depends on when the failure occurs. For example, the cost to detect and replace components at your incoming inspection may amount to only a few pennies per device.

Your costs, however, rise significantly as undetected defective ICs are integrated into systems.

Still more costly are defective components that go undetected at the system test level, but later fail in field applications. Here, the damage inflicted not only applies to the thousands of dollars lost in trouble-shooting, downtime, and replacements, but it also affects your company's reputation for high-quality, reliable equipment and systems.

For all these reasons, the extra quality built into every TI device means added value for you and your customers. And tremendous cost savings over the years.

GUARANTEED AQL

TEST	CONDITION	PPM (parts per million)
DC PARAMETRIC	0°C to 70°C	400
AC PARAMETRIC	25°C*	1,500

*Sampled and guaranteed.

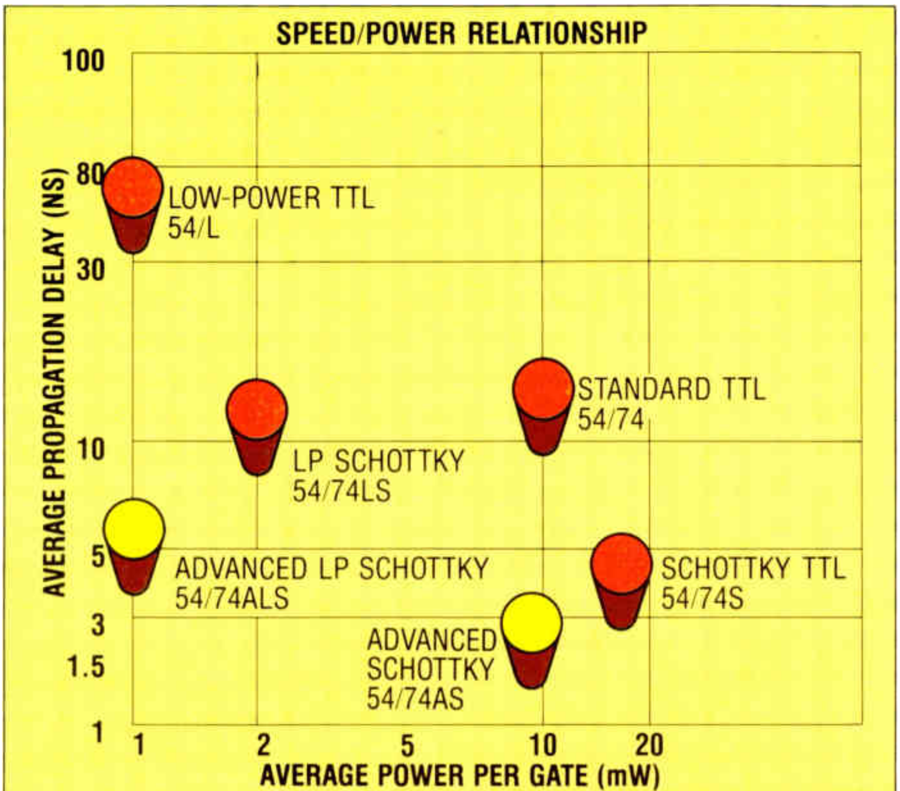
To further assure IC quality, TI performs QA sampling to the tightest Acceptable Quality Limits (AQLs) in the industry.

Higher quality ICs mean higher profits

For every dollar decrease in reported failure costs, there is a positive "multiplier effect" on your profit margins. Estimates for electronic equipment range from five to 10 times.

By incorporating a "do it right the first time" concept, the TI Quality Improvement Program eliminates defects before they happen. To you, this means greater profits. Today and tomorrow.

High-performance ALS/AS logic. 100 quality reasons to choose TI.



Greater performance and lower power consumption make high-quality TI ALS/AS devices your best choice for a wide range of state-of-the-art applications.

Superior quality. Higher performance. And reduced power consumption. You get all this and more from TI's Advanced Low-power Schottky (74ALS) and Advanced Schottky (74AS) TTL devices.

Twice the speed, half the power

With a typical 1.5-ns gate delay and 8-mW gate power dissipation, TI's 74AS Series devices give you double the speed and less than half the power dissipation of earlier Schottky ICs. Internal gate delay for MSI functions is typically less than 1 ns, while power consumption is less than 5 mW.

TI's 74ALS Series devices offer you typically 50% lower power consumption than 74LS ICs, with speed approaching that of standard Schottky devices. Featuring 1-mW gate power dissipation and a typical 4-ns gate delay, TI's 74ALS family is ideal for low-power, high-speed applications.

Save board space

Many of these new Schottky ICs are MSI and LSI functions offered in plastic dual-in-line packages — 300-mil wide, 24-pin; and 600-mil wide, 52-pin. This lets you virtually double functional densities and reduce board space by 30% — or more.

Still greater improvements in functional densities can be yours with 20-, 28-, 44-, and 68-pin plastic chip carriers. All are JEDEC standard with lead spacings on 50-mil centers.

Economical for the '80s

We project TI's 74ALS devices will reach price parity with today's widely used Low-power Schottky (LS) functions by the second half of 1984.

Today you can choose from more than 100 ALS/AS functions from your local TI distributor or direct from TI. In 1983 alone, TI plans to add more than 100 new functions.

For military systems, data processing, telecommunications, or process control, TI's ALS/AS devices can be your key to cost-effective TTL solutions in the '80s.

For more information on the TI Quality Improvement Program and a complete list of TI bipolar logic devices, write Texas Instruments, Semiconductor Group DA, Dept. 013EC, P.O. Box 401560, Dallas, Texas 75240.

 27-5037

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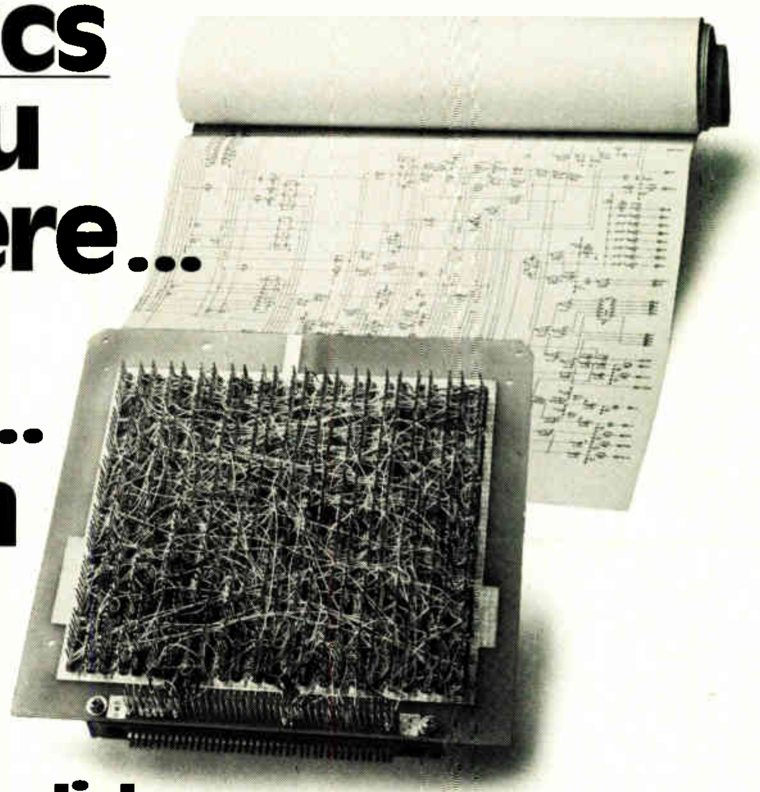

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"Most 16-bit support is still in the talking stage. But our 68000 partnership is already producing results."

John Meyer
VP-General Manager
MOS MPU Division

Most benchmarks and design engineers agree that the 68000 is the standard for 16/32-bit applications. But you need more than an exceptional microprocessor to build leading-edge products.

So Signetics and Motorola are working together closely to bring you the circuits and support you need to design successful systems.

We've developed a large family of VLSI subsystem chips—more complex than the CPU itself. We took a big step to cut development costs, too. And made it easier for you to get to the market first by offering powerful VMEbus board-level products.

"We're surrounding the CPU with powerful VLSI peripherals."

After you helped us define the key applications and requirements, we started designing the VLSI subsystems you needed for networking, datacomm, memory and CRT control.

Many of these Signetics circuits contain more than 100,000 transistors. They use either HMOS or bipolar technologies, depending on which provides the best solution.

The SCN68681 DUART (Dual Universal Asynchronous Receiver/Transmitter) is our first major addition to the S68000 family. With two independent full-duplex asynchronous channels, programmable data format, baud rates, channel modes and timer/counter, it fills all your asynchronous data communications needs in a single package.

The SCB68430 Direct Memory Access Interface (DMAI), has also arrived. This bipolar product provides the unmatched transfer rate of 4 megabytes per second and supports automatic rerun on bus error.

Among the most important newcomers this year will be our SCN68454 Intelligent Multiple Disk Controller (IMDC), and its companion, the SCB68459 Disk Phase Locked Loop (DPLL). In late 1983, we'll be sampling our SCN68562 Dual Universal Serial Communications Controller (DUSCC).

By 1985, about 20 MOS and bipolar devices will have opened new areas for our 16-bit family, such as local area and public switching networks, co-processors, and intelligent disk and advanced CRT display controllers.

Besides planning the family to fit your products, we've also developed the quickest way to get them working together.

"We built a development system that uses your resources."

Instead of introducing yet another expensive special purpose computer, we've created an economical User Workstation (UWS) that taps into the power of your existing host computers and laboratory test equipment.

Working with the host system, the UWS performs virtually all your 68000 software development chores, such as in-circuit emulation, debugging and program execution. It also communicates with a variety of peripherals used for command entry, PROM programming and hard-copy recording of debugger events.

The UWS can break on specific instructions, trace instruction execution, display and alter both registers and memory, transfer control to user programs or a computer, and assemble and disassemble code. It also has unique features, such as the ability to debug code written for multiprocessor systems. And it does all this at less than a third the cost of a conventional development system.

To link the UWS to the host computers, we're providing cross-software packages for the 68000, including Macro Assembler, Pascal and C compiler with linker/loaders.

"Our board family gets you there first."

As part of our plan to get you to market faster, we built a number of VMEbus board products around the SCN68000. OEMs, in particular, will find these ideal for prototyping component designs. Or to use just the way they are in a finished system.

To date, our VMEbus family consists of a system controller board, a CPU board with memory management option, a memory board, a hard and floppy disk controller board, and a CRT controller board. There's also a card cage, real-time multitasking operating system and debugger/monitor software packages.

Even with this kind of help, you won't have to go to it alone. Signetics factory and Field Application Engineers are ready to put their systems experience to work for you. And our long-term joint development program with Motorola assures you of complete compatibility among the whole family of products, present and future.

So if you want to take advantage of all the S68000 family has to offer, contact your local Signetics office. Or send us the coupon. We'll help you make the best of a very good thing.

I'd like to know more about the Signetics S68000 family of integrated resources: chips, development system, software and VMEbus boards.

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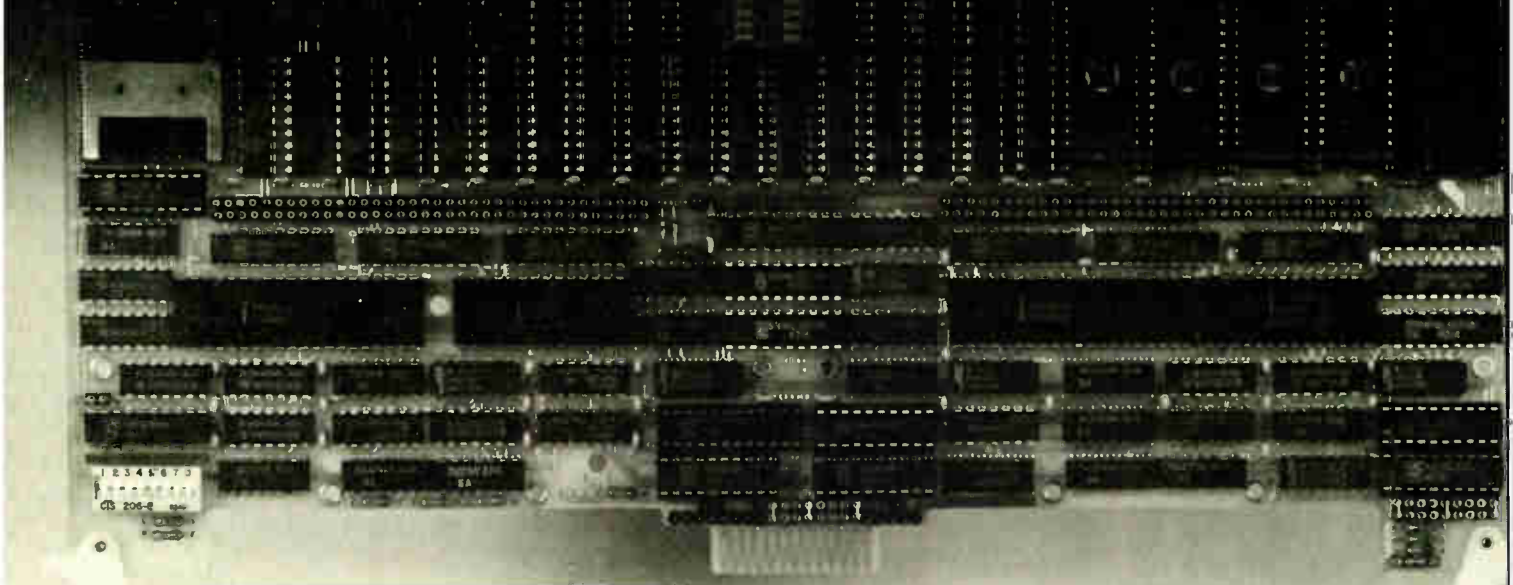

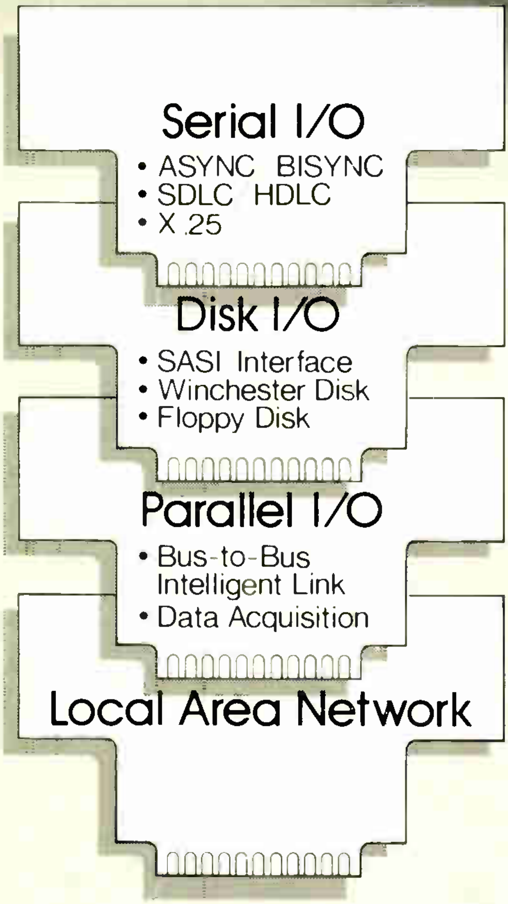

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Circle 64 on reader service card

Washington newsletter

IC protection bill to be revised

Proposed legislation to protect IC mask designs will be redrafted as the result of Senate subcommittee hearings earlier this month at which witnesses questioned whether the best approach is amending the Copyright Act of 1976 [*Electronics,* May 19, p. 54]. Both the U. S. Copyright Office and the Association of Data Processing Service Organizations told the Senate Commerce Committee's subcommittee on patents, trademarks, and copyrights that the Semiconductor Chip Protection Act's interpretation of chip products as "writings and discoveries" would run into legal trouble; **they urged the adoption of a separate statute covering mask designs only.** Representatives from Intel, Intersil, and the Computer and Communications Industry Association confined their testimony to a provision that would penalize what they termed legitimate reverse engineering—a process they say is necessary for innovation and the interconnectability of different brands of computer equipment. After changes in the measure—S.1201—are made, it will be reported to the full committee, says a congressional aide, adding that the drafting of a separate mask bill is unlikely.

Satellite makers fear competition from space shuttle

Satellite builders testifying before Congress have endorsed President Reagan's policy of commercializing operations but want Washington to foster industry-Government cooperation rather than competition. They fear that planned Government subsidization of space-shuttle launches through 1987—the Office of Management and Budget has directed NASA to revise its pricing policy after that to ensure the recovery of all costs—will price satellite services out of the market. Last November, for example, the National Aeronautics and Space Administration charged **$10 million to orbit a shuttle payload, about $15 million less than the cost of an satellite launch.** Until 1988, notes a congressional staff member, industry's best hope is to market satellite services as more reliable than shuttle operations.

Biggest satellite contract awarded to Rockwell

A $1.21 billion contract covering the construction and launch of 28 Navstar global positioning satellites over the next five years has been awarded by the U. S. Air Force to the Space Transportation and Systems Group and Shuttle Integration and Satellite Systems division of Rockwell International Corp. of Downey, Calif. The Air Force says the award is the largest ever made for satellites. **The network will consist of 18 satellites in six orbital planes** operating in circular 10,900-nautical-mile orbits and transmitting two signals at 1.5 GHz. Navstar will provide North Atlantic Treaty Organization countries with three-dimensional position and velocity data on worldwide land, sea, and air forces.

Electronics leaders push top industry issues

Some 125 electronics executives representing the American Electronics Association **swarmed over Capitol Hill last week in an attempt to sway legislators on three pending issues.** The AEA is lobbying for removal of controls on high-technology exports to friendly non-Communist countries, elimination of a three-year limit on tax credits for incremental research and development, and tax writeoffs for corporate donations to universities of equipment and of cash for raising faculty salaries.

Washington commentary

The short-term syndrome injures U. S. competitiveness

Managers in U. S. electronics companies and other high-technology industries complain continually about Government economic policies—or lack of them—that encourage high interest rates and thereby discourage private investment in the high-risk ventures necessary to keep America competitive. That complaint was reiterated recently by a blue-ribbon panel report on "International Competition in Advanced Technology: Decisions for America." Headed by Howard W. Johnson, chairman of the board of trustees of the Massachusetts Institute of Technology, the panel was sponsored by the National Academy of Sciences and the National Academy of Engineering.

But the high cost of capital is certainly not the only reason for the U. S.'s loss of its competitive edge in markets at home and abroad. Industry managers, too, have made major errors in judgment. "Short-term financial concerns have come to dominate many U. S. corporations," the Johnson panel says. "Managers equate this near-term emphasis with the need to survive, yet the result—a reluctance to take long-term risks—sacrifices major technological innovations."

Miscalculating markets

A case in point is the video-cassette recorder, a technology in which RCA Corp was an early pioneer. Yet the consumer video recorder market—where U. S. sales alone doubled between 1981 and 1982 despite a recession—has gone by default to the Japanese, whose annual VCR sales worldwide run to an estimated $10 billion. The default was signaled in 1979 when RCA reported it could not come up with the $200 million required to develop its own product. That was the same year that RCA bought a finance company for some $1.2 billion.

Photovoltaic technology may prove to be a case where shortsightedness on the part of both industry and Government will make the U. S. market fair game for imports. Of course, direct conversion of sunlight into electricity—another technology pioneered in the U. S.—has proven a boon to space satellite power systems. At the time of the Arab oil embargo a decade ago, photovoltaics began to receive heavy Federal research and development funding as an alternative energy source. Then oil prices came down, and so did U. S. R&D money for photovoltaics.

As the Federal R&D roller coaster turned down, the handful of companies pursuing photovoltaic technology was forced to search for private venture capital at double-digit interest rates. Many of those who found it at a lower price did so by searching out foreign investors in Europe or the Middle East. Among those was Chronar Corp. of Princeton, N. J., producer of thin-film amorphous-silicon photovoltaic panels. Chronar president Zoltan Kiss struck a deal in March with a European syndicate that is led by the Somdia subsidiary of Les Grand Moulins, which is one of the largest agricultural operations in France. Part of the package includes setting up a series of turnkey photovoltaic manufacturing plants in Europe.

Sunshine in Japan

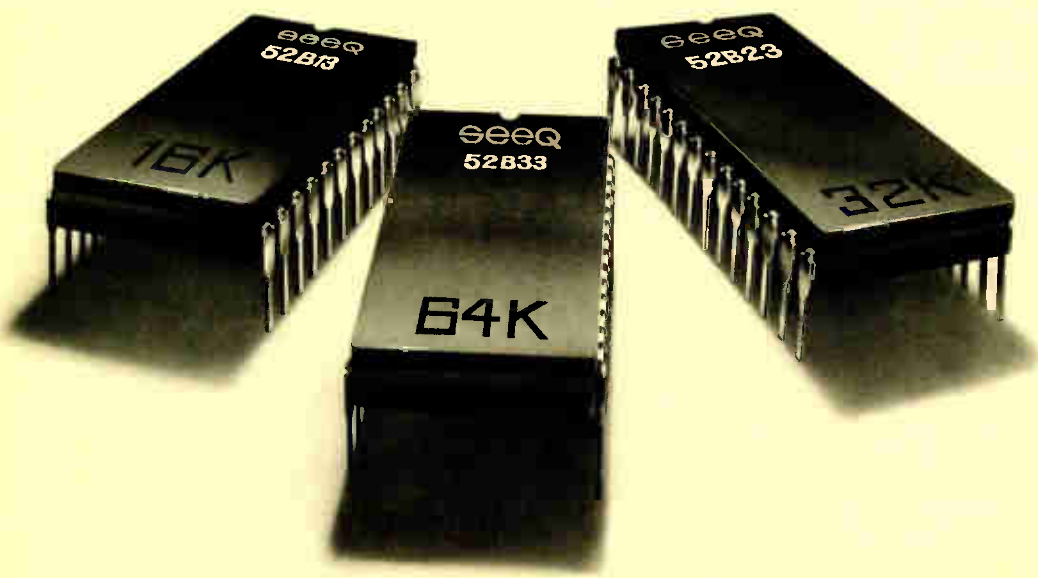
In Japan, meanwhile, the drive to commercialize photovoltaics goes on under the code name Project Sunshine. Started in 1977 by the Ministery of Trade and Industry, the program seems relatively modest—about $20 million, Kiss estimates. However, the five participating companies are getting substantially more money in the form of Japan Development Bank loans that Kiss says "have either very low or no interest accruing until there is a product. Interest and repayment come as profits are available for the product." Japan's timetable for commercialization of photovoltaics is 1990.

For the U. S., there is no meaningful timetable at all. Continuing Federal deficits on the order of $200 billion annually seem certain to keep the cost of capital too high for most of the small, innovative corporations like Chronar who need it, thereby driving their operations—and perhaps their ownership—offshore. Too many large U. S. corporations, meanwhile, continue to pursue the short-term gain, instead of risking the investment in potentially more profitable new markets for the long term.

No one wants to see the evolution of an America Inc., but there has to be a viable middle ground of Federal economic policies that, on the one hand, make investment capital available at competitive rates, and, on the other hand, encourage corporate managers to invest more wisely. **–Ray Connolly**

SEEQ SETS ANOTHER STANDARD FOR 5V E² ROM.

FAMILY PLANNING.



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Circle 69 on reader service card

There's only one single-chip hard disk controller that really lives up to its name.

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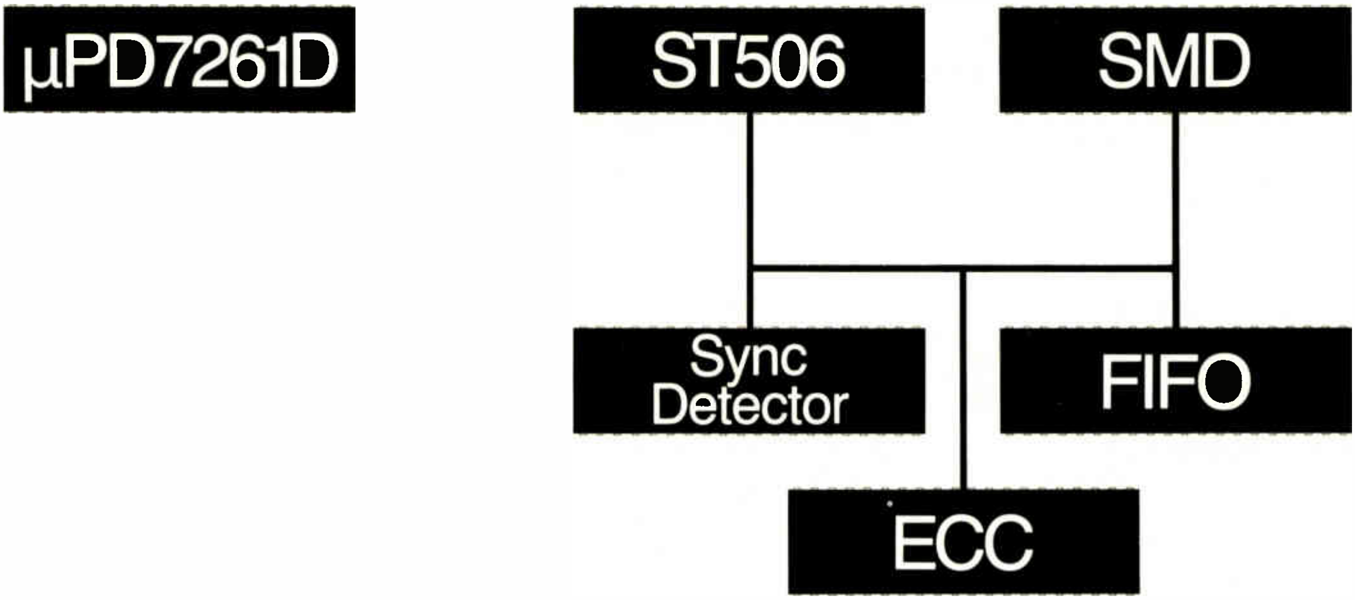
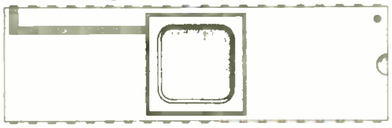


µPD7261D



NEC's single-chip HDC, the µPD7261D. It outperforms the competition one to five.

At NEC, we don't think a single-chip HDC should require three or four extra chips to make it do all you want it to do. Obviously, not everyone agrees.

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Circle 71 on reader service card

11:30-12:00 **Session Four: Industry Profile**

Charles Mantell
Gnostic Concepts

12:00-1:40 **Lunch**

Featured Speaker
To be announced

1:40-3:00 **Session Five: Technology Forecast Panel**

Capabilities of Scaled CMOS

Rob Walker
Vice-President
LSI Logic Corp.

Medium Speed Replacing Low Power Schottky TTL

Frank Deverse
President
International Microcircuits, Inc.

On-Chip Testing for Large CMOS Array

Dennis Sabo
Gate Array Marketing Director
National Semiconductor Corp.

Integrated Schottky Logic for Mainstream TTL-type Applications

Paul Scott
Design Manager
Bipolar Gate Arrays
Signetics Corp.

Current Mode Logic for High Density Bipolar Arrays

Allan Cox
Marketing Manager
Interdesign Inc.

Session Five: Technology Forecast (continued)

Subnanosecond ECL

Erich Gottlieb
Manager, Strategic Marketing
Advanced Digital LSI Products
Semiconductor Products Sector
Motorola Inc.

Linear-Digital Combinations

Paul Brown
Manager, Custom Products
Exar Integrated Systems Inc.

3:00-3:20 **Break**

3:20-4:30 **Session Six: Design Tools Panel**

Design Automation

Michael Feuer
Vice-President
California Automated Design Inc.

Stand-Alone VLSI Design System

Gene Chao
President
Metheus Corp.

Engineering Project Management

William Johnson
President
Cadtec Corp.

Industry-Standard Simulation & Test Generation Software

Mike Jenkins
Director, IC Marketing
Comsat General Integrated Systems

Popular Place & Route Programs. Other CAE Software

Bill van Cleemput
President
Silvar-Lisco

4:30-5:00 **Session Seven: Systems Integration**

Peter Quinn
Apple II Hardware Design Manager
Apple Computer

Merrill Brooksby
Manager, Hewlett Packard Design Aid
Hewlett Packard Co.

Steve Rothman
LSI Marketing
Digital Equipment Corp.

5:00 **Closing**

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Bipolar–C-MOS gate arrays work at TTL speed

The equivalent of TTL output drive and speed with complementary-MOS power consumption are features of bipolar–C-MOS arrays with 550 and 1,600 gates just made available by Japan's Hitachi Ltd. The chips are designed with low-power Schottky TTL I/O buffers around the periphery and 3-μm C-MOS gates in the center. **The output buffers can drive 20 TTL loads, eliminating the need for the external inverters that are often needed to match C-MOS gate arrays to loads.** Internal gates have the same 4-ns propagation delay as do previous Hitachi C-MOS gate arrays built to the same design rules. But input buffer delay is cut to 5 ns from 10, and output buffer delay is cut to 8 ns from 38 to 29 ns in on-chip C-MOS buffers and to 9 ns in an external low-power Schottky TTL inverter.

CCITT considers codec standard for video conferencing

A universal codec for international video conferencing developed in the UK under a research contract between British Telecom and GEC McMichael Ltd. is under consideration as a worldwide standard by the International Consultative Committee for Telegraphy and Telephony (CCITT). Its possible adoption is significant because **it resolves incompatibilities between American and European standards at two levels, the television signal level and the telecommunications transmission level.** The codec can code and decode either the European 625-line, 50-Hz PAL and Secam signals or the North American 525-line, 60-Hz NTSC signals, furnishing signals at either 1.544 or 2.048 Mb/s. The device was developed as part of a six-nation, five-year European video-conferencing program, and British Telecom went on to harmonize it with U. S. standards. It will be first used in three transatlantic services due to start in the second half of 1983.

Optical disk holds up to 15,000 pages

Look for Thomson-CSF of Paris to start first-quarter 1984 production of its Gigadisc optical-disk system for digital document storage. **Thomson expects to meet a market demand of about 10,000 units per year with its own production in France and that of U. S. partner Xerox Corp.** The French company estimates the system's price at between $10,000 and $14,000, with nonerasable 30-cm disks having a capacity of 10,000 to 15,000 pages and costing from $20 to $35 each (see related story, p. 54).

PCM video recorder uses standard VCR parts

Hitachi Ltd.'s Central Research Laboratory in Kokubunji has built a prototype broadcast-quality pulse-code–modulation video-cassette recorder using the mechanism and cassette from a standard VHS VCR. Such a unit will also be useful for other image-storage applications, including document files, but the error rate is probably too high for storage of computer data. **A product in a package similar in size to professional ¾-in. U-Matic recorders probably could be marketed within two years,** but the firm might delay further while awaiting completion of standardization of tape material and format by the Society of Motion Picture and Television Engineers. In the prototype, a TV signal is sampled at a rate of 10.7 MHz, three times the color subcarrier frequency, with a resolution of 8 bits. Video bandwidth is a full 4.5 MHz. Signal-to-noise ratio is 56 dB, compared with 48 dB for analog studio recorders and somewhat more than 40 dB for consumer VCRs. Metal tape, similar to the kind to be used for upcoming 8-mm VCRs, makes it possible to record with a density of 0.36 μm/b, double that of conventional VCRs.

International newsletter

Real-time languages to share common development tools

Two of Britain's biggest computer users, British Telecom and the Ministry of Defence, will finance the development of a single set of program-development tools for the real-time programming languages Chile and Ada. Chill (for CCITT high-level language) is recommended by the International Telegraph and Telephone Consultative Committee (CCITT) for use in telecommunications applications, and Ada is a modular standard language under development for the U. S. Department of Defense. Chapse (for Chill and Ada programming support environment) is a realization that **the real-time software for both applications has much in common and would benefit from the use of a single set of support tools.**

Brazilian government gives Racal-Milgo its marching orders

Racal Milgo Inc., a Miami-based subsidiary of the UK's Racal Electronics plc, in effect has been informed by Brazil's government that it must withdraw its 47% participation in a local modem manufacturer, Coencisa Indústria de Comunicações S/A, Brazilia. The order came from the Special Secretariat for Informatics (SEI), **which is gaining a reputation for its chauvinism on matters of computer production, software, and transborder data flow.** The crunch came when Coencisa was denied permission by SEI to start producing a new high-speed version of its 9,600-b/s modem unless there was 100% Brazilian control, although the technology can come from foreign suppliers. The company was left with no option, since competitors Elebra S/A Electrônica Brasileira, São Paulo, and Moddata S/A Engenharia de Telecomunicações e Informática, Rio de Janeiro, already have their high-speed models, with technology acquired from Codex Corp., Mansfield, Mass., and Japan's NEC Corp., respectively.

Wide use of digital TV seen in decade

Digital TV will gradually grow in popularity so that by 1992 about 40% of all color receivers sold in industrialized countries of the West will have a digital chassis. That is the main conclusion of a study from market research firm Mackintosh International of Luton, Beds., UK. **Linear technology will still dominate the transitional period, but with a higher level of integration,** the study says. Already, highly integrated analog color TV chips are being announced by various firms [*Electronics*, May 19, p. 76], and these will keep competing with purely digital solutions.

Addenda

Australia's Royal Melbourne Institute of Technology claims to have developed the world's first multiproject gate-array wafers. It says that **the cost up to the point of prototype acceptance is about one fifth that of fully custom multiproject chips.** . . . Sweden's LM Ericsson has filed for what is claimed to be the biggest-ever stock issue by a foreign company on Wall Street—4 million shares, at $62.50 a share. **The $250 million raised will finance the company's international expansion** and probably include some U. S. acquisitions. About 20% of Ericsson shares are held by American investors; the new issue will bring this to 30%. . . . Denmark's parliamentary decision—made over government objections—to lift trade sanctions against the Soviet Union will not affect its policy of restraint on electronics exports. Imposed a year ago to protest Soviet interference in Poland, the sanctions affected only a few Danish purchases from the Soviets, mainly items like caviar.

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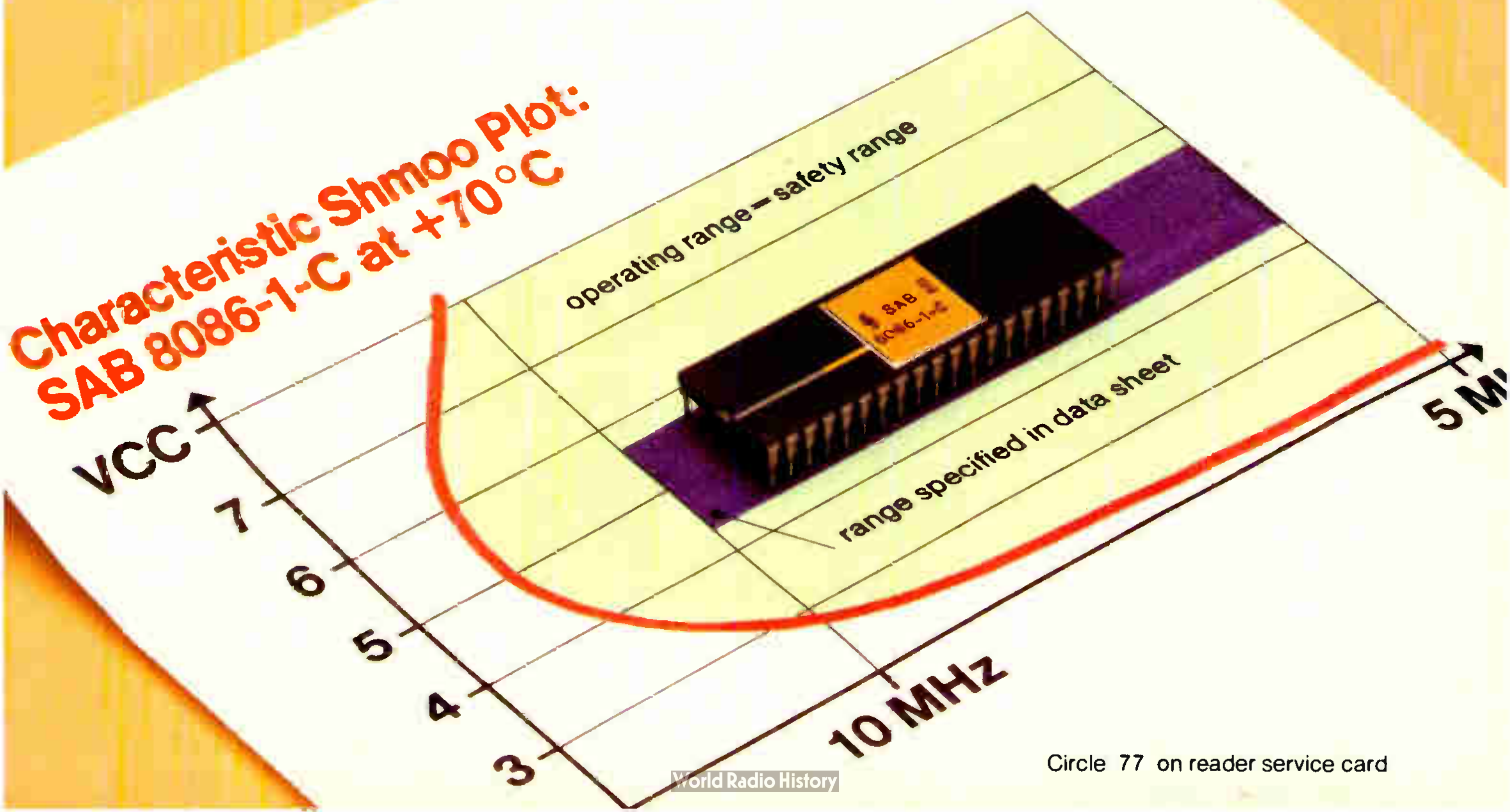


Circle 77 on reader service card

Low-cost now make

The new generation of word processors features flat-panel displays. Result: More efficient use of desk space. And an easier-to-read, more attractive, and more reliable terminal.

New display drivers from Texas Instruments are making AC plasma flat-panel displays practical. And providing reliable operation up to 225 volts.

The secret? TI's patented BIDFET process. It combines the best of several technologies—bipolar, JFET, CMOS, and high-voltage DMOS—all on one monolithic chip. Providing dramatic cost savings as well as reliable high-voltage operation.

In fact, only TI's BIDFET-based, flat-panel display drivers give you the extra margin of reliability built into DMOS high-voltage outputs. Plus high-speed, rugged inputs. Low power consumption. And the capability to integrate logic *and* drivers all on a single chip.

Cost-effective AC plasma display drivers

TI's leadership in AC plasma flat-panel display drivers is confirmed by the fact that we make the only totem-pole 32-bit drivers on the market. By integrating more lines per chip, these advanced drivers make AC plasma systems cost-competitive with high-character-density CRTs (see cost-projection chart).

You can select from four economical TI AC plasma display drivers. The SN75500AN and the SN75501CN have CMOS-compatible inputs. The SN55500AN and SN55501CN offer the same operation, but over the full −55° to 125°C temperature range. All can handle the 100-V swings. High speeds. And the complex logic required by AC plasma panel displays.

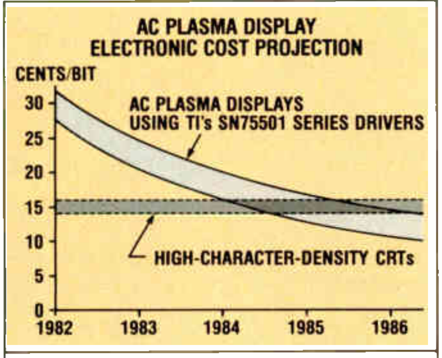
All feature thirty-two 100-V totem-pole outputs. 20-mA output-current capability. 4-MHz (max) input data rates. A 100-kHz (max) operating rate. And

◀ Advanced word processors, which are more compact, more reliable, and more attractive, incorporate flat-panel displays made possible by TI's new, cost-effective drivers. The flat-panel display shown is a mock-up that is conceptually similar to terminals now coming on the market from several manufacturers.

 27-5087

TI BIDFET display drivers flat-panel displays practical.

200-ns output transition times. While consuming only 40 mW of power.



Bringing down the cost of AC plasma display systems to levels competitive with CRTs—just one of the advantages TI's patented BIDFET process brings to flat-panel displays.

Five VFD drivers for 60-V operation

Unique BIDFET technology enables all TI vacuum-fluorescent display (VFD) drivers to operate reliably up to 60 volts. These drivers include the widely used UCN4810A, plus the new TL4810A, SN75512A, SN75513A, and SN75518.

Pin compatible with the UCN4810A, the TL4810A gives you twice the speed and active totem-pole drivers on all 10 outputs. Plus, a strong 1-mA pull-down reduces interdigit blanking time to maximize system efficiency.

The SN75512A and the SN75513A offer the advantage of 12 drivers per package and complement each other in VFD applications. The SN75512A has a serial-input data register, data latches, and high-voltage buffers with totem-pole output structures—making it ideal for anode or grid control. The SN75513A—which includes a reset function instead of parallel data latches—is primarily used as the grid or line-select controller.

The SN75518, a 40-pin device, provides control and drive circuitry for 32 lines using the same architecture as the TL4810A (or SN75512A).

With the advantages of increased integration, the SN75518 represents a 30-percent reduction in equivalent system cost over the popular UCN4810A.

How TI BIDFET pays off for you

No other technology matches TI's BIDFET process for producing reliable large- or even medium-scale ICs with high-voltage capabilities. That's because only TI's BIDFET pools the advantages of many technologies.

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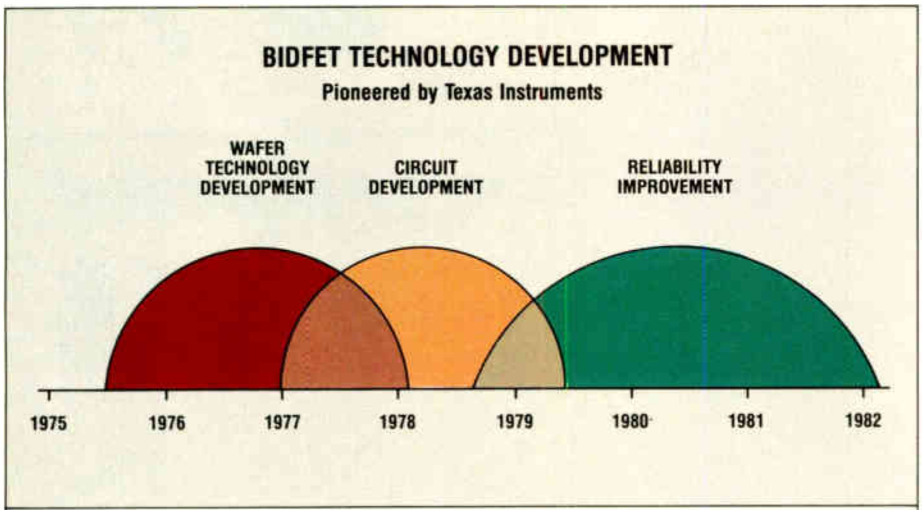
CMOS permits dense packing of the logic, while consuming very little power.

And DMOS transistors in the output stage handle exceptionally high voltages—up to 225 volts! Which makes TI's BIDFET-based drivers far superior to other display drivers, many of which can push the reliable limits of bipolar technology to only 60 volts.

Simple interfacing to VF displays of any size—from small segmented types to large dot matrix formats—can be achieved affordably with TI BIDFET drivers.



Reliable high-voltage operation results from BIDFET technology—a process TI has invested more than seven years in development.

A big, flat success

Outstanding today, TI's flat-panel display drivers will be even better in the future. That's because we soon will be applying BIDFET technology to electroluminescent display drivers. These will be able to operate reliably with DMOS output transistors up to 225 volts. And they will be available in space-saving plastic chip carriers. All ready to meet your needs for large, high-resolution panels that are thin and lightweight.

Find out how advanced TI flat-panel display drivers can increase reliability. Save money. Improve your design. And attract customers.

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Circle 270 on reader service card

The data

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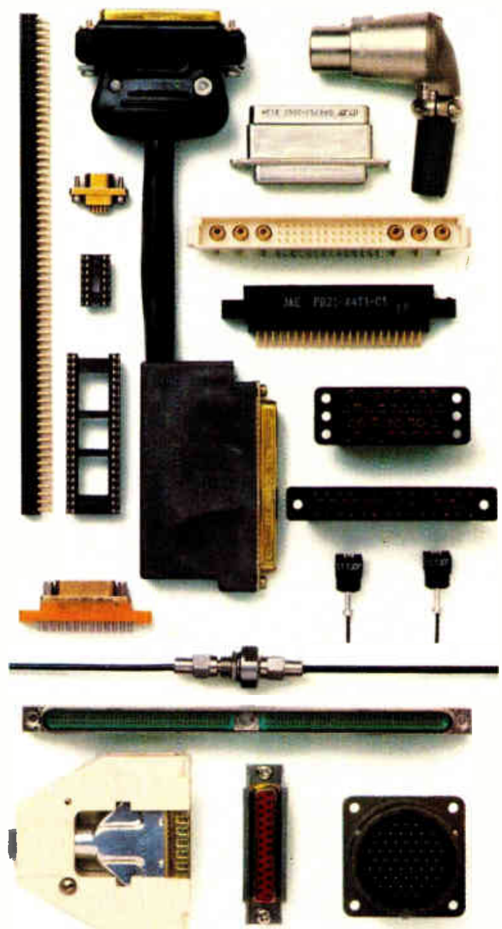
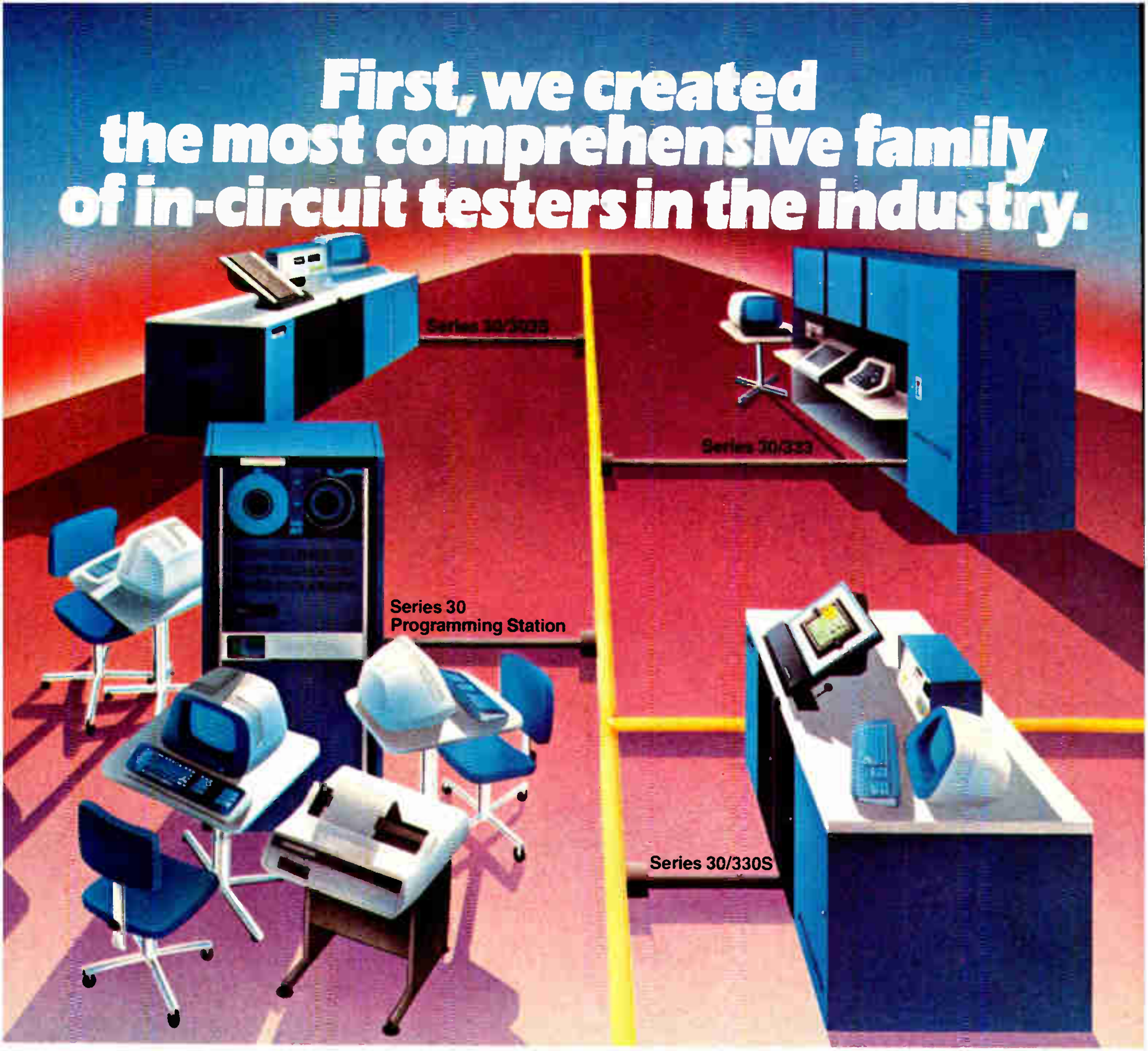
ITT Cannon has already solved many of the connector problems you run up against every day in the development of sophisticated information systems.

Take a look at these:

Our PB18 zero-force edgecard connector not only increases the length of the board, but the life as well.





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Reader Service No. 82

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Reader Service No. 212

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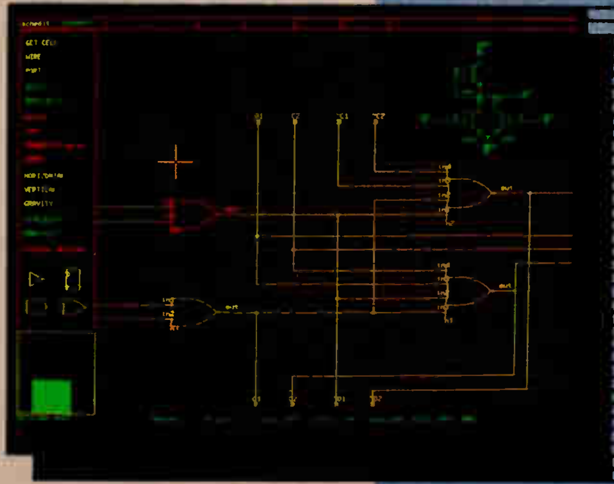

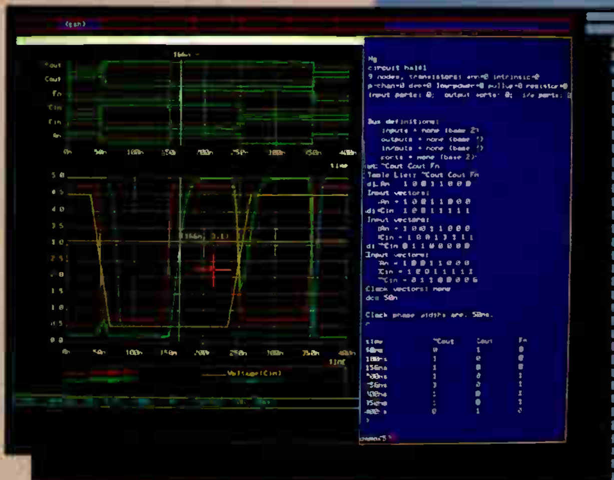

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Color TV set with LCD screen fits in pocket

by Charles Cohen, Tokyo bureau manager

Twisted-nematic liquid-crystal display with color-filtered pixels is driven by arrays of polysilicon thin-film field-effect transistors

Portable color TV sets with liquid-crystal displays may be in consumers' hands right on the heels of the introduction of black and white versions from several manufacturers. Suwa Seikosha Co., Suwa, Japan, has just shown a prototype of such a pocket set with a 2-inch screen that it says could be on the market within a year for as little as $430.

The firm also showed a black and white version built using the same technology that would feature a somewhat lower price and twice the battery life. Managing director Susumu Aizawa says that he doubts it could be sold, though, after people have seen the color model.

Similar twisted-nematic LCD technology is used in the monochrome and color versions. Both displays are driven by arrays of polysilicon thin-film field-effect transistors adjacent to individual picture-element electrodes on the high-temperature glass substrate. The 240-by-240-pixel mosaic occupies most of the 43.2-by-32.4-micrometer display, which has a 2.13-in. diagonal. The pixel electrodes, gate and data lines, and the counterelectrode are made of transparent indium tin oxide.

Filtered resolution. The color unit operates in a transmissive mode with backlighting by diffused light from a small fluorescent lamp, whereas the black and white display is reflective. Individual red, green, or blue filters above each pixel electrode in the color display reduce effective resolution to 138 pixels in each direction. Still, the bright color display appears to have a higher resolution than that, except in the case of characters.

In production sets, the fluorescent backlight uses about half of the slightly more than 1 watt consumed by the set, according to Shinji Morozumi, who managed research and development for the project. This power consumption will enable the color TV to operate for about 4 hours from five alkaline penlite-size cells.

Size should be similar to the prototype, which measures 16 by 8 by 2.8 centimeters and weighs 500 grams, power cells included. Conventional fluorescent-lamp and TV microelectronic technology are adequate and were used in the prototype, but it may be possible to improve the efficiency of the fluorescent lamp.

Reasonably conventional. Both the color and monochrome displays include LCD panels with liquid-crystal cells sandwiched between polarizers. In the color display, the lower substrate carries the thin-film–FET array and pixel electrodes. Above the approximately 6-μm-thick cell cavity filled with liquid-crystal material is the common counterelectrode, color filter, and upper substrate.

Morozumi will not identify the

Color sandwich. Tiny color TV receiver includes liquid-crystal cells sandwiched between polarizers. The lower substrate carries the FET array and pixel electrodes with individual red, green, or blue filters above each. Four IC drivers, each capable of handling 120 gate or data lines, are distributed around the display's periphery. Photo shows actual size of device.

materials used for the organic filters and the protective passivating layer that lies between the filters and the upper electrode. However, he says that firms now making filters for charge-coupled-device color pickups and for color vidicons have the required technology.

In the color display, light from the fluorescent panel passes through the rear polarizing filter and impinges on the lower substrate. In the black and white display, the color filter is obviously not present. Its cell structure is flipped so that the common counterelectrode is to the rear, and a reflective layer is used there, rather than a backlight.

Four integrated-circuit drivers, each capable of handling 120 gate or data lines, are distributed around the periphery of the display. Alternate lines are driven from top and bottom if vertical or left and right if horizontal so as to simplify interconnecting the ICs and the LCD.

The drivers to the left and right drive FET gates to enable one line at a time. The drivers at the top and bottom include sample-and-hold circuits to drive individual FET sources or drains with a pulse whose amplitude is inversely proportional to pixel brightness. The same electrode changes from drain to source as the maximum pulse voltage changes from +4 volts to −4 V on alternate lines to provide the ac drive for the panel.

In action. The unit's pixels are transparent up to a threshold of 2 V at either polarity and saturate at maximum density at 2.7 V. However, transient effects at the pulse width of less than 60 microseconds in Japanese TV signals cause the dynamic voltages to be somewhat different. Display rise time is 30 milliseconds, and fall time is 45 ms, but Morozumi says that values below 50 ms are too fast for the eye to follow.

The thin-film transistors that control the display are fabricated on a polycrystalline silicon layer about 3,000 angstroms thick that has not been annealed to single-crystal silicon. A dual-gate MOS FET configuration is used to cut current in the deselected state. The length of each channel is 15 m, for a total length of 30 m; channel width is 10 m.

When off, the dual channels act as two reverse-biased diodes in series, and halving the voltage greatly decreases the off current—which increases exponentially with voltage. Current when conducting, though, is only halved. The on-off conduction ratio is about 10^6 in the dark and falls to 10^5 only in sunlight.

France

Scan-conversion CRT shows 7-GHz signals

To meet the demands upon real-time high-frequency digital oscilloscopy that will be made by tomorrow's microwave systems and components, engineers at the Laboratoires d'Electronique et de Physique Appliquée have designed a highly sensitive scan-conversion cathode-ray tube that will operate at a bandwidth reaching from dc to 7 gigahertz.

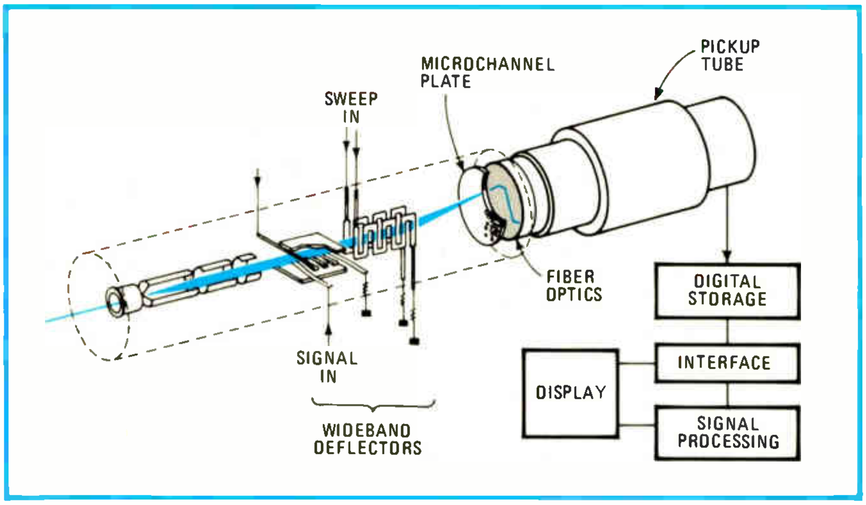
"Designed" is indeed the appropriate word, because all work at the Limeil-Brévannes laboratory was by simulation—not a single prototype was produced. Production of the LEP design will be the job of its fellow Philips subsidiary, RTC-La Radiotechnique Compelec of Paris.

The new design marks the arrival of the third generation of scan-conversion CRTs, claims Charles Loty, the LEP engineer who coordinated the project. The most visible change from the second generation is the replacement of the visual output, in the form of a screen, by an interface giving access to a digital signal.

"The future of oscilloscopy is digital, and the reason is that it is far more flexible," explains Loty. "You can process the output signal any way you want to and use a standard television monitor as a display."

Simplified advance. Despite the change in output, not all is new. The third-generation CRT makes use of the advance that separated the second generation from the first: a microchannel wafer that multiplies the tube's electron beam to dramatically lower the threshold voltage while increasing sensitivity. Because the new tube produces no visible image of its own, the active surface of the microchannel wafer is reduced tenfold, significantly simplifying the tube's electronics and thus making possible its exceptional bandwidth.

Basically, the tube consists of an electron gun whose writing on the microchannel wafer is controlled horizontally and vertically by a deflection helix and two meander lines, respectively. Any trace written on the wafer's 10-by-12-millimeter active surface benefits from a 10^3 gain because, as oscilloscopy requires no



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	IRFD 113	60	0.8	0.8	6.4	1.0
	★ IRFD 120	100	0.3	1.3	10.4	1.0
	★ IRFD 123	60	0.4	1.1	8.8	1.0
	★ IRFD 210	200	2.4	0.6	4.8	1.0
	★ IRFD 213	150	1.5	0.45	3.6	1.0
P-CHANNEL	★ IRFD 9110	-100	1.2	-0.7	-5.6	1.0
	★ IRFD 9113	-60	1.6	-0.6	-4.8	1.0
	IRFD 9120	-100	0.6	-1.0	-8.0	1.0
	IRFD 9123	-60	0.8	-0.8	-6.4	1.0
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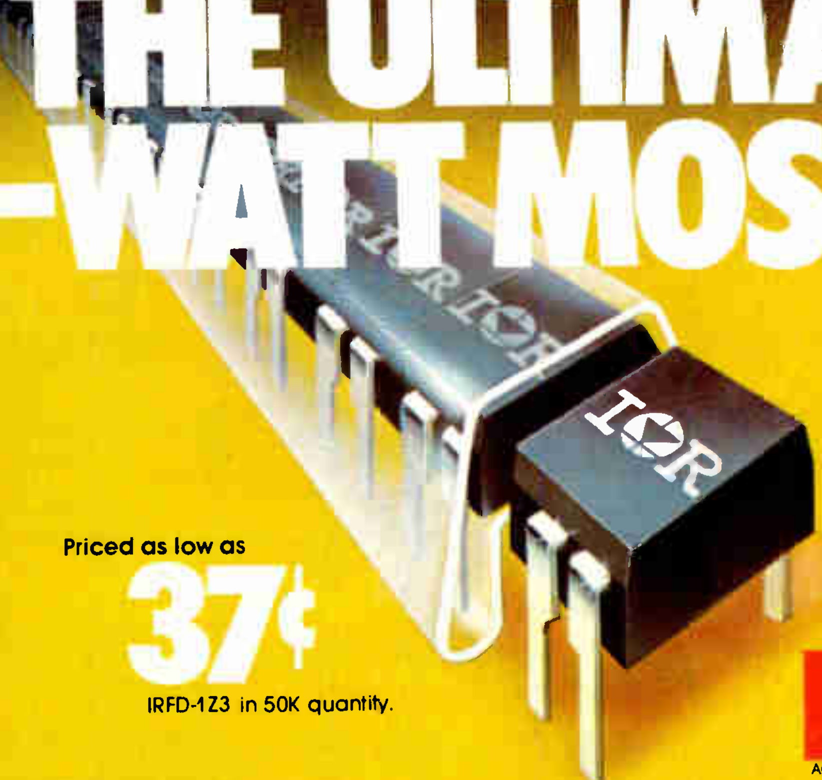

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shading of image, the wafer can be used at its saturation level. The trace is then transferred by what is called an optical-fiber window to a video pickup tube that serves as an analog buffer memory before conversion into digital form and storage.

The heart of the tube is composed of the wideband deflectors—the helix and the meanders. The helix has little phase dispersion and is easily matchable to a constant 50-ohm impedance (careful matching being indispensable for a bandwidth as broad as the tube's). Almost completely enclosing the helix is a shielding piece so accurately machined that Loty likens it to the precision of fine watch components.

This shielding piece includes the vacuum-tight coaxial connectors that open to the outside. These connectors, along with an ultrahigh-frequency bypass, ensure less than a 1% reflection in the full bandwidth. LEP says dc sensitivity is 5 volts for full-scale deflection.

Meanderings. Horizontal deflection is governed by the two symmetrical meander lines of 50-Ω impedance each. They can be used with either linear ramps or sinusoidal sweeps or with a combination of the two. Phase velocity is somewhat dependent on frequency, and because the tube can accept some mismatch at low frequencies while matching the velocity of the electrons at the high frequencies, response is remarkably flat up to 3 GHz. Sensitivity for full deflection is given as 17 V.

Future improvements in the tube will probably come on the pickup side of the microchannel wafer. An obvious step would be replacing the vidicon tube by a solid-state component like a charge-coupled-device array. –Robert T. Gallagher

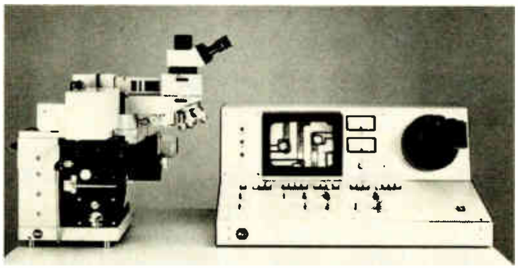
West Germany

Acoustic microscope peers inside IC layers

Microscopes that let the viewer look not only at an object but also inside it are the subject of intensive investigations in West Germany, Japan, and elsewhere. Using ultrasound waves that penetrate the object to produce an image of its internal structure on a cathode-ray tube, such microscopes are already at an advanced stage of development at two firms at least: Ernst Leitz GmbH in Wetzlar, West Germany, and Olympus Optical Co. in Tokyo.

The development at these two firms is being carried out under license from California's Stanford University, where Calvin F. Quate and his associates worked out the principles of scanning acoustic microscopy during the 1970s. Olympus has delivered a model to Tohoku University in Japan, but more work is needed on applications, the company says.

For its part, Leitz, the world's largest and oldest microscope producer, has readied a prototype of its Elsam (Ernst Leitz scanning acoustic microscope), which the firm first demonstrated at the Semicon/West show last week in San Mateo, Calif. "We will have commercial units ready for the market during the fourth quarter of next year," says Walter J. Patzelt, product manager for microscopes at 134-year-old Leitz, known to outsiders mainly as the originator of Leica cameras.


Depth sounder. This prototype of the Leitz scanning acoustic microscope consists of the working unit on the left and the evaluation unit on the right. The screen shows part of an IC, complete with subsurface flaws.

Handy tester. For semiconductor specialists, acoustic microscopy should come in handy, particularly in investigating and inspecting integrated circuits. Anita Röhm, applications expert at the Wetzlar firm, sees the technique as eminently suited for penetrating opaque layers to make visible, for example, microcracks, delaminations, and faults due to poor contacts between metallic layers and other layers beneath them, "all of which goes undetected with optical microscopes," she says. A big advantage is that the semiconductor material need not be specially prepared for examination. Polishing, for example, is not required.

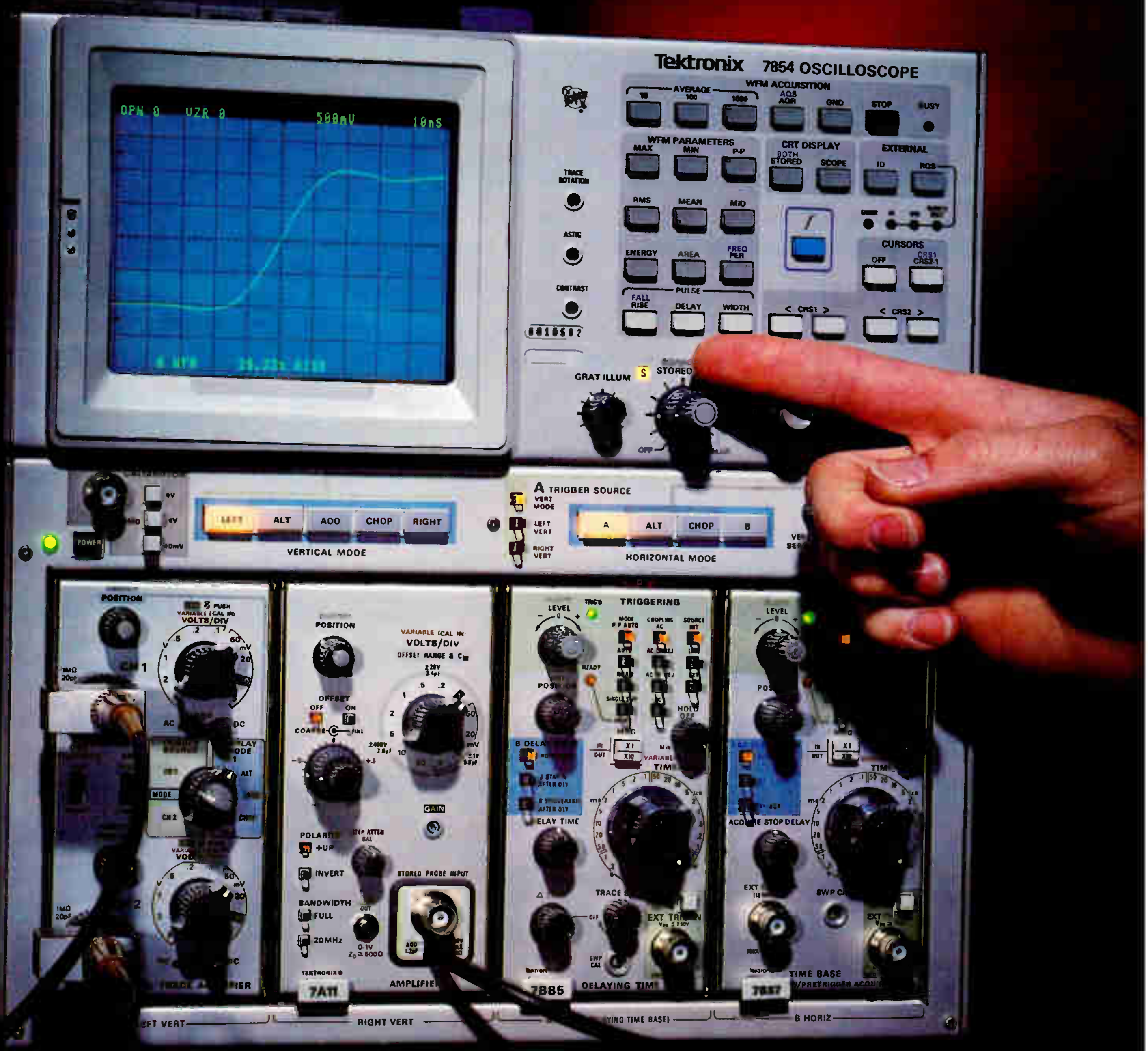
The gain in information on an object's internal structure that the new instruments provide should benefit other disciplines as well, Röhm points out. Acoustic microscopy can be used in metals research, for all sorts of quality control, and of course in microbiological work. Because ultrasound is nondestructive, investigations can be carried out even on living organisms. Adds Röhm, "The new technique, however, is not intended to replace ubiquitous-light microscopic methods, only to supplement them."

Central to the Elsam microscope is a planoconcave sapphire lens, an acoustic lens whose concave side has a spherical cavity that faces the object to be examined. A piezoelectric layer on the lens's plane side changes pulsed microwaves from an external source into mechanical vibrations.

These vibrations set up ultrasound waves in the sapphire, which the cavity focuses through a coupling medium—a water film—onto and into the object. The piezoelectric layer converts the ultrasonic waves reflected from the object back into microwave signals. These echoes, on the order of nanowatts, are amplified and fed to the CRT.

To obtain a complete picture of the area under study, the object is moved in both the X and Y directions in incremental steps in the focal plane of the lens. The echoes from the object being scanned in this fashion are shown on the screen in synchronism with the movement of the object.

Sapphire preferred. The choice of sapphire as the lens material and water as a coupling medium is crucial, Patzelt says. On their way through these different substances, ultrasonic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waves encounter an abrupt change—about sevenfold—in velocity at the sapphire-water interface. This change results in a strong refraction of the ultrasound, which translates into a small focal length (about 40 micrometers), a small free working distance (the distance between the lens and the surface of the object under study), and, finally, in low losses.

Also crucial in acoustic microscopy, Patzelt notes, is the frequency of the microwaves, for it determines both the depth of penetration and the resolution. As a rule, the lower the frequency, the greater the penetration of ultrasound into the object; but the higher the frequency, the better the resolution.

As a good compromise for many materials, the Leitz engineers are using an ultrasound frequency around 2 gigahertz. At that value, a resolution of about 0.6 μm can be achieved, a little less than that obtainable with light microscopes. Significantly improved resolution, even better than anything possible with light microscopes, can be obtained, though, if liquefied argon or helium is used as a coupling medium instead of water.

Besides being dependant on frequency, the penetration varies according the type of material being studied. At 2 GHz, ultrasound penetrates, say, silicon to a depth of several micrometers. **–John Gosch**

Hungary

Revitalization plan pushes IC effort

Although a worldwide electronics exporter with several long-established companies in telecommunications, Hungary is now making a concerted effort to regain momentum as a technological innovator.

The country's electronics industries produce over 100 million semiconductors annually, including 30 million transistors and 15 million integrated circuits. However, they have become heavily dependent on imports of wafers and chips in order to remain competitive.

To redress the situation, the government decided in December 1981 to give top priority to a crash program for the electronics industries, earmarking about $175 million for it. Most of this money is being spent on research and development and the purchase of machinery and know-how for microelectronics.

IC monopoly. The first step was merging the Research Institute for the Telecommunications Industry in Budapest with the Gyongyos factory, a semiconductor producer located 80 kilometers east of the city in Tungsram. Employing 4,300 men and women at present and with an annual output of about $40 million, the new Microelectronics Enterprise is expected to have a monopoly on the manufacture of very large-scale ICs, master masks, semicustom circuits, silicon wafer processing, and design operations requiring large computers for simulation. These facilities are not worth duplicating in a small country like Hungary.

At first, the enterprise will provide services to appliance manufacturers, some of whom are expected to develop their own facilities at least to finish the ICs. The program affects two dozen companies, which altogether employ 160,000 persons, including 10,000 in R&D. The next investments are to introduce or to improve the manufacture of hybrid circuits at Remix and ceramic parts at Korporc, both of which are in Budapest.

The government commissioner for the electronics program, Mihaly Sandory, says that the fundamental aim of the program is not to make Hungary self-sufficient in electronic parts and components, but to achieve an approximate balance between exports and imports. The program is aiming at the production of custom-designed and semicustom circuits with small runs of a few hundred to a few thousand pieces and medium sophistication, while mass-produced catalog items are to be imported.

Sandory feels that his country has a competitive edge in ICs with a relatively high software content, owing to the high quality and relatively low cost of programming there. Hungarian software exports to Western Europe—including custom work—amounted to about $5 million last year before the program really got started.

Plans call for a design capacity of 300 new ICs annually, mainly for instruments. Researchers succeeded in putting a powerful design system adjusted to the wafer technology process into operation a full year ahead of schedule.

Master-mask production is well in hand, but has to be expanded to provide for the planned annual production of 25 million ICs (120,000 wafers). Packaging and testing function satisfactorily at Gyongyos under a license obtained from Fairchild Camera & Instrument Corp. in the 1970s.

Hungary also intended to purchase silicon-wafer technology from Fairchild, but this plan had to be abandoned when the Mountain View, Calif., firm withdrew. Soviet and East German technology is being introduced instead, with MOS technology now being adapted and with bipolar technology the next step.

The industry intends to export 30% of Hungarian IC output by 1985, mainly to western markets, and to become a main supplier of custom-designed and semicustom circuits within Comecon, the Communist Bloc eqivalent of the European Communities. Comecon has just set up country tasks through 1990 for the implementation of the general agreement on standardized electronic components, special-purpose machinery for the production of semiconductors, and semiconductor-grade materials.

Comecon governments are free to decide in which common projects they will participate, but Hungary is too small to develop everything on its own. Therefore, its program fits into the Comecon game plan, cooperation being especially close with Soviet, East German, and Czechoslovak industry. Although most of the machinery and know-how for the revitalization effort is being imported, the government's program also includes the development of component manufacturing equipment and know-how. **–Karoly Ravasz, McGraw-Hill World News Service**

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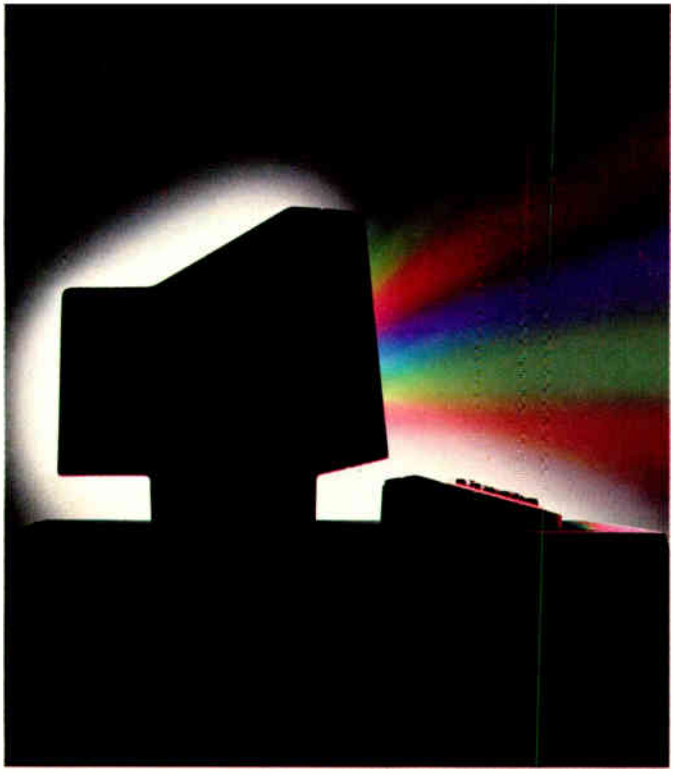

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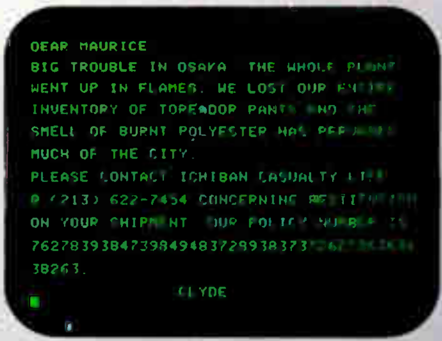

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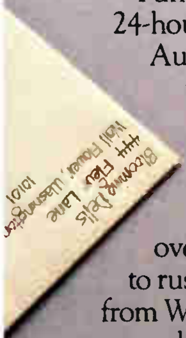

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UK pursues fifth-generation computer

Historic joint effort of industry and government calls for four-pronged $550 million drive

by Kevin Smith, London bureau manager

Cooperative research and development between industry and government, very much in the Japanese mode, promises to be the electronics trend of the 1980s. Now it is Britain's turn: after months of stalling, the UK government has given the green light to a program to develop a fifth-generation computer. The cost, spread over five years, will be as much as $550 million, with $316 million coming from the government.

That expenditure will roughly double Britain's research effort in information technology. The program will concern itself with four key sectors: software engineering, very large-scale integration, man-machine interfaces, and intelligent knowledge-based systems (see "British will advance along four fronts," p. 102).

Unlike previous efforts, British industry should get more for its money because member companies will have to pool results. Remarks industry minister Patrick Jenkin, "This is the first time in our history that we shall be embarking on a collaborative research project on anything like this scale. Industry, academic researchers, and government will be coming together to achieve major advances which none could achieve on their own."

As Britain's Conservative government gets ready for the June election, it will doubtless claim credit for the program. But Japan's Ministry of International Trade and Industry should share some of the plaudits. At its invitation, a British delegation last year attended the Tokyo conference at which Japan's fifth-generation program was unveiled. The delegation's members returned with an alarming message.

Britain, already wrestling with a serious and worsening trade imbalance in data processing, would not even get to the starting line in the race to develop fifth-generation computers, they said. The government immediately commissioned a working party under John Alvey, technical director of British Telecom, to advise on the scope of a similar collaborative research program.

Moving with impressive speed, the Alvey committee reported back to the government just a few months later, in October. In formulating its program, it built on the experience of other high-technology collaborative ventures.

For one, its broad-theme research framework is modeled on its Japanese counterpart. The legal structure for handling what are called intellectual property rights to research results and to licensing comes from Esprit, the European Strategic Program for Research in Information Technologies. And the section on VLSI almost totally absorbs the very high-performance IC program (VHPIC) worked out in detail by Britain's Ministry of Defence. Also, both VHPIC and other parts of the Alvey program rely on the use of demonstration projects to ensure that basic research leads to an end product, a feature of the U. S. Very High Speed Integrated Circuits (VHSIC) project.

Committee leader. John Alvey, technical director of British Telecom, headed group that proposed a collaborative research program.

Little choice. In some Conservative eyes, Alvey's proposal has a nasty interventionist hue. They believe that its adoption would be a retreat from the hands-off philosophy with which the Conservative government came to power.

In the end, Prime Minister Margaret Thatcher's choice was really no choice at all. As Benjamin Franklin put it in describing the American colonies' need for united action to shed British rule, "We must all hang together, or assuredly we shall hang separately." So Mrs. Thatcher, following that revolutionary advice, agreed to the industry-government research program, modifying only two of its proposals.

Alvey had recommended that work requiring very wide dissemination of the results should be funded at 90% by government, with other research work getting 50% of its cash that way. But the government decided that a 90% contribution would not secure a sufficient industrial commitment and could lead to the program's becoming divorced from industry's needs. So all industrial work will be 50% government-funded, and work in universities will, as usual, get 100% aid.

Another Alvey proposal calls for a

strong 15-person directorate to drive the program along, but the government has slimmed the group down to five. Brian Oakley, the secretary of the Science and Engineering Research Council, will be its head; four industrial specialists, one for each of the key areas identified by Alvey, will serve as well. They will report to a part-time board headed by Sir Robert Telford, chairman of GEC-Marconi Electronics Ltd.

Industry does well. The bottom line is that industry gets most of what it asked for, because both the scale of the program and the level of government funding are of the right order. There remain two questions: can the program be made to work? If so, can it lead to a successful industrial follow-up?

There are some snags. Oakley, project director for the Alvey program, believes that it will be far harder to get smaller companies to collaborate without the carrot of 90% government funding that was sought. Another problem, says ICL's technical director, is the way the program will be managed. It will be important to form teams of companies and research groups that can work together with prime contractors to lead each, he points out.

And after Alvey? As industry minister Jenkin puts it, "The idea is to collaborate in basic research and compete in development." But, says the Alvey report, the government still must support product development. The report envisions "the effective use of public procurement and an expanded program to promote the application of information technology to follow up on its [the government's] successful Information Technology Year 1982." □

British will advance along four fronts

Britain's fifth-generation–computer program has four research themes: software engineering, intelligent knowledge-based systems, very large-scale integrated-circuit technology, and man-machine interfaces. Software engineering focuses on the development of what are called information-systems factories: advanced integrated programming-support environments capable of delivering relible and efficient software that works to specification.

Initially, the program will standardize on the Unix operating system, though with enhanced data-base and communications facilities. Further along, there would be a role for Ada and for very high-level languages like Prolog.

Intelligent knowledge-based systems research centered on Britain's universities will be coordinated with industry through the use of demonstration projects. Hardware research will focus on functional-logical and data-flow machines as well as on smart data bases; software research will center on functional-logical and rule-based languages. Researchers in all sectors will be linked into a single community by means of local networks connected through a packet-switched network.

Britain needs access to an internationally competitive VLSI technology, says John Alvey, technical director of British Telecom and head of the committee that designed the nation's fifth-generation cooperative research and development program. He adds that this should include bipolar, digital MOS, and analog MOS processes with 1-micrometer features and with an ongoing research program toward 0.5 μm. Hoping to improve data throughput by two orders of magnitude, the Ministry of Defence had already mapped out its own VHPIC (very high-performance integrated circuit) program [*Electronics*, July 14, 1982, p. 98]. The extra speed would come from smaller, hence faster, circuits and from new chip architectures. This program, minus the system demonstrators, has now been absorbed into the Alvey scheme.

Work on man-machine interfaces will focus on such input/output devices as multifunction flat-panel displays and speech- and image-processing systems. Highly parallel processing architectures for image processing will be developed as part of the VHPIC program. One candidate is a VLSI version of ICL Ltd.'s distributed array processor; another is a systolic array. —**Kevin Smith**

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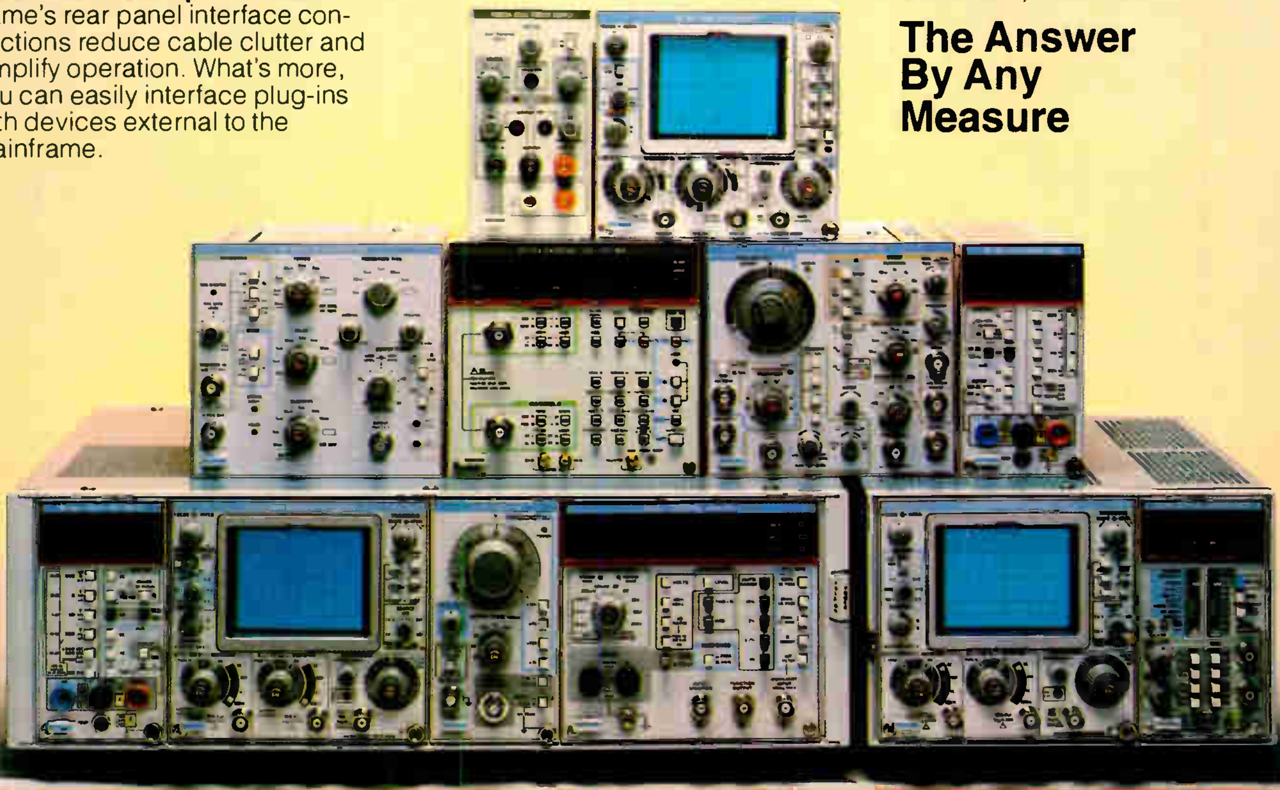

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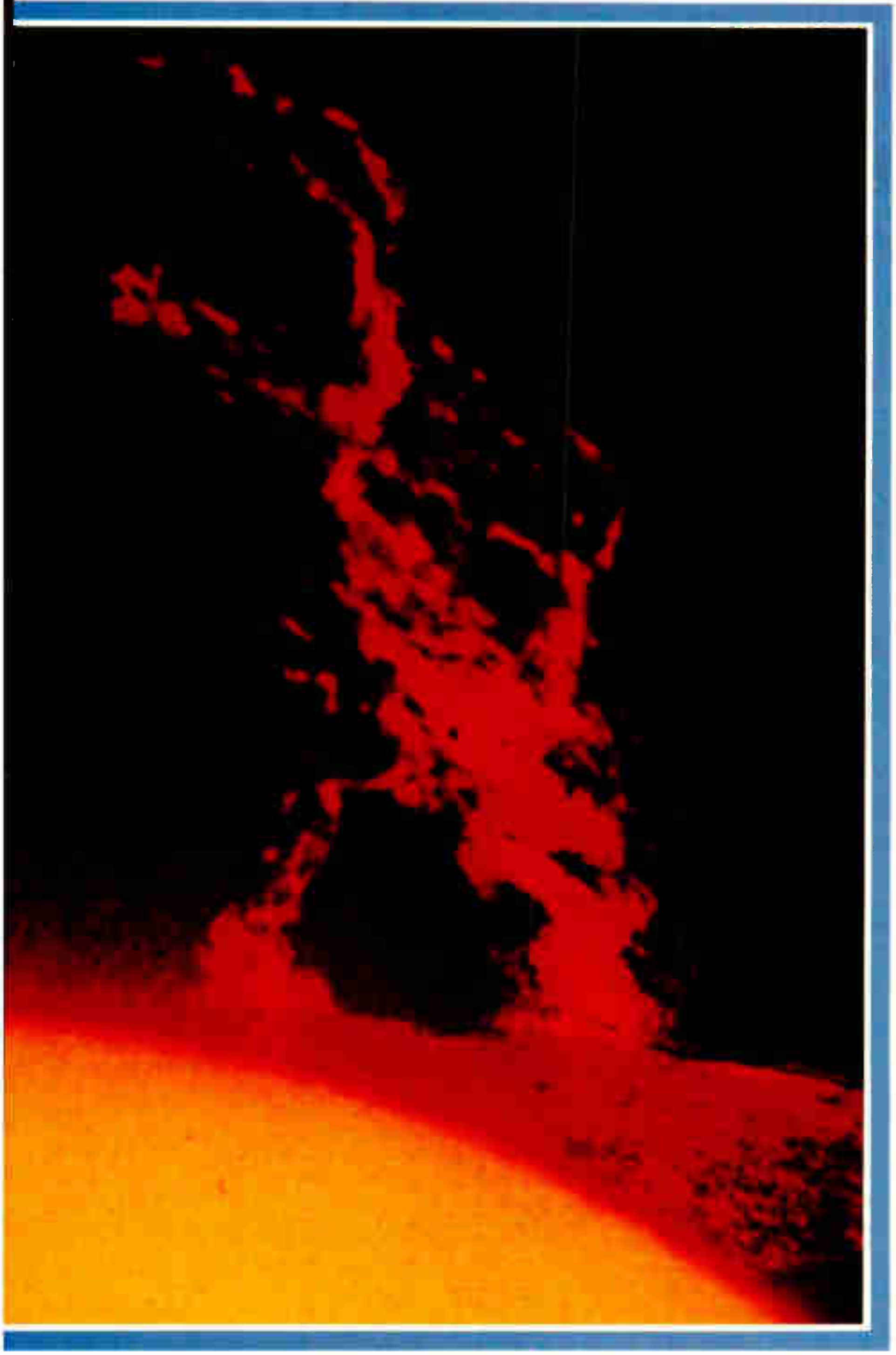

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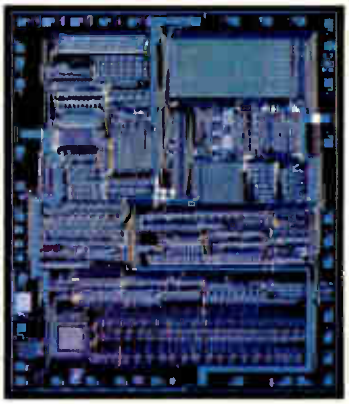

Factory-made and electronically stored receiver adjustments are continuously compared with measured values during the set's whole lifetime. For example, settings are compared with data in the video processor to obtain unvarying picture quality, or with data in the deflection processor to get accurate sawtooth pulses. The ongoing comparison of data with the settings fed by computer at the factory to the CCU's memory is a special feature of DIGIVISION. In contrast to conventional color tv sets, this feature compensates for aging processes. Thus, picture quality is always the same as that of a brand-new receiver.

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Microsystems

When will the shakeout start?

Many anticipate failures among microsystem makers even as the National Computer Conference shows none in sight

by Robert J. Kozma, Business Trends Editor, and Larry Waller, Los Angeles bureau

Since the beginning, in the late 1970s, when Apple Computer Inc. built its first product, the microsystem industry has undergone explosive growth and change. And as a host of products from myriad manufacturers continues to flood the marketplace, there is no apparent slowing in sight.

Nowhere was this phenomenon more striking than at the annual National Computer Conference's four-day run in Anaheim, Calif., earlier this month. From desktop work stations to portables, from briefcase- to pocket-sized processors, microsystems priced at less than $10,000 flowed from vendors ranging from start-up firms to established names in mainframes and minicomputers.

The incentive is clear: all want a piece of the action in the fastest-growing equipment market in the world. According to Egil Juliussen of Future Computing Inc., a Richardson, Texas, market-research firm, the worldwide market for personal computers selling for under $10,000 will reach $10 billion by the end of 1983, about 75% in the U. S. By 1987, moreover, it will grow to $35 billion, with 60% in the U. S. In fact, personal computers will surpass minicomputers and mainframes in growth rates and absolute dollar value.

Fallout. Veteran marketing executives at the show agree that the plethora of new small computers assaulting the market has another side effect: it tends to confuse potential buyers, especially the unsophisticated first-time user. One result is that the buyer often solves the dilemma by turning to what appears to be a safe choice in a microsystem, International Business Machines Corp.

Juliussen notes that IBM is producing at a rate of 25,000 units per month and will probably ship 300,000 this year. It is quickly catching up to Apple, which makes Apple IIs at a 40,000-per-month clip and will ship nearly 500,000 this year.

Tripartite. Ben Rosen, a research analyst turned venture capitalist, notes that the personal-computer industry has evolved into three segments: the IBM Personal Computer and IBM-compatible products, the market built around Apple products, and everyone else's offerings. The first two, especially IBM, will be the major suppliers, says Rosen, whose firm, Sevin Rosen Associates, provided funding for Compaq Computer Corp. and Lotus Development Corp.

"A clear standard is emerging in the 16-bit microcomputer," he notes. That standard revolves around Intel Corp.'s 8086/8088 microprocessor, Microsoft Corp.'s MS-DOS operating software, and the architecture for the IBM unit, which uses the first two. "If they [manufacturers] conform to that standard, they will be in the mainstream and get a chance to grab the brass ring. If they fight that standard and they are not Apple, they will fail," he predicts.

The confidence of all the other firms may be misplaced, in the view of informed parties. One is William H. Davidow, senior vice president and director of corporate marketing for Santa Clara, Calif.–based Intel. He says, "You know, we sell a lot of products to them, and many are buying [devices] to build 200,000 computers. So many tell us that, I wonder if they're all going after the same 200,000 customers."

Industry observers believe that the microsystem market, however explosively dynamic, must like others before it undergo a shakeout that will

IBM System/36 leads introductions at NCC

The bottom line for systems introduced in Anaheim, Calif., at the National Computer Conference is cost-effectiveness: more memory and intelligence at lower prices, plus added hardware and software to allow managers using desktop, personal, or work-station computers to increase their productivity by accessing mainframe data. The result was that most of the large machines introduced can connect to microsystems, and upgrades to allow such networking were announced for some older machines. Among the manufacturers electing to access mainframe data bases were International Business Machines Corp., Honeywell Inc.'s Information Systems division, Harris Corp., and Mohawk Data Sciences Corp.

eliminate most of the more than 200 competitors, with more joining daily. But opinion is widely divided not only about its timing but also about whether it will indeed happen. Portia Isaacson of Future Computing believes that "there will be many companies in the business that won't make it. But there will be more companies in the business three or four years from now than today."

Donald McDougall, divisional director for technical products at Data General Corp., believes "a shakeout won't happen this year—that's a factor of the venture capitalists putting money" into start-ups. Investing by this group has itself created "an artificial floor" supporting some firms that might otherwise fail, he notes.

Grand bloodbath. In line with this thinking, Manny Fernandez, president of Gavilan Computer Corp., a start-up firm that makes a briefcase-sized microsystem, says there will be a "bloodbath" in the under-$1,500 end of the spectrum. He also sees carnage in the portable market, among the makers of what he calls suitcase-sized computers.

Industry executives questioned during NCC note there is price pressure in the microsystem marketplace, but they emphasize this pressure appears to be a normal attempt to remain competitive. Reductions in price also reflect the normal path of the learning curves in manufacturing equipment and evolutionary drops in prices for components.

These executives note, however, that price pressures on the small computers—particularly low-end personal computers, portables, and under-$100 units—are rippling down to producers of peripherals. Companies like Cipher Data, Wangtek, Mannesmann Tally, and Pertec acknowledge pressure from customers to prices at the bottom end of their product lines: tape drives for back-up printers and terminals. Low-end cathode-ray-tube terminals are really being hit with significant price reductions. Printers for home computers and low-end floppy-disk drives are also feeling pressure.

No shakeout yet. George Morrow, president of Morrow Designs in San Leandro, Calif., which puts out a low-priced 8-bit microsystem, says that there is always price pressure in the computer industry, but "there will be no shakeouts as long as the technology is churning." Morrow says people are still discovering new uses for computers and that "there won't be any fallout until it settles down as to what a computer is." Individual companies may fail, he adds, but not, or not yet, because of a shakeout.

William J. Godbout of CompuPro, at Oakland Airport, Calif., another company that makes microsystems, observes, "There are new computers popping out from under every mushroom. Where's the shakeout?" □

Additional reporting was provided by Clifford Barney, Tom Manuel, and Samuel Weber

IBM, which does not ordinarily introduce computers at the show, unveiled its System/36 (left), the long-anticipated replacement for its System/34. The company says that the 36 offers up to 70% more throughput than the 34, depending on configuration. One such setup uses the IBM Personal Computer as a work station with a hardware adaptor and an emulator program.

Honeywell and Harris are offering similar services. Waltham, Mass.-based Honeywell's new MicroSystem 6/10 work station can act as a simple terminal emulator to access mainframe files but also has an optional Intel Corp. 8086 16-bit microprocessor capability to provide mainframe data-base access, such as file manipulation. Harris, of Melbourne, Fla., introduced the System 9000, which is geared for office automation and will be able to download and use data from IBM mainframes. Both the International Standards Organization X.25 and IBM's binary synchronous communications protocol will be accommodated.

Typical of the upgrading of existing computer products to make the personal-computer connection is the Personal Computing 21, from Mohawk Data Sciences in Parsippany, N. J. The machine permits access to the Series 21 distributed data-processing computer system. Files generated by the 21 can be shared with personal computer users through a CP/M operating system that has been added to the Series 21's operating system. —**Harvey J. Hindin**

Regions

Midwest zeroes in on high technology

First edition of Ohmcon show, in Detroit, features discussion on revamping area's aging and weakened industrial economy

by Wesley R. Iversen, Chicago bureau

For the recession-racked heavy industrial states across America's Midwest, the search for a share of the high-technology pie has a particularly insistent quality. Those states, such as Ohio and Michigan, are not deficient in research, technology, entrepreneurs, or capital, contends George E. Wilson, a former Ohio development director. What they lack is a coherent strategy to put those ingredients to work, Wilson says.

Some focus will be offered through the lens of a new annual electronic technology show scheduled for the region. Called Ohmcon, for Ohio-Michigan conference, the first is slated to be held June 14–16 in Detroit. There, Midwest electronics engineers will hear plenty of discussion on how best to put high technology to work as a means of reviving the region's sagging smokestack economies. Wilson is one of four panel speakers at the Detroit show's lead-off session, "High Technology, High Growth Industries—Cultivating Them in the Midwest."

Ohmcon's professional program is tailored to regional interests, including sessions on automotive microprocessors, sensors, and actuators, as well as photovoltaics, flat-panel displays, and millimeter-wave technology. The show's organizers hope to attract about 10,000 attendees, all from a 450-mile radius.

But perhaps the prime topic of conversation at Ohmcon will be the economy and the show's session on cultivating high technology. The organizer of the panel, Lionel Robbins, calls attention to the massive unemployment problem faced by the Great Lakes states. Despite early signs of a national economic recovery, some forecasts predict joblessness in Michigan, Illinois, and Ohio will remain in double digits through 1985. "In terms of magnitude," Robbins says, "we're talking about the need to produce not thousands of jobs but hundreds of thousands of jobs in the Midwest."

Understandably, Robbins sees photovoltaics as one possible means of salvation. He is vice president of corporate affairs at Energy Conversion Devices Inc., a Troy, Mich., firm that holds basic patents, dating from the late 1970s, on amorphous-silicon solar cells. "We see market projections ranging from $10 billion to $100 billion for photovoltaics by the year 2000," says Robbins. The industry could generate large numbers of jobs in production, field installation, and maintenance, he says.

The case for photovoltaics will be presented on the panel by Stanford R. Ovshinsky, Energy Conversion Devices' president and chief executive officer. Ovshinsky, for one, believes a fundamental Midwest problem is a lack of effective financing methods for local high-tech firms. But other panel participants point out recent encouraging trends.

Capital freed. One example comes from Richard H. Cummings, vice chairman of the National Bank of Detroit. Michigan-based employee pension funds, he says, are being quick to take advantage of an

Chicago moves to capture a slice of the pie

Within the last couple of years, the Midwest, like other parts of the country, has seen a proliferation of programs sponsored by cities, states, universities, and business, all aimed at attracting and cultivating high-technology industry. One of the latest to near implementation is in Chicago.

The city's newly elected Mayor Harold Washington is expected to approve $5 million in funding, split between the city and the State of Illinois, for use in establishing a for-profit corporation to invest in local technology ideas, says Louis H. Masotti, a professor at the Northwestern University Center for Urban Affairs. The $5 million will be pooled with at least $25 million raised privately for use by the Science and Technology Investment Corp., explains Masotti, the city's high-technology development coordinator.

Now, Masotti says, five major local universities have agreed to cooperate under a plan that calls for the new unit to invest in promising ideas at the pre-prototype level. Support will be provided to bring university inventions to the prototype level, at which point they will be showcased to attract traditional venture-capital investments. Thanks to the presence of city money, any start-up companies that result will be required to locate in Chicago, providing a "capture clause" that Masotti believes is unique among technology-support programs. Other parts of the Chicago proposal call for a privately and publicly funded foundation that would invest in basic university research, as well as for a facilities trust that would oversee the development of local high-technology research parks and incubator buildings. **–W. R. I.**

amendment, passed last summer by the state legislature, that allows them to invest up to 2% of their holdings in venture-capital deals, thus creating a potential pool of $400 million to aid Michigan start-up firms. Cummings notes, too, that Michigan banks have lately begun setting up separate venture-capital investment subsidiaries.

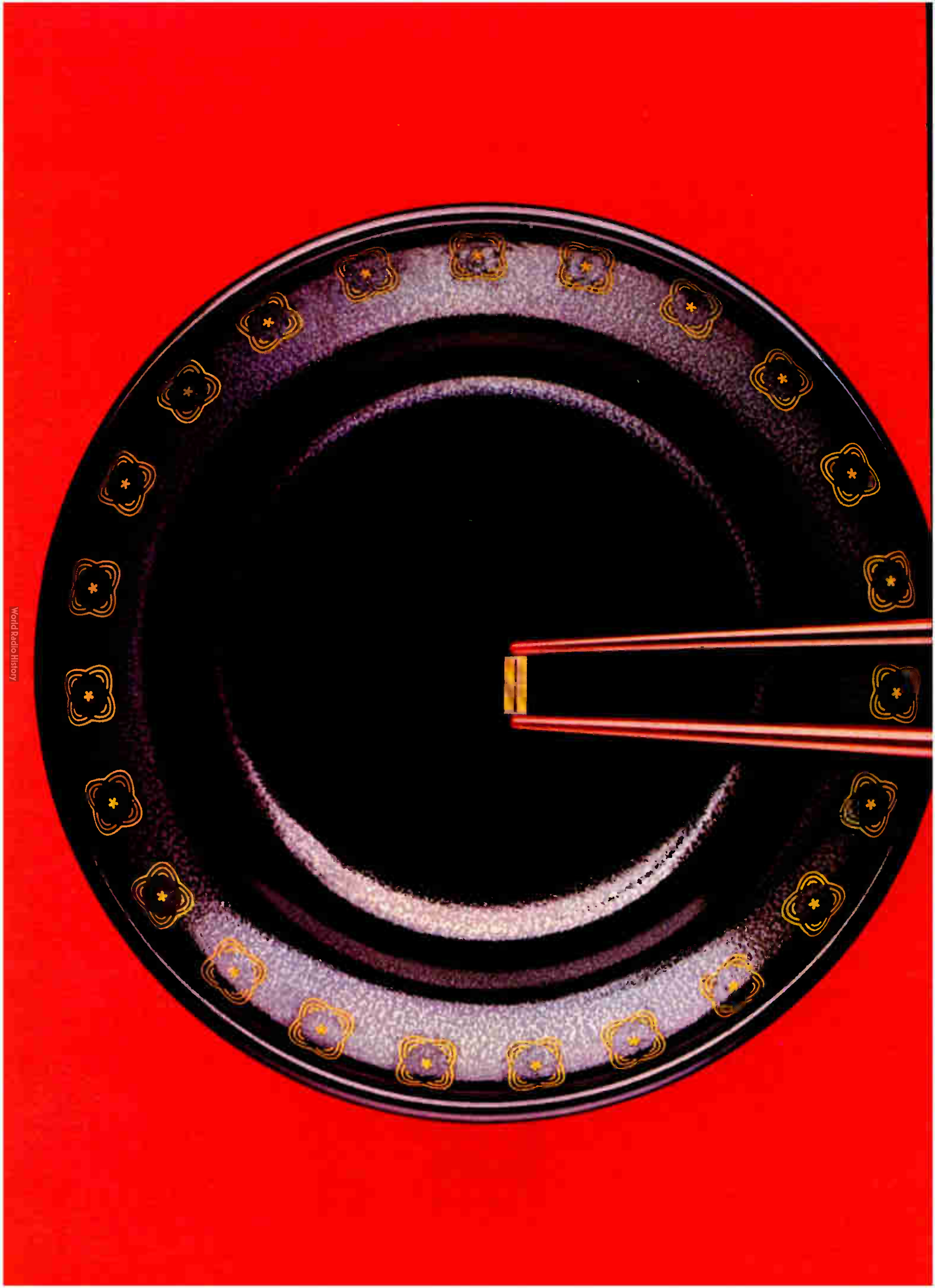
Also encouraged is Edward R. Fisher, associate dean for graduate research at the Wayne State University College of Engineering, in Detroit. "The kinds of efforts that are going on across the state right now are extremely exciting," he says. "Universities and business are talking to each other in ways that they have never talked before."

Although retraining programs for unemployed blue-collar workers are needed, Fisher points out that engineers in the Midwest's basic industries are also in need of upgrading. "Many engineers," he says, "are just as outmoded as the blue-collar workers." Among other things, Fisher will describe at Ohmcon a recent contract signed between Wayne State and Ford Motor Co. to provide "large-scale manpower upgrading for Ford automotive EEs."

Back to class. The Ford program will emphasize upgrading computer literacy. Ford engineers will be removed from their regular jobs and sent to an intensive, four-month, 40-hour-per-week classroom and laboratory program that will lead to a certificate in software design.

Scheduled to begin in June, initial classes will be aimed at Ford's engine-control engineers, Fisher says. Working from a curriculum developed jointly by the university and the company, Wayne State and Ford will share the faculty teaching load. Fisher expects that every year Ford will train at least two classes of 16 to 20 engineers each. Programs for other Ford engineers are also being discussed.

Under another part of the Ford contract, Wayne State will start offering this fall an interdisciplinary master's program that will deal with advanced concepts in automotive electronics and control systems. About 40 Ford employees are expected to enroll for classes to be given at company locations. □



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Consumer electronics

Video designers move toward ICs

The trend is emphasized as technical consumer-electronics conference also turns to digital TV, personal computers, and batteries

by Howard Bierman, Managing Editor, Technical, and Erik L. Keller, Industrial & Consumer Editor

When the International Conference on Consumer Electronics convenes in Des Plaines, Ill., it will spend most of its time bringing small chips into the big picture. Integrated circuits replacing the equivalent of jammed printed-circuit boards for televisions and other video products will take up a major portion of the conference. This year's gathering, to be held June 8–10 after the Summer Consumer Electronics Show, will focus on developments, mostly Japanese, ranging from the emerging market of digital TV to the trusty D battery.

Seeking to smooth the transition to digital TV, Rolf Deubert from ITT Intermetall GmbH, Freiburg, West Germany, will present at session 7 a paper on "Feature ICs for Digivision TV Sets." In it, he describes digital techniques for adding features to TV sets that conform to the color standards of the National Television System Committee. These features include a digital comb filter that replaces the video processor, decoders for teletext signals, and circuits for interlace-free TV signals. Production of these chips is slated for July, and simulations of them will probably be shown at the September West Berlin Radio and TV Show.

Home computers also have a session to themselves, No. 15, in which Hans Stellrecht, Dan Hariton, Deitmar Beer, and Bob Blauschild from Signetics Corp., Sunnyvale, Calif., hold forth in "A Low-Cost Analog/Digital Proportional Control System for Personal Computer and Robotic Applications." Using personal computers to communicate with other devices for special applications, like robotics, is a dream of many, and Signetics has designed a chip set addressing such needs in real time.

Many advantages. The set uses a multichannel serial bus that transmits a pulse-position–modulated signal. This method of encoding combines digital and analog techniques, has high noise immunity, and is low-cost. Another advantage is that it uses a standard 8-bit format.

In a typical application, a personal computer interfaces with the control system through one of its peripheral ports. Either a play or a learn mode can be initiated with the system, along with remote sensing. As a result, a fully duplex control system can be formed. To achieve such capabilities, the chip set has its operation divided into sections for computer interface and encoding, decoding, feedback encoding, and feedback decoding and interfacing.

Another IC that may figure in the video-cassette–recorder picture is a chip that incorporates head drivers, preamplifiers, and record-playback peripheral switches. This development comes in session 5 from Sony Corp.'s Masafumi Kikuchi and Chikara Yamada in the paper "Single-

Summer CES heats up for personal computers

The June 5–8 Consumer Electronics Show promises to be larger than last year's, with its home-computer portion leading the growth. Spread about downtown Chicago in four locations, the show encompasses 735,000 square feet with 1,200 exhibitors, up from last summer's 603,000 ft² and 1,056 exhibitors. More than 20% of the exhibition space will be devoted to home computers and software. With price cuts and rebates coming almost weekly in the volatile personal-computer market, competition will be tough for such stalwarts as the Atari 400 and Commodore VIC-20, as well as for Mattel Inc.'s new Aquarius computer, which with 4-K bytes of random-access memory and a built-in cassette drive costs $150, and a new inexpensive computer from Coleco Industries Inc. Such giants as IBM and Apple Computer are not attending this show but their presence is felt: both are believed to be ready to introduce inexpensive computers by yearend, says Jack Wayman, senior vice president of the Electronic Industries Association.

In a-m stereo radio, an infant technology with much promise even though the Federal Communications Commission has left standards up to the marketplace, Sony Corp. is following the lead of Sansui Electric Ltd. [*Electronics*, Jan. 27, p. 41] and is entering the fray. The company is showing its SRF-A100 unit, which is slated to hit the market in August and like Sansui's can pick up signals from any of the competing systems offered by Harris Corp., Kahn Communications Inc., Magnavox Consumer Electronics Co., and Motorola Inc. However, Sony's costs less, $90. The 3.8-by-8.9-by-1.4-inch unit has two mode settings for a-m stereo—one for the Kahn system and the other for the remaining three. This announcement leaves General Motors Corp.'s Delco Electronics division, which has placed its money on Motorola's approach, as the only company gambling on a single technology. **–E. L. K.**

Probing the news

chip IC with Head Drivers and Preamplifiers for Home VCR."

By placing all of these functions into one chip that can accept a 5-volt supply, Sony can lower power consumption, making the device useful for portable sets. Power consumption is reduced to 125 milliwatts, which is half that of conventional units. In addition, peripheral parts count is also halved. Through the use of computer-aided design techniques to design the preamplifiers, Sony was able to create a chip with a carrier-to-noise ratio of 58 decibels at 4 megahertz, which is excellent when compared with designs using conventional discrete transistors.

Battery news. Portable radio and cassette units and, most recently, wristwatch TV receivers have captured buying interest and promise a market boom for the batteries that power them, as well. Session 6 is devoted to the battery industry—estimated at over $3 billion—and to the designs to meet the higher energy-density demands.

The session leads off with Ralph Brodd from Broddays Inc., Pomona, N. Y., giving a paper on "Battery Systems for Electronic Devices." Brodd says that to meet the new demands of power-hungry components, the old standard workhorse, the popular carbon-zinc cell, has been refurbished with a zinc chloride electrolyte and an oxidation-resistant coated-paper separator. He says that, at low and intermediate drain for as long as a few days, performance is comparable to that of an alkaline cell at only a third the cost.

For low-power uses, like the backlight of a digital watch, mercury-zinc and -silver cells are best, offering efficiencies up to 95% at 10 to 15 milliamperes for 0.5 second, says Brodd. But a zinc-air system offers the highest button-cell power density: 15 watts per cubic inch compared with 3 to 9 $W/in.^3$ for others. But the zinc-air cell has a drawback: once put into use, it remains on and will provide only one month's service.

Another type of battery, based on lithium, will be discussed in "Lithium Inorganic Batteries for Consumer Electronics," by Nikola Marincic

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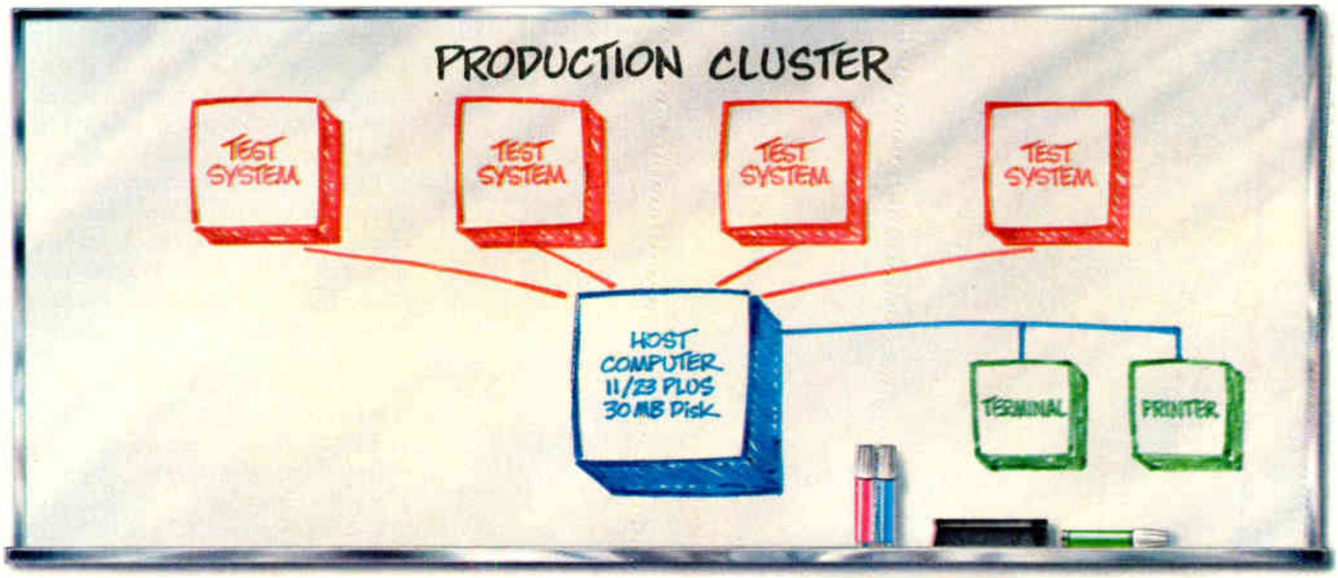

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Probing the news

from Battery Engineering Inc., Hyde Park, Mass. Lithium inorganic batteries, says Jim Epstein of Battery Engineering, offer 10 to 12 times the energy density of common manganese-alkaline batteries, making them the highest energy-density system.

But there are some serious limitations for consumer applications because of the inherent volatility of lithium. This danger dictates the need for stainless-steel packaging, hermetically sealed construction, and welded glass-to-metal seals. Efforts are currently under way to improve the safety factor for lithium inorganic cells by fusing battery packs, providing a rupturable vent to prevent pressure buildup and improving glass-to-metal seals, Epstein notes.

Lead-acid cells found their way into industrial and consumer products years ago in the form of the jelly-acid electrolyte, or gel cel. But with many exotic materials being used, the old-fashioned lead-acid battery is still around, with John Devitt, a consultant from Denver, giving his opinions in "Application of Sealed and Maintenance-free Lead Batteries to Electronic Products."

Soaked. More recently, similar batteries, with the electrolyte soaked in porous pads instead of being gelled, have been marketed, says Devitt. These devices are considered "flooded," since the space between the internal battery plates is filled by a liquid or quasi-liquid electrolyte. A starved acid-lead cell, in which the oxygen released from the positive plate during overchange reacts at the negative plate to re-form water, emits no acid or gases.

Rounding out the session is a presentation by Harvey Seiger, a consultant from Waterford, Conn., entitled "Nickel-Cadmium Battery Cells—Consumer Technology." With recent advances in active-material deposition, nickel sintering, and optimization of nickel concentration, sealed cells have been made that deliver 23 watt-hours per pound and 2.3 w-h/in.^{3}, up from today's ratings of 16 w-h/lb and 1.5 w-h/in.^{3} In addition, Seiger points out, breakdowns have decreased by a factor of four thanks to new manufacturing processes. □

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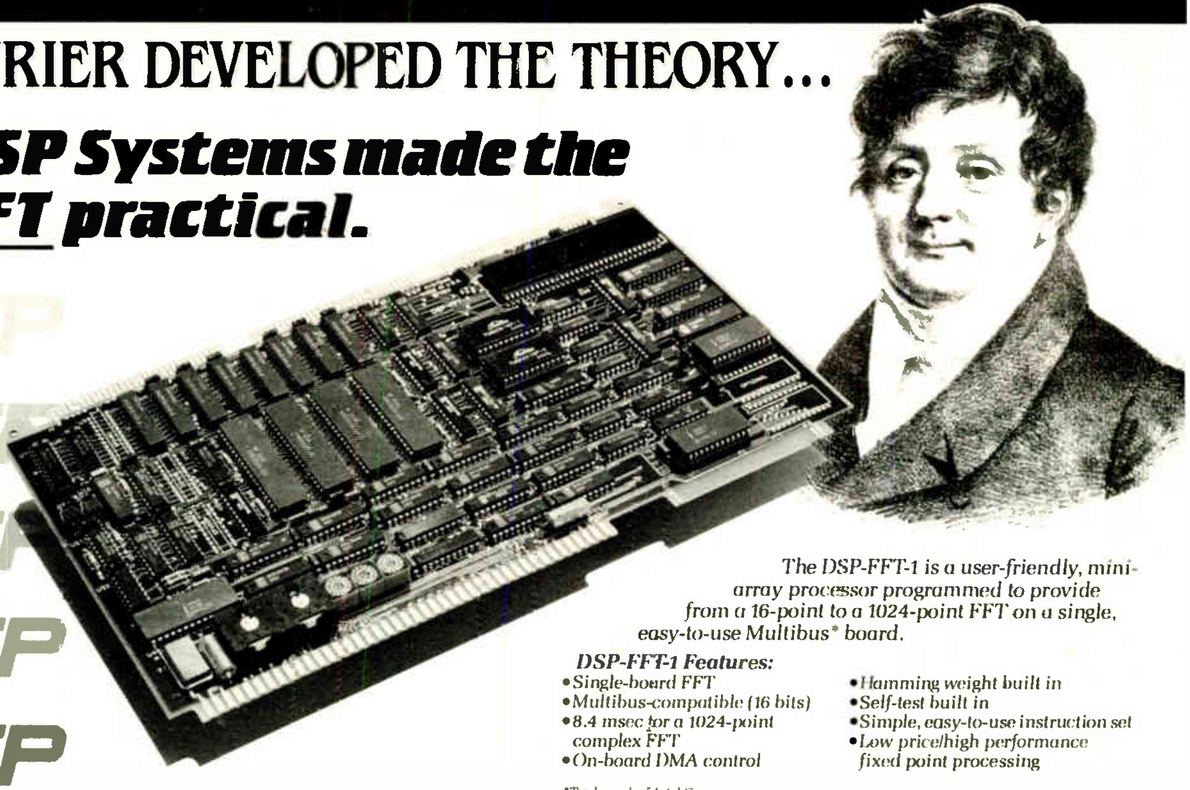

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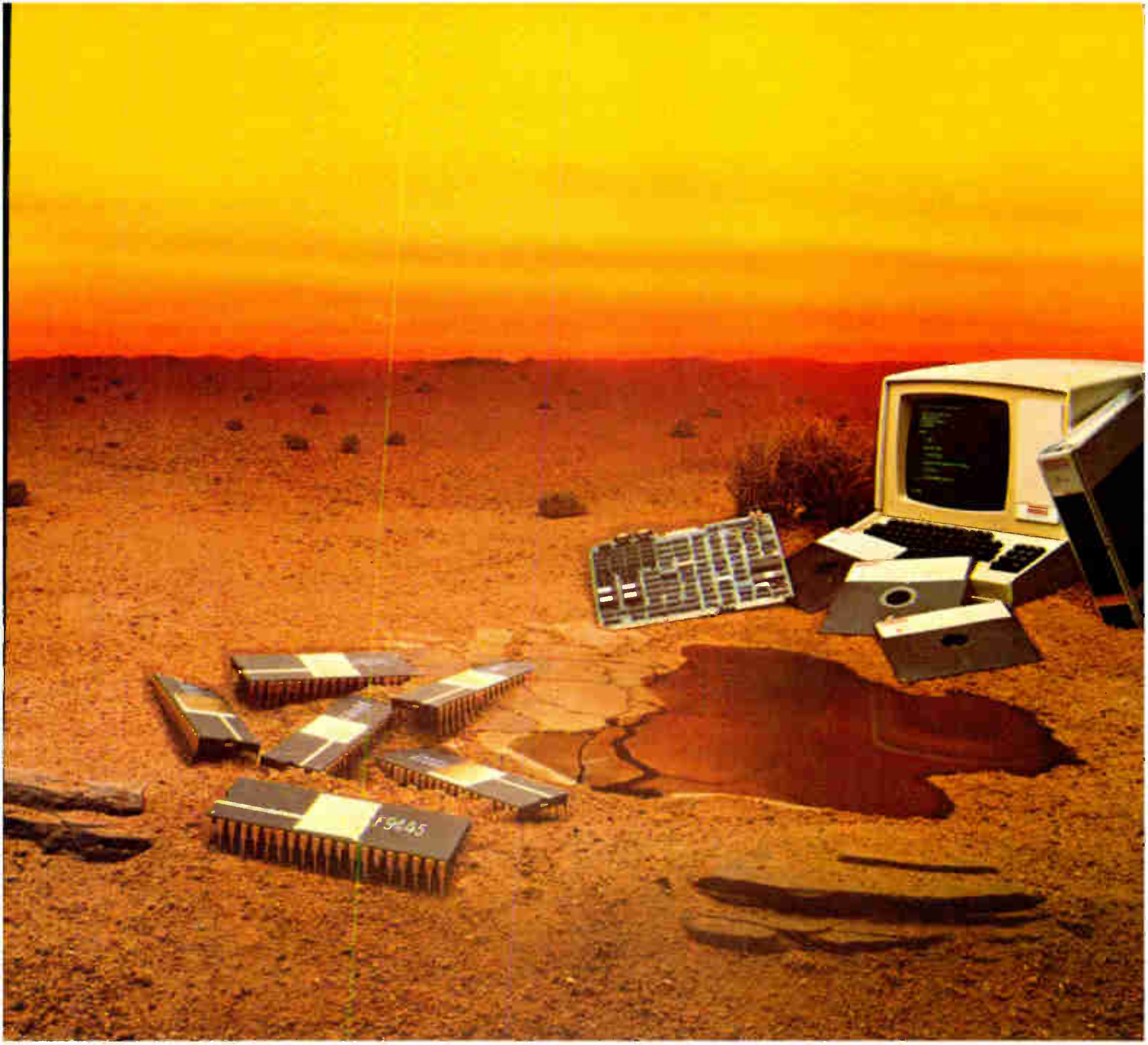

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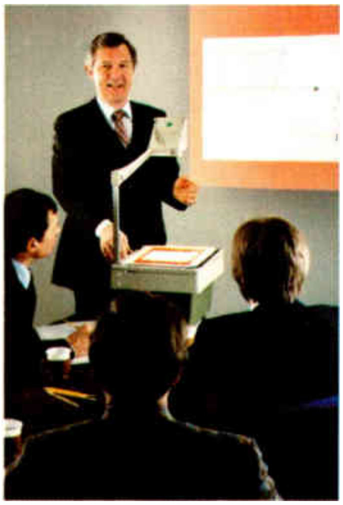

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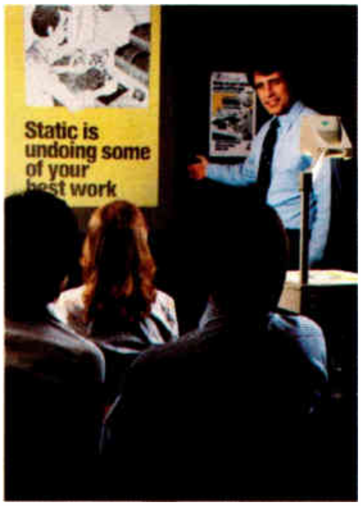

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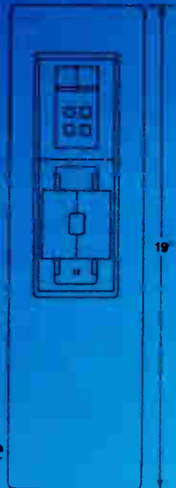

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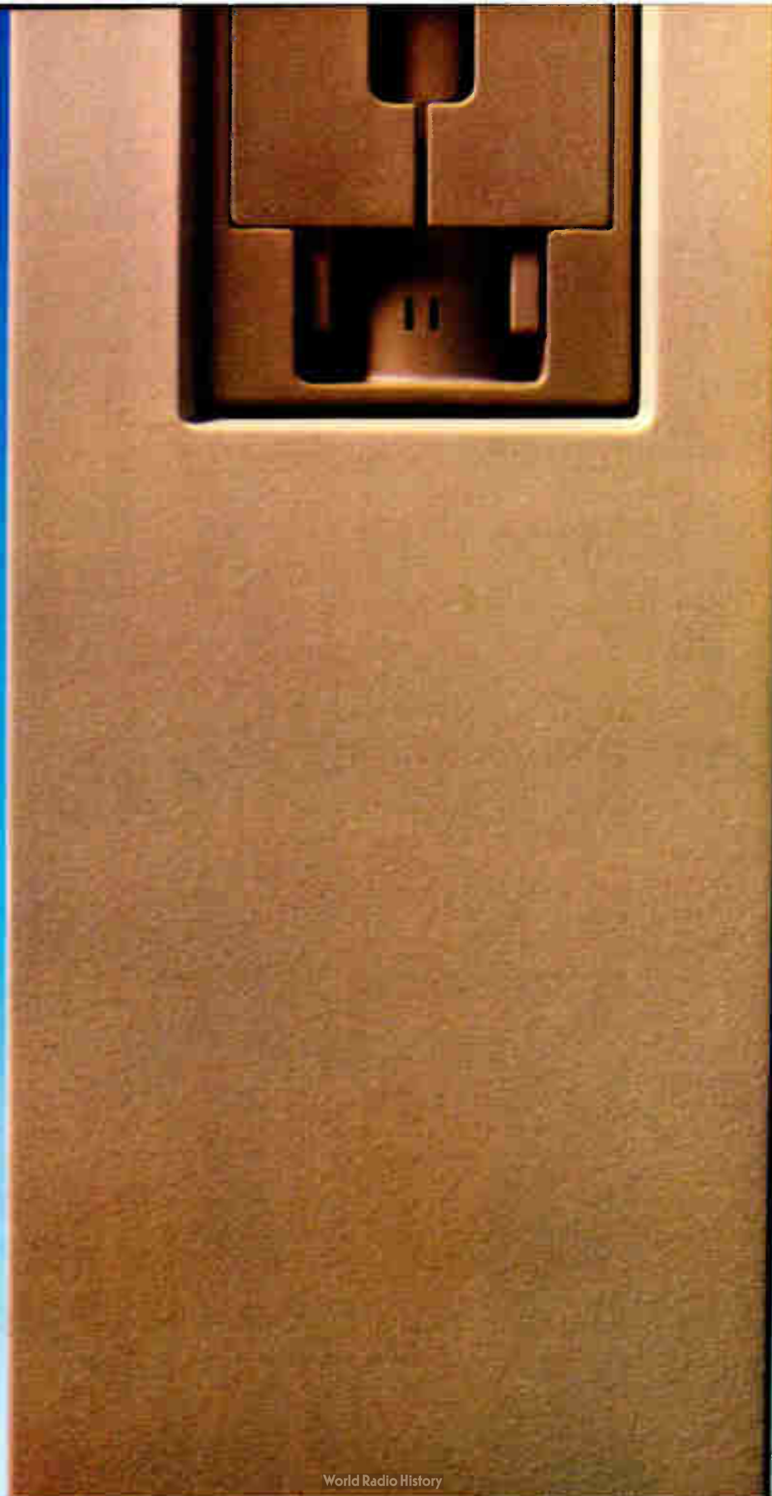

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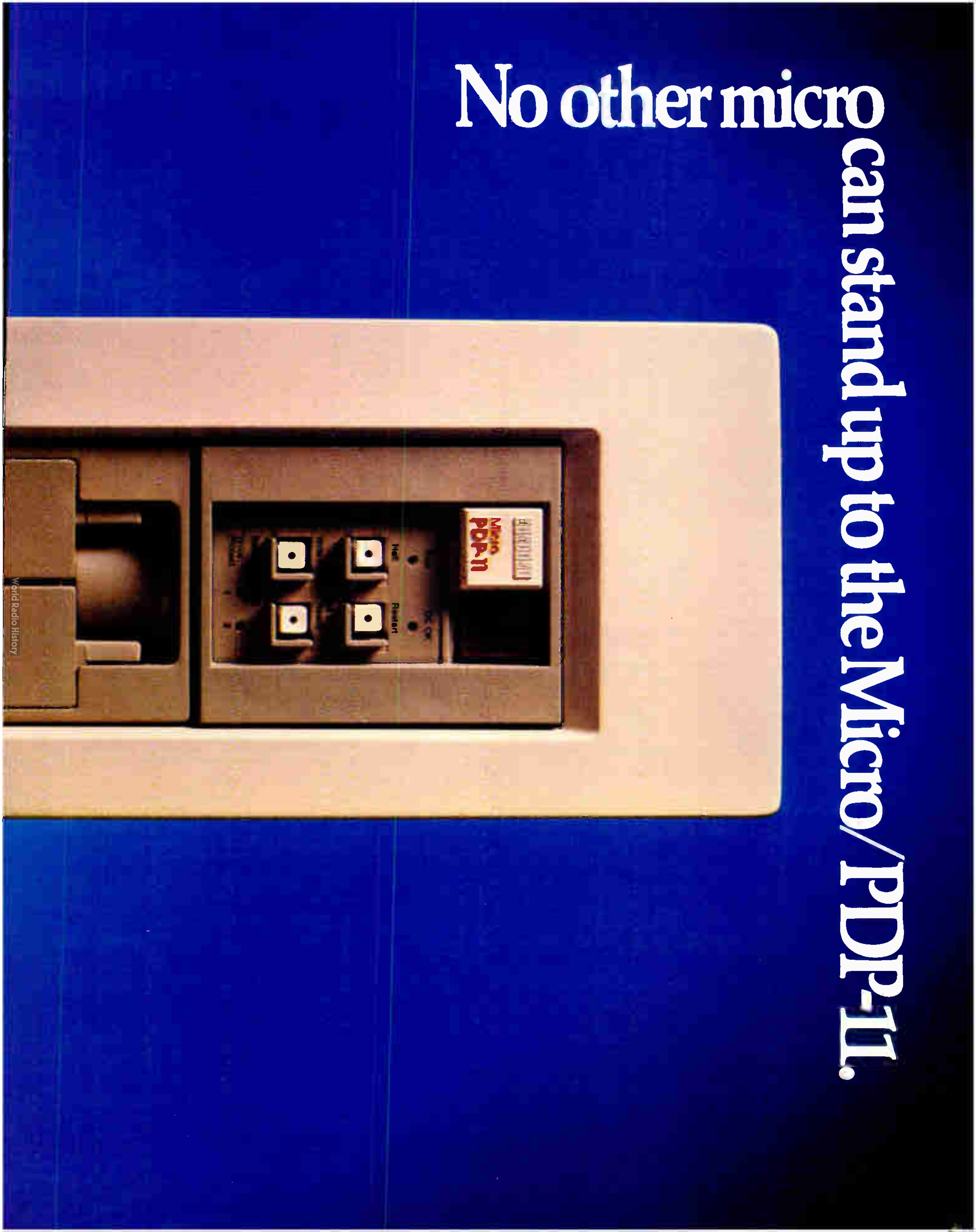
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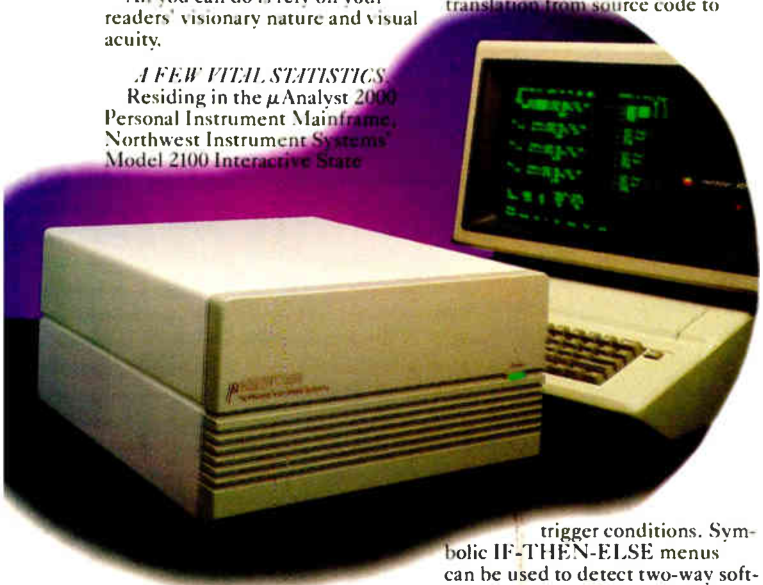

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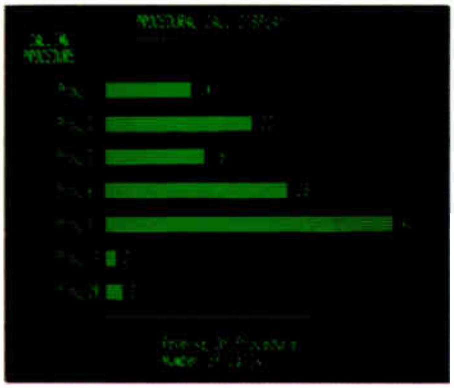
TRUE LOGIC ANALYSIS.

Tightly coupling a personal computer to a logic analyzer like the Model 2100 adds intelligent analysis to the picture. The system's operating software is written in Apple Pascal with enough memory left to accommodate co-resident programs written by the user to control instrument functions. For example, you might instruct the system to bin occurrences of a certain data value then format them in a histogram or other type of display.



Co-resident programs are used to format acquired data graphically.

EASY TO LEARN, EFFICIENT TO USE.

The Interactive State Analyzer combines the best features of a menu-driven instrument with the strengths of a personal computer operating system. Command and Message lines prompt you with instructions and assistance. Single keystrokes on the ASCII keyboard make the system easy to learn and easy to use. And with a large personal computer CRT, data is clearly displayed in a readable size.

HOW PERSONAL INSTRUMENTS BRING YOU CLOSER.

Engineers today face a serious dilemma. Too much time must be spent in the mechanical phases of problem-solving: setting up tests and wading through data. Leaving less and less time for the far more important creative phase: developing new solutions.

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First, because they are personal computer peripherals and therefore eliminate much redundant microprocessor circuitry, NWIS instruments set a new standard of cost-effectiveness. And second, because they were designed from the beginning to be a system, NWIS personal instruments offer far greater ease and range of user-configurability.

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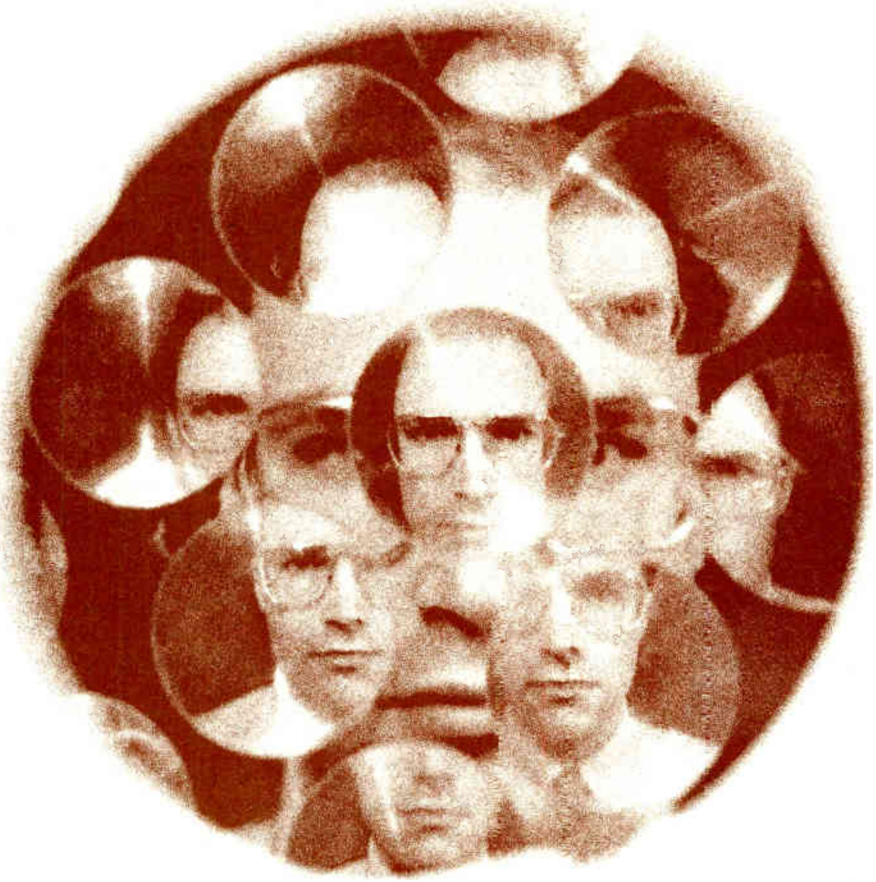
THE CHANGING FACE OF ENGINEERING



Harnessing computer power in chips has wrought a revolution in the way electronics engineers work, and to flourish, they must cope with the ongoing challenges of software and systems design

□ Change is everywhere, altering the life of everyone on earth. And nowhere is the change more telling than among the engineers who, more than anyone else, bring it about.

For the technology they sire in turn sires formidable changes in the way they work. More new technology comes of that, and the forces of change escalate again, adding yet another turn to a seemingly unending spiral of advances.

Ceaseless striving, then, is the lot of the electronics engineer. Accelerating the pace more than anything else is the onrush of computer-chip technology. So much has the cost of computing power been slashed that incredibly accurate timepieces now grace millions of wrists around the world, electronic calculators nestle in millions of pockets, and powerful computers are found in millions of households, offices, and factories.

The onrush of the microprocessor is, in essence, forcing hardware engineers to think like systems and software people. Just as important, it has spawned powerful engineering work stations that both facilitate their work and encourage them to complicate it beyond belief.

Formidable though they are, such changes do not faze a sizeable majority of engineers. Most are stimulated by the permanent challenge of their workplace. By and large, the engineers among the readers of *Electronics* are satisfied with their jobs. In a survey made in mid-March and early April, 85% rated themselves "very satisfied" or "reasonably satisfied." Fully two thirds of them, now aware that their careers depend on how well they can manage change, said they would study engineering again if they were just starting college.

And to perhaps the true bottom-line question, "Would you encourage your child if he or she wanted to study engineering?," more than 85% answered "Yes." (Salient survey questions and answers are highlighted throughout the stories that follow.)

But as might be expected, a not-so-silent minority responded with outcries ranging from despair to outrage.

Commented a West Coast aerospace engineer, "Mature engineers who have not switched to semi-management positions are likely to be devastated by the engineer oversupply in the next five years. Young engineers will be stifled. Those that do survive will be taxed to death."

Even more dire predictions were advanced by technologists disappointed by management. From an engineer at an industrial controls maker in the Northeast came this: "Our technological base is in danger of collapse, thanks to greedy corporate management and the financial community."

Says another East Coast respondent, "The major problem in my company is the [technical] incompetence of upper-level management. But how can an engineer fire a manager?" So far, no way.

Abundant computer power propels sweeping change

☐ Like a grain of sand that irritates an oyster and gives rise to a pearl, the ubiquitous computer chip seeds startling changes wherever it enters. In its earliest widespread manifestation, as a microprocessor, it forced mainstream electronics engineers to switch from analog to digital concepts for their designs and to marry their hardware to software.

Then as microprocessors became more powerful and whole catalogs of sophisticated peripheral chips appeared, hardware designers had to metamorphose into system builders adept at combining chips carrying large function blocks. Now the heavy populations of logic packages once necessary to weld together subsystem chips are being liquidated by an invasion of large-scale semicustom circuits—gate arrays and cell arrays. As if all this were not enough, more and more computer power is slipping into the workaday tools of engineers, compelling them to rework their work habits.

As William L. Sweet, chief engineer for GTE Corp.'s Sylvania Systems Group, Western division, in Mountain View, Calif., puts it, "The abundance of a key resource, computer processing power, is transforming the way an engineer does his job." Formerly, he explains, this resource was scarce and expensive, forcing engineers to use it efficiently. "At no time in history has an abundant resource come on so fast," he maintains. This dynamic surge, he goes on, is what is supporting the rapid spread of technology.

Migrating to a systems world

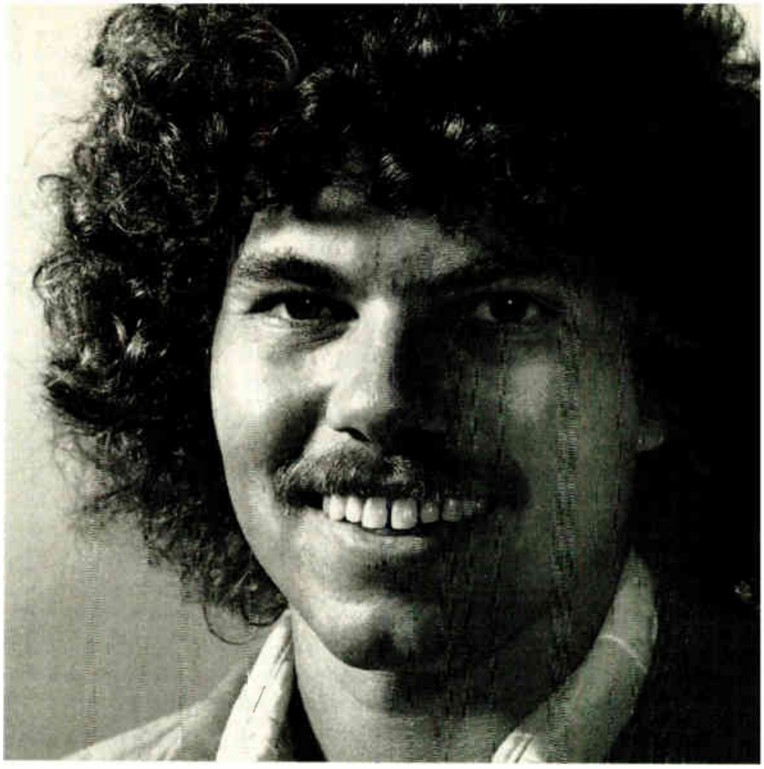
These sweeping changes have taken place essentially in the past dozen years. And one major upshot has been a serious thinning out of the ranks of circuit designers—the people who create function blocks out of components, discrete or integrated. "The circuit designer will become a dying breed outside the semiconductor houses," says A. Fred Susi, manager for network systems for GTE's Communications Systems division in Needham, Mass. "Today we are migrating more and more toward a systems world."

In that world, designing pieces of hardware becomes less significant than integrating hardware into systems. "It's not sufficent anymore to make a single stand-alone processor," says Charles J. Holland, the computer architect who drove the design team at Data General Corp., Westboro, Mass., that became famous as the "Microkids" of Tracy Kidder's Pulitzer Prize–winning "The Soul of a New Machine." "Everything has to connect up and be seen as part of a network solution," he says.

The connections, precisely, explain why the systems world will have a teeming population of semicustom-chip designers, systems engineers devising "glue" chips to link up standard very large-scale integrated packages. "In five years, 80% of all ICs will be designed by systems houses," maintains William S. Johnson, president of Cadtec Corp., San Jose, Calif., a start-up firm that produces engineering work stations. (For more on work stations, see p. 141.)

In a systems world, software counts as heavily as hardware, sometimes more. Software costs are the fastest

To the point. Chief engineer at GTE's Western division, William Sweet explains that computer power, once scarce and expensive, has become an abundant resource that fuels the surge of technology.



Networker. Designing bits and pieces of stand-alone hardware no longer makes sense for Data General's Charles Holland, who led the "Microkids" in Tracy Kidder's "The Soul of a New Machine."

rising element in new equipment, estimates James H. Frame, vice president of programming at the New York City world headquarters of the International Telephone & Telegraph Corp. And Cynthia Kozin, who runs a 100-person software department at the AIL division of Eaton Corp., Deer Park, N. Y., now expects that "in the next few years, software development may grow to be 20% to 30% [of the cost] of a finished product."

This swelling importance of software can be troubling for old hands at hardware. "The biggest problem I have in working with microprocessors is managing the software—it's new to me," says Arthur S. Muto, 37, a project manager at the Santa Clara, Calif., division of Hewlett-Packard Co. "I have a hardware background, and so do most of the engineers in my group."

Even to engineers whose expertise is founded on software, the challenges seem unending. One facing many software engineers today is having to tailor program packages for systems that mix old hardware with new, suggests Jack Clemons, manager of software development and verification of on-board programs for the space shuttle program at International Business Machines Corp.'s Federal Systems division facility in Houston, Texas. For that reason, he explains, software engineers are finding themselves more and more often in the role of system integrators, interfacing hardware that may represent a number of "leading edges" in designs over a period as long as a decade.

"At each stage," says the 39-year-old Clemons, who was trained as an aerospace engineer at the University of Florida but has been intimately involved in software for most of his career, "you had to take a quantum leap forward in what could be done with software. The differences in computational power between Apollo and what we've done with the space shuttle, for example, is like a Model T Ford and a Thunderbird. And what the software itself can do on board the shuttle is several generations ahead of what we were able to do on Apollo."

Further generations of software will inevitably emerge. "We're moving towards the day when we can develop software components that can be used and reused just the way standard hardware components are today," notes S. Tucker Taft, who heads one of the six teams at the Compilers and Support Software division of Intermetrics Inc., Cambridge, Mass. The group is working on a package of Ada programming aids for the Air Force, and with Ada, explains the 31-year-old Harvard graduate, one or two levels of reusable program blocks are possible. "But that's just a beginning," he points out. Taft expects that in the future there will be dynamic high-level languages that allow more sophisticated program bits and pieces to be patched in from a library, much as hardware can be built from modules.

In fact, "a lot of research is currently directed at ways of making the software engineer's job easier," says Barbara B. Krieg, one of the software people who developed the Electronic Design Management System (EDMS) at Prime Computer Inc., Natick, Mass. [*Electronics,* March 10, 1983, p. 64]. One great need Krieg sees is for more automated techniques for the management of large software systems—better ways of keeping track of who makes what changes, and when, to software as it is being developed. Interestingly, this is exactly what EDMS—with its huge data base, components library, and interactive access—provides for hardware engineers. EDMS alone, for example, required approximately a quarter of a million lines of code, and Krieg understandably would like to see "a kind of CAD for software engineers."

Computer-aided design for software also appeals to ITT, which has a global force of 8,300 programmers. To boost their productivity, 140 software specialists at ITT's programming complex in Stratford, Conn., are hard at work on an "optimum" programmer work station. A key element will be a master program that will automatically integrate software elements into the total package. ITT vice president Frame has great expectations for the leading-edge work station and a companion program of intensified training for each of the company's programmers. He predicts that by 1986, each programmer should be generating 3,000 lines of code per year with no more than 0.2 to 0.3 defect per 1,000 lines, or about 500 more lines than today with 50 times fewer errors.

Vanishing loners

Time was when someone working largely on his own could score a noteworthy advance in science or technology. Now a computer chip can have tens of thousands of transistors on it—so many that "a single circuit designer, no matter how expert, cannot design a chip by himself in a reasonable amount of time," maintains Kim Hardee, senior design engineer at Inmos Corp., Colorado Springs, Colo. And equipment designers have largely become systems people, forced by the very nature of their efforts to work in groups. To function effectively amidst the swirl of technology, engineers have to be as deft at communicating as they are at understanding logic diagrams.

"The old stereotype of an engineer was a guy with a

Programmed. An old hand at hardware, HP's Arthur Muto finds managing microprocessor software a major task. His project group plans to split programs into modules that can be done separately.

slide rule hooked to his belt and who was not into sports, not into team play," says 36-year-old Tim D. Isbell, engineering manager for industrial linear circuits, National Semiconductor Corp., Santa Clara, Calif. "The jobs that we have to do now are not 1–man-year projects but are 5-to-10– or 10-to-20–man-year projects. Integrated circuits, even linear ICs, are so complex that they are no longer designed by one engineer, but by teams . . . this concept may be new to us [U. S. companies], but it's not new to the Japanese."

The teams, in a sense, include chip users as well. The transformation of the business into a market-propelled industry is "driving many engineers out of their own little cubicles," notes Karla Callahan, 29, process engineering manager of logic array products at Texas Instruments Inc.'s Houston operation. Because her group is into semicustom components, its engineers have to visit customers a lot more often to make sure TI knows what they want.

Getting into getting out of the cubicle seldom comes easily. Alan Helenius, who did a 12-year stint at Digital Equipment Corp. and then joined Apollo Computer Inc. just 16 months ago, recalls, "At DEC, my responsibility was in CPU [central processing unit] development and nothing else, so I could spend days at a time locked in my office with my logic template and schematics. There was a lot of culture shock when I got to Apollo and found myself interfacing with a wide range of people."

Project leader for the Chelmsford, Mass., firm's desktop engineering work station [*Electronics*, Jan. 27, 1983, p. 143], he finds himself in continual contact with manufacturing, marketing, and support people, as well as with his fellow engineers and with outside hardware suppliers. "Engineering schools may give their graduates a good grounding in the basics of technology, but I don't think they yet address the people skills engineers need for an increasingly team-oriented workplace," he says.

With loners eclipsed by the shift from stand-alone hardware to systems, group dynamics now determines to a large extent the success or failure of engineering projects. A young engineer's loyalty is really to himself, says Data General's Holland, now a manager of systems architecture at the minicomputer firm. By immersing a young engineer immediately in a group project, it is possible to transfer some of that loyalty to the team, says the 31-year-old native of Dallas, who holds bachelor's and master's degrees in electrical engineering from the Georgia Institute of Technology. That was why the team that built the MV8000, as reported in "The Soul of a New Machine," developed an intense cameraderie.

But sometimes, Holland points out, such a group can then develop an "us versus them" feeling toward the company, particularly if they perceive the company as manipulative and uncaring. He is convinced that it is far easier to effect the transition from personal to group loyalty than it is to effect the transition from group to corporate loyalty.

For this reason, Holland feels, it is more important than ever for an engineering-team leader—manager if you will—to develop strong marketing skills. If he truly understands the market, he can more effectively channel the creative energies of his young engineers towards projects they will be able to sell to top management. That is essential in today's competitive market for top engineering talent (see p. 134.)

Remember the end user

Design teams, whether working on chips or systems, put themselves at enormous risk if, in the course of devising their creations, they fail to keep in mind that the effort is essentially for naught if what comes out cannot be manufactured, tested, and sold. As change swarms

Whence the numbers?

To get a reading on how electronics engineers feel about themselves and their work, *Electronics* made two surveys, one informal and the other highly structured. For the first, we simply printed a four-page questionnaire in our February 24 issue. Some 650 readers—mostly from the U. S. but a few from Europe and even one from Australia—found the questions provocative enough to take the trouble to tear out or copy the pages and mail them back to us.

For the second survey, we commissioned the McGraw-Hill Research Department to pose the questions to a random sample of those of our U. S. subscribers who work at engineering or engineering-management functions. The questionnaire (essentially the same as the one printed in the magazine) was mailed out in early March, together with a covering letter on *Electronics'* letterhead, a token 25¢ incentive, and a postage-paid envelope addressed to McGraw-Hill Research. Of the 953 subscribers in the sample, 432 responded, a respectable 45.3% of those quizzed.

The responses to identical questions in the two surveys tracked quite closely. But because the random sample is more representative, we have used the figures from it throughout this report.

about them, engineers have to keep an an ear tuned to the marketplace.

"It's the easiest thing in the world to design something that can't be manufactured in quantity," notes John B. Clayton, who designs Ethernet interface boards for Interlan Inc. of Westford, Mass. The greatest challenge in engineering, he feels, is to design something that makes not only engineering sense, but also production and marketing sense.

To pull it all together, Clayton feels that engineers today must aggressively cultivate market knowlegeability. "It's very rare," he says, "that you find a company where [the] marketing [group] knows exactly what it wants designed and what the technology can actually produce. Engineers do know what technology can produce but don't have the customer exposure and marketing training. I think it's important for engineers to be able to relate to marketing problems."

Testability is a concern

Crucial, too, is testability. "You have to be aware of test in design and build self-test into boards," Clayton says, adding that this can be easily accomplished on a microprocessor-based board if the design is kept modular and the core logic is used to test the other logic elements. Even on "dumb" boards, he says, it is possible to build in testability with a technique like signature analysis.

The chips that are making testing more crucial are changing the way that people who build test equipment work, as well. The ability to model test routines on a computer terminal is a major change, according to David P. Orecchio of LTX Corp., Westwood, Mass. "It's like an extension of my internal thought process, and I'm not tied down to a tedious process of trial and error the way I would be if I had to run everything on the test system to see how it worked."

Orecchio expects digital signal processing (DSP) will have a major impact on engineers, leading to a greater understanding of software. "Right now in our test systems, we've replaced the old analog filters with DSP approaches that let filtering functions take place in software; that means the engineer can't just look at hardware specs anymore and expect to know what's going on in a system." The surge in digital signal processing, Orecchio feels, portends a time when "we won't have purely analog engineers any more; there won't be that old distinction between analog and digital."

Software engineers have high concern for testability and testing as well. And perhaps the ultimate concern about error-free code lies in Houston, where an IBM unit headed by Jack Clemons writes and checks out the software for the space shuttle—software on which the missions and lives of U. S. astronauts who fly the shuttle into space depend.

Compared with writing programming code, verifing it is "a much more rudimentary discipline, perhaps 10 years behind the discipline for software programming and development," Clemons believes. "It is entirely different [from development]," he says. "What I'm discovering is that the whole area of software test is really just now emerging . . . there is a fair amount of discipline in place for the development of software tests, but when

WHEN IT GETS TO THE BOTTOM LINE, ELECTRONICS ENGINEERS BY AND LARGE . . .

. . . find their work satisfying . . .

Leaving out of consideration your pay, how do you rate your satisfaction with your work?

28.9% very satisfied
56.9% reasonably satisfied
10.4% hardly satisfied
3.5% unsatisfied

. . . figure they are fairly paid . . .

Compared with other college graduates in your company, do you think engineers are paid fairly?

71.8% yes
23.8% no

. . . most often would do it again . . .

If you were entering university as a freshman, which major would you choose?

67.6% engineering
10.6% medical or dental
8.6% pure science
6.5% business administration
6.7% other

. . . encourage their offspring to follow in their footsteps . . .

If your child wanted to study engineering in college, would you encourage him or her?

87.7% yes
9.2% no

. . . think management values their skills . . .

How does your company's top management view its engineers?

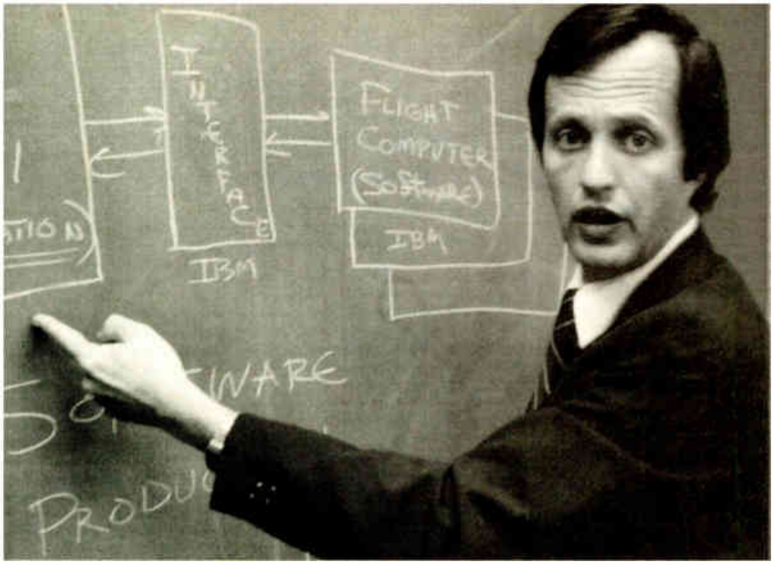
36.6% as essential
32.9% as skilled, hard-to-find people
23.4% as skilled, but easy-to-find people
5.6% as low-echelon types

. . . feel what they're doing counts . . .

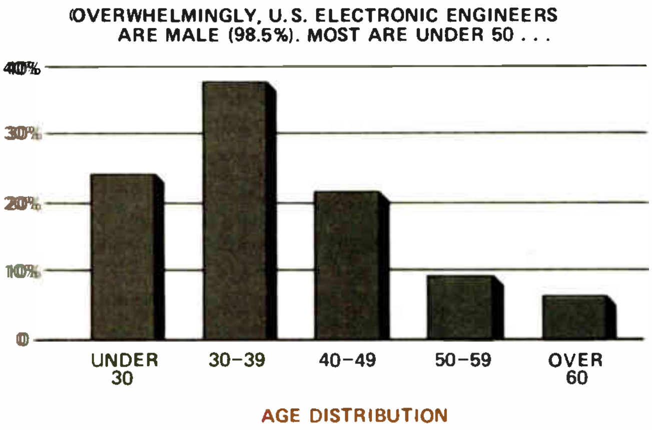
How important to the well-being of society do you feel your work is?

27.8% very important
53.9% fairly important
16.4% hardly important
1.6% unimportant

Where the total for a question is not 100%, the difference is the percentage of respondents who did not reply to it.



Long leap. Software for the space shuttle is several quantum leaps beyond that of the Apollo moon mission, explains Jack Clemons, in charge of the IBM team doing the shuttle software.



you go to an independent testing group or software engineering group, how do you go about verifying that (a) this meets the requirements and (b) it will integrate properly into the software-hardware system? That discipline is just now emerging."

A crucial question: specialize?

Sooner or later, every engineer has to answer a nails-hard question: "Will I do best as a specialist or a generalist?"

There is no unfailingly correct answer. No one, having taken one course, can ever fully know what would have happened had he taken the other. And yet anyone, having started down one path, can probably branch over to the other if he moves intelligently and has a little luck. The trick is to know when.

"I think I'm a classic case of specialization," says Kim Hardee, a designer of mainstream memory products at Inmos. Hardee decided to specialize because, he observes,"I find that I get paid more for doing what I'm good at and I just like what I'm doing."

But he recognizes "there are risks to specialization"—notably, winding up in a specialty that gets diverted out of the mainstream of technology. The key, he feels, is looking out for the warning signals. When they appear, Hardee says, it is time to consider a change.

Some specialists, however, would rather fight than switch. One such is AIL's Cynthia Kozin. Although she has 100 software people working for her, she still considers herself in the specialist camp. "The challenge of engineering is in having a specialty and growing with it." One of the dangers of management, as Kozin describes it, lies in becoming alienated from actual development. So far, though, she has managed to keep her hand in. "If I ever find myself unable to keep up with the technology, I would be tempted to switch to a more technical job," she declares.

Some generalists are spawned by their early jobs, but some get that way from a determination not to become specialized. One such is Daniel H. Miller, a project engineer at the Space and Communications Group of Hughes Aircraft Co., El Segundo, Calif. Only five years out of Cornell University, Ithaca, N. Y., and with a master's degree in electrical engineering from Stanford since then, Miller gets called on to tackle nearly every aspect of Hughes communications satellites, from designing an on-

Fun and games on the leading edge

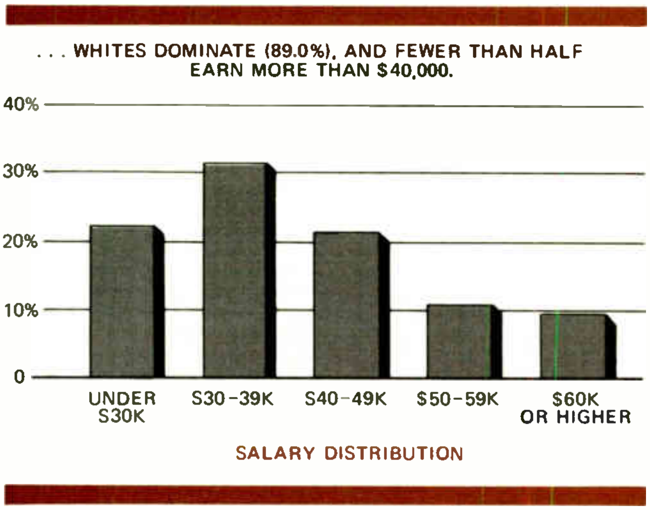
One of the fastest tracks a designer of electronics can line up on is electronics games, where a market-busting hot seller can flare and fade within a year.

Jay Smith, the 43-year-old founder and president of Western Technologies Inc., Santa Monica, Calif., has logged a good many laps there. His firm employs about 35 people, most of them electronics engineers, and Smith, a graduate of the California Institute of Technology, himself ranks as a top electronic-toy inventor. Products that he helped to develop for companies like Milton Bradley, its subsidiary Playskool, and Parker Brothers last year alone accounted for over $100 million in retail sales, he claims.

Smith maintains game designers work out on the leading edge since they draw on latest developments in semiconductors, computers, telecommunications, programming, and display graphics. As it is now, the video-game business is nearly mature, he acknowledges, admitting that "you can only do them in so many ways."

What life is left in them has to do mainly with going to bigger read-only memories in order to get graphics that provide more realistic animation. The current ROM size is mostly 4-K, with Atari and some others at 8-K and moving to 16-K. The limitation is the resolution of the television screen, for which 32-K of ROM is about the ultimate.

But a new generation of games will keep Smith and his ilk high on technology. In the offing are action on multiple screens and arcade games that can be "refueled" with software broadcast by satellite. Smith is tight-lipped about these, except to say that first versions will surface in June at the Consumer Electronics Show in Chicago. —**Larry Waller**



board computer that controls antennas—his first task—to dealing with some of the political-economic factors that influence design of a spacecraft. "It's the kind of job I thought would take me 15 years to have," says the 27-year-old engineer.

Though his rapid advance has surprised Miller, it confirms the choice he made as a heavily recruited computer architecture and design major at Cornell, class of 1978. He thought communications satellites were new enough and so fast-moving that a young engineer would not get pigeonholed into one job. That attitude contrasts with classmates who are happy spending years designing microprocessors. "I don't want to be known as the guy who does only that," says Miller.

Awash with information

Breasting the swelling tide of technology is a major concern for an engineer whether he be specialist, generalist, or manager.

Asked if they thought they would need further higher education to hold an engineering job 10 years from now, close to half of those who responded to *Electronics'* survey answered "yes." To a question on the ways they keep abreast of technology, 95.4% indicated they read technical magazines, 70.1% read technical books, 65.5% talk technology with colleagues, and 61.6% attend technical meetings and seminars.

"There is an incredible amount of information available, and to stay completely current, a person would spend his whole life reading and not designing," says Dean J. Westman, a 27-year-old design engineer in the MOS group at Honeywell Inc.'s Solid State Electronics division in Plymouth, Minn. Indeed, Westman believes that the pressure of keeping up with advancing technology is taking its toll on today's engineers. "You're going to see a lot of engineers burning out because of the intense pace," he observes. "It gets to be a job that takes a phenomenal amount of energy."

This same abundance of technical reading matter, on the other hand, is considered a boon by John Klacka. He has been designing memories for 27 years at Litton Industries Inc.'s Data Systems division in Van Nuys, Calif., living the history of memories from magnetic cores up to the dense MOS chips that dominate the technology today. Klacka sees no reason why any engineer who wants to cannot keep up with technology. "Vendors bombard us with data," he says. Anyone who fails to keep up has only himself to blame, Klacka feels.

Litton, like many companies, provides time, support, and encouragement for science, computer, and engineering courses at a nearby university—in this instance, California State at Northridge. And Litton is not unique; in fact, many companies run in-house courses, as well as supporting employees who continue their education at colleges and universities.

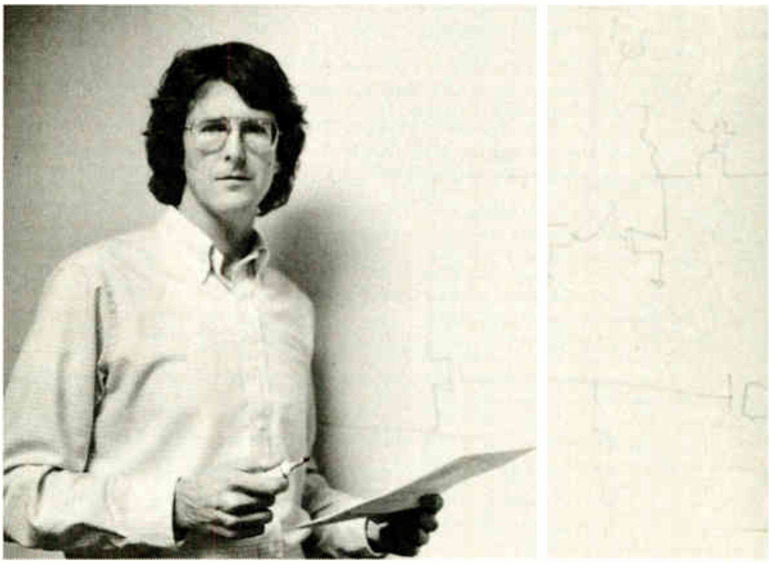
For example, Loreen Breda, a technical staffer on a team that develops speech-recognition chips at Bell Laboratories, Murray Hill, N. J., already had her master's degree in electrical engineering when she joined the labs two years ago. Since then, she has had on-site training in the Unix operating system, the programming language C paired with it, simulation tools for logic design, and VLSI design. And she has supplemented these with graduate courses at Stevens Institute of Technology in nearby Hoboken. Between her assigned tasks and her extra learning, the work day for Breda, who is in her late 20s, sometimes stretches out until midnight.

Engineers at Hughes Aircraft Co., El Segundo, Calif., as well, are urged to burn the midnight oil. The company runs what amounts to a graduate school for its scientists and engineers.

Briefcase or work station?

Specialist or generalist, most engineers reach a point in their careers where they must decide whether to remain engineers or move on to something else—usually marketing or management. Some make the move out of engineering reluctantly, forced by economics to get onto a higher-paying track. Others drop out because they lose the knack of coping with new technology. Still others simply stagnate. A lucky few exit gleefully, starting new

Market minded. Inmos memory man Kim Hardee maintains that chip designers must throttle their innovation enough to come up with products that can be manufactured and sold at a profit.



companies or moving to key jobs in start-ups.

But there remains a hard core of engineers who hold fast to the technical track. Fascinated by the work they do, they continue to man their work stations, sometimes at economic penalty. But more and more, they can stay on the track without drastic financial sacrifice, thanks to dual-ladder promotion schemes that make it possible for them to reach middle-manager pay levels without becoming middle managers. Slightly more than half of the engineers who responded to *Electronics*' survey reported that their companies have dual-ladder schemes.

"I'm convinced that more engineers are staying technical longer," says Tim Isbell, the National Semiconductor manager of industrial linear-integrated-circuit design, adding that "I don't have any intention of changing [out of engineering] . . . solving technical problems is much more fun than solving people or paper problems, although as an engineering manager I still have a little of those.

"And the establishment—the companies we work for—have done a good job at paying us. We can afford to stay technical—there's no financial penalty for being an engineer." He says this was not always the case. "The delta in pay between management and engineering is not as large as it used to be, and while there still may be some difference, it's not big enough for me to change."

Nor does the pay differential between marketing and engineering seem overriding to James Wilson, a senior staff engineer at Analog Devices Inc., Norwood, Mass. A year as an applications engineer in the firm's marketing department was enough for him to realize that that side of the business was not for him. "I'm just too curious about the intricacies of the engineering process to be away from it very much," he says.

Moving up in the company

Some engineers, by contrast, prefer to transform their hardware and software skills into a propellant that boosts them into the higher orbits of management, particularly in high-technology companies. Plotting a common career path, HP project manager Arthur Muto says that he would like to stay in technical management for the short term, the next 5 to 10 years.

After that, he adds, "I would like to rotate through marketing, production, and R&D to see other points of view." Hewlett-Packard has a policy of rotating managers through different jobs so that they can learn the various aspects of a project. "These functions [marketing, production, and the like] are all heavily staffed by people with engineering backgrounds," Muto points out.

Convinced that "there is a lot of room for general managers who have a good technical background," William L. Thomas finds himself "quite comfortable having moved off the bench" to a manager's office. The 31-year-

UK: higher status for the 'hired hands'?

Once an electromechanical enclave, telecommunications technology has shed its crossbars and joined the mainland of electronics technology by a switch to solid-state circuitry. As a result, the sector has become very attractive to engineers with a bent for systems.

One such is 32-year-old Gordon Boot, at present a design manager at Plessey Telecommunications & Office Systems Ltd. in Nottingham but with ambitions of going higher. Boot now heads up one of three teams at work on the company's IDX digital private automatic branch exchange. His group is melding the two major subsystems—the switch itself and the telecommunications network interface—and designing everything else that is needed for the exchange.

For Boot's line of work, knowledge of chip hardware and software is mandatory for success. But even more important is a thorough background in telecommunications systems. Boot has that. He joined Plessey more than a decade ago directly from Bilborough Grammar School to take a four-year program that alternated six-month stints of full-time work at the company with like periods of full-time study at the Nottingham Technical College.

Currently, Boot holds a responsible position in a high-technology project crucial for Plessey: it is the focal point of the company's office automation strategy. So what comes next? His answer typifies the way many UK engineers feel about their profession. "Most realize that engineering is a dead end if you want to be a high flyer," he remarks. So he wants "to move up into engineering management," clearly distinguishing between the two.

Boot's frustration at the lowly status of the UK engineer is widespread and reflects a peculiarly British malaise. Having invented the Industrial Revolution, Britain seems to have turned its back on the engineers who made it possible. The malaise has been examined—but never solved—in official reports dating back to 1852.

The latest, in 1980, calls for an Engineering Council to address the task of the "formation, education, and training of British engineers." But as a survey by Leicester Polytechnic that came out in March reveals, the council faces an uphill struggle. Interviews with some 250 graduate engineers and some 200 of their colleagues in 55 different organizations produced the consensus that present-day engineering education is often too specialized and does not provide insights into other disciplines. The upshot: a relatively low ceiling on engineers' careers.

Efforts to raise that ceiling are under way at some universities. And within Plessey, at least, Boot notes, "there recently has been a change of attitude that will hopefully continue." But the status of engineers will generally remain low until the people running Britain realize that a high-technology economy cannot flourish if the engineers who nurture it are considered "hired hands." —**Kevin Smith**

Special. Cynthia Kozin runs a 100-person software development unit for Eaton Corp.'s AIL division but maintains she has managed to manage and keep up with her specialty—tracking systems—as well.

old graduate of Purdue University, who got both his bachelor's and master's degrees in electrical engineering there, now heads the cable television, videotex, and data-communications operations of Zenith Radio Corp., Glenview, Ill. Once a "hands-on" engineer in videotex development, Thomas says his major technology contributions now are "systems concepts and ideas." Even so, he does not fear losing his technological edge, at least for the present: "I read quite a bit on two-way cable, videotex, and teletext."

The urge to manage flourishes even in small electronics companies, where engineers sometimes rate higher than managers in the corporate culture. "I've spent enough years putting gates together, and I enjoy the greater variety of tasks I'm finding on the management side," says Apollo Computer's Helenius. "Some engineers," he observes, "are quite happy implementing ideas in a working hardware design; some like to carry it farther, from idea to finished product or to a tangible share in the market—it's a matter of individual preferences and individual skills."

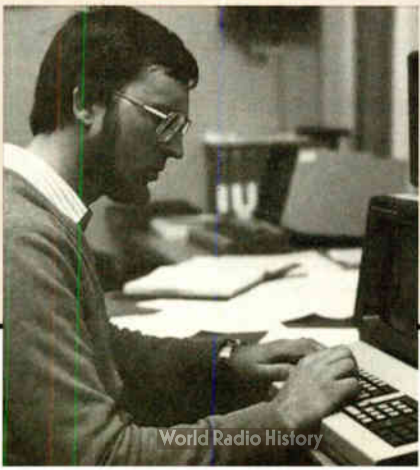
Engineers who have an urge to manage often find themselves scratching an entrepreneurial itch. The rash is endemic in Silicon Valley, reaching well down into the companies' hierarchies of technologists. Says Michael Dhuey, who streaked to Cupertino, Calif., and a job at Apple Computer Inc., rather than go on to graduate school after he won his bachelor's degree in computer and electrical engineering at the University of Wisconsin three years ago: "This is Mecca. You don't come to this area if you don't have that idea [of becoming an entrepreneur]. Every engineer in this valley would like to start his own company."

The Netherlands: divide and conquer

"For me, the biggest challenge is coping with the increasing complexity of systems," says Han Schaminée, a young software engineer in the Science and Industry division of NV Philips Gloeilampenfabrieken in the Netherlands. To his mind, the best way to bring complexity under control is to "divide and conquer"—split the system into a number of manageable subsystems and then tackle them individually.

"Rising complexity," he goes on, "is also leading to new ways of handling a problem. The traditional approach has been finding the best layout for a given system and then implementing it; now, a more structured approach is required. It calls for defining the functions, drawing up system specifications, and determining which parts can be implemented in hardware and which in software. Generally, engineers with a mathematics background are better prepared to cope with such problems.

"Testing, too, has turned from something simple into a complex operation, one that also calls for dividing a system into modules and subsystems and then testing them at their interfaces. This is a challenge particularly for the software 'toolmaker'—the designer of the compiler and assembler—who must develop test tools that minimize the chance of missing an error." Two years out of school, Schaminée is himself just such a toolmaker for users of the microprocessor development system (PMDS) that Philips launched about two years ago.



Schaminée has strong ideas about the role of the computer. "My mathematics professor was fond of saying, 'It used to be the program's purpose to instruct the computer—now it is the computer's purpose to execute our programs.' I have found that to be true in my daily work. Formerly, one programmed a computer in terms of jump instructions, which led to a spaghetti style of programming. Now we use procedures, with microprocessors supporting these procedures by generating call instructions.

"As software design is increasingly becoming a mathematical activity, so is logic hardware design. At the same time, the need for the classical circuit designer is diminishing. So the 'conventional' mathematics that many schools teach no longer suffices. Differential calculus, Fourier analysis, and the like may do for solving waveguide and other hardware problems but aren't enough for complex digital systems. What's required is 'discrete' mathematics, based more on algebra than on continuous analysis."

The 25-year-old Schaminée joined Philips in 1981, right after receiving his master of science degree in—what else?—mathematics from the Technical University in Eindhoven, Philips' headquarters and his home town. He feels that an engineer is most creative during his first 10 years or so in his profession. "After that, he should get involved in technical management." That is exactly what the young Dutchman plans to do. **–John Gosch**

Electronics engineers: too many or too few?

This year sees some 404,000 electrical and electronics engineers at work in the U. S., estimates the Bureau of Labor Statistics. Whatever the number, every so often some industry, Government, or academic group comes out with a study proclaiming that a shortage of engineers threatens the economic welfare of the country. And usually when that happens, dissident engineers' organizations respond with a disclaimer. They maintain the announced shortages are a myth promoted by academics out to increase their enrollments and by trade groups for whom an abundance of engineers translates into lower labor costs.

Sorting out the claims and counterclaims has become a thankless task. There is no doubt that top graduates from top engineering schools this June will not be hanging around unemployment-benefits offices. On the other hand, there is a good chance that some "over-age, out-of-date" engineers will be. Between these extremes, it depends on what specialty and what sector of the country is in question.

For some EE specialties, like chip design and aerospace systems work, the shortfall is indisputable. Says John Wilhite, manager of corporate college relations at Hughes Aircraft Co., Culver City, Calif., "There is always a shortage of highly specialized people—we never seem to get enough of them." In much the same vein, Don Mattson, controller for Data-Control Systems Inc., Rockville, Md., states unequivocally, "There is no doubt that a shortage of experienced EEs exists." Mattson is convinced the shortage will be a long-lived one.

But other companies toss aside talk of shortages. Tim Elliott, a spokesman for Eastman Kodak Co., Rochester, N. Y., says his company is an active hirer of EEs and computer scientists and has been able to find "as many as we needed in past years." At Burroughs Corp., Keith J. Horngren, director for employment and placement, admits to some difficulties in hiring experienced EEs. But he says the Detroit-based firm has managed to keep its roster filled by aggressive recruiting.

The soft economy hit the class of entry-level engineers much harder than it did employed engineers. A study by the Engineering Manpower Commission of the American Association of Engineering Societies showed that, by fall, 70% of last year's computer and electrical engineering bachelor's-degree graduates had already accepted job offers. For holders of an MSEE headed for industry, the figure was 95%. "It is a situation of students getting two or three offers rather than six," says Burroughs' Horngren.

Still, that is a far cry from the 10 or more they would have gotten not many years ago, and it could get worse. William Kays, dean of engineering at Stanford University, Palo Alto, Calif., predicts that there will be an oversupply of engineers having only a BS degree starting late this year or early next. "All of a sudden the job market is weak," he says. And the College Placement Council backs up that view with its report that the tightened job market has brought to an end the string of the sharp annual rises of starting salaries for entry-level people. Neophyte EEs, says the CPC, this year can expect average beginning monthly salaries of $2,111, up only slightly from the $2,058 for 1982, when there was a 10% jump.

So much the better, employers feel. "The supply and demand [now] is more in the employer's favor in terms of numbers," says a spokesman for Atlantic Research Corp., Alexandria, Va. "The situation differs widely from a couple of years ago—it's not difficult for us at all to find electrical and electronics engineers." John P. Dawley has much the same impression. Vice president for human resources at Harris Corp., Melbourne, Fla., he sees more companies competing actively on campus for new recruits, but because more students are looking for fewer jobs, finds his company is "doing very well at the entry level." At present, companies are finding that they need put out only one or two offers to hire, whereas five years ago, it was closer to half a dozen.

Employment patterns reflect the transitional nature of the economy as it makes a painful comeback from the recent recession. Some firms are hiring, others are staying the same, and still others are cutting back. Kodak is in a "hiring mode," according to Tim Elliott, largely because of the high electronics content of new products like the disk camera and copying machines. Data General Corp., Westboro, Mass., too, is hiring, says personnel director Jonathan Lane. In particular, the company is looking for experienced hardware, software, and semiconductor engineers. Hughes, however, is hiring only selectively because the insecure economy has lowered employee turnover—with fewer vacancies, there are fewer hirings.

School's in. There soon will be too many engineers with just a BS degree, says Stanford engineering dean William Kays.

This generally low-key economic picture has had a direct impact on salary levels. In *Electronics'* survey, fully 72% of the engineers who responded said they felt they were fairly paid. But salaries are not rising as fast as they were a few years ago. A quick sampling among major electronics firms indicates that salary levels this year will hover around last year's, with perhaps slight increases to stay competitive.

"What bothers me," says Irwin Feerst, the industry gadfly and a consulting engineer from Massapequa, N. Y., "is that when a genuine shortage happens, like in wheat, the real cost for these commodities goes up. In fact, the constant salaries of EEs have gone down since 1969. How can this mean a shortage?" —**Jesse J. Leaf**

EE who stayed the course still finds zest in job

A dozen years ago, *Electronics* profiled Al Titan, then a 31-year-old hardware designer at Loral Corp.'s Electronics Systems division in Yonkers, N. Y. At the time, Titan had made up his mind, after some soul searching, to stay in engineering. "I realized I like being an EE," was how he put it.

Loral's sole business still is military electronics systems, but much else has changed. Titan has shaved off his moustache, sired two more children, and had two promotions, elevating him to staff engineer. Above all, he has acquired a whole new panoply of technical know-how, largely through after-hours courses on microprocessors, software, and digital design. "Ten years ago, I didn't know software from Tupperware," he says. "You've got to keep on top, or you become obsolete and get put on some meaningless project. It's a burden to keep up, but there's no other choice."

All told, Titan feels he made the right decision. He thrives on the team effort of systems work and enjoys seeing an abstract concept evolve into hardware that works. "It's a comfortable living," he says.

Veteran. After a dozen years of designing electronics equipment, Al Titan still finds his zest for hands-on technology running so high that he has no designs on a management job.

Fingered. Debugging a prototype controller that he designed for the Rapport III radar warning and power-management system, on which he has been working for three years, Titan singles out a bad chip for a technician to replace.

Well informed. Catalog-thumbing is rare for Titan, who has access to a microfiche library bountifully stocked with specifications.

Silicon Valley life-style blends software, sports

Almost anyone having a bent for science can get hooked on computers. And so when young biologist Kate Rosenbloom learned programming for graduate work she was doing in neurobiology, she switched career tracks abruptly and signed on at Xerox Corp.'s Palo Alto Research Center as a programmer, finding the work "satisfying on a day-to-day basis."

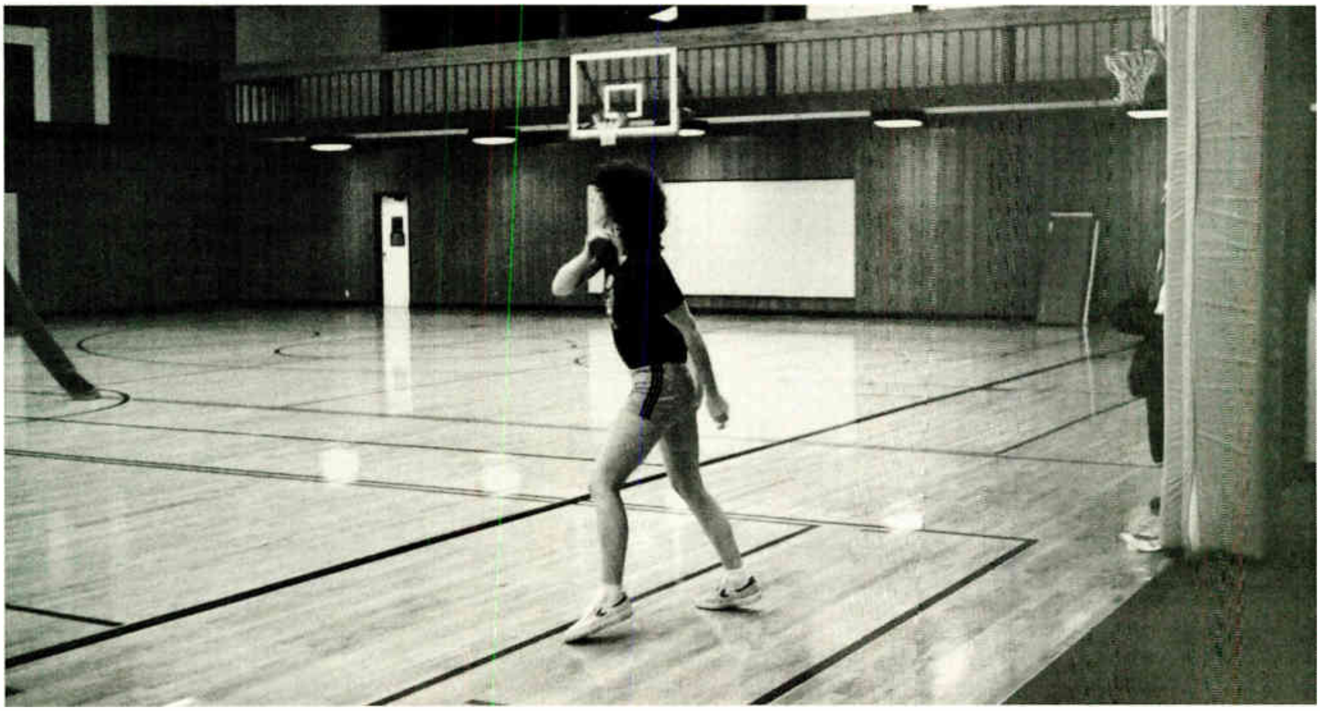
The switch came seven years ago, and after a stint at the Ames Research Center of the National Aeronautics and Space Administration, she went to the Rolm Corp. in neighboring Santa Clara, where she now is a software engineer. There is a lot to like at Rolm besides the work. Like other engineers there, she sets her own schedule for a work week that runs between 40 and 50 hours. After work, it's off to Rolm's lavish sports layout.

Getting through. For Kate Rosenbloom, telephone tag is a game people should not have to play. Since joining Rolm some 18 months ago, the 30-year-old software engineer has been working on the firm's electronic store-and-forward mail system, PhoneMail, which is set to go to market in about a month.

Well-screened. Rosenbloom spends much of her day working with a computer terminal, either in her office or out in the laboratory. But the idea of working on a terminal at home alone does not appeal to her. As it is now, she would like to see more human interaction on the job. "Understanding ourselves is more important than building better tools," she feels.

On the bench. In a verdant nook on the Rolm "campus," Rosenbloom chats with Eve Newman of *Electronics'* Palo Alto office. Married, Rosenbloom as yet has no children but plans to raise a family one day. Meanwhile, her career suits her well. She likes the detail involved in software, and the pay is good. "Salaries in this industry," she says, " are ridiculously high."

No place like Rolm. When it hired Rosenbloom, Rolm recruited a volleyball player—on Thursday nights she captains a company team—as well as a software engineer. In fact, a major reason why she switched to Rolm was the extensive sports facilities that the company has laid on for its staff. There is a full gym, a tanning room, plus heated wading and swimming pools.



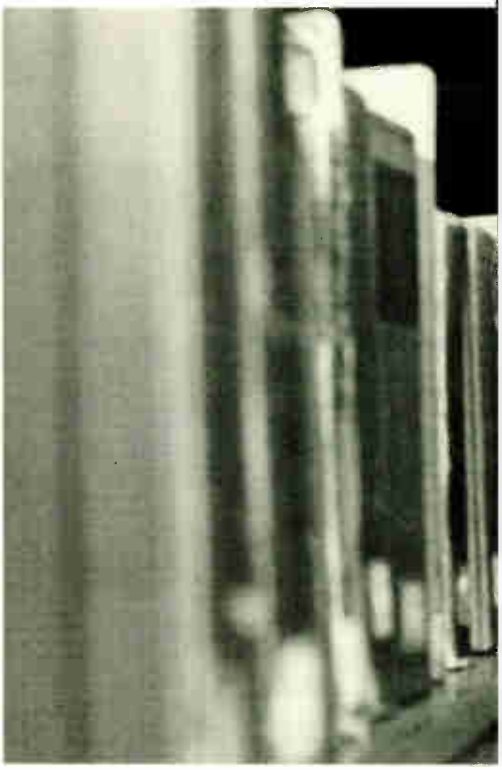
Japanese EE strategist puts in 13-hour day

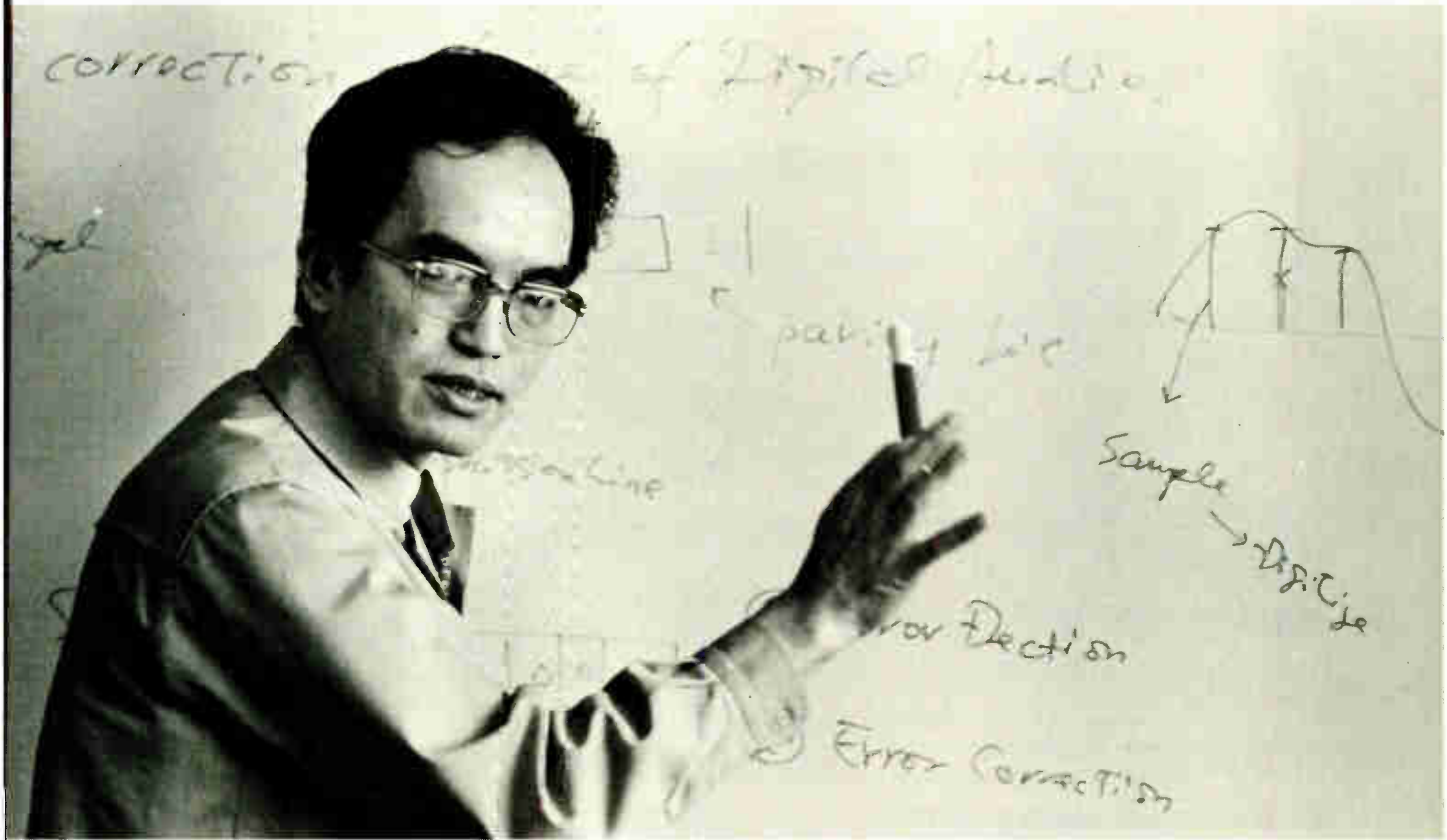
Mornings at eight. All Matsushita worksites in the vast company headquarters at Kadoma start the day with an 8 a. m. mass meeting. Wireless Research Lab general manager Masahiro Kosaka (front, right) will already be a half-hour into his usual 13-hour work day by then.

Japanese consumer-electronics companies already score high marks for marketing, but now the Matsushita Electric Industrial Co. has carried the concept of market-oriented strategy all the way back to its Wireless Research Laboratory.

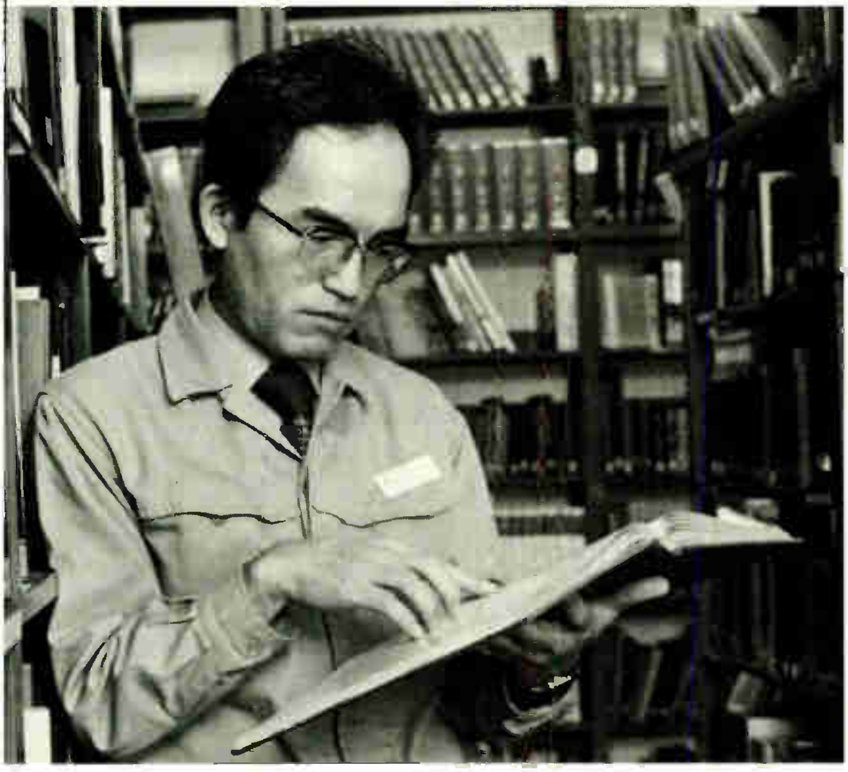
Masahiro Kosaka, the 44-year-old electrical engineer who heads the lab's six-month-old project-planning office has a difficult charter: his team must foretell what the market will want and then marshal the technologies for upcoming generations of products.

Kosaka no longer does hardware design, and he misses that. But he regards his switch to product strategy as "part of the changing role of the engineer."





By the numbers. Until six months ago a specialist in digital audio tapes and disks, Kosaka explains the theory behind a new error-correction scheme.



Backgrounder. During a long day of talking and listening, Kosaka manages to slip into the library to bone up for his new role: plotting strategy for a range of leading-edge products

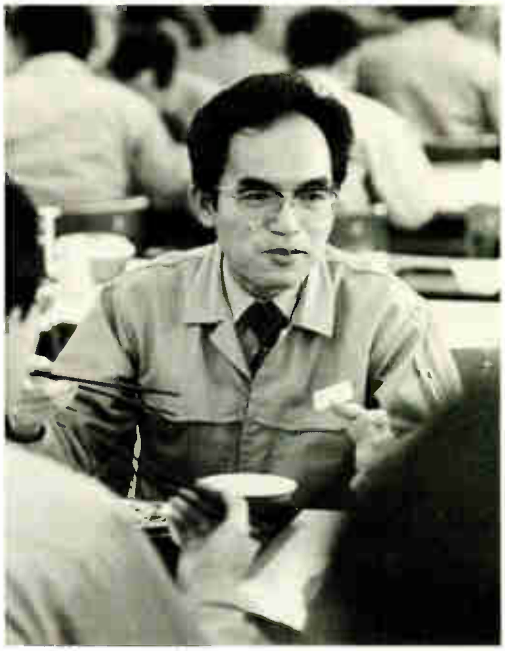
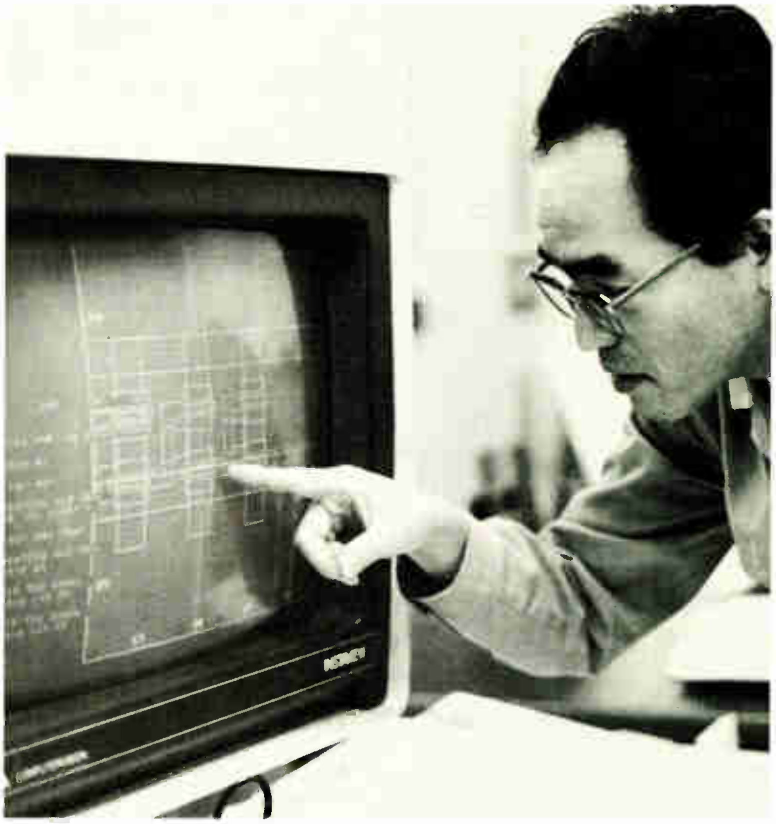


Table talk. By the time he sits down at the cafeteria for a fast working lunch with his staff, Kosaka has already checked off a half-dozen meetings on his agenda.



Delving into details. Hands-on design is no longer Kosaka's domain. Nonetheless, he still keeps an eye on the hardware in the works at the lab, like this layout for a large-scale integrated circuit (right) and the transport mechanism for a new video tape recorder (above).

Rocky Mountain EE sees CAE now coming on fast

Kent Hardage (left) has been working at Hewlett-Packard Co.'s R&D operation in Colorado Springs for 15 years now, and he has managed to keep up with technology all that time. "Here, engineers have always been able to pursue their interests," says the 39-year-old EE, whom *Electronics* profiled 12 years ago.

By pursuing his interest in computer-aided engineering, Hardage has become the man in charge of engineers' productivity at the operation, as well as a section head. "In that 1971 report, people were suggesting that everyone would soon be using CAD . . . it didn't happen. But today, I think we are really on the edge of a new CAE age."

Chip power leverages engineers' design skills

□ Time was when pencils, T-squares, and drawing boards were primal tools of the trade for engineers. But now computer-aided tools threaten to turn even electric pencil sharpeners into museum pieces. Indeed, a triad of techniques—computer-aided design (CAD) to automate drafting, computer-aided manufacturing (CAM) to automate production, and computer-aided engineering (CAE) to automate equipment design—portend sweeping changes in the ways electronics engineers work and what they are capable of doing.

The exodus from the drafting boards has been speeded by the advent of inexpensive work stations that boost engineers' productivity prodigiously, freeing them from mundane, time-intensive aspects of design like compiling specifications and parts lists. Both CAD stations, used primarily for physical layout and design, and CAE stations, used for logic design and analysis, have plummeted in price in the past few years from $200,000 and up for a single-station system to less than $50,000 for turnkey systems having one or more work stations.

For electronics engineers, such work stations and the data bases to which they are tied make it possible to create, simulate, and test on a terminal very large-scale integrated circuits that were nearly impossible to attempt before. But with this boost in capabilities will come added demands. Soon engineers who conceive of equipment will be responsible for the suitability of their designs, all the way from their terminals to the manufacturing floor. In addition, designers will be expected to turn out more complex products in a shorter time. And for those that can not or will not integrate software skills with design skills, the career outlook will pale.

Last January, at Cadcon '83 in Anaheim, Calif., keynote speaker and industry consultant Edward Zimmerman echoed this belief by stating that "by 1990, a Cadcon advertisement predicts, one out of five engineers will be applying CAD in their everyday work. I predict that by 1990, there'll be a minimum 20% differential in the salaries of CAD-augmented designers, as compared with their CAD-less professional competitors."

The prediction implies a boom in work stations, and heady forecasts abound. According to research firm International Resource Development Inc., Norwalk, Conn., the installed base of CAE work stations should rise from its current level of 8,800 to over 275,000 by 1993. And Strategic Inc., a forecasting firm located in San Jose, Calif., predicts that the market for such gear will grow at a rate of 81% a year. A dozen firms already have systems on the market, and they can expect much new company as the demand grows.

Electronics' survey of some 1,000 engineers among its subscribers suggests that roughly half the electronics firms in the U. S. have something going in CAD now—23.4% responded that they used it for all design work, and another 27.1% said it came into play mainly for big projects. Of the half that to date are not CAD-clad, 32.6% rate themselves candidates for automated design tools; the rest do not.

The numbers certainly will grow as the more advanced CAE work stations catch on. They are evolving out of today's CAD terminals, 70% to 80% of which are still mainly used for drafting, according to Ron Schlie of Aydin Controls Division, Fort Washington, Pa. Stifling their use for loftier tasks, he notes, is that many designers, especially in nonelectronic fields, "feel that certain design tasks are more art than science."

Young tigers

Because of this feeling, many managers say that it is hard to retrain an engineer with a lot of classic design experience to work with an automated design system. "It is rare that I can take a good design engineer with a lot of smarts and put him on a CAD system," claims Arthur Waller, design manager for Sperry Corp., Great Neck, N. Y. As a result, Waller looks for the "bright young tiger" who he feels is more acquainted with computers

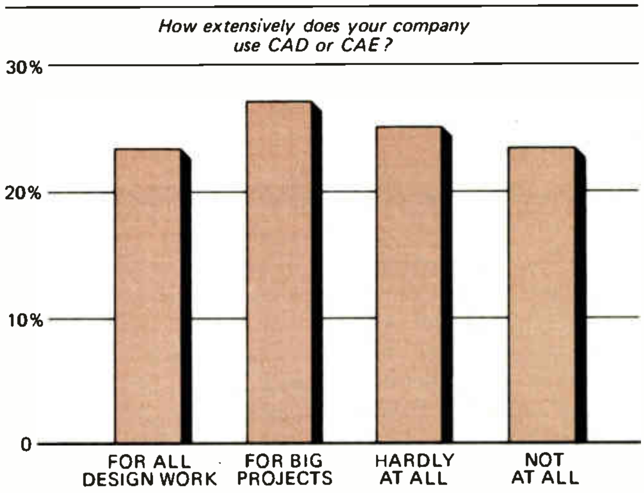
More than a drafting aid. Computer-aided-design (CAD) work stations are taking the drudgery out of many design tasks through the use of interactive graphics displays and an extensive data base.

and wants to use them in design. Many of the top students now graduating, he adds, would not consider working at a firm that lacked CAD or CAE capabilities.

These bright young tigers also differ in design philosophies from those of their older counterparts who are willing to use such systems, says Sam Stephens, manager of design automation for TRW Inc.'s Large-Scale Integration division in La Jolla, Calif. The old hands are accustomed to limited computing resources. As a result, they analyze a program more throughly in advance and structure it to run efficiently well within the constraints of the system.

On the other hand, youngsters who are used to such powerful tools as virtual memory push CAD and CAE equipment right to its limits. "Both [groups] are effective and useful, but it illustrates the difference in engineering educations," says Stephens.

AS YET, ONLY HALF OF THE COUNTRY'S EEs ARE REALLY INTO COMPUTER-AIDED DESIGN . . .



The first wave

One aspect of CAD that has changed working conditions for engineers is that it requires them to become broader-minded and more concerned with other disciplines and the production steps following design. CAD, says Steven Petrovits, project head of GEMS (Grumman Engineering and Manufacturing System) for Grumman Aerospace Corp., Bethpage, N. Y., will "break down the walls between disciplines." CAD users do not have to reinvent the wheel, he adds.

Engineers used to drawing the same circuit or device over and over will welcome the absence of reiteration. Mark McDermott, senior design engineer at Comsat General Integrated Systems Inc., Austin, Texas, believes that a successful CAD system takes the monotony out of being an engineer and potentially makes the job fun. "I think it's our job to make it enjoyable to sit down and design something," says McDermott, who has worked on chip designs. However, at present "a lot of problems come in when you are trying to get data into a computer. It's got to be easy and certainly forgiving."

John Bremer, program director of corporate design automation at Honeywell Inc.'s Solid State Electronics division in Plymouth, Minn., says that "in the past, circuit engineers did all of their design on paper and submitted it to a computer for analysis. In the future, design will become more personal, with the engineer doing the analysis as he goes along." He adds that "these are very exciting times for the new engineer since with

Netting a flock of work stations

Far from working in isolation, today's design engineers must interface routinely with all their colleagues, and at Apollo Computer Inc., those links are enhanced with the engineering work station. An in-house network that began evolving "literally within weeks after our first product was up and running" [*Electronics*, Dec. 4, 1980, p. 182] uses Apollo's distributed-operating multiple-access interactive network (Domain) terminals and an expanding array of software packages, says Russell Barbor, who is director of engineering at the Chelmsford, Mass., company.

Apollo's network, now linking over 100 terminals, "gives about two thirds of our engineers a personal work station, and we expect that all our engineers will have one by mid-year," Barbor predicts. In its early days, the network provided "clerical rather than design tools," helping engineers maintain wire lists and develop software; today it includes both circuit-design software packages from Mentor Graphics and from Silvar-Lisco and electronic-mail and project-management software that were developed by Apollo. "We developed the electronic-mail package ourselves because we wanted it up and running very quickly," says Barbor.

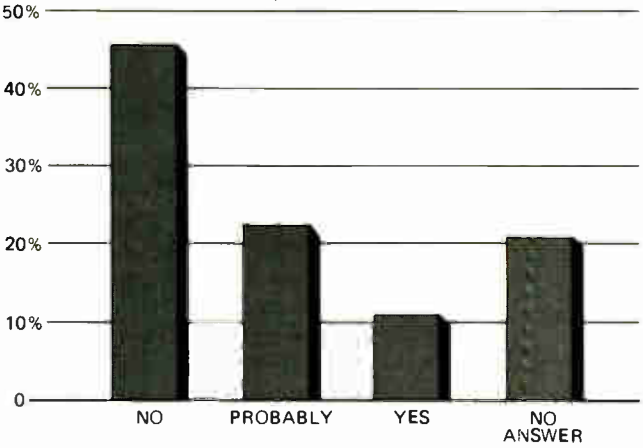
Yet another package, which Barbor expects to have on line before mid-year, will bring packaging design tools onto the network for the benefit of Apollo's mechanical engineers. Later on, the firm will bring its manufacturing and automatic-test activities onto the network, he adds.

The trick to building such a multidisciplinary tool, he says, "is to develop an effective central control mechanism for managing data, so people can find what they need quickly and avoid replicating one another's work." In this case, says Barbor, the key is Apollo's data-base management system, which facilitates the sharing of peripherals, programs, and data. It also ensures that all data is automatically updated across the network whenever any user makes modifications to a program.

Apollo's engineers, as might be expected, have responded enthusiastically to the network. "They like having all that computing power sitting on their desk," Barbor says. Adds Apollo engineer Jeffery D. Kurtze, "The electronic-mail feature also makes the job easier; the project I'm working on now involves tight cooperation among R&D, manufacturing, marketing, and customer-service people, but I can stay in close touch by terminal, so I'm more relaxed and flexible about my working schedule." **–Linda Lowe**

. . . AND HALF OF THOSE WHO ARE NOT, EXPECT THEY NEVER WILL BE . . .

If you are not now, do you expect you will have to become proficient in CAD?



design automation he will be much more responsible for whatever it is he is working on from start to finish."

But this responsibility may have an effect further down the production line, says James Rinderle, assistant professor at Carnegie-Mellon University in Pittsburgh. Because engineers will have a much better control of the design process and may tend to create products much closer to the listed specifications than before, manufacturing flaws will be more prone to appear. "CAD will force others to do the job well. It brings to the forefront the difficulties of others," he maintains, because the fudge factors traditionally found in designs will no longer be present.

Many of the firms just now turning to automated design tools of course start by exploring their capabilities. According to Pat Hennessy, design section head at Sperry, CAD terminals enable engineers to visualize the job better since they can now include the fine detail. "The kind of detail that you can get from a CAD system, you would have chewed a guy out for spending that kind of time on it years ago."

What's more, with the extra time afforded by CAD, an engineer can go back and tweak his design in ways that were previously impossible. As a result, simple projects that previously took 12 weeks are being replaced by more complicated ones taking six weeks, says Sperry's Waller, "—and I am unhappy with six."

Waller's engineering section has 13 Computervision terminals, which are used around the clock, six days a week. The usual 9-to-5 work schedule is something that Waller says he cannot afford because of the size of his investment in these tools and the business that they bring. And with work picking up, he may ask his crew to come in on Sundays.

Waller may be going to an extreme, yet many companies having CAD systems find that they must use them for at least two shifts. Aydin Controls Division's Schlie said that one architecture firm that bought the company's Aycad system cut back from 13 to 5 draftsmen yet tripled its workload.

Better, faster work

Such gains in productivity are often the carrot that is bobbed in front of engineering management to entice it into purchasing automated design tools.

According to Grumman's Petrovits, the extra time

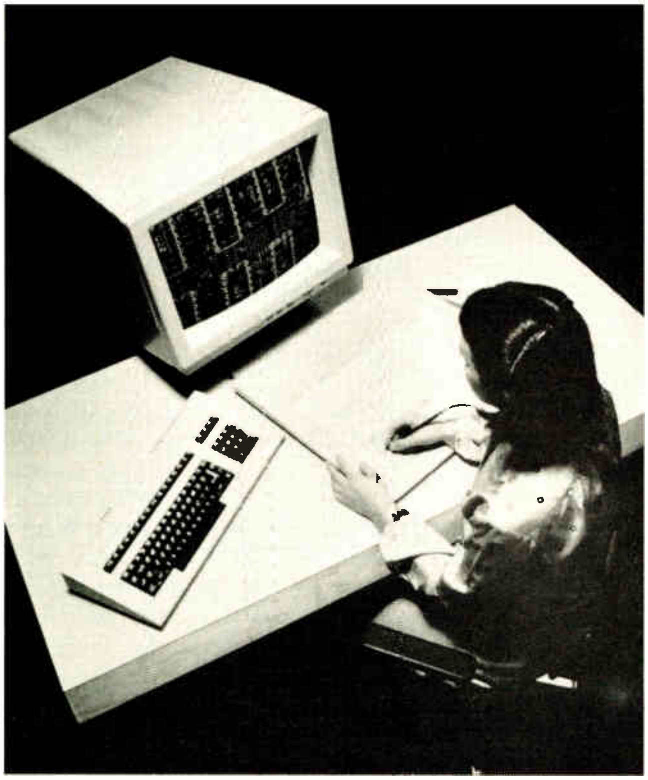
Waiting for CAE

With the imminent arrival of 12 computer-aided-engineering work stations dedicated to gate-array design, Jerry Williams, director of logistics for Gould Inc.'s Systems Engineering Laboratories, expects to shave at least a year off the company's next minicomputer development effort. But not all of his colleagues at the Fort Lauderdale, Fla., firm share his strong convictions. In fact, while Williams was extolling the virtues of CAE work stations to management, the engineers back in the design room were raising doubts as to how quickly the alleged productivity gains would materalize.

The initial battle was fought in conference rooms with top executives over whether the time was right to buy a product still in its infancy. However, they were won over by the impressive gate-array software package offered, plus the promise of shortening what Williams describes as a "very high-risk program with an aggressive schedule." In the end, he added, "everyone bit the bullet, agreeing that pushing state-of-the-art requires taking risks early on."

Though the conference-room battle was won and the work stations are on their way, Williams must now face the 24 engineers who will be using the dozen Gate Master and Logician CAE systems from Daisy Corp. of Sunnyvale, Calif. Their fears center on three concerns, says Williams. First, they question whether the new technology will enable them to perform their jobs as well as before. Second, they concede that the equipment may show long-term gains but only at the cost of slowing them down in the short run. Finally, they worry about the integrity of their work should the system fail or be broken into by someone out to corrupt their designs.

Although only experience will allay their fears, Williams contends, the group is convinced that CAE work stations can be a productive tool if properly managed and implemented—a task that is William's main responsibility. Those holding the most negative opinions are the older engineers "who tend to perceive rapid technology advances as a bit unsettling," says Williams. On the other hand, young engineers see CAE as an opportunity to stay in the forefront of their specialty. –**Karen Berney**



Eases IC design. CAE work stations are helping engineers to create complex ICs faster with fewer errors. The chip's operation may be simulated graphically so they can be tested and altered quickly.

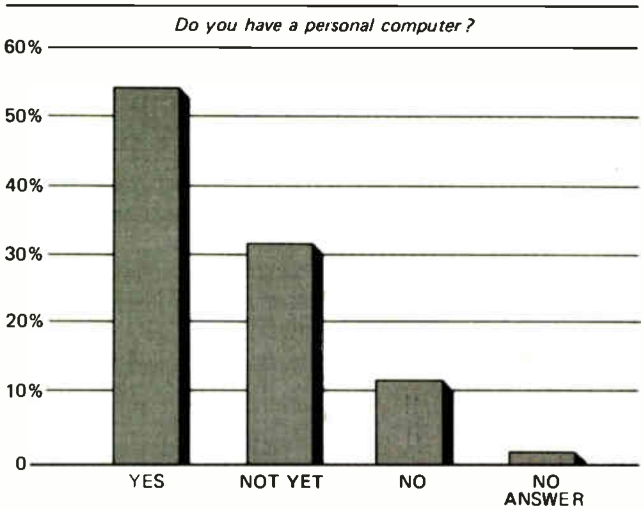
freed up by such tools is being spent on increasing the complexity and shortening the project times for systems . "Without these aids, there [would be] no way that we could meet the schedules," he says.

But this gain in productivity is not all good: engineers working with automated design tools tend to tweak their creations excessively. "It gives you more time, but that doesn't mean that you are going to use it more effectively," says Petrovits. As a result, he is convinced that engineers using the tools should be closely monitored.

The great data bases

One major advantage of automated designing is that all the data pertinent to a project is saved so that others may draw from it (see "Netting a flock of work stations," p. 142). To Schlie, this reduces the dependence on

. . . BUT EVENTUALLY A HEAVY MAJORITY OF ENGINEERS WILL BE WORKING OR PLAYING WITH A PERSONAL COMPUTER.



each individual and lets the company using CAD systems retain the expertise of the engineer if he leaves.

In fact, to Alfred Vachris, the existence of a data base appears to be perhaps the best thing about CAD systems. As project leader for Grumman's Rapid Aerospace Vehicle Evaluation System, what he wants is information that can change and be tapped by any designer needing it. He maintains that designers have maybe 90% of a design in their heads and need stimulation to express it on paper. Computer tools force an engineer to record all the parameters of a design exactly.

These data bases offer the bonus of decreasing design errors. Robert Payne, manager of Honeywell's design network, says, "We've got examples of how if you fail to get it right and thus delay a project by several months, you can impact the cost of a project by millions of dollars." Costly errors will occur much less frequently using CAD, says Payne, because of safeguards built into the system at various checkpoints along the path of the design process.

New wave

New systems on the way will do still more. According to Richard Miller, director of marketing for Applicon Inc., Burlington, Mass., traditionally the strongest CAD presence has been felt in the area of physical layout for integrated circuits and printed-circuit boards. However, a host of developments is expanding the role of CAD systems into CAE, embracing automation of the logic design process and verification of system logic and timing. Speeding these developments, observes Miller, are the current shortage of logic designers and the resulting pressures on those that are available to increase their productivity.

Honeywell's Payne says, "Engineers will be increasingly looking toward gate arrays and silicon as a way to do their designs. Much more of the job will be automated, so the engineer can raise himself above the mundane tasks that he's had to do in the past."

To make the engineer feel at ease with these complex tools, the burden of data entry must be reduced says McDermott of CGIS (see "Waiting for CAE," p. 143). Standard interfaces should help, according to David Carter, senior consultant of CAD/CAM operations for McDonnell Douglas Automation Co., St. Louis, Mo. They would mean that an engineer could work equally well on any work station and not be constrained to a particular vendor's model.

CAE may even diffuse down to the level of personal computers. John Spivack, industry manager for International Business Machines Corp.'s Engineering CAD/CAM Support Center in Los Angeles, says that IBM fully expects that the Personal Computer will have a large role to play in design systems. Design engineers will want to have a personal computer at home and have it look like a design terminal when it is hooked up to a CAE design system. That situation is not here yet, but it is coming, he adds. □

Computer imperatives pose problems for educators

☐ Never in the past 25 years have the 255 colleges and universities in the U. S. that award degrees in electrical engineering known more feverish public scrutiny than they are getting right now. They are the wellspring of the high technology that is the source of much of the country's economic well-being.

Once considered supreme, American technology has been partially eclipsed in world markets by the rising sun of Japan. What's more, the Soviet Union, if one can believe U. S. leaders, now has at least matching military prowess. To many observers, a higher output of engineers is essential to cope with these challenges.

Indeed, the raw statistics underscore a serious shortfall. Some 950,000 students receive bachelor's degrees annually in the U. S., three times as many as Japan. Yet U. S. schools turn out 15% fewer engineering graduates than Japan does. The Soviet Union awards fewer bachelor's degrees than does the U. S., but nonetheless manages to turn out four-and-a-half times as many engineers.

Covering the shortfall will be difficult. Despite a declining high-school population and the woeful weakness in mathematics and science of many college freshmen, U. S. engineering schools still cannot find room for all the qualified students who apply. There are not enough classrooms and laboratories; and there are too few professors. Although the business community has long clamored for more engineers, major industry contributions of money and equipment to engineering schools started coming in only recently; thus it will take years before they will have an impact on the output of engineers.

Crowd control

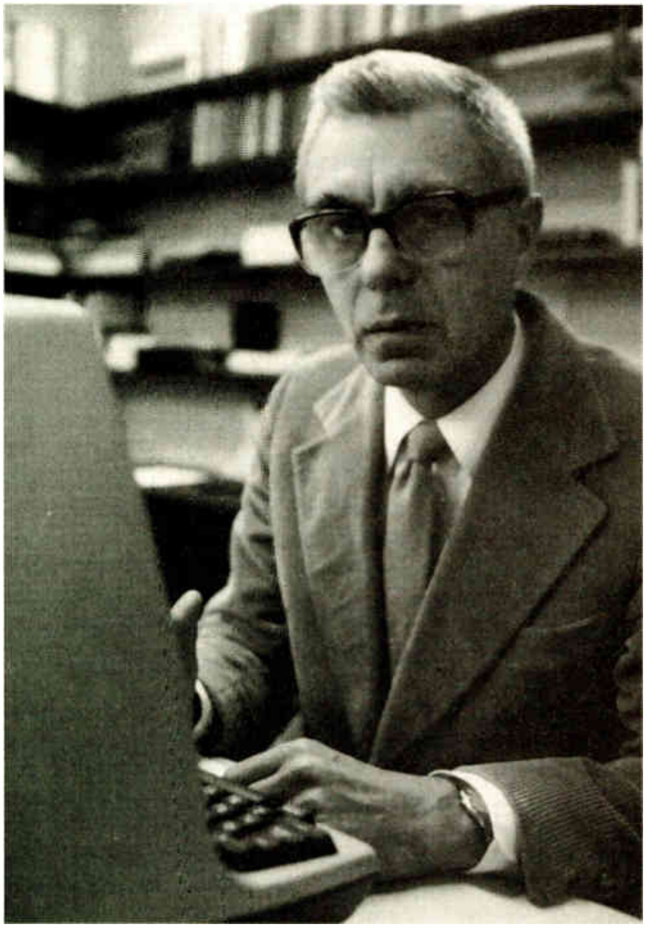
Strapped for resources, most university engineering deans insist they must concentrate on maintaining the quality of education before they can think about increasing the quantity. "We can't build buildings as fast as students are applying," says Robert H. Page, engineering dean at Texas A&M University in College Station, where work will shortly wind up on an $18-million engineering laboratory complex, to be followed by another two buildings still on the drawing boards.

Page's plaint is not an unfamiliar one. California's San Jose State University, for example, turns away four or five applicants for every one it accepts. In West Lafaytte, Ind., Clarence L. Coates, chairman of Purdue University's electrical engineering department, expects to see enrollment caps set for EE majors in the next five years.

If the leading schools cannot take in all the would-be engineers, they at least get a top-drawer selection. Page and his counterparts at other schools are nearly unanimous about the increasing degree of computer literacy among incoming students. "They're sold on computers, and they expect as a matter of course that computers will be standard tools," says Angel E. Jordan, dean of the Carnegie Institute of Technology at Carnegie-Mellon University in Pittsburgh, Pa. Computers, indeed, figure prominently in the changing curriculums that many schools are devising to turn out graduates who can cope with the onrush of technology when they move out into the workaday world (see "CSU's Johnson would add computer courses to core," p. 147).

Not only are schools adding courses in computer architecture, microprocessors, and computer-aided design, they are also exploring computer-aided instruction as a means of easing the teaching load on faculty. Texas A&M,

Believer in basics. Texas A&M's engineering dean Robert Page is convinced that graduates well versed in basics like mathematics and trained in problem solving can cope with changing technology.



One-on-one. MIT's Joel Moses expects computer-based "intelligent tutors" will augment classroom and laboratory instruction by providing students with the individual instruction professors cannot always give.

for one, has run a year-long test of CAI, using Control Data Corp.'s Plato educational software. Now the school plans to make it a standard part of basic engineering courses. Lehigh University in Bethlehem, Pa., has had CAI on line for a year, says Donald M. Bolle, dean of the College of Engineering and Physical Science.

Although educators refute any notion that CAI could replace human instructors, they do see its potential as an "intelligent tutor." Joel Moses, head of the department of electrical engineering and computer science at the Massachusetts Institute of Technology, Cambridge, predicts, "Artificial intelligence programs will be a great help when they come along, since they'll track a student's consistent problem areas, as well as simply feed information." But CAI is expensive, points out Purdue's Coates; for that reason, he adds, it is probably not going to play anything but a limited role in the near future.

Pressed for time

Even with computers helping out, educators admit there is not time enough to teach EE students all they would like in the four or five years allotted to the task. The trend toward incorporating more specialty courses in important new technologies is making most schools' traditional goal of educating engineering generalists hard to maintain, says Francis Boesch, chairman of the electrical engineering and computer science department at Stevens Institute of Technology in Hoboken, N. J. Boston's Northeastern University, for example, recently added several new offerings, ranging from robotics to software engineering, to its increasingly popular computer engineering program. "Something's got to get pushed aside to make room," says engineering dean Harold Lurie.

At some schools, the humanities component of the curriculum most likely will suffer. Continued insistence on humanities appears more and more at odds with real-world concerns, laments Boesch at Stevens. However, most schools are still trying to hold the line on liberal arts requirements. Columbia University in New York, for example, recently introduced required courses in very large-scale integration and microprocessor design, but its EE students still must deal with compulsory courses like contemporary civilization and great books.

James Freeman, chairman of San Jose State's electrical engineering department, points out that students have only a few years to prepare for a decades-long career in a fast-changing field. So schools, he says, must make their major effort a grounding in the "invariant knowledge" that any engineer needs before setting off on a specialty. The school thus has not changed its traditional mix of requirements in basic mathematics and physics, engineering subjects, and humanities. Nor has nearby Stanford University. Despite "pressure to liberalize the undergraduate program, the requirements haven't changed one

Think big. At Purdue, microcomputer courses carry great weight. EE department head Clarence Coates sees them as a way to instill a "big problem perspective" in the minds of engineering students.

iota," says William Kays, the dean of engineering.

Having the best of both worlds—a graduate who takes hold quickly at work and still has the fundamentals to stay the course—is the goal of co-operative programs like the one Northeastern uses for all its students. The school sends undergraduates out to work in industry co-op jobs at various times during their five-year career, so that at graduation "they've already got nearly two years' worth of on-the-job experience under their belts," notes Lurie.

The University of California at Berkeley has an optional co-op program, which may be elected by students in their junior or senior year. MIT offers a five-year combined bachelor's and master's degree program, which however accomodates only about 25% of its engineering students; it includes three summers and one full semester of work in industry. Duke University in Durham, N. C. has no formal co-op program, but many Duke students take the option of working part time at nearby Research Triangle Park, which has attracted numerous high-technology firms since its establishment 25 years ago.

Ideally, the school years should put in place "a foundation for lifelong learning," says Texas A&M's Page, and educators are increasingly turning their attention to the ongoing educational needs of their alumni. An MIT report that last year urged industry and academia to cooperate on a massive scale in providing educational support for working engineers throughout their careers [*Electronics*, Oct. 6, 1982, p. 76] has already been through several printings, with about 3,500 copies sent out.

The tutored-video-instruction (TVI) approach pioneered by Stanford University in the last decade is serving as a model for education's outreach to working engineers. Purdue, which offers master's-level courses at regional campuses in most metropolitan centers in Indiana, also beams these courses to companies with a satellite downlink on the premises. Both Northeastern and MIT say they will begin transmitting courses for credit to companies on the Route 128 perimeter this fall; MIT will offer a Lisp programming course with a laboratory component, while Northeastern will start with two or three graduate-level engineering courses.

Columbia's engineering dean Robert A. Gross wants to see his department initiate a TVI program, "but so far local firms haven't organized and put up the considerable money it would entail." The electrical engineering department of the University of Minnesota in Minneapolis may take an even more individualized approach: it is considering putting coursework on magnetic disks for access by working engineers at their own computers.

Industry lends a hand

Meanwhile, back on campus, industry-sponsored research programs are typically geared to graduate students with their more specialized interests, but they can have a stimulating, filter-down effect on undergraduate curriculums as well (see "Industry abets Minnesota engineering education," p. 148). Some educators reject product-oriented research however; Columbia's Gross speaks for most in saying "that's something universities do terribly; it's intellectually dull and pedagogically wrong."

Far more productive for all involved is what Steven's Boesch calls "motivated basic research," programs that

CSU's Johnson would add computer courses to core

Adding to the number of required courses may not be popular with students, but professor Gearold R. Johnson of Colorado State University's College of Engineering feels something must soon be done to incorporate more computer education in undergraduate engineering curriculums.

"There is absolutely no doubt. We are going to have to do it. Today, it's not only important that undergraduates become computer literate but they must also be semi-experts," he says. Johnson teaches computer science and mechanical engineering at the Fort Collins, Colo., campus; he also directs the college's Center for Computer-Assisted Engineering, currently fitted out with $1.3 million worth of CAE hardware and $300,000 worth of software.

Despite the extensive facilities, computer-aided design at CSU still is an elective pursuit. Johnson and some of his colleagues are determined to change that. At the moment, the curriculum committee is debating whether or not it should make six credits for computer and CAD-related classes part of the core program for the bachelor of science in engineering. Also, a B. S. degree requires 128 credits, and it has not yet been decided whether simply to add the proposed credits on or to substitute them for other core courses. One three-credit course would introduce freshmen to programming fundamentals and computer technology. The second would be an introduction to computer graphics.

"Until the engineering schools in the country recognize that computer science is a fundamental core subject and treat it like we now treat chemistry, physics, or mathematics, I think we [educators] will always view engineering and computer students as on totally separate paths," maintains the 43-year-old Purdue Ph. D. That view, he says, may be difficult to change on many campuses because computer tools have only recently become necessary to perform advanced engineering tasks. "The working experience of many faculty members actually predates the massive infusion of computers," he says. **—J. Robert Lineback**

Industry abets Minnesota engineering education

In the planning stages just three years ago, the University of Minnesota's industry-funded Microelectronics and Information Sciences (MEIS) Center already is having a major impact on undergraduate and graduate curriculums at the university. MEIS's research projects, which focus on a variety of design and software engineering problems in very large-scale integration, currently involve about 50 graduate students, 25 of whom the center is supporting with $11,500-per-year fellowships, and some 45 faculty members.

Moreover, the center also has provided $120,000 for the addition of two professors at the undergraduate level, who last fall began teaching newly developed sophomore courses in digital design and microprocessors. The funding is for two years, with the understanding that the new faculty members will be picked up by the university's regular budget afterwards. MEIS contributed about $80,000 for laboratory equipment for the two undergraduate courses.

At the graduate level, the center is sponsoring a six-quarter VLSI engineering and laboratory course, with lecturers drawn from its corporate sponsors, as well as from the university faculty. In the course's first year, students designed several complementary-MOS and emitter-coupled-logic chips, which the sponsor companies have fabricated. During this quarter, the students are testing and designing packaging for their creations, says Bernd Hoefflinger, head of the electrical engineering department. He adds that MEIS is sponsoring shorter graduate courses in computer-aided design techniques and software engineering.

The center's first sponsor was Control Data Corp., which provided $2 million to get it rolling [*Electronics*, April 24, 1980, p. 98]. CDC was soon joined by Honeywell Inc., Sperry Corp., and 3M Co.; jointly they have committed $7 million to the center for a five-year period ending in 1985. Another industry sponsor, General Electric Co.'s Calma Co. subsidiary, has contributed a CAD system with three color-graphics work stations worth about $700,000.

MEIS expects further funding from industry, which the state of Minnesota may match to the tune of $2.9 million, and about $3.2 million for the 1983–85 period from the Department of Defense and the National Science Foundation, Hoefflinger reports. One sponsor company, Honeywell, currently is loaning a "scientist in residence," and Hoefflinger expects to see more such adjunct faculty in the future. He says that all industrial support is unconditional, and that any patents resulting from MEIS research will belong to the university. **–Wesley R. Iversen**

either pursue promising but long-term technological leads for which industry does not have time or else explore new and possibly better approaches to current technical problems. Although most schools say government funding for research is either holding steady or slightly increasing, all report a new surge in industry commitment to such projects.

Thus Carnegie-Mellon notes its two largest research programs, the robotics institute and the magnetics laboratory, are supported by industry to the tune of 50% and 70%, respectively. The California Institute of Technology in Pasadena recently put in place a $500,000 program in optoelectronics research with the aid of Rockwell Corp., while Stevens has graduate students and faculty working on specialized communications methods for the likes of ITT, IBM, and the U. S. Army. MIT, whose VLSI research center needs $21 million to get underway, has to date raised $19 million—half of it from industry. Purdue's year-old Computer-Integrated Design, Manufacturing, and Automation Center has a $2 million annual budget for work on new approaches to factory automation; most of the money comes from sponsor companies that include Control Data, Cincinnati Milacron, and TRW. Each of the corporate sponsors has contributed at least one employee to live on campus and work with Purdue graduate students and faculty at the center.

Often in conjunction with programs they help fund, companies lend their own employees to act as part-time professors—the beginnings of recompense for all the faculty and potential graduate students industry lures away with offers of higher salaries. Columbia, for instance, boasts 42 such part-time professors from firms like Bell Laboratories and IBM. Though such teachers do not have as much time for student supervision as regular faculty have, they do bring to the classroom a wealth of real-world experience, notes Carnegie-Mellon's Jordan.

Despite industry's willingness to donate teaching staff, however, most engineering deans are pessimistic about their schools' ability to educate effectively without the financial means to attract high-quality faculty. "An assistant professor wth a Ph. D. now gets about what industry pays entry-level engineers with a bachelor's degree," says Lurie at Northeastern. Given those economies, it is hardly surprising that not only are the number of graduate students declining yearly, but also that "the number of Ph. D.s that go into the academic field is now a quarter of those receiving degrees; it used to be a third," says Texas A&M's Page. □

All of Electronics' *field bureaus in the U. S. and abroad interviewed typical electronics engineers in their areas for this special report on the sweeping changes taking place in the practice of engineering and then contributed reporting. Senior Managing Editor Arthur Erikson organized the report and wrote the main story. Reporting for the four picture stories came from Marilyn Harris, New York Bureau (Al Titan); Eve Newman, Palo Alto Bureau (Kate Rosenbloom); Robert Neff, Tokyo World News Bureau Chief (Masahiro Kosaka); and J. Robert Lineback, Dallas Bureau (Kent Hardage). The article on computer-aided engineering was written by Industrial and Consumer Editor Erik L. Keller, and the piece on enginering education was done by Linda Lowe, Boston Bureau Chief.*

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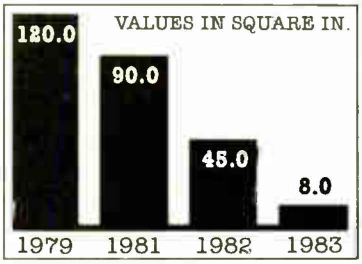

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Dual-modulus synthesizer needs little power

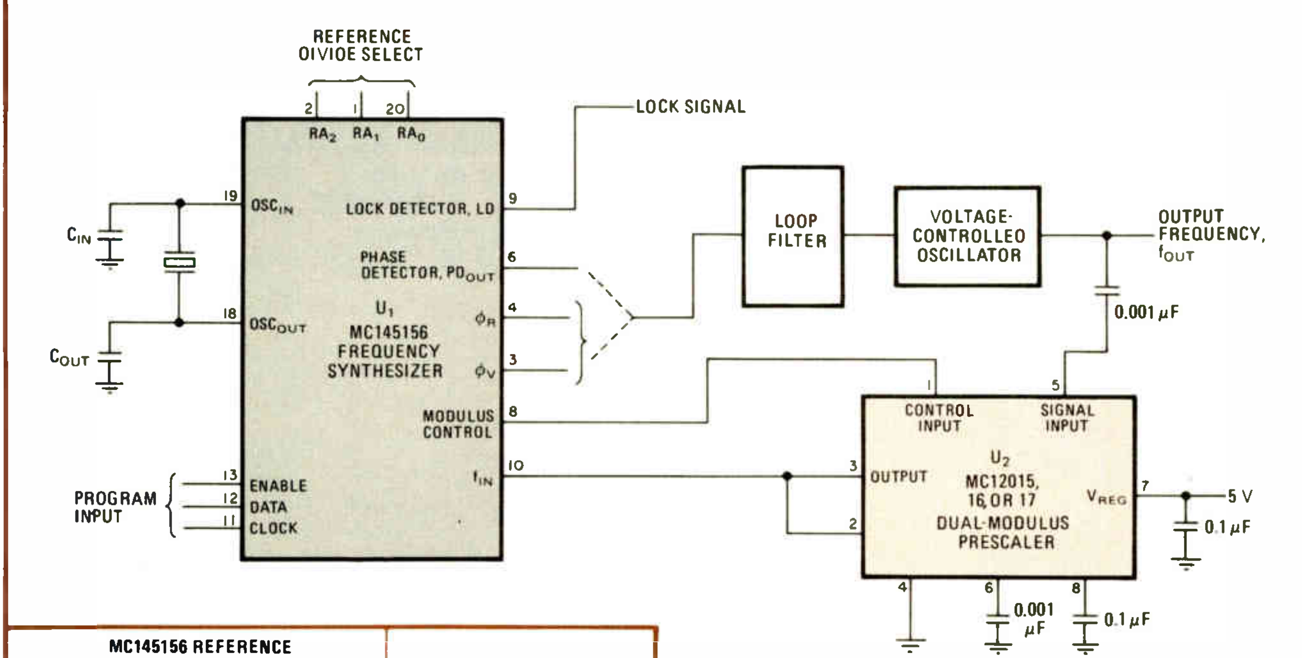
by John Hatchett
Motorola Semiconductor Products Sector, Phoenix, Ariz.

Dual-modulus prescaling has long been recognized as the technique of choice for achieving high frequency and performance in phase-locked–loop radio-frequency synthesizers [*Electronics*, Oct. 9, 1980, p. 148]. Unfortunately, such designs have consumed too much power and space to be practical for small battery-operated instruments. This version, however, uses only two chips to provide a 225-megahertz synthesizer that requires less than 10 milliamperes from a 5-volt dc supply.

The total system division value, N_{total}, sets the synthesizer's output frequency. The output frequency is represented by $f_{out} = N_{total} \times f_R$, where f_R is the loop's phase-detector reference frequency and is determined by dividing the oscillator's frequency by the value of the reference counter.

If values for N and A, which are the numbers programmed into the on-chip divide-by-N and divide-by-A counters of frequency synthesizer chip U_1, the system division value can be determined from $N_{total} = (N \times P) + A$ for $N \geq A$, where P represents the smaller division value that is provided by dual-modulus prescaler U_2.

The modulus-control signal generated by frequency synthesizer U_1 selects the prescaler's division values in a specific timed format, while the 3-bit code applied to the division-value select pins of U_1 sets the division value of the reference counter. The voltage-controlled oscillator is maintained at f_{out} by the error signal generated by the phase detector of U_1. In addition, the frequency synthesizer allows an integer value of 3 to 1,024 for N and 0 to 128 for A. □



MC145156 REFERENCE ADDRESS CODE			TOTAL REFERENCE DIVIDE VALUE
RA_2	RA_1	RA_0	
0	0	0	8
0	0	1	64
0	1	0	128
0	1	1	256
1	0	0	640
1	0	1	1,000
1	1	0	1,024
1	1	1	2,048

DUAL-MODULUS PRESCALER		SYSTEM DIVIDE RANGE $N_{TOTAL} = (N \times P) + A$
PIN-EQUIVALENT DEVICE	DIVIDE VALUES (P / P+1)	
MC12015	32 / 33	992 TO > 32,799
MC12016	40 / 41	1,560 TO > 40,999
MC12017	64 / 65	4,032 TO > 65,599

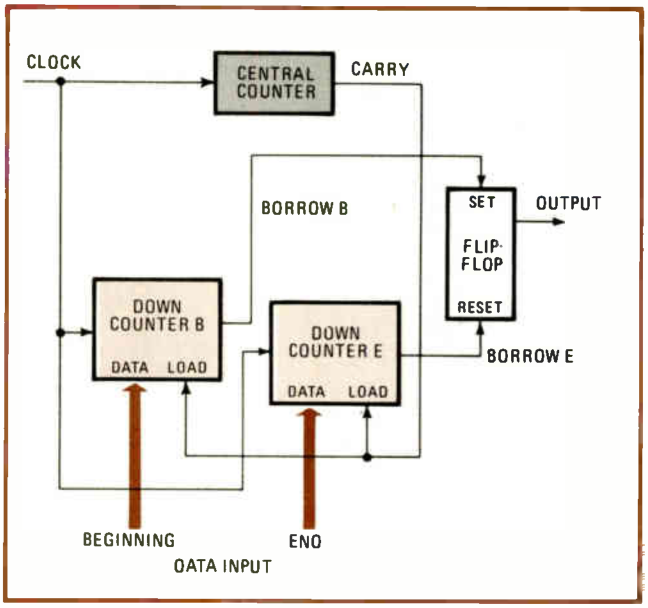
Scaling. This circuit provides a rf synthesizer that consumes very little power and operates from a 5-V supply by pairing dual-modulus prescaler U_2 with C-MOS synthesizer chip U_1. U_1 furnishes U_2 with the control signal that selects U_2's division value. Division ratios can range from 992 to 65,599. In addition, the circuit can synthesize frequencies up to 225 MHz.

Digital pulser provides programmed width, position

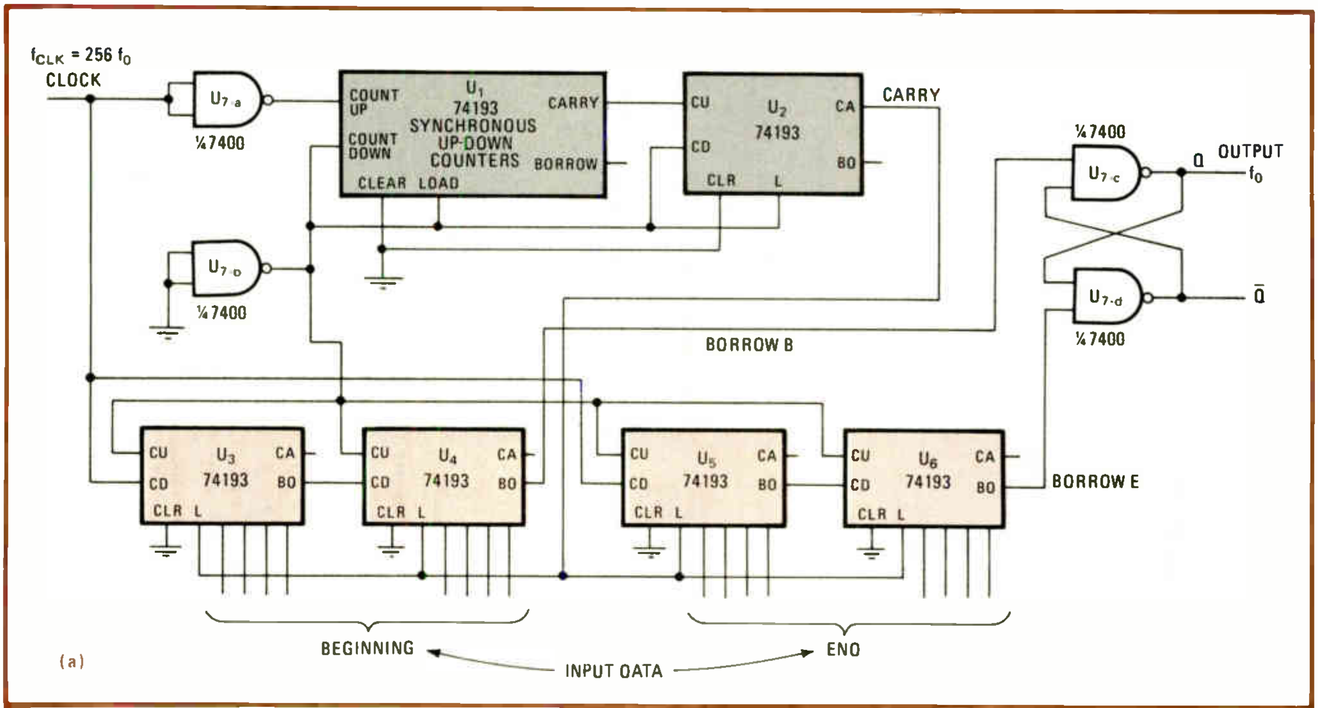
by Marian Stofka
Bratislava, Czechoslovakia

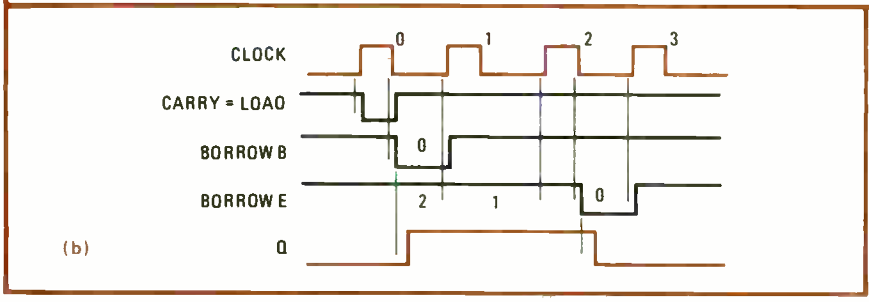
The job of testing a digital circuit design often requires a pulse generator whose start and stop times are controlled by a precise and programmable amount. With a central counter and two programmable down counters, this design (Fig. 1) accomplishes this task and has a resolution that is a function of the counters' capacity. Two digital words at data input port determine the turn-on and -off times of the output pulse.

Whenever the central counter reaches an overflow state, a carry pulse is generated at its output. At this point, the two down counters B and E are programmed with the input data, which carries the information concerning the output pulse. When counter B reaches the value of zero, a pulse generated at its borrow output sets the flip-flop, thus initiating the start of the output pulse. Similarly, when counter E reaches zero, a borrow pulse at its output resets the flip-flop, thereby giving the desired width of the output pulse.



1. Selectable edges. This pulse generator produces a pulse having a defined width and position within a given period and with a resolution given by the capacity of the counters. Two digital words serving as a data input determine the start and stop times of the output pulse. The borrow pulse generated by counter B sets the output flip-flop, while the borrow E pulse resets it.





2. Hardware. The fundamental pulser is realized by incorporating six 4-bit programmable counters U_1–U_6 and a NAND gate chip U_7 (a). The 256 selectable start and stop edges of the output pulse are programmed by the two 8-bit words functioning as data input. Counters U_1–U_2 function as the central counter, while U_1–U_6 simulate down counters B and E. The various pulses generated by the circuit are shown in (b).


REF LEVEL
10 dBm
INPUT ATTEN
10 dB ATTEN
LOG SCALE
10 dB/
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PTS
FREQUENCY SYNTHESIZER MODELS
40 MHz, 160 MHz, 200 MHz, 500 MHz
PTS
PROGRAMMED TEST SOURCES, INC.
Circle 152 on reader service card
Littleton, MA, 617-486-3008

The counters employed may be binary or binary-coded decimal. For the binary counters used in this setup, the start and stop times can be resolved to within $2\pi/16^k$ radians, where k is the number of 4-bit chip counters cascaded within the fundamental down counter.

The hardware realization (Fig. 2a) uses two 4-bit programmable counter chips to form the basic down counter and has a resolution of one part in 256. Two 8-bit words form the input data that program the output pulse's 256 edge positions. The timing diagram (Fig. 2b) illustrates the relationship between the clock, input data, and output pulse. □

Pulse generator has independent phase control

by Roberto Tovar Medina

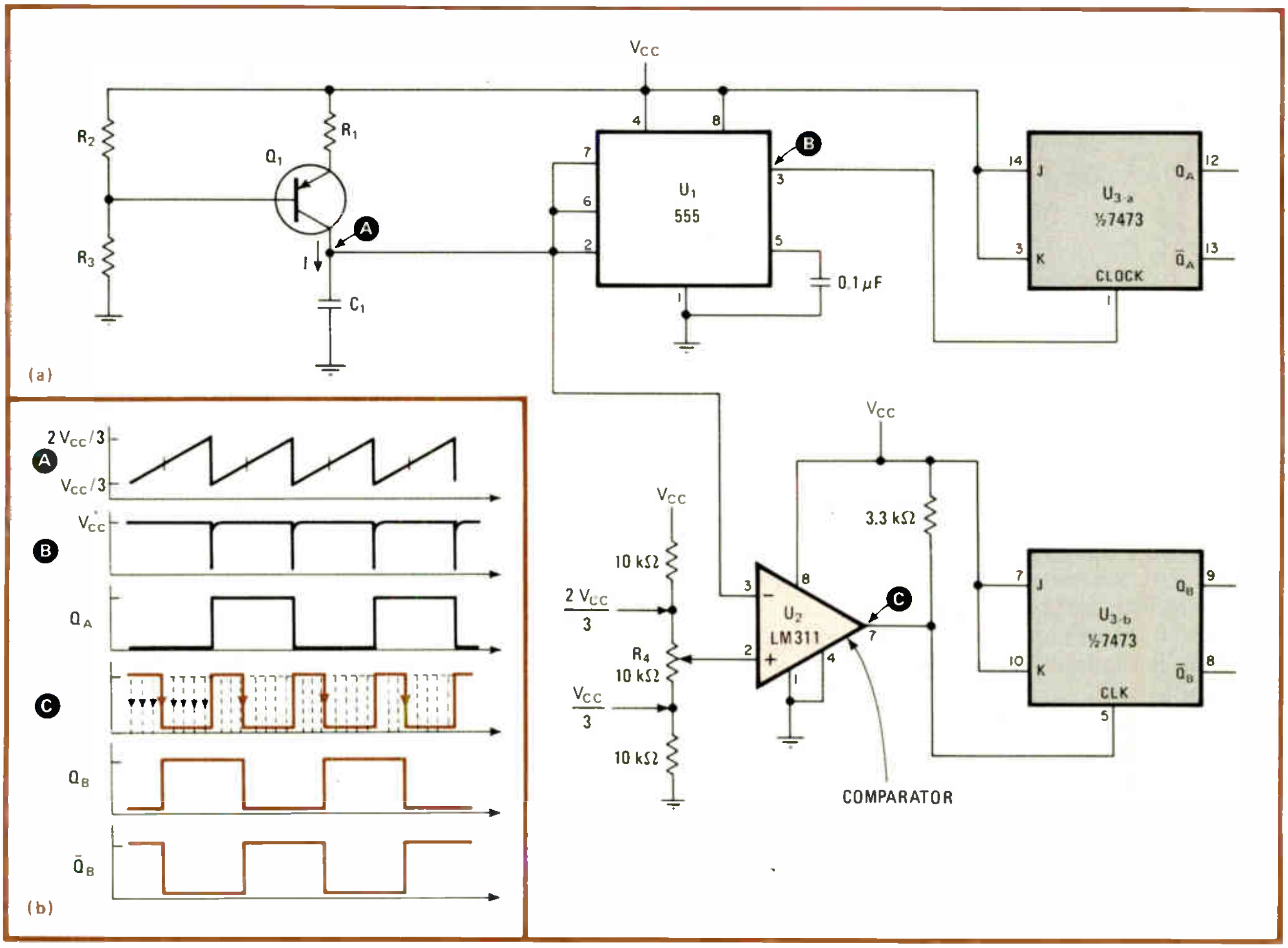
Institute of Applied Mathematics, University of Mexico, Mexico

Many phase-locked–loop applications need a circuit to generate signals whose phase can be controlled independent of their other characteristics. Using a 555 timer and a few discrete components, this design provides a pulser with independent phase control between 0° to 180°. In addition, the phase is continuously adjustable.

Timer U_1 (a) together with transistor Q_1 and capacitor C_1 generates a sawtooth signal whose amplitude is between $V_{cc}/2$ and $2V_{cc}/3$ (b). For every cycle of this sawtooth wave, a short pulse is produced at the output of U_1. This pulse clocks flip-flop $U_{3\text{-}a}$ to generate reference signal Q_a. By comparing the sawtooth signal with a reference voltage provided by potentiometer R_4, the comparator output clocks flip-flop $U_{3\text{-}b}$ to generate pulse Q_b that is phase-shifted with respect to the reference.

Because this phase difference bears a linear relationship to the reference voltage at the noninverting terminal of U_2, R_4 is calibrated in terms of the phase control, with $V_{cc}/3$ corresponding to 0° and $2V_{cc}/3$ to 180°. Since both Q_b and $\overline{Q}_b$ are available from the output flip-flop, the circuit provides both phase-advance and phase-lag versions of the reference signal. □

Designer's casebook is a regular feature in Electronics. We invite readers to submit original and unpublished circuit ideas and solutions to design problems. Explain briefly but thoroughly the circuit's operating principle and purpose. We'll pay $75 for each item published.



Adjusting phase. Using a 555 timer and a few components, this design (a) provides a pulse generator with independent phase control. The output can be either delayed or advanced with respect to the reference at Q_a. R_4 is calibrated in terms of the phase difference, with $V_{cc}/3$ corresponding to 0° and $2V_{cc}/3$ corresponding to 180°. The timing diagram (b) depicts the phase relationship between the reference and the outputs.

VLSI test system grows in pin count and functionality

New pin card supports up to 256 pins and all common logic families; pattern processor mixes stored and algorithmic sources for functional checks

by Alan Whiteside, *Tektronix Inc., Beaverton, Ore.*

□ Very large-scale integrated circuits, with their increased pin counts and improved timing parameters, demand increased versatility and precision from a test system. To ensure high quality, a VLSI test system must be able to accurately simulate a worst-case "real world" situation; to be cost-effective, it must do so for all types of devices. Further, it must reduce test times and program development time in spite of the mushrooming complexity of VLSI parts.

In response to these criteria, the 20/40-megahertz S-3295 VLSI test system (Fig. 1) couples an expanded pin count and enhanced functional-test capability with the proven architecture of the S-3200 series. Its 256 data channels, twice as many as previous S-3200 systems, are configured as 128 input and 128 output pins, any or all of which may be connected in pairs as I/O pins.

Functional testing is controlled by a new high-speed pattern processor that can compress and recreate functional patterns at the time of a test run, as well as switch to other pattern sources on a cycle-by-cycle basis. These features are complemented by the voltage-, current-, and time-measurement facilities of the S-3200 series.

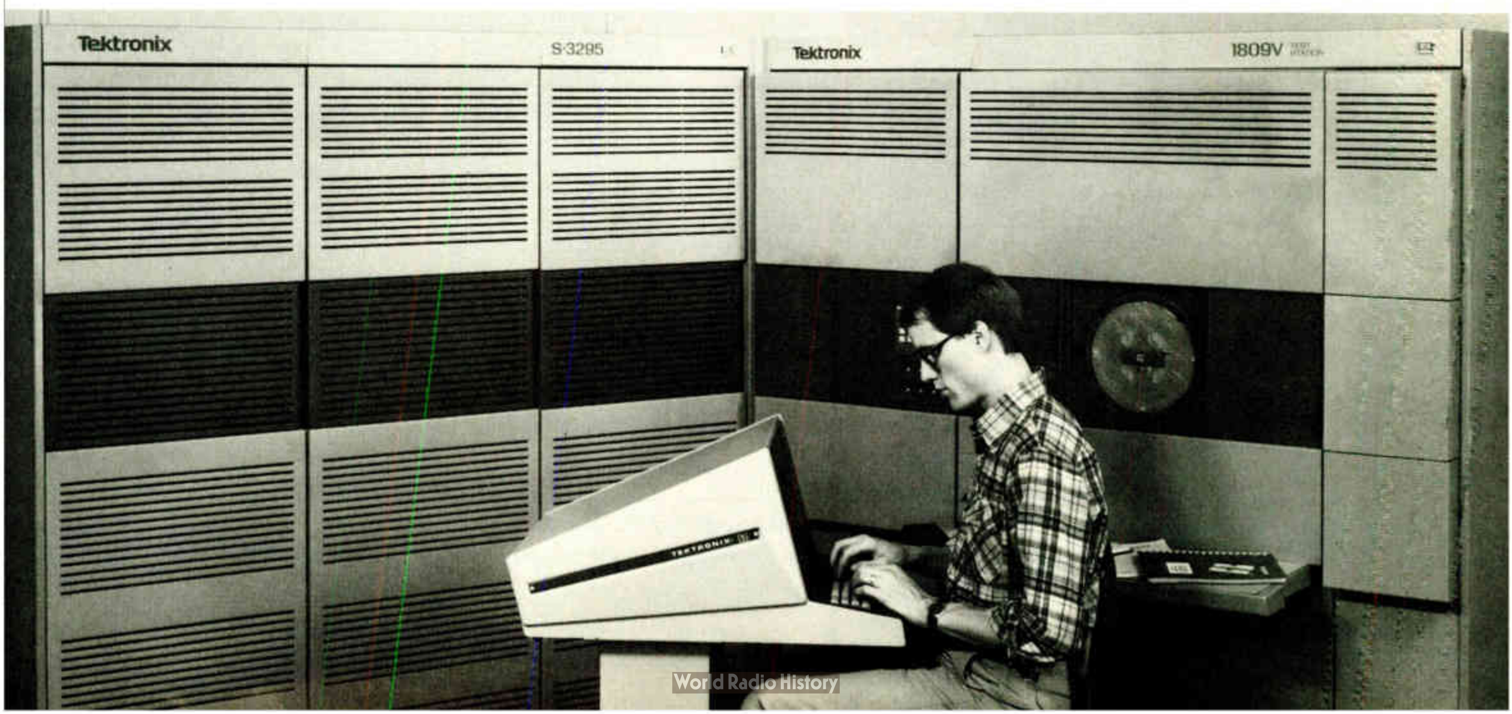
The S-3295's pattern processor is able to compress pattern data by removing repetitive lines and sections of a pattern. This step reduces storage requirements, while preserving the integrity of the pattern. The deleted portions are restored at test time by loop iteration and subroutine calls that are part of the instruction set the pattern processor generates when compressing pattern data. The processor also can store repetitive sections of a test as a single subroutine.

At test time, the pattern processor calls instructions up from a 4-K-by-96-bit emitter-coupled-logic random-access memory. As the test proceeds, the current pattern-processor instruction evaluates loop counters, index registers, and interrupts to derive the address of the next instruction and its associated pattern vector.

Program flow is set by if-then-else statements. For example, the if statement can be programmed to test for an error condition during a microprocessor test. The then statement would initiate a branch to a diagnostic routine if an error were detected, and the else statement would specify to continue standard testing. The addresses of the branches involved are stored in the pattern processor's 16 index registers.

The pattern processor controls and feeds the pin elec-

1. Family growth. The S-3295 VLSI test system above, based on the S-3200 family architecture, uses a new pin card and pattern processor that increases the system's ability to check the functional performance of 20-MHz very large-scale integrated circuits with up to 256 pins.



tronics cards from which each active pin in the device under test receives its test vectors. Each pin card provides four channels of formatted data—two input and two output channels—which can be combined to form I/O channels. For a group of two to four DUT pins, one pin card provides a complete operating environment; not only does it provide the usual formatted input signals, but it also handles I/O switching, output loading, and recording error as well.

Every pin-card data channel is serviced by 64 K of local memory for a total of 256 K per card. Because storage needs vary with differing device types, the local memory has a variety of partitioning options, such as the memory structure in Fig. 2 for one of the two I/O channel pair Ordinarily, the S-3295's pattern processor is used as the pattern-data source—it reconstructs force, inhibit, compare, and mask data that has been compressed and stored in its memory. The pin electronics card supports each of these four data functions with 32 K of serially addressed RAM. In effect, a 32-K-by-4-bit shift register resides behind each channel pair.

Partitioning memory

For long nonrepetitive patterns, though, a deep serial memory is needed to feed the pattern to the DUT without frequent wait states. Therefore the test system allows the user to increase the memory backing up a particular combination of functions or to specify 32-K increments for error storage. The full 256-K of local memory can even be used for a single function (providing either force or compare data, or recording input or error data) if the DUT demands it.

Another important aspect of the pin electronics card is its driver circuitry. The predominant logic technologies—MOS, TTL, and emitter-coupled logic—have widely differing terminal characteristics and input drive parameters. Input currents, amplitudes, offsets, and rise and fall times all play important parts in simulating a real-world stimulus environment for the DUT.

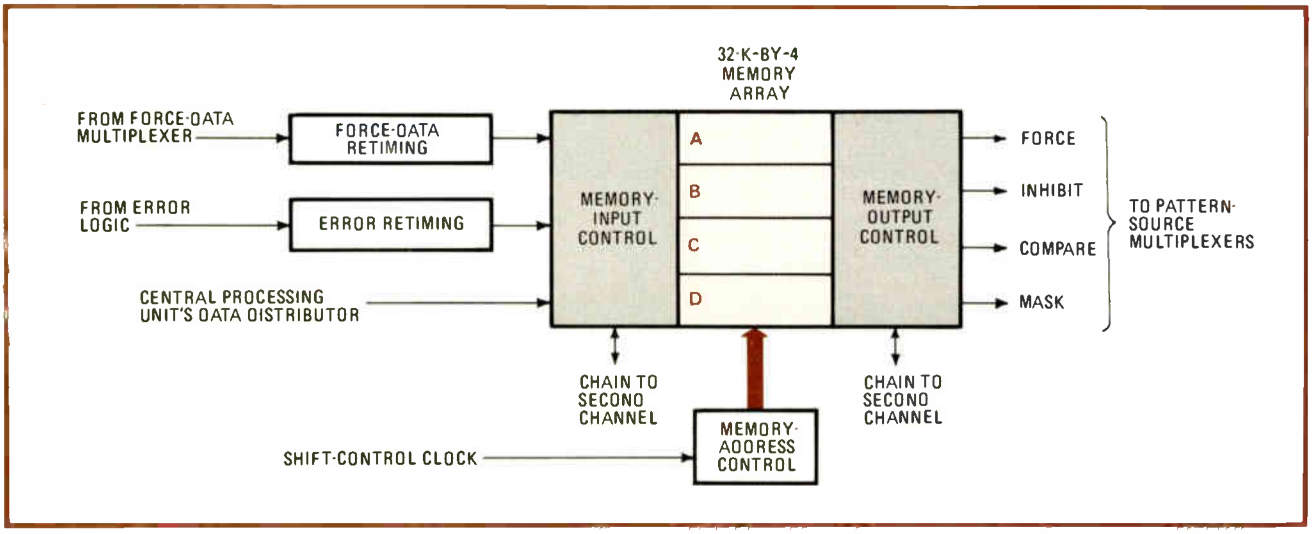
Meeting these divergent test requirements with a single driver design has been an elusive goal challenging designers of automatic test equipment. The S-3295 addresses the problem with a new driver circuit that features a programmable slew rate, low-leakage inhibit, and a wide output-voltage range.

The programmable slew rate allows the test engineer to vary the slope of a signal edge over a 5:1 range. Figure 3 is a multiple-exposure photograph showing the result of setting the driver's slew rate at three different points within its programmable range. At low amplitudes the slew rate is approximately 1 volt per nanosecond, allowing ECL rise times as low as 800 picoseconds. On the other hand, the driver is equally comfortable meeting the much slower rise-time tolerances of the TTL and MOS families. Similarly, the S-3295 driver's amplitude can be accurately programmed, in 366-millivolt increments, over a –5 to +12 V range, which encompasses all of the prevalent logic families.

Drive off and on

To test a multiplexed part where the pins can accept data from bus lines or send data to them depending on the activities being performed, the driver and comparator are connected to the device's I/O pins. When the DUT is running in the output portion (the comparison frame) of its cycle or when it is entering a high-impedance floating state, the driver that forced data during the input portion must be inhibited—in effect, disconnected. Without the inhibition, spurious interaction between driver and test pin could affect the ability of the DUT to dominate the I/O bus.

The S-3295's pin-driver circuit utilizes high-performance Schottky diodes, with their characteristic low capacitance and low storage time, to implement the inhibit function. When the driver is inhibited, the DUT pin sees the extremely high impedance of the reverse-biased Schottky diodes, rather than the 50-ohm impedance of the driver's output transistors. Current leakage through the diodes is minuscule—only 50 nanoamperes at ECL levels—and the capacitance is about 2 picofarads, an order-of-magnitude improvement over existing equipment. Consequently, undesirable loading of the DUT pin



2. Memory flexibility. Local memory on the pin card, shown in schematic form for one pair of input and output channels, is usually formatted into four 32-K-by-1-bit blocks With chaining, however, up to 256 K can be put behind one pin for exceptionally long patterns.

is negligible. The compliance voltage of the inhibited driver is V_H + 1.8 V and V_L – 1.8 V, which well exceeds the requirements of most logic devices.

The user has a choice of three inhibit timing phases per driver. A control bit derived from a pattern source determines the cycles in which inhibit will occur, while the inhibit phase positions the start and stop times within the cycle. A variety of formats can be stipulated under program control to model virtually any real-world force-inhibit sequence.

The test system designer fights a battle on two fronts: while wrestling with the increasing complexity of VLSI circuits, he must also face the concurrent challenge of escalating speeds. Today, a growing demand for test data rates in excess of 20 MHz exists. Fortunately, the fastest devices usually have fewer pins than the slower, more complex ones.

The S-3295 tackles high-speed (40-MHz) driver operation with a multiplexing scheme that joins the formatted data streams of two adjacent drivers on a pin card. The number of fully supported drivers is halved, but two driver pulses can be positioned within a single cycle. Thus the DUT is exercised at twice the usual data rate of the test system.

The driver's data streams are combined at the driver inputs (Fig. 4), as opposed to the less desirable wired-ORing of the driver outputs. By combining data streams at the input, the DUT sees the same signal-path characteristics from the source in either the standard or the double-pulse modes, since it is connected to the same driver output in both instances.

In the double-pulse mode, one driver per pin card becomes the signal driver, and the force formatter of the dormant driver becomes the subordinate—its signals are rerouted to serve the signal driver. Thus the signal driver receives formatted force and inhibit data from its usual source, as well as formatted force data from the other channel on the pin card.

On a cycle-by-cycle basis, the inhibit data bit from the subordinate channel determines when the signal driver switches between data streams. A side benefit of this multiplexing method is that the control driver can gate the two data streams into the signal driver to produce a final output pulse as little as 1 ns wide. The extremely narrow strobes needed to test edge-driven synchronous logic ICs can thus be produced on demand.

DUT loading

A thorough functional test requires that the DUT outputs drive a load approximately that of an operating logic gate's input. Almost any sort of load impedance can be modeled using common passive components, but such schemes are limited in flexibility—a specific passive load circuit is suitable only for one device family. What is needed is a load circuit whose impedance characteristics can be quickly adapted to the immediate test.

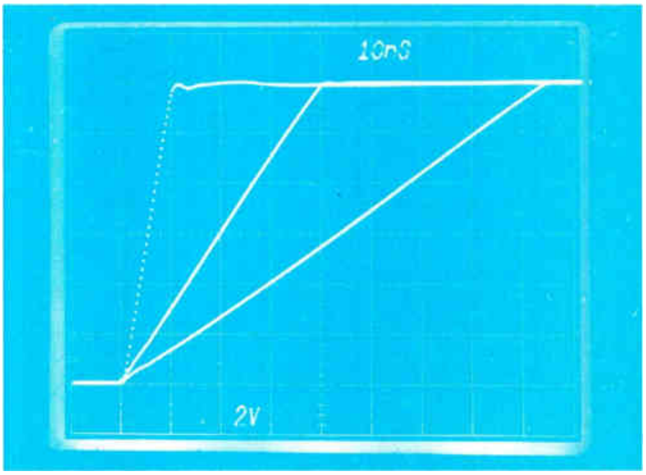
The S-3295 handles this problem with a fully programmable active load appended to each DUT output channel. Whereas passive load circuits operate at fixed source and sink current values, the active load offers independently programmable currents—50 milliamperes in either direction. The turnover threshold voltage, at which the circuit switches from source to sink, is also programmable. When connected, the active load dictates the amount of current that passes through the DUT pin-comparator measurement node. This characteristic permits the user to run device-wide, go/no-go parametric tests under real-world operating conditions.

For ECL devices, however, a passive load is mandated because they usually operate with a terminated transmission line, with the termination implemented by means of a 50-Ω resistor connected to a –2-V supply. This terminating resistor determines the output current drawn from the circuit driving the line. The S-3295's pin card makes available a 50-Ω resistor connected to a programmable power supply, allowing the DUT to experience the same current demands it would encounter in an operational circuit. When the ECL load is selected for a given DUT output pin, the active load for that pin is disconnected.

Checking the test results

The comparator signal path is essentially an analog environment, in that it must carry the DUT output signal to the comparator input without introducing distortions that might alter the outcome of the test. Because comparators do their job by detecting voltage thresholds and because rise-time degradation causes the threshold crossing to shift in time, the comparison path's rise time should be compatible with the rise times produced by the DUT. Therefore the signal path must have low stray capacitance and high impedance, as must any accurate measurement instrument. Furthermore, the comparator should have the versatility to handle the differing voltage ranges of the logic families in use and should be able to detect all modes of DUT operation—logic 1, logic 0, high-impedance state, and error.

For error detection, the S-3295 uses a buffered dual-threshold analog comparator interfaced with an error-logic circuit. The dual-threshold approach allows the user to define an analog "window" that encompasses the failure region for the 1 and 0 states and the pass region for the high-impedance three-state mode. The thresholds (both V_H and V_L) can be set up within either of two



3. Rising to the occasion. To test ECL parts, the pin card's driver electronics can be programmed to produce signals with rise times as fast as 1 V/ns, left in this triple-exposure photograph. The card can provide longer rise times for TTL (center) and MOS (right) parts.

ranges: ±5 V or ±15 V. The system provides for detection of logic-state errors, or three-state errors, or both, and a full-time mask mode (errors disabled) is also available. The actual error detection occurs only during the time specified by one of the comparison phases, of which eight are available to every comparator. The comparison path's rise time is 3 ns or less (1-V steps), easily compatible with most outputs. Special error-detection modes further enhance the tester's capability, making evaluation of device performance much simpler (see "Finding problems, not faults," opposite).

Deskewing all paths

All of the events occurring at the DUT are timed and synchronized by the system clock, which provides 16 phases distributed around the test station. Each driver has available to it eight timing phases, as does each comparator. Each inhibit circuit has three phases to select from. The per-pin phase selection is accomplished in the mainline test program.

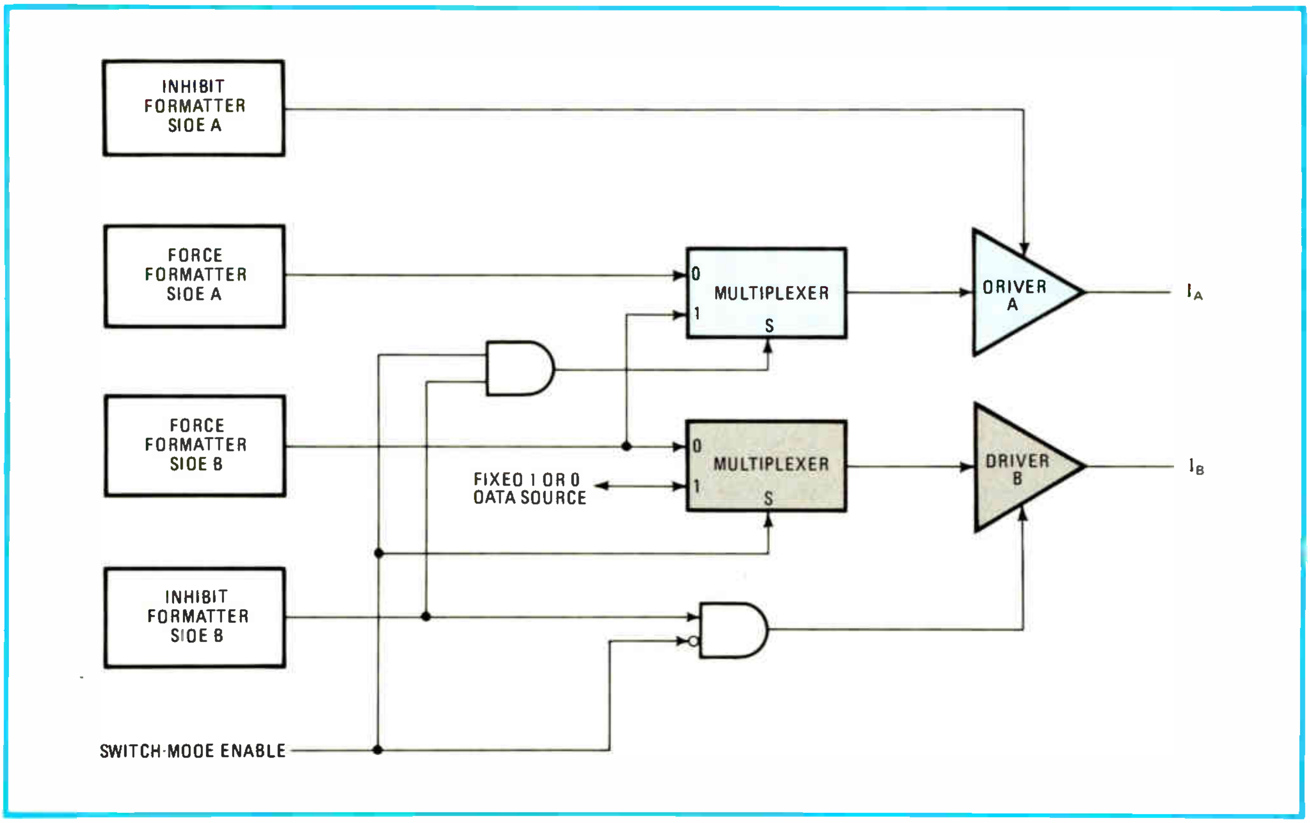
Timing accuracy and consistency are essential to meaningful testing of digital logic devices. A central aspect of the accuracy issue is the shift in time (skewing) of signals that are supposed to be coincident.

In the real world, the progation delays, cable delays, and distributed capacitance of two presumably identical signal paths are rarely equal. Consequently, a signal that is split and sent along two such paths will not arrive at its two destinations simultaneously. The test-system designer must strive to minimize the effect of this phenomenon wherever possible and to counteract it where necessary, since DUT input and compare signals simply must be aligned if valid tests are to be performed.

For each timing phase on every pin card, the S-3295 uses local look-up tables to correct skew differences related to the signal path. In the deskewing circuitry shown in Fig 5, the contents of the registers are delay constants determined at system calibration time under controlled conditions, then stored in a disk file. Upon subsequent system power-up, the constants are automatically transferred to the registers for use by the system. The incremental resolution of the delay data is about 50 ps, and the adjustment range 8 ns.

This look-up–table technique yields pin-to-pin driver and comparator skew figures as low as ±350 ps, and the data is updated whenever calibration is performed. As a result, long-term drift in system performance is counteracted. Furthermore, if a particular application requires even greater precision, the user may construct delay tables based on the parameters of a specific format or timing set used by the DUT.

Though all of the preceding attributes—driver flexibility and precision, loading versatility, and timing accuracy—are necessary requisites for a VLSI test system, they are ultimately of no benefit to the user if the system is not able to provide the types of patterns he or she needs to check out a device. Typically, the functional pattern data going to the DUT derives from one of two types of sources: stored-response sources such as a serial memory or a pattern processor or an algorithmic processor that generates pattern data at test time. Each pattern source is mated to a specific set of applications; no source can be



4. Doubling up. For 40-MHz operation, the inputs to two drivers can be tied to one, using the switch mode enable to inhibit one driver (driver B). Tying inputs together, rather than outputs, lets the device under test see the same back impedance, regardless of its speed.

sacrificed without a corresponding loss in the utility of the system.

The S-3295 integrates stored-response and algorithmic modes into its pattern processor. The pattern processor can itself store up to 4,096 words of force-compare pattern (as well as 1,024 words of inhibit-mask pattern), and it has control over the two other possible sources of functional data: the pin card's local memory and the algorithmic pattern input.

Choosing sources

The serial-memory approach is primarily useful in testing devices requiring long, nonrepetitive data streams. Logic ICs produced by computer-aided design techniques are ideal candidates for serially sourced patterns. CAD patterns—the code lines used in modeling and debugging logic circuitry on a computer—usually consist of densely packed unique pattern lines. They cannot be condensed any more, nor can they be characterized by an algorithm.

The S-3295's pattern processor is well suited to testing such parts: it can select the pattern source at test time on a cycle-by-cycle basis. During every cycle, one of eight programmed combinations of force, inhibit, compare, and mask data sources can be supplied to the DUT.

This programmable processor enhances the local-memory partitioning of the pin card. If the pattern processor provides inhibit and mask data, the 32-K local-memory segments usually allocated to those functions can be used for force-compare pattern storage instead, effectively doubling the force-compare memory. As needed, the source combinations can be changed in successive cycles.

For functional testing of serial-scan-path design devices (CAD-designed parts with auxiliary serial I/O pins that allow the test engineer to monitor otherwise invisible internal processes), the serial stored-response approach typically is used. However, scan testing has unique requirements that may not be met by simple read-write patterns. For example, the stored pattern may have to be subdivided into segments, each of them constituting a module of a full test. Furthermore, pattern-storage needs can exceed the practical capacity of local memory. Finally, specialized circuitry is needed to store and trace serial-scan-testing errors.

For these parts, the S-3295 offers a dedicated pattern source, the scan buffer, which is an optional 3-megabit serial memory (1 megabit each for force, compare, and mask) that can be segmented into chains 64 K to 1 Mb in length. This buffer operates under control of the pattern processor and feeds the external signal input on the pin cards. It includes a 4,096-word error memory that keeps a record of every location of a failing chain bit, as well as additional circuitry to flag failing chains.

Real-time pattern generation

In contrast to the serial storage and pattern-compression schemes where both input and output states are fully described, algorithmic patterns contain no stored-response information. At test time, an algorithmic pattern processor generates the regular, predictable patterns used to test semiconductor memories. The algorithmic approach yields the most condensed pattern storage of all—billions of pattern lines can be issued from the half dozen instructions that define a "galloping" pattern, for instance. The pattern processor may be switched between

Finding problems, not faults

While basic go/no-go device testing is all that is required in most production situations, data from the cycles preceding an error is indispensable if device designers or evaluation engineers are to make a meaningful assessment of device performance. The design or evaluation engineer must be able to determine where in the pattern a device failed in order to spot address-related failures in the case of a memory or instruction-related failures in the case of a microprocessor. If the failing test cycle is to be correctly localized, the test must, in effect, stop immediately upon detection of the error in the device under test—that is, during the same cycle.

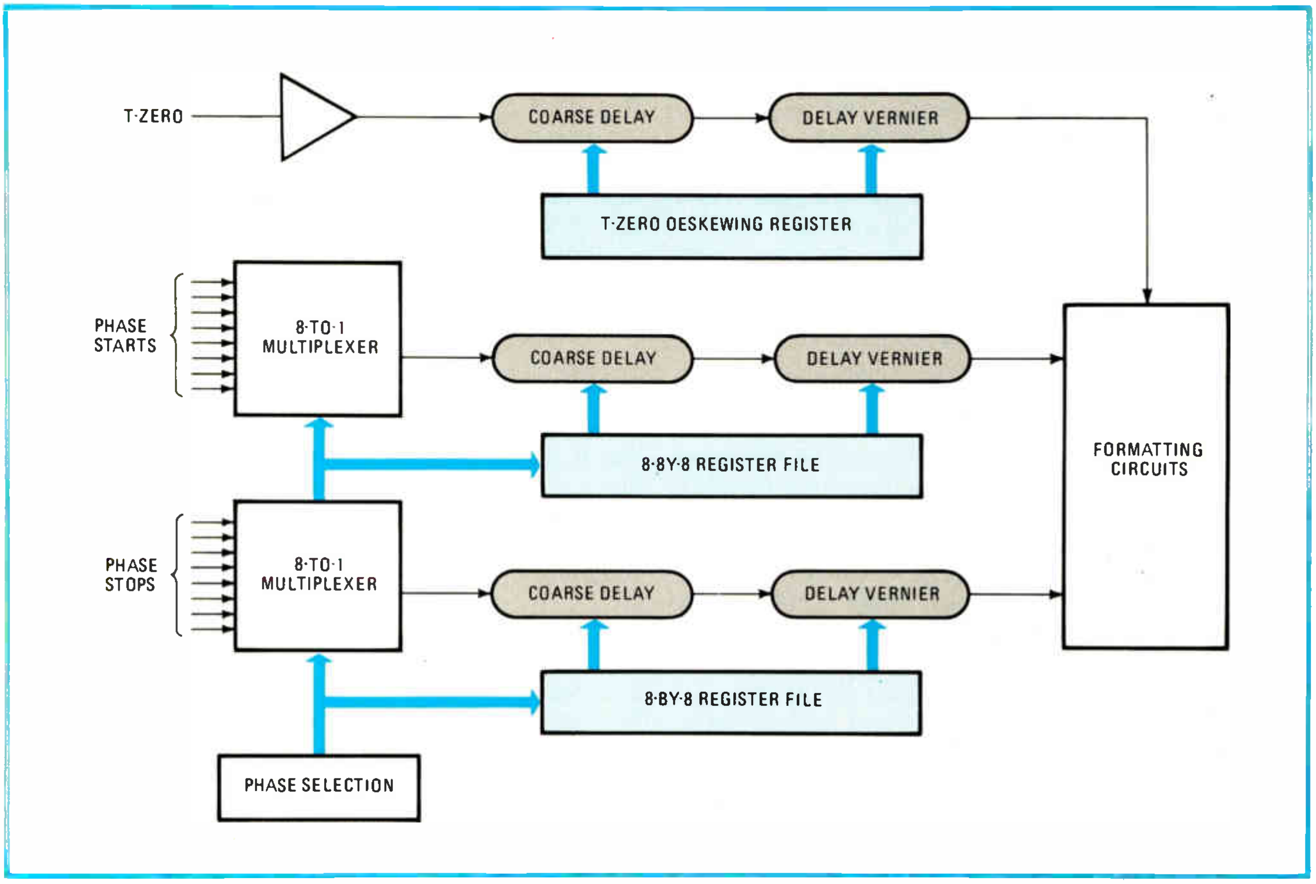
However, inherent delays between pattern sourcing and DUT response make it very difficult to stop during the actual error cycle, particularly at maximim test rates. To counteract these delays, a test system must provide a means of accounting for any cycles that occur between error detection and test shutdown. Once the error cycle is determined, the pattern information from that cycle can be retrieved and digested during the postmortem.

To do this, the S-3295 uses a last-in, first-out history stack and an error-event counter. The stack, located in the pattern processor, keeps a running record of the 255 most recently executed program-counter locations. Immediately upon detection of an error, the counter begins tracking the number of cycles until the stop-on-error process has run its course. Thus the stack can point out the precise location and sequence of data that cause the failure.

The S-3295 also provides another error-storage mechanism particularly useful in the algorithmic pattern mode. Under mainline program control, a shift-on-error condition can be set up before the functional test begins. For every error the pin cards' comparators detect, the force pattern and the error data from all pin cards operating during the failing cycle are shifted into local memory by a clock pulse.

Proper alignment of stimulus data and the related errors is guaranteed by a set of retiming registers. This shift-on-error function enables the test system to decipher a device under test—a read-only memory, for instance—by comparing the DUT output against a fixed bit (usually 0) and storing errors as described.

A third error-storage variation involves the use of the stop-on-error mode in conjunction with continuous local memory storage of force and error data during a test. The test stops upon detection of an error, and the error event counter records the number of post-error events. Thus, the failing pattern line is pinpointed, accompanied by 32-K lines of pattern preceding the error (or more, depending on memory partitioning). In this application, the system acts as a very powerful logic analyzer.



5. Digital deskew. The time it takes a signal to reach the output pins of the tester is measured at calibration time and digitized. At test time, the T-0 and 8-by-8 registers use these digitized constants to adjust the signal delay in accordance with the phase selected by the system user.

stored-response and algorithmic modes on a cycle-by-cycle basis. A common application of this feature is in testing microprocessors with on-board memory; the stored-response vectors are used to test the processor's registers, arithmetic and logic unit, and so forth, while the memory is exercised with patterns.

Functionally, a memory is easy to conceptualize as a simple matrix of storage cells. Addressing the cell locations and storing and retrieving data are usually seen as straightforward processes, but these functions represent only the tip of the iceberg.

Beneath the surface lie unforeseen threats to smooth testing—page-mode addressing, regional-data inversions, pattern sensitivity, topological encoding: the list goes on indefinitely. A truly versatile algorithmic pattern generator must deal with these memory-test issues, as well as expediting the creation of simple, widely used and accepted test patterns.

In its algorithmic mode, the S-3295 pattern processor's 4,096-word memory is loaded with algorithmic instructions that compute pattern data in real time. As with the stored-response modes, the pattern output per cycle is dictated by loops, branches, and subroutines.

However, each algorithmic instruction is also linked to a group of dedicated registers: two 12-bit address generators, a 12-bit Z-axis generator; and a 32-bit force-compare data register. The Z-axis and the data registers may be expanded to twice their standard width.

The full power of this pattern processor is needed in testing today's dynamic RAMs. These memories are usually partitioned into regions, with each region's data inverted relative to that of a neighboring region: in one a charge stored in a cell might represent a logic 1, while in its neighbor the absence of charge represents logic 1. Further complicating testing is the fact that dynamic RAMs usually scramble their addresses; consecutive addresses do not access adjacent cells. If it is necessary to address adjacent cells sequentially, as in testing with a surround-disturb pattern, the address scheme must be unscrambled. Before using such a pattern, a background of all 0s typically is written into the memory to ensure a known starting state, and this also requires regional and addressing knowledge.

In the algorithmic mode, the S-3295 pattern processor generates address vectors by arithmetically manipulating base registers, minimum- and maximum-address registers, the parity-mask register, a group of general-purpose registers, and a 4,096-word topology RAM. The DUT's data-inversion regions can be determined by address-parity states and base-cell equality.

In the test situation outlined above, the basic background-fill/surround-disturb pattern is written using the maximum address, base, and general-purpose registers; the address output is channelled through the topology RAM to propagate the incrementing address count into corresponding physical locations in the memory matrix. Finally, an address-parity test condition is established to invert the data word based on region. □

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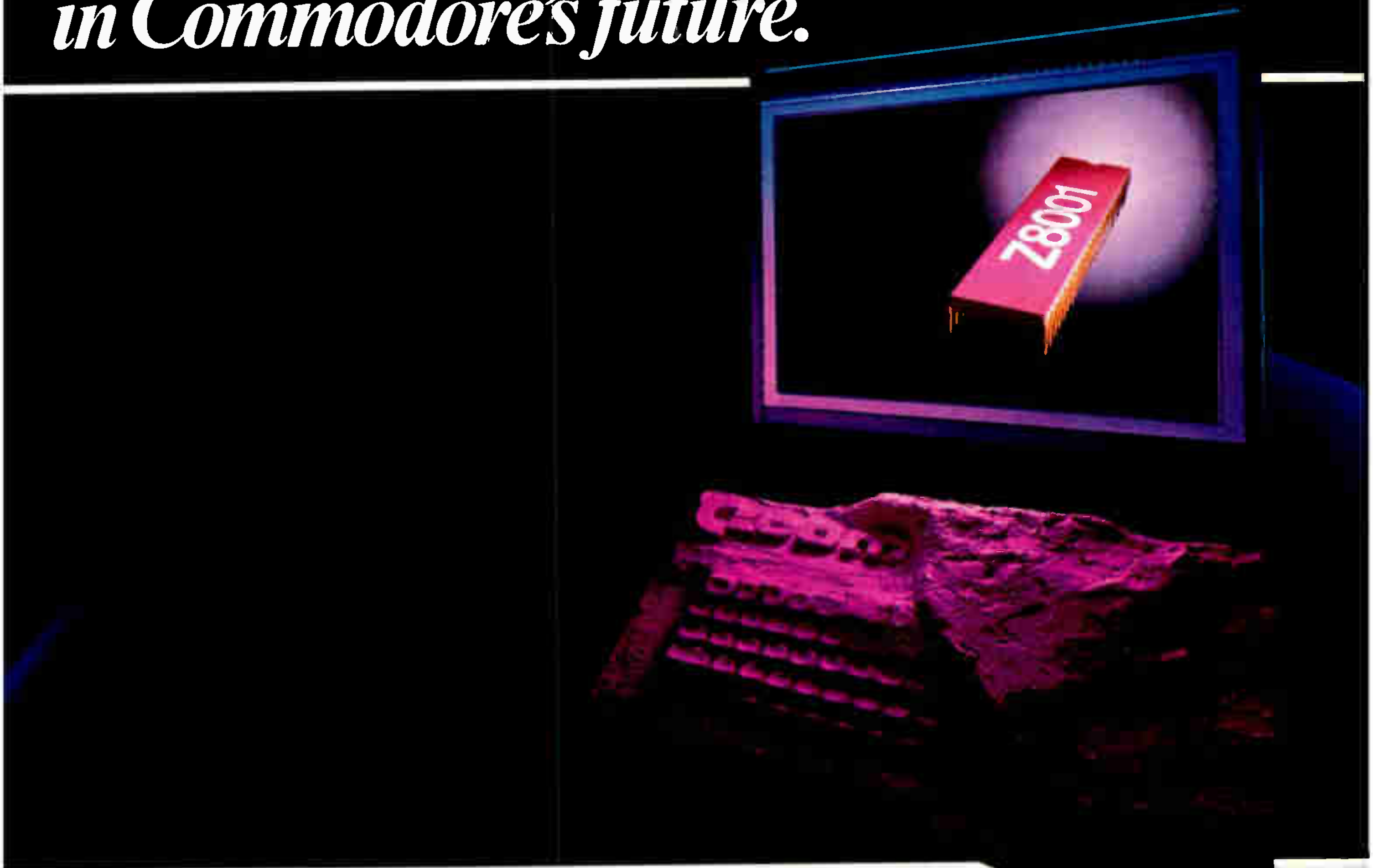

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Engineer's newsletter

Capacitor maker builds inserter that outspeeds commercial versions

Unable to get equipment manufacturers to develop a high-speed insertion machine for its increasingly popular capacitor housed in a two-lead dual in-line package, AVX Corp. has done the job itself. **The result is a head that runs at 12,500 units/h** when combined with a Universal Instrument or Dynapert positioning table, whereas the typical speed of the fastest previous system is 3,800 units/h. The Myrtle Beach, S. C., firm plans to sell 12 of the custom magazine-fed heads to Western Electric Co. and then look for a licensee to build more.

Video course reveals Deming's 14 points for quality and productivity

W. Edwards Deming, the internationally renowned consultant given much of the credit for sparking the quality-control movement in Japan, believes that improved quality is the key to increased productivity. To help engineering managers learn Deming's approach, the **Massachusetts Institute of Technology has produced a video course that delineates his 14 points for management.** In the 16 videotapes, Deming demonstrates how improved quality leads to high productivity, why quality production requires a system of statistically based process control, and where the responsibility for quality belongs. Further information about the tapes and the accompanying textbook is available from Cynthia D. Robinson, educational information officer, MIT, Room 9-234, Cambridge, Mass. 02139, or phone (617) 668-8360.

Composite materials for computer enclosures battle emi-rfi problems

With the Federal government tightening its regulations on electrical interference levels emitted by all types of equipment, the search is on for cost-effective and easy-to-handle enclosures. Allied Corp.'s Fiber and Plastics Co. **is experimenting with shielding composites for the computer industry by sandwiching thin metal meshes or conductive graphite with fire-resistant plastics.** The Morristown, N. J., firm says the outlook is good for cheap shielding materials that can be easily molded or stamped into equipment enclosures that will work to block electromagnetic and radio-frequency interference.

Toll-free hotline gives clean-room advice

Help with clean-room needs is just a phone call away. The Berkshire Paper Co. of Barrington, Mass., has established a Wiper Hotline to make the company's extensive research data on all known clean-room wiping materials available to anyone. Wiper Hotline callers can ask for comparative data on different wiping materials and get advice on the types of products to use for specific applications. **They can also ask about methods of testing for various wiper characteristics** like absorbency, particle generation, and purity, and find out about new and custom products. Queries will be answered Monday through Friday from 9 a.m. to 5 p.m. Eastern Standard Time at (800) 242-7000, or (800) 242-4034 forMassachusetts callers.

Jedec booklet simplifies symbol searches

To help engineers speed through specs, the Joint Electron Device Engineering Council has issued a handy **guide to approved symbols for discrete and integrated semiconductors and optoelectronics.** The convenient booklet is aimed at making data sheets easy to read and write. It is available from the Electronic Industries Association, 2001 Eye St., N. W., Washington, D. C. 20006 **-Roger J. Godin**

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SPL53-4000	8A	2.5A/5A PK	0.6A	0.6A					
SPL53-4101	8A	1.2A	0.6A		1.5A/3A PK		80W cont.	2.10 x 4.25 x 8.25	$125
SPL53-4102	8A	1.2A	0.6A			2.5A/5A PK			
SPL65-5000	8A	1.2A	1.2A	0.5A	1.2A/1.5A PK		85W cont. 95W PK	2.10 x 5.00 x 9.00	$150
SPL130-4100	15A	4A/6A PK	1.5A			1.5A			
SPL130-4101	15A	1.5A	1.5A		2A/4A PK		130W cont. 150W PK	2.45 x 5.00 x 10.50	$198
SPL130-4102	15A	4A/6A PK	1.5A	1.5A					
SPL200-4100	35A	4A/8A PK	1.5A	1.5A					
SPL200-5100	35A	4A/8A PK	1.5A	1.5A		1.5A	200W cont. 250W PK	2.45 x 5.00 x 13.00	$270
SPL200-5200	35A	4A/8A PK	1.5A	1.5A	4A/6A PK				

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Circle 163 on reader service card

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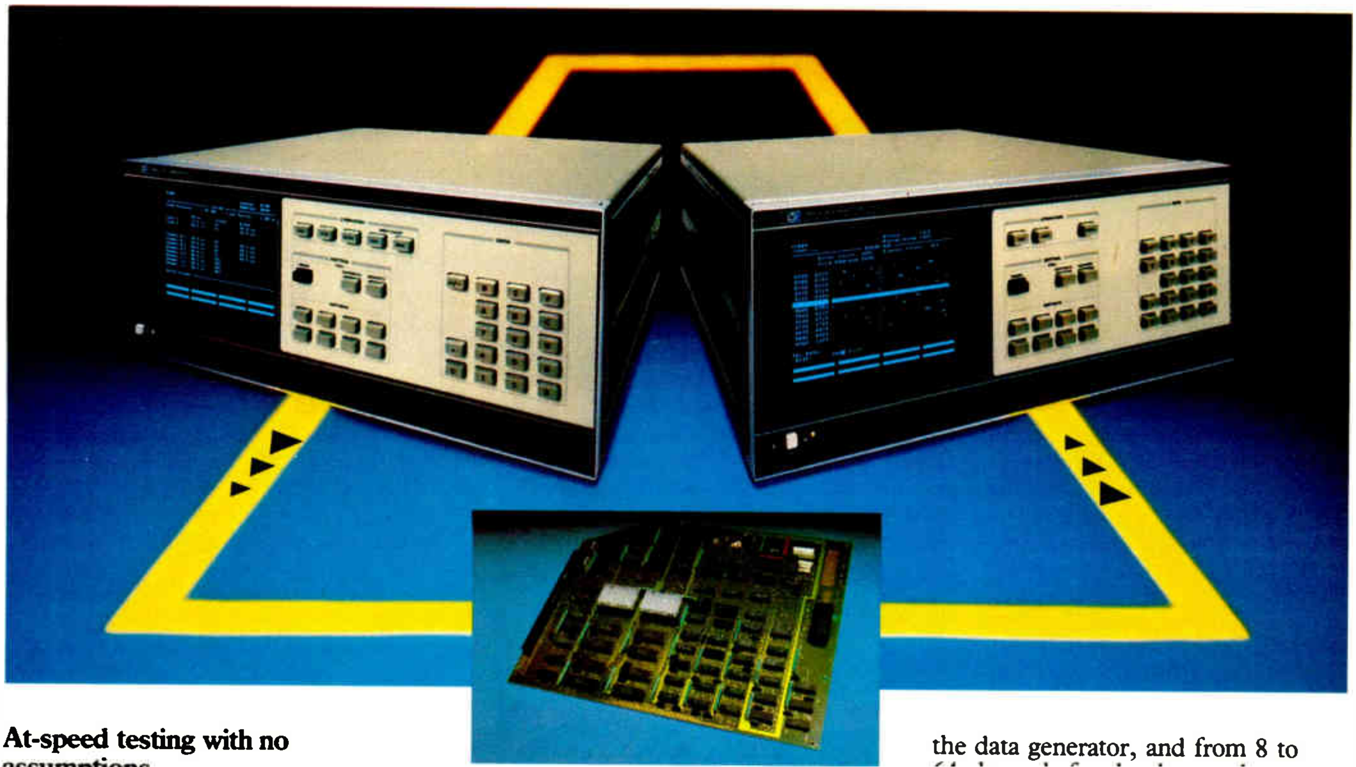

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Work station integrates design, layout

Monochrome CRT display handles logic-design chores; color tube does IC layout; software links two sets of processes

by Clifford Barney, Palo Alto bureau

An engineering work station that unites design and layout of very large-scale integrated circuits offers two cathode-ray-tube displays for simultaneous use by a single designer. It comes with software that integrates the two tasks, allowing a designer to change a logic gate or an electrical value and then look at the corresponding device on the layout.

The station's high-resolution eight-plane color CRT is for displaying chip layouts, and its four-level gray-scale CRT shows schematics and text. A mouse moves cursors on both of the screens. The Scaldstar system will be demonstrated at the Design Automation show in Miami in June and shipped to customers this fall by Valid Logic Systems Inc.

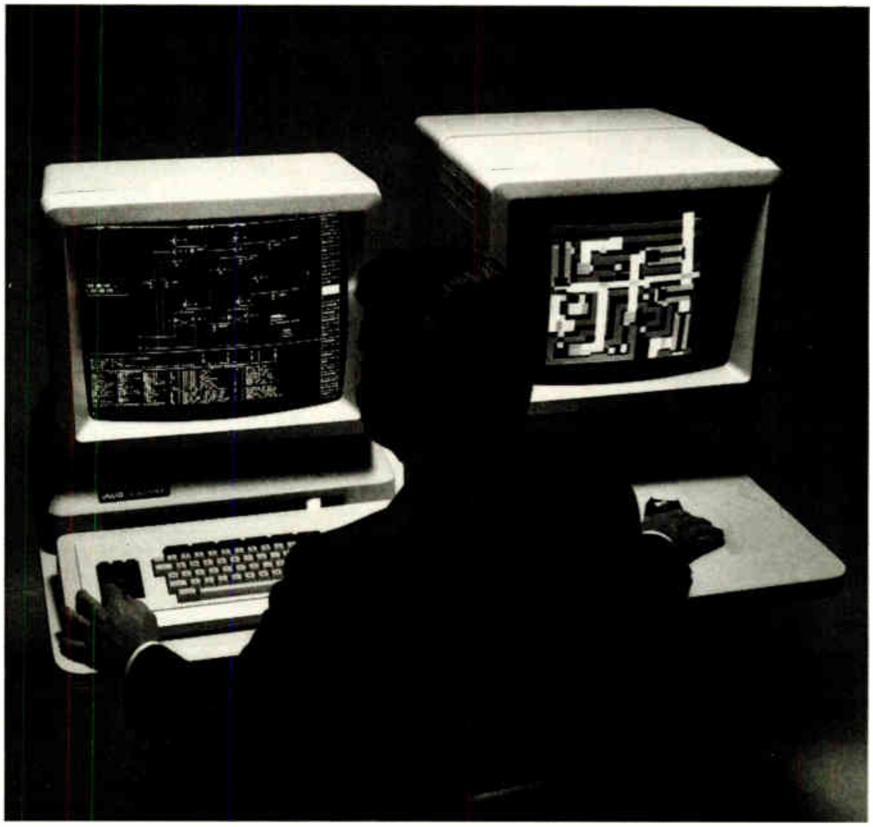
The system adds an expanded version of the Caesar layout program that was developed by John E. Osterhout at the University of California at Berkeley, plus the firm's own design-rule–checking software, to the firm's present Scald (structured computer-aided logic design) system of hierarchical design tools. The company will also supply and support the recently released Berkeley 4.2 version of Unix with Scaldstar.

Scaldstar's color tube, which has a resolution of 1,024 by 800 picture elements, is from Mitsubishi; the monochrome monitor has the same resolution. The system's processor is Valid's 68000-based S-32 computer, supported by a 35-megabyte Winchester disk and 40-megabyte tape-cassette drive. The entire package, both hardware and software, is aggressively priced at approximately $70,000, and the firm maintains that the layout capability alone is more efficient than elaborate minicomputer-based plotting systems selling for $250,000 and up.

The products in the work-station line that Scaldstar augments are all based on the Scald hierarchichal-design process, which was developed in part by the company's engineering vice president, L. Curtis Widdoes. The Scald work stations simplified the process of developing VLSI architecture, logic design, and performing timing analysis and simulation of chip operation.

In development, however, there remained the practical matter of translating a design into a chip, which requires layout, design- and electrical-rule checking, and circuit extraction. The purpose of the two-monitor system is to integrate the two sets of processes.

Cookie cutter. The color screen will display up to 256 overlappable colors. Color rectangles representing circuit geometries are painted by the Caesar software's special rectangular cursor, which makes it easy to convert a single instance of a circuit cell into an array. The dimensions of the cursor itself determine the spacing of the array elements. The process of copying or moving rectangles is simplified by treating the cursor as what Osterhout calls an electronic cookie



cutter, which can create a buffer for all the graphics information contained in the area beneath it.

Checking the design rules on a layout with 500,000 or so rectangles can chew up hours of time on mainframe computers, points out Lou Scheffer, who helped write the software. One solution to this problem is to check in a hierarchical manner. For example, a designer can develop an adder cell, check it once, and then store a version with the interior of the cell erased, remembering only the connectivity when going on to check a larger area.

Each succeeding hierarchical level can be placed using only the inner and outer connectivity of a doughnut-shaped area around the edge, Scheffer says. The process requires storing several representations of each cell, but the area of the doughnut, which is about 5 μm across, is small compared with the area of an entire cell, which might measure about 100 μm across.

Cell restriction. Also, the design-rule–checking software restricts cell overlap, such as occurs with bus structures shared by two adjacent cells, to make the hierarchical design procedures possible. This restriction, however, does not result in chip-area penalties, according to the firm.

A single data base supports both logic design and circuit layout. The designer can begin with a block diagram, or "floor plan," of the chip, showing elements such as a register stack, adder, or programmable logic array, and then perform cell layout and both analog (electrical) and logic simulation, and design- and electrical-rule checking.

The hierarchical structure fits well with the file structure of the Unix operating system used in the system. Unix keeps information about how blocks of stored data relate to one another. For instance, an adder-cell file might have subfiles labeled /layout, /donut, and /logic, all relating to the same block. A comparison utility can then check logic against a schematic diagram.

Valid Logic Systems Inc., 650 North Mary Ave., Sunnyvale, Calif. 94086. Phone (408) 773-1300 [338]

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Large LCD suits portable computers

Dot-matrix liquid-crystal display draws only 200 mW while displaying graphics or sixteen 80-character lines

by Robert Neff, Tokyo bureau

Designers of portable gear ranging from personal computers to measuring instruments will get a welcome addition to their bag of tools this summer with the advent of an unprecedentedly large and affordable dot-matrix liquid-crystal-display panel from Sharp Corp of Osaka.

Boasting approximately half the display capacity of the typical cathode-ray tube in a much more compact and energy-efficient package, the LM-48001G [*Electronics*, April 21, p. 75] will become available on a sample basis starting in June at a domestic price of about $346. Export prices have not been determined yet, but samples are expected to be in the ballpark of the domestic price.

The 340-g panel is just 18 mm thick but can display 16 lines of 80 characters each or 480-by-128-dot graphics in a 230-by-61-mm viewing area. The unit itself measures a compact 290 by 110 mm. Power use is a modest 200 mW maximum.

Producing a large and affordable LCD panel poses a number of engineering problems. One is driving the large number of electrodes involved. The LM-48001G uses fully 28 complementary-MOS integrated circuits to do this, 24 to drive the vertical signal electrodes and four to drive the horizontal scan electrodes. The ICs are mounted on either side of the printed-circuit board to which the panel is attached. Circuits on the pc board are linked through a rubber zebra connector to leads printed on the panel's two glass sheets.

Sharp uses a multiplexing scheme that divides the 128 horizontal rows of dots into 64-row halves. Each block is driven at a 1/64 duty cycle. Even at such a low duty cycle, engineers obtained a generous 25° range of viewing angles (rotating the display around a horizontal axis) at a contrast ratio of 2.

New formula. Key to the wide viewing angle is Sharp's newly developed liquid crystal, the exact composition of which the firm will not divulge. It contains estercyclohexane, phenylcyclohexane, cyanoester, and another ingredient not named. The electrodes are of indium-tin oxide, also used in other company displays. For the LM-48001G, a different production process achieves lower resistance and better transparency.

Another challenge is obtaining sufficient flatness in a glass panel so large. Sharp engineers will not explain their solution to this problem in detail either, but say the key is to put bead or glass-fiber spacers between the glass sheets that sandwich the liquid crystal. When warmed, the spacers bond the sheets together and serve as a low-pressure suspension.

The panel's operating temperature range of 0° to 50°C and storage range of –20° to 55°C are adequate for most office and field-testing environments. They are attained by the use of temperature-compensation circuits. But for automobile dashboards—an application Sharp managers already see demand for—the range must be widened. At 0°C, the rise time is 550 ms and the decay time 950 ms. Those times fall to 300 and 500 ms, respectively, at 25°C.

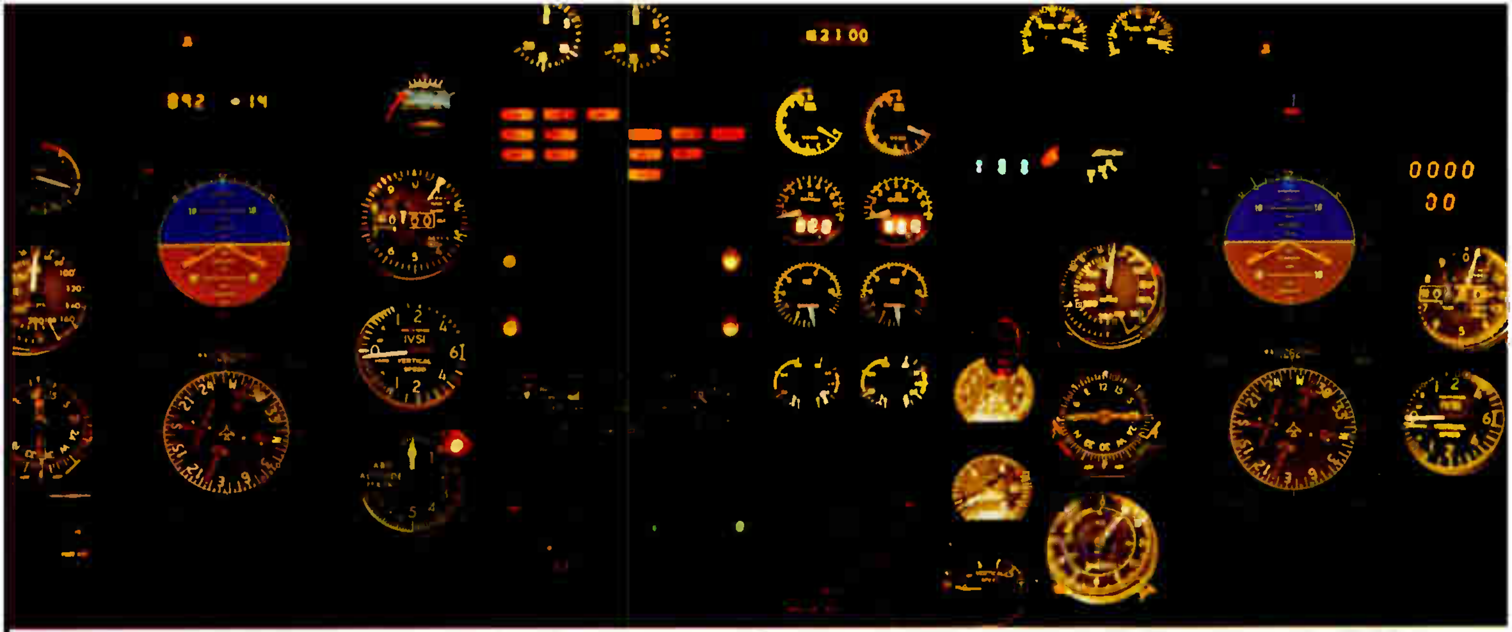
The contrast ratio of the dark-blue-on-white display can be adjusted with an external potentiometer. The dots measure 0.4 by 0.4 mm and are spaced 0.08 mm apart. Each dot can be addressed separately.

Akira Fujimori, general manager of Sharp's display division in the Nara prefecture, attributes the panel's affordability to in-house manufacture of integrated circuits and highly automated processing of the electrode patterns. He talks openly of plans to roll out a 24-line LCD panel, but notes that hurdles remain. The required depth of 196 rows of dots means more ICs and a multiplexing scheme with a 1/96 duty cycle. Tighter squeezing of segment-on and -off voltages will reduce the viewing-angle range to about 15°.

Fujimori says the LM-48001G generated intense interest at the recent Electro/83 in New York from personal computer and instrument makers. Sharp may need to build up quickly the monthly production rate of 5,000 units set to start in June.

Sharp Electronics Corp., Electronic Components group, 10 Sharp Plaza, Paramus, N. J. 07652. Phone (201) 265-5600 [479]

Sharp Corp., 22-22 Nagaike-cho, Abeno-ku, Osaka 545, Japan [339]



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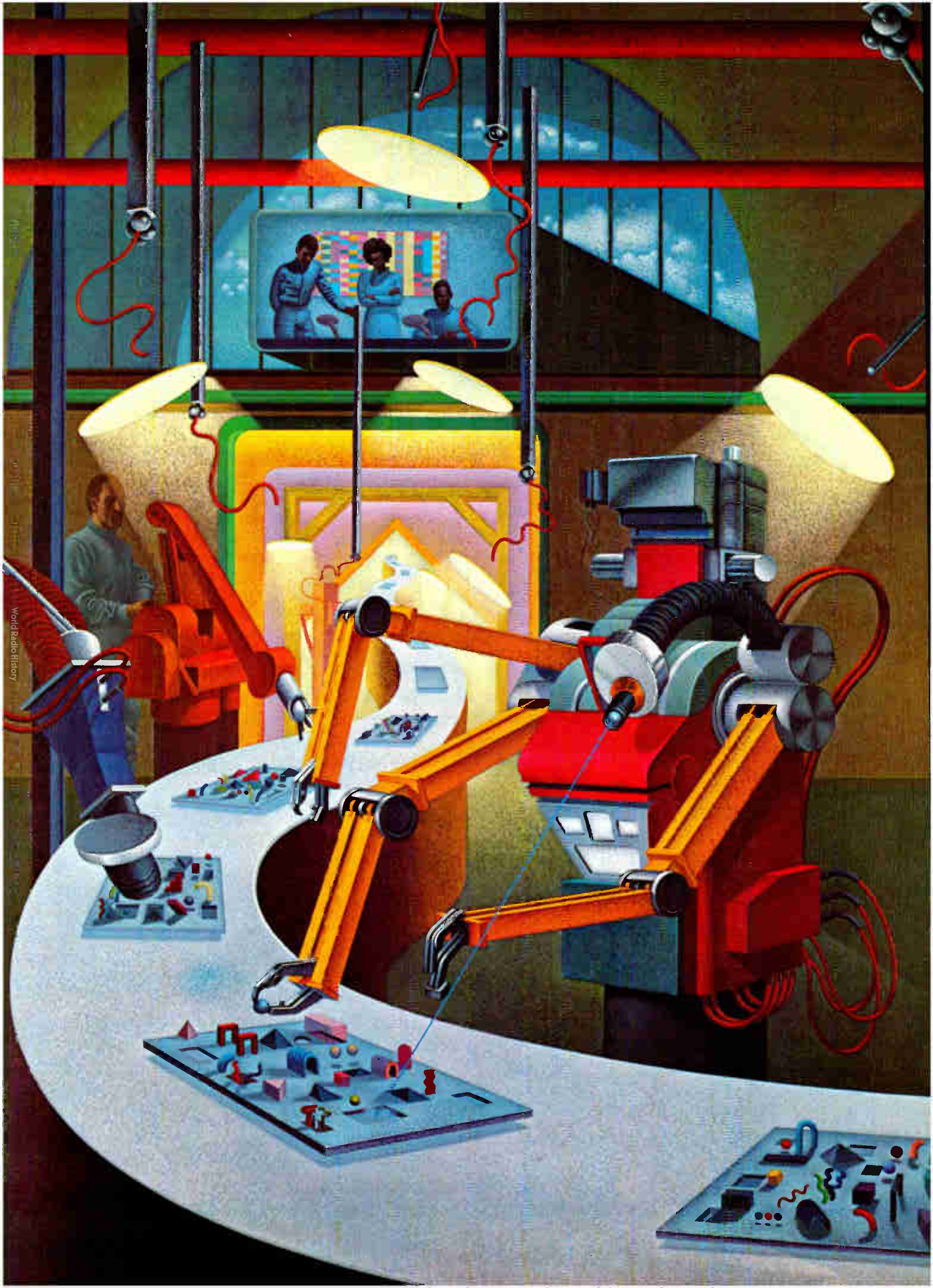

Teleconferencing rolls into the office

Station on wheels has camera, monitor, and graphics module, adds flexibility and informality to video conference systems

by Jeremy Young, New Products Editor

Radically scaling down the facilities required for small video conferences, the MCS (for mini-conference system) is a roll-around console that can be trundled into any office or conference room with a coaxial-cable hookup to local communications equipment. The $35,000 MCS from Compression Labs Inc. can be used for conferences with one to three people at its end of the link, freeing fully equipped teleconferencing rooms, which typically cost $175,000 or more *sans* telecommunications gear, for larger meetings.

The system is designed to work with the firm's VTS 1.5 digital codec or the recently introduced VTS 1.5E, which both use 1.544-Mb/s T1 ditigal transmission channels for communications with remote locations. A number of MCS units can share the expensive telecommunications equipment, augmenting the capabilities of a dedicated conference room.

Offering the convenience of holding small conferences in handy locations, the MCS lends itself particularly to informal and impromptu use. Consisting of a video camera, a 15-in.–diagonal color monitor, microphone, speaker, graphics module, and handheld controller, the system can be linked to another of its kind or to a teleconference room over a local analog network. Multiple remote or local stations and teleconference facilities can be linked at once.

The graphics module can be placed next to the person using the station and stored in the MCS stand when not in use. It contains its own color camera, light, and opaque glass in a desktop-high stand and functions at the selected video rate or, when the VTS 1.5E is in use, can send a still frame at 56 kb/s.

The handheld controller lets the user zoom the camera in and out from his seat, adjust audio volume, mute the microphone for privacy, and select the main camera or the graphics camera as the output signal from the system. He or she can also swivel the monitor unit, which has the camera built in, over a 10° range.

High compression. The VTS 1.5E video teleconferencing system's main improvement over the 1.5 is its use of a compression algorithm called DXE, for differential transform coding. DXE improves picture quality for a given transmission rate by combining the advantages of intraframe and interframe compression techniques.

Interframe video-data compression involves sending only the parts of a frame that have changed since the last frame; its drawback is that as the amount of motion increases, pictures begin to blur. Intraframe compression divides a frame into cells and compresses each cell; those with little detail require little data to be sent. Intraframe images remain stable with motion, but tend to be less crisp than an interframe system's display of a low-motion scene.

DXC first applies Compression Labs' patented scene-adaptive intraframe coding and then interframe coding. Depending on scene content, it achieves up to three times the compression of the intraframe coding alone used in the VTS 1.5, says the firm. Picture stability is maintained with motion, and the picture quality formerly available at 1.544 Mb/s is now produced at 768 kb/s.

The VTS 1.5E operates at rates from 512 kb/s to 2.048 Mb/s, allowing users to trade picture quality for reduced operating cost. If a conference involves mainly still graphics and audio, data rates can be significantly lowered: a graphics option sends still frames at 56 to 64 kb/s. The system also handles binary data.

The VTS 1.5E sells for $145,000, and its television graphics option is $16,500. It will be available in October. The MCS will be available during the first quarter of 1984.

Compression Labs Inc., 2305 Bering Dr., San Jose, Calif. 95131. Phone (408) 946-3060 [340]

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The Symbolics 3600 puts the level of computer power associated with supermini class computers in your hands at a fraction of the usual cost. It has a 36-bit tagged architecture and executes programs at an average of one million high-level instructions per second. Our standard 3600 system software, a powerful and proven Lisp-based operating and program development environment, also supports FORTRAN, PASCAL, C, Interlisp compatibility and Flavors object-oriented programming.

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Symbolics 3600 Capsule Specifications

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88 keys with n-key rollover
3-button mouse
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Circle 175 on reader service card

less than 5 μm in diameter surrounded by carbon.

The layer has a surface smoothness of 3 μm and withstands pressures of up to 10^4 N/cm^2. Uniformity of the resistance layer, a prerequisite for linearity, is ensured by precisely maintaining the thickness during the production processes.

The Graphic Commander will be available in samples in September and in larger quantities in January of next year. The unit price in large volumes will be between $200 and $250, depending on the interface. A keyboard-and-pad combination with the pad measuring 11.5 by 9.5 cm will be $500 to $550 in volume.

Preh Electronics Industries Inc., 8101 Milwaukee Ave., Niles, Ill. 60648 [362]
Preh-Werke, P. O. Box 1540, D-8740 Bad Neustadt, West Germany [477]

Mouse and interface adaptor serve IBM Personal Computer

Teamed with its LogiMate interface adapter, LogiMouse requires only three simple connections to become an integral part of the IBM Personal Computer that can be used with all Personal Computer software needing some kind of cursor movement.

The mouse's movement is converted to cursor-key inputs with programmable X and Y resolution. Its function keys are also programmable.

LogiMouse gives users three levels of software sophistication for various functions. On the first level, movements of LogiMouse are viewed by the system as simple keyboard inputs. On the second level, a dynamic change of values is allowed, thereby implementing a communications protocol between LogiMouse and the Personal Computer.

On the highest level, the LogiMate adapter discriminates and counts the X and Y pulses of the mouse and communicates with application software. This level is useful for the implementation of drawing programs in which every step of movement is important. At the third level, resolution is at a software scaling factor of over 200 dots/in. The mouse itself is putting out electrical signals at a 381-dot/in. resolution.

The mouse and adapter combination sells for $375 each; in lots of 100 to 499, the price falls to $273 each. The user can obtain from the mouse's maker a program that runs under MS-DOS and CP/M-86, which interactively allows the changing of parameters. Delivery is from stock.

Logitech Inc., 165 University Ave., Palo Alto, Calif. 94301. Phone (415) 326-3885 [363]

12-character/s daisy wheel printer goes for under $700

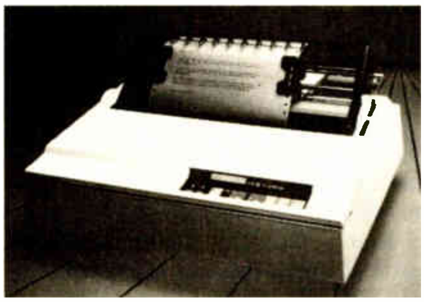
Personal computer users can get letter-quality printing and other word-processing features for under $700 with the ComRiter CR-II daisy wheel printer. The unit boasts a 5-K-byte buffer that can store up to three pages of input, allowing a user to reproduce multiple copies of documents stored in its memory.

The CR-II prints at an average speed of 12 characters/s, equivalent to 140 words/min. Printing is bidirectional from an ASCII-standard cassette with 96 pedals per wheel. Other features include printing superscripts, subscripts, underlines, and boldface; the unit also has backspacing and proportional spacing.

Two standard interfaces are available: Centronics parallel and RS-232-C serial. The printer can be operated in a word-processing mode by simply selecting the Diablo 630 SPI protocol.

The CR-II is available in quantity now. Options include a tractor feed, color print ribbons, a cut-sheet feeder, and interchangeable print wheels.

Comrex International Inc., 3701 Skypark Dr., Torrance, Calif. 90505. Phone (213) 373-0280 [365]



Educational system overlays text and graphics on video

A multimedia video learning station that incorporates a hardware/software option for the Professional 350 personal computer marks Digital Equipment Corp.'s entry into the education- and training-system market. The Interactive Video Information System (IVIS) integrates moving or still television pictures with computer-generated text and graphics on the Professional 350 color monitor.

The IVIS option enables the 350 personal computer to combine moving video images, using either RS170 or National Televison Systems Committee standards, with text and graphic overlays and synchronized sound. It accepts two external video sources, such as disk, tape, camera, or other video inputs. In addition, the system will control several models of industrial laser video-disk players. Two selectable audio inputs allow the use of stereo soundtracks or bilingual narration. An audio output capability is also available via the 350 computer's optional Telephone Management System.

A minimum working configuration includes the Professional 350 system unit, IVIS interactive video option, country kit (which contains a native language keyboard and documentation), VR241 13-in. color monitor, cable, 5-megabyte hard disk and controller, and P/OS operating system. The basic system sells for $12,624. Deliveries will begin late in the year.

Digital Equipment Corp., Maynard, Mass. 01754 [364]

new

Kyowa's compact data recorder. It goes right along with you.

At last, Kyowa engineering has created a data recorder which you can conveniently pack into a suitcase with room left for the other necessities. The compact 10-lb design measures only 10.5 x 4.6 x 5.7". And beneath that modern styling you get high vibration and shock resistance clearing ±2G and 10G respectively, allowing for accurate data recording even on a motorcycle travelling over the roughest roads.
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Circle 179 on reader service card

Microcomputers & systems

64-K E-PROM rides on CPU

Expanded addressing capability lets microcomputer shoulder more piggybacked memory

The contents of an 8-K-by-8-bit memory chip can be addressed by the latest in a line of single-chip microcomputers designed to carry software in erasable programmable read-only memory plugged piggyback style into a socket built into the top of the package. The MK38P70-97521 is the first chip to be added to Mostek's 38P70 8-bit microcomputer line in nearly three years.

To access 64-K of off-chip E-PROM, the United Technologies Corp. subsidiary modified the 38P70's program counter and address circuitry. Previously, 2-K-by-8-bit E-PROMS were the densest chips used with a 38P70. Jim Vittera, microcomponents product line manager at Mostek, says the device is being introduced in order to better meet the future needs of 8-bit microcomputer applications, which require an increasing amount of memory.

"There are two schools of thought when it comes to E-PROM," Vittera explains. "Ours is to use piggyback packaging technology to make the part work with standard E-PROMS. The other approach is to put E-PROM and all of the other circuits onto a single die in a package with a little UV [ultraviolet] window."

One step ahead. The latter approach limits more severely the size of the E-PROM: large on-chip memory arrays increase die size to the point where yields begin to fall. "Our largest memory size is now 8-K bytes, while people placing E-PROM on chip are still in the 2- or 4-K-byte areas. Generally, we will always be two to four times ahead with the piggyback approach," Vittera claims.

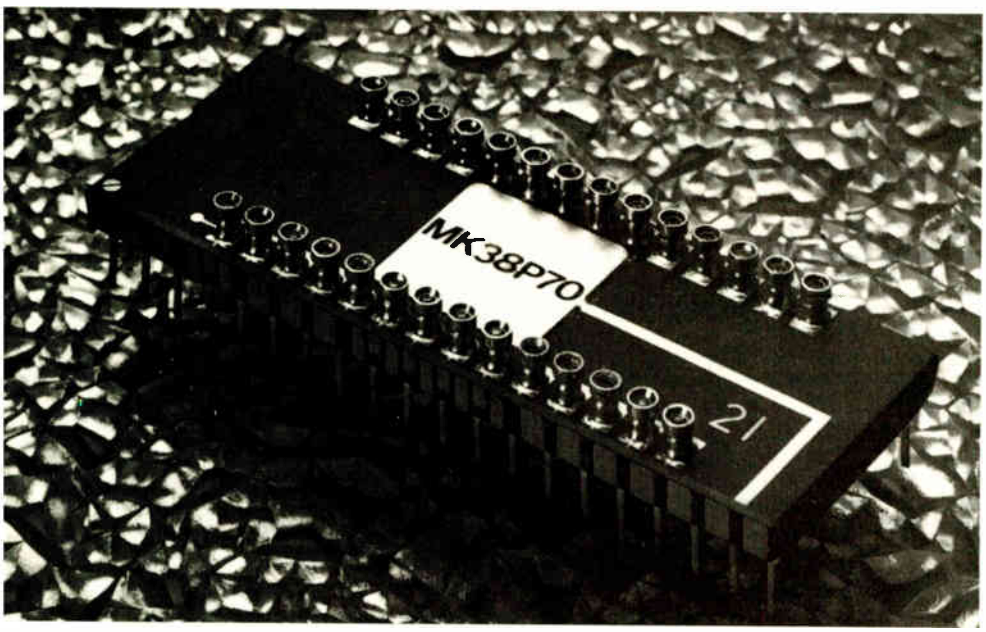
Available in 40-pin ceramic dual in-line packages with 28-pin sockets on top, the 38P70-97521 is priced at $45.30 each in 100-piece quantities. Samples are now available, and production volumes are scheduled for late June.

Just as with current 38P70 family members, the processor operates at temperatures from 0° to 70°C. Made with Mostek's silicon-gate n-channel MOS technology, it has a maximum power dissipation of 655 mW. It uses a 4-MHz crystal and a single +5-V power supply.

The MK38P70-97521 is pin-compatible with MK3870 microcomputers, which have on-chip ROM for high-volume applications. It has a programmable binary timer and 32 TTL-compatible input/output lines. Of 128 bytes of on-chip random-access memory, 64 bytes are scratchpad and the rest is available for program execution.

The device is expected to address a wide range of controller applications, such as in instruments, terminals, and motor-control systems. It is particularly applicable to prototyping and low-volume designs, where customers often alter the firmware for each system.

Mostek Corp., 1215 W. Crosby Rd., Carrollton, Texas 75006. Phone (214) 466-6000 [381]



Fast unit can burn programs into 450 types of memories

The model 22A personal programmer needs no personality modules to burn programs into over 450 different chips, including MOS erasable programmable read-only memories, fuse-link and bipolar PROMs, and single-chip microcomputers. With its 32-K-by-8-bit random-access memory, it can program the new 32-K-by-8-bit E-PROMS.

The portable unit, which has a built-in ultraviolet erasing light, is designed for high-speed high-yield programming. For fast programming, it incorporates the latest intelligent algorithms, eliminating redundant programming pulses by checking memory cells after each pulse to see if they have been programmed. To maximize yields, it reads Jedec-encoded electronic signatures, which allows it to adjust its programming algorithm to the requirements of individual devices.

Standard features include device manufacturers' approvals of all programming algorithms, simplified source-destination command protocol, a comprehensive data editor for revising or debugging software, and 27 data formats, including 16-bit formats. Device tests include illegal bit, blank check, backwards device, and two-pass verification. Available six

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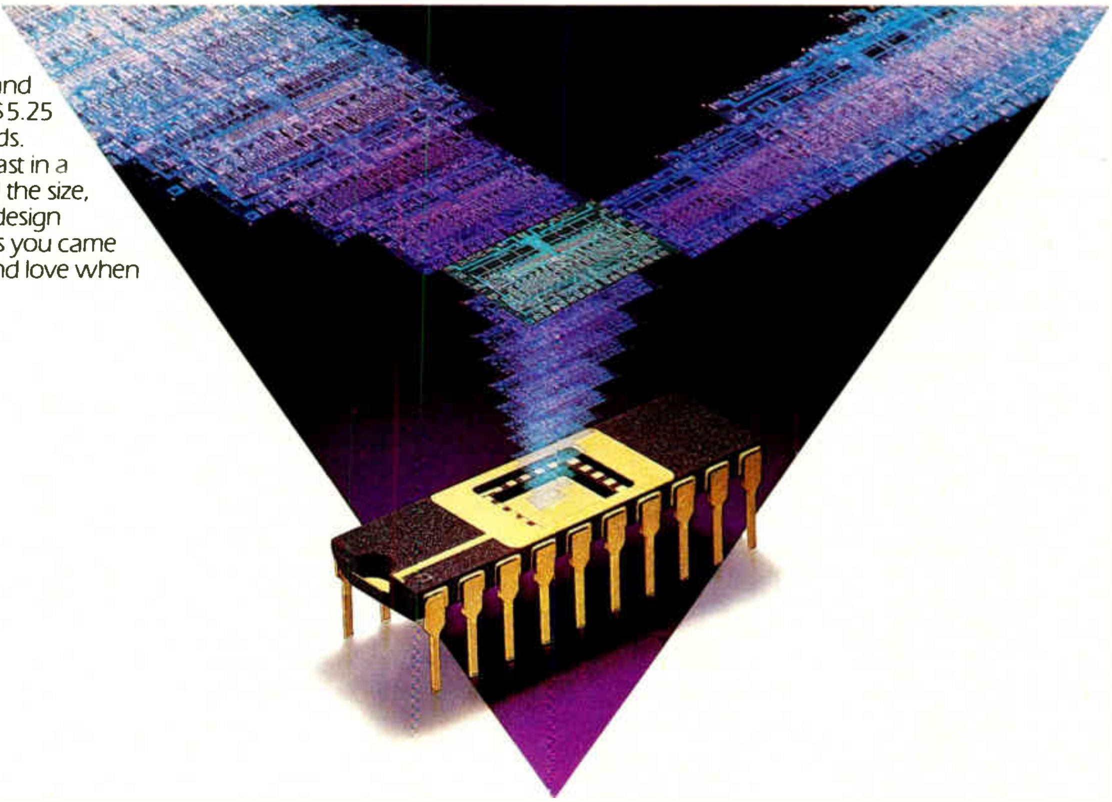
ANALOG DEVICES



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weeks after receipt of order, the 22A sells for $5,150.

The company is also introducing an accessory product to program multiple MOS PROM sets and those with wide words in one pass. Called the GangPak, it is compatible with the company's 29A and 100A universal programmers. It sells for $2,150 and is available in eight weeks.

Data I/O, 10525 Willows Rd., N. E., C-46, Redmond, Wash. 98052. Phone (206) 881-6444 [389]

On-chip peripherals and cache speed Z800 operation fivefold

Thanks to some on-chip peripherals and an on-chip cache memory, the Z800 microprocessor family runs any software written for the Z80 up to five times as fast as the Z80. The new family, to be available in the first quarter of 1984, can run in an 8- or 16-bit bus architecture and operate at clock rates of from 10 to 25 MHz, compared with the fastest Z80 running at 8 MHz.

On-chip functions include four direct-memory-access channels, three counter-timers, one timer, a programmable universal asynchronous receiver-transmitter, an interrupt controller, a 10-bit dynamic random-access-memory refresh controller, a clock oscillator, a memory management unit, and a 256-byte cache.

The Z800 family includes four devices: the Z8108 and the Z8208 support the Z80 8-bit nonmultiplexed bus, and the Z8116 and Z8216 support the Z8000's multiplexed 16-bit Z-bus. The Z8108 and Z8116 will come in a 40-pin package, supporting 19 of the 24 address lines but not permitting external access to the on-chip peripherals; the 64-pin Z8208 and Z8216 include extra lines to support all 24 address lines and external access to the on-chip peripherals.

In lots of 1,000, the Z8108, Z8116, Z8208, and Z8216 are $40, $48, $60 and $72 each, respectively.

Zilog Corp., 1315 Dell Avenue, Campbell, Calif. 95008. Phone (408) 370-8000 [382]

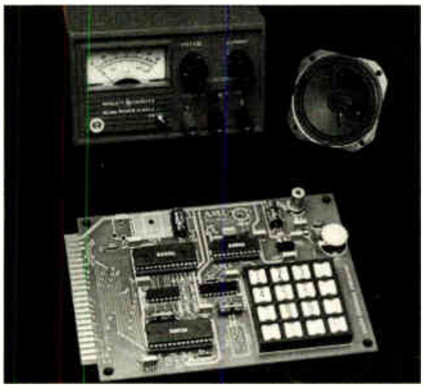
Speech-synthesis prototyper also can act as demonstrator

American Microsystems Inc.'s EVK 3620 speech-synthesis evaluation board is suitable for demonstrating the high-quality speech of the company's S3610 and S3620 speech synthesizers and for developing prototype systems. A preassembled speech evaluation board, the EVK 3620, includes AMI's S3620 LPC-10 speech synthesizer, S6805 microcomputer, S3630 128-K read-only memory, audio amplifier, and keyboard.

The S3630 ROM is programmed with 158 words in a female voice. The words can be addressed and spoken individually or combined in sequence using the keyboard to form phrases or sentences.

The EVK 3620 can be used in two different modes. When connected to a 5-V power supply and a speaker, the board is a stand-alone speech-demonstration unit. By use of the on-board, 22-pin edge connector, it can be directly controlled by another product or system. Available now, the board sells for $310.

American Microsystems Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051. Phone (408) 246-0330 [383]



Controller runs DMA transfers between host, external units

For applications requiring high-speed data transfer between a PDP-11 or VAX host and external devices, the DMA-700 controller provides buffered direct-memory-access transfers at rates approaching 1 megabyte/s. Complex device control can be microprogrammed into the controller to unburden the host computer.

The controller is based on a 16-bit 2901B bit-slice processor and contains 16-K bytes of memory. A custom interface card provides the interface with a wide range of graphics terminals and recorders.

In addition to the DMA-700, the company provides a microcode development system for user development of custom software, as well as programming support to help the user customize the controller to meet his or her needs.

Available in 45 days, the controller sells for $3,500.

General Digital Industries Inc., 500 Wynn Dr., Huntsville, Ala. 35805. Phone (205) 837-8305 [385]

Memory module can pack 2 megabytes in a Multibus slot

Compatible with both 8- and 16-bit Multibus-based systems, the CI-8086+ memory module can add up to 2 megabytes and occupy only one Multibus slot. Other versions are available with capacities of 128-K bytes, 256-K bytes, 512-K bytes, and 1 megabyte.

On-board refresh-control logic contained in dynamic random-access memory permits maximum processor throughput. CI-8086+ is addressable in 32-, 64-, or 512-K-byte blocks. Data-access time is quoted at 270 ns, cycle time at 400 ns.

Delivered from stock, the 2-megabyte board sells for $8,700.

Chrislin Industries Inc., Computer Products Division, 31352 Via Colinas, Westlake Village, Calif. 91361. Phone (213) 991-2254 [387]

Semiconductors

C-MOS PROMs use 13 mA/MHz

2-K-by-8-bit polysilicon-fuse programmable read-only memory has wide temperature range

Substantially bettering the power consumption of other nonvolatile memory types, a 16-K complementary-MOS programmable read-only memory aims at a variety of microprocessor-based systems. Based on polysilicon-fuse technology, the HM-6616's low power, high speed, and reliable data retention at extreme temperatures particularly befit applications in harsh environments such as military or high-temperature industrial systems, maintains Walt Niewierski, C-MOS technical marketing engineer at Harris.

The 2-K-by-8-bit part's maximum operating power of 13 mA/MHz contrasts favorably with the 25 mA/MHz of 16-K C-MOS erasable PROMs and the 100 mA of n-channel MOS E-PROMs. Standby current is a maximum of 100 μA over temperature; both industrial (-40° to +85°C) and military (-55° to +125°C) versions are available.

At the same time, its maximum access time is just 175 ns, compared with 350 ns for E-PROMs. In contrast, the fast 45-ns access time of 16-K bipolar PROMs is achieved at the cost of power consumption of 180 mA, even on standby. Power-down bipolar parts with 100-mA active power consumption (45 mA on standby) sacrifice speed, however, with access times stretching out to 125 ns. Thus the HM-6616 constitutes a unique combination of high speed and low power.

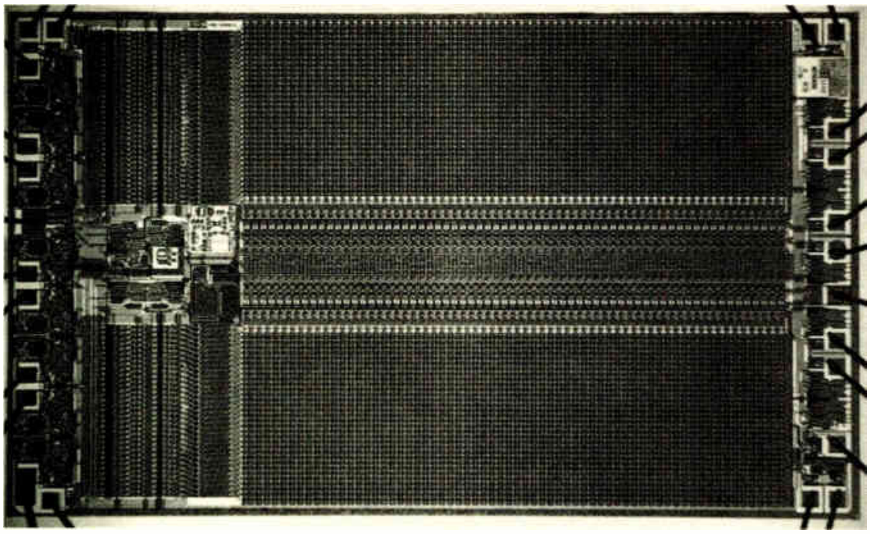
90-ns part coming. A faster version (the HM-6616B) with an access time below 90 ns will be available in the third quarter of this year. In addition, an 8-K-by-8-bit version is now being designed.

The 6616 comes in a 24-pin side-brazed ceramic dual in-line package or in a 32-pin leadless ceramic chip-carrier compatible with Joint Electron Device Engineering Council standards. The 24-pin package meets the standard pinout for byte-wide memories and thus is pin-compatible with 2716 and 27C16 E-PROMs.

Unlike the E-PROMs, however, the part operates synchronously to reduce active power consumption. Synchronous operation requires an enable strobe for each valid address, which is thereby latched internally. An additional benefit thus is the elimination of the need for external latches when using the part on a multiplexed bus.

The chip-enable access time is 150 ns; address setup and hold times are 25 and 30 ns, respectively. The cycle time is 200 ns. The part's input and output lines are TTL-compatible; outputs can drive up to 12 low-power Schottky-TTL loads.

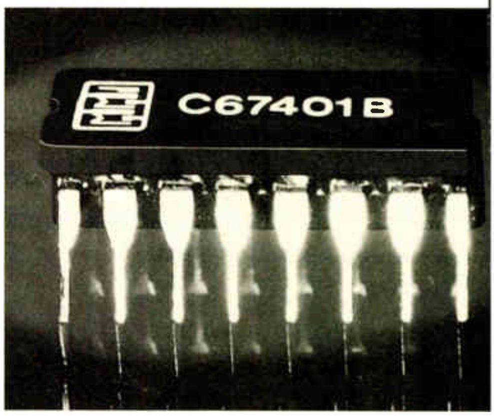
HM-6616 programmable ROMs are available now, at a price of $22 each for 100 or more pieces of the industrial version.



Harris Corp., Semiconductor Digital Products Division, P. O. Box 883, Melbourne, Fla., 32901. Phone (305) 729-5261 [411]

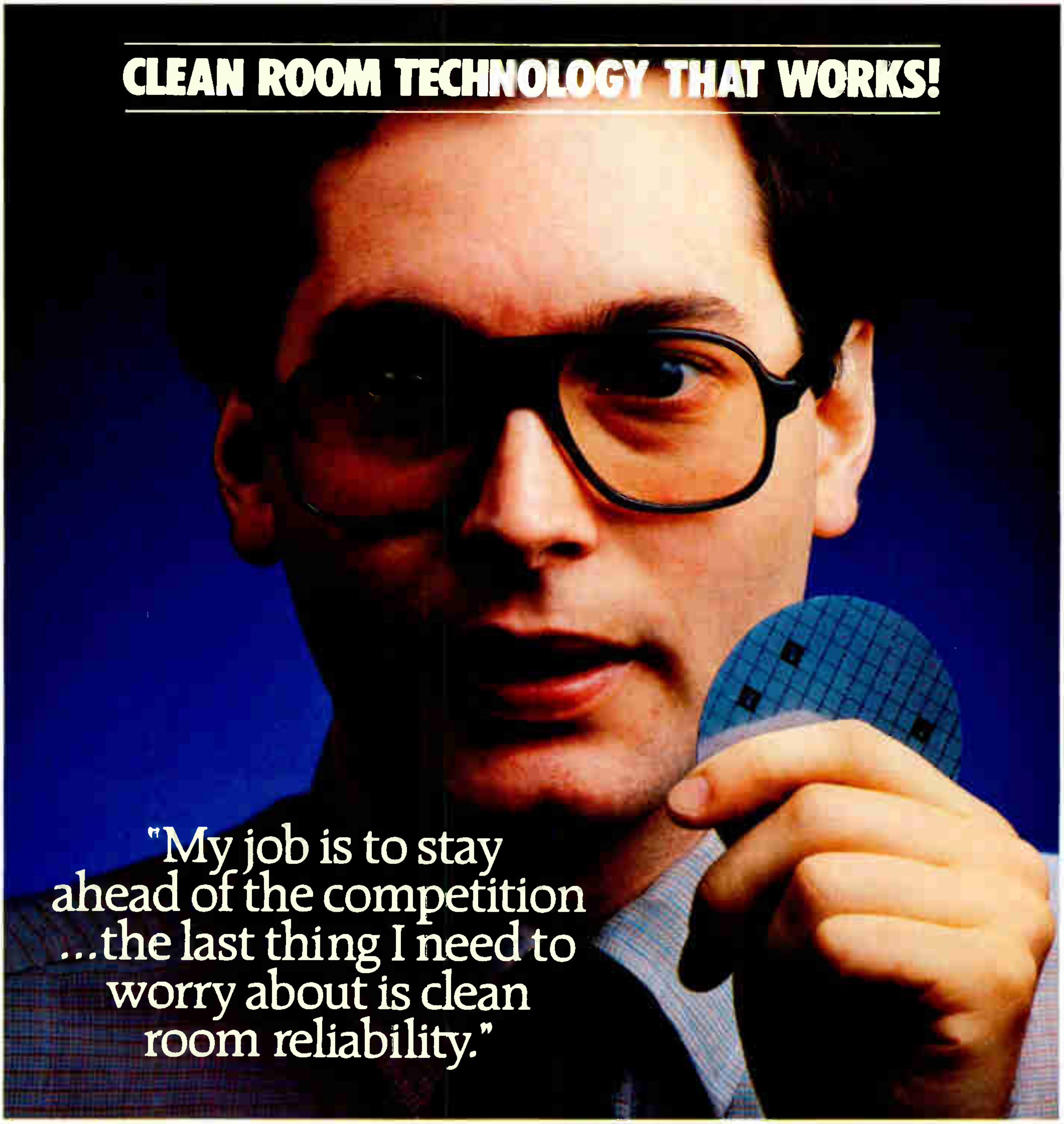
First-in, first-out memory operates at 16.7 MHz

A first-in, first-out memory circuit boasts a guaranteed 16.7-MHz shift-in, shift-out rate, making it a likely candidate for use in digital video systems, where high cycle rates are a must for data transfer. With a guaranteed maximum fall-through time of 1.3 μs, the part is 20% to 30% faster than existing FIFO units, the company claims.



Organized as 64 words by 4 bits (part C/67401B) or 64 words by 5 bits (model C/67402B), the FIFOs are offered as stand-alone devices or in versions that allow cascading for applications that will require increased buffer depth. The versions in the commercial temperature range (from 0° to 75°C) that operate on a single 5-V power supply are now available in production quantities. Power consumption is specified at 180 mA for the 64-by-5-bit part, and at 200 mA for the C/67401B.

In lots of 100 to 999 and housed



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Circle 185 on reader service card

in a 16-pin ceramic dual in-line package, the C/67401B goes for $35.43 each. The C/67402B, housed in an 18-pin DIP, goes for $43.46 each in like quantities. Delivery takes about six to eight weeks.

Monolithic Memories Inc., 1165 E. Arques Ave., Sunnyvale, Calif. 94086. Phone (408) 739-3535 [414]

3-μm–channel arrays boast 2,400 gates, 96 bonding pads

The ISO 3/5 family of fast complementary-MOS gate arrays has two new members, designated the ISO-3H and ISO-5H, that contain 2,400 gates with 96 available bonding pads. Each bonding pad has the required devices to allow it to be used as either an input with protection circuitry or an output with TTL or C-MOS buffer drivers.

The arrays use the firm's unique topology, which permits high density and a high cell count but requires only one level of metal. The ISO-3H has a 3-μm gate length and can run at toggle speeds of 75 MHz; the ISO-5H claims a 30-MHz toggle speed for its 5-μm gate lengths.

The company's oxide-isolated silicon-gate C-MOS process makes use of a minimum number of masking steps, which allows very fast turnaround times for prototypes—typically 20 weeks from schematic input to shipped prototypes. Development charges, including 20 prototypes, are $35,000 for the 3H arrays and go to $30,000 for the 5H versions.

Universal Semiconductor Inc., 1925 Zanker Rd., San Jose, Calif. 95112. Phone (408) 279-2830 [416]

Latching feature cuts ROM's access time to 35 ns

A unique latching feature allows an 8- and 16-K registered read-only memory to operate at twice the speed of standard devices. The ROMs contain an 8-bit edge-triggered register at the output that allows the memory to pipeline data and reduce the effective access time to 35 ns.

Designated the SY3308R and the SY3316R, the two ROMs are organized as 1-K by 8 bits and 2-K by 8 bits, respectively. They are targeted at bit-slice–microprocessor pipeline applications, replacing the 27S35/37 and 27S45/47 programmable ROMs at the time a design is transferred from prototype to production.

Both ROMs are designed to be compatible with industry-standard 8- and 16-K bipolar PROMs, eliminating the need to redesign printed-circuit boards when replacing prototyping PROMs for volume production. They have full TTL compatibility on all inputs and outputs and operate off a single +5-V power supply.

Available now, the 8-K part goes for $8.50 each, and the 16-K version for $22.50, both in lots of 1,000.

Synertek, 3001 Stender Way, MS-34, Santa Clara, Calif. 95054. Phone (408) 988-5618 [418]

64-bit RAM gets speed boost to 25-ns access time

The industry-standard 74S189 64-bit random-access memory, with three-state ouptuts, is now available in a high-speed version. Organized as 16 by 4 bits, the part now boasts an access time of 25 ns instead of 35 ns.

Its maker claims that as a result of the improved access time, the new 74S189A will be more useful in systems where small scratchpad RAMs and register files are required. Because outputs are in a high-impedence state during writing and data inputs are inhibited during reading, both inputs and outputs can be connected to a data bus without the need for interface circuitry.

The 74S189A is fully decoded and features a chip-enable input to simplify the decoding needed to achieve the desired organization. It is available in sample quantities in a 16-pin ceramic or plastic dual in-line package. In lots of 100, the plastic package goes for $2.70 each.

National Semiconductor Inc., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Phone (408) 721-5000 [419]


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Packaging & production

Process builds tiny print heads

Micromachining techniques make titanium and tantalum parts such as heads for ink-jet printers

High-yield micromachining techniques with photolithographic precision and step-and-repeat characteristics similar to that of integrated-circuit processing have been developed by the Millis Corp. for fabricating accurate titanium or tantalum components. These components are processed in parallel and targeted for use in ink-jet print heads, liquid-and-gas mixing nozzles, flow restrictors, and spinnerette nozzles for the fiber-drawing industry.

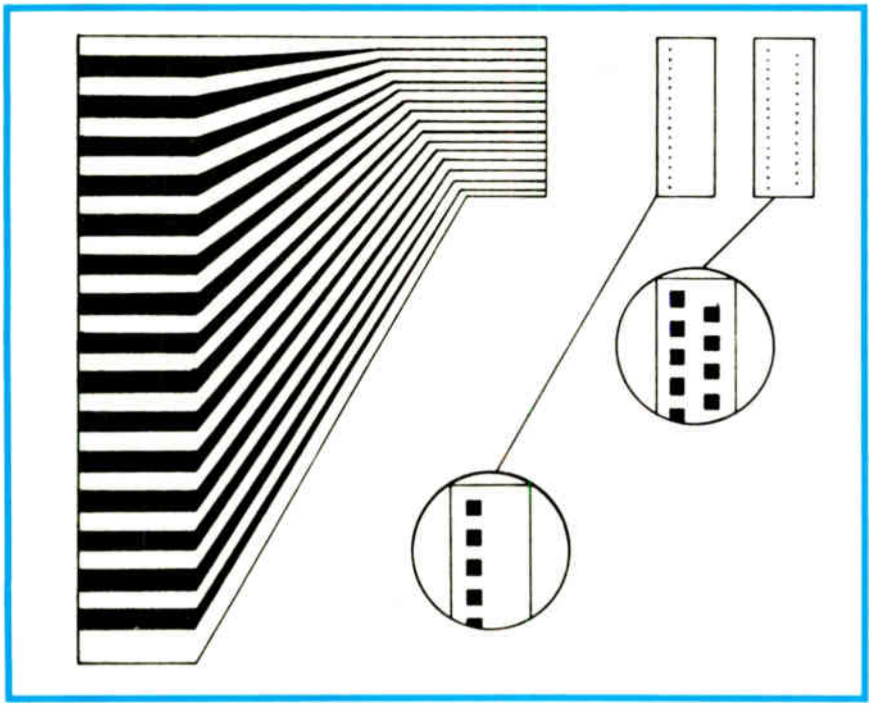
In many of these applications, the fluid is caustic or interacts with passageway material and tends to clog. The chemically resistant titanium or tantalum parts can be made with multiple grooves or channels with complex shapes. A thin cover of the same metal is bonded to the surface to seal the channels and form a strong monolithic structure. Layers can be stacked and bonded with the desired interconnection paths, forming three-dimensional fluid paths. The bonded interface is of high quality and will have the temperature, pressure, and caustic resistance of pure bulk titanium or tantalum, according to the firm.

Small dimensions. Channels can be made with cross-sectional dimensions as small as 1 mil wide and 2 mils deep. Centers can be spaced as little as 3 mils apart. Moreover, the grooves of, for example, flow restrictors can be tens of feet long.

A precise groove shape and maximum packing density is ensured by controlled shaping of the side walls: they can be within 4° of the vertical. The separation or relationship of the grooves may be varied from the inlet face to the outlet face to achieve the desired flow characteristics.

The price of these components is about $100 each in small quantities. Deliveries are in 12 weeks.

Millis Corp., 140 Dover Rd., Millis, Mass. 02054. Phone (617) 376-2611 [391]



Channels. Millis Corp. uses techniques related to IC photolithography to form grooves in titanium, which are covered to make tubes that carry fluid, as in this ink-jet print head.

Multilayer capacitive array cuts cost of emi suppression

Electromagnetic radiation from home computers, video games, and other consumer electronic items is a major problem for equipment vendors, and one of the worst radiation sites is right at the input/output connector. Usually this is taken care of by using relatively expensive filtered connectors. A new alternative is the use of multilayer ceramic capacitor arrays, which may be combined with standard connectors to give a less expensive, more reliable solution to radiated electromagnetic interference.

These multilayer ceramic capacitor arrays have been developed in rectangular and circular shapes. Each hole of an array is connected to one plate of a capacitor, and the periphery of the substrate is a common ground for all the capacitors. The array of parallelled capacitors is tied on the ground side to a solid radio-frequency sink like the shell of a metal connector. The pins of a connector are fitted through the holes in the array; all pins may be filtered.

In a circular configuration, devices can be manufactured to accommodate up to 168 pins. The usual hole diameter is 46.5 mils, and the thickness for each 20-nF capacitor in the array is 60 mils. Two capacitor arrays can be combined with ferrite beads to form pi filters. Prices range from 10¢ to 50¢ per pin in quantities of 10,000 to 100,000, depending on the complexity of the unit.

AVX Corporation, P. O. Box 493, Olean, N. Y. 14760. Phone 716-372-6611 [392]

Circuit-board press produces four laminations at once

The model 3040-270 press for multilayer printed-circuit boards is rated at 270 tons force and can produce four 30-by-40-in. laminations simultaneously. It features a fully automated in-line materials-handling system with a simplified indexing loader and gravity-fed off-loader. The press

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also offers full programmed cycling of separate hot- and cold-press stations.

Electrically heated, the hot-press section is designed with thick platens to ensure even heat distribution and to help minimize press deflection. Temperatures can be set as high as 600°F. Press deflection is held to just 0.001 in./ft. This low deflection rate, attributed to heavy-duty frame and component construction, keeps layers in parallel.

An optional microprocessor-based control system is available to program, run, and monitor all press functions. Priced at $142,000, the system can be delivered 16 to 20 weeks after receipt of order.

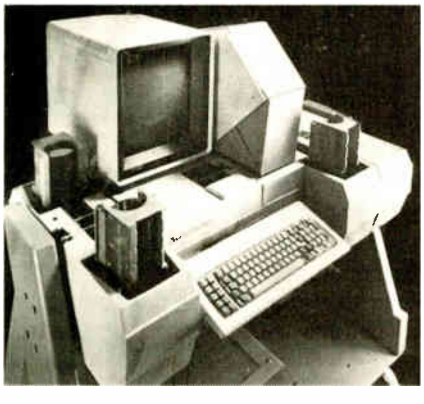
Technical Machine Products, 7850 Old Granger Rd., Cleveland, Ohio 44125. Phone (216) 441-5581 [393]

Wafer-flatness analyzer simulates two printing systems

Total indicated runout, or flatness, alone does not accurately predict which wafer will produce the highest chip yield in a specific projection process. For this reason, the AutoSort Mark II surface-topography analyzer directly simulates wafer-stepping and scanning-slit projection printing systems.

Each wafer's surface topography is analyzed according to where its surface lies with respect to the image plane. Wafer flatness for mix and match lithography is easily determined using consecutive simulations.

AutoSort also tests and sorts slices and wafers according to taper, bow, warp, total thickness variation, focal plane deviation, percentage of surface within the aligner's focal plane, local slope, and percentage of surface within local slope specifications.



Using a 68000 microprocessor, the AutoSort tests one wafer at a time, or more than 65,000 wafers a week if required. Vacuum and nonvacuum state tests are automatically performed without any physical contact on the wafer's top surface. To be available in the third quarter, AutoSort Mark II will sell for $110,000.

GCA Corp., 209 Burlington Rd., Bedford, Mass. 01730. Phone (617) 275-9000 [394]

Automatic solderer comprises robot, wire-stripping machine

Equipping an IBM 7535 robot with special soldering equipment and a modified wire-stripping machine, Design Technology Corp. has created an automated robotic soldering system. The SolderMate 400 is completely programmable, including solder joint locations, motion of the grippers for handling circuit boards, palletizing and depalletizing, and transferring wires from the optional wire stripper.

The system strips wires, loads circuit boards, and solders the stripped wires to programmable locations on the boards. A different pattern of solder joints and a different number of wires may easily be placed and soldered on different products.

A basic system, which starts at $41,900, includes the robot with standard grippers, a base, solder wire feeder, soldering head, and soldering controls. Delivery takes six weeks.

Design Technology Corp., Second Avenue, Burlington, Mass. 01803. Phone (617) 272-8890 [395]

E-beam lithography systems boast 10-MHz stepping rate

Two electron-beam lithography systems, the Chiprite 1 and 2, use an advanced vector-scan beam-deflection system with a 10-MHz beam-stepping rate. Writing resolution can be set to match minimum line-width requirements with computer-controlled selectable step sizes from 0.016 to 1.25 μm.

Chiprite 1, designed for use in mask shops, will both generate 1× master masks and produce 1× to 10× reticles. A typical rate for finished products is six to eight 5-in. mask plates or reticles per shift. A PDP-11/44 controls the unit.

Using a more powerful computer, the 32-bit VAX-11/780 plus a PDP-11/24, coupled with a completely automated workpiece-loading system, the Chiprite 2 has a typical throughput rate of eight 5-in. mask plates or 20 reticles per shift. The Chiprite 2 can be expanded to a total of four work stations.

Either system provides automatic focusing of the electron gun and can write on wafers up to 6 in. in diameter. Chiprite 1 is priced at $1.5 million; Chiprite 2 goes for $2.2 million. First shipments will begin in 90 days.

Cambridge Instruments Inc., 40 Robert Pitt Dr., Monsey, N. Y. 10952. Phone (914) 356-3331 [396]

Burn-in baths cut out hot spots, are controlled to within 0.1°C

A pair of liquid burn-in baths with their temperature control to within 0.1°C and heat dissipation of up to 1,100 W offers better component stability and eliminates the hot spots that typically occur in ovens. The baths are temperature-controlled from −10° to +150°C.

The baths are refrigerated above a set point to prevent thermal runaway in the devices under test. The liquid baths prevent oxidation and permit manufacturers to screen out electronic devices that may fail prematurely. A tabletop model, which sells for $3,000, permits testing of boards up to 5.5 by 6 in. A floor-standing unit that sells for $6,500 handles boards up to 24 by 12 in. Both are available in four weeks.

FTS Systems Inc., P. O. Box 158, Rte. 209, Stone Ridge, N. Y. 12484. Phone (914) 687-7664 [398]

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Our system features all the support you've come to expect from those other guys — plus a lot more!

Execute in real-time.

The 68000 Satellite Emulator provides true real-time transparent emulation. This means there are no restrictions of any kind on memory, instructions or interrupts. And at speeds of up to 10 Mhz.

Microprocessors Supported:

ES-Series	EM-Series*		
68000	8035	Z80	6800A/B
Z8000	8039	Z80A/B	6802A/B
Z8001	8040	MK 3880	6808A/B
Z8002	8048	MK 3880A	6809A/B
Z8003	8049	8085A	6809EA/B
	8050	8085A-2	
	8748	8080A	
	8749	8080A-1	
		8080A-2	

*EM-Series pricing from $3750.00 (U.S.)

Simplified software saves time.

An English-like command structure and help-oriented menus help you track down even the most complex problems, quickly and easily. This means you can learn to use the emulator faster and put it to work sooner.

Built-in versatility.

We've provided you with a variety of powerful features to use when debugging your 68000-based system. With Trace Memory, you can go back and observe up to 2046 steps of the program. The Event Monitor System lets you set breakpoints on any combination of address, data, status, pass counter or logic state inputs. You can specify 32 comparators in four different nesting levels to allow for almost any conceivable combination of triggering events. And the RAM Overlay Memory feature eliminates the tedious process of burning a new set of PROMs every time you reassemble or recompile your program.

Turn promises into products for a reasonable price.

When you are looking at systems from Tektronix, Gould, or HP, take a look at doing it our way. You'll be surprised at all the money you won't have to spend to get the performance you demand from a microprocessor debugging tool. Call us TOLL FREE today at (800) 426-3925. Or write us at 5020 148th Ave. N.E., P.O. Box 568, Redmond, WA 98052. In Washington, call (206) 882-2000.

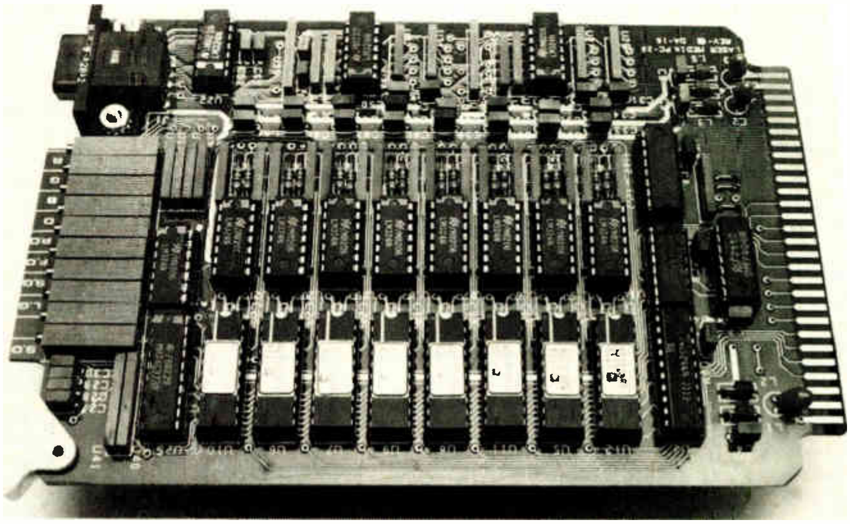
Applied Microsystems

Circle 193 on reader service card

Industrial

D-a card carries 16 channels

STD-bus board's 8-bit converters can be configured in pairs for four-quadrant multiplication



Oriented toward industrial controls and robotic applications, LM Inc.'s LM16STD digital-to-analog converter offers up to 16 channels and the capability for four-quadrant multiplication. Other uses for the card in STD-bus systems include digitally controlled multiple-channel hardware multipliers, function generators, and graphics display systems.

The flexible card lets a user either select straight-through d-a conversion or use pairs of converters for four-quadrant multiplication. Either 2's complement or straight binary operation may be chosen.

In order to obtain four-quadrant multiplication, two d-a converters must be interconnected in the standard multiplying d-a configuration. The eight Analog Devices AD7528 dual multiplying d-a converters used on the board are set up to make this configuration possible. An on-board nine-pin D connector provides eight multiplied output signals in the standard board configuration. A 26-pin 0.1-in. grid connector is offered as an option for those applications requiring up to 16 channels of straight-through d-a conversion.

Buffered op amps. Four buffered precision 0-to-12-V sources are available as references. Buffered operational-amplifier outputs are configured so that any number of channels may be summed. Unipolar or bipolar output may be selected; a full-scale swing is ±10 V in the bipolar mode.

Among the other features of the STD-bus d-a converter board are 8-bit resolution, an accuracy of ±½ least-significant bit, a gain error of ±2 LSB, and 16 independently latched channels that require no sample-and-hold circuitry. The nonlinearity of the board is ±1 LSB, and its offset error is correctable to ±½ LSB. A maximum of 1 μs elapses between the latching of a digital input and output of the valid analog level. The card's power requirement is 5 V at 100 mA and ±12 V at 100 mA.

All converter outputs are buffered by operational amplifiers that can supply full-scale voltage swings with a 5-kΩ load. The operating temperature range of the board is 0° to 70°C.

The LM16STD may be used to control the speed of servo motors. It also can serve for image manipulations, such as three-dimensional rotations and enlargements, in graphics applications.

The board costs $495 in single quantities, and delivery is in 30 days.

LM Inc., 2046 Armacost Ave., Los Angeles, Calif. 90025. Phone (213) 820-3750 [371]

Photodetectors' sensitivities cover 0.6 to 8.0 mA/mW/cm²

A pair of high-sensitivity detectors uses more of the available light signal and permit engineers to design systems to operate at lower light levels. The light-sensitivity characteristics of the two families range from 0.6 to 8.0 mA/mW/cm^2. Adding to the parts' flexibility, a base lead is provided that enables designers to control device sensitivity.

Designated the L14N1 and -P2 and the L14P1 and -P2, the detectors are npn silicon phototransistors in hermetically sealed TO-18 packages. The L14N has a flat window and the L14P a domed lens.

Priced between $1.20 and $1.40

each in 1,000-piece quantities, the detectors are available from stock.

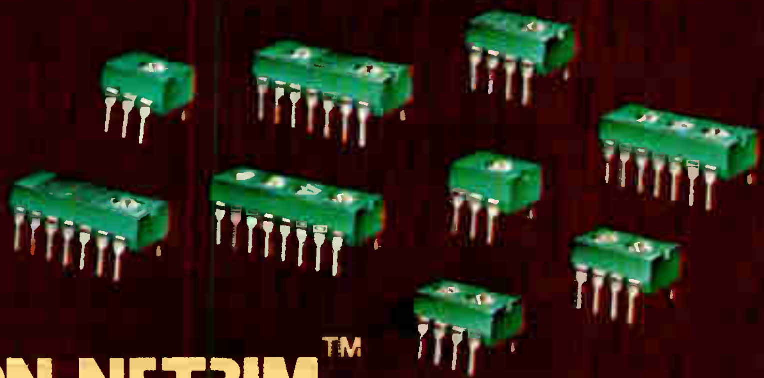
General Electric Co., West Genesee Street, MD 44, Auburn, N. Y. 13021 [373]

110-V ac line monitor retails for under $130

Simply plugged into a standard 110-V ac outlet, the Circuit Judge, an ac line-monitoring device, protects voltage-sensitive computers, entertainment equipment, laboratory and medical instrumentation, and telephone systems. It identifies the guilty parties when problems occur.

The Circuit Judge monitors ac circuits for surges of 300 V or more, high voltages in excess of 125 V, low

nine reasons to be choosy



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The NETRIM™ series will cut circuit manufacturing costs, lessen circuit design time, improve temperature tracking performance and boost dependability. Years of Weston development assure you of highest quality and outstanding reliability . . . the same reliability which has made Weston an industry leader.

NETRIM™ series compatibility with auto-insertion and auto-test devices, for example, will slash your production costs while delivering superb performance in less PC board space. That's just one reason why we think you'll specify NETRIM™ trimmer resistor network every time. Find out more today. Write or call for complete specifications, evaluation samples and pricing.

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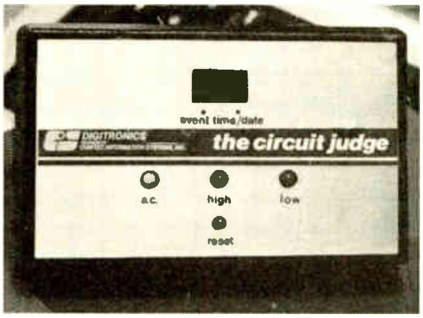
Circle 195 on reader service card



voltages of 100 V or less, and complete power losses. When disturbances occur, a light-emitting-diode display is lit, and a digital clock stops, recording the time and date of occurrence. The unit holds the information until it is reset.

The monitor retails for $129.95; dealer inquiries are invited.

Digitronics, 53 John St., Cumberland, R. I. 02864. Phone (401) 724-8500 [374]

Photoelectric control works over a distance of 40 ft

The MLS8C retroreflective photoelectric control features a modulated light-emitting diode effective to 40 ft, immunity to ambient light and electrical noise, false-pulse protection, and a tough polycarbonate housing. The standard version provides amplifier circuitry with a 10-A double-pole, double-throw relay. A two-wire ac version offers solid-state output.

The standard photoelectric control has on-off response without a plug-in card or jumper. Five additional plug-in logic cards are available for on-delay timing, off-delay timing, combined on- and off-delay timing, one-shot pulse output, and delayed one-shot pulse output. Logic cards cannot be employed with the two-wire version, however.

Leakage current on the two-wire control is 2 mA maximum, which permits direct interface with programmable controllers and other solid-state devices. Maximum response time for standard two-wire versions is 20 ms on, 20 ms off. Maximum rate of operation is specified at 15 kHz over its –40-to-+70°C temperature range.

The MLS8C sells for under $80 in lots of 250; deliveries are from stock.

Micro Switch, 11 W. Spring St., Freeport, Ill. 61032. Phone (815) 235-5731 [375]

Power conditioner guards against spikes of up to 7,000 V

The latest models in the Power Master line of power conditioners are hard-wire line monitors that offer a three-stage electrical-spike filter and a four-stage noise filter. They protect electronic equipment from moderate to severe voltage transients and electronic noise.

The models LM7400 and -7500 boasts a maximum spike voltage of 7,000 V and a clamping spike voltage of 55 V. The units protect against both common and transverse mode noise. The filter network's freqeuncy range is specified at 1 kHz to 100 MHz. Attenuation is 20 to 40 dB.

The model 7400 is for 15-A 220-V hard-wire designs; the 7500 handles 20-A 125-V systems. The 7400 is priced at $188.25; the 7500 goes for $206.15.

SGL Waber Electric, 300 Harvard Ave., Westville, N. J. 08093. Phone (609) 456-5400 [376]

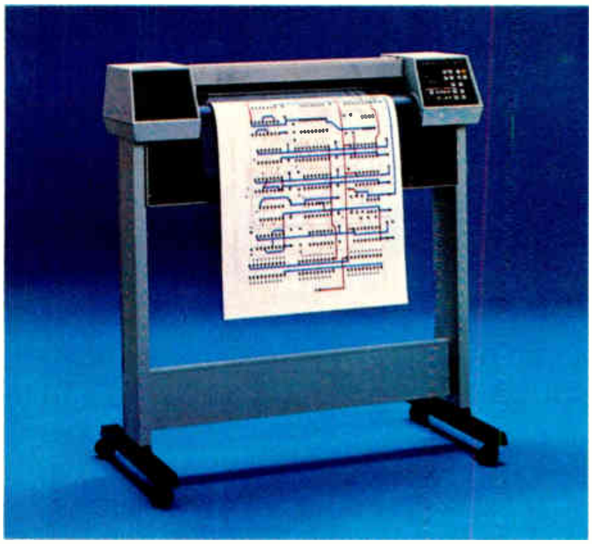
Photovoltaic panels targeted at 6- and 12-V systems

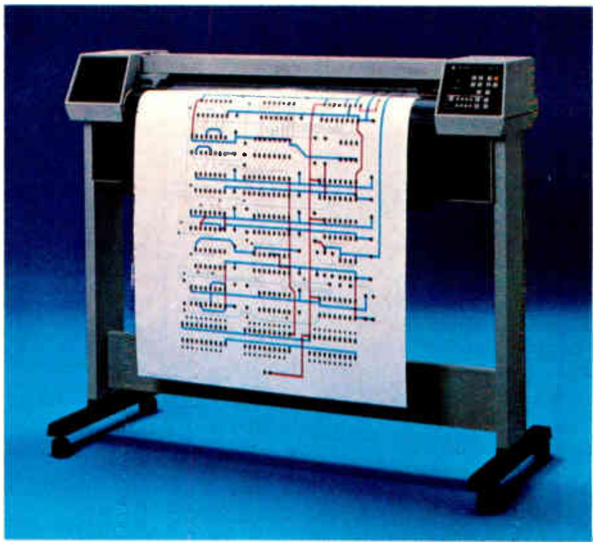
The SX series of photvoltaic panels, a line of small panels that are intended for low-power applications like remote telemetry units, radio-communications equipment, and instrumentation systems, gets two new members with the introduction of the SX-10 and -20. Both feature 40 semicrystalline silicon solar cells to power 6- and 12-V systems.

The SX-10 is rated at 9 W (peak), generating either 1.05 A at 8.6 V or 0.52 A at 17.3 V. The SX-20 is rated at 18 W (peak), generating either 2.09 A at 8.6 V or 1.05 A at 17.3 V. Available now, the SX-10 sells for $188 and the SX-20 for $285.

Solarex, 1335 Piccard Dr., Rockville, Md. 20850. Phone (301) 948-0202 [378]

Now you have a choice!





The best way to make the HP 7580 better was to make it bigger.

Introducing the new, larger-format HP 7585 Drafting Plotter.

You asked for it!
Ever since its introduction two years ago, the HP 7580 Drafting Plotter has enjoyed an unparalleled reputation for price/performance excellence. User reaction has been overwhelmingly positive.

But some of you wanted *more*, and expressed the desire for even *larger* plotting capabilities. And now Hewlett-Packard has met your challenge.

The new HP 7585 Drafting Plotter maintains *all* of the many benefits of the HP 7580. The significant difference is the ability to output plots up to 36.5"x 48."

Now, *both* plotters can:

Interface with HP, DEC®...
and other ASCII computers with RS-232-C or IEEE 488 (HP-IB, GP-IB) interfaces. (Both interfaces are standard on each plotter.) Also, a new capability for both plotters is modem operation for remote or timeshare applications.

Interface with existing FORTRAN application programs...
using the HP Industry Standard Plotting Package, our version of the standard CalComp plotting software.

Give you high throughput and quality output.
4 G's acceleration; 60 cm/s (24ips) speed; addressable resolution 0.0250 mm (0.000984"), with a mechanical resolution of 0.0032mm (0.00012").

Cut the cost of high-performance plotting in half.
It took a technological breakthrough to bring the price of an E-size, high-performance plotter in at only $22,900, and a D-size unit at $16,100. *(Domestic USA prices only.)*

Provide long-term satisfaction with their ease of use and reliability.
Hewlett-Packard has a worldwide support organization that can provide quick on-site maintenance.

Take the hassle out of handling pens.
8 pens are capped automatically in each of three carousels, keeping your pens always ready to write. Carousels are matched for fiber tip, roller ball, and liquid-ink drafting pens. This allows automatic, manual, or program control of pen forces and speeds for optimum plot quality.

Plot on a wide range of media and sizes.
Produce plots on paper, vellum, double matte polyester film—even preprinted forms. All standard sheet sizes from notebook size sheets to 24.5"x 48.0" for the HP 7580, and 36.5"x 48.0" for the HP 7585 are easily accommodated.

For more information.
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Mail the coupon to: Hewlett-Packard
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Attn: Nancy Carter

☐ Please send me more information about the HP 7585 and HP 7580.
☐ Send a sample plot from one of your drafting plotters.
☐ Have a Hewlett-Packard representative call me.
☐ I am interested in re-selling your plotter as part of my system. Have your OEM sales manager call me.

My computer and operating system are ____________
My application and software are ____________
Name ____________ Title ____________
Division/Dept. ____________ Company ____________
Address ____________ City, State & Zip ____________
Phone Number (____) ____________

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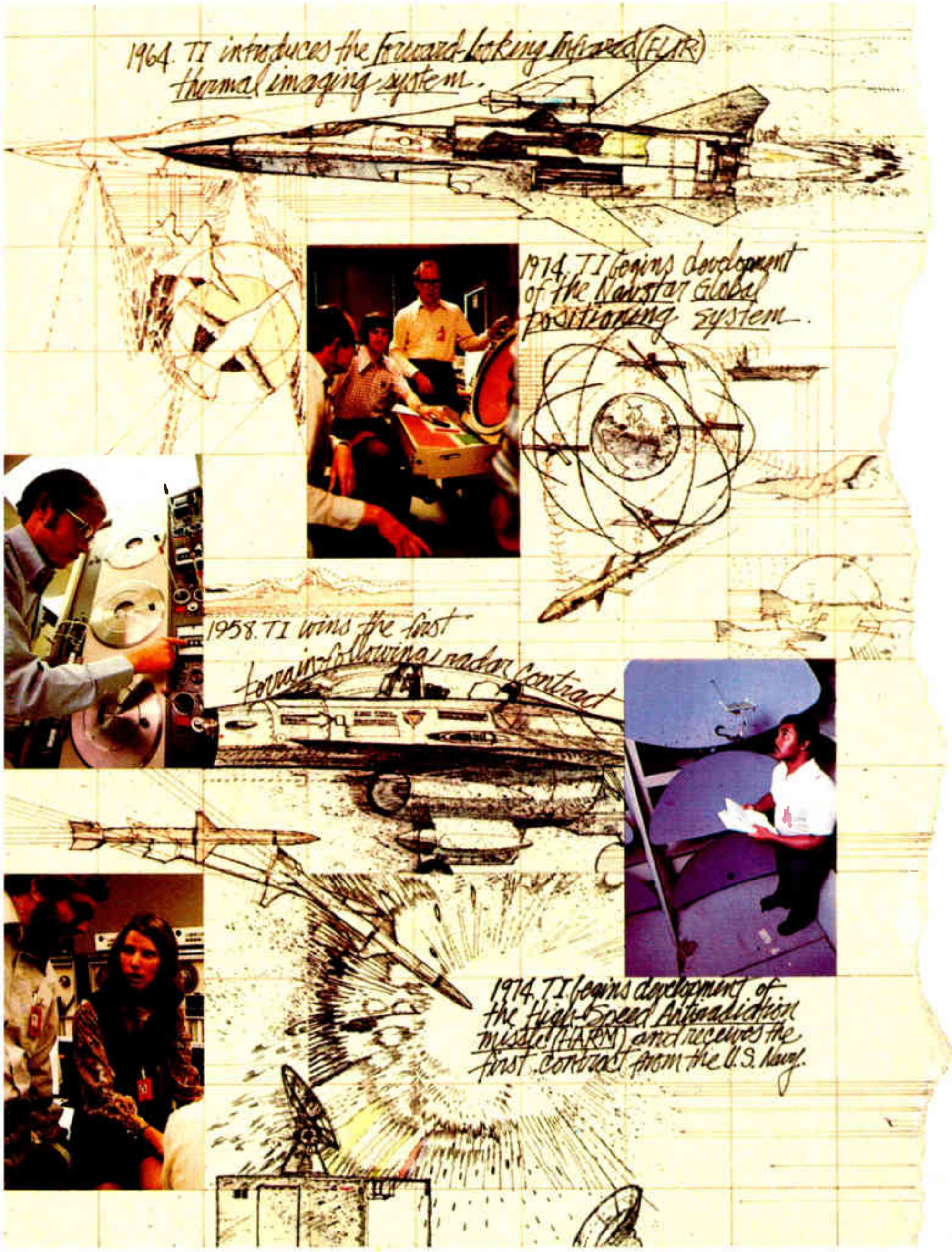
Circle 197 on reader service card

Together we can make history by putting up a good defense.



Security restrictions limit this presentation.

As a leader in state-of-the-art technology, the Equipment Group of Texas Instruments develops and produces radar systems . . . electro-optic systems . . . missile guidance systems . . . and communications, navigation, and intelligence systems. Our technological breakthroughs in these fields have not only benefited America's defense, but also the way we Americans live.

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Easy money. Entrepreneurs can tap the knowledge of one of the "Big 8" accounting firms with a book called "Raising Venture Capital: An Entrepreneur's Guidebook." Prepared by Deloitte Haskins & Sells, the book guides the businessperson through the intricacies of launching a new high-technology company and obtaining venture capital. The 104-page publication helps the entrepreneur organize a new business, develop a viable, concise business plan, and make effective presentations before prospective venture-capital firms. In addition, a 34-page appendix provides guidelines for preparing a financial forecast and includes an example of the forecast, including cash-flow projections, income statements, and *pro forma* balance sheets. The book is available at no charge to entrepreneurs and $5 to others. It can be obtained from any of the firm's offices or by writing to the company's executive office, 1114 Avenue of the Americas, New York, N. Y. 10036. Circle reader service No. 421.

Publish or perish. That publishing is an important element in the engineer's role in the professional community is a major premise of "How To Write and Publish Engineering Papers and Reports." Writing actually helps the engineering work, too, according to the book. It shows how writing problems can be anticipated, how negative criticism of reviewers can be forestalled, how refereed manuscripts can be successfully defended, and how writing and thinking processes can be aided by using a computer terminal. Illustrative examples instruct how to prepare manuscripts for technical journals, trade magazines, conferences, and company reports. Selling for $17.95 (or $11.95 in paperback), the work is available from ISI Press, 3501 Market St., Philadelphia, Pa. 19104. For more information call (215) 386-0100. [425]

Who's who in ATE. Designated the "Test Equipment Selection Guide 1983," a pair of looseleaf-bound volumes includes hundreds of pages of product data sheets, in-depth prod-

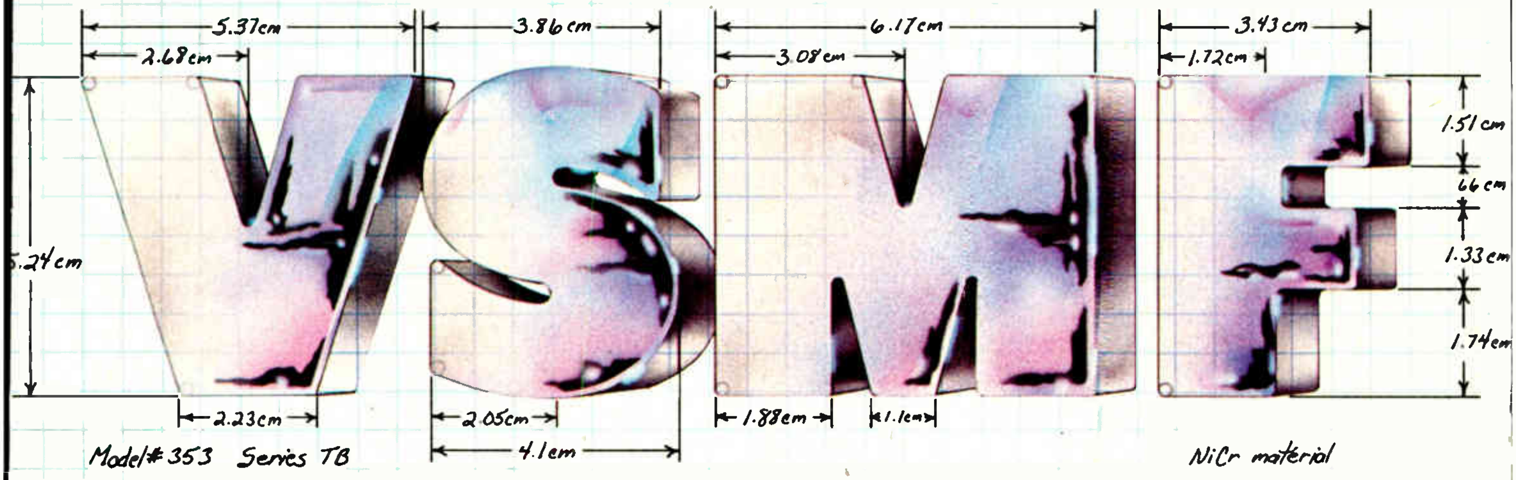
New literature

uct descriptions, and company profiles of both major and lesser-known automatic-test-equipment manufacturers. Equipment such as automatic and discrete testers for integrated circuits and in-circuit, functional, and interconnect verification testers is detailed in the guide, which is slated to be updated quarterly. The guide is available at an introductory price of $225 plus an additional $20 for shipping and handling. Write to Test Engineering Solutions Inc., 19234 Vanowen St., Reseda, Calif. 91335 or call (213) 708-0390. [422]

From Japan with love. Mechatronics News, a journal devoted to developments in Japanese robotics technology, is now available for subscription. Each issue is geared to applications in robotics in a particular industry or sector of society. The first issue, for example, examines the impact of robotics on small manufacturers. In addition, the journal will include abstracts of articles about robotics appearing in other publications, mainly Japanese-language journals with limited availability in the U. S. To top that, the full text of the abstracted articles can be supplied to subscribers. Subscriptions, costing $1,000 for 10 issues of 60 pages each, are available by calling (202) 638-4600 or writing to Mechatronics News, Technova Inc., Suite 207, 905 Sixteenth St. N. W., Washington, D. C. 20006. [423]

Fm answers. "Answers to Most-asked Questions About Two-way FM Radio" is the title of a booklet that tells how Midland Land Mobile Radio systems operate, what equipment is required, and how to plan a two-way system for maximum effectiveness. Among others, it covers such subjects as determining range requirements, antenna siting, repeater systems, and Federal Communications Commission licensing. And for nontechnical people, it contains a glossary of common mobile communications terms. The booklet is available at no charge by writing to Midland LMR, Marketing Department, 1690 N. Topping, Kansas City, Mo. 64120. [424]

Because an engineer should spend less time looking for data, and more time using it.



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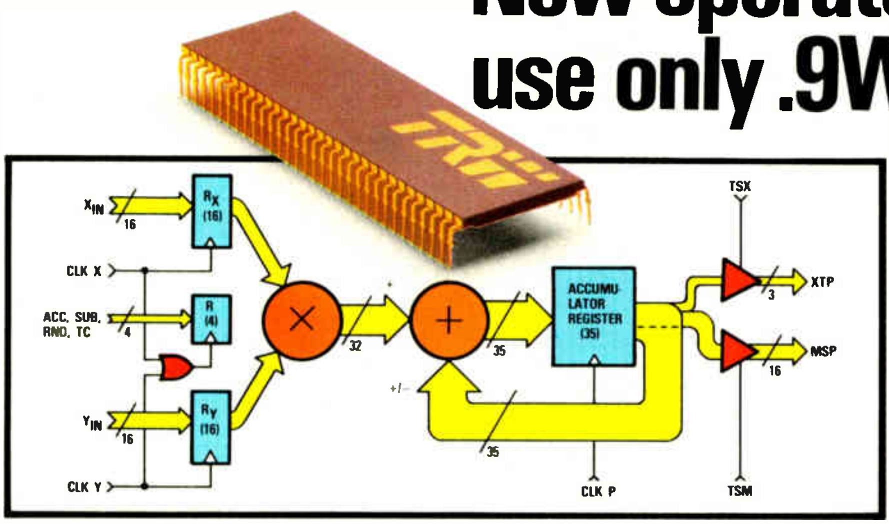
E

Circle 201 on reader service card

High-speed 16-bit multiplier/accumulators just got a lot faster (and cooler).

Now operate at 100 nsec, use only .9W of power!



Our new 100 nsec* multiplier/accumulator (TDC1043) is 40% faster and 1/4 the power of its predecessors. This dramatic improvement is made possible through TRW's exclusive new OMICRON-B™ 1-micron bipolar technology.

With the TDC1043, you can increase your processing speed for superfast image or video processing, array processing or interactive graphics. And with the power you save, you can reduce the size of your power supply, design-in more devices, or even extend your product line into such areas as airborne or portable equipment. The possibilities are up to you!

*100 nsec (worst case T_A = 0 °C – 70 °C); 0.9W typical.

Circle 202 on reader service card

The TDC1043 provides full 35-bit double precision accumulation with optional subtraction internally, with a 19-bit extended output (16 MSB's plus 3 guard bits). It can also easily operate as a superfast multiplier by simply disabling the accumulate function. Packaged in a standard 64-pin DIP, its pin-out is compatible with the industry standard TRW TDC1010.

Our TDC1043 has a U.S. price tag of only $190 in 100s—which makes it not only the fastest, but the lowest priced 16-bit multiplier/accumulator available!

To get your complete data sheet on the new 100 nsec TDC1043 multiplier/accumulator, circle reader service card. Or, for superfast information, call or write our Literature Service Department:

LSI Products Division,
TRW Electronic Components Group,
P.O. Box 2472, La Jolla, CA 92038,
(619) 457-1000.

In Europe, call or write:
TRW LSI Products
Europe, Konrad-Celtis-Strasse 81,
8000 Munchen 70, W. Germany,
(089) 7103-0.

In the Orient, phone: Kowloon, Hong Kong, 3856199; Tokyo, Japan, 4615121; Taipei, Taiwan, 7512062.

TRW

LSI Products Division
TRW Electronic Components Group

Products newsletter

Graphics package makes 3-d–like charts from spreadsheet data

A graphics package that displays business charts with the appearance of three dimensions will be available in August from Corvus Systems to run on the Corvus Concept microcomputer. Developed by a new firm, DDD Software of Beverly Hills, Calif., **the package, called DDD Graph, is written in Pascal and is easily portable to most microsystems.** The program simulates a "virtual camera" that looks through the window of a bit-mapped cathode-ray tube at a 3-d chart. Input from as many as five spreadsheets can be stacked in a single bar graph, which can then be rotated in space for the most useful view of the data. The $395 package requires 256-K bytes of memory and a hard disk. DDD Paint, a companion package that allows use of a mouse to draw directly on the screen, provides 3-d displays for graphic artists and architects.

Financial program translates into French

Comshare Inc.'s Target Software unit in Ann Arbor, Mich., is making available a French-language version of its PlannerCalc spreadsheet program, including documentation, help screens, commands, and error messages. Called Modélisation Numérique et Financière, **the program accepts existing English-language financial models and translates them, even changing dollars to francs.** A user merely inserts a floppy disk containing a French version into his or her personal computer along with the English version of a PlannerCalc model. The logic of the model and format of numbers are automatically translated into French, and *vice versa.* Look for the company to add German and Italian versions to the French offering, which sells for about $99.

Keyboards can carry display components

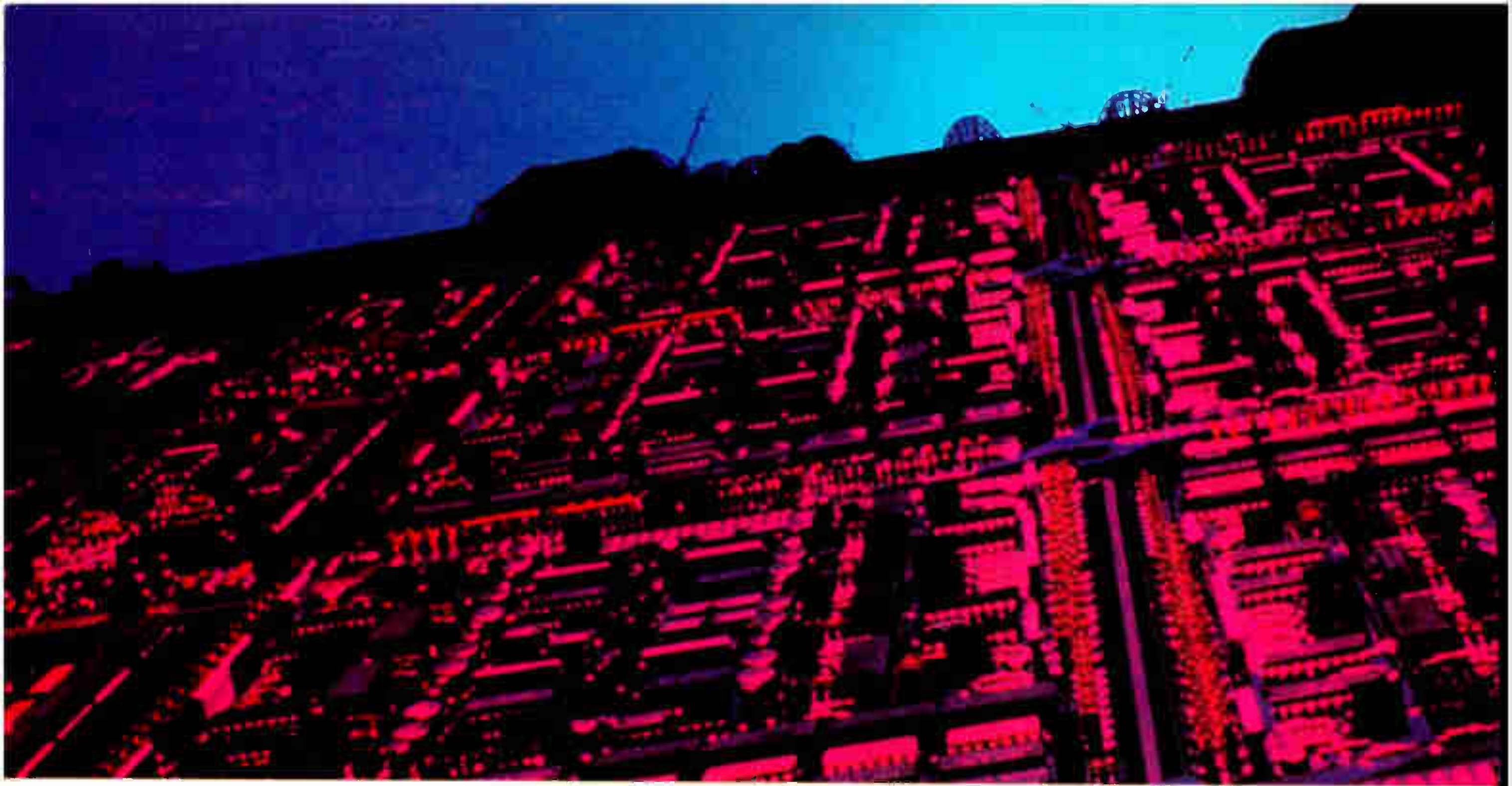
Customers of the Dorman Bogdonoff Corp. now can specify added electronic components like light-emitting diodes, seven-segment displays, and related integrated circuits for the Andover, Mass., firm's line of membrane and tactile keyboards. The technique enables original-equipment makers in the instrumentation, industrial, electronic, and computer markets to **eliminate the need to inventory the same components or add a second printed-circuit board to house the devices.** On average, the option adds 20% to the firm's custom keyboards. Delivery takes up to eight weeks.

Robotic board handler drops in price . .

The price of Zehntel Inc.'s 600 robotic board-handling system [*Electronics*, Jan. 27, p. 135], which features Corvallis, Ore.–based Intelledex Inc.'s six-axis robot arm, has been slashed from over $60,000 to $52,000. The Walnut Creek, Calif., firm says the reduction is **due to streamlined installation procedures and lower service costs.**

. . . as does some graphics equipment

Both Chromatics and Advanced Electronics Design Inc. have cut prices on their graphics equipment. The Tucker, Ga.–based Chromatics' CGC 7000-01, a bit-mapped color graphics computer with a 1,024-by-1,024–picture-element resolution, now sells for $11,995. The system is built around a 68000 processor and comes with a 19-in. screen and 128-K bytes of memory. AED, of Sunnyvale, Calif., **has slashed by 35% the price of its AEDS11 stand-alone color graphics work station, from $31,000 to $19,995.** It emulates the Tektronix 4010 graphics system and has a resolution of 768 by 575 pixels.



More than 2/3 of the Electronic Engineers sampled read Electronics® first.

Source: Crossley Surveys, Inc.

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In a recent survey more than ⅔ of electronic engineers said they read Electronics first, before any other electronics industry publication.

That means if you advertised in Electronics they read your ad first too. If you didn't, they didn't.

And when you're selling in the multi-billion dollar electronics market, having your ad read first makes a big difference.

Especially when it's read by those at the top of the buying pyramid, where your sales really begin.

They're the key individuals who unlock the door to a bigger share of market. They authorize purchases and directly influence buying policies. They're the important people who read the best editorial in the field.

That's the readership Electronics delivers.

So while Electronics reaches the top of the buying pyramid, other publications just give you the numbers at the bottom.

And in Electronics your advertisement is surrounded by timely, respected, world-wide editorial. The right kind of environment for your message.

Read at the right time.

First.

This is a story about Al Roberts, a successful yet frustrated executive who wanted to take advantage of the computer revolution, but just didn't know where to start. In it, you'll follow Roberts' progress as he gains more and more knowledge and finally has the ultimate learning experience: a "hands-on" session in a computer store.

HANDS-ON

By Donald M. Klein

Of all of the adjectives you could use to describe someone, "insecure" is probably the last word you would use to describe Al Roberts.

At 41, Roberts has the athletic good looks of a movie star. His financial situation is equally handsome: as the national sales manager of one of the country's largest sporting goods companies, Roberts' substantial annual salary is augmented by a host of "perks" that include stock options, a car and access to the corporate jet. As if that weren't enough, Roberts is immensely likeable and very down to earth. In short, he has, as they say, "everything going for him." Yet up until about six months ago you could send shivers of fear down Al Roberts' spine by simply mentioning one word: computers.

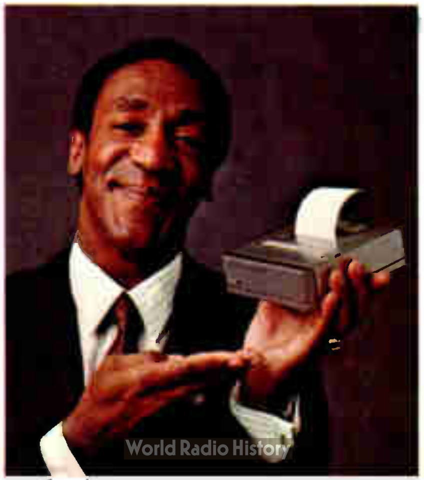
TI's new Compact Computer. It takes over your work, not your desk.

The ordinary personal computer occupies too much of the ordinary desk.

Now Texas Instruments brings you a cordless compact computer that puts much of the problem-solving power of Apple™ or IBM™ personal computers within your reach, wherever you go. You can expand its internal 6K RAM and 34K ROM with TI Solid State Software™ cartridges for an effective memory of up to 168K — more than enough for most personal computer tasks. Yet the Compact Computer 40™ is smaller than a magazine page.

TI Solid State Software cartridges, containing up to 128K bytes of ROM, let you plug in powerful, convenient, easy-to-use application programs. Sophisticated software is available right now for finance, statistics and production planning. Graphics, spreadsheet and word processing are just around the corner.

The TI Compact Computer 40 has low-cost peripherals that make it even more useful: a TI Wafertape™ drive for convenient, reliable program or data storage; a 4-color printer/plotter; and an RS-232 interface for talking with other computers or running a larger printer.



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"In retrospect, I suppose it was a simple matter of fear of the unknown," Roberts says. "Kind of silly, I suppose. But it was very real to me then."

Silly? Perhaps. But Al Roberts' "silly" fear is unfortunately...and increasingly...typical of the attitude of many of America's middle and upper managers today. These are intelligent, well-paid, often aggressive executives. And while their routine responsibilities may very likely include the approval of *purchasing* computers for their corporations, when it comes to their becoming personally involved with the equipment, they turn off.

As with Al Roberts, fear of the unknown (or fear of embarrassment) accounts for some managers' reluctance to use computers first hand. Others claim that computer implementation is a "clerical" task, and as such is beneath their station. Still others claim that they "don't have the time," or that computers are "fine for accountants and bookkeepers, but not applicable to what I do."

While it is true that computers are better suited for some tasks than for others, and that they do, indeed, require the somewhat "clerical" task of being manipulated by a keyboard, the truth of the matter is that most middle and upper managers would *like* to take advantage of the "computer revolution" if only they knew how.

As Al Roberts discovered, obtaining that knowledge was easier than he had feared.

"It all came to a head sometime around the holidays," Roberts recalls.

"It was just one of those days...you know, when nothing goes right? Anyway, it was about ten in the morning ...my secretary had called in sick, and I was just about to call personnel and request some help from the typing pool when I was interrupted by a young marketing assistant who had been dispatched to find me. He told me he was new, that he worked for Robert Bradshaw, (our unbelievably humorless director of marketing), and that Bradshaw needed some important sales data as quickly as possible.

I invited the young man to sit down and asked him what the urgency was all about. He politely explained that the marketing department was planning the introduction of a new product...a quoit game called 'Hoity Quoity'...and that their research indicated that there was a correlation between the sales of our archery and horseshoe sets and the projected sales of the new product. The information Bob Bradshaw wanted was nothing less than a complete breakdown by marketing area of the sales figures for what we call 'shoes' and 'arrows' *for each of the last five years*! What's more, he wanted it by the end of the day... preferably before lunch.

"Young man," I said to him, "what's your name?"

"Lathrop, do you realize what you've done?" I asked, my eyes burning with intensity.

"Me? What I've done?! N..no, Sir, I'm afraid, I don't , Sir." By this time I can assure you that young Lathrop was sorry he hadn't taken a job with PPG or General Motors.

"What you've done, young man, is manage to get yourself between a rock and a hard place. You've got Bob Bradshaw in back of you, expecting you to come back upstairs with a pile of sales numbers, and *me*

in front of you, telling you you're not going to have that data. Not today, anyway, and probably not tomorrow, either. There's just too much work involved...too much searching, too much reading, too much writing and too much calculating."

Young Lathrop looked like he was going to be sick. His first mission to the dreaded sales department, and he was failing.

"Unless," I said, "unless..."

The color returned to Lathrop's face as he started to realize that there might be an alternative to coming up empty-handed.

"Unless what, Sir?" he managed.

"Unless, of course, you were able to lend us a hand yourself. You see," I said, gesturing to the wall of file cabinets that lined the hall outside my office, "all of the information you want is in those files. It's getting it *out* of the files that's the problem."

"That's fine, Sir," he said with audi-

"Lathrop," he answered. "John Lathrop."

"Lathrop, how old are you?"

"Twenty-three," came the response.

"And I assume you're well educated? MBA and all that sort of thing?"

"Yessir." At this point the poor kid was starting to sweat, wondering desperately why I was giving him such a hard time. But there was a method to my madness, if not my meanness.

"WOULDN'T IT MAKE MORE SENSE TO HAVE ALL OF THIS ON COMPUTER?"

ble relief. "Just let me get my calculator, and I'll be right back."

"Take mine," I said, tossing it to him. "And make yourself at home at Julie's desk. She's out sick today anyway."

And so my method paid off: at the risk of feeling only slightly guilty I snaked one of Bradshaw's own boys to do my grunt work for me. The thing is, I knew in my heart there was a better way...a saner way...to get those statistics than chaining a budding young executive to a file cabinet and a calculator for five or six hours. I suspected that John Lathrop knew it too, and my suspicion was confirmed when he asked me the following question:

"Mr. Roberts...wouldn't it make more sense to have all of this on computer?"

He was, of course, right.

You know, I have to laugh when I think back on that day, but at the time it wasn't very funny. There was just too much for John to handle by himself, so I rounded up a couple of secretaries and pitched in myself to get the job done. It took the four of us seven hours of searching, writing, tabulating and typing. By the time we were finished I was exhausted. But what really bothered me was the comment that John had made earlier in the day...the one about having everything on computer.

That thought nagged at me all the way home.

The next morning, I ran into Bryce Deeter on the train. Bryce is the fleet manager for a huge manufacturing company. He's in charge of all their vehicles, ranging from the passenger cars used by their sales people, to the trucks they use for shipping and repairs. They even have their own limousine fleet! Anyway, Bryce is a friend, and I'm always glad to see him. I really don't know much about the details of his business, but I'm always teasing him about upgrading his fleet. When I saw him that morning I grabbed the seat next to him and asked him when he was going to buy a fleet of Ferraris.

"Not this week, pal," he said. "I just convinced the CEO to spend his money on something *really* classy...a bunch of desktop computers." Naturally, my ears perked up.

"Oh really? Tell me more. I've been thinking about taking the plunge myself."

"That's funny," he replied. "I would've thought that you guys were totally computerized over there by now."

"On a corporate level we are," I explained, "for things like payroll and manufacturing. But that's not what I'm interested in. I want something that can help *me*, you know, to get through my daily workload."

"Oh I know, alright!" Bryce exclaimed. "Why do you think I was so hot to get some units for us? Listen," he continued, moving closer so that I wouldn't miss an ounce of his enthusiasm, "those things are going to change my life. Here," he continued, taking a magazine article from his briefcase, "look at this."

The article was entitled "FROM ENGINEERS TO POETS, AMERICANS ARE LEARNING TO LIVE WITH COMPUTERS," and it detailed several case histories about people from all walks of life who got "computerized." The first example was a chief engineer of a large consumer appliance firm. The article told how he used very sophisticated computers to design three-dimensional schematics of new products. 'Computer-Aided Engineering' they called it, and while it was fascinating to read about, frankly, I couldn't see how it applied to me at all.

"Bryce, this is all very interesting, but why in the world do you need equipment like that in *your* job?"

"Keep reading," he said. "See what it says here? 'Although computer applications dominate high-tech industries, the advent of the personal computer has allowed previously non-technical people to benefit as well. And while it comes as no surprise that engineers are among the most likely to find ways to apply personal computers to their everyday lives (the chief engineer, for example, uses his personal computer for scheduling and planning), we are now seeing general businessmen growing increasingly dependent on their micros. For example, take the case of a chief financial officer of a major aircraft manufacturer who reports that 80 percent of his workload is now put on computer, including all of his charts and graphs... work previously done by hand with far less satisfactory results.'

"See," Bryce said. "I can't wait to get my hands on one!"

"Me neither," I said as the train pulled into the next station, "only I've got one small problem."

"What's that?"

"I don't know what to do with it when I get it!"

Although Bryce knew that I wasn't joking, he couldn't help laughing at my confession. He was still chuckling when the new passengers climbed aboard. Among them was Sally Peters. Sally is a purchasing agent with a metal refinishing outfit and both Bryce and I know her and her husband from when they used to live in town.

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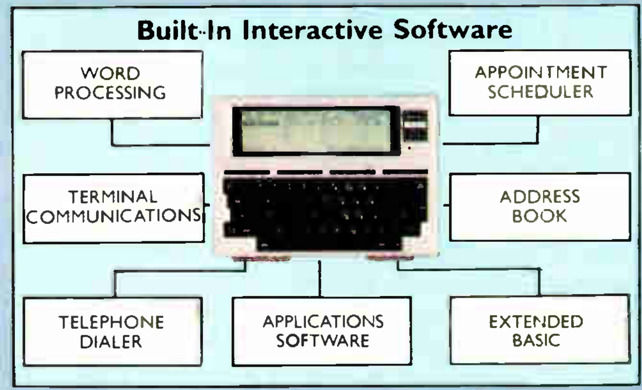

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"Hi, guys," Sally said as she joined us. "What's so funny?"

"Our friend here has a classic case of 'Compufear,' " Bryce answered. "What's the matter, Roberts? Are you intimidated by a few pieces of wire and plastic connected to a TV screen?"

"Well," I countered, "I wouldn't exactly say 'intimidated,' but I *will* admit to a slight case of ignorance."

"Have you ever actually tried to use one?" Sally asked. "They're really a lot friendlier than they're accused of being."

"AL, YOU DON'T NEED TO KNOW PROGRAMMING..."

I had to admit that she did have a good point: for all my alleged concern about computers, I had never, in my entire life, as much as typed in one command.

"As a matter of fact, no," I confessed. "I don't know the first thing about programming."

If my earlier comment had struck Bryce as humorous, this one struck him as hilarious.

"PROGRAMMING!" he bellowed. "I thought you were a sales manager, not an electronics engineer!"

"Al," Sally chimed in, "you don't need to know anything about programming to use a p.c.!"

"P.c.?" I said, more than a little sheepishly. "What's a p.c.?"

"Personal computer. Look, you don't need to know about programming at all. When we first got our computers at the office I was a nervous wreck. I'd been doing my purchasing analyses a certain way for years, and I was really comfortable with it. I was scared to death that I'd have to learn a whole new way to do my job."

"Well? Didn't you?" I asked.

"Not at all! Sure, it took a little while to learn how to operate the machine itself, but it's sort of like training an assistant...you teach *it*, it doesn't teach *you*! I still use the exact same procedures I've always used, only now the computer does the work for me. And I *still* don't know anything about programming."

"But you *do* have to be willing to learn some abbreviations," Bryce said. "Sometimes I think that computers were invented by the same guys who invented CB radios; there's just as much jargon."

"Like what?" I asked. Whether or not they realized it, Bryce and Sally were giving me my first computer lesson, and I was really getting into it.

"Like RAM, ROM, bit and byte," Bryce said.

"Sounds like the words to an old rock and roll song! What does it mean?"

"RAM means 'random access memory,'" he advised. "This means that the CPU...the actual "brain" of the computer...can add or take from this memory whenever it wants to."

"Oh," I said. Suddenly, my first lesson wasn't so much fun anymore, but I didn't let on. Undaunted, Bryce continued.

"ROM, on the other hand, stands for 'read only memory.' That means the CPU can take information *out* of this memory, but can't add to it." Then he said something which almost made sense:

"It's kind of like the difference between a tape recording and a record. ROM is like the record. You can listen to it...or, in this case, take information from it...but you can't *add* to it or alter it. The RAM allows you to do both: just like a tape recording, you can add to it *or* take from it."

"If that's the case," I asked, "why bother with ROM at all? Why not just have RAM?"

"That's a good question," Sally said, "but it turns out that there's an equally good answer. ROM is memory that's installed at the factory. You can think of it as being 'sealed into' the computer. It stays there all the time and is applicable to whatever you're using the computer for. But RAM is temporary; it lasts only as long as you have the computer on. When you turn it off, the RAM goes away. Still, you need RAM capacity, otherwise you can't use the computer to do what you want it to do."

"Okay," I said. "I think I've got it. Now this might not be a perfect analogy, but tell me if it makes sense.

"Let's say that I have a certain vocabulary I have learned over the years. You could say that those words are in my memory...sort of built into my brain. Now let's say I have a conversation with somebody. I use those words...and maybe even some other, new words that I'm using for the first time. During the conversation, I'm using my memory in a flexible kind of way...I'm using it to create a conversation...a conversation that's relevant to what I want to communicate at that time. But once that conversation is over, it doesn't take long for me to forget what the exact exchange of words was. If I *do* want to remember it, I'd better write it down or tape record it. But the basic vocabulary... the words that I drew from to create the conversation...stays with me long after the conversation itself is over. In this analogy, the vocabulary I've learned over time is my ROM. The conversation is the RAM. Right?"

"Well, not exactly," Bryce said. "But it's not all wrong, either. In your analogy, the vocabulary is your data base, not your memory. But you *are* right in that the ROM is fixed, or 'built in,' while the RAM gives you flexibility and allows you to manipulate the data base the way you want to."

"I've got to admit, it *is* a little confusing."

"Sure it is...at first. But it's like anything else: once you start to learn about it, it becomes easier and easier. The problem most people make is that they assume they have to learn *too much* about computers in order to use them. Sure, you should know the difference between RAM and ROM, but a superficial knowledge is all you need. It's like knowing about horsepower and torque," he continued, "Do you know what horsepower is?"

"Sure," I said. "Everybody knows what horsepower is."

"Wrong," he said, "hardly *anybody* knows the true engineering definition of horsepower. But everybody understands the *concept* of horsepower, and that's all you need to know to use it in a practical sense. Well, the same is true about many of the terms that apply to computers. All you have to know is that before you buy a computer, you need an adequate amount of RAM." The lesson was getting to be fun again.

"ALL WE'D NEED IS... A STANDARD SPREAD SHEET PROGRAM."

"But what's 'adequate?'" I asked.

"Well," he said, "let's go back to the horsepower analogy. How much horsepower is adequate?"

"It depends," I said. "Are we talking about sedans? Sportscars? Motorcycles? Trailer trucks?"

"Exactly!" Bryce said. "It depends on what use you have in mind. Most p.c.'s have anywhere from 16k to 64k RAM, but some have as little as 1k and others go as high as 256k. Again,

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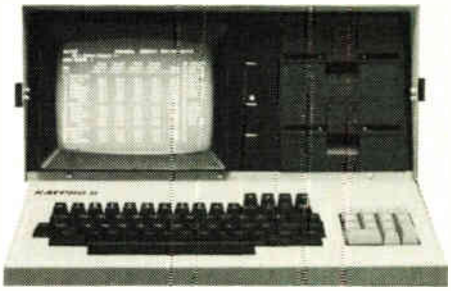

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if it's really important to you, you can learn the exact scientific explanation of what that means, but it really isn't necessary."

"Then how come you learned all that stuff?" I asked.

"Well, it's a funny thing," he said, "but I didn't consciously set out to learn it...I sort of acquired it. You'll see ...the same thing will happen to you."

As it turns out, Bryce was right: I *did* come to learn all about bits and bytes and everything else that seemed so mystical that morning on the train. But what I *really* wanted to know was how were all those bits and bytes going to help *me*? It's one thing to understand what a computer *is*, but it's something else again to understand what a computer *does*.

When I got to the office I asked Julie to get John Lathrop for me on the phone, and then to hold my calls. Today, I had decided, was 'Teach Al Roberts About Computers Day.'

Lathrop didn't sound too happy to hear from me, but I told him it was important that he come to my office as quickly as possible. He did.

"Lathrop," I said, "I need your help. Are you willing?"

"Sure," he replied. "As long as you clear it with Mr. Bradshaw."

"Oh, Bradshaw won't mind," I assured him. "In fact, by helping me, you'll be helping him too. The real question is are you *able* to help me?"

"That depends, Sir. What is it that you want help with?"

"Computers. Yesterday was a terrible waste of time, and I got the feeling that it was particularly frustrating for you because you, unlike me, knew exactly how a computer could have helped us."

"That's true," he admitted. "We could have knocked that project off in a matter of minutes. All we needed was a micro and a standard spreadsheet program. In fact, when I was in school we..."

"Wait a minute! Stop right there!" I exclaimed. "That's just the point, John. I don't know what a 'micro' is, let alone a 'standard spreadsheet program.' In fact, I just learned about RAM and ROM this morning. We're going to have to take this real slow."

"Okay," John smiled. "I get the picture. But if we're going to do this right, this is the wrong place to be doing it. We should go to one of those computer stores. There's one about ten blocks from here, and if we go over now, it'll probably be pretty empty."

"Julie," I said into the intercom, "Call Bob Bradshaw and tell him I've kidnapped Lathrop. Tell him I'll return him unharmed by the end of the day."

"Yes Sir," she said, and we were off.

The place John took me was exactly as he described it: a computer "store." I had passed by it several times before, but I never actually looked inside. I guess I thought it was just a place to buy video games, but I got over that notion in a hurry. There must have been fifty computers on display, ranging from the kind you hook up to your own television set to little portable units that you can use anywhere ...even on airplanes.

John apparently knew Ted, the manager, from his previous visits, and he explained why we were there.

"OK," I SAID, TAKING MY SEAT IN FRONT OF THE MACHINE, "HOW DO I TURN IT ON?"

"You've come at a perfect time," he said. "We get pretty busy around lunch time, but right now, I can give you all the help you want. For starters, why don't you tell me what you do for a living, and give me a couple of your 'typical days.' "

I spent about fifteen minutes describing my job, and then Ted made two observations: one, that every day was different from the day before, and the other, that most of the numbers work I did involved analyzing the same data (for example, sales of a particular inventory item) over and over again for each of the different sales areas. He also ascertained that the 'generation of the primary data' (for example, the sales figures themselves) were provided and reported for me by the appropriate sales reps.

"You," he finally said with a big smile, "are ripe for computerization."

"Great," I said. "So computerize me."

"First," he said, "I'm going to *software*-ize you. One of the biggest mistakes people make is to buy a computer...what we call the 'hardware'...first, only to find that the programs for the things they want to do aren't available for their machine.

"In your case," he continued, "the software you want is among the most popular made. For example, you'll want something called an electronic spreadsheet program. These are sold under several different brand names."

"What do they do?" I asked.

"Rather than explain it," he said, "why don't I demonstrate it? In fact, why don't *you* demonstrate it to yourself?" With that he led me across the floor to a row of computers.

"Take your pick," he offered. "They're all equipped to handle spreadsheet programs."

I surveyed the machines and ultimately selected one that I had seen advertised before.

"Okay," I said, taking my seat in front of the machine. "Now what?"

"Turn it on."

"How?" I asked, and both Ted and John couldn't resist laughing.

"It's really tricky," Ted cautioned. "You push the 'on' button."

"Careful, Ted," I joked. "I can get your friend Lathrop fired in two seconds flat." I pushed the button.

"Now what?"

"Now you load the program."

I was beginning to feel like Luke Skywalker in "Star Wars." My pulse actually quickened.

"How?" I asked.

"Insert this diskette into the disk drive."

Now, I had heard the terms 'disk' and 'disk drive' before, but this was my first hands-on experience with them. The diskette, or 'floppy disk' as it is sometimes called, looked like one of those old viewmaster disks, only a diskette is a little bigger—about five inches square. I say 'square' even though it's a disk because the disk stays in its little paper cover...kind of like a miniature record album...even when you insert it into the disk drive housing. Inserting it is easy enough...you just push it through a slot, like mailing a letter. When you've pushed it in as far as it goes, you pull a little tab down over the slot to lock it in. The whole process takes about three seconds.

"Okay," I said, feeling rather proud of myself. "Is it loaded?"

"Almost," Ted said. "All you've got to do is push a few buttons."

Every computer has a different keyboard, but they're all basically the same. They look and feel very much like an electric typewriter keyboard, but there are a few extra keys. On the machine I had selected one of these extra keys is marked 'RESET,' and that's the key Ted told me to push first. Then he told me to push a key marked 'CTRL' (for control) while pressing the 'p' key. Finally, he had me push 'RETURN.'

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DATAPOINT

and instantaneously the screen lit up. From left to right there were four columns, marked A, B, C and D. From top to bottom there were twenty lines, each appropriately numbered.

"Does that look familiar?" Ted asked.

"Sort of. It looks more or less like the format of one of my sales forecast worksheets."

"What would be required to make it look *exactly* like your sales forecast charts?"

"Well, for one thing, I need more than twenty rows. I've got fifty marketing areas that I do projections for."

"That's no problem," John volunteered, and by pushing a few buttons, an additional thirty lines appeared along the left hand side of the screen.

"You can add more columns, too," Ted said, "but obviously you're limited by the width of the paper that the computer will ultimately print out on."

"Okay. That makes sense. But how do I assign names to the rows and columns?"

"You just type them in. It'll take you all of about thirty seconds to learn," Ted said, and he was right. When you want to enter words or numbers into a computer, you have to place a little blinking light called a "cursor" in the position where you want to put your entry. You place the cursor into position by pushing certain keys on the keyboard: some make it go up and down; some make it go left and right. Using these keys, you can position the cursor virtually anyplace on the screen in just a matter of seconds.

"Okay," Ted said when I had aligned the cursor with the first row. "What do you want to call that row?"

"FOR THE FIRST TIME, I WAS STARTING TO APPRECIATE THE PRACTICAL APPLICATION OF THE COMPUTER."

"Well, all of our marketing areas have names and numbers. Unfortunately, the numbers don't coincide with the names alphabetically, which has always been sort of a pain in the neck, but usually I make my charts by market area name, in alphabetical order."

"In other words," Ted figured, "if you were to put your market areas in fifty rows in alphabetical order and then were to put the appropriate numbers next to each one, the numbers would read something like 12, 22, 45, 13 and so on, instead of 1, 2, 3, 4 and so on?"

"That's right. It's not really a big deal, but it is a nuisance since sometimes we do analyze the data by market area number."

"And don't you ever analyze the data by a sales rep's name, too?" he asked.

"Oh, sure," I replied, "But that's a whole other story."

"It doesn't have to be," Ted said, smiling. "That's one of the beauties of a program like this. You can enter your sales data under several different code names at once, so that you can analyze it any way you want to."

For the first time, I was starting to appreciate the practical application of the computer.

"In other words," I asked, "once I have this thing fed properly, I can find out sales either by market area name, market area number or sales rep's name just by pushing a few buttons?"

"That's the whole idea," Ted said. Now I was smiling, too. "But wait a minute," he continued. "As they say, you ain't seen nothin' yet."

"Go on," I encouraged.

"Let's go back to your sales forecasting example. I would imagine that in the sporting goods business your sales are variable by season, right?"

"Sure," I replied.

"Well, I'm just guessing, but I would imagine that it makes forecasting a bit difficult. I mean, don't you find that the percentage by which you anticipate sales varies by quarter, depending on the seasonality of the product in question?"

"Sure it does," I replied, "but we sort of fudge over that. It's hard enough to do projections on an annual basis, let alone do quarterly ones that are adjusted for seasonality."

"But would it be helpful to you if you could have that information?" he asked.

"Let's put it this way," I said. "It would be a luxury, not a necessity. I mean, it *would* allow me to forecast more reliably, and it *would* help the sales reps figure which products to put more time against..."

"So it's something you'd like to have, then?" he concluded. "Because it's something that the computer can figure out for you in just a few seconds. And it can figure it for you by market area, by sales rep, by sales district or by any other classification you want."

"That's unbelievable," I muttered.

"And that's still just the tip of the iceberg," he went on. "Suppose you do a dollar forecast for your entire product line for the year. Now, the computer will save you a lot of time and effort, but you still have to do *some* work, and doing that type of analysis *does* require a lot of input. Anyway, let's say that you've completed your analysis and you've got it all printed out, and then someone tells you the bad news that the prices on six of your items are going to be increased, each by a different percentage. Under your current method of forecasting, what would happen?"

"I'd get an instant migraine headache," I replied, "then I'd go back to the drawing board and recalculate everything. It would take days."

"Not anymore," Ted said, flashing that grin again. "With this program, it would take minutes."

"There are other ways you could manipulate the data, too," John offered. "For example, suppose that after you get the whole forecast completed you find out that marketing has increased the ad budget for several of the items and as a result we anticipate an x percent increase on those items. Obviously, that's going to change your entire forecast, not only for the items in question, but for the

line in total. With this program, you can automatically calculate the effect that changing one variable will have on the entire forecast."

"In other words," I said, trying to grasp the full implications of this incredibly powerful device, "I can play 'what if' games all day long."

"That's right," Ted agreed. "And that's exactly what more and more executives are using p.c.'s for. They really let you explore options. And you can just imagine how these things have changed the lives of people in the financial community! Number crunching is a thing of the past."

"I'VE HEARD ABOUT WORD PROCESSORS, BUT I THOUGHT THEY WERE COMPLETELY DIFFERENT MACHINES."

"But they help you do more mundane things, too," John added. "For example, there's a program called a 'data base management system.' It allows you to manipulate or 'play with' huge collections of individual pieces of information."

"Like what?" I asked.

"Like your inventory. Or like your customer names and addresses. With a DBMS you can organize all of your accounts, say, alphabetically, or by volume, or by earned discount, or by terms, or by any other variable that would be useful to you."

"For what type of practical application?"

"Let's say that you have a certain type of promotion which you feel only customers doing a certain minimum volume would be interested in. Rather than culling through all of the accounts manually, or requesting each sales rep to file a report, you could simply ask the computer to do the work for you and present you with a list of qualifying accounts. You could then write each customer a personal letter, explaining the promotion in terms of their specific stores' sales, and even have the mailing labels printed up...all by computer."

"You're right...that *does* sound pretty exciting. My secretary would be happy to have one of these computers, too."

"Don't laugh," Ted said. "You would be amazed at how a computer can increase your secretary's efficiency, especially if you get a word processing program."

"I've heard about word processors, but I thought they were completely different machines."

"Those are called 'dedicated' word processors," Ted explained, "and those *are* completely different machines. In effect, a dedicated word processor is a computer that 'specializes' in word processing. The alternative is getting a word processing program. That's a diskette, just like a spreadsheet program, that allows your computer to function as a word processor when you want it to, but allows it to turn back into a computer when you need it to."

"So what's the advantage of a dedicated word processor, then?"

"The advantage is that they are customized to handle only word processing problems, so they are somewhat easier to operate and they can perform more word processing tasks than diskettes. In that sense, if you know that you'll never want to use your computer for anything other than word processing, a dedicated machine makes sense. But in your case, I'd recommend a conventional microcomputer with a couple of word processing programs."

"Why do I need a couple of word processing programs? Isn't one enough?"

"One is enough to perform basic word processing tasks," he advised, "but as with other applications programs, the software inventors weren't content to leave it at that, so they invented programs which automatically scan what you've written and point out the misspelled words."

"You're kidding!"

"Nope," he continued, "they've even got programs which point out trite phrases in your text and offer alternative ways to say the same thing."

"Now *that* I find scary," I said.

"If you think *you* find it scary, how do you think professional writers feel about it?" he said. But after we had our laugh, he went on to point out that word processors have done more, literally, to change the lives of people who write for a living than any invention since paper and pencil.

"A writer can edit, change words, even move whole paragraphs around in just seconds. And when he has everything just the way he wants it, he just pushes a button and it prints itself automatically. Why, the storage implications alone are worth the price of the machine...volumes of words can be stored on a five-inch diskette."

"Well," I said, "I'm hardly what you would call a professional writer, but I certainly can see the advantage of having a word processing program. I mean, even for routine salesforce memos and inter-office communications I can see how one would be helpful. Are they expensive?"

"Not at all," said Ted. "In fact, depending on the machine, you might even get a word processing program included in your basic diskette set. Spelling correction programs, though, are sold separately and range from $75 to $200. Like anything else, if you use it, it's worth the price. But if it's just going to sit around, it's a waste of money."

"Speaking of money," I continued, "what's the price range on these beauties?"

"Well, let's see exactly what we've got. The prices on the microcomputers you've been looking at here are all in the same basic price range, anywhere from $1,200 to $6,500 depending on what we call the 'peripherals.' Peripherals include things like disk drive units, printers and graphics systems. For example, there are printers that can give you a wide range of type faces and sizes. Or graphics systems that allow you to print out multi-colored charts and graphs."

"But basically what you're telling me is that I can get a perfectly adequate computer set-up for somewhere in the $5,000 price range."

"Easily," Ted said. "And remember, that's including the disk drives and the CRT as well as software."

"CRT? What's that?"

"It stands for cathode ray tube. It's simply the monitor that you use in conjunction with the micro. In many cases, you can just use a TV set instead. In fact, there's one little computer that costs less than $100! It doesn't have much memory...only 1K ...but it *is* expandable, and it's a great way to learn about computers at home.

"They even make a modem for it, making it a really inexpensive way to hook up to a data bank."

"Wait a minute," I protested, "Hold it! What's this about data banks and, what was that, modules?"

"Modems," Ted corrected. "Stands for 'modulate/demodulate.' A modem is a device that lets your computer talk to other computers

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through the telephone. It 'modulates' ...or puts into sound frequencies... information from your computer so that the audible signals can be carried over the telephone lines. When it gets to the other computer's modem, the information gets *de*modulated so that the other computer can understand what it's being told. By using a modem, your computer can give you access to huge 'warehouses' of information which are too vast to be stored in a microcomputer, but which can be stored in what we call "mainframe" computers. Mainframe computers are the biggest computers made. They have incredibly gigantic memories. They also have gigantic price tags! Some manufacturers are now making desktop computer terminals which can be hooked up to their mainframes, thereby providing a relatively inexpensive way for companies to take advantage of mainframe capacity. Others are making the information stored in their mainframe computers available to the general public (via modems) for a fee, thereby providing themselves with an opportunity to make some money while at the same time providing a valuable service."

"What kind of information is available?" I asked.

"All sorts of good stuff," Ted enthused. "For example, there are several data banks which offer information of interest to the general public. If you subscribe to one of them, you get your own password. Whenever you want to use the service you simply call them on their WATS line, give your password, and as if by magic a "menu" appears on your CRT. The menu is like a table of contents. The headings are rather general: News, Business, Catalog Shopping, Home and Leisure, Entertainment, and so on. After your initial selection...say you pick Home and Leisure...another menu appears. This selection process goes on until you arrive at your 'destination'...in this case, maybe it's a game or recipe ideas for home entertainment. You then play the game, copy the recipe or do whatever else it is that you've accessed. You can even select one destination called 'chat' which enables you to talk to other computer operators via your CRT."

"Sounds like fun."

"There's a lot more than fun and games," John pointed out. "For example, there are financial data banks that specialize in business news. In addition to up-to-the-minute stock quotes, you get special security analyses, world economic news, and so on. It's a pretty no-nonsense deal."

"How do they charge you?"

"You're charged only for the time you use, but usually there's an initial fee of about $100 or so to get your password. Data banks generally charge only about $5 an hour, but it can really add up, because as they say, time flies when you're having fun."

With that I glanced at my watch and noticed to my amazement it was already after noon.

"I'll say time flies when you're having fun!" I exclaimed. "We've really got to get going. Ted, I can guarantee that we'll do business. In fact, I'll be back to you at the beginning of the week. I can't tell you how much I appreciate the hands-on exposure...I learned more about computers in three hours than I would have learned in three days of reading articles and textbooks."

"I'm glad to help," Ted said. "If only more people would take the time to do what you did this morning, I'd be able to retire in a year. These things sell themselves once people get their hands on one."

With that, we were off.

The rest is history. I wound up getting the $6.500 package Ted told me about. Within three months I bought an additional four or five programs, including some graphics software that enabled me to do color graphs and charts. A basic word processing disc came with the computer and I do use it from time to time, but my secretary was so excited about it that we got her a dedicated word processor of her own. She swears she doesn't know how she existed without it.

John Lathrop gained with a bonus of his own, too. It seems that Bob Bradshaw was curious about Lathrop's sudden interest in the sales department, and looked into it. When he discovered that we bought a computer, his competitive instincts got the better of him and before you could say "Holy Central Processing Unit!" the marketing department had a micro of its own. Since Lathrop was the only one on the floor who knew how to drive it, it wound up on his desk. Ironically, he thanks *me* for getting it for him!

After that, microcomputers spread like wildfire throughout the entire company. Once the Executive Committee found out that the machines could be interconnected to "talk" to each other, we set up our own internal computer network with all of our regional offices...but that's another story for another time.

Al Roberts' story is not unique. In fact, if you're at all typical of American business management you probably noticed a number of parallels between Roberts' anxieties about computers and your own. If you have any interesting computer-related anecdotes, or any examples of how computers have made your life easier, please let us know. Correspondence should be addressed to:

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Donald M. Klein, the author, is Executive Vice President, Creative Director of MacNamara, Clapp & Klein, Inc., a New York City advertising agency.

Lou E. Frenzel, Senior Vice President, McGraw-Hill Continuing Education Center, served as technical advisor for this article.

Where to learn more

1. McGraw-Hill Microcomputer Literacy Program for Executives, Managers and Professionals. Audio cassette and print program covering all aspects of microcomputer operation application and selection. $95 from McGraw-Hill Continuing Education Center, 3939 Wisconsin Avenue, Washington, D.C., 20016.

2. Crash Course in Microcomputers by L. E. Frenzel. An introductory programmed instruction book that discusses all aspects of microcomputers. $19.95 available in most book stores or directly from the publisher Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN., 46206

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Career outlook

Fighting the start-up odds

The promise is that you might retire a multimillionaire; but the odds are 3 : 1 you'll fall flat on your face. Still interested?

Then when the persuasive voice on the phone mentions "start-up," hang on. With new entrepreneurial ventures at an all-time high, if you are in your late 30s, a top-echelon manager at a small firm who has a corporate background, and a proven "company-grower," chances are that a head-hunter has your number.

Finding the right person to leave the comforts of a carpeted office and a tidy pension plan for a high-risk entrepreneurial venture has become a lucrative business for Richards Consultants Ltd., an executive-search firm based in New York.

Venture-capital firms on the hunt for top brass are the chief clients of the company's Boston office, and Boston manager Steven Garfinkle and company founder and president Barry Nathanson in New York offer some insights on what they look for.

Qualifications needed. "The critical issue in any start-up is revenue," Garfinkle says, "so the venture firm seeking a chief executive officer looks for someone with profit-and-loss responsibility. They want someone with a strong operations background and an impressive track record in financial controls."

Typically, he says, the successful candidate will have a technical degree but will never have functioned as an electrical engineer. Instead, he or she will have gone into sales and marketing and have risen through the ranks at a major corporation before joining a smaller firm. "The pedigreed big-company background is important: working at an IBM, for example, gives a sense of structure, plus experience in interfacing with different areas like engineering and manufacturing," he explains.

But, adds Nathanson, the person who has stayed at the giant corporation would be unlikely to leave. "He's used to more fat in the organization, more support. He's probably unwilling, or even unable, to get along with less." Hitching one's star to a start-up, he cautions, means rolling up the sleeves and going back to jobs happily left behind. The new executive might find himself calling on customers or managing cash.

With so many risks and disadvantages, what are the hooks that land the executive? "The guy is turned on by entrepreneurial drive," says Nathanson. An equity position—a piece of the pie—is the kind of bait that makes at least the younger candidates bite. A potential CEO is usually offered some 5% to 8% of the new company. Since the risk is substantial, though, those in their 50s or older are unlikely to go for it.

Look at potential. From the other side, how should someone who is approached for start-up management evaluate the situation? First, says Garfinkle, he or she should be aware of the industry segments slated for growth in the next decade—for the 1980s, for example, computer-aided design and manufacturing and biotechnology are good bets; process-control instrumentation is not.

The candidate should also determine how well the venture is financed—in the first round, $2 million or more is respectable; in the second, at least another $2 million to $4 million is needed. However, software ventures need less funding than do hardware-based newcomers. The quality of the venture-capital backers is important, too, as is the management already in place.

Finally, the site of the venture is a consideration. Boston's Route 128 area and Silicon Valley still take top billing as fertile technological seedbeds, but Research Triangle Park, N. C., and Austin, Texas, are coming on strong. "You're going to have to draw on a substantial pool of talent," points out Garfinkle. "It's unlikely that an out-of-the-way location could provide that."

Success can be stunning, with millions made overnight if the venture ever goes public. Defeat, on the other hand, is no cause for despair. The executive who gambled and lost will likely come out unscathed, the consultants maintain, and be taken back into the corporate fold wiser, if sadder. –**Marilyn A. Harris**

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HDC-1001 with a 5 MEG byte hard disc $1800

HDC-1001 with a 20 MEG byte hard disc $2000

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COMPUTER:	STANDARD DATA	IBM PERSONAL COMPUTER	DEC RAINBOW 100	WANG PROFESSIONAL COMPUTER	RADIO SHACK TRS-80 MODEL 16	APPLE III
MICROPROCESSORS:						
16-bit:	8088	8088	8088	8086	68000	—
8-bit:	8085	—	Z-80	Optional	Z-80	6502
MEMORY:						
Minimum:	128K	16K	64K	128K	128K	128K
Maximum:	768K	576K	256K	640K	512K	256K
DISC-LESS OPERATION	Yes	No	No	No	No	No
NETWORK READY	Yes	No	No	No	No	No
FLOPPY DISK STORAGE:						
Per Diskette:	320K	320K	400K	320K	1.2 MB	140K
Maximum Internal:	640K*	640K	1.6 MB	640K	2.4 MB	140K
EXPANSION SLOTS:	Five S-100 (four available)	Five (three available)	Three	**	One	Eight
I/O PORTS:						
Parallel:	1	—	—	1	1	—
Serial:	2	—	2	2	2	1
DISPLAY:						
Pixels:	640 x 225	640 x 200 (2 colors) 320 x 200 (4 colors)	800 x 240	**	640 x 200 (Monochrome)	560 x 192 (Monochrome)
Colors:	8	4	4	Optional	Not available	16
OPERATING SYSTEMS:	CP/M-85 Z-DOS (MS-DOS)	CP/M-86 IBM-DOS (MS-DOS) UCSD P-System	CP/M-86/80 MS-DOS	CP/M MS-DOS	RS 16-DOS TRS-DOS	Apple SOS

Information current as of 7/7/82. *External disk storage available soon. **Information not available at this time.

Circle 901 on reader service card