THE BIG MOVE TO PHOTO-LIKE PC GRAPHICS/105

SUPERMINI KILLER: FIRST OF A NEW RISC BREED/120

MIDYEAR MARKET REPORT PAGE 81

A VNU BUSINESS PUBLICATION

JULY 1988

Electronics®

THE CHANGING WORLD OF AUTO ELECTRONICS

PAGE 53

THE VENDORS' JOB GETS TOUGHER EVEN AS MARKET GROWTH ACCELERATES

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ROUND TWO: THE CASE AGAINST STARTUPS

MIT's Charles Ferguson says isolated entrepreneurs, however ingenious, can't solve the chip industry's problems alone

We sure heard from people after siding in our May 12th column with author-economist George Gilder when he named entrepreneurs, not large, centralized organizations, as the driving force behind the U. S. chip industry. So it seems only fair that we give a platform to his arch nemesis, Charles H. Ferguson, a researcher at MIT's Center for Technology, Policy and Industrial Development—since we really feel that neither one hit the mark exactly.

Ferguson says this country's business outlook faces serious problems that isolated entrepreneurs, however ingenious, can't solve alone. It's merely wishful to think U. S. industry can stay competitive without government intervention, he insists. Like Gilder, he cherrypicks facts to back his arguments. He talks about the decline in the U. S. share of the world chip market to 40% from 60% without acknowledging the declining dollar's impact. He says powerful computers get cheaper because big firms, not small ones, mass-produce them. Hogwash! Ferguson thinks the long-term viability of small-scale entrepreneurship in semiconductor production ended with the advent of very large-scale integration in the late 1970s. Heck, that integration accelerated it!

The overwhelming majority of semiconductor markets will be dominated, he says, by diversified, vertically integrated companies with wide technology bases and global operations, because cost structures will be dominated by the initial and fixed costs of R&D, capital investment, and marketing. Marginal and direct labor costs will decline to negligible levels. He believes the Japanese chip industry is successful because it's a stable, concentrated, government-protected, vertically integrated oligopoly that built its success on imported U. S. technology and high-quality mass manufacturing.

He further contends the U. S. chip industry is fragmented and chronically entrepreneurial. It's afflicted by personnel mobility, ineffective intellectual-property protection, risk aversion in large companies, and tax subsidies for the formation of new companies. So it can't sustain the large, long-term investments required for continued U. S. competitiveness. Only collective action and large domestic investments in education, reforming government procurements and tax policies, R&D, and capital formation will ensure that the U. S. plays a full part in the information revolution, says Ferguson.

Maybe, maybe not. Technology change still rules the chip business and it's the startups that drive it. Until technology's pace begins to slow, the small guy in the business remains the real key to the health of the U. S. chip industry. **ROBERT W. HENKEL**

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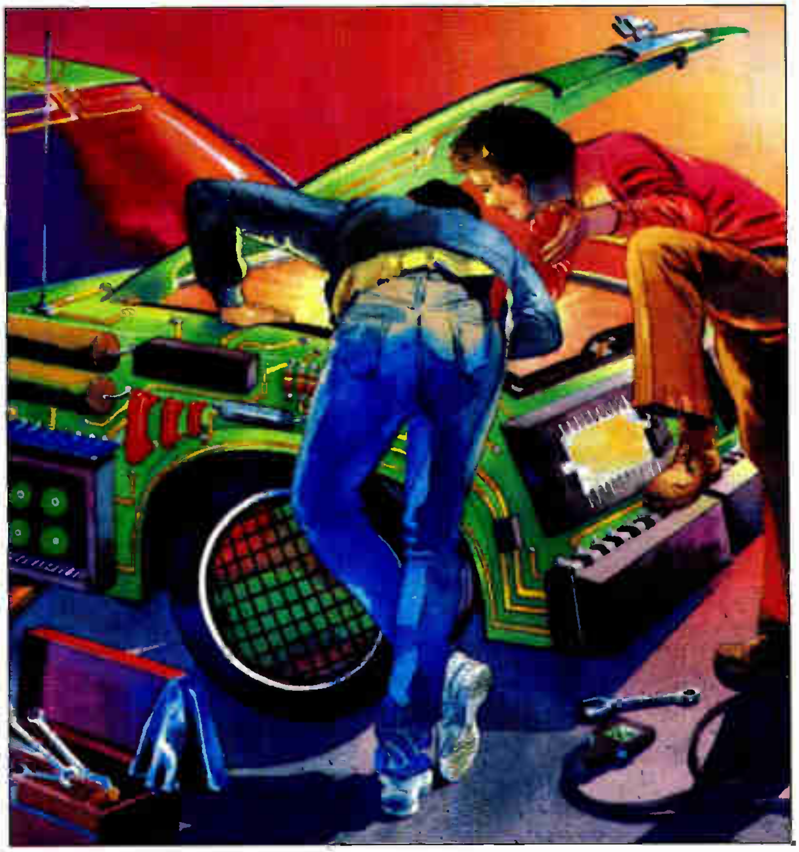
NEWS ANALYSIS

FEATURES

COVER: JIM KINSTREY



PAGE 53

INTERNATIONAL

COMPANIES TO WATCH

PEOPLE TO WATCH

DEPARTMENTS

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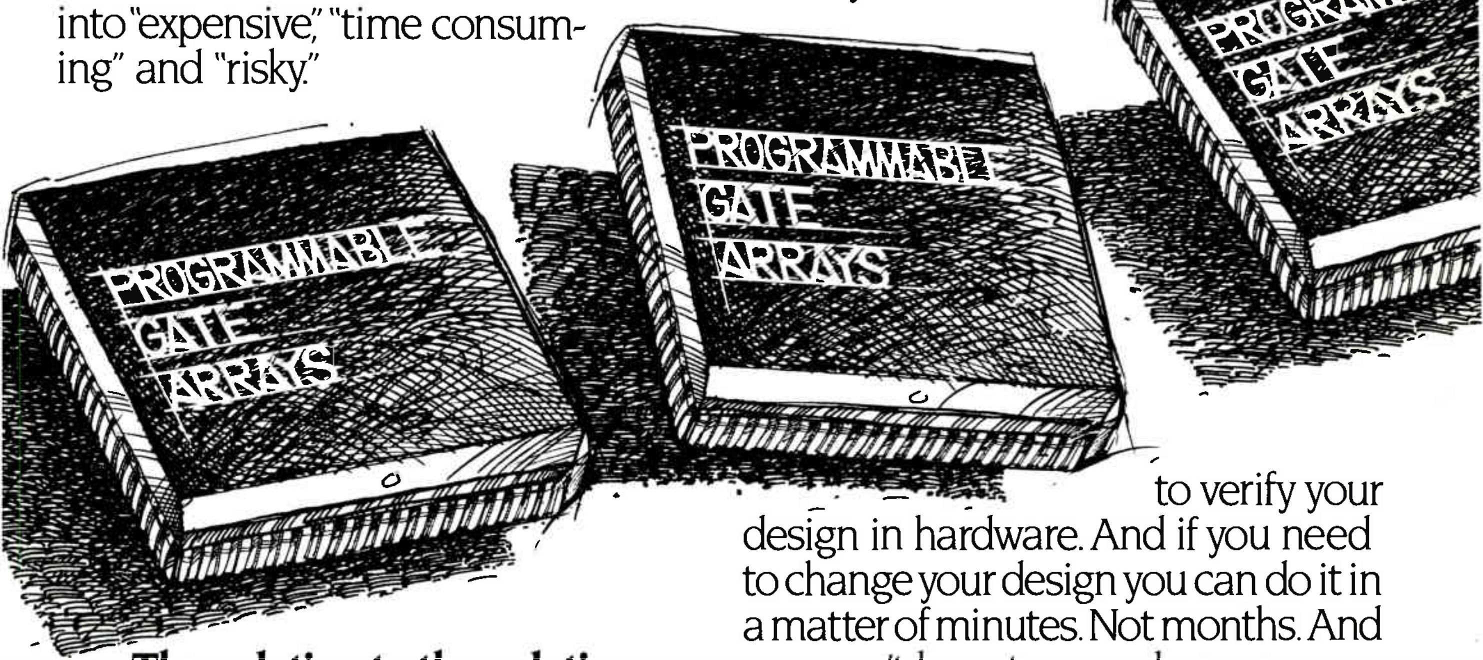
Everyone thought gate arrays would be a great solution to their semi-custom design needs. Then they designed one and discovered that "semi-custom" translated into "expensive," "time consuming" and "risky."



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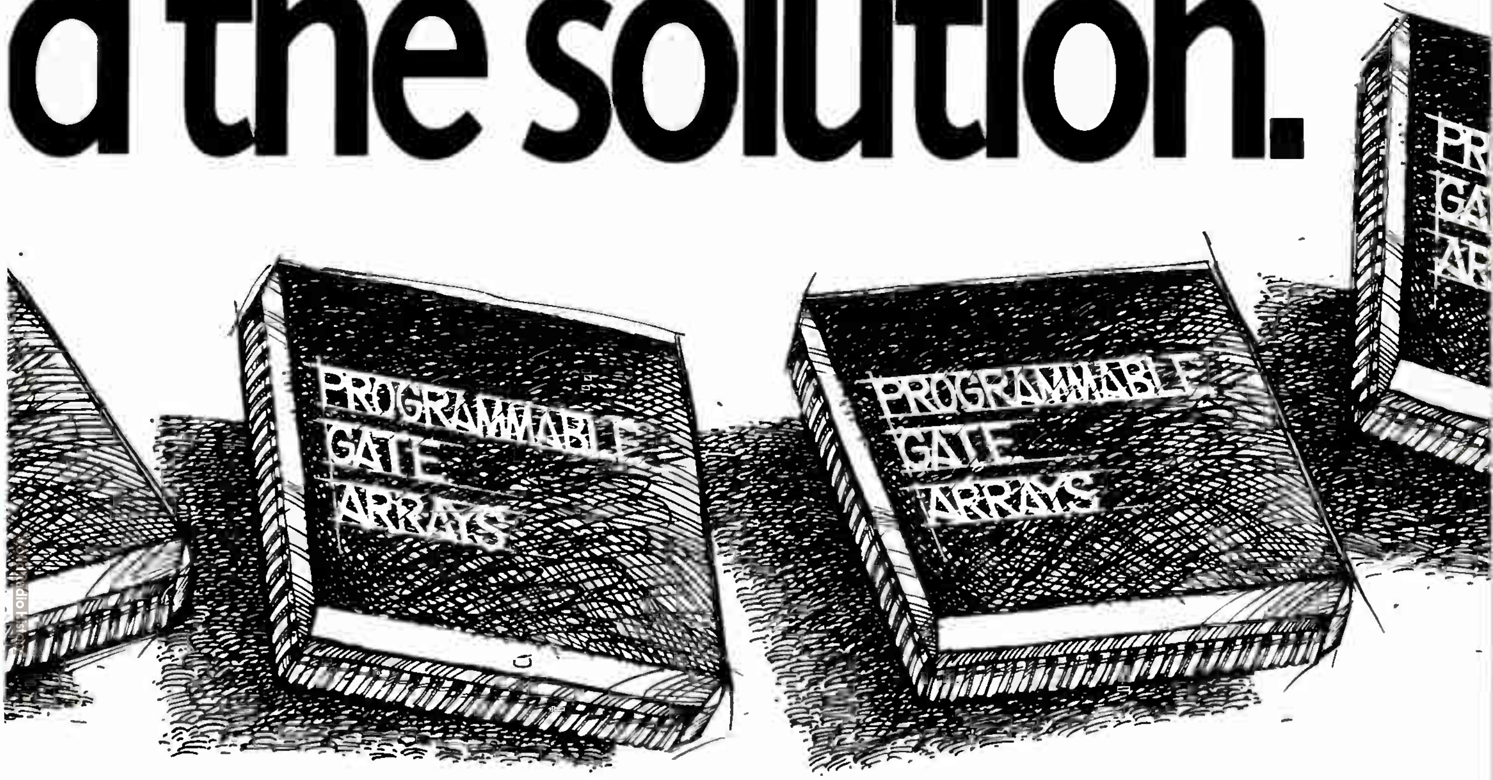

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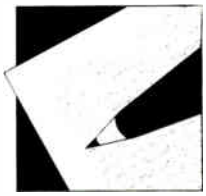
IN THE ROCKIES, THEY'RE STILL HIGH ON HIGH TECH

COLORADO SPRINGS, COLO.



The business climate is filled with hope in Colorado Springs as the spring blossoms give way to summer blooming. The area that advertised itself at the start of the 1980s as a competitor of Phoenix and Austin in recruiting electronics companies has had to learn how to face sobering reality as the 1990s come bearing down. During this decade, the people of the city and its environs have weathered a host of problems: slowed growth, plant closings, and postponed military programs. On top of that, the city fathers have retreated a little from their broad program of business incentives as the infrastructure stretches to cover the gaps in basic services the spurt of growth in the early part of the decade created.

The story is in the numbers. Colorado Springs, a city of 370,000, was growing at a 5% annual rate in the early 1980s; now, it's 2% to 3%. The 3,266-person strong labor force in the semiconductor industry in 1985 shrank to just 2,612 employees by last February. Overall, manufacturing employment grew from 147,590 in 1981 to 195,570 in 1985. But from 1985 to 1987, it grew only to 200,320.

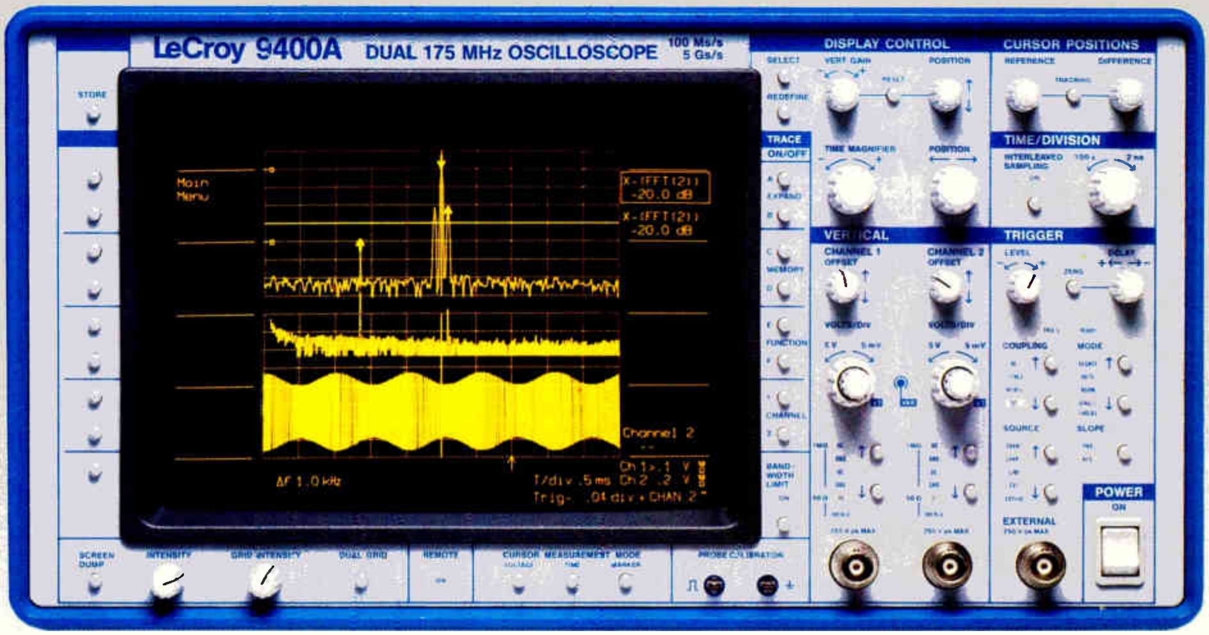
Major disappointments to the people who were working to attract high-technology business to Colorado Springs came on both the civilian and military fronts. Such companies as Brown Disc Manufacturing, OptoTech, and Inmos either pulled up stakes or radically reduced their presence. Also, Colorado Springs, one of the five finalists in the competition as the headquarters of the Sematech semiconductor-manufacturing research cooperative, was rejected in favor of Austin. Another blow was the cancellation of the Pentagon's space shuttle plans. The city was to have been the site of the Shuttle Operations Planning Complex.

But life can be good in the Springs, and with many companies in the area remaining bullish on the city, there is reason for optimism. Many high-technology companies that settled into the area over the past decade have stayed and grown with the city helping. There have been marked improvements over the years in university programs, industrial services, and in the general awareness of the city planners in developing what's needed to support hardware manufacturers in the semiconductor, instrumentation, computer peripheral, and other high-technology areas. Additionally, the planners are creating a cultural climate that will attract top-notch people so that the companies will prosper.

At the Third Silicon Mountain Symposium in Colorado Springs, June 8 to 10, an annual event in which the area's electronics companies show themselves off to visiting journalists and others, about a dozen companies, from chip manufacturers to systems houses, showed their technical prowess and discussed the business climate in their home.

NCR Corp., for instance, with facilities in both Colorado Springs and Ft. Collins, cites the area's reasonably solid and abundant labor force, relatively low utility rates, and an over-all quality of life that helps it attract the people it feels it needs for growth. Over the last three years, according to Larry Villatz, the general manager of the Microelectronics

For companies like Crystal Specialties, a maker of GaAs wafers, one pesky problem is periodic power outages that disrupt production and could ruin entire production runs.



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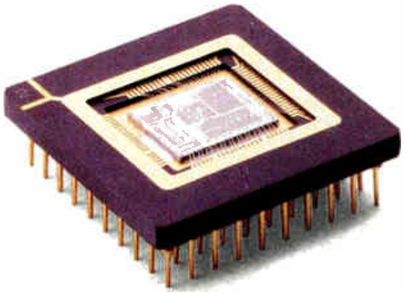
DESIGN ENGINEER, 1988



For years, people have been intrigued with the latest in technology. But, they've been less than enthusiastic about learning how to put it to good use. The Transputer from INMOS is no exception.

System designers agree that Transputer's are revolutionary, but the prospect of learning a new programming language has made some of them a little uneasy.

The truth is, Transputers can actually be easily programmed in most high level languages developed for standard microprocessors including C, Fortran and Pascal. And, since Transputers are so much more than standard microprocessors, we've also developed OCCAM.

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Together with just one or more Transputers, the formal rules of OCCAM provide the design methodology for true concurrency and unlimited system extendability. And OCCAM programs do not have to be rewritten as Transputer-based systems grow to utilize future levels of integration.

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Division, the company has increased its workforce in the Springs by about 80% and plans even more growth for the rest of this year.

Four of the largest employers in town—Digital Equipment, Hewlett-Packard, Martin Marietta, and Texas Instruments—each put thousands of people to work. DEC, with 2,000 employees in its Winchester disk operation, has passed HP as the largest employer. On the other end of the scale, many of the startup companies, such as Ramtron Inc., a manufacturer of nonvolatile CMOS memories that use a novel ferroelectric storage cell, employ just a few dozen people.

Thus the climate for high technology still seems strong despite the recent defections as new companies arrive to take the place of early pioneers such as Brown Disc and Inmos. Some even move into the empty buildings and employ some of the same people. For example, Cray Inc. bought the main Inmos building and by 1990 expects to be manufacturing its Cray-3 supercomputer in that facility. For the Wisconsin company, it's the first time it will build its supercomputers outside Chippewa Falls, founder Seymour Cray's hometown [*Electronics*, June 1988, p. 149].

A utilities problem continues to plague electronics companies, especially chip makers. Their heavy dependence on a constant flow of electricity brings out the voice of frustration in more than one executive. Even short-duration power outages disrupt production, explains Steve Leavitt, manager of quality assurance for Crystal Specialties International Inc. The company, a gallium arsenide wafer manufacturer, depends on the power to create its single-crystal materials. Outages could ruin entire production runs.

To work out solutions, the business community is talking with city planners and the power company. Possible answers are multiple power lines to feed the plant for backup, or installation of uninterruptible power supplies on critical pieces of equipment. The power company is also working to provide cleaner power.

There is a large available labor force in town; partly due to the U. S. government, which has established several major facilities nearby. The most well known facility is the NORAD monitoring station. Other facilities include Peterson Air Force base, the Air Force Academy, and the Army's Fort Carson.

In fact, Colorado Springs is brimming with military space facilities. It houses Consolidated Space Operations Center, which tracks missiles and satellites and is in charge of the Air Force Space Command. It is also headquarters for the U. S. Space Command. And at Falcon Air Force Base the National Test Bed Facility for the Strategic Defense Initiative is being established under a contract just awarded to Martin Marietta Corp.

There might have been more, but the tragic destruction of the Challenger space shuttle and the cutbacks in funding for the National Aeronautics and Space Administration's programs that followed took a deep bite out of the area's space ambitions. The loss of the space shuttle-related program didn't hurt current employment much, says Chuck Zimkas, operations director at the U. S. Space Foundation, an education and information group with headquarters in Colorado Springs.

All those installations continue to provide a pool of spouses that can take on many of the clerical and manufacturing positions the companies need to fill. And to address the problem of unemployment among unskilled labor, Colorado Springs is setting up training programs to give those workers the skills that would make them hireable in many of the high-tech companies. Additionally, the one state university in the city, the University of Colorado at Colorado Springs, has added many new masters programs in areas such as physics and engineering to allow engineers and scientists to continue their education without the long commutes to schools in Denver or Boulder.

> The life is good—especially if you like outdoor recreation

Traveling to and from the Springs has also gotten easier over the years—flights from the local airport connect the city to some major hubs, and a major expansion project has just been approved by city planners to upgrade the airport. The area's unpredictable winter weather patterns have closed roads and airports as early as October and as late as May with severe thunderstorms or snow, but it hasn't repelled residents who enjoy the advantages of the high altitude, relatively temperate winter days and summer nights.

It can be easy to live the good life if you like outdoor sports. "Most of the activities take place outside," says Clelia DeMoraes, a marketing specialist at HP's Logic Systems Division. "In that respect, it's a great place."

"It's a well rounded city in terms of recreation, and it has an adequate amount of culture," adds Glenn Goschen, a marketer at NCR Corp. "The weather? If you're from Arizona, it's bad; if you're from New York, winter's nothing," he says. *–Dave Bursky*

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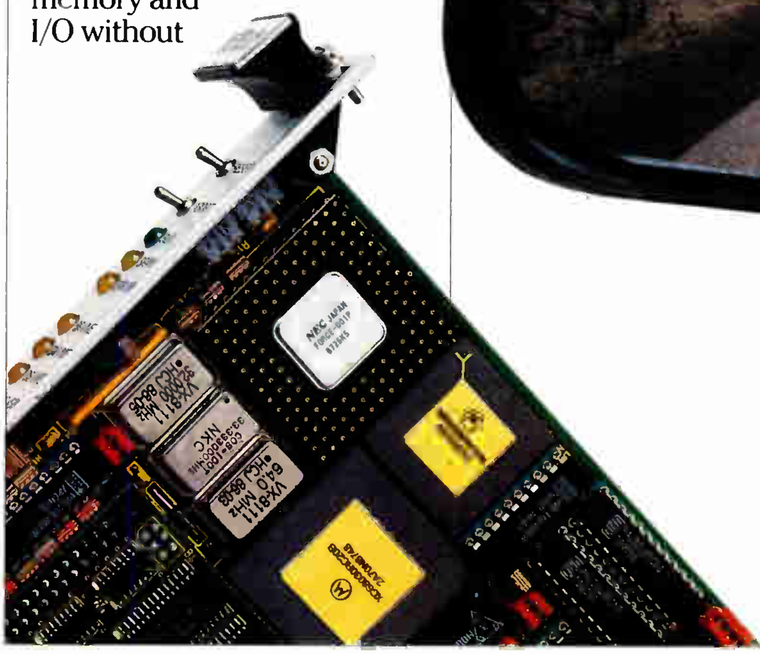

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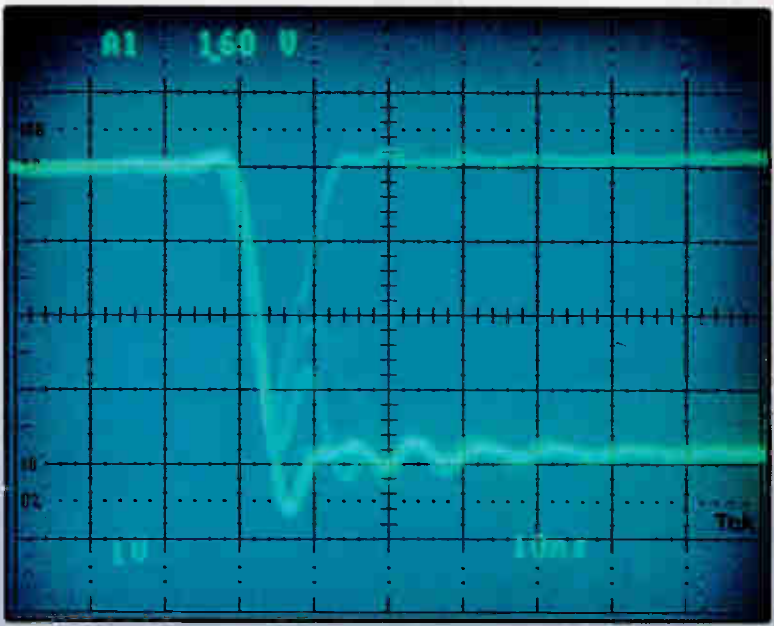

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ELECTRONICS NEWSLETTER

WHY INTEL DROPPED OUT OF THE GATE ARRAY BUSINESS . . .

The biggest surprise about Intel Corp. dropping out of the gate-array market and restructuring its other ASIC operations is that the move was ever a surprise to begin with. Reports that changes were in the works had circulated for months, because Intel, which never became a factor in the gate-array business, was beset by delays in its other ASIC business—standard cells. The Santa Clara, Calif., company has been struggling to convert its microcontroller architectures into standard cells. That doomed attempt to establish a toehold in low-end gate arrays, where Intel needed to play catch-up to earlier starters, was hurt by cutthroat price competition. In the end, company officials concluded that gate arrays were not really central to Intel's future—and that standard-cell application-specific integrated circuits based on proprietary controller architectures offered greater promise. So now Intel is consolidating all of that into a new Microcomputer/ASIC Division in Chandler, Ariz. □

. . . AND WHAT THAT MEANS TO OTHER CHIP GIANTS STRUGGLING WITH ASICs

In the wake of Intel Corp.'s sudden retreat from the gate-array scene, the broader question on the industry's mind is whether or not big chip makers have the flexibility to be competitive on the ASIC front. Since 1985, the prevailing strategy at Intel and other U. S. chip makers has been to split application-specific integrated circuits off from standard product lines in order to expedite development of design tools and processes. But now some people are questioning that strategy—and wondering if Intel's move to consolidate its standard-cell line with its microprocessor product family isn't a wiser way to do business. "All the big guys have a power structure oriented to product flowing through," says Matt Crugnale, president of Crugnale and Associates in Mountain View, Calif. What they need, he says, is to add flexibility for fast-turnaround and small-volume production and a commitment to ASICs. □

LEVEL ONE TEAMS WITH MITEL TO BUILD AND SOURCE TELECOM CHIPS

Rather than go it alone against industry heavyweights such as Intel, National Semiconductor, and Texas Instruments in the hotly contested T-1 and Integrated Services Digital Network market, Level One Communications Inc., a two-year-old Folsom, Calif., startup, is teaming up with Mitel Corp. of Ontario, Canada, a leader in the communications IC business. The two will unveil their five-year agreement July 5, announcing plans to jointly develop and source data-communications products. Though it hasn't yet introduced a product, Level One was able to attract Mitel's attention because of the groundbreaking work it has done on an advanced computer-aided-design methodology for telecom chips. The company's CAD system uses system- and transmission-dedicated design simulation tools to build circuits from modular predefined functional blocks. Level One expects the transceiver market for twisted-pair to hit $700 million by 1992. □

AMD USES A CLOCKLESS MACROCELL TO ADD STABILITY TO PLDs

Designers at Advanced Micro Devices Inc. think they have found the solution to the timing instability that often plagues the asynchronous bus-interface circuitry built with programmable logic devices. Conventional PLDs control the timing problems, which include data-to-clock setup requirements, with a complex series of latches and registers. But AMD says that method leads to inefficient use of PLD real estate. The Sunnyvale, Calif., firm is instead touting a new input/output macrocell design it is incorporating in its upcoming PAL22IP6 series of PLDs. Called the Interface Protocol Asynchronous cell, or IPAC, it eliminates the need for a clock on chip. □

ELECTRONICS NEWSLETTER

INTELLIGENT MEMORY CHIPS CONQUER GRAPHICS AND FLOATING-POINT CALCULATIONS

A new startup has developed an intelligent memory design that could revolutionize computing in such fields as signal processing, pattern recognition, graphics, and very high-speed floating-point number crunching. Oxford Computer's novel architecture improves certain memory operations by over 100 times through a small amount of logic processing on specially configured memory chips. "We designed these chips originally to enhance the convolution and correlation for signal processing and fast neural-network pattern recognition," says Steven G. Morton, Oxford's founder and chief technical officer. The Oxford, Conn., company says its intelligent memory design will speed up fast Fourier transforms for 3-d graphics and whiz through floating-point calculations. And a floating-point version of the chips will enable a single-board supercomputer to deliver over 1 billion floating-point operations/s, Morton says. Oxford plans to offer initial samples of the chips within a year. □

ANOTHER FORECAST PROMISES A BRIGHT FUTURE FOR RISC

If any doubts still linger about the takeoff of 32-bit reduced-instruction-set-computer chips, a new market projection from the Information Network should put them to rest. The San Francisco consulting firm says RISC consumption will grow from about $17 million, or 6% of all 32-bit microprocessors last year, to nearly 39%, or $505 million in 1992. That's even more than the 35% share Integrated Circuit Engineering Corp., of Scottsdale, Ariz., forecast earlier this year. The steep jump in sales will produce a 96% compound average growth rate for the five-year period, against about 25% for conventional microprocessor chips. And as use rockets, the cost for every million instructions/s processed on a RISC machine will plummet from $15,000 last year to only $1,000 in 1992. □

FINALLY, A SOFTWARE-INTEGRATION ARCHITECTURE THAT'S READY TO GO

In the ongoing search for software that can integrate programs from a variety of vendors, several powerhouse groups have suggested architectures. However, none of these—such as the Common Applications Environment from the London-based consortium X/Open Co. Ltd. and the Applications Binary Interfaces by AT&T and Sun Microsystems Inc.—is up and running. But now one is: it's called OpenWorks and it comes from Landmark Graphics Corp., a Houston company that has been better known for its software and computer systems than for oil exploration. Two oil companies are already using OpenWorks, and Landmark is also proposing the software as an industry standard for integrating software applications on other systems. □

APOLLO TAKES A SHOT AT SUN WITH TWO 68030-BASED WORK STATIONS

Like a long-distance runner, Apollo Computer Inc. has found its second wind and is giving arch-rival Sun Microsystems Inc. a run for the money in the heavily contested work station race. Apollo will beat Sun to the wire this month with a work station based on Motorola's 68030 microprocessor, its latest attempt to regain some of the ground Sun has gained in the last two years. The two have traded new product introductions all year: Sun brought out the Sparc-based Sun 4 Work Station, and Apollo countered with its DN 10000; Sun offered the low-end 386i, and now Apollo's unleashed its 68030-based DN3500 and DN4500. For Apollo, these are must-win products. "Sun beat Apollo out in unit shipment, revenue, and installed base by a small margin in 1987," says Jennifer Johnson, CAD/CAM Analyst with International Development Corp. in Framingham, Mass. If Apollo can't fend off its challenger this year, times can only get worse. □

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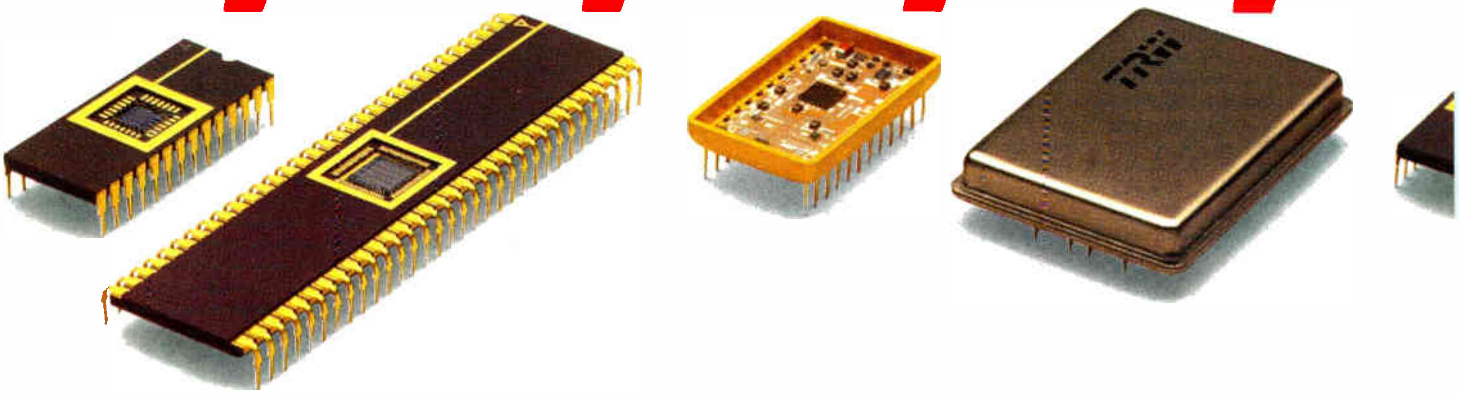

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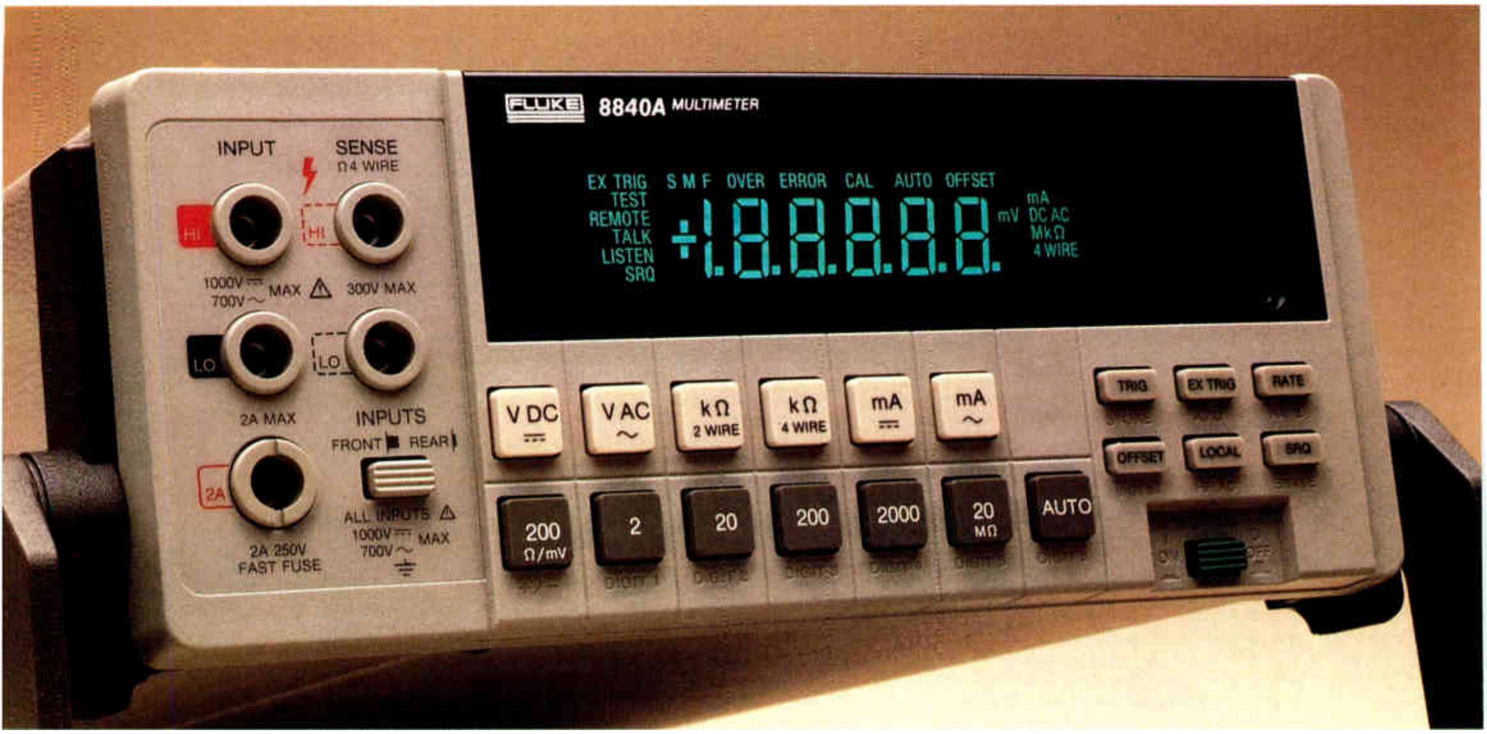

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PRODUCTS NEWSLETTER

HITACHI's 1-MBIT SRAM USES LESS THAN HALF THE COMPETITION'S POWER

Markets in space- and power-sensitive applications such as laptop computers, portable instruments, and point-of-sale terminals are naturals for a 1-Mbit static random-access memory from Hitachi America Ltd. The device takes up about one-third the space of four 256-Kbit SRAMs and really shines in power consumption, using 37% of the power of the 1-Mbit SRAM competition [*Electronics*, June 1988, p. 29]. Fabricated in the San Jose., Calif., company's 0.8-μm CMOS process and organized as 8 by 128-K bits, the HM628128 delivers 70-ns access times. It draws 45 mA typical and 1 mA in standby mode. The part also boasts an energy-saving data-retention mode that automatically activates when the 5-V power supply drops below 3 V—the level for lithium batteries used in electronic systems. In this mode, the typical current drain is 1 mA. The HM628128 will come in 70-, 85-, 100-, and 120-ns speed grades. Samples of the 70-ns part are available now at $220; production quantities are scheduled in the first quarter of 1989. □

ETA SYSTEMS LINKS UNIX WORK STATIONS TO ITS SUPERCOMPUTERS

Look for a wave of new applications programs to be written for supercomputers now that ETA Systems is making Unix System V available for all models of its ETA10 family of supercomputers. The move means that anybody with an industry-standard work station based on AT&T Co.'s Unix operating system can develop software that can run on a supercomputer. Systems from the St. Paul, Minn., subsidiary of Control Data Corp. perform up to 6 billion floating-point instructions/s. ETA's introduction also gives an easy migration path to supercomputer performance for the installed base of Unix programs running on minisupercomputers. □

MOVING TO OS/2 FROM MS-DOS GETS EASIER WITH MICOM SYSTEM CONTROLLER

Managerial headaches from contemplating the expense of moving local-area networks of MS-DOS computers to the OS/2 operating system could get relief from Micom Systems Inc.'s LM9210-OSI data-link controller. Anticipating the release of Microsoft Corp.'s LAN Manager software, the new controller combines Micro Channel architecture and Open Systems Interconnect protocols into a single product. The LM9210-OSI lets DOS work stations communicate with the OS/2 LAN manager, which is slated to debut in September, says Micom of Simi Valley, Calif. The controller supports Ethernet or unshielded twisted-pair media. Final operating specifications for the product are not yet available, but deliveries will start within 90 days from Micom's Interlan Division in Foxboro, Mass. Retail price is $595. □

JAG ELECTRONICS' TOOL KIT PUTS MACINTOSH IN THE RF DESIGN BUSINESS

Acceptance of circuit-design software that runs on Apple Computer Inc.'s Macintosh II, SE, and Plus models will get a big boost from JAG Electronics Ltd.'s high-performance radio-frequency tool kit. The RF Designer includes full nodal analysis, random and gradient optimizers, stability analysis, and automatic calculation of parasitics among its many features. It's also fast. While work stations run calculations faster, the Macintosh's faster drawing speed makes calculate-and-display times comparable. A typical 14-component, 16-node amplifier can be analyzed at five frequencies—and the results displayed—in 6 s on the SE. The $1,000 package also delivers a big price advantage compared with competing products that cost $5,000 and run on $20,000 work stations. RF Designer does not handle microwave design, which the Ontario, Canada-based company says many rf designers don't need anyway. RF Designer will be available in September. □

PRODUCTS NEWSLETTER

PYRAMID REVAMPS ITS RISC SUPERMINIS TO BOOST PERFORMANCE BY UP TO 100%

Architecture modifications in Pyramid Technology Corp.'s 9000TA series of RISC superminicomputers deliver performance gains of up to 100% over the company's original 32-bit 9000 series. Even though the machines still have a top mips rating of 24, the changes boost throughput by 35% to 80% for data-base applications, 30% to 70% for software development, and 60% to 100% for communications applications. One important innovation puts the Unix operating system in control of the instruction cache, dynamically allocating space in the cache to the users' applications and to the operating system kernel. The series includes four models—the 9815, 9825, 9835, and 9845—that contain from one to four processors, respectively, and range in price from $128,000 to $425,000. The Mountain View, Calif., company also enhanced its Unix implementation, called OSx 4.4, to accommodate the cache and expedite tasks running on the processors in the system. For example, the system can allocate tasks to specific processors or can have a common queue and allocate tasks to the next available processor. □

INTEL'S 80386-BASED AT-COMPATIBLE FAMILY TARGETS REAL-TIME SYSTEMS FOR OEMs

A new milestone in price-performance for real-time computing is being set by Intel Corp.'s System 120 family of 80386-based computers, which cut the price in half for an entry-level system. The single-processor system teams the 80386 microprocesor with AT-bus architecture and Intel's popular iRMX real-time operating system to offer original-equipment manufacturers a low-cost platform for real-time systems. A major cost saving came from eliminating the Multibus. System 120s come in two flavors; an OEM target platform for as low as $3,800 in quantities of 50; and a development-system configuration featuring a lot more software at a single-unit price starting at $9,250. □

PC PLUG-IN ARRAY PROCESSOR HAS FULL HOUSE OF SOFTWARE ROUTINES

By packaging its 32-bit floating-point-array processor plug-in board with a powerful set of 457 microcoded software functions, Eighteen Eight Laboratories Inc. is delivering functionality found only in minicomputers. Based on AT&T Co.'s DSP32 chip, the 32-bit PL800 plugs into an expansion slot on an IBM Corp. PC AT or compatible and can handle 8 million floating-point operations/s. But while competitors offer little software to capitalize on the hardware's processing capabilities, the San Diego, Calif., company includes a rich library of array and matrix processing routines that can be called from Fortran, C, or Pascal programs running on the host PC. This means users need not concern themselves with the PL800's assembly language or its pipelined parallel-processing architecture. What's more, the software allows up to eight of the boards to team up on a single PC, delivering 64 megaflops of power on the desktop. Available now, the PL800 costs $1,995. □

EMUCOM'S X.25 PRODUCTS DELIVER DIAL-UP SECURITY USING CCITT SPECIFICATION

Emucom Inc. is looking to capitalize on the wave of concern about data security on public packet-switched phone lines by incorporating the CCITT X.32 recommendation for X.25 dial-up security in its packet assembler/disassembler products. While other firms offer security packages, the Chelmsford, Mass., company claims to be the first to handle it using an international standard that resolves compatibility problems. Other major features include the ability to store up to 500 passwords and limit access to specific times of the day. Available now, the company's board-level 2,400 bit/s EM1100 packet assembler/disassembler costs $125 each in 1,000-unit purchases. An end-user product—the EM2400—adds a modem and costs $795 in single units. □

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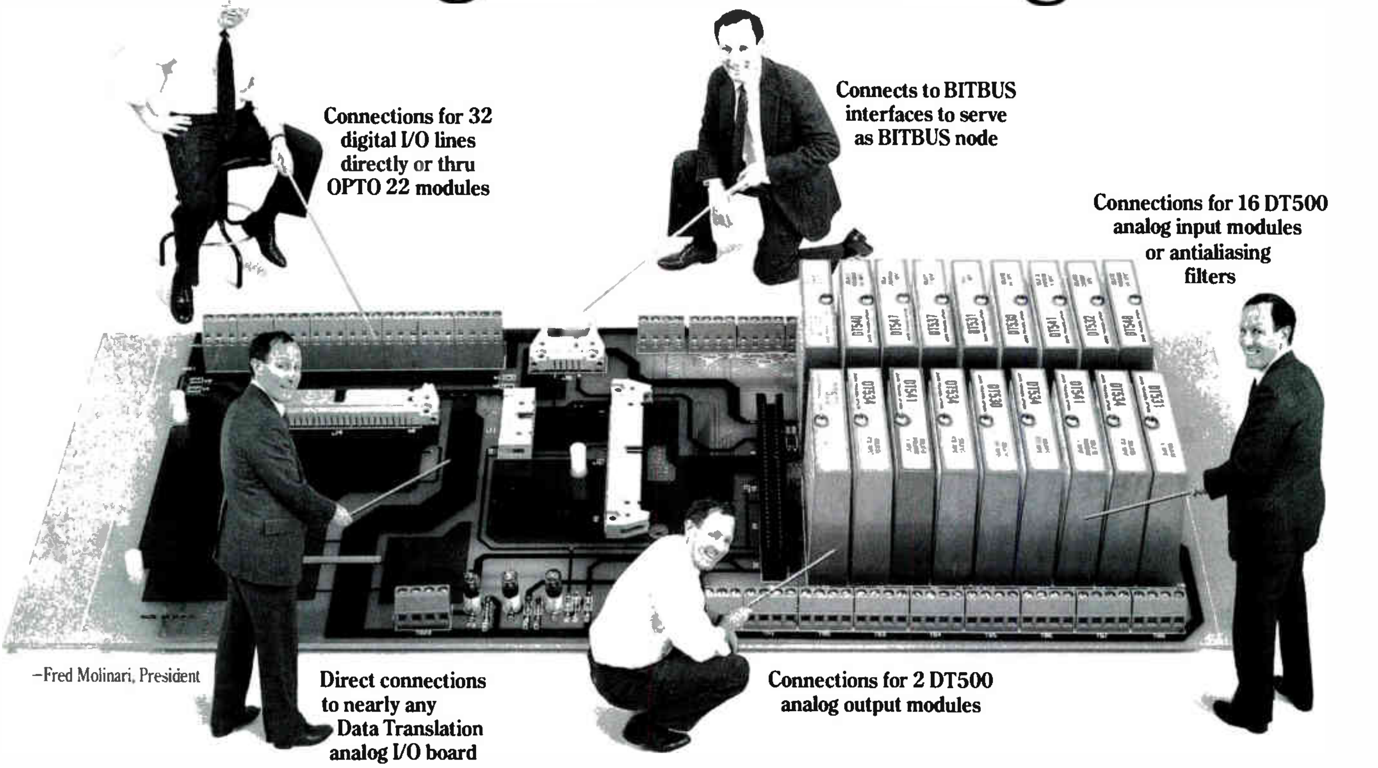

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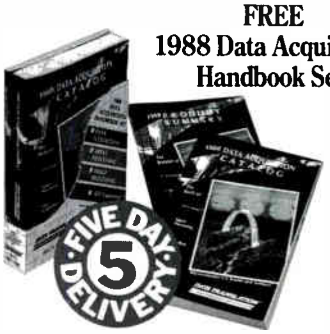

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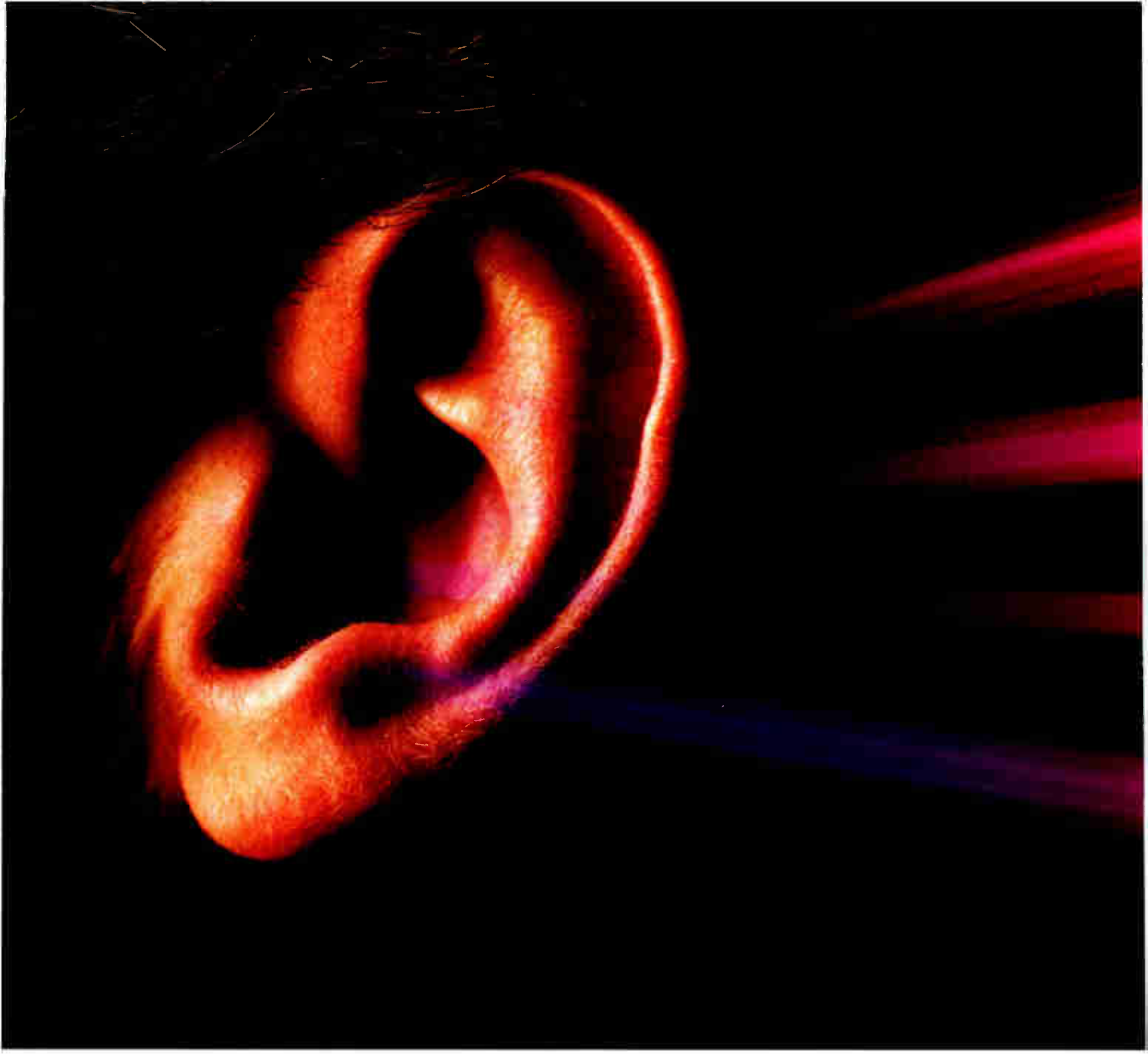

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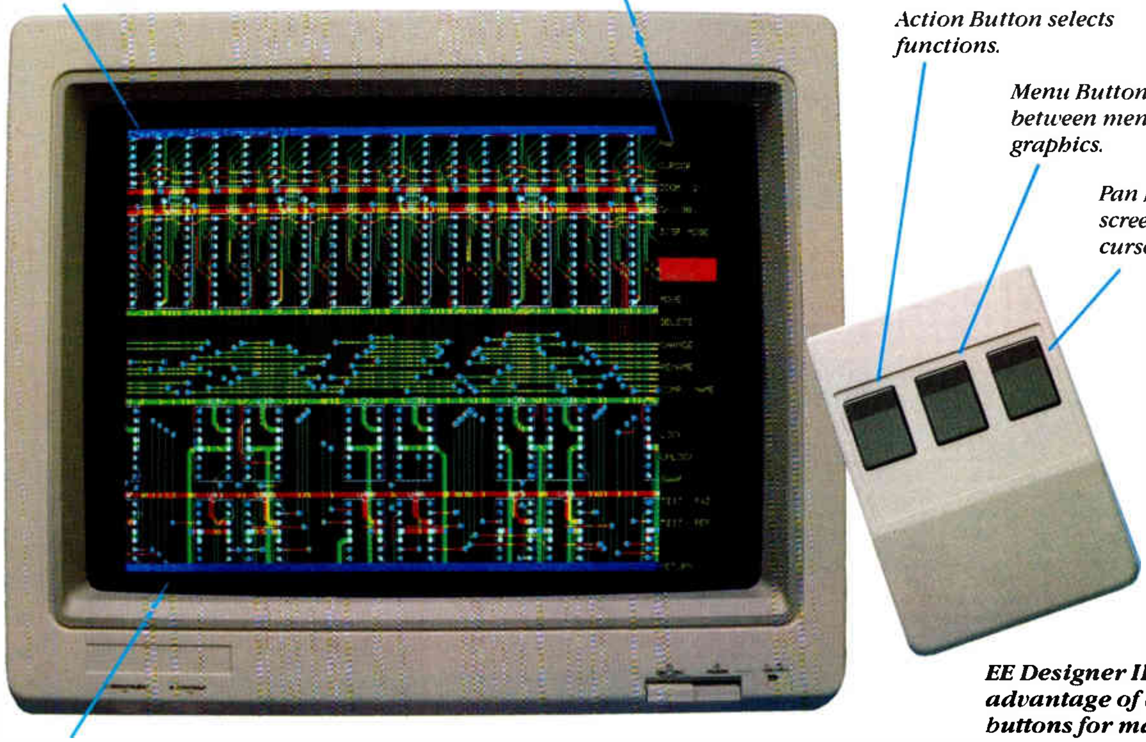

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PROBING THE NEWS

COULD THIS BE THE MISSING LINK BETWEEN MIMIC AND VHSIC TECHNOLOGIES?

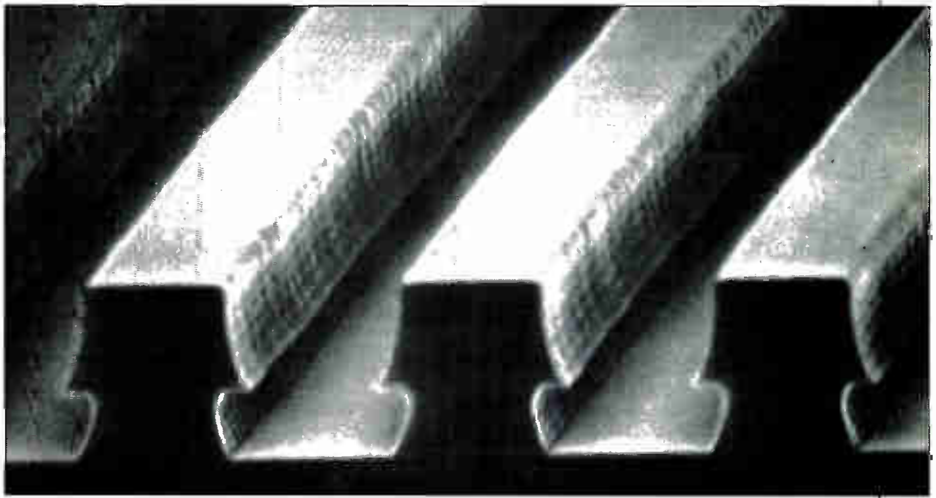
Surface acoustic waves may be able to handle the bandwidth mismatch between the pair

URBANA, ILL.

An embryonic technology that many believe to be the missing link between Mimic and VHSIC, the Pentagon's high-profile development programs for analog gallium arsenide and digital silicon circuitry, is increasingly making waves in defense electronics circles. Backers of the technology—acoustic charge transport—say it promises radical improvements in high-speed, wideband analog signal processing.

What has emerged is no less than a new class of analog signal processors that combine surface-acoustic-wave and charge-coupled technologies. ACT proponents say their technique could reduce to one-tenth the cost, size, weight, and power requirements of some parts of the electronics that are now used in military radar, electronic warfare, surveillance, and communication systems. And ACT chips, which could be used in programmable delay lines, transversal filters, and analog transient recorders, may also find jobs in commercial communication and navigation schemes.

For now, ACT remains a mystery to all but a few companies, with the bulk of the work going on at tiny Electronic Decisions Inc. of Urbana. Founded five years ago by ACT co-inventor Bill J. Hunsinger, it has so far won more than $30 million in development contracts from the Defense Advanced Research Projects Agency and the Air Force for the technology.



A sample chip made with Electronic Decisions' ACT technology holds 5,000 tap electrodes, each 1 μm wide on 1-μm spacings. The result is a massively parallel analog processor.

ON SAME CHIP. The Pentagon believes that ACT devices could handle preprocessing chores, such as interference rejection, signal detection, and signal-rate reduction, that would offset the mismatch between Mimic—the Microwave and Millimeter Wave Integrated Circuits program—and VHSIC—the Very High Speed Integrated Circuits program. Without ACT, system designers envision using a wealth of discrete preprocessing circuitry and memory as an interface between analog Mimic chips that operate at bandwidths between hundreds of megahertz and several gigahertz, and digital VHSIC parts running typically in the 50-MHz range. And since ACT and Mimic devices are both gallium arsenide technologies, they could some day be integrated on a single chip, proponents say.

"We're excited about the bridge between Mimic and VHSIC," says Henry J. Bush, assistant chief of the Communications Transmission Division of the Rome Air Development Center, Griffiss Air Force Base, N. Y. "With ACT, you can almost talk about a full rf-to-baseband capability in a monolithic integrated circuit."

What makes ACT technology work is an unconventional approach to using SAW for analog sampled-data signal processing. The parts are somewhat similar to charged-coupled devices, which move packets of electrons along in bucket-brigade fashion. But unlike CCDs, which use a series of voltages to move the packets, ACT parts generate a single-frequency SAW on chip, and rely on the traveling wave's electric field for packet transport. The wave thus acts as a built-in clock, sweeping packets along through a buried channel in the device.

In a system, an ACT part receives an analog signal through an input electrode, then forms sample packets that the SAW moves from one device end to the other. In its simplest form, the circuit serves as an rf delay line. But the key to ACT's flexibility is its ability to nondestructively sense or extract packets in the channel as they pass by. By using a series of nondestructive tap electrodes above the channel, integrated with other circuitry on the device, the packet data can be sampled, stored, and processed on-chip under digital programmable control. Electronic Decisions has already proved this with ACT circuits containing up to 5,000 tap electrodes, each 1 μm wide on 1-μm spacings (see photo), producing a massively parallel sampled analog processor.

THE LEADER. ACT devices can work at high frequencies, with bandwidths approaching the Nyquist maximum—half of the sampling frequency. "We're working with 600-MHz devices right now, and we'll probably be at a gigahertz before too much longer," says Daniel A. Fleisch, engineering department manager at Electronic Decisions, who credits the high electron mobilities inherent to GaAs for the speed.

Electronic Decisions is way ahead of the pack developing the technology, but ACT work is also going on at Lockheed Corp., Calabasas, Calif., and at the University of Central Florida, for example. And researchers at the United Technologies Research Center, in East Hartford, Conn., are developing ACT devices built in advanced heterojunction aluminum-GaAs structures. *–Wesley R. Iversen*

SPACE CIRCUITRY

THERE'S A NEW RAD-HARD CONTENDER—CMOS!

WASHINGTON

The race is on for an obscure but growing piece of the chip market: radiation-hardened parts for use in satellites, the space shuttle, and strategic weapons. At stake is a business worth about $250 million by 1992—30% larger than it is today, by one manufacturer's reckoning—and the opportunity to get in position to take advantage of even more dynamic growth expected beyond that. Competitors like IBM, GE, Honeywell, and Texas Instruments are all lining up for a piece of the action.

But the contest doesn't just pit one giant electronics company against another. It is also a battle of technologies, matching exotic processes like silicon on sapphire and other silicon-on-insulator variants against enhanced bulk silicon processes. And despite all the attention paid to SOS and SOI, it now appears that for most short-term applications, plain old CMOS may offer all the radiation hardness anyone needs.

Leading the way in CMOS is Honeywell Inc.'s Solid State Electronics Division in Colorado Springs, Colo. The division is actively marketing an entire family of products, from gate arrays and standard-cell application-specific integrated circuits to 16- and 64-Kbit static random-access memories, all built in Honeywell's 1.2-μm RICMOS—for Radiation Insensitive CMOS—technology. RICMOS is a rad-hard adaptation of Honeywell's most advanced silicon process, CMOS III, which supercomputer maker ETA Systems Inc. is using in its ETA10.

"There's a full family of semiconductors that people can actually get their hands on," says David Wick, manager of Honeywell's military ASIC product line. "A lot of the other processes out there are still in the lab."

COMING LATER. Indeed, while Texas Instruments Inc. has impressed officials at the Defense Advanced Research Projects Agency and the Army's Strategic Defense Command with its silicon-on-insulator process, it won't have any SOI products on the market until 1990. GE's Microelectronics Center at Research Triangle Park, N.C., is just seeing the first of its 1.25-μm SOS parts now. And even IBM Corp., which like Honeywell is using CMOS for its rad-hard parts, won't have engineering samples of its 64-Kbit chip until October.

"We have a similar strategy to Honeywell and we're essentially coming up behind them," says Bob Estrada, Very High Speed Integrated Circuits program manager at IBM's Federal Systems Division, Manassas, Va. The IBM and Honeywell efforts grew out of follow-on developments to the VHSIC program. Each is developing a version of the Generic VHSIC Spaceborne Computer for the Army, and the memory chips were designed to support that program. The differences are that Honeywell is pushing a more mature 1.2-μm technology, while IBM is pursuing more ambitious 1- and 0.5-μm processes, and that Honeywell is far more established in the marketplace.

The target is attractive. Honeywell's Wick estimates the total rad-hard logic and memory market was about $193 million in 1987, with $128 million of that going into strategic missiles and the rest going to space applications, such as satellites and the Space Shuttle program. By 1992, he says, the total market will reach $250 million, of which $165 million will go into strategic missiles, mostly as retrofits to existing systems built to withstand lower radiation levels than the Pentagon now finds acceptable. Considering the general downturn in defense spending that most industry watchers expect to last into the mid-1990s, that represents a phenomenal market opportunity.

"In recent months we've been flooded with new orders," says Lucien DeBacker, the director of military products at Honeywell Solid State Electronics. "Not big orders, but 100 here, 1,000 there." But at costs that can reach as much as $2,000 for each of 1,000 64-Kbit SRAMs screened to Class S requirements, that's a healthy piece of change.

–Tobias Naegele

RICMOS HEADS FOR SPACE

PARAMETER	SPACEBORNE REQUIREMENT	RICMOS TEST RESULTS
TOTAL DOSE	10^6 RAD (SiO_2)	$>3\times10^6$
DOSE RATE UPSET	10^9 RAD (Si)/s	$>10^9$
DOSE RATE SURVIVAL	10^{12} RAD (Si)/s	$>10^{12}$
SINGLE-EVENT UPSET	10^{-10} errors/bit-day	up to 10^{-10}
NEUTRONS	10^{14}/cm2	$>10^{14}$

SOURCE HONEYWELL INC

DESIGN AUTOMATION

MERGER FEVER IS THE TALK OF DESIGN AUTOMATION SHOW

ANAHEIM, CALIF.

Romance of the corporate kind was in the air at the Design Automation Conference. The June wedding of Cadnetix Corp. of Boulder, Colo., and HHB Systems Inc. of Mahwah, N. J., was the talk of the conference in Anaheim, Calif. And it left many potential suitors wondering who might be next in a business atmosphere that was encouraging many to consider the big move themselves.

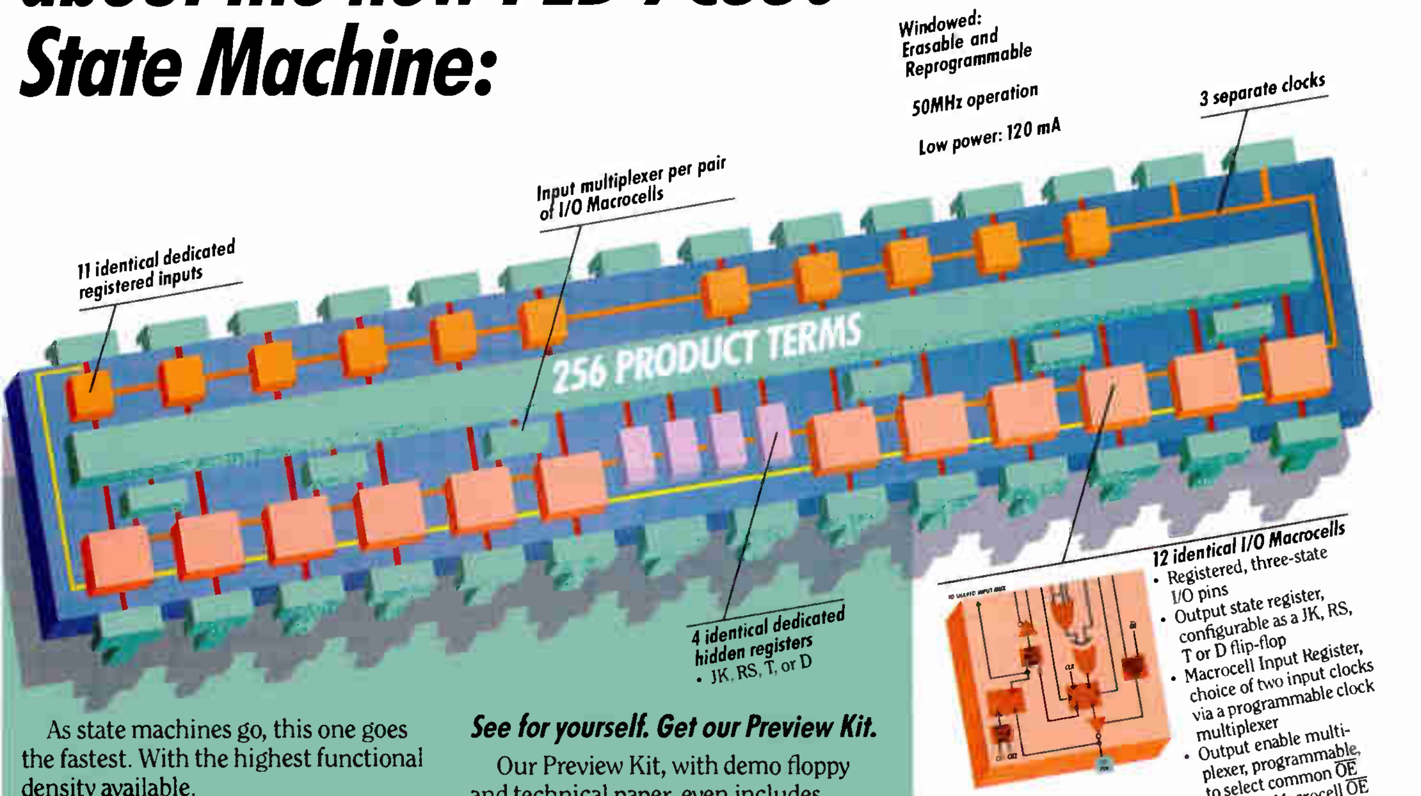
The implications of new alliances such as the Cadnetix/HHB agreement also left some conference attendees feeling a bit uptight for a couple of reasons. First, rejected suitors can face suddenly strengthened competition. And second, original-equipment manufacturers can find that their suppliers are just as suddenly owned by the competition.

That was the case when Cadnetix took over HHB [*Electronics*, June 1988, p. 20]. Cadnetix acquired controlling interest in an HHB simulator that was being used by two OEMs, Computervision Corp. and Racal Redac Inc., who are direct competitors of Cadnetix in printed-circuit-board CAD systems.

Computervision, for one, will stay with the HHB Cadat simulator, says Barry Heller, electronics marketing manager at the Bedford, Mass., company. But industry sources believe that Racal will find it difficult to keep buying a key technology from a rival.

The same problems that have cropped up from the Cadnetix-HHB merger also reared their heads recently in the industry when Hewlett-Packard Co. and Integraph Corp. said they would both be

Why high performance designers are so excited about the new PLD 7C330 State Machine:



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OEMs for GenRad Inc.'s Hilo system [*Electronics*, May 26, 1988, p. 65]. These two archrivals were depending on a common third party for a key technology, while a third rival had already made off with the only remaining alternative simulator a month before.

That's why the names of other unattached simulator companies on the market for HP and Integraph to consider kept coming up. The two most often heard were Gateway Design Automation Corp. and Vantage Analysis Systems Inc.. The two offer a particular advantage to a CAE company out shopping, because they provide system-level simulation capability and both are moving to support VHDL, which is expected to be mandated next year by the Pentagon for military CAE systems.

But the cost of acquiring the two companies may be steep. Cadnetix plunked down $70 million-plus for HHB. That shows that buyers are willing to pay more than the present value of a company in hopes of long-term returns, says Robert Herrick, an analyst at Hambrecht & Quist in New York.

So observers believe that Gateway and Vantage only top the list of firms that could be wooed. Others range from small niche players such as Ikos Systems Inc. all the way up to Daisy Systems Inc. and Valid Systems Inc. "I think that HP acquiring Valid could be in the realm of possibility," says Herrick. "The problem is Valid's largest customer is Digital Equipment Corp., so a buyout by HP would probably result in losing the DEC business."

But what if a marriage doesn't work out? Corporate divorces can be painfully costly. One answer, particularly for chip makers, is to live together for a while. At DAC, National Semiconductor Corp. and Cadence announced a partnership; so did Fujitsu Microelectronics Inc. and Daisy. *–Jonah McLeod*

SOLID STATE

CYPRESS GETS OFF TO A FAST START WITH SPARC INTEGER IC

SANTA CLARA, CALIF.

Out the door ahead of time, with unprecedented speeds and a price that will rock its competitors: that's the boast of Cypress Semiconductor Corp. about its 32-bit CY7C600 reduced-instruction-set chip set. The Santa Clara company is speeding up an already ambitious schedule, and this month is shipping first samples of the key chip in its version of the Sun Microsystems Inc. Scalable Processor Architecture (Sparc) processor family. Not surprisingly, the samples went to work-station maker Sun in nearby Mountain View.

That's three to four months ahead of schedule. But at least one industry watcher says he wants to see more of the chip set out there before he will be ready to call Cypress' chip set a step ahead of such rival RISC processors as Motorola Inc.'s new 88000.

Cypress is confident that its first chip, the integer unit, broke the ground for the entire chip set. "Under our agreement with Sun, we had committed ourselves to delivery [of the IU] by October or November," says Dane Elliot, manager of applications engineering at Cypress. "This was assuming at least one or two passes at silicon would be required." However, to everyone's suprise, the first pass produced working parts.

The performance and the yields were just as surprising, says Elliot. Although the parts are specified at 20 million instructions/s at 33 MHz, first tests performed by Cypress indicate that clock frequencies of 55 to 60 MHz are in reach. "Although we will still ship parts guaranteeing 20 mips throughput initially, faster parts will be released for production soon," he says.

Cypress executives would not specify how much yield improved, but it is enough for the company to announce an aggressive pricing policy. According to Elliot, a typical nine-chip implementation of the Cypress version of the Sparc architecture using sample-quantity pricing will be available for $2,984, compared with currently published prices of $6,855 for sample quantities of Motorola Inc.'s recently introduced 88000 RISC processor.

The first part released to production by Cypress is the integer unit, and that's the rub, says Michael Slater, president of Microdesign Resources Inc. of Palo Alto, Calif., and editor and publisher of Microprocessor Report. "All they're announcing is the IU, and that's only an incremental improvement over the Fujitsu [25-MHz] version" of Sparc, he says. "However, if they manage to produce a 50-to-60-MHz part for the other chips [in the Sparc chip set] too, they have a good solid offering."

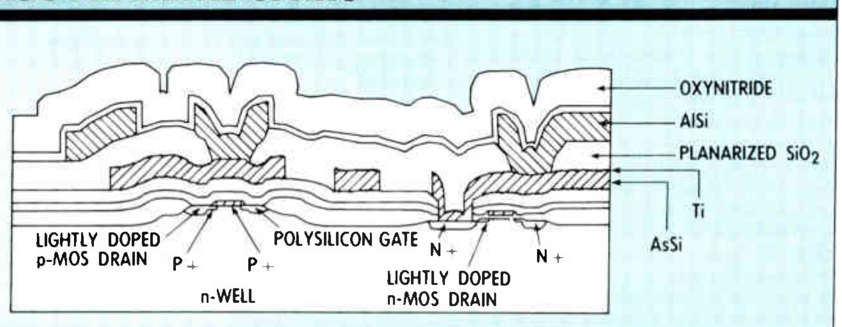
Elliot, confident that Cypress can do just that, says the combination of high performance and lower cost are due to processing, packaging, and partitioning. Cypress uses an advanced 0.8-µm n-well double-level-metal CMOS process with an effective gate length of 0.65 µm (see figure). It is a big jump over the standard 1.25-to-2-µm processes currently in production by most manufacturers, but the process is an offshoot of a well-tested, single-metal process.

By using advanced packaging, the company reduced the noise and ground-bounce problems that normally plague CMOS circuits as they push clock speeds much beyond 30 MHz by physically isolating sections of the circuitry and using multiple power, signal, and ground lines. To do this, Cypress engineers designed a pair of proprietary 207-pin packages with 82 power pins.

The company chose an alternate path to that used in the 88000 to partition the architecture. The 88000 uses a physical caching scheme, the Sparc a virtual caching scheme. Physical caching requires a virtual-to-physical address translation on every memory reference, translating into lower system performance. With virtual caching, the cache can intercept a memory reference without the need for an address translation.

But Cypress' engineers added a twist. Earlier Sparc designs incorporate the MMU, cache-tag RAM, and data RAM onto the same chip, but the Cypress design has separate chips. This removes the MMU from the critical path so that when address translation is not needed, there is no need to go through the MMU. *–Bernard C. Cole*

DOUBLE-METAL SPARC



The layered metal scheme—tungsten, aluminum, tungsten— in Cypress Sparc chip reduces raised surfaces on the inner dielectric layer. These "hillocks" can significantly lower yield.

LAMBDA'S RUGGED LOW NOISE LRS

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Lambda introduced the first LR Series power supply models in 1984. Since then, a succession of new power levels have been added. Each time the new models were tested, and passed MIL-STD-810C procedures in accordance with the specifications.

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THE LR SERIES FEATURES:
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- International Input of 95 to 132VAC or 187 to 265VAC, 47-440Hz
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- MIL-SPEC Construction — Components, ratings and mounting methods rigidly specified by Lambda. Quality Assurance procedure similar to MIL-I-45208. Referenced to MIL-Q-9858A. Products are manufactured in ESD controlled facilities.
- Special Assemblies Available — LRA-14, LRA-15, LRA-17 rack mounting accessories and custom assemblies available from Lambda.

THE LR SERIES SWITCHING POWER SUPPLIES PASSED THE FOLLOWING TESTS:

MIL-STD-810C PROCEDURE

Low Pressure (Method 500.1 Procedure I)
Units are operated in a chamber simulating 15,000 feet altitude. Units are exposed for one hour prior to check.

High Temperature (Method 501.1 Procedure I & II)
Units are operated and checked at +71°C after 48 hours exposure to this temperature.

Units are also subjected to three 12 hour high temperature cycles between +49°C and +71°C. After the third cycle, units are checked at +71°C ambient.

Low Temperature (Method 502.1 Procedure I)
Units are subjected to −57°C for 24 hours. Temperature is then increased to 0°C and the units are operationally checked.

Temperature Shock (Method 503.1 Procedure I)
Units are transferred between two chambers, one at −57°C, the other at +71°C. Units remain in each chamber for four hours. After twenty-four hours, the units are allowed to return to ambient conditions when a check is carried out.

Temperature — Altitude (Method 504.1 Procedure I Class 2)
Units are put through the following cycle in accordance with this test.

Step	Temperature	Altitude	Unit operation
1a	+25°C	40,000 ft.	Non operating
1b	−62°C	Site	Non operating
2	0°C	Site	Operating
3	0°C	10,000 ft.	Operating
4	−10°C	Site	Operating
5	+25°C	Site	Operating
6	+85°C	Site	Non operating
7	+55°C	Site	Operating
8	+71°C	Site	Operating
10	+52°C	10,000 ft.	Operating
11	+68°C	10,000 ft.	Operating

Humidity (Method 507.1 Procedure I)
Prior to starting the test period, chamber temperature is maintained between +20 and +38°C (+58° and +100°F) with uncontrolled humidity. During the first two hour period, the temperature is gradually raised to +65°C. This temperature is maintained during the next 6 hour period. During the following 16 hour period, the temperature is gradually reduced to +30°C. This 24 hour period constitutes 1 cycle. This cycle is repeated 10 times (240 hours) with relative humidity maintained at 95% throughout all cycles. At the conclusion of the 240 hours of test, and while units are still at 30°C and 95% relative humidity, the units are operationally checked.

Fungus Proofing (Method 508.1 Procedure I)
Units are exposed to the spore cultures of the specified fungus species in an environment capable of encouraging fungus growth. At end of test, units must not show signs of fungus growth, deterioration or corrosion.

Vibration (Method 514.2 Procedures X & XI)
Units are secured to the test machine by their normal mounting means and subjected to simple harmonic motion with an amplitude of 1.0 inch (double amplitude) or 1.5g at frequencies from 5Hz to 200Hz. An operational check is then carried out.

Packaged units are placed on a bounce machine and bounced 2.0 inches at 284 rpm for three hours (thirty minutes on each face). Units are tested and inspected for evidence of physical change.

Shock (Method 516.2 Procedures I & III)
Units are secured to the shock machine by their normal mountings and subjected to 18 half-sine, 11 millisecond, 15g shock pulses. An operational check is carried out afterwards.

Units are also tested for crash safety. Again units are secured to the shock machine by their normal mountings but this time subjected to twelve half-sine shocks of 30g with 11 millisecond duration. The mounting attachments are then checked for failure or hazard.

Conducted Interference (MIL-STD-461A)
Units were tested according to the procedures laid down under MIL-STD-461A Notice 4 CE04 for conducted EMI. The units were found to conform with cover with either output grounded. LRS power supplies also meet VDE 0871 Class A and FCC Docket 20780 Class A.

LR SERIES Switching Power Supplies

SINGLE OUTPUT

	MAX CURRENT AT OPERATING TEMPERATURE OF (A) 40°C	50°C	60°C	71°C	DIMENSIONS (inches)	PRICE	MODEL
2V ±5% ADJ.	4.0	3.2	2.4	2.0	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	$ 150	**LRS-49-2**
	7.0	5.6	4.2	3.5	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	**LRS-50-2**
	12.0	9.6	7.2	6.0	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	**LRS-51-2**
	15.0	13.7	11.1	5.9	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	308	**LRS-52-2**
	25.0	21.5	17.5	10.0	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	420	**LRS-53-2**
	40.0	34.0	27.5	19.5	$3 \times 4\frac{7}{8} \times 11$	515	**LRS-54-2**
	60.0	51.0	41.0	30.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	655	**LRS-55-2**
	90.0	77.0	61.0	45.0	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	812	**LRS-56-2**
	130.0	110.0	90.0	68.0	$5 \times 4\frac{7}{8} \times 12$	1064	**LR5-57-2**
	180.0	147.0	120.0	83.0	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1288	**LRS-58-2**
	250.0	200.0	165.0	125.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1568	**LRS-59-2**
5V ±5% ADJ.	4.0	3.2	2.4	2.0	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	**LRS-49-5**
	7.0	5.6	4.2	3.5	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	**LRS-50-5**
	12.0	9.6	7.2	6.0	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	**LRS-51-5**
	15.0	13.7	11.1	5.9	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	**LRS-52-5**
	25.0	21.5	17.5	10.0	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	**LRS-53-5**
	40.0	34.0	27.5	19.5	$3 \times 4\frac{7}{8} \times 11$	460	**LRS-54-5**
	60.0	51.0	41.0	30.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	**LRS-55-5**
	90.0	77.0	61.0	45.0	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	**LRS-56-5**
	130.0	110.0	90.0	68.0	$5 \times 4\frac{7}{8} \times 12$	950	**LRS-57-5**
	180.0	147.0	120.0	83.0	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	**LRS-58-5**
	250.0	200.0	165.0	125.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	**LRS-59-5**
6V ±5% ADJ.	3.3	2.6	2.0	1.7	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	**LRS-49-6**
	6.0	4.8	3.6	3.0	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	**LRS-50-6**
	10.0	8.0	6.0	5.0	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	**LRS-51-6**
	13.5	12.2	9.9	5.2	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	**LRS-52-6**
	21.0	18.5	16.0	8.3	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	**LRS-53-6**
	35.0	31.0	24.0	17.0	$3 \times 4\frac{7}{8} \times 11$	460	**LRS-54-6**
	52.0	44.0	36.0	26.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	**LRS-55-6**
	80.0	69.0	54.0	39.0	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	**LRS-56-6**
	110.0	93.0	76.0	58.0	$5 \times 4\frac{7}{8} \times 12$	950	**LRS-57-6**
	150.0	123.0	100.0	70.0	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	**LRS-58-6**
	210.0	170.0	140.0	105.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	**LRS-59-6**
12V ±5% ADJ.	1.7	1.4	1.0	0.9	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	**LRS-49-12**
	3.0	2.4	1.8	1.5	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	**LRS-50-12**
	5.2	4.1	3.1	2.6	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	**LRS-51-12**
	7.8	6.8	4.9	2.3	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	**LRS-52-12**
	12.5	11.2	9.6	7.2	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	**LRS-53-12**
	22.0	18.5	15.0	10.0	$3 \times 4\frac{7}{8} \times 11$	460	**LRS-54-12**
	30.0	26.0	22.0	16.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	**LRS-55-12**
	47.0	41.0	34.0	21.9	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	**LRS-56-12**
	65.0	58.0	48.0	34.0	$5 \times 4\frac{7}{8} \times 12$	950	**LRS-57-12**
	84.0	69.0	56.0	40.0	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	**LRS-58-12**
	110.0	92.0	74.0	53.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	**LRS-59-12**
15V ±5% ADJ.	1.4	1.1	0.8	0.7	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	**LRS-49-15**
	2.6	2.0	1.6	1.3	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	**LRS-50-15**
	4.2	3.3	2.5	2.1	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	**LRS-51-15**
	6.4	5.6	4.0	1.9	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	**LRS-52-15**
	10.0	9.0	7.7	5.8	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	**LRS-53-15**
	18.0	15.0	12.0	8.0	$3 \times 4\frac{7}{8} \times 11$	460	**LRS-54-15**
	25.0	22.0	19.0	13.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	**LRS-55-15**
	38.0	33.0	28.0	17.9	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	**LRS-56-15**
	52.0	46.0	38.0	27.0	$5 \times 4\frac{7}{8} \times 12$	950	**LRS-57-15**
	68.0	56.0	45.5	32.0	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	**LRS-58-15**
	90.0	75.0	60.0	43.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	**LRS-59-15**

LR SERIES Switching Power Supplies

SINGLE OUTPUT

	MAX CURRENT AT OPERATING TEMPERATURE OF (A) 40°C	50°C	60°C	71°C	DIMENSIONS (inches)	PRICE	MODEL
20V ±5% ADJ.	1.0	0;8	0.6	0.5	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	$150	LRS-49-20
	2.1	1.7	1.3	1.0	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	LRS-50-20
	3.5	2.8	2.1	1.7	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	LRS-51-20
	4.9	4.3	3.0	1.5	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	LRS-52-20
	7.7	6.9	5.9	4.5	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	LRS-53-20
	13.5	11.5	8.5	5.5	$3 \times 4\frac{7}{8} \times 11$	460	LRS-54-20
	19.0	16.5	14.0	10.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	LRS-55-20
	29.5	27.0	22.0	13.8	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	LRS-56-20
	40.0	36.0	30.0	21.0	$5 \times 4\frac{7}{8} \times 12$	950	LRS-57-20
	52.0	43.0	35.0	24.5	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	LRS-58-20
	70.0	58.0	46.0	33.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	LRS-59-20
24V ±5% ADJ.	0.9	0.7	0.5	0.5	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	LRS-49-24
	1.8	1.4	1.1	0.9	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	LRS-50-24
	3.0	2.4	1.8	1.5	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	LRS-51-24
	4.1	3.6	2.6	1.2	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	LRS-52-24
	6.5	5.8	5.0	3.8	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	LRS-53-24
	11.5	9.5	7.5	4.5	$3 \times 4\frac{7}{8} \times 11$	460	LRS-S4-24
	16.0	14.0	12.0	8.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	LRS-S5-24
	25.0	22.5	18.5	11.6	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	LRS-S6-24
	33.5	29.0	24.0	17.0	$5 \times 4\frac{7}{8} \times 12$	950	LRS-57-24
	44.0	36.0	29.5	20.5	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	LRS-58-24
	60.0	50.0	40.0	28.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	LRS-59-24
28V ±5% ADJ.	0.7	0.6	0.4	0.4	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	LRS-49-28
	1.6	1.3	1.0	0.8	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	LRS-50-28
	2.5	2.0	1.5	1.2	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	LRS-51-28
	3.5	3.1	2.2	1.1	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	LRS-52-28
	5.7	5.1	4.4	3.3	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	LRS-53-28
	9.5	8.5	6.5	4.0	$3 \times 4\frac{7}{8} \times 11$	460	LRS-54-28
	14.0	12.0	10.0	7.0	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	LRS-55-28
	22.0	20.0	16.0	10.0	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	LRS-56-28
	29.0	25.5	21.0	15.0	$5 \times 4\frac{7}{8} \times 12$	950	LRS-57-28
	38.0	31.0	25.5	17.5	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	LRS-58-28
	52.0	43.0	34.0	24.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	LRS-59-28
48V ±5% ADJ.	0.4	0.3	0.2	0.2	$1\frac{1}{2} \times 3\frac{17}{32} \times 4\frac{23}{32}$	150	LRS-49-48
	0.9	0.7	0.5	0.4	$1\frac{1}{2} \times 4\frac{17}{32} \times 5\frac{15}{32}$	190	LRS-50-48
	1.5	1.2	0.9	0.7	$1\frac{11}{16} \times 4\frac{17}{32} \times 7\frac{13}{64}$	240	LRS-51-48
	2.0	1.7	1.2	0.6	$2 \times 4\frac{7}{8} \times 6\frac{1}{4}$	275	LRS-52-48
	3.3	2.8	2.4	1.8	$2\frac{3}{8} \times 4\frac{7}{8} \times 8\frac{1}{2}$	375	LRS-53-48
	5.8	5.1	3.6	2.3	$3 \times 4\frac{7}{8} \times 11$	460	LRS-54-48
	8.2	7.2	6.2	4.2	$3\frac{3}{4} \times 4\frac{7}{8} \times 10\frac{1}{2}$	585	LRS-55-48
	13.0	12.0	9.5	6.0	$4\frac{7}{16} \times 4\frac{7}{8} \times 11\frac{1}{2}$	725	LRS-56-48
	17.5	15.5	12.5	9.0	$5 \times 4\frac{7}{8} \times 12$	950	LRS-57-48
	22.5	18.5	15.0	10.5	$5\frac{1}{2} \times 4\frac{7}{8} \times 13\frac{1}{8}$	1150	LRS-58-48
	31.0	26.0	21.0	15.0	$6\frac{5}{8} \times 4\frac{7}{8} \times 13\frac{25}{32}$	1400	LRS-59-48

LR SERIES

Specifications

DC OUTPUT
Voltage range shown in tables.

REGULATED VOLTAGE
regulation, line .... 0.1% from 95 to 132VAC. 95 to 132VAC or 187 to 265VAC on LRS-49, 50, 51, 57, 58 and "M" option models. 187 to 265VAC on LRS-59 and "V" option models.
regulation, load .... 0.1% from no load to full load.
ripple and noise .... 10mV RMS, 35mV pk-pk for 2V models of LRS-49, 50, 51 and all 5V and 6V models. (25mV pk-pk for all other 2V models).
15mV RMS, 100mV pk-pk for 12V through 28V models.
35mV RMS, 150mV pk-pk for 48V models.
temperature coefficient .... 0.03%/°C.
remote programming resistance .... 1000Ω/volt.
remote programming voltage .... volt per volt.

AC INPUT
line .... 95 to 132VAC, 47-440Hz.
95 to 132VAC or 187 to 265VAC (user selectable), 47-440Hz on LRS-49, 50, 51, 57, 58 and "M" option models. 187 to 265VAC, 47-440Hz on LRS-59 only.
power .... LRS-49: 30 watts maximum.
LRS-50: 51.5 watts maximum.
LRS-51: 96 watts maximum.
LRS-52: 137 watts maximum.
LRS-53: 225 watts maximum.
LRS-54: 380 watts maximum.
LRS-55: 515 watts maximum.
LRS-56: 819 watts maximum.
LRS-57: 1100 watts maximum.
LRS-58: 1350 watts maximum.
LRS-59: 1900 watts maximum.

DC INPUT
145VDC ± 10%. (260 to 370VDC for LRS-49, 50, 51, 57, 58, 59 and "M" and "V" option models.)

EFFICIENCY
50% min for 2V model of LRS-49. 55% min for all other 2V models. 65% min for 5V and 6V models of LRS-49. 67% min. for 5V and 6V models of LRS-52. 66% min for 12V and 15V models of LRS-49. 68% min for 5V and 6V models of LRS-50. 70% min for 5V through 15V models of LRS-53, 54; 12V and 15V models of LRS-50; 20V through 48V models of LRS-49. 73% min on 5V and 6V models of LRS-51; 20V through 48V models of LRS-50. 75% min for 5V and 6V models of LRS-55, 56; 5V through 15V models of LRS-57, 58, 59; 12V and 15V models of LRS-51; 12V through 20V models of LRS-52; 20V through 48V models of LRS-53, 54. 77% min for 12V through 20V models of LRS-55, 56. 78% min for 20V through 48V models of LRS-51; 24V through 48V models of LRS-52. 80% min for 20V through 48V models of LRS-57, 58, 59; 24V through 48V models of LRS-55, 56.

OVERSHOOT
No overshoot at turn-on, turn-off or power failure.

OPERATING TEMPERATURE RANGE
Continuous duty −10°C to +71°C with suitable derating above 40°C. Guaranteed turn-on at −20°C.

STORAGE TEMPERATURE RANGE
−55°C to +85°C.

OVERLOAD PROTECTION

ELECTRICAL
External overload protection, automatic electronic current limiting circuit limits the output current to a preset value, thereby providing protection for the load as well as the power supply.

THERMAL
Self-resetting thermostat.

FUSING
Line fuse removes the power supply from the line if a short occurs in the input circuitry.

OVERVOLTAGE PROTECTION
Overvoltage protection is standard on all models. If output voltage increases above a preset level, inverter drive is removed.

COOLING
All units are convection cooled. No fans or blowers are needed.

IN-RUSH LIMITING
The turn-on in-rush current will not exceed 40 amps peak from a cold start. (13 amps on LRS-49, 50. 19 amps on LRS-51. 50 amps on LRS-57, 58, 59.)

DC OUTPUT CONTROLS
Simple screwdriver adjustment over the entire voltage range.

INPUT AND OUTPUT CONNECTIONS
All input, output, sensing, and remote on/off connections for LRS-49, 50, 51, 52 and LRS-53 are made through barrier strip terminals. All input, sensing and remote on/off connections for LRS-54, LRS-55, LRS-56, LRS-57, LRS-58 and LRS-59 are made through barrier strip terminals. DC output connection is made through heavy duty threaded bus bars.

MOUNTING
Two mounting surfaces and two mounting positions on LRS-52, 53, 54. One mounting surface and one mounting position on LRS-49, 50, 51, 55, 56, 57, 58, 59.

POWER FAILURE
2V, 5V and 6V models will remain within regulation limits for at least 16.7 msec. after loss of AC power when operating at full load, V_O max, and 105VAC input at 60Hz. (105 or 210VAC for LRS-49, 50, 51, 57, 58 and "M"option models. 210VAC at 60Hz for LRS-59.)

REMOTE SENSING
Provision is made for remote sensing to eliminate the effects of power output lead resistance on DC regulation.

REMOTE TURN-ON/TURN-OFF
Provision is made for digitally controlled remote turn-on, turn-off (TTL Compatible).

FUNGUS PROOFING
All units are inherently fungi inert.

MILITARY SPECIFICATIONS
The LR Series is built in Lambda factories to quality and inspection procedures which are similar to MIL-I-45208. The LRS-49, 50 and 51 are pending approval of environmental testing. The remainder of the series has passed environmental testing in accordance with MIL-STD-810C.
1) Low Pressure — Method 500.1, Procedure I.
2) High Temperature — Method 501.1, Procedures I and II.
3) Low Temperature — Method 502.1, Procedure I.
4) Temperature Shock — Method 503.1, Procedure I.
5) Temperature-Altitude — Method 504.1, Procedure I. Class 2 (−10°C Operating).
6) Humidity — Method 507.1, Procedure I.
7) Fungus — Method 508.1, Procedure I.
8) Vibration — Method 514.2, Procedures X and XI.
9) Shock — Method 516.2, Procedures I and III.

EMI
Conducted EMI conforms to FCC Docket 20780 Class A, and MIL-STD-461A Notice 4 CEO4 for power leads. LRS-57, LRS-58, LRS-59, and "M" and "V" option models also conform to VDE 0871 Class A.

PHYSICAL DATA

Package Model	Lbs. Net	Lbs. Ship	Size Inches
LRS-49	1 3/8	2 3/8	1 1/2 × 3 17/32 × 4 23/32
LRS-50	1 1/2	2 1/2	1 1/2 × 4 17/32 × 5 15/32
LRS-51	2	3	1 11/16 × 4 17/32 × 7 13/64
LRS-52	2 1/4	3 1/4	2 × 4 7/8 × 6 1/4
LRS-53	3 1/4	4 1/4	2 3/8 × 4 7/8 × 8 1/2
LRS-54	6 1/2	7 1/2	3 × 4 7/8 × 11
LRS-55	7	8 1/2	3 3/4 × 4 7/8 × 10 1/2
LRS-56	8 1/2	10	4 7/16 × 4 7/8 × 11 1/2
LRS-57	10 1/2	12	5 × 4 7/8 × 12
LRS-58	12 1/2	14	5 1/2 × 4 7/8 × 13 1/8
LRS-59	16 1/2	19	6 5/8 × 4 7/8 × 13 25/32

OPTIONS

AC Input

Add Suffix[1]	For Operation at:	Price
−V (LRS-55, 56 only)	185 to 265VAC 47-440Hz	12%
−M (LRS-52, 53, 54 only)	95 to 132VAC or 187 to 265VAC, 47-440Hz (customer selectable)	12%

[1] Add Suffix after package number, i.e.: LRS-55V-5, LRS-52M-5.

ACCESSORIES
Rack Adapters (LRA-14, LRA-15, LRA-17) and cable system available.

FINISH
Grey, Fed. Std. 595, No. 26081.

GUARANTEED FOR 5 YEARS
Five year guarantee includes labor as well as parts. Guarantee applies to operation at full published specifications at end of 5 years.

UL/CSA
UL Recognized. CSA Certified. LRS-49, 50, 51, 57, 58, 59 under evaluation.

TUV LICENSED
110/220 and 220 input versions. LRS-49, 50, 51 under evaluation.

GOOD TIMES ARE GETTING BETTER FOR THE 386

NEW YORK

These are heady days for the Intel Corp. 80386 microprocessor family. First, Intel is giving the family a big push by unleashing a new chip, the 80386SX, designed to boost development of low-cost personal computers. Then, on June 20, the world's two biggest makers of PCs announced new 386-based computers. Compaq Computer Corp., the reigning champ in 386-based PCs, came out with a new high-performance machine. IBM Corp. showed the world its first desktop 386 Personal System/2 models using the advanced full-blown 32-bit 386. And to add to the harvest, Weitek Corp. brought out a single-chip floating-point coprocessor to bolster 386-machine performance.

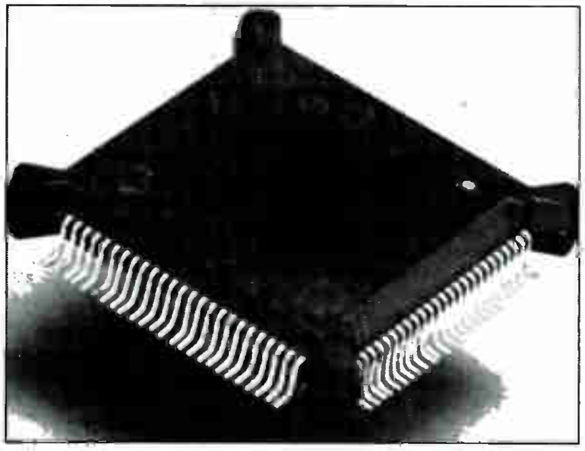
These developments add to the already staggering potential for 386-based growth. Personal computers based on the 386 will make up only 8% of the $17 billion PC market this year—but by 1991 their share will increase dramatically to 67%, according to Future Computing/Datapro, the Dallas-based research firm. And that's not counting the add-on business. For example, also on June 20, NCR Corp. quickly announced 386SX-based board-level products; a flock of other companies followed.

On the one hand, 386SX-based machines will provide great strides in price/performance. On the other hand, top-end technology is moving 386 machines into work-station, minicomputer, and even some mainframe territories.

With the coming of Intel's 80386SX processor, a lower-cost, scaled-down version of the 386, less-costly 386-based computers will enter the market. They will be completely software-compatible with full-386 systems. So the new chip will enable a new class of users to take advantage of the full range of software being generated for the advanced mainframe-like architecture of the 386. Up to now, it was reserved to the so-called power users, those working with the top-of-the-line work stations and computers.

SIMILARITIES. The Intel 386SX processor has the same 32-bit internal architecture as the 386 with a 16-bit external data bus and 24-bit addressing. The 16-bit data bus allows development of cost-effective computers not only because of the lower cost of the chip ($219, versus $299, in lots of 100), but also because of the reduced component counts and smaller board space.

The first computer available in this category of more affordable 386 PCs is the Compaq Deskpro 386s, designed to sell for less than $4,000. The original Deskpro 386 was in the $10,000 class. The 386s family, which comes in three models initially, is small because of new integration and packaging. Compaq VGA graphics capability is integrated on the systems board. Industry insiders rate the new machine highly, and agree that it will help Compaq stay ahead as the leading supplier of 386 machines.



Intel's 80386SX, a scaled-down version of the 80386, promises to bring power computing to users of lower-cost PCs.

Not satisfied with something for the bottom of the line, Compaq also has a new machine at the top: the Deskpro 386/25, using the 25-MHz 386. It faces IBM's new PS/2 model 70 product line, an upgrade to its year-old PS/2 line that puts 386 power in small-footprint desktop models. IBM announced that its most powerful model 70 would use the new 25-MHz 386.

One big difference between the top-of-the-line Compaq and IBM models is that Compaq's is being shipped now and IBM's is scheduled for September. In addition, the Compaq engineers expect that their machine will prove capable of outperforming IBM's machine when it is available for benchmark tests.

But Compaq hasn't stopped there. For the most performance-hungry power users, it teamed with Weitek to offer a powerful option for high-speed numerical computation in the form of Weitek's new single-chip version of its 1167 chip set. The level of floating-point performance delivered by the new $2,599 Abacus chip can move 386 PC performance into the range of work stations. The Abacus is designed to plug into the Extended Math Coprocessor socket that many 386 PC manufacturers are now installing. *–Tom Manuel*

COMPUTERS

'SILVERLAKE' LOOKS GOOD: CAN IT END IBM MIDRANGE WOES?

NEW YORK

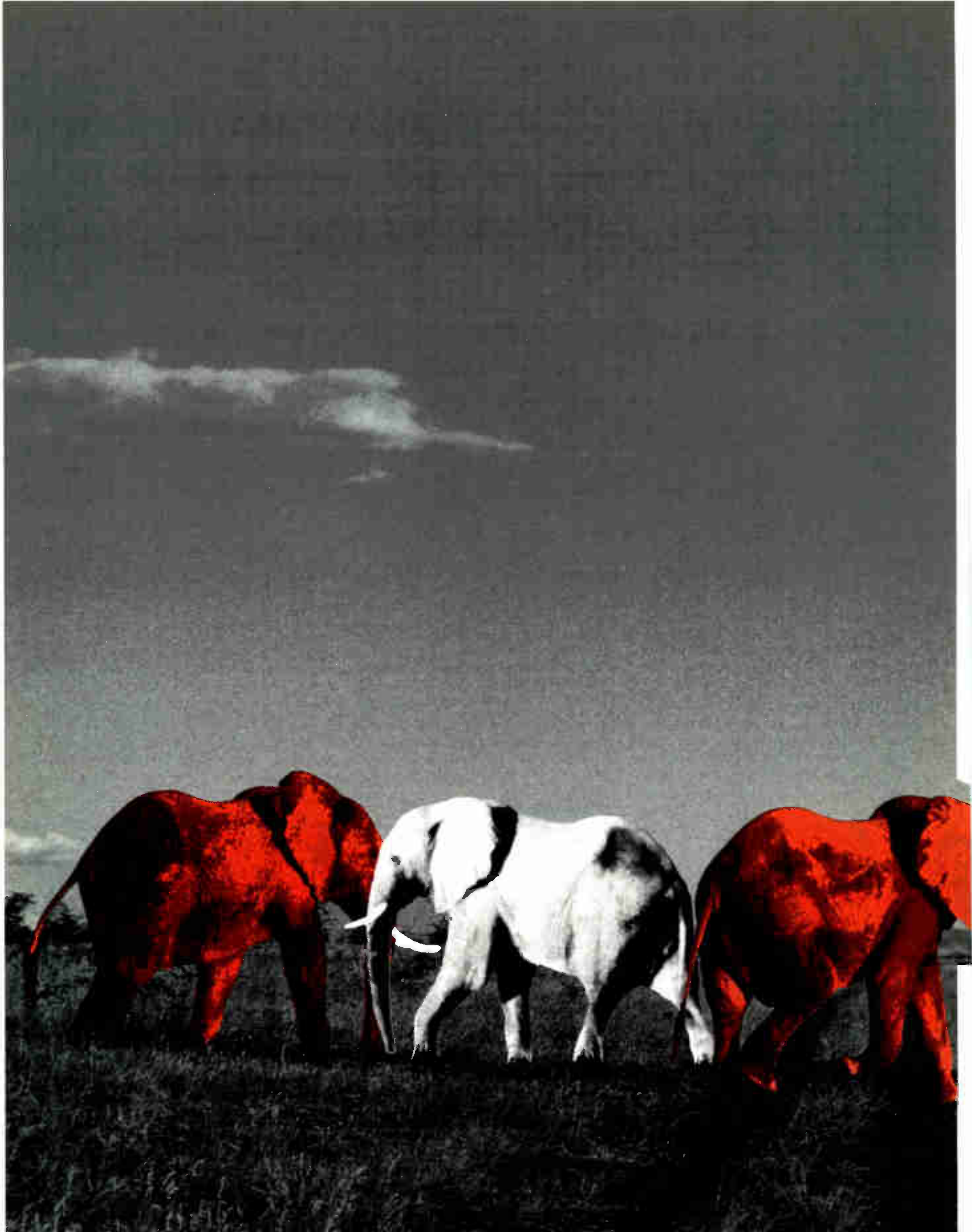
The long-awaited "Silverlake" upgrade for IBM Corp.'s midrange System/36 and 38 computer line is off to a running start: introduced in late June, it will start popping up in customer sites around the world next month. Now the big question is whether the new IBM Application System/400 can reverse IBM's declining market share in midrange machines.

The Armonk, N.Y. computer giant sorely needed two things for its System/3X customer base: a performance upgrade path to its top-of-the-line systems and closer connectivity to other IBM systems, such as personal-computer work stations and mainframes. That lack of connectivity across product lines has been costing it business, lost to midrange specialists such as Digital Equipment Corp.

The six models in the new line answer both needs. The AS/400 architecture and the OS/400 operating system are significant advancements in system technology for ease of use and connectivity—and they're designed to provide an easy migration path for both S/36 and S/38 application programs. Applications do have to be ported to run under OS/400 on the AS/400, but the company claims that it is relatively easy to do.

The new line is a potent weapon, says Michael J. Geran, computer analyst at Nikko Securities International in New York. "It's price/performance-competitive; it's scalable; it provides enough growth for those guys with System/38s that are running out of gas," he says. "And, unlike the 9370, this thing is being introduced with 1,000 software package and will have 2,500 by the fall."

All this muscle could spell trouble for DEC, which stands to be hurt badly if users flock to the AS/400 systems. But



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We are the world leader in CMOS and NMOS static RAMs. We make fast 2Kx8, 4Kx4 and 16Kx4 static RAMs – all at 25 ns! And a 1Mb VSRAM at 100 ns. We also offer 64Kx1, 8Kx8, 8Kx9 (at 35 ns) and industry standard 32Kx8 CMOS static RAMs.

But we make a lot more than static RAMs. The chart shows we have a complete line of DRAMs and EPROMs with a high density 1Mb EPROM and one-time programmables. And they are all in volume production today.

Tradition of being first.

We were also the first to introduce the 1Mb DRAM and we're now the market leader. We were one of the first suppliers of 256K CMOS static RAMs. We were a leader with the 256K ROM and within a year of introduction, we shipped more than all other suppliers combined. And we are matching that with our 1Mb CMOS mask ROM.

So you can see that we have the capability to supply the memory products you want – when you want them.

TOSHIBA. THE POWER IN MEMORIES.

TOSHIBA AMERICA, INC.

TOSHIBA MEMORY PRODUCT SUMMARY

PART NO.	ORG.	PROCESS	SAMPLES	PROD.	SPEED SORTS AVAILABLE (ns)	PKG OPTIONS & COMMENTS
DYNAMIC RAMS						
TC511000P/J/Z	1MbX1	CMOS	YES	YES	85 100 120	P/J/Z
TC511000AP/AJ/AZ	1MbX1	CMOS	04'88	05'88	70 80 100	P/J/Z
TC511001P/J/Z	1MbX1	CMOS	YES	YES	85 100 120	P/J/Z
TC511001AP/AJ/AZ	1MbX1	CMOS	04'88	05'88	70 80 100	P/J/Z
TC511002P/J/Z	1MbX1	CMOS	YES	YES	85 100 120	P/J/Z
TC511002AP/AJ/AZ	1MbX1	CMOS	04'88	05'88	70 80 100	P/J/Z
TC514256P/J/Z	256KX4	CMOS	YES	YES	85 100 120	P/J/Z
TC514256AP/AJ/AZ	256KX4	CMOS	04'88	05'88	70 80 100	P/J/Z
TC514266AP/AJ/AZ	256KX4	CMOS	04'88	05'88	70 80 100	P/J/Z
TC514258P/J/Z	256KX4	CMOS	YES	YES	85 100 120	P/J/Z
TC514258AP/AJ/AZ	256KX4	CMOS	04'88	05'88	70 80 100	P/J/Z
TC514268AP/AT/AZ	256KX4	CMOS	04'88	05'88	70 80 100	P/J/Z
TC524256P/J/Z	256KX4	CMOS	YES	2Q'88	100 120	P/J/Z
TC524257P/J/Z	256KX4	CMOS	YES	2Q'88	100 120	P/J/Z
TC521000P	256KX4	CMOS	YES	YES	N/A	P
TC41000L	1MbX4	CMOS	06'88	07'88	70 80 100	L
THM81000S/L	1MbX8	CMOS	YES	YES	85 100 120	S/L
THM91000S/L	1MbX9	CMOS	YES	YES	85 100 120	S/L
THM91020L	1MbX9	CMOS	02'88	04'88	70 80 100	L
THM8512L	512KX8	CMOS	YES	YES	85 100 120	L
STATIC RAMS						
TMM2064AP	8KX8	NMOS	YES	YES	70 100 120	P28 600mil DIP
TMM2063AP	8KX8	NMOS	YES	YES	70 100 120	P28 300mil DIP
TC5565APL	8KX8	CMOS	YES	YES	100 120 150	P28 600mil DIP 4T Cell
TC5565AFL	8KX8	CMOS	YES	YES	100 120 150	SOG28 4T Cell
TC5563APL	8KX8	CMOS	YES	YES	100 120 150	P28 300mil DIP 4T Cell
TC5564APL	8KX8	CMOS	YES	YES	150 200	P28 6T Cell Ultra Low Power
TC5564AFL	8KX8	CMOS	YES	YES	150 200	SOG28 6T Cell Ultra Low Power
TC55256PL	32KX8	CMOS	01'88	06'88	(85) 100 120	P28 6T Cell Ultra Low Power
TC55256FL	32KX8	CMOS	01'88	06'88	(85) 100 120	SOG28 6T Cell Ultra Low Power
TC55257APL	32KX8	CMOS	YES	YES	85 100 120	P28 4T Cell Low Power
TC55257AFL	32KX8	CMOS	YES	YES	85 100 120	SOG28 4T Cell Low Power
TC51832PL	32KX8	CMOS	YES	YES	85 100 120	P28 Pseudo Static
TC51832SPL	32KX8	CMOS	YES	YES	85 100 120	P28 300mil DIP
TC51832FL	32KX8	CMOS	YES	YES	85 100 120	SOG28 Flat Pack
TC518128P	128KX8	CMOS	YES	03'88	100 120	P32 Pseudo Static
TC518128P	128KX8	CMOS	YES	03'88	160 190	P32 Virtually Static
HIGH SPEED STATIC RAMS						
TMM2018AP	2KX8	NMOS	YES	YES	25 35 45	P24
TMM2068AP	4KX4	NMOS	YES	YES	25 35 45	P20
TMM2088P	8KX8	NMOS	YES	YES	35 45 55	P28
TMM2089P	8KX9	NMOS	YES	YES	35 45 55	P28
TC5561P	64KX1	CMOS	YES	YES	55 70	P22 4T Cell Low Power
TC5561J	64KX1	CMOS	YES	YES	55 70	SOJ24 4T Cell Low Power
TC5562P	64KX1	CMOS	YES	YES	35 45 55	P22 4T Cell Low Power
TC5562J	64KX1	CMOS	YES	YES	35 45 55	SOJ24 4T Cell Low Power
TC55416P	16KX4	CMOS	YES	YES	25 35 45	P22
TC55416J	16KX4	CMOS	YES	YES	25 35 45	SOJ24
TC55417P	16KX4	CMOS	YES	YES	(20) 25 35 45	P24 OE
TC55417J	16KX4	CMOS	YES	YES	(20) 25 35 45	SOJ24 OE
EPROMS						
TMM2764AD~	8KX8	NMOS	YES	YES	150 200	D
TMM2764ADI	8KX8	NMOS	YES	YES	150 200	D
TMM27128AD~	16KX8	NMOS	YES	YES	150 200	D
TMM27128ADI	16KX8	NMOS	YES	YES	150 200	D
TMM27256BD~	32KX8	NMOS	YES	YES	150 200	D
TMM27256BDI	32KX8	NMOS	YES	YES	150 200	D
TC57256AD	32KX8	CMOS	YES	YES	120 150 200	D
TMM27512AD~	64KX8	NMOS	YES	YES	200 250	D
TMM27512ADI	64KX8	NMOS	YES	YES	200 250	D
TC571000D	128KX8	CMOS	YES	YES	170 200	D
TC571001D	128KX8	CMOS	YES	YES	170 200	D
TC571024D	64KX16	CMOS	YES	03'88	200	D
ONE TIME PROGRAMMABLES						
TMM2464AP/AF	8KX8	NMOS	YES	YES	200	PF
TMM24128AP/AF	16KX8	NMOS	YES	YES	200	PF
TMM24256BP/BF	32KX8	NMOS	YES	YES	170 200	PF
TC54256AP/AF	32KX8	CMOS	YES	YES	200	PF
TMM24512AP/AF	64KX8	NMOS	YES	YES	250	PF
TC541000P	128KX8	CMOS	YES	YES	200 250	P
MASK ROMS						
TC53257P/F	32KX8	CMOS	YES	YES	200	F, P28
TC531000AP/AF	128KX8	CMOS	YES	YES	200	F, P28
TC534000P	512KX8	CMOS	YES	YES	200 250	P32

P = PLASTIC C = CERAMIC F = FLAT PACK D = CERDIP Y = DIE T = PLCC J = SOJ L = LEADED MODULE
Z = ZIP *CMOS = 4 TRANSISTOR CELL LOW POWER ~ = ±10% Vcc AVAILABLE S = SOCKET MODULE
* = SELECTABLE SPEED SORT AVAILABLE = IN DEVELOPMENT

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Circle 41 on reader service card

executives at the Maynard, Mass., company say it has stout defenses, with a more compatible and flexible solution, at a lower total cost of ownership, for these users in its VAX and MicroVAX product lines.

"Users in the System/36 and System/38 space are very sensitive to cost, and here [in moving to the IBM AS/400 systems] they have to bear the cost of migration," says Gary Hoppe, manager of U. S. sales consultants at DEC. "There is no such cost for users of Digital VAX VMS systems."

GOING STRONG. And DEC argues that it has had connectivity and communications up and down its product line for 15 years. "We have a mature network product in DECnet," says Hoppe. What's more, he says, "we have an experienced sales and support staff to back it, while the other people are new at dealing with connectivity."

DEC can be expected to make the most out of the fact that Big Blue, saddled with multiple incompatible operating systems, saw the need to create yet another one in its move toward compatibility. Yet, given the new AS/400 architecture, IBM is probably doing the best it can under the circumstances.

Those circumstances are truly daunting. It is estimated that there are more than 8,000 application programs for the more than 300,000 System/3Xs installed worldwide. And IBM and a host of global business partners have announced that some 2,500 software packages will be ready for the AS/400 by the time the first systems are available in August. But there is still a long way to go to get all current applications converted; that's why the AS/400 package includes migration aids. IBM software engineers have built a lot of services and functions into the OS/400. Within the operating system are a relational data-base management scheme, communication capabilities, a training package, and system service support. Also included are graphics, imaging, and security support.

On the architecture side, the AS/400 maintains the large 48-bit address space of the System/38, which allows all storage—whether in main memory or on disk—as one directly addressable 281-trillion-byte space. This means that storage management is handled by the system, making programming and running applications much simpler. The large address allows programs of effectively unlimited size. *–Tom Manuel*

MILITARY

THEY'RE FINALLY HERE: SAW DEVICES THAT CAN FLY

LEXINGTON, MASS.

Makers of airborne radars have been longing to use surface-acoustic-wave resonator oscillators in their systems. SAW oscillators work better and take up less room than the bulk acoustic-wave oscillators now used, but they have one big disadvantage: they can't fly. They're too vulnerable to vibration to be used in planes or missiles.

But now engineers at Raytheon Co. have come up with a hermetically sealed all-quartz package, laser-tuned after sealing, that effectively removes that barrier and opens a world of airborne jobs to the devices.

The Raytheon advance means that it is now possible to make SAW oscillators "that are comparable to or better than bulk-wave oscillators in vibration sensitivity, and their size now becomes a great advantage," says Thomas Parker, principal scientist in Raytheon's Research Division, Lexington, Mass.

Ground- and ship-based radars incorporating SAW parts detect moving targets at greater range than can radars using the bulk alternatives. The SAW-based radars can also better identify smaller moving targets in the presence of clutter.

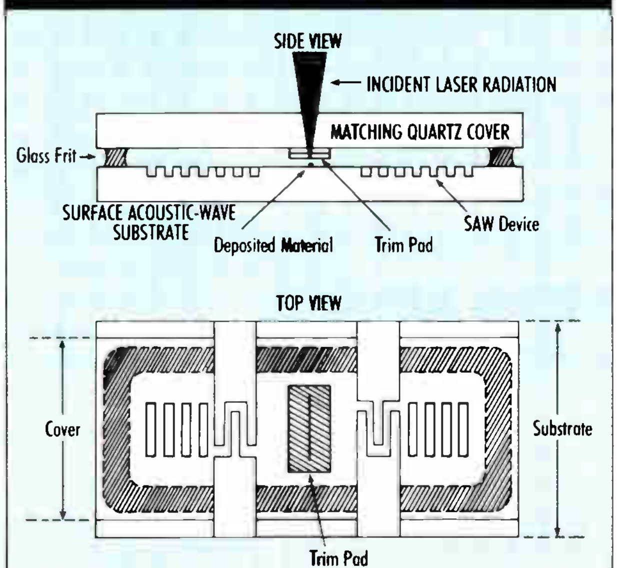
And their circuitry is simpler, which translates into less space and weight. SAW oscillators need fewer components because less frequency multiplication is required to reach the desired frequencies in the C band (5 GHz) or X band (10 GHz), says Parker. Parker and Joseph Callerame, manager of the Research Division's Stable Sources Laboratory, explain that bulk oscillators have to be multiplied by a factor of about 2,000 to reach X band; a SAW oscillator, in contrast, requires only 20-times multiplication. Callerame says that more multiplication also means more noise in the system—by the amount of the multiplication factor squared.

WITHSTANDING VIBRATION. But vibration sensitivity put those advantages out of reach until Raytheon's developers went to work. Vibration typically degrades phase noise, which is undesirable, Callerame says. Thanks to the new package, "we're getting about an order of magnitude improvement in vibration sensitivity," he says, pointing out that the improvement corresponds to 20 dB less degradation in phase noise than possible with other packages. And Callerame believes Raytheon's techniques can be refined to produce another factor-of-10-improvement—meaning another 20 dB less potential phase noise degradation.

The two-piece all-quartz package has the SAW substrate on the bottom of a sandwich (see figure) that's sealed together in a vacuum chamber by means of a glass frit. The substrate and cover are made of identically oriented single-crystal quartz, with each measuring 0.6 in. long by 0.5 in. wide. The substrate is 0.035 in. thick; the cover is slightly thinner to allow electrical connections to the exposed busbars (black stripes) of the SAW device transducers.

The high temperatures and stresses associated with sealing can slightly alter the oscillator frequency. But the clear quartz package permits a laser to tune the device to the precise frequency required in the oscillator after sealing. Raytheon deposits a trim pad that is a sandwich of aluminum and aluminum-oxide on the inside of the quartz cover and trims it by zapping with ultraviolet light from an excimer laser. A precise frequency is thus achieved—to within one part per million of the specified frequency, Callerame says.

ALL-QUARTZ PACKAGE IS KEY



Raytheon has developed prototype SAW devices for the ground-based radar in the Patriot air-defense system; in production are parts for Raytheon's Hawk air-defense system as well as for the shipboard Tartar radar. *–Lawrence Curran*

INTERNATIONAL NEWSLETTER

TOSHIBA HEADS TO MARKET WITH CMOS 256-KBIT FLASH EEPROMs

Toshiba Corp. is raising the stakes in flash EEPROMs with a low-power CMOS 256-Kbit flash part that should be in volume production by September. Flash parts, high-density variants of electrically erasable programmable read-only memory, are expected to challenge ultraviolet erasable PROMs in their large market because they can compete in density while offering the application flexibility of in-circuit electrical erasability and programmability [*Electronics*, March 3, 1988, p. 47]. Industry projections have the market for flash EEPROMS exploding from next to nothing this year to $1 billion in the early 1990s. Semiconductor heavyweights Hitachi, National Semiconductor, and Texas Instruments are all working on products to compete with those from Tokyo-based Toshiba, Intel Corp. of Santa Clara, Calif., and Seeq Technology Inc., San Jose, Calif. Toshiba's new 1.2-μm, triple-layer-polysilicon CMOS parts cut die size and power consumption compared to the nMOS parts it has had on the market since last November. Operating current is only 30 mA for the TC5825AP/AF, which is organized as 32-K by 8 bits and will come in 170-, 200-, and 250-ns versions. Sample shipments are scheduled to begin in July at $50 in 28-pin plastic DIPs and $55 in plastic flat packs. □

MOTOROLA-TOSHIBA PLANT STARTS TURNING OUT CHIPS . . .

A year and a half after Motorola Inc. and Toshiba Corp. made history with their agreement to jointly produce semiconductors, their new plant in Sendai, Japan, has started turning out chips. Rolling off the lines at the $300-million facility are 1-Mbit dynamic random-access memories and 256-Kbit static RAMs based on Toshiba designs and Motorola-developed 8- and 16-bit microprocessors. In the future, the plant's 3-million-chip-per-month capacity will be used to produce 4-Mbit DRAMs from Toshiba designs and 32-bit Motorola microprocessors, say executives of the joint venture company that manages the plant, Tohuku Semiconductor Corp. The agreement between the two giants caused a stir in the international semiconductor industry when it was disclosed in late 1986, and was seen at the time as a winning deal for both players [*Electronics,* Dec. 18, 1986, p. 33]. In addition to access to each company's manufacturing and design technology, the deal gave Motorola improved access to the air-tight Japanese market, and gave Toshiba rights to Motorola's expertise in microprocessor technology. Now, if the deal proves to work in practice as well as it does on paper, the two companies may have another agreement to announce: a similar arrangement covering the U. S. market and, perhaps, a second shared plant. □

. . . AS SIEMENS PUMPS 1-MBIT DRAM PRODUCTION UP TO 1 MILLION UNITS A MONTH

While Toshiba and Motorola are getting their new chip plant up and running, Siemens AG is cranking up production of 1-Mbit dynamic random-access memories at its memory plant in Regensburg, West Germany. Siemens says production of 1-Mbit chips, which has caused trouble for chip makers the world over as they've struggled to drive yields to reasonable rates, is going so well that it is now revising its output projections for the year. Since January, when deliveries began, Seimens has sold some 1.5 million units to such major players as IBM Corp., and the company expects to turn out another 2 million units by the end of September. That will put Siemens 1.5 million units over its original schedule heading into the fourth quarter, when company officials expect production to reach 1 million chips per month. Siemens attributes the strong showing and high yields in part to intensive worker training, and officials say similar results have been achieved at the company's Villach, Austria, plant, where 256-Kbit chips are fabricated. This year that plant will triple its 1987 output of 6 million devices. □

INTERNATIONAL NEWSLETTER

NOW HITACHI AND MITSUBISHI HAVE A CHIP SET FOR HIGH-RESOLUTION TV

Improved definition TV is picking up steam in Japan. Hitachi Ltd. and Mitsubishi Electric Corp. will begin marketing a jointly developed IDTV chip-set in August for about $214. And by fall, each will be selling TVs incorporating the new chips into the Japanese market. The seven-chip set—Hitachi builds four, Mitsubishi three—works in conjunction with analog-to-digital and digital-to-analog converters, line memories, and 11 Mbits of random-access memory. And with the addition of other chips next spring, it will meet the emerging standard for enhanced-definition TV. Like a similar chip set and receivers announced by NEC Corp. last winter [*Electronics*, Dec. 17, 1987, p. 118], the Hitachi-Mitsubishi collection offers an improved picture by providing noninterlaced scan and better color separation using the broadcast TV standards now used in the U. S and Japan. EDTV, however, which Japan's Ministry of Posts and Telecommunications is trying to standardize, will require a change in broadcast equipment and cameras. □

EUROPEAN MATERIALS MAKER TAKES A RARE STEP—IT SETS UP SHOP IN JAPAN

A West German company is turning heads in Japan, where it's setting up shop in a research park in Tsukuba. Degussa AG of Frankfurt, which specializes in precious-metal products for the electronics industry, is settling in the Tsukuba park, near Tokyo, and will start production there next year. It's hoping the move will improve its sales of sputter targets—high-purity materials used for making ultrathin coatings—as well as powders and pastes containing precious metals for use in electronics. The intent is to provide better customer service and application support, which the Japanese value highly. Degussa will put up application labs and a production facility on a 300,000-ft^2 site, investing about $12 million. □

FAST-GROWING MARKET BECKONS, SO COMPAQ SPEEDS UP SCOTLAND PLANT EXPANSION

The personal-computer business in Europe is so good—growing at a 14% compounded rate—that Texas-based Compaq Computer Corp. is rushing to raise its stake. The world's No. 1 maker of 80386-based personal computers, Compaq is pushing ahead the scheduled expansion of its European manufacturing capacity by a year. The original plan called for it to double the size of its facility at Irskine in Scotland to 256,000 ft^2 during 1989. But now it will open the addition in September. In the UK alone, the PC market is increasing at a 20% annual pace, says Joe McNally, Compaq's UK managing director. Compaq's target: to maintain dominance in the market for 80386-based machines, where British corporations spent about $42.5 million last year. □

HITACHI LAUNCHES A HIGH-PERFORMANCE 8/16-BIT MICROCOMPUTER

Hitachi Ltd. is coming to market in July with a new high-performance single-chip microcomputer that it says is the fastest in its class. The H8/532 can execute instructions in as little as 200 ns, running on a 10-MHz clock, thanks to its internal 16-bit bus. But on the outside, the chip looks like an 8-bit processor, so it can be used in traditional 8-bit applications where 16-bit performance is needed. The 1.3-μm CMOS chip comes with 1-Kbyte of random-access memory and 32-Kbytes of read-only memory, which comes in three forms: mask-programmable ROM, windowless electrically programmable ROM, or an EPROM with a quartz window. The part will be launched in the Japanese market and will probably make it to U. S. shores in the fall. But with a well-entrenched base of U. S. vendors, including Intel, National Semiconductor, and Motorola, dominating the microcomputer market, Hitachi's new part isn't likely to win much U. S. market share. □

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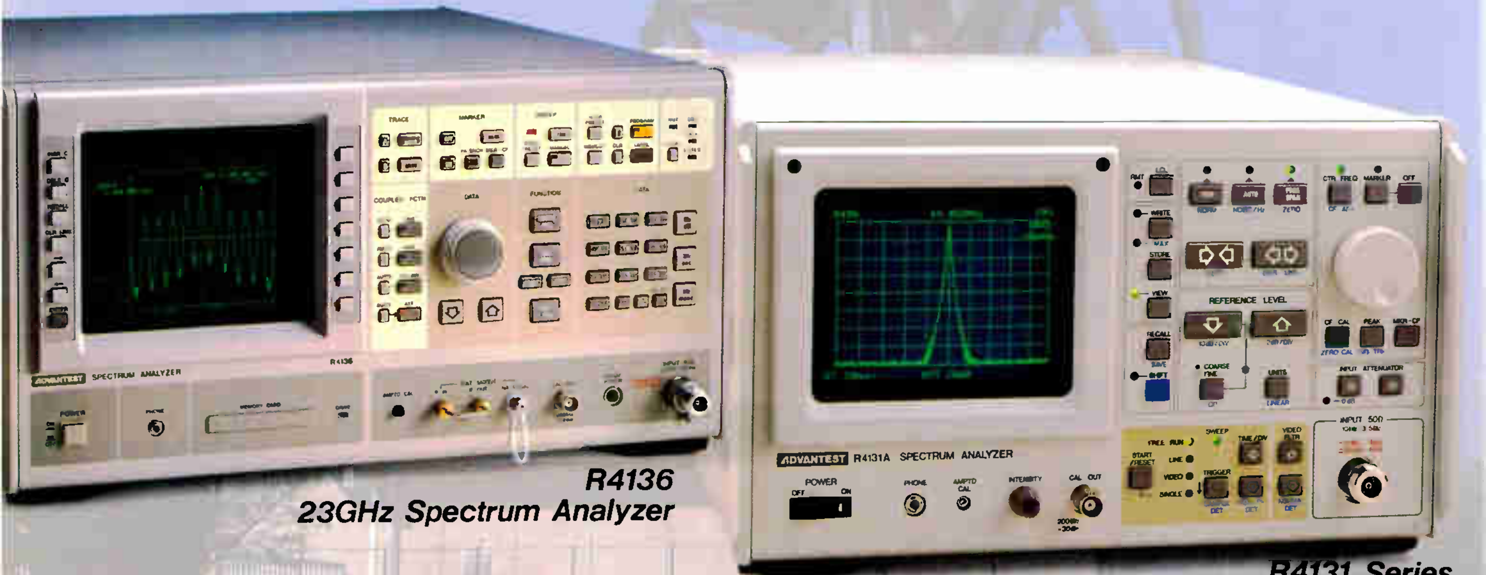

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INTERNATIONAL

NEC LAB AIMS FOR LOW-COST WAY OUT OF CROWDED RADIO SPECTRUM

Modified GaAs technology could replace hybrids with a monolithic receiver front end

KAWASAKI, JAPAN

Engineers at NEC Corp.'s Microelectronic Research Laboratories are developing a new gallium arsenide technology to reduce fabrication costs of devices for communications equipment that operates above 10 GHz—an attractive spectrum for a variety of applications because the spectrum there is less crowded. Present solutions at these frequencies now require hybrid IC alternatives, which is a costly, labor-intensive technology.

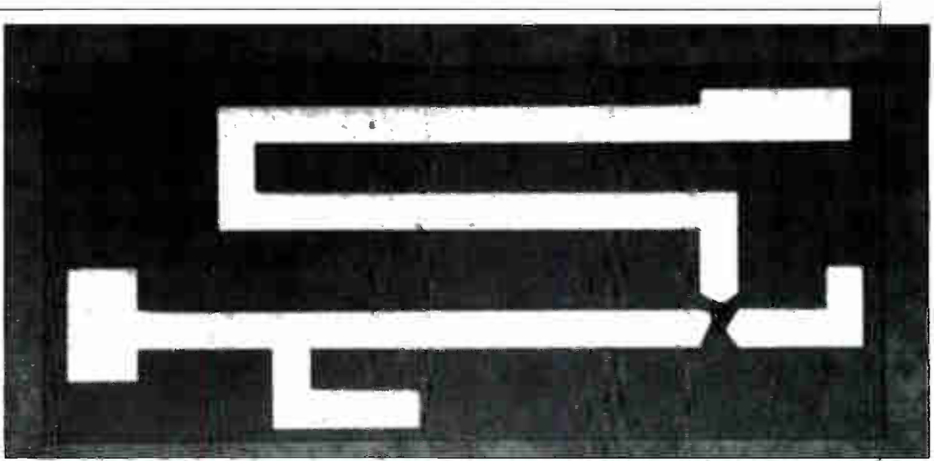
Devices with more than 10-GHz performance are needed for a wide variety of systems ranging from direct-broadcast satellite TV receivers and radar systems to futuristic wristwatch personal communications systems.

NEC's engineers are working on a GaAs/aluminum-GaAs self-aligned heterojunction bipolar transistor, which will be used in low-noise oscillators. The move to GaAs/aluminum-GaAs heterojunction devices and away from GaAs field-effect transistors is necessary because GaAs FETs make noisy oscillators and must be modified with hybrid components.

Researchers say their experiments show that a heterojunction-device oscillator operating in the 15-GHz band tuned only by aluminum lines on the chip develops less than 1/300th of the phase noise of an oscillator implemented with GaAs FETs. They expect similar results throughout the microwave and millimeter-wave bands.

In the future, the heterojunction devices will make implementation of a complete receiver front end—including radio-frequency amplifier, mixer, and local oscillator on a chip—for direct broadcast satellite or other receivers. The device is tuned to an approximate frequency by positioning a bonding wire on an aluminum tuning line on the chip. It is fine-tuned by shifting bias voltage.

Early experimental heterojunction devices that were developed by NEC have a cutoff frequency of 47 GHz and a maximum frequency of oscillation of almost 30 GHz, the start of the millimeter wave band. But cutoff frequency and maximum frequency of oscillation have only a loose correlation, and NEC expects to push the oscillation frequency above 100 GHz by reducing the stray capacitance.



Bipolar heterojunction transistors based on GaAs technology and connected with aluminum strips boost the performance of monolithic receiver front ends above 10 GHz.

Heterojunction devices solve the problem that causes GaAs FETs to be noisy oscillators: the large surface areas they have between source and gate—and between gate and drain—generate low-frequency noise that modulates the oscillator and causes phase instability. The end result is that using GaAs FETs necessitates a hybrid-IC configuration with a ceramic resonator. Moreover, the resonator at these frequencies measures about 10 mm in diameter by 4 mm thick. Above 20 GHz precise placement and adjustment becomes a serious problem.

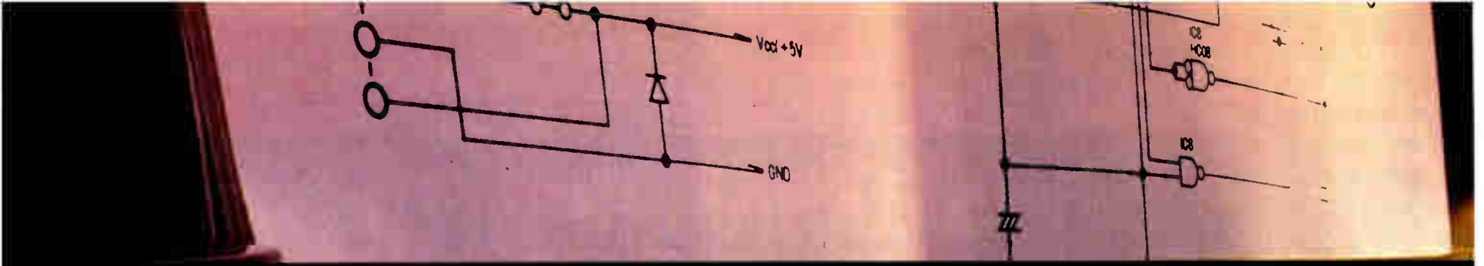
WON'T FIT. The ceramic resonators won't fit in a wristwatch radio, for example, says Kazuhiko Honjo, research manager in NEC's Ultra-high-speed Device Research Lab., Microelectronics Research Laboratories. A more immediate consideration for eliminating the ceramic resonators is cost. Honjo says that at the present modest rate at which microwave equipment is made, the labor-intensive fabrication of hybrid circuits is acceptable. But when the demand increases to millions per month more automated production methods are required.

For systems using the heterojunction device oscillators, frequency is stabilized using a phase-locked loop that includes a frequency-divider circuit and a 10-MHz crystal as the reference. The critical frequency-determining component now operates at a relatively low radio frequency that manufacturers have learned to handle easily.

Initially, Honjo says, systems will be built with a GaAs heterojunction device incorporating tuning elements as the oscillator and another chip with two GaAs FETs as the rf amplifier and mixer. GaAs FETs provide excellent performance in these functions. In the future, selective epitaxial techniques will be used to fabricate the entire front end of a single heterojunction device and two FETs on a single chip, he adds.

Silicon bipolar transistors have been used as oscillators in some applications and have much lower noise levels than GaAs FETs. Unfortunately, silicon bipolar transistors only oscillate to about 8 or 10 GHz. Frequency doubling—or higher-order multiplication—brings the frequency up to the range of interest, but each stage of the multiplication increases the noise level by 6 dB.

In logic devices, heterojunction bipolar transistors have much greater current derivability than FETs, leading many observers to expect the future emergence of heterojunction-FET devices as the GaAs analog of silicon BiCMOS. Experimental heterojunction device gates have a propagation delay of 9.5 ps.—*Charles L. Cohen*



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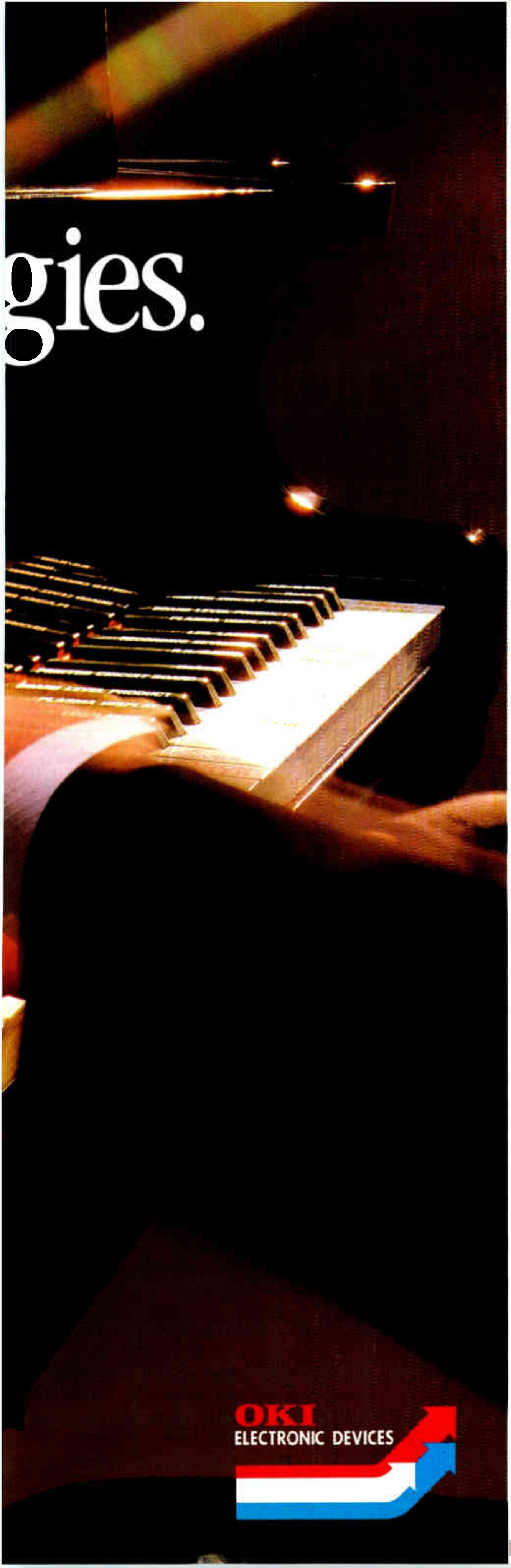

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Tokyo, Japan

Circle 49 on reader service card

NEURAL COMPUTERS

COPROCESSOR PUTS JAPAN IN NEURAL COMPUTER RACE

TOKYO

The select group of vendors chasing the nascent market in neural-computer coprocessor boards just got another contender—and this one is from Japan.

Like its main U. S. competition, NEC Corp.'s Neuro Engine accelerator board plugs into machines running Microsoft Corp.'s MS-DOS and has accompanying software written in C. Since benchmarking neural processors is far from an agreed-upon science, specific comparisons are hard to come by. But NEC's board appears to offer higher performance than Hecht-Nielson Corp.'s Anza board while falling short of the San Diego, Calif., company's second product, the Anza Plus [*Electronics*, Feb. 4, 1988, p. 133].

Price comparisons are also problematic, because the software and hardware options vary widely, depending on the application. The basic Neuro Engine board will sell for $1,440; software that includes both MS-DOS execution files and utilities, and also C library files for more rigorous programming, is $4,000.

Although introduced with considerable fanfare late June, the Neuro Engine board will not be available until December and is not expected to be a big seller initially. NEC is still sorting out strategic application areas for the board, which mimics the massively parallel architecture of the human brain. NEC is estimating 500 to 1,000 sales during its first year.

In fact, corporate sources indicate that most of the marketing thrust will be in exploring applications. The company will attack that problem in house and in concert with its customers. Two prime areas are voice and optical character recognition, and NEC will offer selected alphanumeric OCR components including sensors and software to aid third-party developers. Value-added resellers and software houses are also expected to develop applications.

For the right applications, performance gains over conventional processors are impressive. NEC engineers say that for certain classes of problems, their board provides performance superior to superminicomputers at about one-hundredth the cost. Among potential areas of use are expert systems in medicine, machinery diagnostics, and evaluation of loan applications.

SELF STARTERS. Besides their massively parallel computing architecture, neural systems offer the significant advantage of creating their own software. This makes them useful in tasks for which it may be almost impossible to write a procedural program. Neural computers program themselves through a process in which the computer generates its own rules and then refines them during repeated iterations.

Offering 512 Kbytes of memory, the accelerator board includes four NEC ImPP pipelined data-flow microprocessors developed originally for image processing and operating at a clock cycle of 200 ns. The ImPP processors are used in pairs, with one chip doing address computation while the other does data computation. *–Charles L. Cohen*

DATA COMMUNICATIONS

WILL RACAL'S UK DATA NET SPARK A TREND?

LONDON

A radical restructuring of Europe's telecommunications landscape may be in the offing if the UK's latest move into privatization takes root and grows.

In a role-switching deal unique in Europe, a private UK company—the Racal Data Group (Europe) Ltd.—has been selected to install a packet-switching network and then sell the services to the government.

When completed, the Government Data Network will be one of the largest packet-switched data-communications network in Europe, ultimately serving about 350,000 terminals located in 7,000 civilian administration offices throughout the United Kingdom. Racal will put up all the cash for its construction and installation, recouping its investment from traffic revenues.

Tim Holley, chairman of Racal Data Group (Europe) Ltd., says the company is expecting 10-year cumulative revenues of more than £1 billion to accrue from the network, against an investment for the network infrastructure of approximately £50 million over the next decade.

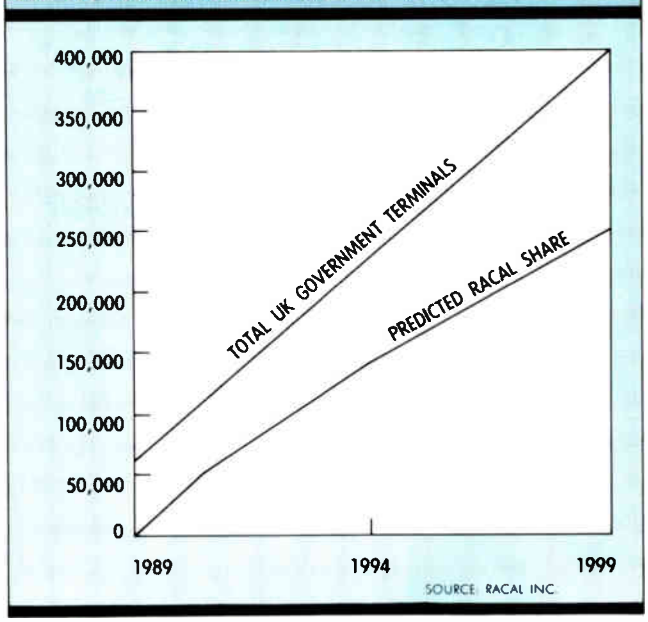
The network will operate on a "pay as you use" basis with a scale of tariffs that has already been set. Holley would not reveal details of the tariffs, but predicts that the government will "save at least 30% compared with the cost of using public services."

Winning the contract also marks the beginning of a transition phase for the Racal Group: "It's a major milestone in our migration from products to services," says Holley, who has also laid plans for more service-structured business. Racal has targeted winning at least 10% of the worldwide market for managed networks and associated value-added services, he says.

A new company, Racal Data Networks Ltd., has been formed to act as prime contractor and network operator. Government departments using the GDN will pay a fixed fee for access plus volume-dependent traffic charges.

Additional revenue will be generated from a range of other services such as electronic mail, digital facsimile, information services, and electronic document interchange. Government sources estimate that 400,000 terminals could be in use by the end of the next decade; however Racal has calculated its potential revenue on the more conservative figure of 250,000. *–Peter Fletcher*

A BIG MARKET FOR RACAL



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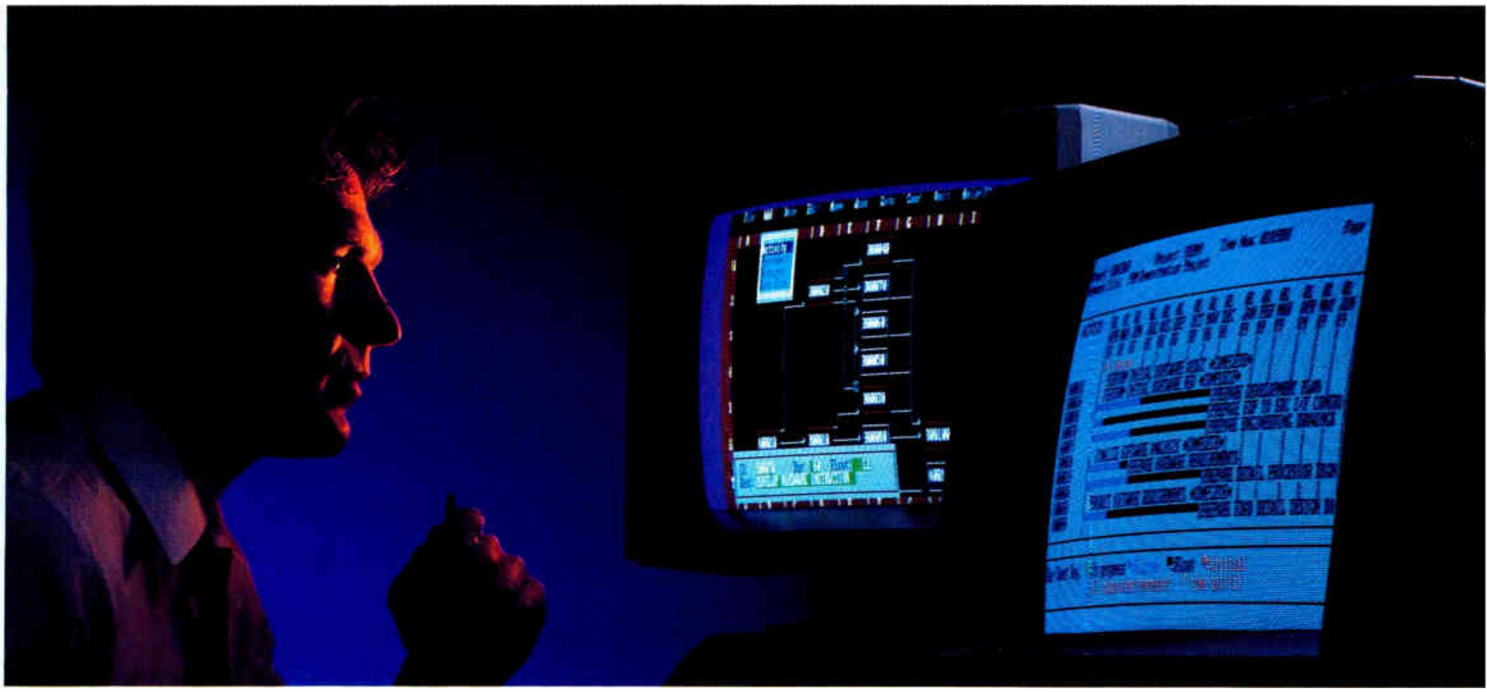

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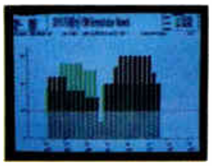

Sample Resource Histogram

Enter information in a format similar to Lotus 1-2-3™ (lettered columns and numbered rows), draw boxes/activities on the screen and connect them with relationships.

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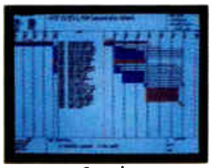

Sample Rolling Wave Bar Chart

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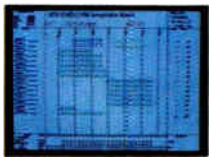

Sample Resource Usage Bar Chart

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AUTO ELECTRONICS GROWS EVEN FASTER, BUT IT GETS HARDER TO WIN BUSINESS

Technology integration from ground-up changes auto maker and vendor relationships

by Wesley R. Iversen

The hottest growth market in the electronics business rides on four wheels, comes in a variety of shapes and sizes, and can easily be parked in a garage. Today's cars are using more electronics than ever, and analysts expect high growth through the 1990s. Yet that doesn't mean that electronics suppliers are on easy street, for as the auto market explodes, it's also getting tougher to sell into it.

So electronics companies are now scrambling to get—or keep—a piece of the business. But the rewards are worth it. Electronic subsystems and components added $800 to the price of the average car in 1987, almost double the amount for 1982 models, says market researcher Dataquest Inc. of San Jose, Calif. And even though total vehicle production in the U.S. dropped by 6% last year, the auto electronics market grew by 6.5%, Dataquest says. By the 1991 model year, electronics are expected to account for about $1,100 of the average car's price tag.

SHIFTING GEARS. Rapid growth, however, is bringing rapid change. Auto makers are changing the way they look at electronics, moving away from gee-whiz gimmickry and emphasizing safety, performance, and luxury. They're also beginning to look at electronics as something more than a jelly-bean commodity—forging tighter relationships with suppliers and taking advantage of vendors' design expertise. Lastly, the auto makers are beginning to shy away from doing all of the subsystem development themselves, and they are increasingly looking to subsystem suppliers, like Allied-Signal's Bendix Electronics Group in Southfield, Mich.

"The old ways of doing business are rapidly disappearing," says Jerry Rivard, vice president and group executive at Bendix. Auto makers are not dictating their needs and choosing the cheapest bidder anymore. "It used to be a cutthroat, adversarial kind of relationship," Rivard says. "But today, the OEMs are developing close relationships with one or sometimes two suppliers in an area, and they are bringing them in at the start of a project."

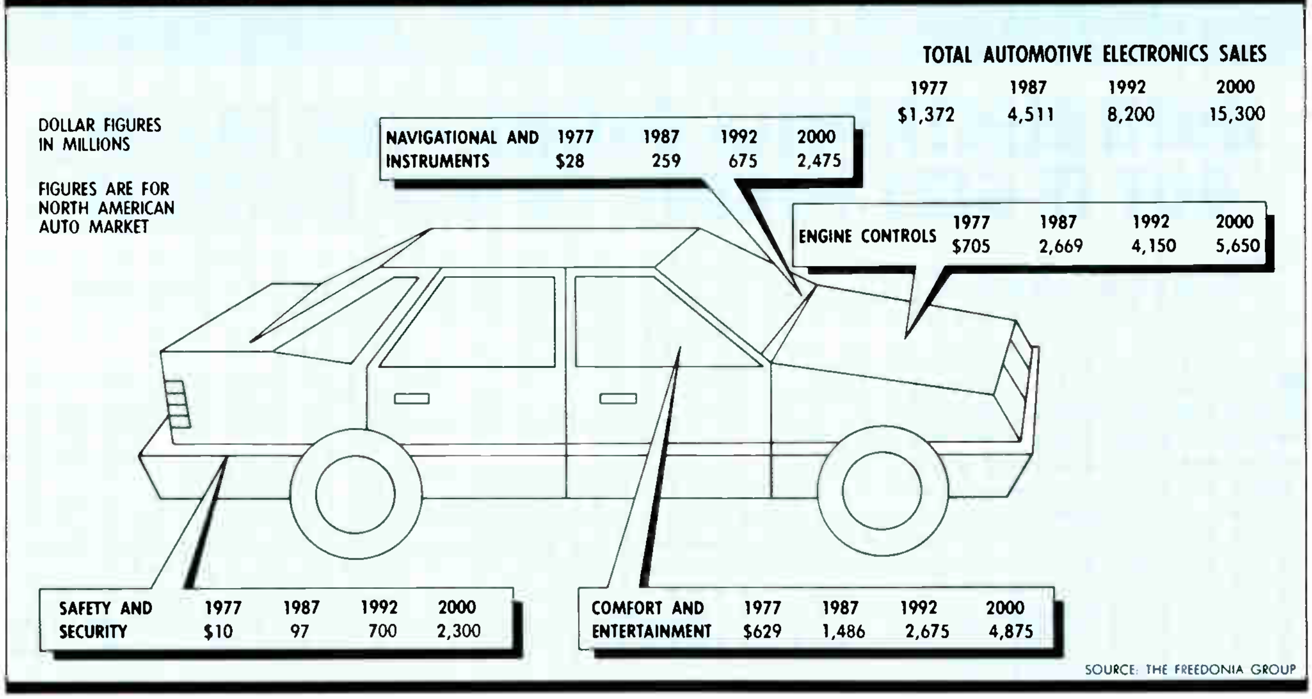
The automotive electronics business is expected to grow 10% to 20% a year until the mid-1990s, according to industry analysts. The Freedonia Group Inc., a Cleveland market research firm, estimates the wholesale value of electronics in cars built and assembled in North America will jump from $4.5 billion in 1987 to $15.3 billion by the year 2000 (see chart p. 54). And Delco Electronics

Corp.—General Motors Corp.'s huge captive electronics producer—believes the total auto electronics markets it serves will nearly double worldwide to $30 billion by 1993 from $17 billion today. Other estimates place the potential size of global auto electronic markets as high as $60 billion at the turn of the century.

All of this will combine to make the North American merchant automotive semiconductor market grow by 10.8% annually, according to Dataquest, rising from $909 million last year to almost $1.4 billion in 1991 (see chart, p. 55). Bipolar logic, MOS logic, MOS memory, and linear ICs will all see double-digit growth, says Dataquest. All of the major chip makers report they are mounting aggressive programs aimed at meeting the auto makers' needs for closer working relationships and full-service capability, from concept and design work to flexible delivery that is designed to meet the car makers' just-in-time manufacturing requirements.

In North America, the fastest growth will be driven by federal safety requirements, says Kevin Swift, a vice president at The Freedonia Group. He predicts that safety and security systems alone will grow at 27.6% annually, totaling $2.3 billion in the year 2000. Passive restraint systems, such as air bags and seat belts, will grow at more than a 40% annual rate, making this the fastest growing near-term opportunity for new

HOW CAR MAKERS BUY AUTO ELECTRONICS



car electronics. But even with that potential bright spot, electronic-based systems are facing a surprising challenge from a simple, low-cost, all-mechanical design (see p. 64).

In Europe and, to a lesser extent, Japan, car electronics use lags behind the U. S. (see p. 56), in part because legal conditions play a lesser role, and in part because Americans place a higher value on luxury electronic features. Such luxury features include navigational computers and cellular telephones, the use of which Swift says will increase by 30% to 40% between now and the early 1990s. In that same timeframe, Swift predicts, there'll be 15% to 30% growth in premium sound systems, intelligent windshield wiper controls, antilock braking systems, antitheft systems, electronic locks, antiknock devices for engines, digital instrument clusters, automatic load-level controls, and new controls for seat and mirror adjustments.

Since the auto makers produce only about half of what they use, the new gear promises to add up to huge new business opportunities for electronic subsystem and chip vendors. But getting the business won't be easy.

Increasingly, complete systems engineering is becoming the nature of the auto-electronics game. Auto makers are also focusing more on functionality and integration of electronics into the complete vehicle rather than the pizzazz of isolated systems a decade ago. For competitive reasons, U. S. auto makers are striving to shorten product development cycles, while maintaining their traditional drive to get high reliability at lower costs.

These trends mean that electronics vendors wishing to stay in the automotive game will have to play by a new set of rules. And that includes a smaller field of competitors. Vendors will be asked to offer more in the way of subsystem design capabilities and service to the car maker. "In the future, you'll see that marketing skills will be key," says The Freedonia Group's Swift. "A supplier can no longer just supply a component or part and that's the end of it."

The result is that while the market for auto electronics is flourishing, fewer companies will flourish. Increasingly, Chrysler, Ford, and GM are doing business with fewer electronic suppliers. "There's no question they've reduced their supplier base, and they're going to keep reducing it. From five years ago to today, I bet they've cut their suppliers by maybe 50%," says Thomas V. Bisconti, senior market planner for IC products at GE Solid State, Somerville, N. J.

A smaller field of larger competitors will play by a new set of rules

In pruning the ranks, the auto makers are working more closely with the suppliers they do keep, however. They are bringing suppliers in at the beginning stages of new design projects. Also, they're striking up long-term partnerships with vendors and asking suppliers to do more, not less, in the design of chips and subsystems.

"One of the things we want to do is develop closer working relationships with our suppliers," says John Stark, purchasing manager at Delco in Kokomo, Ind. "And one of the driving forces is to put ourselves in a better position to utilize our resources." The GM unit, for example, has trimmed back its list of integrated-circuit suppliers from 32 to 27 over the past year, and plans to cut more. "We can get more leverage if we have fewer suppliers," Stark notes. "We need to be able to tap into their design and engineering resources, and to know which direction they're going."

Auto makers also use that closeness as a way to demand quality. Bisconti at GE Solid State says auto makers continue to be among his toughest customers when it comes to quality standards. "They are on a par with the hi-rel [military] customers, in terms of testing, demands, everything," he says. "They audit our production plants, our off-shore assembly plants, you name it. They want life-cycle testing, power and temperature cycling, and they ask questions: How often do you calibrate your equipment? How do you do it? Are you using statistical process control? Things like that. It's a rigorous operation. Those audits are stringent as hell."

One example of the way relationships are changing between chip vendors and their auto electronics customers can be seen in the development of the TMS370, a new family of 8-bit microcontrollers that Texas Instruments Inc. developed jointly with Delco. The part, code-named roadrunner while under development in the mid-1980s, was launched as a product on the open market in the spring [*Electronics*, April 28, 1988, p. 32]. TI began working on the project with Delco at the conceptual stage in 1984, says P. Dale Spoon, automotive operations manager at the Dallas chip maker.

"We're trying to work with the auto maker now from womb to tomb, from concept to successful production," he explains. "The primary difference is that we as component suppliers in the past have tried to design standard products that were fairly generic and fit as wide a market as possible. But now, it's much more application-specific. Instead of us sitting behind a wall, we're actually getting the user to define the product."

Two major benefits result, Spoon says. "They [the customers] get exactly what they want, and we've worked with their help to define the product, such that we can take it to the open market later." This increases the volume, which in turn means still lower costs for the auto maker.

Now auto makers are beginning to apply the same concept to the subsystems business. Instead of buying components and assembling them in-house, car builders are increasingly forming long-term partnerships with outside suppliers to handle the work.

FROM PLANES TO CARS. The trend parallels earlier developments in the aircraft industry, in which a single supplier becomes the integrator for an entire subsystem—such as the undercarriage and landing gear assembly, observes Gene Stohler, vice president of sales and marketing at ITT Automotive in Detroit. Now car makers are sourcing subsystems ranging from lighting assemblies to seat controls and door modules to antilock brake and active suspension systems from subassembly builders. "The days of supplying a component—a part—to the OEMs are damn near gone," Stohler says. "But none of us can do it all. We have to sublet segments of the work."

Indeed, in order to meet the critical mass in engineering and product development skills now being required by the auto makers, major suppliers are increasingly entering into partnerships with each other and with critical component suppliers. For example, Allied-Signal and Siemens AG formed a joint venture to develop, manufacture, and market automotive electronic systems and components worldwide late last year, and Intel Corp. and Robert Bosch GmbH have had a long-term joint effort since 1985 to develop a high-performance multiplexed bus scheme for cars. That work produced its first fruit this year, when Intel introduced its 82526 chip to implement what's called the CAN protocol (for Controller Area Network) that the two companies are promoting as a standard for the automobile industry [*Electronics*, March 3, 1988, p. 31].

"There is a lot of romancing going on," says Allied-Signal's Rivard, referring to the joint ventures, partnerships, buy-outs, and sell-outs that are now part and parcel of today's business. "Auto makers are recognizing that the technology required to produce a car today is growing dramatically, and as a result, they are putting more burden on their suppliers to be subsystems suppliers." That means huge front-end investments by suppliers, who must wait four or five years—given typical auto platform production cycles—for the payoff. Not everyone will be able to stay the course, Rivard predicts. "There are about 10 first-tier (subsystem) suppliers in the world today, but I believe that number will be reduced to maybe five over the next three to four years."

> A lot of romancing is going on as part and parcel of today's business

The trend toward consolidation also is forcing cultural changes within the auto houses. Fred Meisterfeld, a Chrysler engineering supervisor in Highland Park, Mich., says the changes could have an impact as radical as that brought on by the introduction of the electric starter some 70 years ago.

"We're entering a new era, and it's changing the way we do business, the way we're organized, and the way we think about electronics in the vehicle," Miesterfeld says. "We, at Chrysler, were not systems-oriented before. We all just did our own little thing," he explains. "But now, you have to be systems-oriented. One guy over here sees his component price go up by a dollar, but somebody else's cost may go down by $5. You can no longer think about things in the same realm: that making your part cheaper is always the right way to go. Instead, you've got to think about making the total car more reliable and less expensive."

This kind of thinking represents a "third phase" in automotive electronics history, says Rivard, who before joining Bendix, was chief engineer for Ford's Electrical and Electronics Division. "In the first phase, we just went into the car and replaced components, from strict mechanical to electronic," he says. Early phase 1 examples, he says, include the swapping of mechanical clocks and electromechanical ignition systems for electronic parts.

In the second phase, auto makers focused on larger auto modules, such as electronic fuel-injection subsystems. But still, second-phase electronic-replacement features were largely shoehorned into the automobile, with little effort given to fully optimizing other parts of the car for the new technology.

In the new third phase, the growing emphasis is on tying electronic subsystems all together with a ground-up engineering approach. Rivard says auto mak-

CHIP CONSUMPTION IN NORTH AMERICAN AUTO MARKET

	1987 SALES ($ MILLIONS)	PREDICTED COMPOUND ANNUAL GROWTH RATE (1987-91)
IC	$646.0	12.4%
Bipolar	106.3	9.5
Logic	85.1	12.3
Memory	21.2	−4.7
MOS	322.0	14.4
Logic	72.3	12.1
Microcontrollers and peripherals	165.3	16.2
Memory	84.4	12.8
Linear	217.7	10.7
Discrete	201.6	7.1
Optoelectronic	62.5	4.5
Total	$909.9	10.8%

Source: Dataquest Inc.

ers now realize they can't continue to insert isolated subsystems every time they introduce a new electronic-based function. Indeed, many of today's luxury cars include 10 to 20 separate electronic modules, and in some cases more than 30.

"You can imagine the number of connectors and interfaces that you have to put into these cars," Rivard says. "It's getting too complex. You worry about reliability, and you worry about cost. In the past, if we added five new features, we added five new boxes."

So the push is on to find ways to combine features. Delco officials talk of the need for "up-integration," or the incorporation of multiple functions within a single controller, thereby reducing cost and increasing reliability and diagnostic capability. Says Dennis Florence, chief engineer for electrical and electronic systems at Chrysler Corp. in Highland Park, Mich.: "If in truth, we keep having more and more electronics in the car—and I believe we will—we'll either have to find a very clever way to tie it all together, or we're going to have to combine some of those boxes."

Indeed, many automotive engineers now envision the day when the car's major electronics systems will be controlled by perhaps only three master control modules. One controller would handle engine and transmission functions. Another would manage body-embedded electronics, regulating information, and comfort features ranging from instrumentation and navigation systems to door locks, automatic temperature control, and seat adjustment. A third would handle chassis requirements, such as antilock braking systems and sophisticated active adaptive suspension systems. And of course, all three would communicate with their various peripherals, and with each other, over a multiplexed bus eliminating bulky wiring harnesses.

MOVE TO FUNCTIONALITY. Besides focusing on system and subsystem integration, auto makers are also looking more toward electronic features that provide true functionality at an affordable price. Derek Lidow, executive vice president at International Rectifier Corp., El Segundo, Calif., believes that auto makers too many times in the past have gone for electronic features that provided glitz, but not enough to justify the high cost.

"The landscape is littered with their wreckage," adds Lidow. Among cautionary examples, he cites overly complex electronic instrument panels, which proved all but unintelligible to drivers, and talking cars, which were such an irritant that they were soon withdrawn. But Lidow says he now sees "a new maturity emerging" among automobile makers.

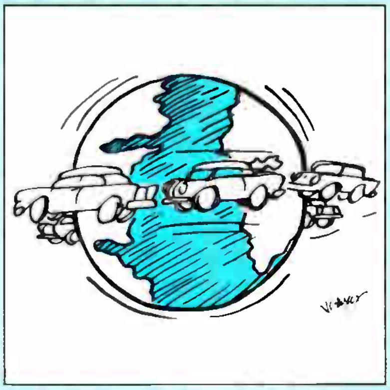
Ford now acknowledges it is taking a more conservative approach to electronic instrumentation. "Our philosophy is

THE PUSH IS DIFFERENT IN EVERY MARKET

Electronic components and subsystems are finding their way into automobiles at an unprecedented rate all over the world, but what's driving the auto makers in the U.S. to use electronics is different from what's pushing their counterparts in West Germany or Japan. The fact is, each market is driven by its own set of circumstances, most of which have very little to do with technology.

Laws limiting exhaust emissions and requiring minimum fuel consumption are a potent force driving automotive electronics markets in both the U. S. and Japan. Luxury and convenience features are also in higher demand in the U. S., where cars are usually larger, and owners tend to spend more time in them. But in Europe, safety concerns and a passion for high-performance road cars has helped to put the market into high gear.

The result is greater use of integrated circuits in models destined for the U. S. roads, no matter their origin; as much as double the dollar value of ICs that are found in Europe's autos. The dollar content of U. S. autos is also nearly a third higher per car than vehicles in Japan, according to one European estimate. Consumer shopping habits and government regulations are expected to keep U. S. vehicles on top of the IC-content heap.



The average U. S. car last year contained about $44 worth of ICs, according to figures from Siemens AG in West Germany. The typical Japanese car had about $30 worth, and the average European model had only $17 worth of ICs. In other regions in the world, the average was $14, Siemens says.

And Siemens, which recently entered into a joint venture with Allied-Bendix to try to tap into the the U. S. market for auto electronics, doesn't expect that disparity to change much in the years ahead. In 1992, the average U. S. car will contain $79 worth of ICs, versus $55 for Japan, $39 for West Europe, and $39 for the rest of the world.

What that means is that although car production is only slightly higher in the U. S. than in Western Europe, the U. S. market for auto electronics is more than twice the size of Europe's market. One reason is the different regulatory backdrop that exists in Europe.

"In Europe, you don't really have any emissions standards," notes Dennis Florence, chief engineer for electrical and electronic systems at Chrysler Corp. "That translates to this: you don't need much electronics for engine control and emissions control."

Agreeing is Jürgen Lange, senior director for the Semiconductor Division of Siemens AG in Munich. Lange says such governmental regulations have a profound effect in shaping the use of electronics, because in order to meet stringent requirements, more electronic technology must be used. There is a limit to which mechanical measures can improve car and engine performance, he adds.

Since U. S. cars are generally bigger and more expensive than their European counterparts, Lange says their price tags can more readily absorb $1,500 worth of electronics. As a result, lawmakers in Europe must take into consideration the greater number of smaller cars in their markets, he says, and they recognize that "in such cars the cost of electronics needed to achieve greater fuel economy and a cleaner exhaust may be prohibitive in relation to the car's overall cost."

The same economic and size factors govern technology use in driving-comfort features. In the small European cars, electronic-seat positioning and memory systems are a lofty-priced luxury, "one that might even be considered a gimmick and out of proportion with the overall car cost," cautions Wolfgang Kreft, who heads electronic systems predevelopment work at Volkswagenwerk AG in Wolfsburg, West Germany. Such features are usually in more demand in leased or rented cars, which are more popular in the U. S.

What some consider gimmicky-use of electronic systems are more popular with Japanese auto makers, according to industry managers in the U. S. and Europe. "Believe it or not, but we have a lot more electronics in the power train area than they do," says Chrysler's Florence. "They seem to add a lot of Jim-crackery, bells, and whistles and all that. But like us, their emission standards are pretty tough, and they can't ignore those kinds of sensors."

–Tobias Naegele with bureau reports from Charles Cohen in Tokyo and John Gosch in Frankfurt

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3545 North First Street, San Jose, CA 95134-1804 (408) 922-9000 that there's got to be a benefit to the customer at the price at which we're able to offer it," says George H. Forrest, marketing manager for Ford Motor Co.'s Electronics division in Rawsonville, Mich. "In the past, we had gee-whiz items and buttons and whistles. But what did it really do for the customer?" Forrest says Ford is now focusing on three basic electronic instrumentation items that it has found popular among consumers: fuel computers, diagnostic systems, and digital readout speedometers. All three features are now standard or optional on more than a half dozen Ford cars and will penetrate further as the price of the $300 cluster comes down, Ford expects.

Delco, too, is getting more conservative. "A few years ago, we thought electronic instrument clusters were going to be a major factor. But it turns out they're not going to be as large a percentage of the total as we thought," concedes Delco's Stark. About 44% of the instrument clusters made by Delco are still mechanical, and another 44% are electromechanical, in which an electrical pulse is generated at the source to power an analog gauge. Application of electronic clusters will increase, Delco says, but they won't become the dominant system until further gains are made in the technology.

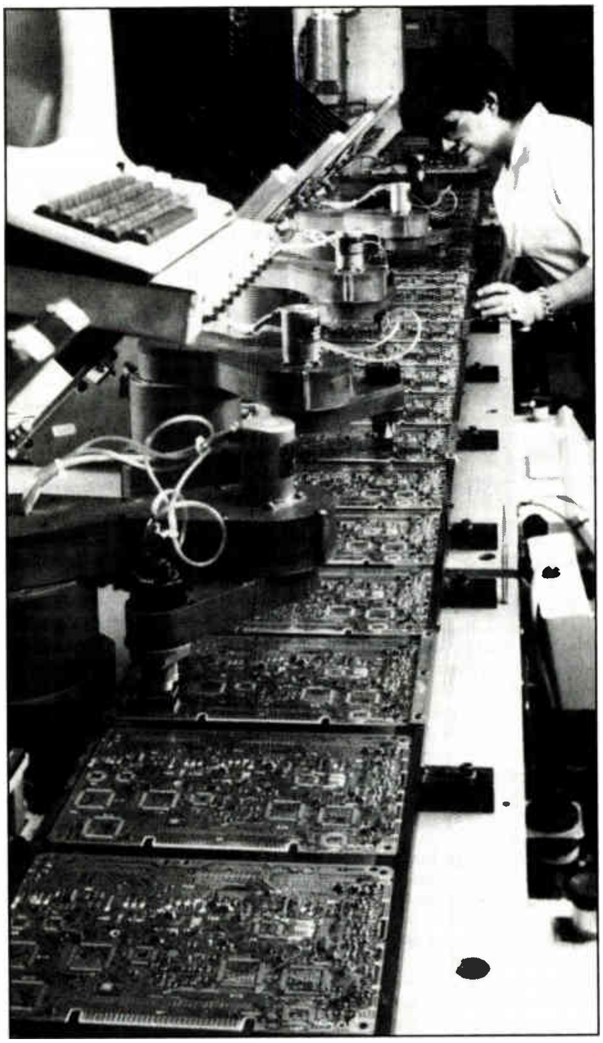
ABS IS HOT. A good example of an electronic system that provides measurable functional benefits and looks like a marketplace winner is antilock braking. Pioneered by Bosch, it has attracted Bendix, Delco, ITT Automotive, and Kelsey-Hayes, as well as European and Japanese competitors. The Berkt Group, an automotive consulting firm in Southfield, Mich., predicts that the cost of antilock braking systems will fall by two thirds over the next five years, as volume increases and electronics costs drop. The technology is now in an estimated 5% of U. S. cars, and the auto makers predict it will grow fast.

"In cars right now, it's about an $800 option, but if we can get the cost down to $400, I can envision it coming all the way down through the Tempo and Topaz," says Forrest. "By the mid-1990s, we could see ABS virtually standard on at least 60% or 70% of cars. And it's not inconceivable that it might even be available on the very low end."

William Rodda, chief engineer, electronic systems, for Delco, is even more optimistic. He puts antilock brake penetration in U. S. cars at 80% by 1995, when he estimates the market will total between $1 billion and $2 billion annually.

Multiplexed vehicle buses are beginning to make inroads in some high end cars. Indeed, since the technique promises to ease the problem of increasing module count by replacing today's bulky wiring harnesses with a single cable or optical fiber, every major auto maker has its own multiplexing effort underway [*Electronics*, August 21, 1986, p. 81]. Intel and Bosch are promoting CAN as a standard protocol for high-performance, 1-Mbit/second multiplexing. And a Society of Automotive Engineers committee expects by this fall to release an initial version of a proposed standard known as J1850 for medium-speed multiplexing at 10 Kbit/s to 100 Kbits/s rates.

But multiplexing has not taken the industry by storm as some expected. It has proven too expensive and tough to engineer, says International Rectifier's Lidow. And while the technology has its champions, many in the industry now believe that widespread use of full car multiplexing is still about a decade away. "We're aware of what auto makers are asking for to go into the 1992 to 1995 models, and it doesn't look like the multiplexed bus will make it before 1995," observes William Maxwell, strategic marketing manager, automotive, for Sprague Electric Co.'s Semiconductor Group, in Worcester, Mass.



Delco operator checks robot arm that places surface-mounted components on fuel injection system.

One hang-up is the high price for smart power chips, which combine logic with power and are needed to switch power to a motor, lamp, or other electrical load. "You can buy a relay today that will switch 10 amps for 70 cents. But for comparable performance in a smart power chip, it costs you $3 to $4," says Rivard. Many say multiplexing will show up more in applications such as steering columns, or in door panels for switches and locks. But, says Chrysler's Florence, "multiplexing is still not cost-effective for most applications. It's going to take some choke points to make it happen in volume."

The key to the success of multiplexing will be chip makers' ability to provide lower-cost products for automotive applications. In the power arena, for example, new technology from Motorola (see p. 73) and International Rectifier (see p. 74) should do just that.

In a more traditional arena, engine control, though maturing, is expected to continue to be a strong market for chip vendors. Eight-bit microcontrollers still dominate here, as in other parts of the car, and are expected to continue to be in the driver's seat well into the next decade. But higher performance 16-bit controllers are expected to find greater use as auto makers strive to integrate more functions, such as engine and transmission control. And the 16-bit chips could also find a place in emerging areas such as antilock braking and active suspension systems that require lots of real-time number crunching capability.

Delco is working with Motorola to develop a 16-bit processor family currently called GM Process X, aimed for use beginning in model year 1993 or 1994 GM cars, says Stark. And Dataquest projects that use of merchant 16-bit controller chips in U. S. cars will grow by six times between now and 1991 to produce an estimated $80 million market. □

Additional reporting by Lawrence Curran, Tobias Naegele, and Larry Waller

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WHY ELECTRONICS IS NO EASY WINNER IN BATTLE FOR AIR-BAG CONTROLLER SALES

Backers say all-mechanical system promises simplicity and low cost

It's shaping up as a battle pitting complex electronic sophistication versus elegant mechanical simplicity. The arena is an explosive new market for car-crash sensors and air-bag triggering devices aimed at meeting U. S. mandated passive restraints for auto passengers. The stakes for auto suppliers is a piece of a big market—by some estimates growing by more than 40% each year and topping $2 billion by 1993 for total air bag systems.

Many believe the electronics share of this business could be as much as one-third through the sale of diagnostic modules, triggering systems, and electronic or electromechanical crash sensors. But electronics face a challenge from what some might consider an unlikely opponent—an all-mechanical design that costs half as much.

Backers of the all-mechanical approach promise lower costs and greater reliability through a simple system. Those pushing electronic-based designs say that all-mechanical systems cannot be tested. Others worry that the concept will prove less suitable for U. S.-made cars, which unlike some European models crush more in collisions. That reduces the ability to detect crashes in the passenger compartment where all-mechanical systems have sensors. So far, U.S. auto firms want some sensors in car front ends and don't plan all-mechanical systems.

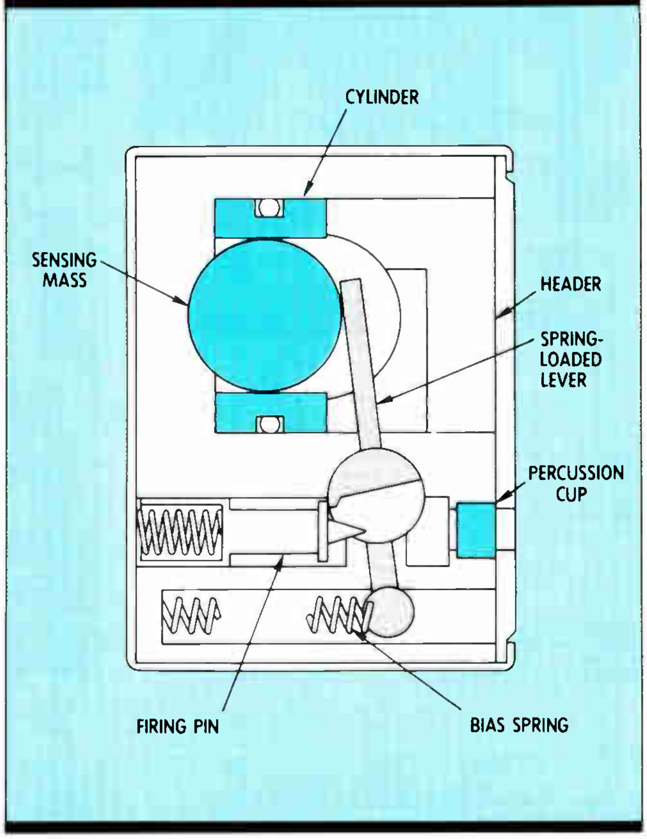
BANG FOR THE BUCK. But the all-mechanical system proponents believe time is on their side. "By the end of the century, I would be surprised if at least 50% of the market wasn't mechanical," says Noel A. Baker, vice president of marketing for Breed Automotive Corp. in Boonton Township, N. J.

Formed in January 1987, Breed Automotive is a spin-out from Breed Corp., a 26-year-old producer of military artillery fuses and arming devices. And by applying time-tested munitions-style sensing and triggering techniques, the firm has developed an all-mechanical air-bag system that Baker says is simpler, more reliable, and potentially half the cost of complex electronics offered by such heavyweight competitors as Allied-Signal, Robert Bosch, and TRW.

The early air-bag systems in production cars today typically rely on a combination of one or more sensors in the front-end "crush zone" of a vehicle, as well as an additional sensor in the passenger compartment. These sensors measure deceleration in a collision, and produce an electrical signal that is processed by an electronic diagnostic module. The module triggers the air-bag gas generator when crash severity exceeds a predefined limit. It also monitors the system, warning the driver with an indicator light when service is needed.

Breed contends that it has a better idea. The firm has been selling electromechanical crash sensors, which are used in combination with diagnostic modules and sensors from other suppliers in air-bag-equipped cars from General Motors Corp. and Ford Motor Co. But next year, the New Jersey company will begin first production on its Breed All-Mechanical Air Bag System. The system is expected to debut on 1990 cars from Jaguar, and perhaps two other auto makers, Baker adds.

NO ELECTRONICS IN THIS AIRBAG TRIGGER

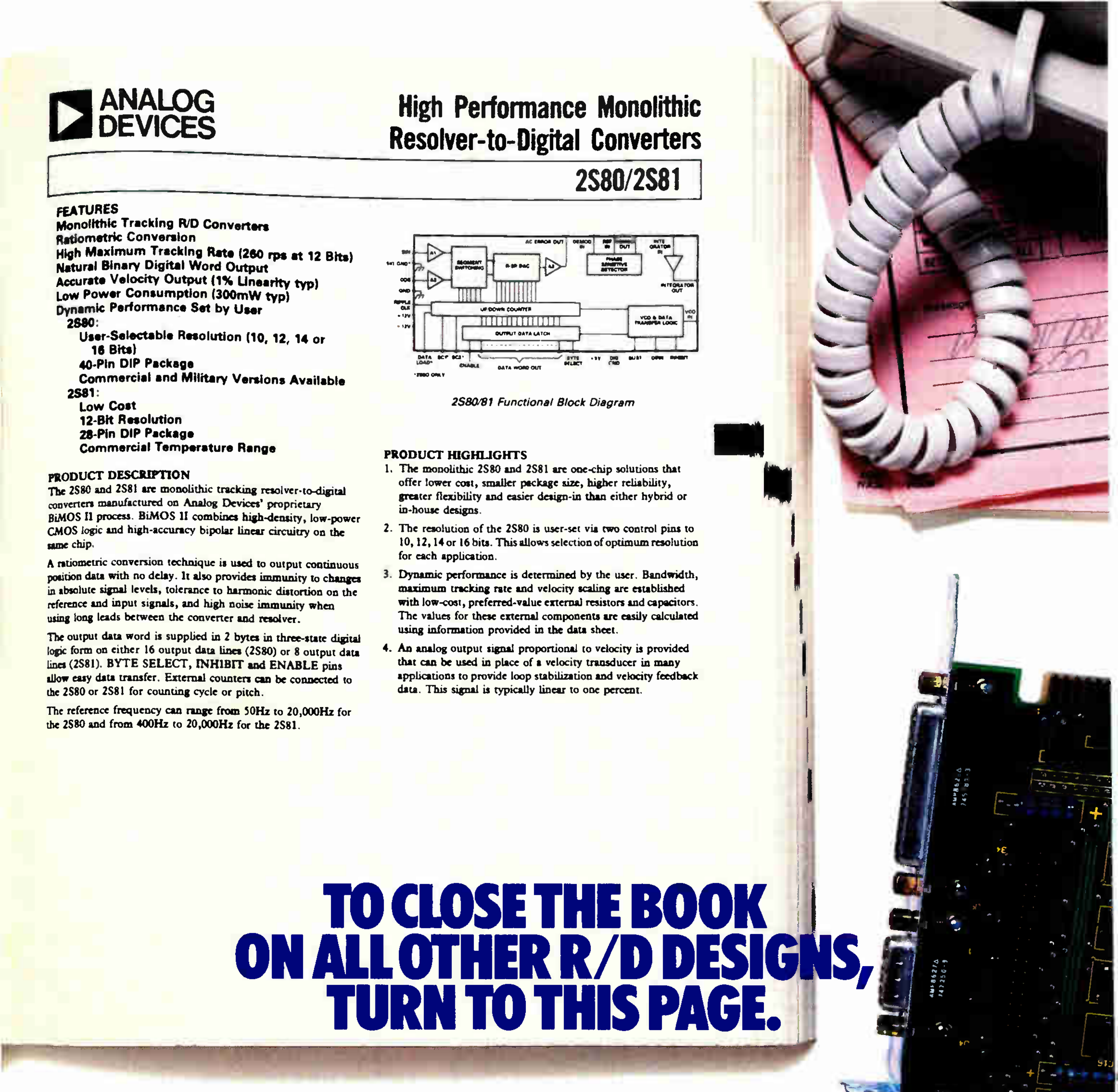


An all-mechanical crash-sensor and air-bag-trigger system is based on techniques that were developed in munitions.

The heart of the system is Breed's mechanical crash sensor/initiator, which is based on a simple ball-in-tube design derived from munitions techniques. The ball, or sensing mass, rests in a tube, biased by a spring-loaded lever (see figure). When deceleration exceeds a preset limit for a certain period of time, the ball overcomes the bias and is drawn forward in the tube, moving the lever far enough to release a firing pin, also spring loaded, that goes into a small percussion cup. The sensor is mounted inside the air-bag gas-generating unit, and the igniting percussion cup triggers inflation of the air bag.

"It's like firing a shotgun," Baker explains. The Breed approach requires none of the wires, connectors, back-up power systems, warning lights, and complex diagnostic modules used in today's production bag systems. Baker says it will be more reliable—perhaps by a factor of 10—over more complex systems. What's more, in volume production the mechanical system can be priced at about half that of conventional electrical air-bag systems, he adds. Air-bag systems are a $800 to $1,000 option now; they are expected to drop to about $300 by the early 1990s.

The company plans to ease concerns about nontestability with a redundant sensor design; each gas-generant module and air bag will be fitted with two mechanical sensors, either of which can fire the bag, Baker says. He also says studies show single-point sensors in the passenger compartment can be adequate for U. S. soft-bodied automobiles with modifications such as stronger bumper beams. *–Wesley R. Iversen*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2S80/81 Functional Block Diagram

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PRODUCT HIGHLIGHTS

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Circle 66 on reader service card

HUGHES TECHNOLOGY FINALLY MOVES INTO GM CARS

It took 3 years to happen, but the automotive manufacturer is applying aerospace-based technology of its subsidiary to new model cars

LOS ANGELES

When General Motors Corp. bought the Hughes Aircraft Co. in 1985 for $5 billion, executives on both sides of the deal extolled the virtues of applying advanced military electronics technology to the car business. It was an idea that couldn't miss, GM said.

There were far more doubters than believers, nonetheless. They cited Litton Industries Inc.'s abortive attempt to bring aerospace design technology to the shipbuilding industry in the 1960s. And then there was Ford Motor Co.'s inability to leverage technology from its Ford Aerospace unit in the 1970s. Some also pointed to TRW Inc.'s failure to convince auto makers to use its expensive solid-state power steering system, which used technology related to TRW's military electronics business. Many believed the cost-plus approach used to fund low-volume military systems just would not mesh with the automotive business, where success is measured in pennies per part.

The task of GM and Hughes was larger than they thought, but it is finally beginning to happen. GM's collaborative efforts are starting to bear fruit, led by the first commercial automotive implementation of head-up display technology. GM is putting the Hughes-developed system on a special version of the 1988 Oldsmobile Cutlass Supreme [*Electronics*, Mar. 17, 1988, p. 34]. Market research is turning up considerable consumer interest, says Ralph V, Wilhelm Jr., and advanced instrumentation engineer at GM's Delco Electronics division in Kokomo, Ind. The retail price should be between $250 and $300, and GM expects 100,000 cars a year to be equipped with the display.

Up to 90 GM-related projects are in the works at Hughes, sources say, waiting for economics and marketing potential to work the technologies into GM products. Among these are such futuristic items as automated navigation gear that operates with data received from direct-broadcast satellites and a system that uses a gallium arsenide chip in a bumper-mounted sensor for collision avoidance.

In June, GM unveiled FAST, for Facility for Automotive Simulation and Test—a systems design and simulation tool for automotive use that was adapted from similar equipment Hughes uses for aircraft design. FAST is GM's most dramatic shot at leveraging Hughes's considerable design expertise, honed over 25 years of aircraft design, for use in its automotive divisions. Significantly, the multimillion dollar facility is not located in Detroit, or even in Michigan. Instead, GM chose to site it at Hughes's Space and Communications Group in El Segundo, Calif. Malcolm R. Currie, Hughes chairman and chief executive officer, says the choice "represents, in reality and symbolically, the increasing partnership between GM and Hughes."

It also shows that GM is taking advantage of what many feel was the most valuable technological asset Hughes brought to the merger: its expertise in simulating, on a computer, the real-time performance of an entire system. The idea is to avoid building costly prototypes until the last possible point in the design phase by catching errors or problems in simulation. "We not only can predict system performance, but also optimize it before hardware is built," Currie says.

IN THE LOOP. For GM auto development, four stalls that each can hold a full-size car have been built at the El Segundo facility for "hardware-in-the-loop" testing, says Gerald K. Slocum, the Hughes vice president in charge of the interfacing effort with GM. For a typical task, the car microprocessor connects to a minicomputer whose programming simulates vehicle performance in a vast range of circumstances. "The computer simulates combinations of possible conditions—sensors, speed, and road surface—then turns on the antilock brakes," he says.

For now, though, all eyes are on FAST, because that system will be the key to optimizing these future technologies for broad commercial use. The first jobs on FAST's agenda are to refine an antilock braking system and an active suspension system, both of which were developed at the Delco division. One goal of the project is to make the units affordable. The brake systems, for example, are now available only as a $925 option on a select group of 1988 GM models. But GM wants to make them cheaper, with the eventual aim of using them as standard equipment—GM has said it already intends to offer antilock brakes for only about $350 on most cars by 1991 [*Electronics*, Jan. 21, 1988, p. 21].

Focusing simulation techniques on auto design has potential for streamlining development and looks to be "something whose time has come for cars," says aerospace analyst Robert Hanisee of Siedler Amdec Securities Inc. in Los Angeles. Hanisee, once highly skeptical about whether the GM-Hughes merger would ever work, still isn't sure the deal will be successful. But he is much less skeptical today. Having the FAST simulation available from Hughes gives GM an advantage over U. S. rivals, Hanisee says, although he points out that some European auto makers, such as Sweden's Saab and West Germany's Mercedes-Benz, have also been pushing ahead in this field.

–Larry Waller

Hughes technician at the GM subsidiary in El Segundo, Calif., operates the firm's Facility for Automotive Simulation and Test to verify Delco design for such systems as antilock brakes.

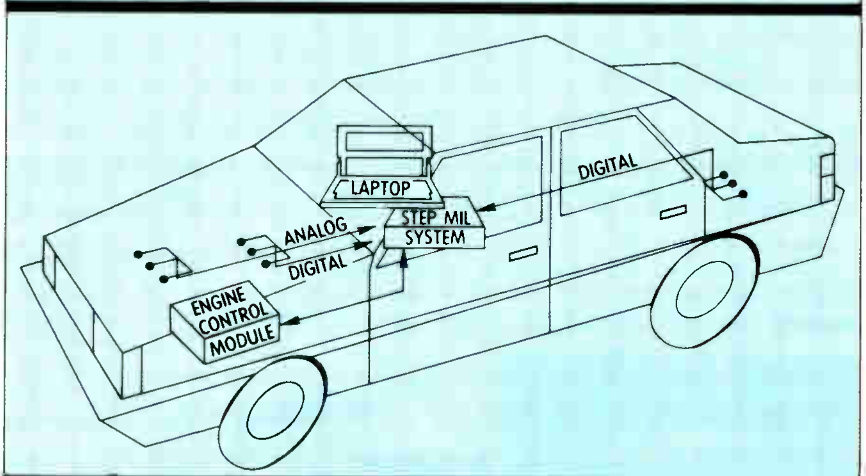
AUTO ELECTRONICS DEBUGGER BORROWS FROM AIRCRAFT FLIGHT RECORDER

Step Engineering tool monitors microprocessor and software for glitches in test vehicles

Finding a bug in a microprocessor-based system is always usually a tough job, but just try to find the glitches in an electronic prototype that's zipping down the highway at 55 miles an hour. That's the kind of hurdle facing auto-electronics suppliers, who are using more microprocessors, microcontrollers, and software in products they're launching into the lucrative auto markets. The challenge is growing even bigger as an explosion of software-running chips edge their way into many corners of the automobile.

Auto-electronics suppliers now have a new way of meeting this problem: a special bug-watching development tool from Step Engineering Inc. that functions much like an aircraft's flight recorder. The Sunnyvale, Calif., company has just started selling the system—originally developed for General Motors Corp.'s Delco Electronics division—on the open market, priced at $14,900. The Mobile Incident Logger, or MIL, contains enough data-logging memory and diagnostic features to monitor and record system performance in test vehicles for a three-month period.

CATCHING THE CAR BUG



Step Engineering's Mobile Incident Logger is a unique prototype debugger aimed at automotive electronics. It can record events for three months in test cars.

"Once the designs of electronic systems have been debugged, they have proven to be the most reliable component inside an automobile," says Darell Wilburn, Step's president and founder. To help reduce debugging time, MIL lets a company correlate the slow, randomly occurring events found in test-vehicle environments with the microsecond-execution speeds of microcontrollers and microprocessors.

The two different operating worlds of cars and microprocessor environments can often clash, with software bugs resulting. The MIL system boasts two features that help it cope with these two operating worlds. First, its small, compact size and rugged design mean that it can reside inside an auto test vehicle for up to three months. All that time, the MIL system is monitoring and logging errors as well as tracking various incidents occurring in electronic circuits (see figure). Second, the MIL's instruments can measure the performance of program code being executed by the monitored system's host microprocessor or microcontroller.

TWO MODES. Debuggers can use MIL in two operating modes. The data it collects can later be downloaded into a computer and analyzed; or, in the second mode, the data can be processed by an IBM Corp. laptop computer right inside the test car, allowing users to perform analysis as the system operates. In either mode, the computer's job is twofold: to set up the MIL to collect data, and concurrently—or off-line—to analyze the information gathered.

Like flight recorders in an aircraft, the MIL records the conditions of a system leading up to the time an error is detected. The user can set the number of pre-error clock cycles to be retained in MIL's memory. The tool has up to 32 Kbytes of random-access memory.

"The instrument has characteristics of a data logger and flight recorder," says Wilburn. "It can look backward in time to see what led up to an error such as the sudden unexpected acceleration that Audi experienced a while back. With store control you can filter out unwanted data to increases the amount of useful data the system captures." The instrument monitors four types of incidents—all of which are time correlated with the program running in the microprocessor or microcontroller. One type involves errors detected by the prototype's processor. Most microprocessors and microcontrollers have error codes that they detect and respond to by jumping to an error routine. The MIL can detect when the host processor makes such a jump, and it records the conditions in the tested system prior to detected error.

MIL also notes incidents where values fall out of a set range. The instrument will monitor any analog sensor and scales the input voltage from 0 to 5 V or 0 to 20 V. A third type of incident monitored by MIL is discrete events occurring on any one of eight channels. On a channel, "it can look at any bit or any combination of bits," explains Wilburn. A typical discrete signal could include a bit indicating that an auto transmission is set in reverse, or that a brake is on or off.

"These [electrical] inputs are designed to be very rugged," says Wilburn. "They can take voltages from 0 to 100 V and are completely protected from transient voltage surges." The MIL can be triggered manually to monitor incidents. "For example, the designer is recording RAM variables over time and something goes wrong. He can push a button to grab a condition of the electronics as the incident occurs," he says. The instrument also can correlate all these incidents with the program being executed by the microprocessor. In addition, MIL system provides source-level debug capabilities. *–Jonah McLeod*

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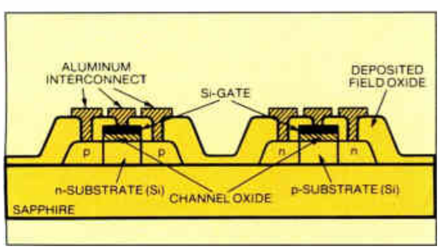

CMOS/SOS structure uses sapphire substrate to insulate the n- and p-transistors from each other. This structure is highly resistant to transient radiation, total-dose radiation, and single-event upsets.

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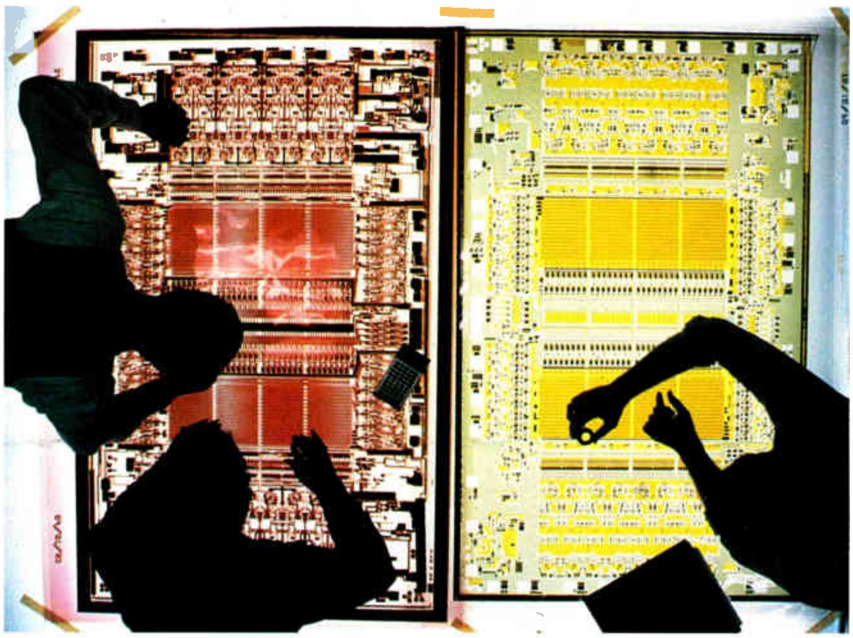

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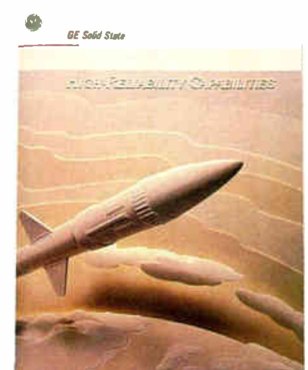

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NEW DISCRETE POWER FETS ADD FUNCTIONS TO CUT AUTO SYSTEM COSTS

They could delay the takeover of smart power ICs in autos

Sophisticated smart-power integrated circuits are the wave of the future, and will ultimately dominate the electronic systems in cars. But the smart-power takeover may come more slowly than some thought, because manufacturers of discrete power chips are finding ways to add functionality to their parts to make them more cost-effective. These new parts are making elegant but expensive smart-power solutions look less attractive for now to the cost-conscious automotive industry.

The strategy is to build high-reliability discrete power devices that need less support circuitry, reducing the number of parts for a given function. Motorola Inc., for example, is building special features like avalanche diodes and separate current-sensing transistors into their power FETs. In addition, International Rectifier Corp. has added a family of devices that can be controlled directly by logic-level signals to its line of rugged power MOS FETs, which are built to survive the tough avalanche-current conditions found in the automotive environment (see p. 74).

A BIG DEMAND. As the amount of electronics in cars grows, a lot of power devices are needed. Typical applications for power MOS FETs include high-speed switching regulators, switching converters, and drivers for motors, solenoids, relays, and higher-power bipolar switching transistors. Smart power ICs combine power circuitry and control logic on a single chip and offer easy interfacing to microprocessors and other logic devices, as well as over-current and over-temperature protection, and diagnostics. They look very promising for these jobs. "But in spite of their attractiveness, right now these devices have disadvantages that limit their applications," says Randy Frank, automotive and technical marketing manager at Motorola's discrete and special technologies group in Phoenix, Ariz.

The primary limitation for smart-power ICs at this point is cost-effectiveness, Frank says, especially for highly efficient, large-output devices. Die-size limitations also constrain the ability of smart-power chips to deliver high current levels for such applications as reversible motor controls.

But new Motorola discrete power MOS FET products provide some of the functionality of smart-power ICs at a much lower cost. Conventional wafer-processing technology is used, yielding very cost-effective products with a known reliability history.

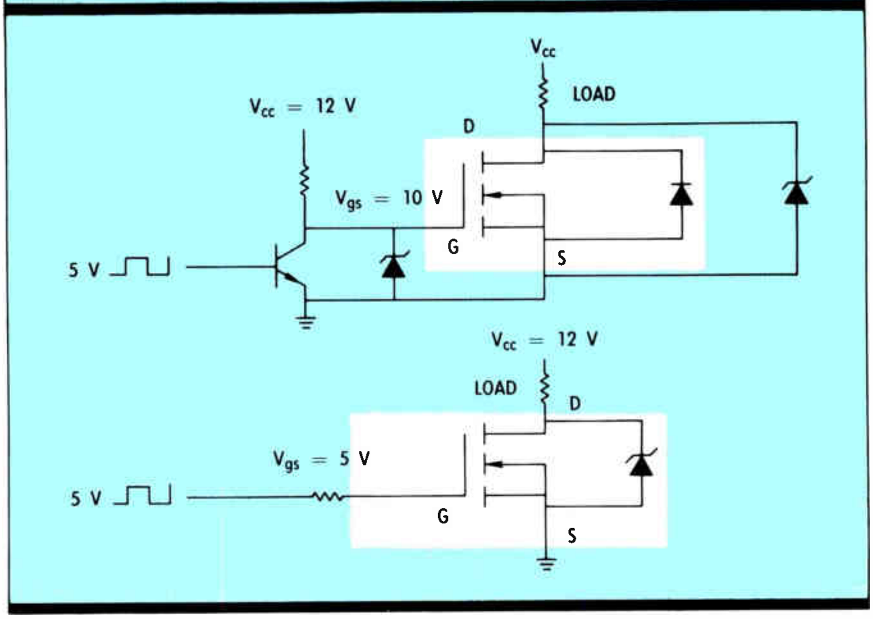
Power FETs have been produced in several varieties to provide more ruggedness, ease of interfacing, or special functions. Newer products incorporate combinations of these features. One Motorola product Frank points to is the MTD3055EL—a logic-level power MOS FET that sports an integral-body diode with avalanche capability: a feature that has been added outside of MOS FET devices so that they could withstand conditions found in automotive electrical systems. It comes in a surface-mount package with ratings of 60 V, 15 A, and 0.18 Ω on-resistance. The device also features improved ability to withstand gate rupture: the 40-V rating of earlier devices has been upped to 90 V. While logic-level power MOS devices have been in production for several years and avalanche capability has been incorporated in new devices for over two years, the MTD3055EL combines these features for the first time, says Frank.

The saving in circuit components made possible by this device can be seen in the circuit diagram. The device eliminates the need for a level-shifting transistor and pull-up resistor. The integrated body diode provides the capability of withstanding millions of avalanche cycles. Standard wafer processing is used except that a thin gate oxide is grown to achieve a 1-to-2-V gate threshold voltage.

ANOTHER PART. A second type of device that adds functionality to the basic discrete FET is the current-sensing power FET. Motorola's MTP40N06M SenseFet is a high-current (40-A) 60-V unit with only 0.040 Ω of on-resistance. In addition to the standard gate, drain, and surface connections, a current-sensing and Kelvin connection for sensing circuit ground are provided.

Soon, SenseFets with logic-level gate thresholds will be available—they are already in limited sampling for automotive applications. P-channel SenseFets represent another possible extension of the feature-combining trend, says Frank. Other devices will address protecting power devices from inadvertent shorts. Several more techniques are being explored, including two-chip temperature sensing with a shut-off function, monolithic temperature protection, and monolithic current limiting. *–Samuel Weber*

MORE CAPABILITIES FOR POWER MOS FETS



Reduced parts count can be seen when a typical power MOS FET circuit (top) is implemented with a device with avalanche capability built in and logic-level drive (bottom).

POWER MOS FETS PROMISE LOWER-COST AUTO SYSTEMS

International Rectifier's new family boasts built-in resistance to electrical failure, reducing the need for external parts

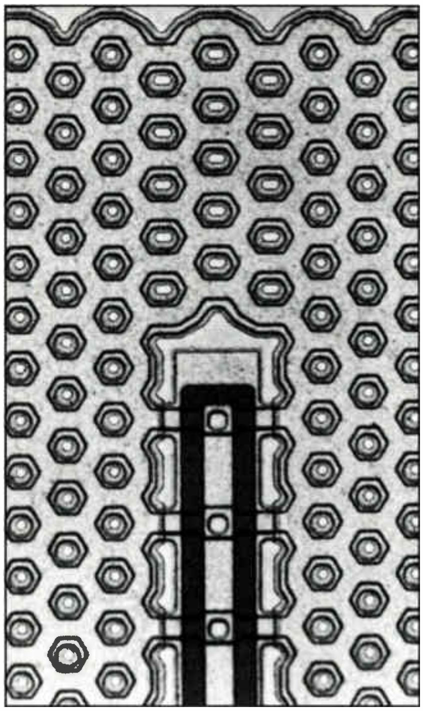
The eight power MOS FETs that make up International Rectifier Corp.'s new IRL product line flourish a tantalizing promise: lower-cost automotive electronic systems. Like the new types of discrete power FETs from Motorola (see p. 73), the International Rectifier parts are high-reliability discrete power devices that are cost-effective alternatives to smart-power integrated circuits, as well as to older-generation discretes that require more external support components.

The new IRL series can be controlled by logic-level signals, eliminating the need for voltage-shifting drive circuits. And, for the first time, says Ravi Rao, Hexfet product manager at the El Segundo, Calif., company, logic-level power MOS FETs will achieve high reliability in automotive systems without the need for external protection devices. The International Rectifier parts don't need those external devices because of their resistance to two types of failure.

For one, the new logic-level FETs can consistently withstand large amounts of the repetitive avalanche energy. At the same time, they resist the condition known as dV/dt failure, in which fast-changing voltage levels turn on the parasitic bipolar device in the MOS FET structure and the current that flows as a result causes hot spots that destroy the device. Both phenomena are common causes of failure in conventional power MOS FETs.

A RUGGEDIZED PROCESS. The IRL logic-level devices are built with a modified version of International Rectifier's third-generation Hexfet III ruggedizing process, a process introduced for high-voltage products two years ago. International Rectifier is already selling what it calls "rugged" power FETs, devices that can withstand brutal electrical conditions that can destroy power transistors in cars and trucks. The logic-level drive voltages of the new IRL series are made possible by reducing the 1,200-Å gate-oxide thickness by about half, among other process modifications.

Four of the initial IRL power transistors are rated at 60 V, and the other four at 100 V. They all have a 1-to-2-V switching threshold, which is compatible with TTL and CMOS logic circuitry, including microprocessors and microcontrollers. That means no interface circuit is needed between the logic driver and the IRL device. Other than that, there is essentially no difference between logic-level and standard-threshold MOS FETs. However, because the gate-oxide thickness has been halved, the maximum gate voltage rating of the logic-level Hexfets comes down correspondingly, from 20 to 10 V.



A guard-ring structure can be seen encircling each of this HEXFET's gate elements.

The automotive market is in particular need of logic-level power FETs for switching regulators and converters, as well as drivers for electromechanical parts like motors and solenoids, points out Rao. Low-battery and engine-startup conditions demand efficient operation from MOS FETs, even when a gate drive of 10 V is not available from the car's electrical system. There already are logic-level power MOS FET devices available from other vendors; what the IRL line of Hexfets brings to the party is assurance of high reliability of such devices when they are subjected to avalanche and high-dV/dt conditions.

The vulnerability of power MOS FETs to avalanche failure is due to the fact that they are formed of alternate layers of n- and p-type silicon, which creates a parasitic bipolar transistor that is intrinsic to the structure. To neutralize this parasitic transistor, the p- or n-doped body region is brought to the surface so that the base and emitter of the parasitic transistor are shorted together by the source metalization. This also creates a parasitic body-drain diode between the drain and the source.

Even with the base and emitter shorted, the parasitic transistor may turn on if avalanche current travels laterally through the p-doped region. The voltage drop produced in the p region may place a forward bias on the emitter-base junction of the parasitic transistor and turn it on. Even short-duration spikes can cause device failure in a weak or poorly designed power MOS FET due to avalanche, but International Rectifier's rugged Hexfet III devices can withstand such events repeatedly.

GOOD FOR CARS. This makes the devices particularly useful in automotive applications, where a condition called "load dump" can occur, says Peter Wood, an International Rectifier application engineer. Load dump occurs "when the battery becomes disconnected from the electrical system and the consequent voltage due to discharge from the alternator can reach dangerously high levels," he says. "And unless built with suitably rated devices, all the semiconductor switches can be blown out due to the resulting avalanche current."

That's why the new IRL devices have specially designed guard-ring structures around each gate element that allow a large amount of energy to be discharged through the device without harmful effects. The devices in the new line are rated to withstand repetitive avalanche energy ranging of up to 15 mJ, and single-pulse energies of up to 230 mJ.

Another big factor in cars is the dV/dt rating of a power MOS FET, which is a measure of its resistance to turn-on of the intrinsic parasitic bipolar transistor and resultant breakdown and eventual destruction of the device due to the formation of hot spots generated by current-flow concentrations. The third-generation Hexfets have higher cell densities with smaller active-transistor and blocking-structure areas, which reduce the resistance between the emitter and base of the parasitic bipolar transistor by a factor of two, thus reducing the forward bias voltage across the junction.

"The entire chip area is turned on by the dV/dt spike, and the current is not crowded into a small hot spot, so the device can withstand a much higher dV/dt," explains Wood. This also results in improving the device's ability to withstand avalanche current conditions. A six-mask process and completely redesigned diffusion profiles have boosted the dV/dt rating—typically 1 to 2 V/ns in previous generations—to a level of 3.5 to 5 V/ns.

–Samuel Weber

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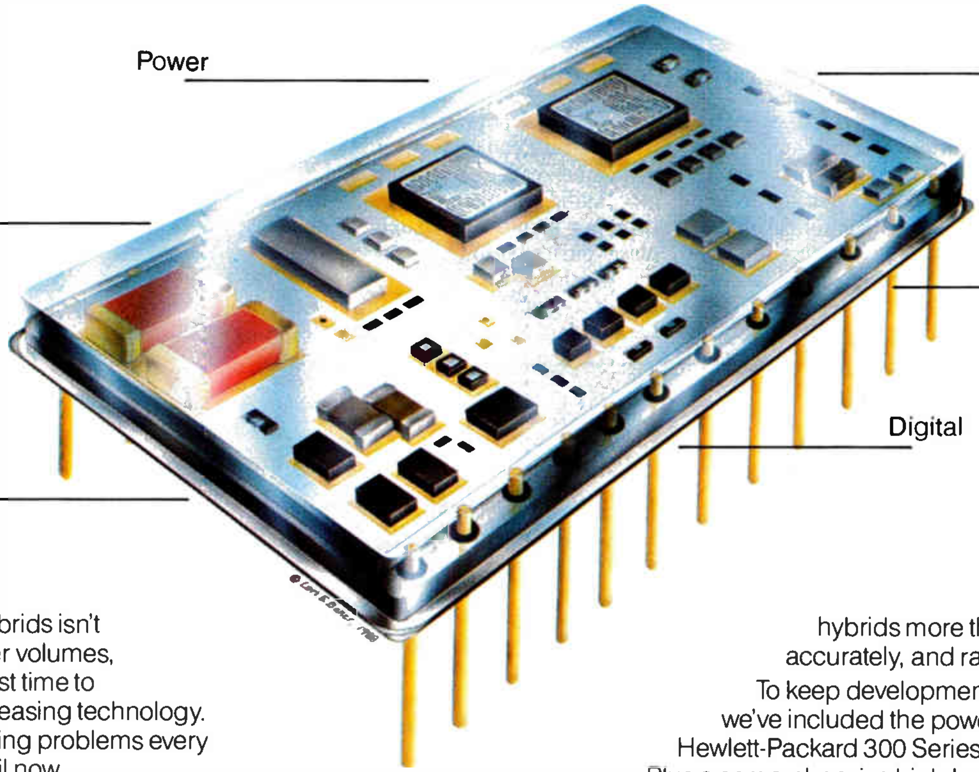

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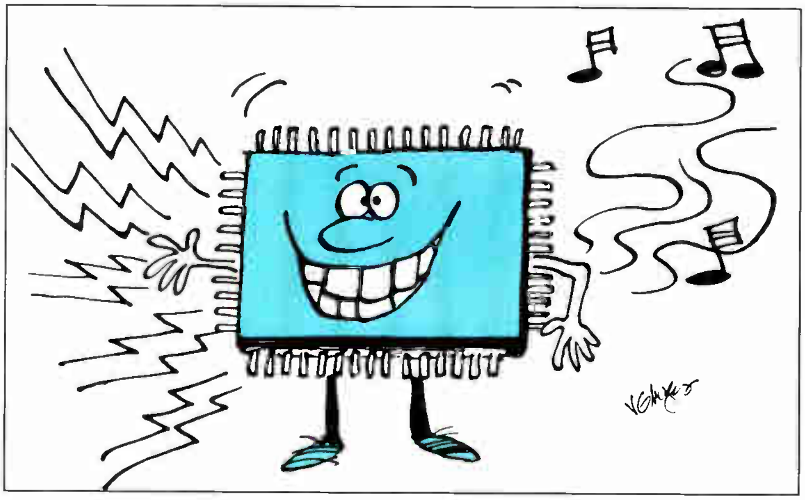
BICMOS CHIP BLANKS OUT IMPULSE NOISE IN AM CAR RADIOS

Sprague Electric combines two blanking techniques that have required hybrid solutions

Consumers bothered by the signal noise that often plagues automotive AM radios will like the sound of this: Sprague Electric Co. has developed a bipolar-CMOS integrated circuit capable of virtually eliminating impulse noise in receivers caused by auto ignition, nearby power tools, or the weather. Developers at Sprague believe the biCMOS chip is the first monolithic IC intended for broadcast-band noise blanking, and it promises higher performance at lower cost than existing hybrid components.

For car-radio makers that should be good news. Consumer gripes about impulse noise in receivers is No. 1 on the radio complaint list. So executives at Sprague's Semiconductor Group in Worcester, Mass., think they are on the verge of a big-time hit.



Samples of the noise-blanker IC, which contains both analog and digital circuits, will be available to audio radio manufacturers in August after Sprague makes a second pass at fabricating fully functional prototypes. The 18-pin device eliminates between 40 and 60 dB of audio noise, which has the effect of "shutting off the engine" in relation to ignition-caused noise, says Robert F. Milewski, product manager for radio/audio and automotive in the Signal Processing Division.

A THIRD THE COST. "This circuit addresses one of the major complaints about entertainment receivers, and especially about auto receivers," maintains Oliver L. Richards, analog applications manager. Noise or interference is the root of 95% of all complaints about auto radios, he notes. The Sprague chip, the ULN 3846A AM monaural noise blanker, will probably sell for about $1.50, which is a third the cost of a thick-film hybrid implementation most often used today. A variation of the new Sprague chip, (the ULN 3845A) will be offered to eliminate noise in AM stereo receivers.

Richards adds that approximately 70 million vehicle radios are manufactured worldwide each year. To tap into that huge potential, Sprague has combined a well-known radio-frequency blanking technique, called Lamb blanking, with an audio-frequency sample-and-hold blanking step. Lamb blanking removes noise pulses before they can overload the receiver, while audio blanking removes residual artifacts introduced in Lamb blanking. That combination produces "an extremely quiet receiver, even under widely varying noise and signal conditions," Richards says.

Lamb blanking has been used for more than 50 years to silence noise in a receiver at the intermediate-frequency stage, Richards notes. The technique is named for James J. Lamb, a technical editor on a ham radio magazine who wrote an article in 1936 first proposing the approach for general-coverage communications receivers. Variations of the technique are widely used in communications and navigation equipment.

Conventional audio blanking detects the incoming noise pulse in the rf or i-f signal, then blanks out the audio to erase the noise, says Richards. This approach involves simple timing requirements, which helps keep system cost low, and it offers good noise elimination on an unmodulated carrier. But those advantages are outweighed by one big minus: audio blanking does nothing to protect the rf and i-f stages from overload, Richards explains.

Further, the noise pulse is stretched in a manner that results in a relatively long blank timing period, which varies with the level of the incoming pulse. That pulse may contain components that are substantially less than the desired maximum audio response. With audio blanking alone, especially under very high pulse levels, the receiver's automatic gain control may be activated to a point that badly attentuates the desired signal. Richards says that the long blank timing also can result in substantially distorting the desired audio signal.

In Sprague's combination of the Lamb and audio blanking techniques, a switch is placed in the rf or i-f stage, ahead of most of the gain and selectivity portion, which overcomes the stretching and agc blocking problem.

The Lamb noise blanker stops the incoming noise pulse at a point in the receiver rf that has wide enough bandwidth to permit insertion of a narrow blanking pulse, which is effectively faster than the audio response of the i-f bandwidth. But the blanking pulse "leaves a hole in the carrier—and in the modulation—of the desired signal," Richards says.

The hole can only approach 100% negative modulation (zero carrier), and is beyond the bandwidth of the intermediate frequency. Therefore, it is filled with the finite decay and rise time of the i-f selectivity. "The i-f selectivity stretches the hole in the carrier to a value twice the rf blanking period," he says.

Richards says the Sprague circuit goes beyond the Lamb approach by recognizing and taking advantage of the synergistic relationship among rf blanking, the brief noise created by the hole, and the function of audio gating. The holes introduced into the carrier create an annoying crackle. The IC is simple, Richards says, requiring no complicated audio frequency phase-shift networks. What's more, only a few other components are needed to deliver that 40-to-60-dB noise elimination, Richards adds: five capacitors for bypass or coupling and timing, plus three resistors to set up the timing. *–Lawrence Curran*

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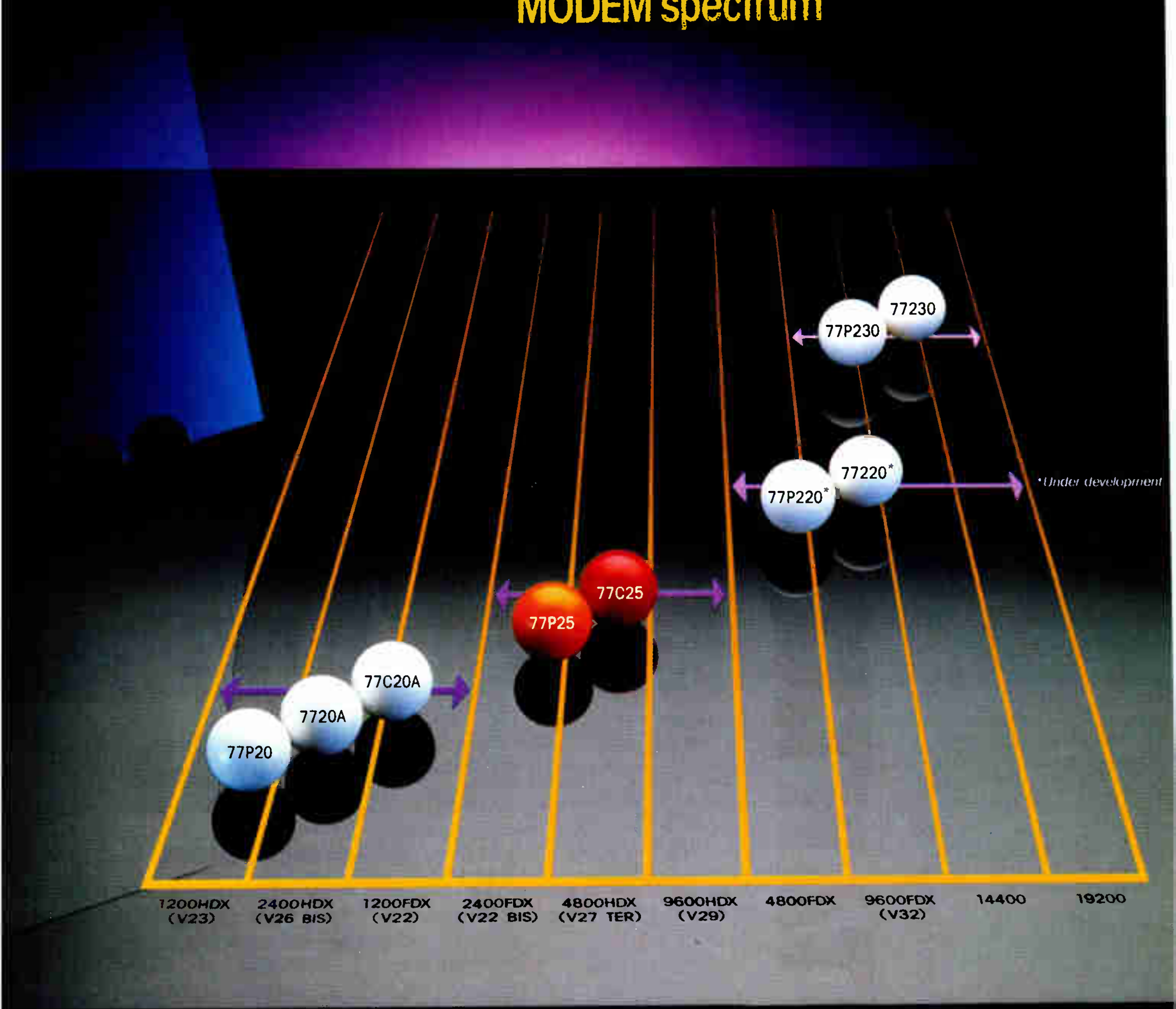

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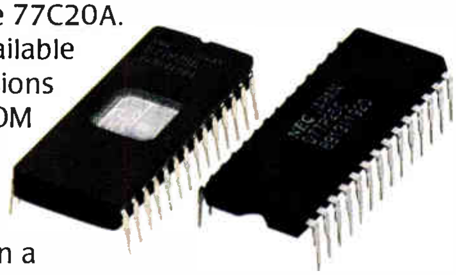

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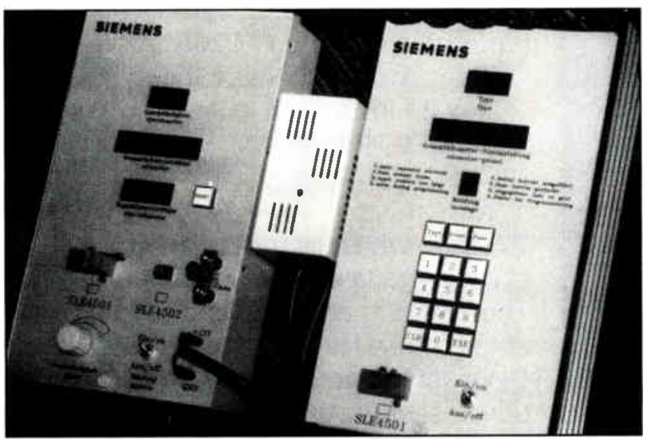
AUTOMOTIVE ELECTRONICS

TAMPERPROOF ODOMETER WILL CURB MILEAGE SCAMS

Siemens's chip set makes it impossible to turn back the electronic odometer; it also slashes assembly time and reduces space needs

Siemens AG hopes its new odometer chip set will ring up two major accomplishments. The first is to get to market an odometer that is totally tamperproof, a claim that cannot be made by existing odometers. That eliminates at least one kind of hanky-panky that can surround used-car sales, the false indication of low mileage. The second accomplishment would be to overrun the last bastion of the electromechanical instrument for car dashboards—doing away with the standard mile-counting odometer with its system of shafts, latches, and gear wheels.

The chips slash both an odometer's assembly time and the space such a unit occupies. With the two integrated circuits and peripheral components mounted on a small printed-circuit board, the instrument's installation depth is about one-tenth that of the bulky electromechanical versions. Such space reduction is good news to car companies, who are eager to trim the depth and total volume of the dashboard. The programmability of the chip set also offers advantages, letting the car manufacturer or a tire installer adjust the odometer so that it operates properly for different car models, as well as for varying tire sizes.



With this setup, Siemens is showing potential customers how its new tamperproof odometer chip set can be programmed.

Siemens has developed a demonstration system with a programming unit and a speedometer section (see photo). With it, an odometer can be loaded with a specified count and the fusible link blown. A car trip can be simulated after the programmed IC is plugged into the speedometer unit.

ON THE MARKET. The chip set is arriving on the market now. Samples have been given to a few European car makers and shown to two U. S. producers—whose names Hauenstein declines to reveal. In volume, the set will sell for about $4. Both chips operate at temperatures from -40° to 85°C and are housed in plastic 8-pin dual in-line packages.

Munich-based Siemens made the counter tamperproof at the urging of car manufacturers. Meeting this demand was possible only through modern electronics, says Alfred Hauenstein, general manager of the Automotive IC Group in Siemens' Semiconductor Division. Electrically erasable programmable read-only memory and fusible-link technologies are the keys to the odometer design.

The fact that odometers can no longer be turned back to lower mileage settings should help make the used-car business more fair and square. No longer can unscrupulous dealers sell a used car as little driven or relatively new. Car makers want this because their images have often been tarnished when used cars break down at a low—but falsified—mileages.

The electronic odometer's flexibility is also a major advantage. The Siemens chip set can be programmed to suit any vehicle model made anywhere in the world. That means car makers need not resort to stocking and installing different odometer models for different car models. At the end of the assembly line, all the manufacturer needs to do is push a few buttons to program the chip for the vehicle. That will help speed up car assembly, says Hauenstein.

The chips can also be programmed to take into account the differing sizes of new tires. Reprogramming to change the number of distance pulses coming from sensors at the wheels or axles per unit distance driven would be done at a service station after a tire change.

The tamperproof feature comes from a combination of several factors: the redundant storage of distance-representing bits in the chip set, an overflow control, and a fusible link. Once the link is blown, just before the vehicle leaves the assembly plant, the odometer cannot be set back. Only the distance pulses from the sensors will influence the count.

Of course the chip set could be artificially pulsed to make it read higher than the mileage of the car it's in, but there is no possible motive for doing this. The overflow protection is important, however, to prevent someone from pulsing the odometer all the way to its maximum count and thus back to zero. Once all count bits are set at one, the chip will ignore any further pulses.

TWO CHIPS. The chip set consists of the SLE4501 counter and the SLE4502 prescaler. The counter stores the miles count as nonvolatile information and feeds it to the total-miles indicator, which may be a liquid-crystal, light-emitting-diode, or other type of display.

Distance sensors—such as reed contacts or Hall-effect devices—whose periods are proportional to vehicle speed, deliver pulses to the CMOS prescaler chip. From the pulses, the prescaler determines the momentary speed of the car for output to the speedometer display, in addition to delivering pulses to the total-miles odometer and the trip odometer. The prescaler chip has a 16-bit programmable divider that scales the incoming pulses down to the smallest distance unit, for example 100 meters or 0.1 mile, for the odometer.

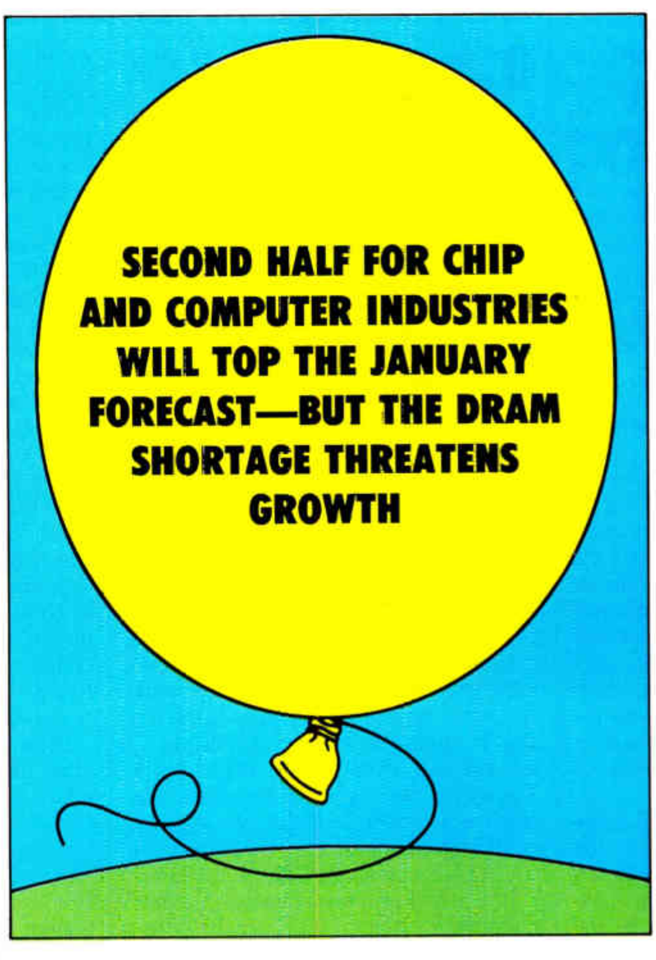
The counter chip, essentially an nMOS EEPROM device, has a count range of 22 bits. Adding the 4 bits of the prescaler chip, the set's range is 67.1 million events. If a distance of 25 meters is chosen as the smallest counting unit, the odometer would be capable of operating for almost 1.7 million km, or roughly 1 million miles.

The count is binary-coded and can be sampled serially on the three-wire bus connecting the two chips. The 64-by-8-bit EEPROM is addressed serially, and its counting operation is executed entirely under on-chip control to increase reliability. Problems in the car's electrical system that cause a loss of power or removal of the car battery have no effect on the count stored in the nonvolatile EEPROM of the counter chip.

During storage of the count information, no other count events are registered, resulting in a maximum deadtime of 10 ms in the chip's rated-voltage range of 4.75 to 5.25 V. The operating voltage must be maintained in the rated range for at least another 100 ms after the start of an operation, or else the last count event might not be permanently stored. Counts that have already been stored are not affected if the operating voltage is switched off during the storage operation. *–John Gosch*

1988 MIDYEAR MARKET REPORT

THE BALLOON IS STILL GOING UP AS THE RECOVERY CONTINUES



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The semiconductor people are fine, thank you, with revised consensus figures showing that last January's prediction—19% growth to $15.6 billion—developing into something closer to 22% growth to $16.1 billion. The computer folk, though not looking at such a fast-climbing curve, are doing business at a rate that should give a 13% increase for 1988, up two ticks from the January prediction of an 11% hike to $57.8 billion.

But hanging over both segments, and to a certain extent the components business as well, is the big cloud that refuses to go away: the shortage of dynamic random-access memories. This is causing systems makers to cut back on production, and keeping equipment prices high.

Meanwhile, telecommunications suppliers expect January's projections—up 9% to $26.8 billion—to hold true. So do test-and-measurement houses, which foresaw a 10% year, to $6.6 billion. The consumer business is expected to rebound from a sluggish first half—blame lagging sales of video products and a decline for video-cassette recorders—to record a modest 4.4% growth rate for the year. The *Electronics* survey had pegged the figure at 5%, to $24 billion.

For industrial electronics, the *Electronics* forecast was for a modest 6% rise to $6 billion, but Dataquest Inc., the San Jose, Calif., market analyst, said 11% then and is sticking to that number now. "The people I'm talking to all seem to have done a landslide business in the first half," says David Penning, Dataquest's director of manufacturing automation services.

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DRAM shortage aside, it's déjà vu for some market watchers. "Without the DRAM shortage, it looks like 1984," says William J. McClean, vice president of Integrated Circuit Engineering Corp., the Scottsdale, Ariz., semiconductor market-research firm. That was the year that saw U. S. chip sales explode 49%. So McClean figures that 1988 will be a 17% or 18% growth year, up from his 12% January prediction.

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Similarly, the shortage is also leaving its mark on components markets. Fewer computers being built means fewer components of all classes being bought. Nevertheless, it looks as if good growth in printed-circuit boards will push 1988 consumption to a 12% increase in sales, to $25.4 billion, rather than the 9%, to $24.6 billion, predicted by *Electronics*.

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But that shouldn't happen, says William Connell, vice president of marketing at NMB Inc., a Chatsworth, Calif., DRAM distributor. He says prices on commodity DRAMs appear to be peaking now, and should start to drop over the next six months. ICE's McClean, however, is less optimistic. He says that higher prices could continue through the summer, and only begin to drop off in the fourth quarter, when a number of new 1-Mbit DRAM facilities come on line in Japan and Korea.

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The fly in the ointment for RAM makers is an anticipated cyclical downturn, a storm that is only just beginning to form. In the chip industry, good times are always followed closely by a downturn, and analysts now say the decline will begin in late 1989, based on historical evidence. But how bad that contraction is—or whether it will happen at all—is still very much a matter of conjecture.

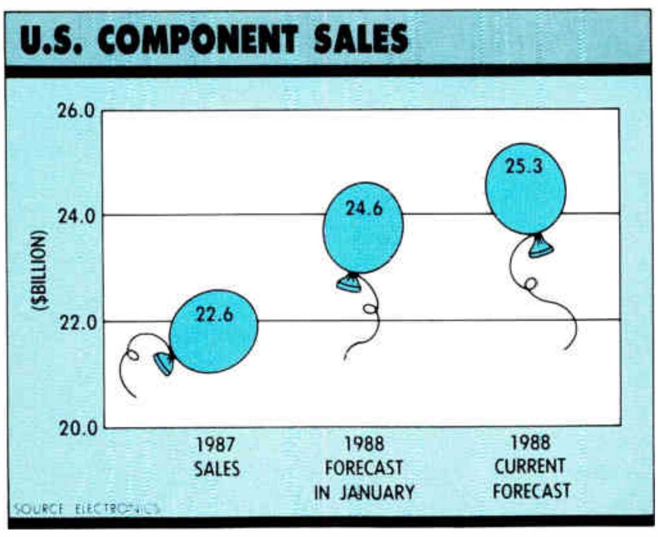
One industry analyst, Michael A. Gumport of Drexel Burnham Lambert Inc. in New York, says he expects a general downturn in chip sales late in 1989. Jack Beedle, of In-Stat Corp., also predicts a drop, but he doesn't expect it to be steep. Instead, he says it will be a is holding fast with his projection that the chip industry will sustain its current hearty growth through 1989, when he promises a 17% increase.

Looking at the May book-to-bill, which showed a slight decline—1.15 in May versus 1.19 in April—Kessler points out that the decline came strictly from increased shipments, and that bookings continued to grow. "That means the industry is catching up with demand, which is still growing," he explains. Kessler believes the industry is now starting to see the end of the DRAM crisis as 1-Mbit producers are finally getting higher yields from their wafers.

"It took them one year," he says. "They have a lot of catching up to do" in price reductions. He predicts that 1-Mbit costs will soon start tumbling and that greater availability and lower prices of 1-Mbit DRAMs will keep the chip industry thriving—and fuel a price war in the personal-computer and workstation markets. *—Bernard C. Cole*

COMPONENTS

COMPONENTS GOING BETTER THAN EXPECTED



With equipment sectors enjoying a good year, it stands to reason that component sales will mirror those gains. And that's what the analysts are saying as they see a second half that will be better than their optimistic projections of six months ago.

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The only problem that could derail the accelerating improvement is the shortage of dynamic random-access memories, which worries all equipment makers. In a worst-case scenario—which is not foreseen now—the unfilled DRAM orders would trigger production cutbacks that would, in turn, reduce demand for even those boards that do not hold memory, says Harvey Miller, president of Kirk-Miller Associates, Palo Alto, Calif., a consulting firm that follows printed-circuit boards and interconnections. "We're all concerned about a slowdown," he says, adding that there is still no evidence that one is imminent.

The strength of the board business at present is underlined by figures compiled by the Technology Marketing Research Council, a Chicago group that follows components markets: from January through March unit sales were proceeding at a 20% greater clip than the rate for 1987. Moreover, when final figures for 1987 were tabulated by the council, the increase over 1986 was 20%, far above the 8% gain, from $20.9 billion to $22.6 billion, estimated by *Electronics'* sources at the start of 1988. Because boards and interconnects make up more than 20% of the component totals, a gain of this magnitude should move the overall increase up

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SEMICONDUCTORS

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In the volatile chip market, rough times are always just around the corner, and this upswing is no different. With limited availability of 1-Mbit and 256-Kbit DRAMs, the average selling price of all ICs has jumped 18.4% over last year, from $1.63 to $1.93. Unit sales, meanwhile, have risen at a much slower 7.6% rate, meaning that those chip makers who aren't supplying memories aren't reaping as much success out of the current market as it might seem. The real winners are the Japanese, who had the stomach to suffer through the great chip slump of the mid-1980s without bailing out of the DRAM market.

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U.S. SEMICONDUCTOR SALES

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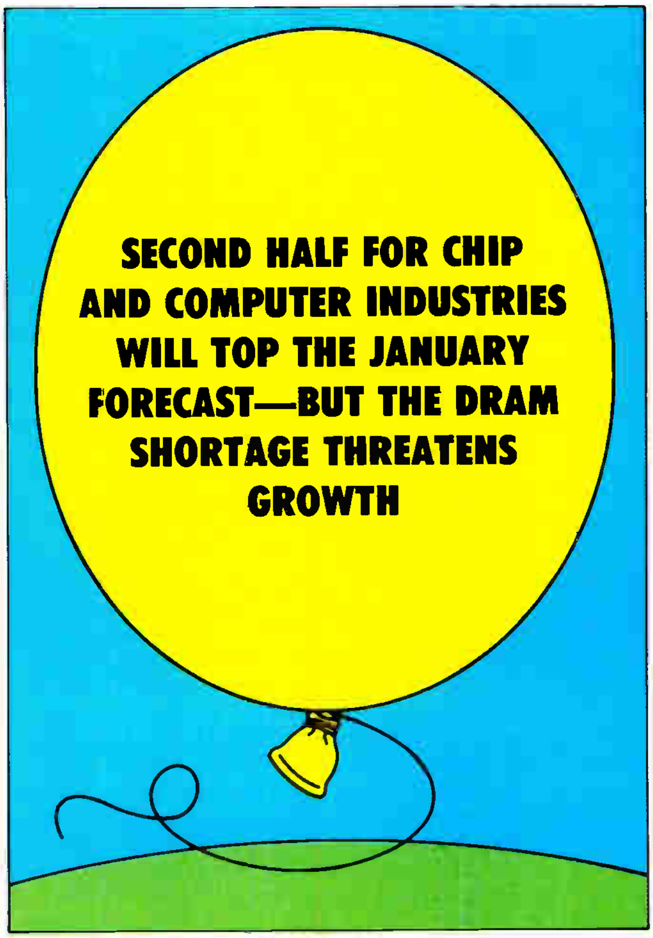

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The outlook is different in West Germany, where there is not much of a native computer industry to be stymied by chip shortages. But electronics consumption will be helped by massive increases in consumer spending—the gross national product in the first quarter of 1988 rose 4.2% over the same 1987 period. "Given the upspurt in private consumption, consumer electronics and some branches of data processing will feel the impact," says Manfred Beinder, chief economist at Standard Elektrik Lorenz AG. So although the *Electronics* forecast six months ago in the West German consumer sector was for a flat 1988, experts are now predicting a 3% rise, to $6.8 billion.

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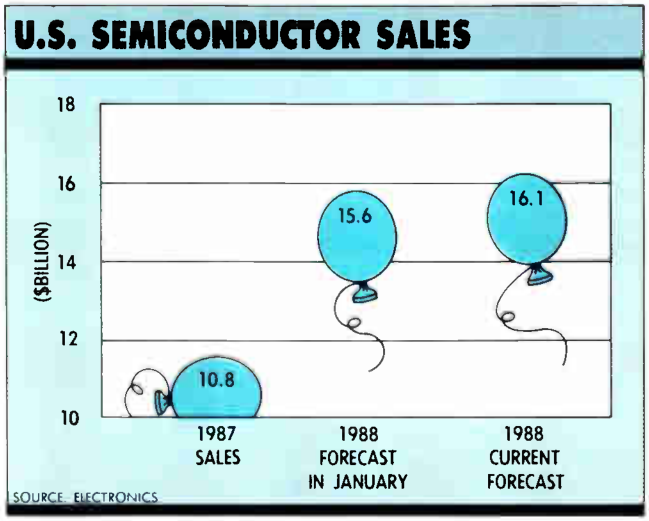
Likewise, the power IC market, which has so far been meeting expectations with 35% growth over



last year, could be squeezed if DRAM prices continue to rise. Power IC sales depend heavily on the personal computer market, which, in turn, leans heavily on the availability of memory chips.

The DRAM shortage hasn't significantly affected the microprocessor market thus far. McLean says ICE still expects 12% growth in all microprocessor categories, and much higher growth for 16- and 32-bit processors—about 30% and 200%, respectively. But if the shortage goes on much longer, says Tim Propeck, vice president of marketing at Advanced Micro Devices, shipments of both 16- and 32-bitters could drop sharply.

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The result has been lower SRAM production and higher prices. The trend should hold through the end of the year, Crane says, when new suppliers come on stream with 256-Kbit and, eventually, 1-Mbit parts. "Price competition will set in during the first quarter," he predicts.

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There are, of course, always optimists. Andrew Kessler, the semiconductor industry analyst at PaineWebber Inc. of New York, acknowledges that DRAM prices will come back to earth. He even admits that the decrease will wound the industry's book-to-bill ratio. However, Kessler is holding fast with his projection that the chip industry will sustain its current hearty growth through 1989, when he promises a 17% increase.

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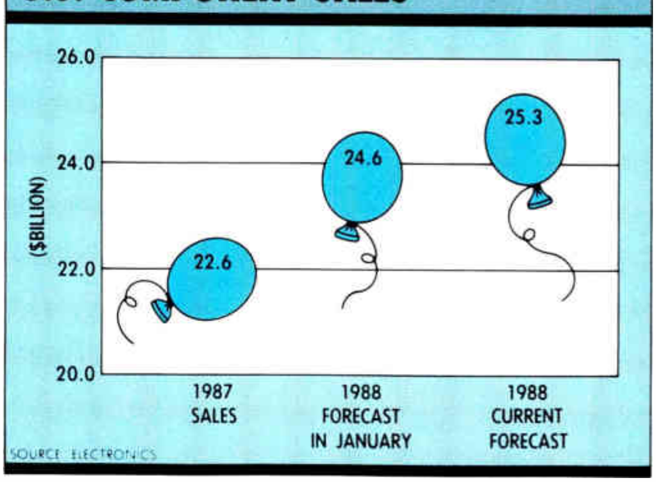

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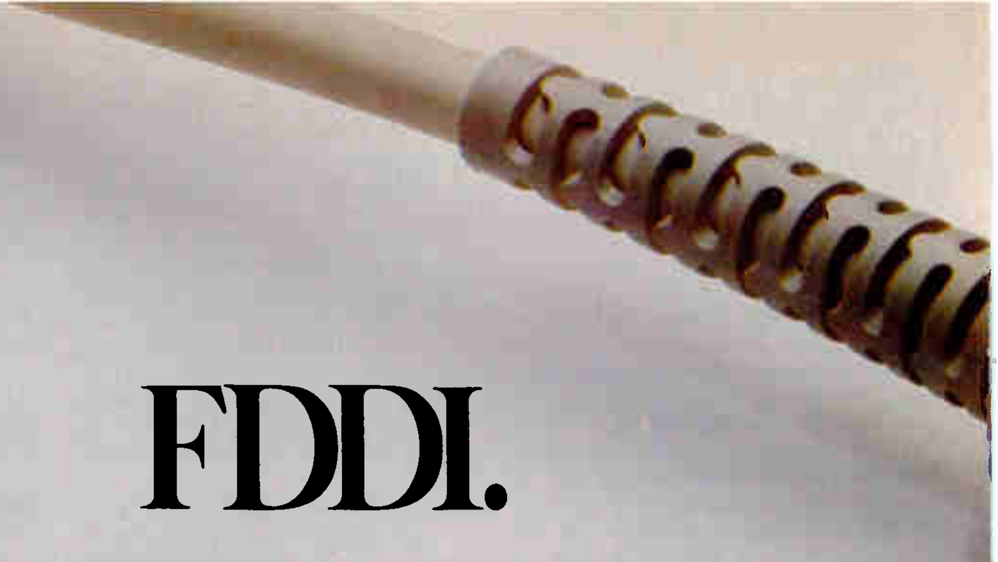

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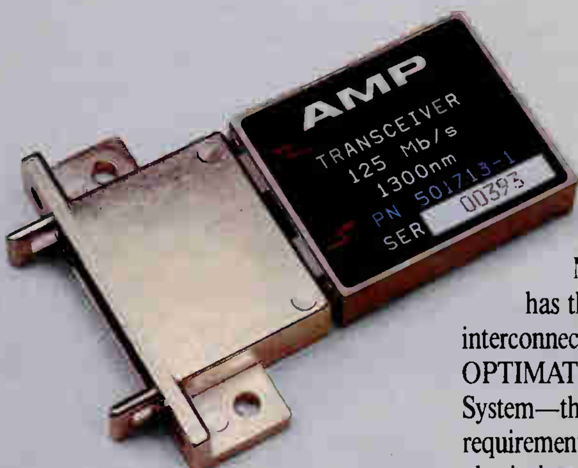

Good news for networks!

The X3T9.5 Task Group, under the procedures of ANSI Accredited Standards Committee X3, has reaffirmed approval of the Media Interface Connector (MIC) for the proposed FDDI (Fiber Distributed Data Interface) Physical Layer Medium Dependent (PMD) document.

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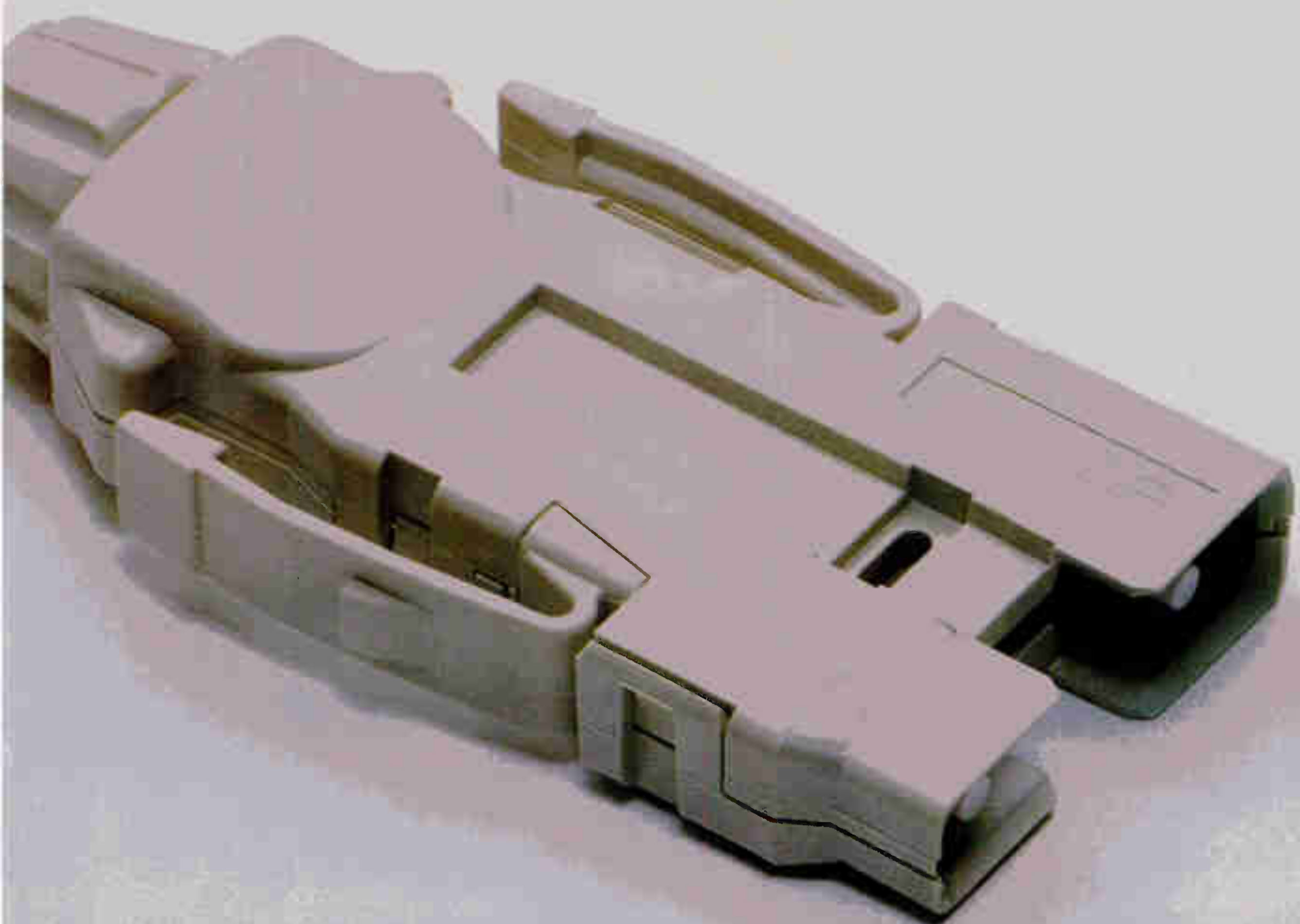

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AMP Interconnecting ideas

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"By the time we got this product out, our competition had been there 5 months. We figure it cost us $3 million in sales."

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What if...

"I think we've got a pretty good handle on why we seem to be lagging behind. We have too many prototype revisions before we get out of the lab. And each one takes time. It's that simple."

"We hear that from a lot of our customers these days. And development time isn't the only problem."

"You're telling me. Our markets are changing pretty much by the month. It's moving so fast and we've got to be able to react. This whole environment is creating all kinds of demands on us we've never had before. In every department in the company. It's absolutely essential that we find ways to meet our schedules for new product introductions."

"We understand those demands at HP. You're talking about resource constraints, cost and time commitments, limited R&D funding, product consistency, that kind of stuff, right?"

"Exactly. We need to make better use of the technology available to us. Let me tell you about some things we need to do. One that's critical is logical integration, not just physical, between groups within the company—design, test, mechanical, manufacturing—so they can work more closely to cut design time without letting quality go out the window."

"What else?"

"We've got to be able to make product improvements or develop entirely new lines at the same time. We've got to handle a tremendous increase in the volume of code we're writing. We've got to make products manufacturable on the first pass. All in a people environment that is notorious for resisting change."

"That's why we need to talk about DesignCenter. We're not talking about equipment alone. DesignCenter gets at the issues of how people work together, how you hold your profit line, how you can deliver products on time and still lead with technology."

"Well, that's what we *need* to be talking about. But we hear this productivity story from every vendor we talk to. What makes HP any different?"

"There's simply nobody out there that looks at the problems you're facing today like we do. We're not here to sell one 'better box' after another. We're here to get involved—to be a partner. We'll help design a multi-vendor system that works, customize interfaces, train your people... until you're running the way you need to be. We're that serious."

"Well, exactly what is DesignCenter? I mean, what's the bottom line, what does it mean to us."

"What we're trying to do is give your people a single data path—plus all the support you need—from the time you come up with an idea through to a finished product. I mean out the door and on the truck."

"You can do that today?"

"No. Nobody can. But the fact is, HP is probably the only company that can get you there any time soon."

"Listen, I want some of our project managers to hear more about DesignCenter."

"I'll put a team together and call you tomorrow. When do you want them here?"

"How 'bout Thursday?"

"Name a time."

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More and more companies are talking to HP about productivity and DesignCenter. Start a dialogue today. Call toll free and request the free booklet "Design Automation... The Bottom Line." 1-800-752-0900, Ext. 501B.

HEWLETT PACKARD

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smartly, even if the rise tapers off later in the year. Miller now projects pc boards at a 14% gain for this year, on the heels of the 20% for 1987, and a 7% increase in 1986. His tentative forecast for next year is 13%.

Confirming the rosy outlook is Flextronics Inc., a Newark, Calif., board-level assembler with a diverse customer list. "We're seeing steep growth—in the case of the six-layer boards in mass memory, 30%-40%," says Dennis P. Stradford, senior vice president for marketing and sales. A particularly hot product is the 3.5-in. disk drive. The reason is that U.S. personal-computer activity is benefiting from the weaker dollar, with some companies opting to keep assembly business formerly ticketed for Asia closer to home, he adds.

The other major components area, power supplies, accounts for less than half the market of pc boards. It seems to be running somewhat behind the 21% growth track predicted six months ago. The problem is not in personal computers, work stations, or peripheral equipment—sectors that are matching or bettering growth predictions. Rather, the shortfall comes from "U.S. power-supply firms shut out of the Asian-produced PC clones," says Barry A. Chenes, vice president for marketing at Powertec Inc., Chatsworth, Calif.

But in a business that's highly fragmented, there are exceptions. One is Power One Inc. of Camarillo, Calif., which sees a 20% hike this year mostly because of its line of 1,500-W mainframe supplies. "Without it, [growth is] only 5%," says vice president Stephen Cole.

Other segments are running close to January projections. In connectors, for example, the year should see a 6% increase, notes an executive at ITT/Cannon, Fountain Valley, Calif. Military sales continue soft, with the best commercial activity in high-pin-count units, especially those that meet stiff rfi/emi requirements. *–Larry Waller*

COMPUTERS

COMPUTER NEWS IS GOOD, BUT IT COULD BE BETTER

The computer business is doing just slightly better than the 12% growth forecast by the *Electronics* survey, mostly because of good tidings from big mainframe systems, midrange multiuser Unix systems, personal computers, and technical work stations. The growth at midyear is shaping up for a 13% hike, to $57.8 billion, but the industry could be doing even better if the minicomputer picture were not mixed. Big 32-bit superminicomputers are still going at a strong 17.5% growth clip but 16-bit systems are likely to drop as much as 20%.

In a surprise, top-performing mainframes are growing 15% or better, to $19.3 billion, considerably ahead of the 6% growth forecast by *Electronics* in January. But the real star performers are the multiuser Unix systems based either on single reduced-instruction-set processors or conventional, multiprocessor systems. The growth, pegged at 25% to 30% this year, derives from their stellar price/performance ratios, ease of expandability, and open architectures.

Technical work stations and high-end personal computers are growing at 15%. Technical work stations will grow to $2.8 billion and high-end PCs to $5.2 billion. Sales of the most powerful personal computers using the Intel 80386 processor will grow 160% this year, according to McGraw-Hill Inc.'s Future Computing/Datapro unit in Dallas.

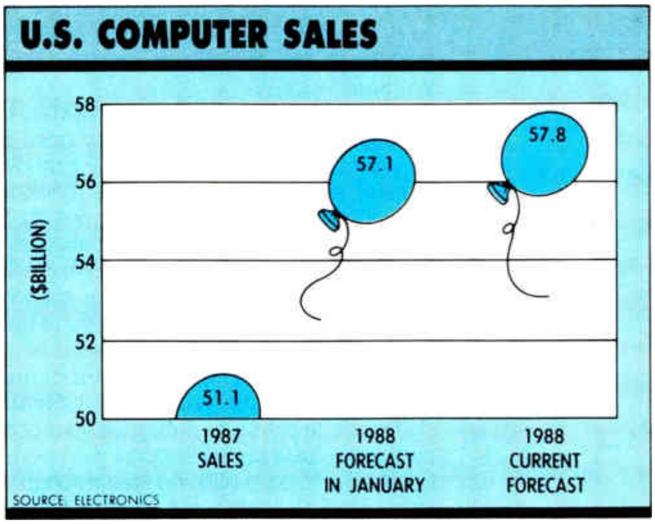
These average percentage growth rates are a bit deceiving. The outlook for the industry varies among analysts and company executives. Charles T. Casale, president of Aberdeen Group Inc., a Boston consulting and research firm, has forecast up to 15% growth for the computer industry. But Ward MacKenzie, vice president for corporate marketing at Data General Corp., the Westboro, Mass., minicomputer manufacturer, pegs growth at only 6% to 8%. But personal computers and work stations will perform at 20% or more, he says.

Important trends to watch, MacKenzie says, include the growing movement to industry standards, an equally fast evolution to high-performance VLSI processors, and the growing integration of PCs into a corporate hierarchy that also includes corporate mainframe, departmental/client servers, and PC computing resources. MacKenzie concludes that these and other developments add up to "a long-term prognosis for the industry that's terrific."

BETTER IN 1988. For the mainframe market, Aberdeen Group's Casale estimates that the segment will be up 10%, which is much better than its usual 6% to 7% growth. "It's anyone's guess as to whether the mainframe strength will carry over into 1989," says Casale.

Similarly, the minicomputer is expected to experience moderate growth. Jacqueline Lustig, manager of investor relations at Prime Computer Inc., is looking for 8% to 10% growth in minicomputer systems this year, which she characterizes as good. Others paint a darker landscape, noting that proprietary 16-bit and low-end 32-bit systems are growing slower than the rest of the computer industry. "For the first time in memory, the minicomputer crowd is growing only as fast as mainframes," says Casale, estimating growth at 10%.

Another market watcher sees the 16-bit minis losing ground. "The older generation of minicomputers—the 1970's technology 16-bit computers—have been on a negative ramp for a couple of years now," says Brad Smith, a senior analyst at market research firm Dataquest Inc. in San Jose, Calif. Dataquest estimates a negative 20% rate.



The forecasts are much brighter, however, for midrange multiuser Unix systems. "The Unix-based multiuser market is growing at more than twice the rate of the computer industry—it's holding up at about 26% at midyear," says Wendel Harrison, computer system division marketing manager at Texas Instruments Inc. in Austin.

Unix-based products are making forecasting a somewhat more complicated task than in the past. "Traditional product categories don't work anymore," says Michael Simon, vice president of marketing at Sequent Computer Systems Inc. in Beaverton, Ore., a Unix-based computer vendor. There is no classification for one of the fastest growing type of systems, big systems built with parallel microprocessors. These computers are neither microcomputers, minicomputers, nor mainframes, yet they span the performance range of all these. But this new market is booming, he says.

A Sequent competitor agrees. "The overall computer industry will grow by 9% to 10% this year, but our segment is growing a lot faster," says Frank Pinto, vice president for marketing at Encore Computer Corp., Marlboro, Mass. Encore is in the high-performance multiuser Unix segment, which Pinto estimates will finish the year with an increase of 20% or more.

Arix Corp., another Unix market player, believes business is picking up this year, says Mike Lambert, vice president, marketing and sales. He sees no signs of a downturn in 1989.

THE MATURE PC. Unlike Unix-based products, which are still on a high-rate-of-growth path, person computers are turning into a mature product sector. "It is clear that the personal-computer market is maturing and the annual growth rate is slowing down on a much bigger base—but the absolute growth is still big," says Andrew Czernek, vice president of product marketing at Zenith Data Systems. However, some segments and application areas are growing at the old higher rates. "There is an increasing orientation towards applications in the PC market: for example, the portable personal computer segment will double as applications are established," says Czernek.

At the other end of the performance spectrum, Carl Ledbetter, president and chief executive officer of supercomputer and minisupercomputer maker, ETA Systems Inc., St. Paul, Minn., reports a healthy market.. "We expect the growth in the high-end supercomputer segment to be two to three times that of the computer industry—24% to 30%," he says.

In the minisupercomputer class, which includes Alliant and Convex, Aberdeen Group's Casale says that two factors are hampering growth compared to recent years. "One is that early adopters have one but aren't placing big follow-on orders; the other is customer confusion about vendor claims," he says. He looks for a drop from the previous 35% growth to a rate in the 20%-to-25%-range for minisupercomputers.

A battleground is also developing in the work station market, says Casale, with Apollo Computers Inc. and Sun Microsystems Inc. "slugging it out and leaving a lot of blood on the floor." Casale pegs 1988 unit growth in work stations at about 45%, but revenues in the segment will grow only 15% because of price erosion resulting from competition. He believes most of the cost cutting is over, however. *–Tom Manuel, with additional reporting by Lawrence Curran and Jonah McLeod*

PERIPHERALS

LED BY OPTICAL DRIVES, PERIPHERALS SALES JUMP

As go computers, so go peripherals, and the word for both is "bullish." The forecast now is for growth of 16% overall, to $27.1 billion; six months ago, the consensus of experts reported in *Electronics* was that growth would hit 11%, to $25.4 billion. Leading the peripherals charge are optical, hard-magnetic, and tape drives.

The *Electronics* poll had pegged the 1988 growth of the optical disk-drive market at 96%, to $315 million. The high rate is not unusual for a new technology just now emerging commercially. Nevertheless, two market research firms following the market disagree; although both say that growth in the second half will be strong. Disk/Trend Inc. of Mountain View, Calif., predicts 72% growth. Somewhat less bullish is Freeman Associates in Santa Barbara, Calif., which says it will be only 47%.

The emergence of CD-ROM and WORM drives fuels the big optical-drive gain

The growth in optical drives is due to CD-ROM (compact-disk read-only memories) and WORM (write-once, read-many) drives finally beginning to ship in volume, says Robert Abraham, vice president at Freeman Associates. Both products took a long time getting there because the support that they needed for growth took a long time to get in place. CD ROMs needed data-base suppliers and disk-replication facilities; and both they and WORM drives had to find new distribution channels for handling new markets.

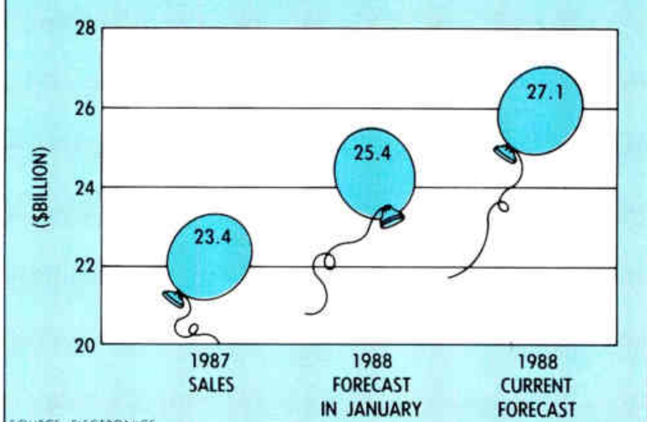
In fixed magnetic-disk drives, the consensus of industry watchers is that the 30% revenue growth rate, to $5.2 billion, projected by *Electronics* will continue in the second half of the year. Disk/Trend agrees with the continued growth but disagrees with the rate. Robert Katzive, an analyst with the company, puts the sales growth rate at 15%.

Disk drive demand is coming primarily from growth in shipments of work stations and personal computers. Work-station makers are buying drives with capacities that exceed 200 Mbytes—particularly the popular 380-Mbyte, 5.25-in. models. And PC manufacturers are buying high-capacity 5.25-in. and 3.5-in. drives.

Floppy-disk drives are continuing their no-growth pattern of the past few years, says Katzive. *Electronics'* January forecast of a dip, from $1.3 billion to $1.2 billion, is expected to hold for the year. Tape drives, on the other hand, will continue their upward spiral. The consensus is that one of the stars in the tape firmament will be 1/4-in. cartridge tape, whose market should keep growing at its current 19% rate to $394 million. The other star performer is 1/2-in. cartridge tape drives. *Electronics* predicts a 23% growth rate for this market segment, easily exceeding the conservative 6% rise, to $542 million, previously forecast.

In printers, impact models are losing market share, says Maureen McManus, associate director of the Electronic Impact Printer Service at CAP International Inc., a Marshfield, Mass., market research firm. Market share will drop to about 65% in 1991 from an 85% share in units in 1986, she says. In dollar value, impact printers will slip from a two-thirds market share to one third during the same period. *Electronics* had predicted total sales would slip to $5 billion from $5.1 billion in 1987. And nonimpact printers are now growing strongly as the preferred output devices for work stations, she says.
–Jonah McLeod, Lawrence Curran

U.S. PERIPHERALS SALES



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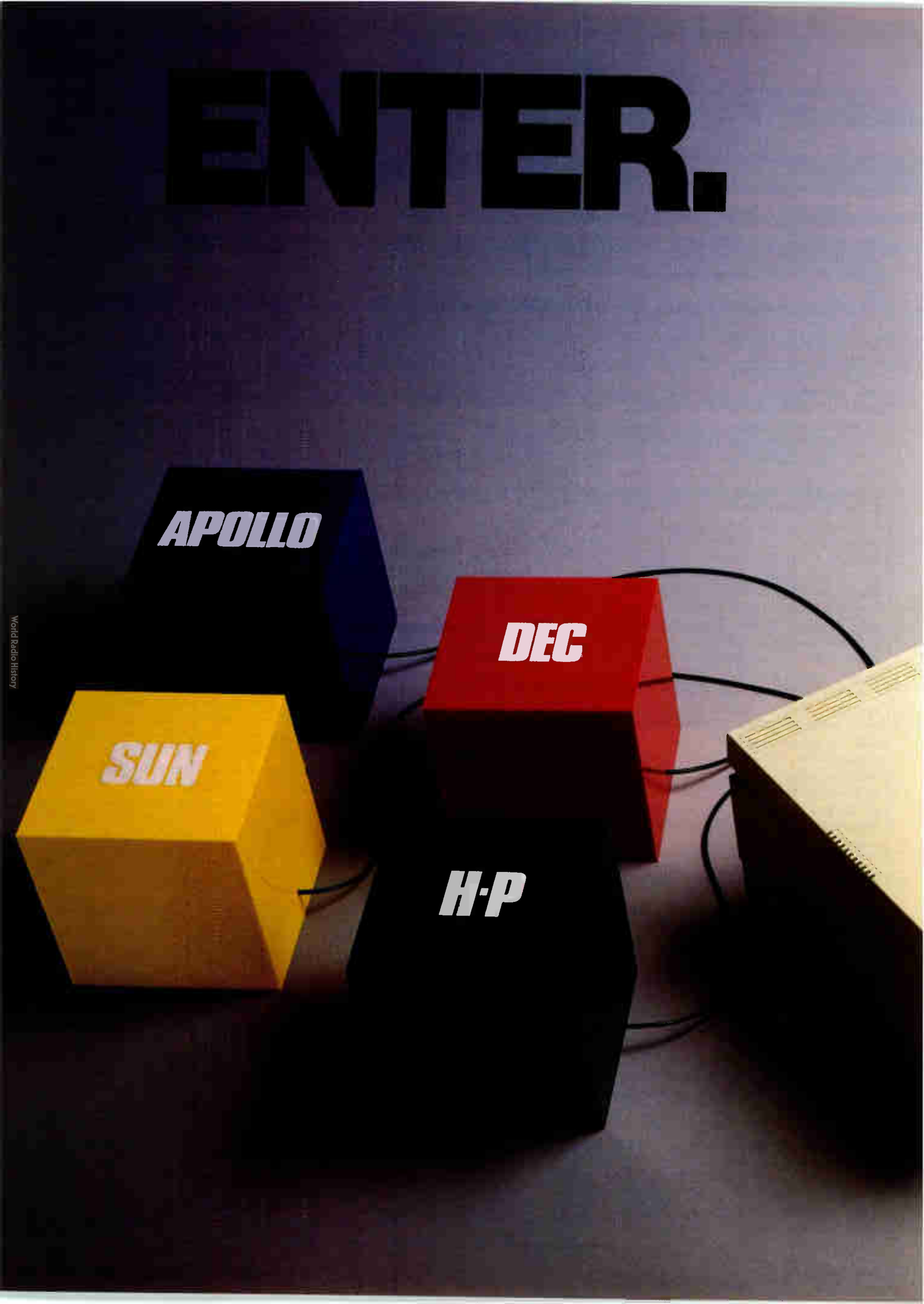
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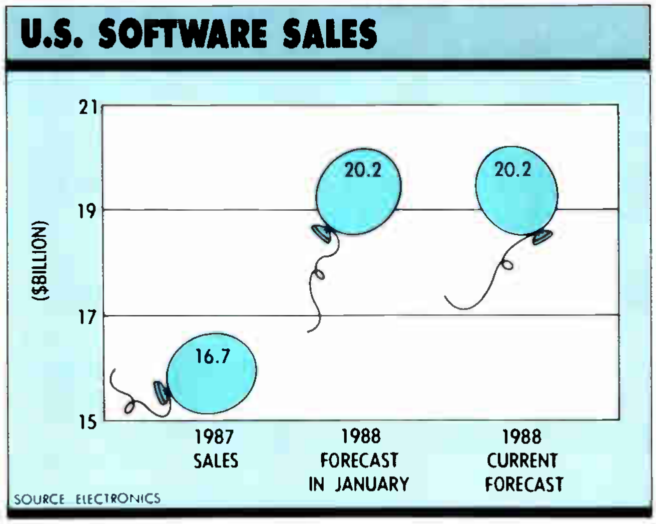
SOFTWARE

SALES OF SOFTWARE ARE HUMMING ALONG AS EXPECTED

At midyear, U. S. software markets are humming cheerfully along at the 21% growth rate predicted in *Electronics'* January forecast. Any change from the $20.2 billion market predicted six months ago, however small, is likely to be upward—a consequence of the strength in hardware sales. In fact, software vendors and industry analysts have figured all along that 1988 would be an overall good year. The one change in expectations is in personal-computer applications programs, which some view as growing a touch faster than anticipated in January.

Some forecasters had a slight case of the jitters at the beginning of the year due to uncertainty about the way the economy would react to the October stock-market crash. But "the crash didn't have much impact," says Scott McLarnon of International Data Corp., Framingham, Mass. "We haven't seen much reason to adjust our numbers during the last six months."

No major market segments are reporting the need to revise their revenue projections downward, and some subsegments of PC application software may grow somewhat faster than projected early this year. PC product types attracting attention are desktop publishing, forms-generation software, and graphics-presentation programs—which jazz up the numerical output from spreadsheets and data bases by adding three-dimensional "depth" to graphs and charts. These are performing very strongly, says David Perro, research analyst with Dataquest Inc., San Jose, Calif. To include the vibrancy of these submarkets, Perro's 1988 projections for the entire PC segment of application software are being revised upward an extra 5% over the original projection.



Mainframe markets are proceeding "much as expected," says Anthony Percy, vice president of strategy at mainframe software house Applied Data Research, an Ameritech subsidiary in Princeton, N.J. From the mainframe perspective, changes spinning off IBM's System Application Architecture as embodied by the upcoming Presentation Manager for the PC OS/2 operating system "will be fairly slow," he says. Also, he adds, "there isn't really the seed demand for the added capability of OS/2." *—Jeremy Young*

TELECOMMUNICATIONS

NO SURPRISES; TELECOM SALES ON TRACK

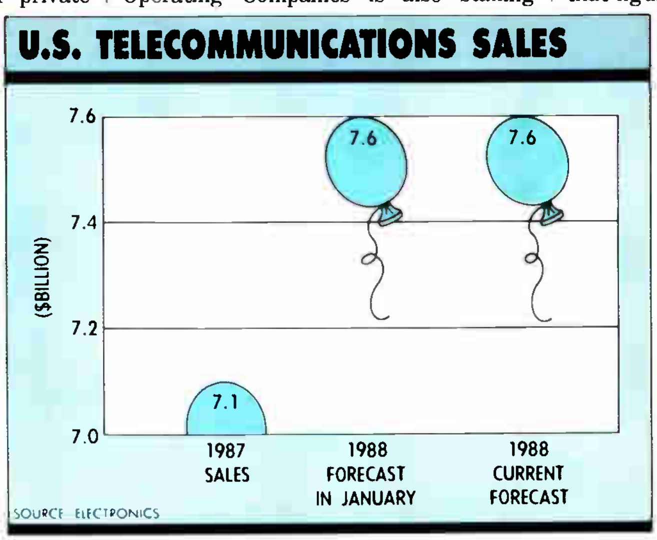
The telecommunications markets, which lack the volatility of such product groups as semiconductors and personal computers, will not vary much over the next six months from the 7% rise forecast in January. Total sales should hover around $7.6 billion.

There are several depressing factors acting at the high end of the market, such as the lower demand for private branch exchanges. But sales of less costly items such as facsimile equipment, modems, and other data devices are growing 14% to 20%. They are acting as a counterbalance, producing a 7% overall rise.

Another high-growth performer is cellular telephones, says Herschel Shosteck of Shosteck Associates, a market research firm. The number of installations has been almost doubling every year since 1984, he says, and a million units will be produced in 1988. At an average wholesale price of $500 each, that adds up to a half-billion-dollar market.

The news is not as good at customer premises, where terminal and switching equipment such as PBXs constitute a large investment that moves in well-defined cycles—and some companies are extending their replacement schedule to see how the integrated services digital network will affect them. The emergence of competitively priced, enhanced Centrex services from the Bell Operating Companies is also stalling PBXs, says Eric Nelson, an analyst with the North American Telecommunications Association.

Despite the uncertainty, the PBX industry is still expected to rack up about $3.3 billion in sales in 1988, says Hal Denton, vice president of product marketing for Intecom Inc., a Wang Laboratories subsidiary in Allen, Texas. But that figure represents only a 2% growth rate. "People are going more for applications solutions rather than investing in new technology," he says.



Another difficulty is the market penetration of foreign companies—and the still-solid trade barriers the European and Japanese PTTs (state-owned postal, telephone, and telegraph companies) have erected against U. S. vendors. "The U. S. is running a $2.2-billion deficit in telecom products," says Mike Frishkorn, president of the Telecommunications Industries Association, "and it wasn't so long ago that we were running a trade surplus." *—Jack Shandle*

T&M GROWS AT ITS FORECASTED 10% CLIP

Thanks to the push it's getting from overseas and from the computer business, the test and measurement sector is on track with the 10% growth rate predicted for it by *Electronics* at the start of the year. Total shipments for 1988 should reach $7.9 billion.

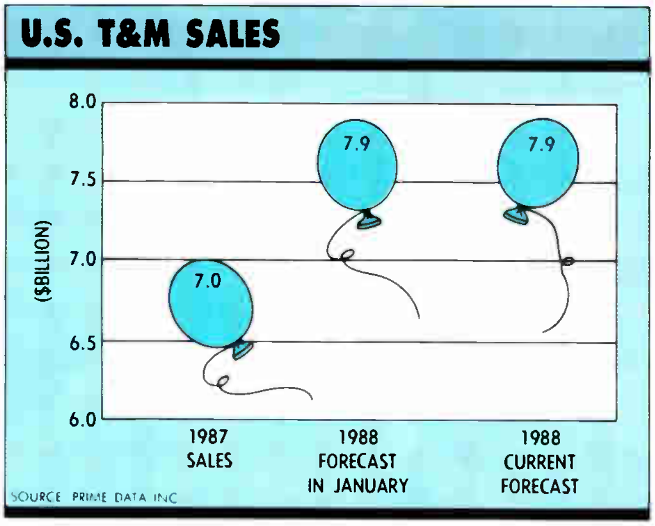
Most of that strength is showing up in high-end automatic test equipment. Overall, including product lines ranging from component test systems to board testers, the ATE market should continue to grow at the 10.2% rate that was forecast at the beginning of the year, to $1.9 billion. For other test segments, however, growth is spotty: among oscilloscopes, shipments of digital models will increase 25%, as predicted in January, winding up the year with a total of $488 million. But analog scopes will be showing weak growth, finishing the year up 5%, to $683 million. And logic analyzer sales, for which the earlier forecast saw a 25% increase in sales, to $370 million, will manage only to advance 10%, say market observers.

The growth in overseas sales can be credited at least in part to the weak dollar. The positive effects of the dollar's slide is being felt particularly at Tektronix Inc. The big company is often cited by market watchers as a T&M industry bellwether because of its wide-ranging product line. At headquarters in Beaverton, Ore., executives say that the percentage of the company's business abroad has grown steadily over the past few years, coinciding with the decline of the dollar. In its quarter ending in May 1987, the figure was 42%, but that climbed to 45% a year later.

Coupled with that evolving development, and adding to the importance of overseas marketing, the U.S. market during the first half of 1988 was relatively sluggish compared with activity abroad, says Galen Wampeter, an analyst at Prime Data in San Jose, Calif. But he expects the domestic market to come alive in the second half, with federal agencies getting into the buying mood as they try to use up their allocations in anticipation of a new administration. That should account for the increase to 13% over 1987's rate, giving the industry a nice kicker.

In big-ticket T&M equipment, aside from ATE, sales of IC testers are also moving ahead at the predicted 10% rate. The January forecast was that the total for the year would reach $856 million. For IC testers, Ken Neff, also an analyst at Prime Data, says that sales would exceed those of board testers, a trend that should continue through the end of 1989 as the chip industry continues to increase its sales. The earlier *Electronics* consensus forecast was for a 9.5% increase, to $680 million.

"The semiconductor business is a leading indicator for the T&M industry in general," says Wampeter. He adds that as memory shortages continue, the strong demand for chips spills into the T&M industry and results in makers of IC testers also running at full capacity.



In fact, makers of IC testers are running at full capacity, says Daniel Hutchinson, an analyst at VLSI Research Inc. in San Jose. He says that the inventory of ATE suppliers has been declining, which means that suppliers are shipping everything they can make. He adds that even a sudden drop in demand today would not be felt for up to six months because of the built-up momentum.

BOARD TESTERS LAG. Board testers have not done as well as IC testers because buyers have not been getting the expected incremental improvement in productivity expected from these high-ticket items. John Zepf, director of marketing at GenRad Inc. in Concord, Mass., says that customers are looking for other functionality such as shorter test-development times on large board testers to justify the purchase. He says his company's board testers are finding market acceptance because the new generation of software being added dramatically cuts test development.

Another ATE trend is the pell-mell race to connect equipment with the design tools used to create chips and boards. The best example of this trend is the acquisition spree that Teradyne Inc. has been on in the past few months. The Boston company has picked up Aida Corp. of Santa Clara, Calif., a maker of simulators, and Case Technology Inc. of Mountain View, Calif., which develops computer-aided-engineering systems. The idea is to take advantage of the significant growth opportunity Teradyne sees in selling tools to engineers that automate the design and test process, says Joseph Lassiter, group vice president.

Other vendors are moving to seize the opportunity. Mentor Graphics Inc. recently entered an agreement with its Beaverton neighbor Tektronix to tightly integrate their design and test equipment. Neff of Prime Data says that front-end simulation tools will continue driving the demand for functional board testers.

For the rest of the T&M industry, Prime Data sees sales growth of 13%, slightly higher than *Electronics*' overall rate of 10%. Wampeter says that analog oscilloscope demand will be flat for all of 1988, while he expects digital scope sales to grow 20% to 30%. The low end of the scope market continues to experience fierce price competition with new entrants still hoping to garner market share lowering prices.

Revenues for logic analyzers have slowed due in part to a price cut brought on by Hewlett-Packard Co.'s innovative logic-analyzer-on-a-chip technology. The net result has been that in addition to the market's expansion as a result of the more attractive prices, HP has gained market share. But despite the wrestling match over market share, the market itself will manage to grow 10% for the rest of 1988.

Among other test equipment designed for digital logic design applications, the microprocessor development system and related components have finally completed the metamorphosis that killed the dedicated MDS and gave rise to the stand-alone in-circuit emulator. Wampeter expects this market segment to grow 10% through 1988 as compared with the steady decline it has experienced for the past few years.

The rest other segments of the T&M market is a mixed bag. "Sales of network analyzers will enjoy a growth rate in the teens," says Wampeter, "while counters will see a year of declining growth." *–Jonah McLeod*

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SUDDEN WAVE OF CONTROLLER CHIPS AIMS TO BREAK LASER-PRINTER BOTTLENECK

Special-purpose ICs will help OEMs tap full potential of laser-printer boom

by Bernard C. Cole

Laser printers are wonderful, capable of very fast output of high-resolution text, and offering graphics capabilities galore for desktop publishing and other applications. But the current crop of laser printers has a problem: when asked to do fancy graphics work, the page rate they deliver drops through the floor.

Now a new generation of application-specific controller chips is hitting the market, chips that aim to solve this problem, freeing up the processing bottleneck that slows the printers down. Laser printers are selling like hotcakes now, and as these chips come into use, customers are going to like them more and buy them faster.

The booming desktop publishing market is intimately linked with the laser printer market—neither could forge ahead without the other. And all indications are that the two markets are growing at tremendous rates.

A casual observer might think that the Japanese had locked up a near monopoly on the laser-printer market, and that as a result, non-Japanese companies might just as well walk quietly away. But the Japanese strength is primarily in the print engines, the technologies developed for office copiers that can be reapplied in laser printers. There is a lot more to a laser printer than its engine, both hardware and software.

The software used to drive laser printers is already a U. S.-dominated game, especially in the area of page-description languages, the languages used on the more sophisticated printers to describe the text—and its typefaces, sizes, placement, and so on—and the graphics that are to be printed. These languages are vital to wringing out the full potential from laser printers.

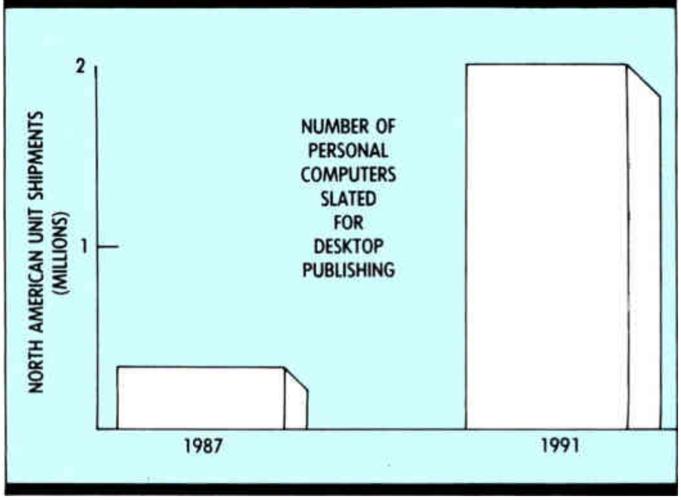
LANGUAGE GAP. But the languages ask a great deal of the controller hardware built into the printers. The laser printers are very fast when asked to churn out a simple page of text, emulating a letter-quality printer. But when complex combinations of fonts, print sizes, and graphics are added to the mix on the page, the controllers in existing printers get bogged down and it takes a long time to produce a page—as much as half an hour—instead of 2 to 10 seconds for a page of simple text.

That's where the new controller chips come in. They aim to unclog the bottleneck of executing the high-level graphics commands so the printers can quickly generate the high-resolution bit-mapped images and do their most impressive work without slowing down to a crawl.

Two basic approaches are being taken by laser-printer manufacturers. The first is to throw more general-purpose processor power at the problem, using higher-performance microprocessors in the printer controller. The second approach is to work with a chip supplier to develop special-purpose chips and chip sets—application-specific processors—that bring greater power to bear on the graphics-related processing task. Such chips are now hitting the market, from Acer Laboratories, Cirrus Logic (see p. 103), National Semiconductor, Weitek, and Western Digital.

All of these companies want a piece of one of this year's hottest markets. Desktop publishing is booming as a result of the popularity of combining high-quality text and graphics in the office environment. According to Dataquest Inc. of San Jose, Calif., desktop publishing is the fastest-growing segment of the personal-computer market. North American sales of PCs will grow to 8.33 million units in 1991 from 5.87 million in 1987, a compound growth rate of more than 10%, Dataquest estimates. Within the PC market, the desktop publishing segment accounted for only 2.5% of all usage in 1987, but will represent a full 22% of the PC market by 1991 (see bar graph). Combined with the overall growth of PCs during this same period, this means the market for desktop publishing will grow by more than 275%.

BEHIND THE LASER-PRINTER BOOM



As a result of its link to desktop publishing, the market for laser printers, particularly the low end, is poised for a significant surge in growth, from about 750,000 units in 1986 to in excess of 1.5 million units by 1991 (see chart, p. 96). According to In-Stat Inc. of Scottsdale, Ariz., laser-printer dollar volume for 1988 in the U. S. alone, which constitutes about 80% of the worldwide market, will amount to about $1 billion.

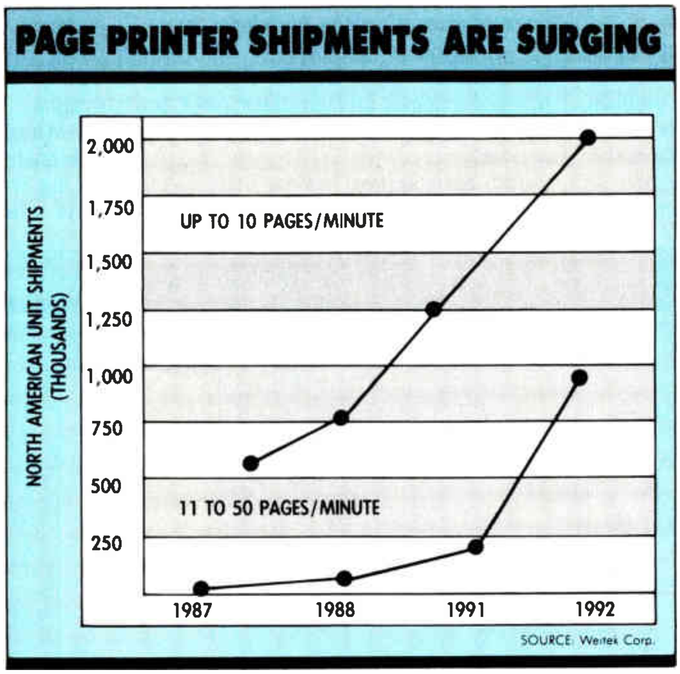
At the heart of a laser printer is a printing engine mechanically similar to the ones used in photocopiers: it takes an image formed on a conductive drum and transfers that image to paper. The difference is that a copier obtains its image through an optical system; in a laser printer, the image is drawn by a laser beam. Not surprisingly, laser printer engines are manufactured primarily by companies in the copier business. With the exception of Xerox, most of the top copier companies today—Canon, Ricoh, Sharp, Kyocera, and Toshiba—are located in Japan. These companies have the engine technology, but few of them have much strength in the retail distribution channels for computer products.

Because of this, the bulk of their engines are sold through original-equipment manufacturers, most of which are U. S. companies. They include the likes of computer manufacturers Apple Computer, Digital Equipment, IBM, Texas Instruments, Sun Microsystems, and Wang Laboratories, plus printer OEMs such as

Data Technology, Hanzon Data, QMS, Star Micronics, and Talaris Systems.

Until now, laser printers have been divided into two categories. The first is the low-end, relatively low-cost, text-only dumb printers with the same functionality as standard impact printers but with higher speed and higher print resolution. The second is the more costly high-end smart laser machines, which provide an array of sophisticated graphics and printing services by means of software interpreters geared to a page-description language. Typically, low-end laser printers in the $1,000 to $2,000 range have been text-only systems, while high-end systems cost between $8,000 and $10,000 or more.

But as the language and font software comes down in price and new chip solutions reduce the cost of controller performance, the laser-printer market is becoming less bifurcated. What is coming, says Les Wilson, corporate manager of imaging technology at National Semiconductor Corp., is not just a two-tier market separated into smart and dumb laser categories, but rather a multiple-tier market with low-, medium-, and high-speed language-based printers with varying degrees of capability and intelligence.



The page-description languages will no longer be restricted to high-end machines, and are becoming increasingly pervasive in the market. These high-level software languages are designed to describe graphics and text and how they fit together in a bit map—a matrix with each bit representing a pixel in the image, whether that image be displayed on a screen or printed on a page. Instructions in the language generated by the host computer tell the printer controller exactly how to draw a page, allowing the user to mix text and graphics, use multiple type fonts, compress or expand typefaces, and manipulate the placement and orientation of both the text and graphics.

At present four basic page-description languages dominate the market: Adobe System's Postscript, Xerox's Interpress, Imagen's Document Description Language and Control-C's CCS Image. Systems using these languages are currently expensive; a cheaper but less versatile way to go is with a printer that uses a printer-control language such as the one Hewlett-Packard Co., Palo Alto, Calif., uses in its LaserJet printers. Printer-control languages allow the text to be scaled up and down and can handle some simple graphics, such as straight lines, but the type fonts are fewer in number and more expensive in this approach and the full potential of laser-based graphics cannot be realized.

It's the page-description languages like Postscript that make the laser printers really hum, and the problem has been to bring down the price of printers that can handle them. Such languages offer higher-quality output with more complex graphics, greater resolution, more fonts, and fancier page layouts. Curves and lines can be rotated, clipped, stretched or shortened, reduced or enlarged; areas can be filled in. The image of a letter of text can be manipulated.

Page-description languages are also device-independent, like programming languages; printer-control languages are not. Host systems generate standard instructions that can be sent to interpreters running in the controllers of printers from numerous vendors.

EARLY JUMP. Postscript is emerging as the clear leader in page-description languages, because of its early use in the first commercially successful laser printer, Apple Computer's Laserwriter series, and to its acceptance by major computer manufacturers like Digital Equipment Corp. and IBM. Its emergence as the de facto standard is underlined by the fact that out of the perhaps two dozen or so language suppliers that are entering the market, most are developing clones of Postscript. Companies entering the market include Bauer Enterprises, Custom Applications, Destiny Technology, Itoh Electronics, LaserGo, LaserMaster, NCR, Phoenix Technologies, Printware, RIPS, QMS, and Kyocera.

Despite the increased competition, Adobe Systems appears likely to retain a leadership position with Postscript because it moved quickly to license the extensive Merganthaler type-font library of Allied Linotype Co., Hauppauge, N. Y., as well as other important font libraries. According to a recent study by In-Stat, font availability may well determine which printers and which languages will be successful.

But printers that interpret commands expressed in a page-description language need a lot more processing power in their controller hardware. This problem is a now major stumbling block, says John Rizzo, vice president of marketing at Weitek Corp., Sunnyvale, Calif. Until recently, he says, the controller of choice for a laser printer was a general-purpose, 5-to-10-MHz, 16-bit microprocessor such as a 68000, 80186, or 80286. Even in the text-only mode, such controllers have a daunting chore to accomplish. Laser printers generally have a resolution of about 300 pixels/in., which translates into about 8.5 million bits of data per page. At least 1.5 Mbytes of memory are necessary, as well as a processor capable of handling this much information quickly. When the chores required to interpret the commands of a page-description language are added on top of that, even a 12- or 16-MHz 68000 is too slow.

With the controller as the bottleneck, says George Alexy, vice president of marketing at Cirrus Logic Inc., Milpitas, Calif., printer manufacturers and users were faced with situations in which a 15-page/min engine was not able to print a page of mixed graphics any faster than a printer with an 8-page/min engine. Add to this, says Rizzo, the fact that the speeds of the print engines themselves are increasing, engines coming out that run at 10 to 20 pages/min.

"For many printer-industry executives, things are getting intolerable," says Alexy. "Some are going so far as to say that the entire laser-printer market will suffer if controller performance is not improved. Users will not pay a premium for a high-speed engine if it cannot offer some form of graphics, and especially if it performs no better than a slower engine."

Chip makers and printer manufacturers are using two general approaches to eliminate the controller bottleneck. The first is a simple brute-force approach, simply throwing more general-purpose processing power at the problem by using a faster microprocessor in the controller. In the second—which offers a cost advantage, its proponents say—more application- and system-specific chip solutions are being considered.

Gambling that printer manufacturers will go the first route are the vendors of general-purpose microprocessors—and reduced-instruction-set-computer chips as well—such as Motorola, Intel, MIPS Computer Systems, and National Semiconductor, among others.

In the second category are companies that are developing application-specific processors designed with laser printing and even particular page-description languages in mind. Falling into this category are Cirrus Logic, Weitek, Advanced Micro Devices (which also sells general-purpose processors into this market), Western Digital, National Semiconductor, Taiwan-based Acer, Bitstream/Bluepoint of Cambridge, Mass., and others.

An example of a printer vendor taking the first approach is Apple Computer Inc., of Cupertino, Calif. In its new line of laser printers, Apple has shifted from the 5-MHz 68000-based versions it used in its first machines to faster 68000s and 68020s in new models.

At the high-performance end of the market, several printer manufacturers are considering a RISC-based approach. One of the first to implement such a design is CSS Laboratories Inc., of Irvine, Calif., which will use a 15-mips Inmos T800 transputer—a processor with RISC-like characteristics—in a family of laser printers with outputs ranging from 20 to 50 pages/min. Also receiving serious consideration for use in several laser-printer designs are AMD's 29000 and Motorola's new 88000.

Aiming at cutting cost as well as boosting performance, such printer manufacturers as Canon, Data Technology, Destiny Technology, Hanzon Data, Olivetti, and QMS have opted for more application- and system-specific solutions from companies such as Acer Laboratories, Cirrus Logic, National Semiconductor, and Weitek.

Acer Laboratories Inc., a Sunnyvale-based subsidiary of Acer Inc. of Taipei, Taiwan, has developed a two-chip set aimed at laser printer applications using the 68000 microprocessor. Working with nearby printer maker Destiny Technology Corp. of Sunnyvale, Calif., Acer came up with the M2203 system controller chip. The chip incorporates the logic for interfacing between the central processing unit, dynamic random-access memory, and input/output devices, as well as a direct-memory-access controller. The M2205 carries the logic for bit-block transfers, video interfacing, and interrupt control.

> Two general approaches are being taken to eliminate the controller bottleneck.

Western Digital Corp., Irvine, Calif., has targeted its system-specific solution at printers that connect directly to personal computers. It consists of the WD65C10 page-printer interface controller and the WD65C20 PC-bus-interface controller. The first chip integrates memory access, video-data generation, printer synchronization, and handshaking functions, and the second incorporates not only printer-interface logic but the circuitry for extended-memory access and asynchronous message handling for easier programming and improved throughput.

Working in cooperation with printer vendor QMS of Mobile, Ala., chip maker Cirrus Logic has developed a family of raster-printer accelerators designed to allow printer manufacturers to continue to use their current generation and yet boost performance by offloading many of the page-description-language-related operations normally performed in software (see p. 101). Designed to interface with any general-purpose microprocessor, the first two devices in the family are the 40-page/min CL-GP-340 and the 15-page/min CL-GP315.

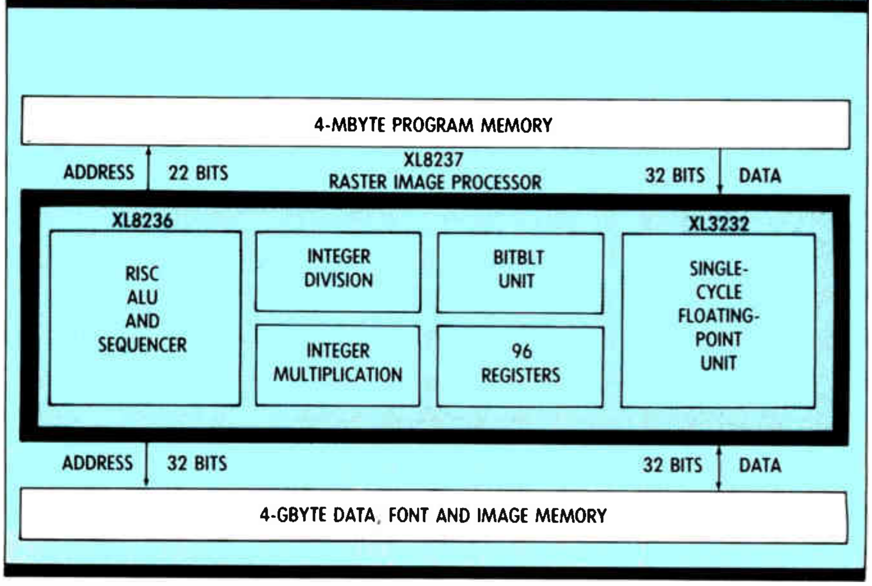
NEW INSTRUCTIONS. The closest to a general-purpose processor solution is the 32CG16 from National Semiconductor, a laser printer/display processor it developed in conjunction with Canon Inc., Lake Success, N. Y., and Olivetti SpA, Ivrea, Italy. A customized variation of the company's 32016 CPU, the 32CG16, in addition to all of the features of the parent processor, contains 18 unique graphics instructions, aimed at bit-block transfers, pixel processing, and high-speed pattern and line drawing, as well as data compression and expansion instructions for font storage.

Aiming to make the broadest possible impact in the increasingly crowded market is Weitek Corp. It has developed a family of 32-bit RISC-based processors customized for raster imaging applications. The family includes the two-chip XL-8200 and the three-chip XL8232. Both offerings have in common a raster control sequencer and a raster image processor. The first is a 22-bit machine that performs the program control functions while the second is a 32-bit integer arithmetic-logic unit that performs all the bit-manipulation and address-generation functions required in laser printers. The XL8232 adds a 32-bit graphics floating-point unit that contains a single-precision ALU, multiplier, and divider. Working in combination, says Rizzo, the processors provide up to four parallel operations per clock cycle, about 50 million operations/s.

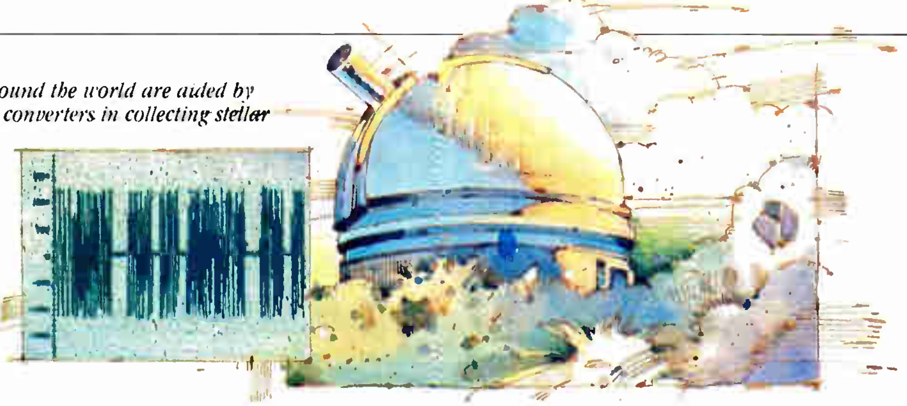
In Weitek's approach, performance in typical laser printing applications can be improved by up to 40 times, says Rizzo. Weitek is also supporting its chips by making available free its own Postscript-compatible interpreter software, as well as other Postscript clones.

The market for graphics-printer chips will extend beyond printers based on laser technology, says Alexy of Cirrus. "As volumes increase and costs drop," he says, "these controllers will be incorporated into a variety of other types of printers, including inkjet and dot-matrix alternatives with the same wide variety of graphics-manipulation features that are now emerging in printers."

DIVIDING UP THE WORK YIELDS HIGH PERFORMANCE



Weitek's controller chip set is one of several special-purpose high-performance processors designed to break the graphics-processing bottleneck in laser-printer applications.



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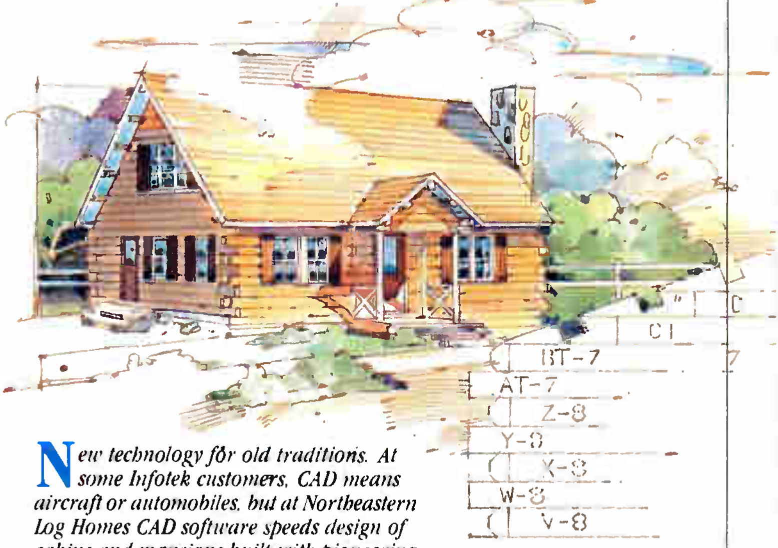

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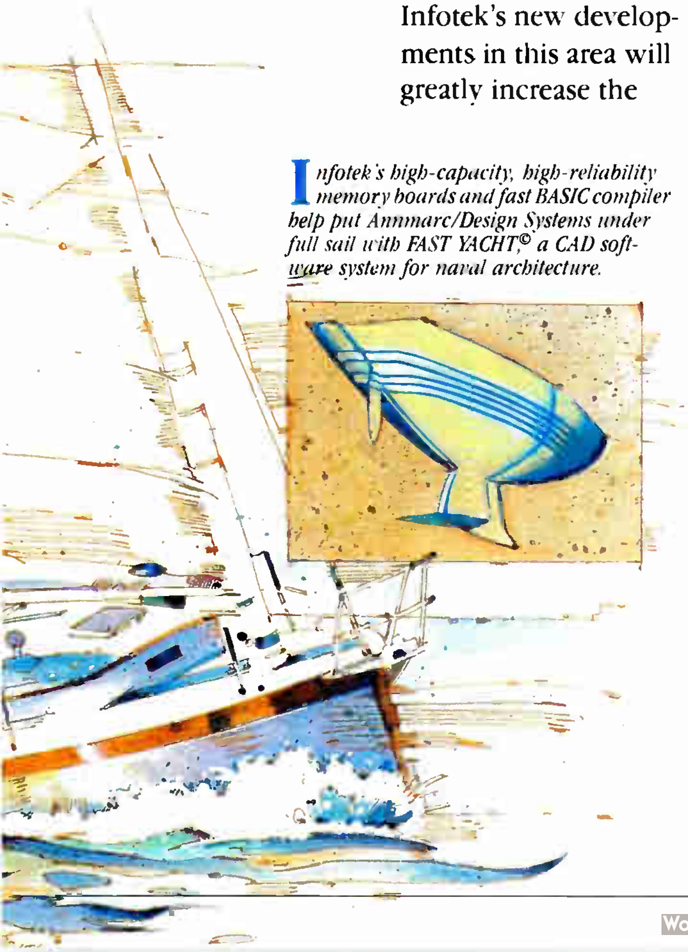

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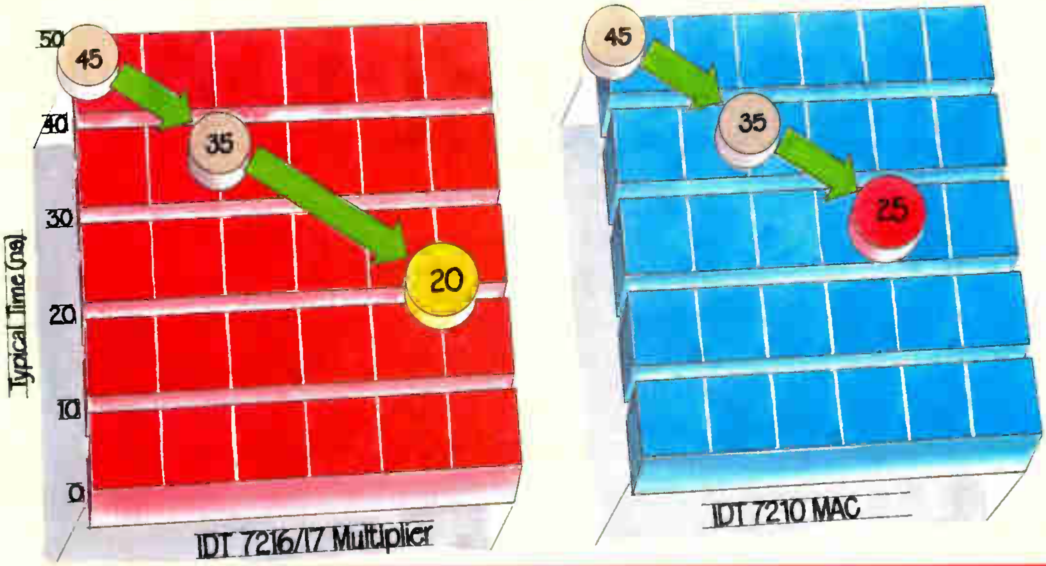

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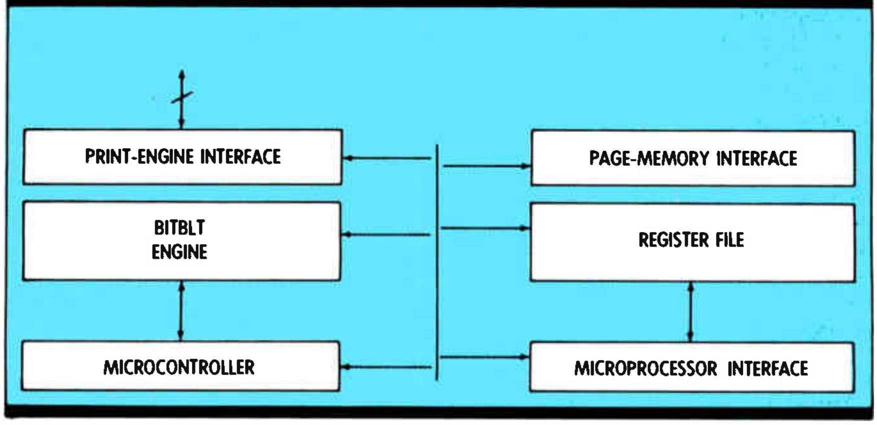
NOW 16-BIT PROCESSORS CAN HANDLE THE SPEEDS OF LASER PRINTING

Cirrus Logic's accelerator peripherals pump new life into 16-bit microprocessors

Once the undisputed powerhouses of the chip business, 16-bit microprocessors desperately need help in keeping up with the newest system demands—a good example being laser printers with their blindingly fast speeds. Enter a new family of peripheral integrated circuits from Cirrus Logic Inc. that team up with the aging 16-bit workhorses to match the performance of 32-bit systems in controlling laser printers.

Company officials at Cirrus in Milpitas, Calif., say the new RPX raster-printer accelerators will allow equipment builders to use their existing 16-bit-based printer controllers to achieve the same performance levels now possible only with 32-bit processors. The Cirrus accelerator chips take on the page-imaging and -printing functions—the tasks of creating bit-mapped image of pages and sending them to the printer engine.

HOW THE CIRRUS RASTER ACCELERATOR WORKS



The RPX raster-printer accelerators from Cirrus offload controllers from data-intensive tasks of page imaging and printing, so 16-bit controllers can handle laser-printout processing.

"Although the RPX family offers advantages for all raster printers, including not only laser, but thermal and ink-jet as well, we expect it to have the greatest impact on personal computer systems priced between $1,000 and $10,000," says George Alexy, vice president of marketing at Cirrus. "Users in this range are the most likely to have printers compatible with page-description languages and will benefit most from the approach we have taken to partitioning printer-controller functions."

FORSAKING BRUTE FORCE. Currently, Alexy says, the prevalent architectural approach to high-performance printer control is to go the brute-force approach of using a more powerful microprocessor to perform all functions in software. There's minimal additional hardware, so this central processing unit must perform all of the primary functions such as command parsing, page imaging, and printing. "The drawback to this approach is that the only way to achieve higher performance is to increase the horsepower of the controlling processor by going from a 16- to a 32-bit processor," Alexy notes.

This presents a number of knotty problems to cost-conscious firms aiming to market low- to mid-range laser printers, he says. The least of these problems is the significant price differential between 16-bit and 32-bit processors: say, $10 apiece for the older parts and $50 to $100 apiece for the 32-bit chips.

Moreover, when using faster 32-bit microprocessors, the costs of other parts in a system go up, Alexy adds. Fast processors require high-speed DRAMs, additional line drivers and receivers, and more control logic for the memory. And if the move is made to upgrade a printer controller from 16- to 32-bit processors, the overall system performance will improve only if software is modified to take advantage of the new features of the more powerful chips—and still more costs added to development, says Alexy.

As an alternative, Cirrus is offering throughput improvements in a proprietary chip design that cuts out the need for multiple passes through software to perform critical bit-block transfer operations, known as BitBlt. An automatic read/modify/write feature reduces the time needed to update each page memory location, and throughput is bolstered on-chip logic and microcoded instructions that perform automatic pattern recognition, cell- and window-mask generation, window clipping, and scan-line processing for solid or pattern fills.

Initial parts in the family are targeted at low- to medium-performance segments of the growing laser printer market, where processing-speed requirements are still outstripping the capabilities of widely used 16-bit host controllers. The raster printer accelerators offload these controller CPUs so they can devote most of their processing power on command parsing, interpreting commands from the attached computer.

Alexy says the RPX devices will build a raster image of the page, scan the image into a raster-print engine, and perform dynamic refresh and control. Acting as a peripheral to the main controller microprocessor, the accelerator chips will load required commands and data into the appropriate registers via three specially designed interfaces. One goes to the central processor to get command parameters. Another is for page memory where the raster image of the page is built, and a third is for the print engine.

Initial parts in the RPX family are the 15-page-per-minute CL-GP315 and 40-ppm CL-GP340, which are aimed at boosting throughput of laser printers when performing complex graphics-manipulation and document-processing functions by 50% to 400%—depending upon the application.

Fabricated with a 1.5-μm CMOS technology, the GP315 and GP340 share a common architecture with a 16-bit microcontroller block, an embedded bit-block transfer engine, a 10-register file, and specialized interfaces for print-engine control, page-memory manipulation, and microprocessor communications. The GP315 can address up to 16 million words (32 Mbytes) of page memories and provide resolutions as high as 1,250 by 1,250 dots/in. The GP340 can address up to 64 million words (128

Mbytes) of page memory and can provide resolutions as high as 5,000 by 5,000 dots/in. Operating at 10 MHz, the GP315 and GP340 support 15 and 40 page-per-minute rates, respectively, with a resolution of 300 dots/in. and 5,000 characters per page when using a 10-point font.

Cirrus is now delivering samples of the GP340, which in quantities of more than 1,000 sells for $70 each. Sample of the GP315 will be available in the fourth quarter, and it will cost $40 each in orders greater than 1,000 pieces.

The RPX family is unusual in that any page can be imaged in a single pass through memory without intervention from the microprocessor, says Alexy. Two key features of the chip make this possible: automatic pattern replication, and the use of a unique three-operand BitBlt transfer algorithm.

Replacing the software usually required to perform pattern-fill operations, automatic pattern replication enables the Cirrus chips to fill in predefined space with any pattern, rather than defining each dot of the pattern individually. In this approach, patterns are repeated, allowing them to be stored as a matrix and automatically replicated within the window in which the pattern is to be placed.

Unlike current approaches, which use a two-operand algorithm, the RPX family uses a three-operand BitBlt operation. This allows all three bit-block transfer operations—source, pattern and destination—to be combined logically and written in one step to the appropriate memory location. It eliminates multiple passes required to image complex figures. By performing this function in one step, says Alexy, controller throughput is doubled in many cases, lessening the time required to print complex pages. While it is possible to combine all three operands with a two-operand BitBlt, it's not as fast, he says, because multiple block transfer operations are required at each memory location.

Concurrent with a BitBlt operation, the page image may be scanned out to the print engine, memory refreshed, and a read/write concurrent through performed by the CPU, further speeding up system operations.

DUAL ACCESS MODES. Also incorporated into the RPX devices is logic that allows access to page memory in two ways: either by direct memory selection or by a read/write through operation.

In the first mode, the RPX provides the CPU with direct random access to the page memory within the CPU's linear address space. This allows outline fonts to be taken directly from read-only memory, converted to a bit-mapped image and then passed directly to the RPX for the bit-block transfer.

The second mode is used to increase CPU bandwidth in operations such as graphics or page-description-language processing. Here, the central processor addresses the page memory as a separate 16-bit-wide linear array. This setup allows the Cirrus RPX chips to fetch command, source and pattern data, perform bit-block transfers and then write data to page memory—all without direct intervention by the host central processing unit, Alexy points out.

To speed operations in both modes, the RPX devices incorporate an automatic read/modify/write feature, allowing the CPU to read the destination address in page memory; perform logical operations combining source, pattern, and destination; and write data back to the destination address—all in one step. Because there's no need for multiple steps to perform such operations, says Alexy, the time required to image a page is reduced by as much as two-thirds. The time savings comes from the elimination of the multiple memory accesses usually needed to update each memory location.

The RPX chips can reduce time needed to image a page by as much as two-thirds

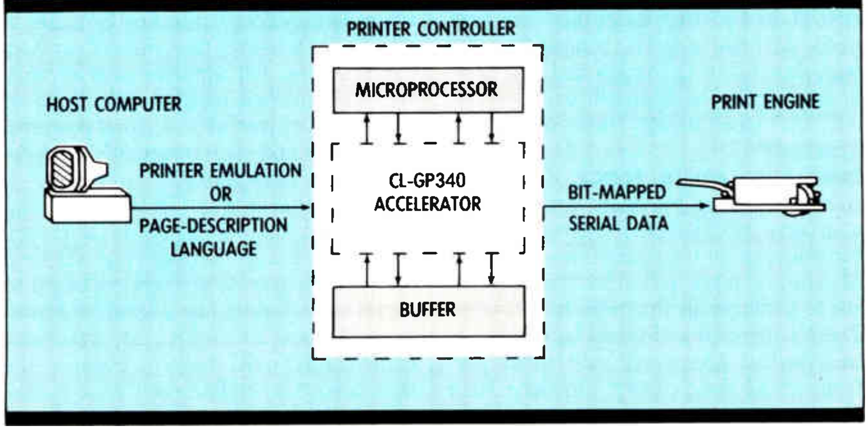
Other functions hardwired into the RPX architecture, further increasing throughput include automatic generation of window masks, clipping, and scan-line processing. A particularly time-consuming task when performed in software, automatic window-mask generation is needed to prevent bits on the left and right of lines being imaged from being overwritten. When performing the page-imaging function, masks must be created for both the left-most and right-most words in the line being imaged. This is because the source, the pattern, the destination, or any combination of the three may not line up at the beginning and end of the line being imaged. By generating and applying the window masks in hardware and automatically adjusting the left- and right-most words, page-imaging time is significantly reduced, says Alexy. The Cirrus circuitry replaces software routines that first would determine the need for a window mask, then generate the mask, and then apply it.

Additionally, he says, clipping allows windows to be created to define the printing area. Doing this in hardware eliminates the need for software to perform the time-consuming task of continually testing for clipping boundaries when writing into page memory.

Also incorporated into the RPX hardware is the logic for scan-line processing. This circuitry increases page-imaging speed by performing the function as a whole, rather on a byte-by-byte or word-by-word basis. It begins at the starting point of a line and performs a particular function—fill with a pattern, for example—until a specificed length predetermined by the program is complete. This function eliminates eliminates the need to test for the end of a line each time the system goes through the process of performing a fill.

Because many printer manufacturers are looking for reduced cost as well as improved performance, Cirrus designers have taken a great deal of effort to incorporate features that allow the end user to signficantly reduce systems implementation cost. One way they have done this, Alexy says, is by incorporating logic for printer-margin control. This prevents the controller from storing white blank space that represents the margins on a printed page, reducing the amount of DRAM required to store the bit image of the page to be printed. Typical reductions range from 21% to 42%, Alexy says. *—Bernard C. Cole*

WHERE THE RASTER-PRINTER ACCELERATOR FITS IN



By offloading tasks from printer-controller microprocessors, Cirrus Logic's RPX chips make it possible for 16-bit systems to reach the performance of more costly 32-bit architectures.

HOW CIRRUS LOGIC IS BREAKING RECORDS

MILPITAS, CALIF.

If industry observers have been impressed with the meteoric rise of three-year-old Cirrus Logic Inc., wait until they see the firm's business targets for the next year. Michael Hackworth, company president and chief executive officer, expects Cirrus to ship 3 million integrated circuits in the next year—breaking what many believe was a startup record set by the young firm: over 2 million ICs out the door in the past a year and a half.

The Milpitas, Calif., company is on the fast track to higher chip shipments because of a silicon-product strategy that hinges on two unique technologies: a chip architecture that is a variation of mask-programmable logic arrays, and a proprietary silicon compiler methodology. The latter allows Cirrus to turn out custom and standard VLSI circuits from its configurable parts in the same time it takes others to build less efficient semicustom parts based on gate arrays or standard cells.

Cirrus Logic company president Michael Hackworth, left, and vice president of marketing George Alexy check over an IC plot of a new semistandard part.

Using this chip-compiler strategy, Cirrus has already managed to grab a leadership position in the growing market for IC controllers used in 3.5-in. hard disk drives. It has also leapt ahead in color graphics chips for IBM Corp. personal computers and compatibles. Company executives expect more success with new products being launched in data communications. It's also now making a bid in printer controller markets (see p. 101).

TAILORED TO SUIT. The pillars of the Cirrus strategy are a storage/logic-array chip architecture and silicon-compiler software: both help the firm tackle these processor-peripheral markets in a so-called semistandard thrust. Typically, Cirrus designers will work with a company or a group of customers in any targeted market segment to develop the needed part from the storage/logic array, or SLA.

Cirrus then comes to market with a derivative of the custom design as a standard IC after a waiting period of usually six months. The company also launches standard parts for the various market segments. Either way, any of the standard parts can be tailored into customer-specific variants, known as semistandard ICs.

Hackworth says this strategy is what has catapulted Cirrus to a top spot in controller ICs for 3.5-in. hard disks, with about 50% of the market for its custom chip set and the standard derivatives, the SH120/SH130. In the personal computer arena, Hackworth says that Cirrus parts claim as much as a 70% share in the market for video graphics adapter cards for IBM-compatible machines.

The company's entree into this niche was its association with Video-7 Inc., a Fremont, Calif., peripheral board maker that came to Cirrus last year for help with its VGA devices. The devices it produced with Cirrus gave Video-7 an early lead in offering adapter cards for 640-by-480-pixel, 256-color VGA standard. Earlier this year, Cirrus started shipping samples of a standard derivative of the Video-7 custom chip set—the GD510/GD520—to more than 20 potential customers following a six-month waiting period.

"This is a highly competitive market in which suppliers are eager to establish a unique identity, but at the same time serve the common needs of the original-equipment manufacturers," Hackworth says. "A semistandard strategy which allows customers to add value to a design is the right way to approach the market."

Yet there are a number of routes to a semistandard approach, and even though Cirrus builds circuits with its proprietary SLA logic technology, it is not in the same business as vendors of gate arrays or programmable logic arrays, say company leaders. Cirrus is keeping its silicon compiler technology to itself and using the SLA to design VLSI microprocessor peripheral circuits that address specific market segments.

Hackworth himself is no stranger to the microprocessor peripheral market. While a senior vice president at Signetics Corp., his last major assignment was managing the company's MOS effort, which had sales of $200 million a year. A key element in his strategy was to focus on the development of microprocessor peripheral circuits. That's when Hackworth began looking for a faster way to introduce products. The search led Hackworth to Cirrus Logic, which had been founded in 1985 by Suhas Patil, inventor of the storage/logic array who is now the firm's chairman of the board and vice president of research and development. Basically, this device is a variation of the mask-programmable logic array, differing chiefly in the positioning of the AND/OR arrays. "What impressed me about the SLA was that unlike traditional approaches, it allows the designer to achieve an architecture well suited to the design at hand," Hackworth says. "It does not force a particular architecture on the designer.

The silicon compiler is the second part of the Cirrus one-two punch. This unit, says Hackworth, is a proprietary process-independent two-level interactive compiler that does not require the designer to learn the details of the device technology to implement a circuit with VLSI densities. Combining these two technologies means that it is now possible to design chips with the VLSI densities of handcrafted standard or custom parts, but with the turnaround time usually associated with a gate array or a standard cell. *–Bernard C. Cole*

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THE BIG MOVE IS UNDERWAY TO PHOTO-LIKE PC GRAPHICS

A coming standard should help photorealistic imaging to filter down to low-cost systems

by Tom Manuel

The dream is alive: practical technologies for photographic-quality computer graphics are arriving. Photorealistic rendering, as it's called in the industry, is destined to become a standard offering on personal computers and engineering and professional work stations.

But before photorealistic imaging can come into widespread use on low-cost machines, some loose ends need cleaning up. In particular, the industry must settle on standards that can help it achieve the right packaging and pricing for mass markets. Such standards, and one particular proposed standard, will be among the hottest topics at the Siggraph show in Atlanta from Aug. 1-5.

The proposal comes from Pixar Inc., San Rafael, Calif. Its RenderMan definition lays out a standard interface between software used to create images and the programs and hardware used to render them. The move towards photorealism will get a tremendous boost if the industry accepts Pixar's RenderMan—or something like it—as a standard specification for three-dimensional scene description. As a standard, RenderMan will add needed flexibility and hardware-independence to the quest for the highest-quality computer pictures. Nineteen vendors of graphics hardware and software have already endorsed RenderMan, giving the embryonic field of photorealism a chance to get off to an orderly start, before vendors head off in several directions at once.

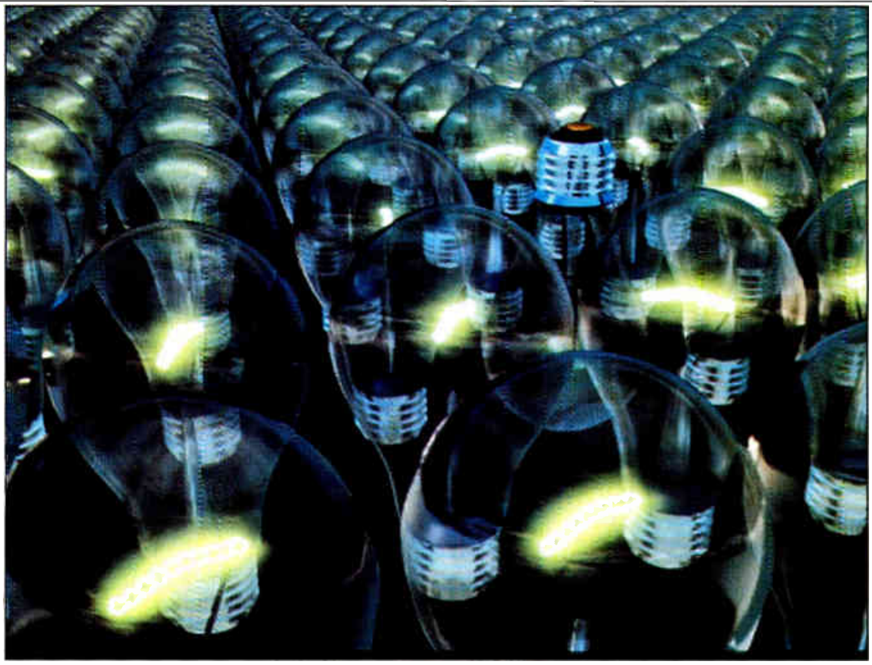
Such a standard will help photorealism spread into many more computer systems at ever lower costs, making it available eventually to all who want it through inexpensive work stations and even personal computers.

NOW IN SIGHT. As photorealism takes off, it will be used—among other places—in applications known as scientific visualization, which allows researchers to "see" unobservable or nonreal (mathematical or algorithmic) phenomena. Visualization techniques are also developing rapidly, and will be discussed in depth at the Siggraph conference.

The most substantial commercial demand for photorealistic images comes from the entertainment industry. Another market where photorealism should begin to play a role as its price comes down is the animated-video portion of the fast-growing market for business presentation graphics. The total market in that segment will grow from \$210 million in 1987 to \$2.8 billion in 1992, according to estimates from Intertec Development Corp., Los Altos, Calif.

Photorealistic image synthesis is beginning to be used in architecture and design work for automobiles and other products. As all these markets develop and photorealism technology becomes economically accessible to the personal computer marketplace, a very large market could develop in a few years. It could be put to use by artists, for example, or publishing companies, or vendors of PC game software.

The basic techniques for generating photorealistic images are already here, but not yet widely applied. Researchers in universities and several-leading edge companies are very near to the perfection of photorealistic rendering techniques for computer-generated pictures. Right now, however, photorealistic rendering is only available on a handful of relatively expensive systems.

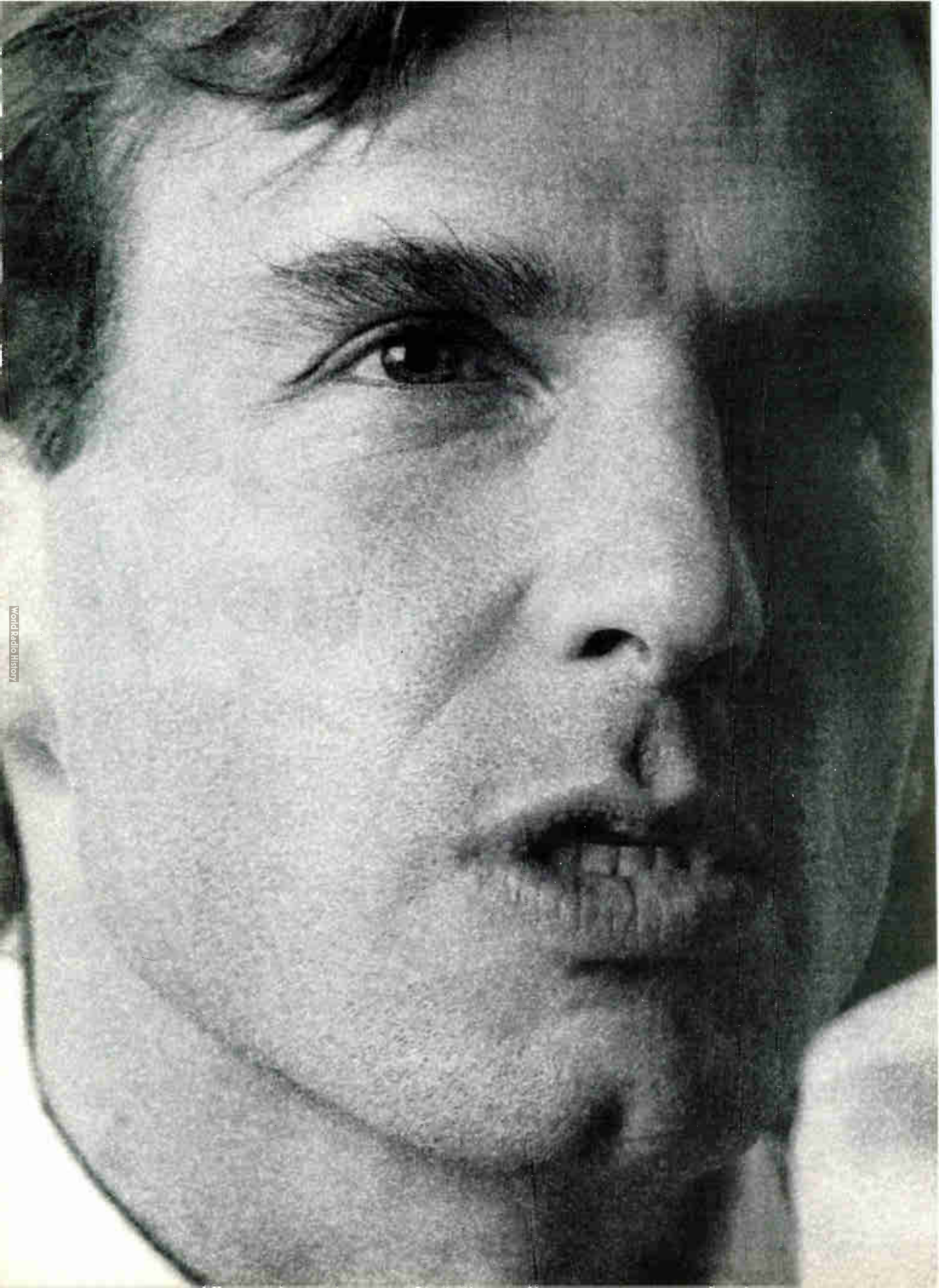


Custom software was used by Pacific Data Images to create this photorealistic image. Standards will encourage development of commerical software, reducing imaging costs.

Pixar wants to remedy that. The company's engineers have struggled to produce good pictures for years, says Tom Porter, director of advanced technology. Its expertise in photorealism has its roots in years of reseach and production of highly realistic images for film, first as part of Lucasfilm Ltd., and now as an independent company.

Pixar says it is well ahead of the engineering and graphics work-station companies in the realm of photorealism. "The work-station companies are currently struggling with texture mapping. We at Pixar have done a lot of texture mapping in the past and have gone beyond textures now," says Porter.

The computer-graphics industry has gone through several steps toward photorealistic imaging. It started in the middle to late 1970s with three-dimensional wireframe images being commercially available for the first time. Each subsequent step has produced more realistic-looking images (see chart, p. 108). The research that made each step possible came before the date ranges indicated, which are meant to show approximately when each of these steps started being represented



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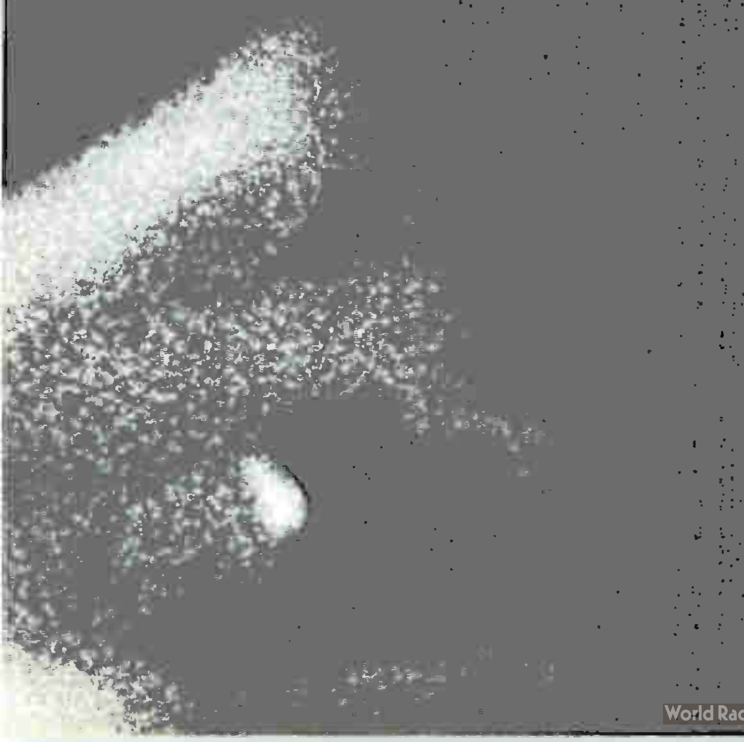

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in new commercial graphics products.

The photorealism step has now been reached by Pixar and some others, such as Hewlett-Packard Corp. The Palo Alto, Calif., company's HP 9000 835 TurboSRX uses radiosity techniques, among others, to produce photorealistic images [*Electronics*, March 17, 1988, p. 95]. Software from companies such as Alias Research Inc. Toronto, Ontario, and Wavefront Technologies of Santa Barbara, Calif., among others, is aimed at photorealistic rendering. Several firms in the imaging business, such as Pacific Data Images in Sunnyvale, Calif., R/Greenberg Associates, New York, and Intelligent Light Inc., Fairlawn, N. J., are generating photorealistic images with proprietary software. But there are no standards yet.

AVOIDING CHAOS. Pixar is offering to share its knowledge and expertise with other graphics vendors in order to speed up the general availability of this kind of imaging and prevent the kind of market-discouraging chaos that occurs when no standards are set. "The last thing we want is 10 work-station companies to go out and and do this next generation [of rendering] 10 different ways," says Porter.

With the unrestricted publication in May of the RenderMan specification for describing complex 3-d scenes, Pixar is offering the industry a way to link modelling programs, which describe a subject to be rendered, to photorealistic rendering programs. Adopters of the RenderMan interface can chose the modelling programs that they like and, independently, the rendering programs they fancy, as long as both the modeler and the renderer conform to the RenderMan specifications.

RenderMan defines a methodology for 3-d modelling systems to attach visual attributes to geometric data. The modellers define the image structure geometrically; then renderers apply visual attributes with such properties as material, texture, reflectivity, and gloss.

Current graphics standards like PHIGS and PHIGS+, which are used on most work stations, have become important frameworks for managing an interactive graphics work station and in defining the geometric content of objects and scenes. But PHIGS and PHIGS+ do not address the techniques needed to achieve photorealism.

One thing that photorealistic digital image synthesis brings to the game is image simulation that does not introduce artifacts from the computational process that would not be in a photograph. A photorealistic rendering program must be capable of:

- hidden-surface removal so that only visible objects appear in the computed image;
- spatial filtering so that aliasing artifacts do not appear;
- dithering so that quantization artifacts are not noticeable;
- temporal filtering so that the opening and closing of the shutter causes moving objects to be blurred;
- and depth of field so that only objects at the current focal distance are sharply in focus.

RenderMan addresses the needs of photorealism in a mathematically sound and consistent way, says Porter. It is designed to be compatible with PHIGS and PHIGS+ and with interactive graphics environments like Ardent's Doré. Work station environments of the future will be able to add photorealism to standard applications programs and run them on various hardware platforms by using RenderMan along with PHIGS or PHIGS+ and appropriate hardware interfaces (see figure, opposite).

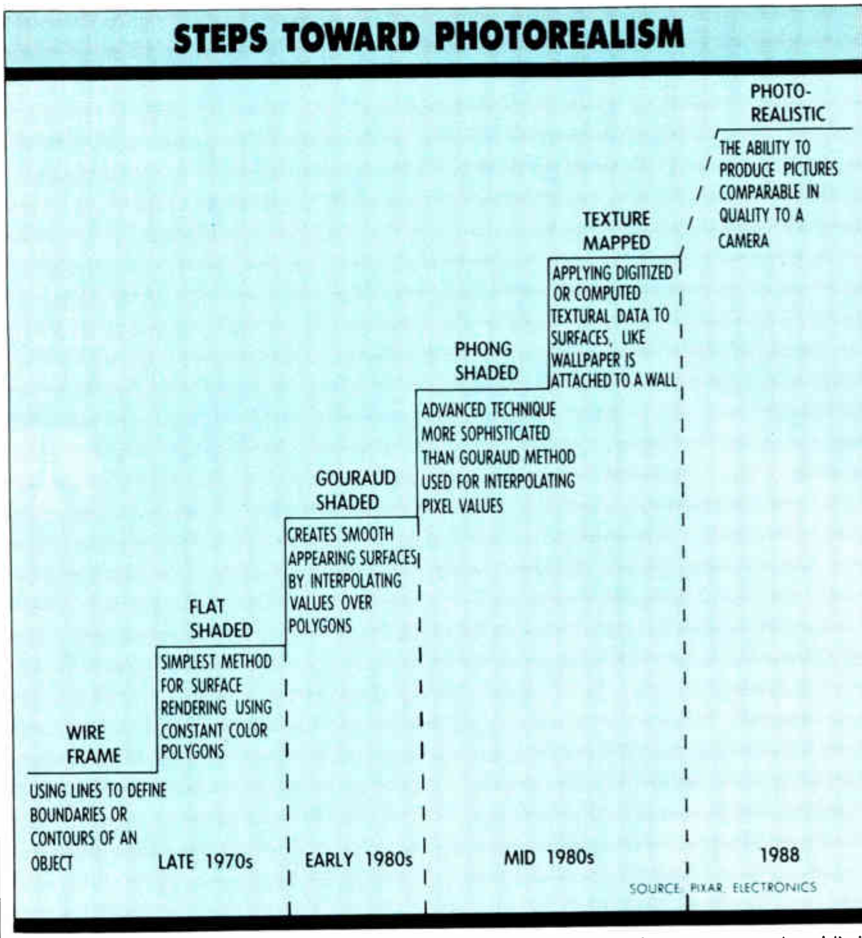
Many different kinds of modelling and rendering programs can be developed conforming to the RenderMan interface. These programs can be mixed and matched by users to meet their specific needs. For example, types of rendering that can be made available in such an environment could include z-buffer-based systems, ray tracing, radiosity, terrain rendering, and molecule or sphere rendering.

Pixar hopes to encourage with RenderMan the development of rich modelling languages to improve the input to rendering programs. It also hopes its proposal will encourage development of new rendering systems to make photorealistic image synthesis more generally accessible and available. Many of the 19 companies that have endorsed RenderMan have committed to using the interface in products.

Other fallouts from the adoption of a scene-description standard such as the RenderMan interface would be to divorce the specifics of scene description from rapidly developing hardware technology. Each succeeding generation of computer and graphics hardware could be put right to work without redoing all the geometric modelling and rendering software.

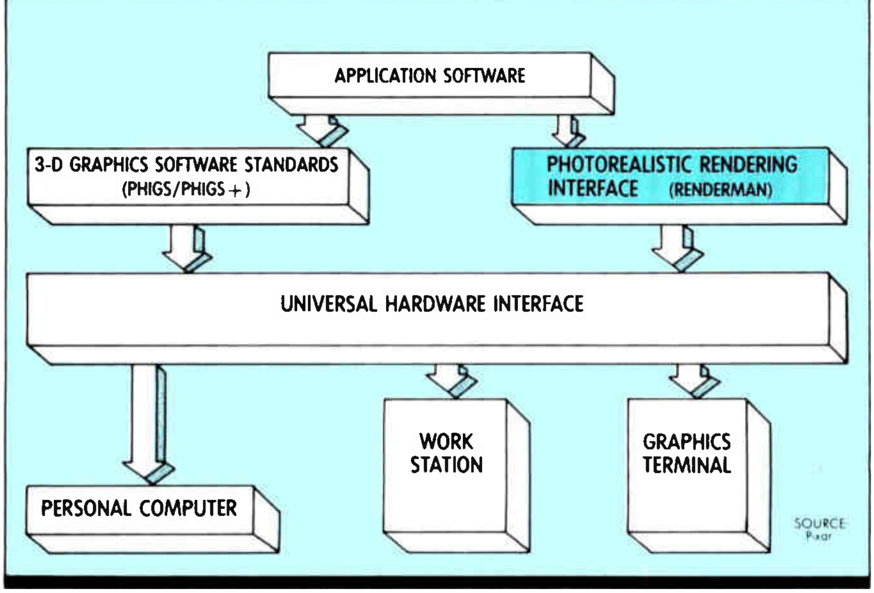
For example, RenderMan is a natural complement to the Graphics Supercomputer [*Electronics*, March 17, 1988, p. 97] produced by Stellar Computer Inc., Newton, Mass. Although Stellar has not announced any products based on the proposed interface, it is "certainly contemplating such products," says Jeff MacMann, director of graphics software.

Stellar has endorsed Pixar's interface



Closer to reality, step by step, computer-graphics image rendering has progressed rapidly in the last decade and is now arriving at a stage where image quality is comparable to photos.

THE MISSING LINK IN REALISTIC GRAPHICS



A photorealistic rendering interface like Pixar's RenderMan forms a device-independent link between modelling software and the rendering hardware in work-station environments.

because if it succeeds as a de facto industry standard, it will bring portability and device independence to photorealistic computer graphics. "Photorealism [in the rendering of images] is required for an important subset of our target customers, such as those doing animation and producing entertainment," says MacMann. "Although not a requirement, it is an important and desirable option or enhancement for many other customers."

Stellar was among the companies that helped Pixar define version 3.0 of RenderMan. Stellar suggested modifications to make RenderMan conform more closely to PHIGS and PHIGS+.

Ardent Computer Corp. of Sunnyvale, Calif. is also endorsing RenderMan. The level of photorealism in computer graphics that RenderMan supports is an important extension to the graphics capability of Ardent's Titan supercomputer [*Electronics*, March 3, 1988, p. 65] and the Doré dynamic object-rendering environment graphics toolkit that Ardent is also offering up as a de facto industry standard [*Electronics*, Feb. 4, 1988, p. 69]. Users of Doré can choose the dynamic rendering software available as part of the Ardent package or, in the future, select a RenderMan-compatible batch-type photorealistic renderer.

Industry sources speculate that complementary products will be made available by both Ardent and Pixar that combine the dynamics that Doré does very well and the photorealistic algorithms that Pixar is good at. But neither company is ready to announce products based on RenderMan.

Apollo Computer Inc., the Chelmsford, Mass., computer and work station company, is another RenderMan backer. "We see a value behind the RenderMan interface for taking the industry to the next level of rendering beyond what is available now," says Al Lopez, director of Apollo's graphics group. Apollo was another of the companies that Pixar consulted with in developing version 3.0.

"We would like to use the level of rendering that exists at Pixar and not have to implement something like it ourselves, so we can concentrate our work on other things," says Lopez. He speculates that there will be some announcements later this summer of RenderMan software tied to Apollo work stations—but not necessarily from Apollo. Apollo's new high-end DN 10000 machines are ideal for such software because of their high floating-point computational performance.

SHAPING IDEAS. One of the producers of highest-quality digital images and a potential user of RenderMan and similar systems conforming to its specifications is Pacific Data Images. Pixar and Pacific Data Images have been bouncing ideas off each other for some time now, says Jim Dixon, senior animator at the Sunnyvale, Calif., company.

Dixon agrees that standardizing the modeller-to-renderer interface is a good idea. Pixar "is handling the hard parts—the computationally intensive stuff," he says. "This allows us and others like us to go on to the next level and concentrate instead on how the image should look and not on how to calculate it."

He also points out that having a standard would allow him and others to work on an image at home on an inexpensive work station and still access powerful rendering tools. To finish an image, a user could then transfer his work to a more powerful machine, to generate the final image.

"The process of rendering a description of a scene and turning it into a picture has been pretty much solved now, but lots of work being done today does not take advantage of that fact," says Dixon.

Dixon produced the image on page 105 using an in-house system assembled by Pacific Data Images with a Ridge RISC computer and graphics subsystems made by Raster Technologies Inc. The picture, a very complex scene with 750,000 polygons, was produced using a spline-based modeler and rendered with a reflection-mapping system. It took three days to construct the description of the image. The computer time to render it was about 45 minutes.

Photorealism will come in handy for practitioners of another important area in leading-edge computer graphics: visualization. Visualization refers to techniques that give visual form to very complex data representations and allows the viewer to see the unseen. It opens a window on complex processes that are happening inside a computer, so that a programmer can watch how a matrix of data evolves under the influence of an algorithm, for example.

But in addition to its application to abstract, "nonreal" mathematical or algorithmic phenomena, computer-graphics visualization also can be applied to real-life phenomena that normally are too fast, slow, small, or dangerous to observe directly. Recent advances in visualization have created an enormous potential for increasing scientific understanding of the physical world.

Scientific visualization does not rely on photorealism. The problem is not to make the image like a photograph, but simply to something visible that previously was not. But photorealism can be an adjunct to visualization in cases where it is valuable to depict some image—or the real parts of a composite image—in as realistic a way as possible to provide a frame of reference.

"Scene depicting in science can be very, very complex; many times it is important to view physical phenomena in the context in which they occur. That is where photorealism comes in," says Stellar's MacMann. "For example, when visualization is used to depict the flow of air over an airplane wing, having the wing itself depicted in photorealistic rendering [is useful]," says MacMann. "The subtle visual clues from a real-looking wing help the user assimilate the total picture better. Even in borderline applications that fall between scientific visualization and the real world, like molecular modelling, photorealistic techniques are applicable and enhance perception," he adds.

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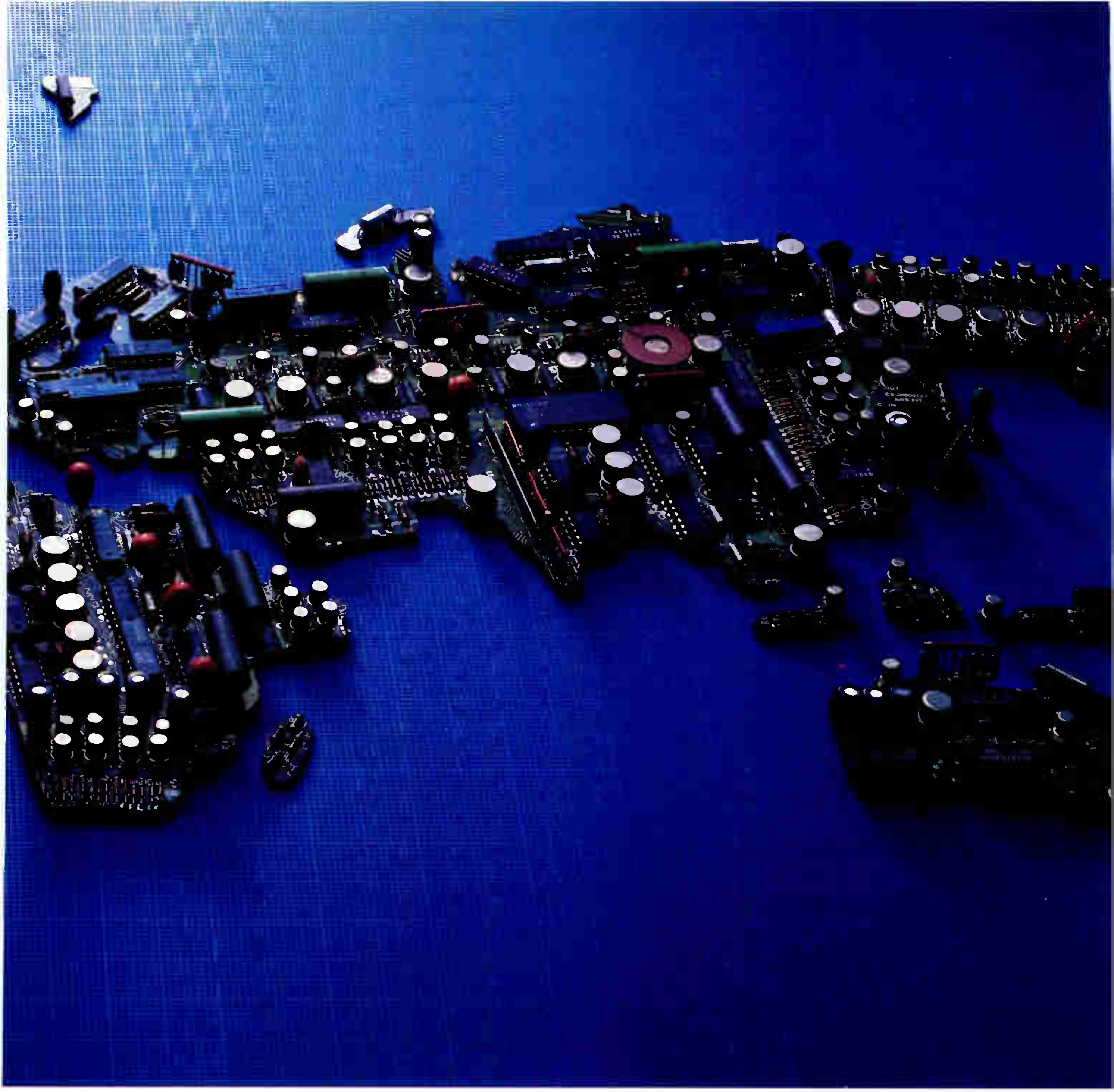


COMPUTER GRAPHICS

CAN VGA AND X-WINDOWS WIN HEARTS AT SIGGRAPH?

Product watching at Siggraph '88 in Atlanta, Ga., Aug. 1-5 doesn't have to begin and end by ogling $250,000 work stations that rotate near-photographic images in real time. Also in abundance will be products that typify other trends—or erstwhile trends—in graphics processing. What's more, exhibitors have also found Siggraph a fertile source of information about their customers' likes and needs. Spirited discussion in and around the display booths will determine future product offerings and help shape opinions are two new developments: IBM Corp.'s Video Graphics Adapter standard, and the emergence of X-Windows as a hardware interface for high-end graphics displays.

HOT TOPIC. One issue that's sure to generate idea interchange will be VGA. Introduced just over a year ago, it delivers better resolution and more color choices than its predecessor IBM standards. But how does it fit into the whole graphics picture?

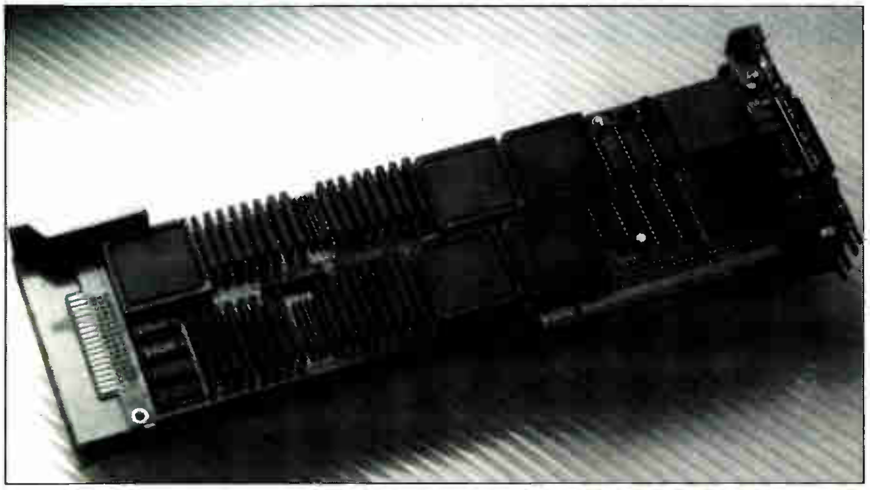
"The VGA display is actually not that novel or high performance," maintains Jon Peddie, president of Jon Peddie Associates, an Oakland, Calif.-based analyst specializing in high resolution graphics. "But its brilliant colors and the very impressive demonstrations IBM has put together have indeed caught the buyer's imagination," he says.

At its 640-by-480-pixel resolution, VGA can display 16 colors from a 262,00-color palette. To get 256-color displays, memory must be remapped and resolution is reduced to 320 by 200 pixels. In other words, says Peddie, "Except for the larger number of displayable colors and color palette, it is hard to understand why VGA has become so much more popular than EGA."In terms of resolution [IBM's 640-by-480-VGA controller], is not sufficient for serious profession computer-aided design users and desktop publishing users."

But entrepreneur VGA board vendors cloners have found they could increase clock speed, add memory and provide higher resolutions. Cards have already been available—and will be shown at Sigraph—that offer up to the 1,024-by-768-pixel resolution suitable for CAD. What's more, customers contemplating the purchase of an IBM PS/2 model 50 or 80 can look forward to compatible cards with even higher resolutions in the future. "IBM sees graphics as a major factor in system designs of the future," says Peddie. By late 1988 it will introduce a graphics coprocessor that delivers 1,200-by-1,600-pixel resolution for desktop publishing applications, and, in 1989, it will introduce yet another standard. The Master Controller Adapter will have 1,200-by-1,800-pixel resolution, he predicts.

Innovative vendors will display a variety of personal computer enhancements—mostly for IBM's XT/AT and PS/2 lines—that find clever ways to overcome the PC's inherent graphics-processing limitations and deliver an approximation of work-station performance.

One of the cleverest is Colorgraphic Communications Inc.'s VGA² board, which circumvents the PC's pokey drawing speeds when rendering full-screen graphics. An AT-bus product, the board uses two VGA chip sets from Chips and Technologies Inc., to manage displays on multiple screens from a single PC, says Charles McCullough, senior design engineer at the Atlanta, Ga., company. In a typical CAD hardware configuration, one screen would display the engineering drawing and the other the command screen. But by using a memory-extension card in tandem with VGA², the designer can store up to five graphics screens that can be summoned to the display terminal with speeds rivaling many work stations. VGA² are expected to be available for $800 each in September.



Offering full VGA compatibility, Microfield Graphics T8/2 color graphics card delivers high-level performance on a PC platform with 1,280-by-1,024 pixel resolution, plus eight color planes.

Other graphics board manufacturers such as Microfield Graphics Inc., Beaverton, Ore., and Matrox Electronic Systems Ltd., Dorval, Quebec, Canada, have already built VGA compatibility into their products, which (unlike Colorgraphics VGA² card) offer considerable on-board graphics processing power. Both companies' products are VGA- compatible at the BIOS level and use the PS/2's own VGA chip to do the hardware functions. Both companies have also offered EGA-compatible cards for years, and shifting gears up to VGA was no big deal, says Rod Steel, Microfield's senior graphics engineer. Although VGA offers increased resolution and color capability, it "uses the same register protocols as EGA and the same strange interface," he says.

PROCESSING POWER. By using a Advanced Micro Devices Inc.'s off-the-shelf 2900 graphics engine and proprietary gate arrays for bit-block transfers, Microfield's VGA-compatible T8/2 delivers 1,280-by-1,024-pixel resolution, and a depth of 8 bits per pixel. Matrox took a different technology path to roughly the same resolution and color performance by integrating Texas Instruments Inc.'s TMS34010 graphics processor on its VGA-compatible PG2-1281 board. Matrox uses proprietary circuitry to deliver a four-fold boost to the 34010's speed. The companies compete on drawing speed, and the winner in that sweepstakes depends heavily on specific application. The PG2-1281 will be available in August for $4,995. Microfield's T8/2 is available now for $3,795.

Other significant product trends to look for at Siggraph '88 are the emergence of more application-specific work stations, a move toward X Windows as an interface to graphics applications programs, and the battle for supremacy that is shaping up for full-color, hard-copy reproductions.

Joel Orr, chairman of Orr Associates, a CAD/CAM consultant headquartered in Great Falls, Va., sees the migration toward more "discipline-specific" hardware configurations as ushering in low pricing structures.

"As vendors become better attuned to the needs of different engineering disciplines, they are coming out with more reasonably priced products for them," he says. Particularly in mechanical and architectural CAD/CAM, where design methodologies are still emerging, vendors will be developing work stations in the under-$30,000 range that deliver performance now found on general purpose machines that cost $100,000.

Whether CAD, desktop publishing or animation is the application, computing the bit blocks for complex images is only the beginning. The final step—displaying the image—may be ready for a sea change. Up until now, the hardware interface of choice for many has been emulation of the Tektronix 4100 series of terminals, but that de facto standard is under heavy pressure from MIT's X-Windows. Graphics applications that run on Digital Equipment Corp. VAX minis, mainframes and VAXstations will lead the way because of DEC's use of X-Windows through DEC Windows.

BANDWAGON. What's likely to follow are the Unix machines based on Intel Corp.'s 80386 microprocessor, says Microfield's Steel. The advantage, of course, is the "automatic" windowing environment lacking in Tektronix terminal emulation. "X-Windows does all the dirty work for you," Steel says. "A lot of end users are saying they want to make the transistion. NASA has a lot of [Tektronix] 4125 stuff, for example, and they want to transition to X-Windows." The major stumbling block, however, says Steel, is that Version 11 "isn't functional; its just limping along. If you're trying to do development with X-Windows as an environment, you don't know if the bug is in your code or X."

Another fly in the ointment is Open Look—the user interface Sun and AT&T Co. introduced a few months ago. Sun is a major graphics platform, and its success in attracting third party vendors to Open Look is being watched closely by analysts such as Orr, although he expects support—or lack of it—will come through announcements rather than products.

Some software and add-on card vendors have already taken the X-Windows plunge. Ithaca Software Inc.'s Hoops three-dimensional graphics development system includes an X-Windows interface. "We follow the hardware," says Ithaca Technical Representative Aline Bernstein," and we'll be watching with great interest how many terminal manufacturers jump on the X-Windows bandwagon." Back at the product level, Ithaca's Hoops is built around an object-oriented structure that greatly simplifies the design and production of advanced interactive graphics applications. It features a hierarchical graphics data base, hidden line andsurface removal, and a device-independent interface. It supports VMS, Unix, DOS, the Macintosh II and, of course, X-Windows.

Advanced Electronics Design Inc., Sunnyvale, Calif., will show off its X-Windows compatible 1280V-FDS Colorware Card that delivers 1,280-by-1,024-pixel resolution with eight bit planes on VMEbus systems. Robert W. Deisher, product manager, says he "expects X-Windows to supplant Tek 41XX emulation as an interface between application software and display terminals." Based on the Motorola 68020 microprocessor, the 1280V-FDS two-board set supports TEK 41XX and DEC VT100/300 terminals as well as X-Windows. Available now, it costs $5,495.

Back in the mundane world of hard copy reproductions, a battle for technological supremacy is shaping up between a Cycolor process developed and patented by the Imaging Divisions of Mead Corp., Miamisville, Ohio, and the present market champ—thermal-transfer printers. The first Cycolor product to hit the market will be Noritsu America Corp.'s QPS-101 Cycolor Slide-Printer—but the technology works on paper, as well.

Cyclor technology is based on coating a polyester film with microcapsules of cyan, magenta and yellow pigments, each about 5 μm in diameter. The microcapsules are sensitive to differing wavelengths of light. Exposing the film to an image selectively hardens some of the globules. 'It's a subtractive process," says Bruce Howard, marketing manager, "so the ones that have not hardened create the color." Under pressure, the unhardened capsules are transferred to the color transparency or paper. Capable now of resolutions equal to or better than present technologies, Cycolor has the potential to produce photographic-quality images, once manufacturing problems have been solved, says Howard.

The QPS-101 prints 7-by-10.5-in. full-color images that can be mounted on a paper background at an average price of 59 cents per copy—which is comparable to present technologies. The first copy takes 45 s, followed by a production rate of 100 prints/hr. It will be available in early September for $8,900. Introduced at the National Computer Graphics Conference in May, it will not be on display at Siggraph.

Thermal-transfer color printers, on the other hand, will be well represented, with products from Sieko Instruments, San Jose, Calif.; Nikon Inc., Garden City, N.Y.; and Mitsubishi Electronics America Inc.

Mitsubishi's G330 prints on glossy paper or transparencies with 150 dots/in. resolution. Copies roll off at a rate of one every 80 s on cut-sheet 8.5-by-11-in. paper. Its video interface captures signals directly from graphics controller boards such as IBM's CGA, EGA, VGA and Apple's Macintosh II. It will be available in August for $5,900. *– Jack Shandle*

Mitsubishi's G330 color printer pushes thermal-transfer technology to 150 dpi resolution and 4,086 hues while offering a build-in video interface to create faster presentation graphics.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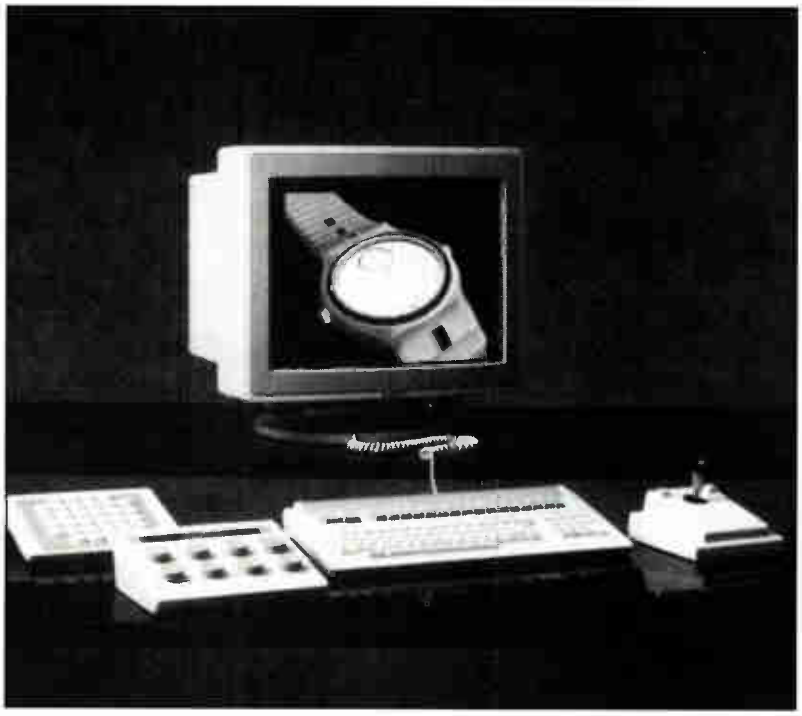
SPECIAL ENGINE MAKES TERMINAL A PHONG-SHADING POWERHOUSE

ASIC-based boards let Seiko terminal do complex shading at interactive speeds

Phong shading a computer-graphics image is a task that requires a substantial amount of computational power. Graphics terminals and work stations until now could only generate a Phong-shaded image if left to the job for a long time—too long to be tolerable in interactive graphics environments. But now Seiko Instruments USA Inc. of San Jose, Calif., has developed a special-purpose graphics engine that makes it unnecessary for Phong-shading jobs to be sent back to the host mainframe or minicomputer for batch-mode execution, as is current practice.



Fortified with a new board set, Seiko terminal makes fast work of images with complex 3-d Phong shading using up to nine modeled light sources.

Phong shading is not absolutely the most sophisticated image-rendering technique known to the industry, but it is now taking a big step into the realm of the economically practical, thanks to a set of Seiko application-specific integrated circuits devoted to the kinds of calculations needed. The gate-array-based engine for the GR4400 graphics terminal is one more shot fired in the war between graphics terminals and work stations.

Seiko's terminal computes three-dimensional Phong-shaded images with nine light sources and can produce in 24 seconds an image of a sphere that takes the VAX-11/780 47 minutes, says Michael Warner, director of marketing. That, he claims, gives it graphics-processing performance that only the most expensive work stations can muster—the new personal supercomputers from Apollo, Ardent, and Stellar.

Those high-end work stations "are $150,000 units," Warner says. "The graphics shading engine adds $14,995 to a GR4400 terminal, which, with networking and double-buffering capability sells for a third the price: around $56,715." Of course the terminal does not offer the general-purpose computing clout the work stations have. It is in graphics applications in particular that the terminal is more cost-effective.

Seiko's three-board shading engine uses two 20,000-gate ASICs that Seiko calls polygon rendering engines. The chips perform as 3-axis scan converters, turning the vectors used by the host computer to define an image into displayable pixel data. One chip calculates the x-, y-, and z-axis components of each pixel while the other computes the red, green, and blue color components of each pixel.

BEYOND GOURAUD. Up to now, most graphics work stations and terminals architectures have provided flat shading, some Gouraud shading, and in some cases Phong shading with no more than three light sources. These rendering schemes are less computationally demanding than the complex, nine-light-source, Phong shading done by the Seiko engine.

Flat shading applies a single light intensity to a section of a surface. The resulting image has shades of a color in different sections of a surface. Gouraud shading interpolates the color between these sections of a surface.

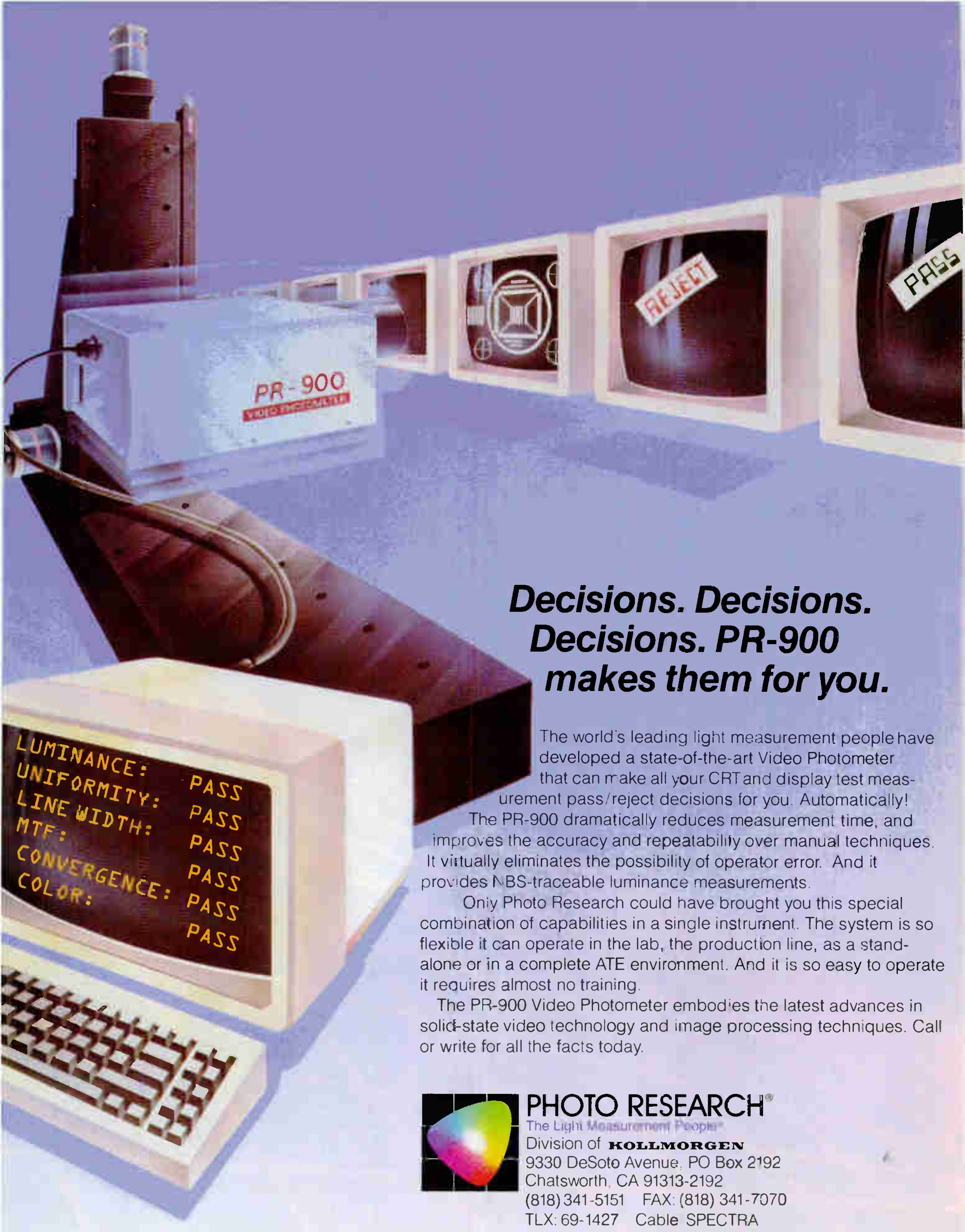
Seiko's graphics shading engine does flat or Gouraud shading as well as complex Phong shading and hidden-line and hidden-surface removal, all quickly enough for an interactive environment. The user doesn't have to switch to some other task while he waits for his image to be produced.

Phong shading is a complex algorithm that involves computing the intensity of each pixel according to how that pixel is oriented with respect to the light sources. There is one calculation of the Phong lighting model for each pixel. The point on an object that is facing a light source directly is given the maximum light-intensity value that source can deliver. In addition to light coming directly from fixed sources, the lighting model takes into account ambient lighting, the specular light (light reflected off the surface of an object), and diffuse light falling on the object. The effect of each of these three types of light are calculated for each pixel on the screen.

In addition, the position of the object with respect to the viewer is taken into account. This computation is called intensity depth cueing. At the same time, the engine calculates what parts of the object are hidden from view and removes them from the image.

Where the Seiko chips differ from other graphics-terminal implementations is in how they perform 3-d position and color calculations. Other high-performance 3-d graphics system architectures stage the computations in a series.

By contrast, the Seiko polygon-rendering engines perform the x, y, z, and R, G, B interpolations all at the same time. The result is high-speed line interpolation for each pixel and Phong shading at a sustained rate of 60,000 pixels/s, the speed at which most terminals and work stations generate an image without Phong shading. *–Jonah McLeod*



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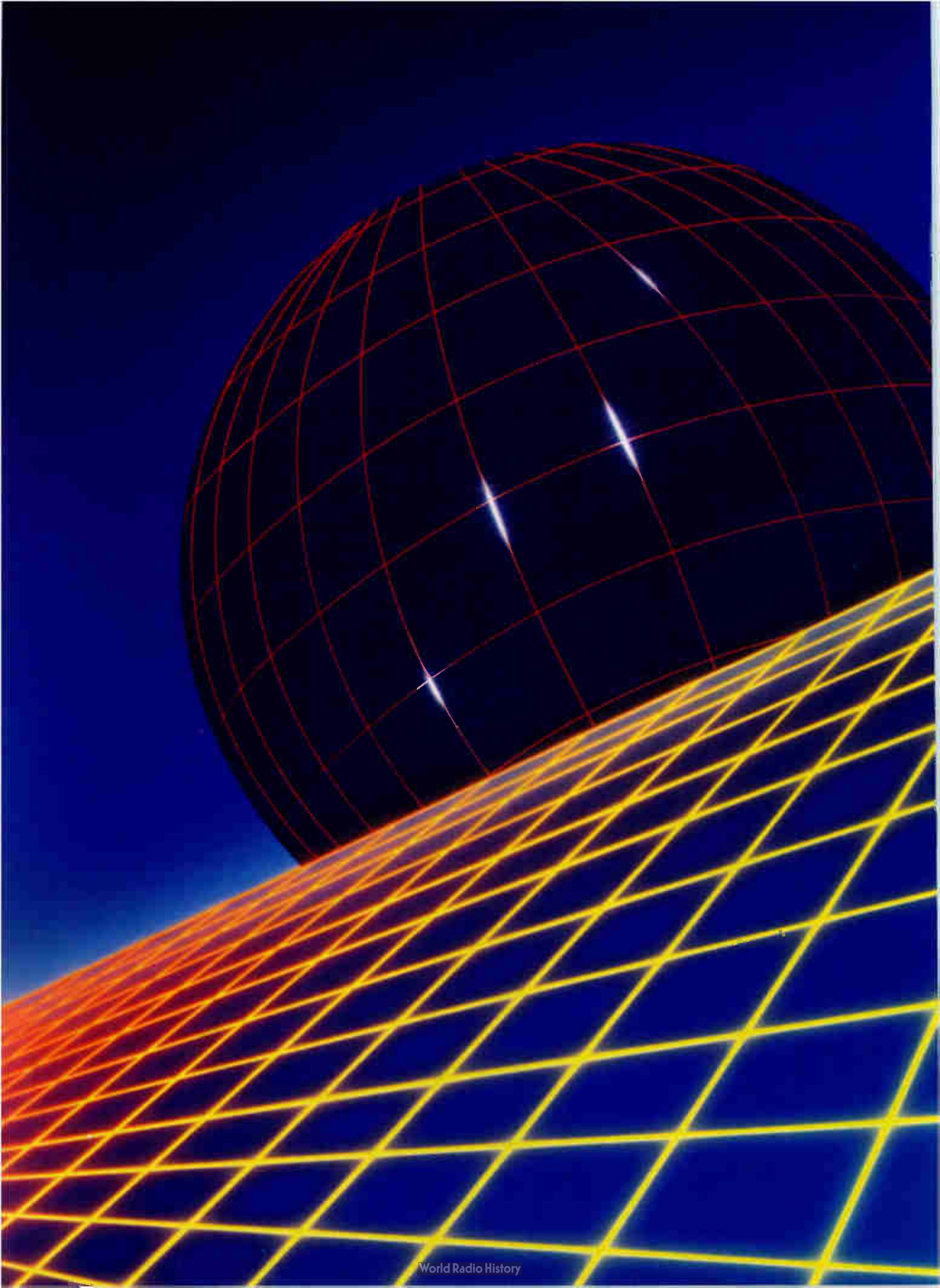

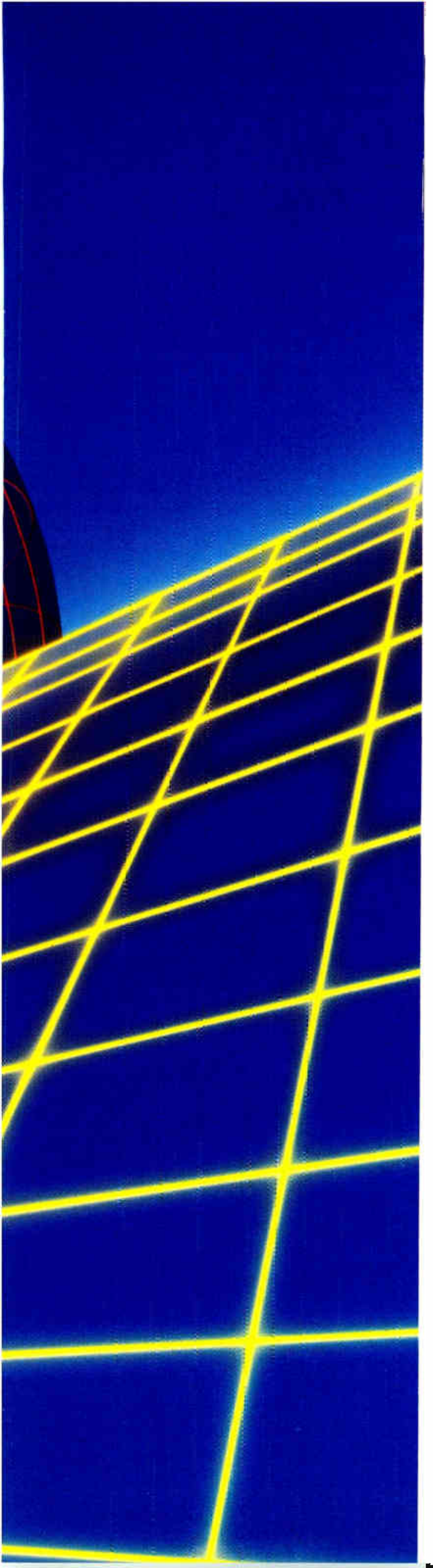

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SUPERMINI KILLER: FIRST OF NEW RISC BREED IS HERE FROM MIPS COMPUTER

The M/2000 delivers a price/performance yield as low as $5,000/mips

The good times could be over for minicomputers. Causing their decline are lean, mean machines based on reduced-instruction-set-computer architectures. Now, MIPS Computer Systems Inc. is unleashing just such a minicomputer killer. Its M/2000 RISComputer system is a new breed of machine that sets new price/performance standards spanning the minicomputer and mainframe marketplaces.

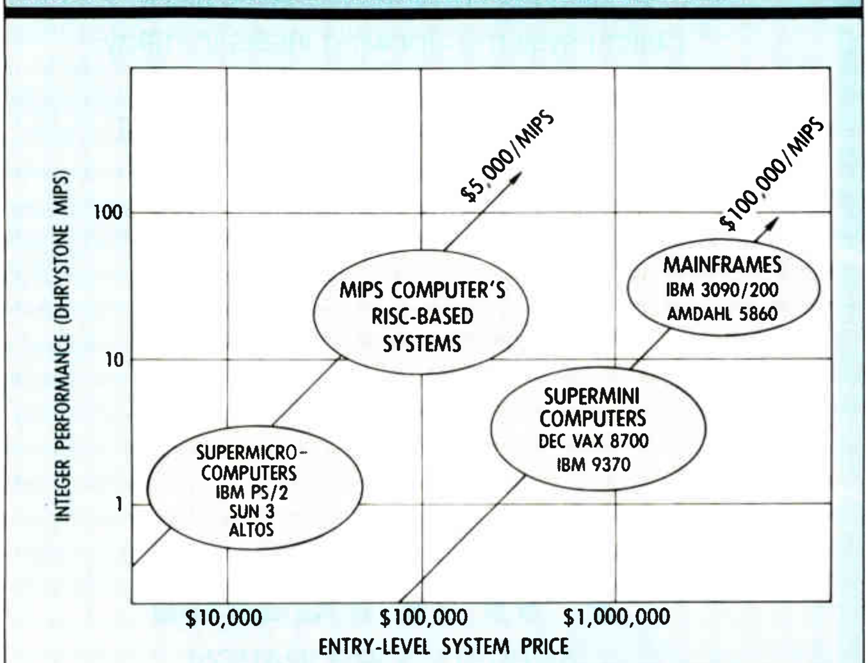
Using its recently introduced R3000 RISC chip set [*Electronics*, March 31, 1988, p. 21], MIPS outstrips the power of today's highest-performance minicomputers—the superminis—but at a much lower cost. For system costs ranging from $100,000 to $150,000, the 25-MHz M/2000 offers a sustained throughput of 20 million instructions/s and a 20-MHz version delivers 16 mips (using the VAX 11/780 as a 1-mips standard of comparison). The cost of $5,000/mips to $7,500/mips looks truly radical when compared with that of typical minicomputers, at $100,000/mips, and mainframe costs of up to $1 million/mips. Even the latest work-station servers can only offer price-performance at around $10,000/mips.

"The power of the M/2000 is twice the top-of-the-line computers from Digital Equipment, Hewlett-Packard, and Data General, and they charge about five times as much," says William D. Jobe, MIPS executive vice president of sales and marketing.

PAYOFF. Computers like the MIPS M/2000 demonstrate that the RISC approach to computer architecture is starting to pay off. The big jump in price/performance that RISC systems can deliver is starting to revolutionize the computer industry. The Sunnyvale, Calif., RISC pioneer is setting the foundation for computing in the 1990s with an advanced machine combining RISC architecture and the Unix operating system. The company has also emphasized design features that will enhance the machine's performance in emerging computing network environments. The MIPS M/2000 offers a slew of industry-standard functions as well as an open software approach.

What's more, the machine is the first fully developed minicomputer architecture implemented with commercially available RISC microprocessor chips (see figure). As such, the M/2000 accomplishes an impressive 1.25-cycles/instruction rating and includes a new memory system that aids in efficient instruction streaming.

RISC'S BIG PRICE-PERFORMANCE ADVANTAGE



SOURCE: MIPS COMPUTER SYSTEMS INC

Until the emergence of systems such as the M/2000, microprocessors were not used to build minicomputers and mainframes—they have been the stuff of personal computers and work stations. The M/2000 is neither a high-performance micro nor a work station. And it is much more than the old minicomputers, which emphasized proprietary operating systems, networking, and other software.

The primary differences between existing minicomputers and what will be their replacements, as MIPS sees it, begin with the basic architecture. The old minis represent the complex-instruction-set computer approach while the next generation will use RISC architecture. Old minis are running at about 2 to 5 mips and that power is increasing by only approximately 25% per year. The RISC machines are already at 10 to 20 mips and that power is doubling every year.

What's more, the M/2000 RISComputer is designed to be a computer for the new world of heterogeneous computing network environments. "The new computing world will be based on standards, networking desktop devices working with servers, and system units from different vendors," says Robert Miller, MIPS president.

MANY FUNCTIONS. The traditional minicomputers with proprietary operating systems and network software have little ability to function in the new environment and will eventually disappear, Miller contends. Computers like the heavily standards-oriented M/2000 are ideal partners in the heterogeneous mix. They can perform a broad range of functions, acting as powerful multiuser computers, network computing engines, applications accelerators, or software development systems.

The MIPS M/2000 is outfitted with a bevy of industry-standard functions and features. Running the Unix operating system, it fits easily into networks with its list of networking tools, including Ethernet, TCP/IP, and Sun's Network File System.

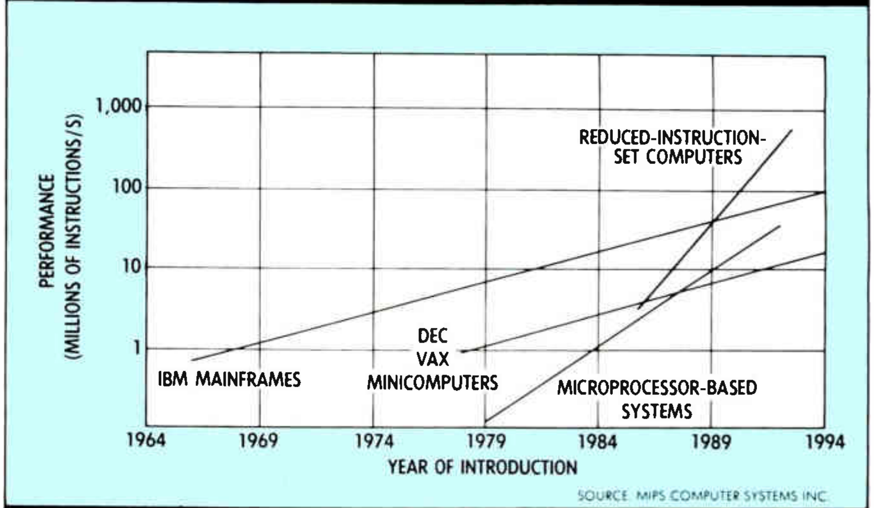
The other major difference between minis and the next-generation RISC computers is the software approach. The systems present an open system, typically based on the Unix operating system, and standard networking hardware and software. Systems programming is done in high-level languages—often C—and instead of individual compiler products, these new systems offer compiler sets with common optimizing back ends.

The environment provided for the users is also quite different. The typical multiuser minicomputer environment is directly connected terminals and a nongraphical, text-oriented interface. The new systems are accessed through local-area networks by terminals, personal computers, and work stations. A rich graphics interface is usually available.

BUILDING PERFORMANCE. Beyond offering an industry-standard software environment, MIPS incorporated several performance-building features into the M/2000 to create an extremely fast minicomputer replacement built on a VLSI microprocessor base. The system's architects designed a much more advanced memory system than those of their previous RISC computers. In addition, they built a high-performance input/output subsystem to match the performance of the RISC central processing unit.

One of the principal goals in the design of the MIPS M/2000 was to achieve uniformly high performance over a variety of load conditions. To this end, a set of benchmark programs was developed to test performance degradation under increasingly heavy loads. The benchmark set attempted to simulate a heavy load under two different conditions: the first was a few very large programs, and the second built up from a large number of moderate-size programs.

RISC PERFORMANCE GROWTH OUTRUNS THE PACK



The M/2000 system achieves its sustained rate of 20 mips on integer benchmarks and 4 million floating-point operations/s on the standard double-precision Linpak benchmark.

The design achieves an average cycles/instruction rating of 1.25, which is an excellent rating, and an improvement from the 1.5 of the previous MIPS systems. The major factor contributing to the 1.25-cycles/instruction rating is the use of instruction streaming, which is an advanced CPU and memory design technique. It allows concurrent instruction execution while the instruction cache is being refilled; optimal block refills of the data cache, which is similar to instruction streaming except that it operates on data rather than instructions; and block writes for localized write traffic, a technique called write streaming.

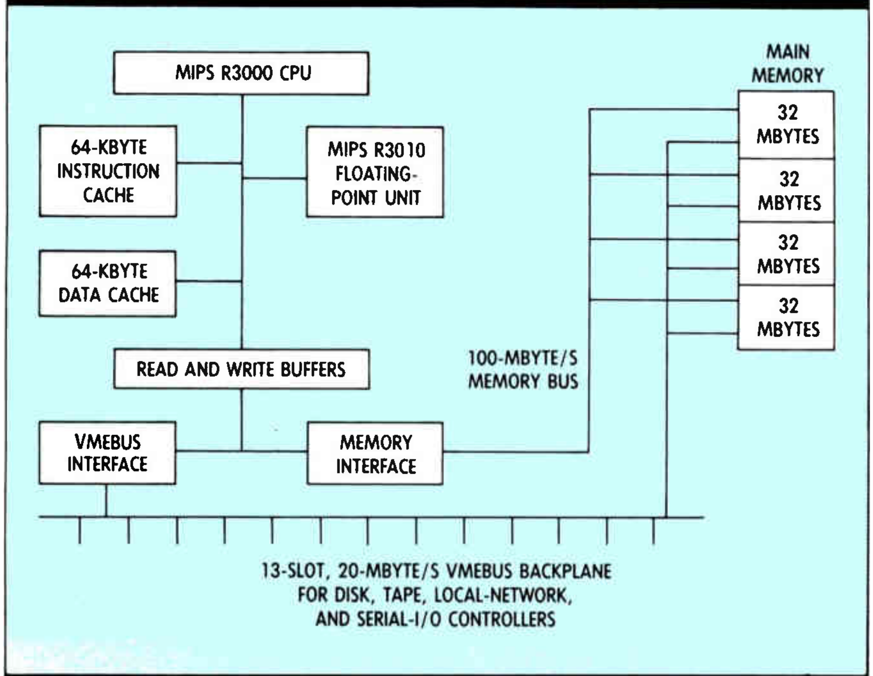
The novel memory system design of the M/2000 aids in efficient instruction streaming. It achieves the required bus bandwidth for streaming support with two interleaved banks of page-mode dynamic random-access memories.

Efficient instruction streaming is also a result of certain aspects of the R3000 CPU design. One is its ability to do both an instruction reference and a data reference in a single cycle over separate instruction and data buses. Another is its delayed-branch mechanism, with which a branch instruction can be executed without disrupting the issuing of instructions in the stream. Instruction streaming in RISC designs is exclusive to systems built with the MIPS R3000 chip set.

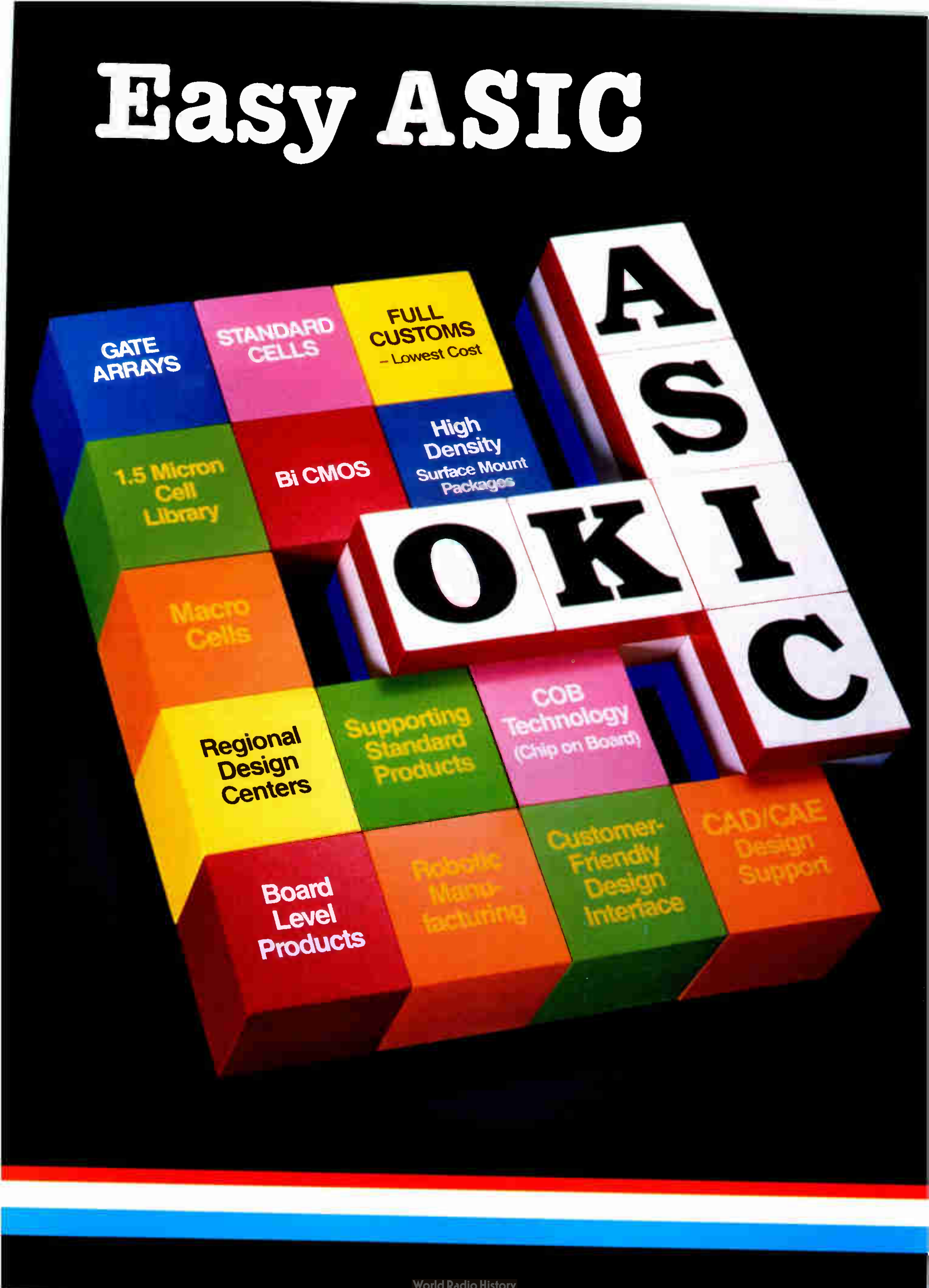
With these features and a five-stage pipeline, the R3000 processor can be working on up to five instructions at once. The five pipeline stages are the instruction-fetch stage, the register-fetch stage, arithmetic-logic-unit execution, the memory-access stage, and the writeback stage.

In order to boost I/O performance, the M/2000 system performs I/O operations simultaneously with memory accesses. The peak I/O transfer rate ranges from 25 to 33 Mbytes/s, depending upon what type of I/O controller used. The most important design attributes of the I/O subsystem are the use of first-in, first-out buffering for both reads and writes between the memory and the I/O bus, and page-mode reads and writes into the memory for contiguous data. *–Tom Manuel*

M/2000: A HIGH-PERFORMANCE ARCHITECTURE



The MIPS M/2000 RISComputer architecture includes a RISC processor, which delivers 20 mips of performance, two caches, and a high-speed floating-point unit.



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COMPANIES TO WATCH

CAN DATA TRANSLATION TRANSLATE ITS 'L. L. BEAN' EXPERTISE TO A NEW MARKET?

The mail-order supplier of data-acquisition boards is jumping into Macintosh image processing

MARLBORO, MASS.

When the Siggraph '88 computer graphics show opens Aug. 1 in Atlanta, a dozen companies will be running Data Translation Inc.'s QuickCapture frame-grabber board and software on the Macintosh II computers in their booths. What is striking about that is the fact that Data Translation, a 14-year-old company built on data-acquisition boards for scientific and industrial uses sold strictly by telephone orders, is betting so much of its future on the Mac and commercial image processing.

The company says QuickCapture is the first image-processing board for the Mac II and that ColorCapture, a sister product, is the first color frame grabber to capture and display live-motion color video images on the Mac II. Data Translation also is coming out with image-processing boards for IBM PCs and compatibles.

Founded and still led by president Fred Molinari, the Marlboro, Mass., company made its reputation supplying data-acquisition boards and software primarily for Digital Equipment Corp. scientific and industrial computers. More recently the boards have been produced for IBM, Compaq, Apple, Apollo, and Sun systems operating in the same scientific-industrial environment.

Fred Molinari is leading Data Translation into "a whole new era" with a market that includes 80% of all Macintosh II users.

Although the company plans to continue to serve its traditional markets, the dominance of its boards at the Siggraph show indicates a substantial change in direction toward a wide range of commercial jobs, including desktop publishing and presentation.

Molinari characterizes the company's thrust as "the start of a whole new era. . . . Our [established] products appeal to about 5% of IBM PC AT users, but with products such as QuickCapture, our market expands to include up to 80% of all Mac II users."

This new era may be a lucrative one, he says: "When we look at Apple Computer growing at around 50% per year, and then look at the percentage of their systems that need frame grabbers, we come up with a big number that gives us plenty of room to grow."

That growth, in revenue and earnings, averaged 35% a year in the last seven years. Net income in 1983 was $830,000 on revenue of $10.5 million compared with $3 million on $31 million in 1987, a solid record during a serious five-year recession in the computer industry.

MAIL-ORDER. A prime factor in Data Translation's growth is its unique sales strategy. The company says it's the only manufacturer of board-level products that relies on catalog and telephone orders. "We don't have a direct-selling function as our primary activity to reach customers," Molinari explains. "We put out catalogs each year to about 70,000 people. We're the L. L. Bean of electronics."

Richard Schwarz, first vice president at Shearson Lehman Hutton in New York, agrees. Data Translation's "most distinguishing characteristic is its method of distribution," he says. "They have a formula to sell electronic imaging products without an enormous in-house infrastructure, which is the Achilles heel of many imaging companies."

The company's origins—capturing and processing analog inputs from sensors such as temperature and pressure gauges on a single board added to a mini or microcomputer chassis—have fueled its growth until recently. However, more than three years ago Molinari and his senior management team realized that image processing offered additional potential for growth via hardware and software disciplines similar to those developed for its traditional business.

In imaging, the sensor is different—often a video camera—and the applications demand high speed to process images at 30 frames/s. But the semiconductor industry has kept pace with the need for high-speed processing on imaging boards by making faster microprocessors and image coprocessors that Data Translation and other suppliers of image processing boards are using in their products.

Data Translation has considerable competition in its thrust into the scientific-industrial image-processing business from companies such as Imaging Technology Inc. of Woburn, Mass., and Matrox Electronic Systems Ltd. of Montreal. The company has a tough row to hoe: analyst Schwarz of Shearson Lehman Hutton regards Imaging Technology "as among the top, if not the top," in this realm, but he doesn't count out the feisty Data Translation.

And it isn't putting all its imaging eggs in one basket. There's another new product, an RGB-to-HSI (red, green, and blue to hue, saturation, and intensity) converter board that Schwarz characterizes as "an interesting product and something worth following."

That color frame-grabber board is one move to combat competition in color image processing, a market Molinari says will fuel growth in scientific-industrial and commercial applications. The company introduced the color frame-grabber board in January. It is a subsystem for the IBM PC AT and compatibles that includes two CMOS application-specific integrated circuits that Data Translation designed in house.

But it's the Macintosh world that has the company particularly excited. Because of the Mac II's advanced microprocessor, NuBus, and monitor technology, Data Translation's QuickCapture doesn't need to be as sophisticated as its other boards, the company says. So QuickCapture is priced at $995 for commercial applications, compared with about $2,995 or more for many of the other boards.

QuickCapture, undoubtedly the forerunner of several Mac II-based products, is a black-and-white frame grabber board and software package that captures, manipulates, and displays images with 256 gray levels from video cameras or VCRs. It acquires moving images in real time, and is compatible with some of the leading commercial imaging programs for the Mac II. In fact, Data Translation has formed alliances with Aldus Corp.'s PageMaker program for page layout, Letraset USA's ImageStudio software for photo retouching, and Claris Software's MacPaint art program. *–Lawrence Curran*

THIS DESIGN HOUSE COULDN'T WAIT TO JUMP INTO CHIPS

SAN JOSE, CALIF.

Making a success of the design-consultant business wasn't enough for the founders of Vadem Inc.: they wanted to jump into the competitive—and lucrative—product world with chips that ease the design of personal computers. And Vadem is setting its sights on a niche that other players in this market, which include the likes of Chips and Technologies Inc. and Western Digital Corp., have passed over.

Not for Vadem the high end of the PC market, using 80286- and 80386-based computers. Rather, the five-year-old San Jose company is banking on its past design experience with chips for MS-DOS and PC-DOS computers to enhance lower-priced microprocessors to run those standard operating systems. The reason is that it expects DOS to remain the dominant operating system through the early 1990s, says Paul Rosenfeld, chief operating officer. And that's his opening: fitting low-cost but high-performance systems based on chips into the PC-XT compatible world. In that niche are NEC Corp.'s V40 high-integration processor and its newer V33 chip as well as Intel's 80C186.

Currently in development is a pair of chips that will allow the low-power 80C186 to achieve full compatibility with PC software. Together, the pair plus the 80C186 will form the entire computer logic core—just a disk controller, video display, and memory must be added. Chip sets running at 16 MHz are planned that will let system manufacturers build computers with IBM PS/2 Model 30 and PC-XT architectures. Those systems will offer performance roughly comparable to 10- and 12-MHz 80286-based systems, but will cost as little as a fourth as much.

In addition to the clutter-reduction chips that surround the central processor, Vadem plans to tackle embedded PC applications that are usually very

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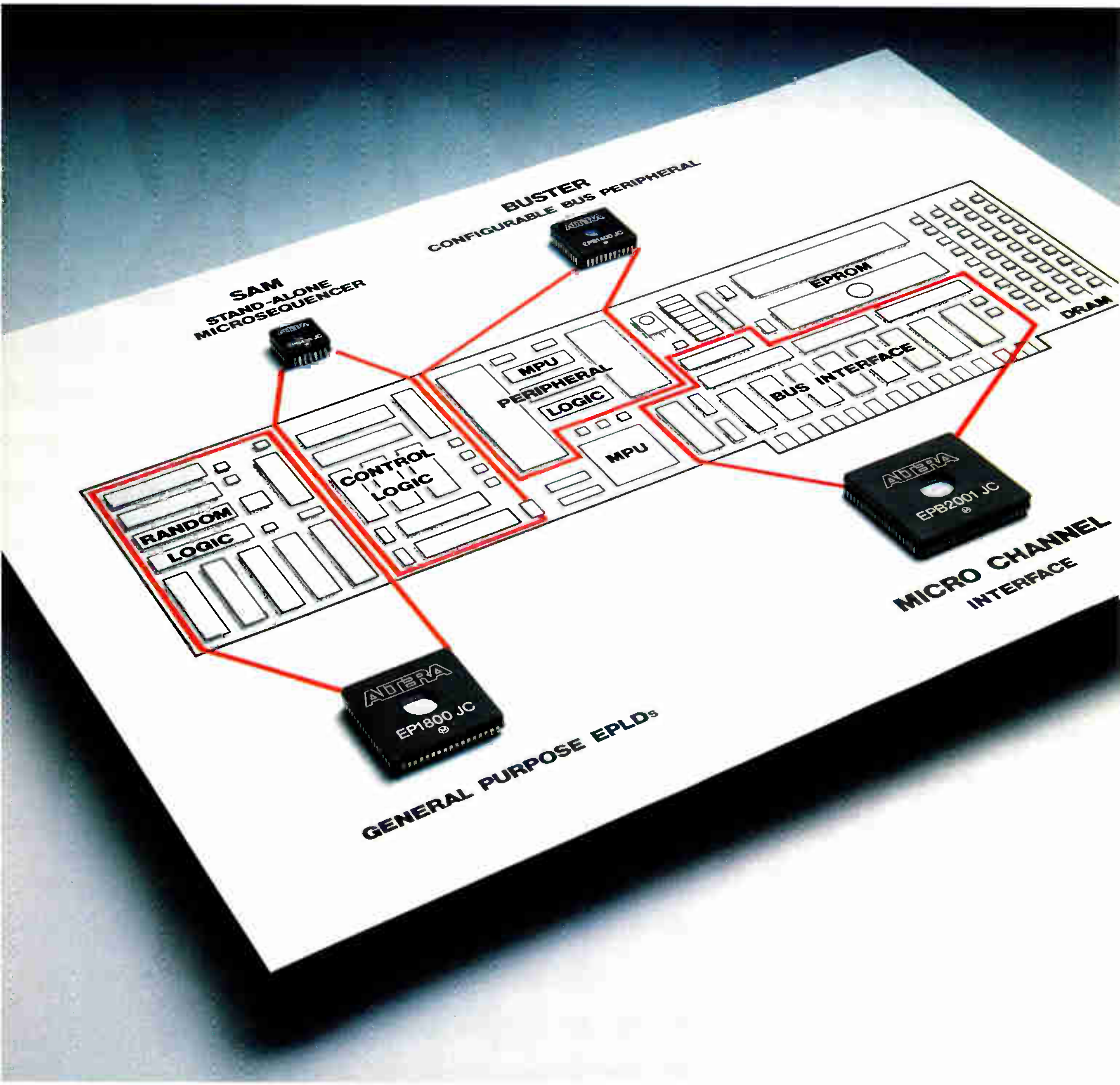

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All of them save you time, money and board space.

And all it takes to get going is your PC and a desktop.

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Simply put, Altera is the fastest route from design to silicon.

Our CAE development system lets you enter your design using familiar TTL macrofunction as well as Boolean and state machine approaches.

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space-limited. Such systems are widespread: they're in handheld terminals, industrial controls, home electronics, networked terminal work stations, point-of-sale systems, and instrumentation.

To that end, Vadem is developing several other chips that solve some of the cost-sensitive interface requirements. One is a controller for liquid-crystal-display panels; another one combines many popular functions such as serial and parallel ports and logic to control nonvolatile memory and make it emulate a disk drive.

Steering Vadem are, from left, Chikok Shing, chairman; Henry Fung, vice president of engineering; and Paul Rosenfeld, COO.

Founded by Chikok Shing, chairman and chief executive officer, and Henry Fung, vice president of engineering, the company has kept its ranks small—there are still only 18 full-time employees and a few consultants. Privately held, the company has been profitable in 1986 and 1987 and expects its revenues to hit $3 million in calendar 1988. For the past four years, Vadem did complete system and subsystem design for computer and peripheral suppliers and concentrated heavily in the areas of laptop personal computers, power-saving techniques, and firmware

Some of the company's credits include developing the first commercial laptop PC-DOS system that Morrow Designs brought to market as the Pivot. Vadem later sold the design to Zenith Corp., which did some revamping and reintroduced it as the successful Z-171. Other successful designs include the Sharp Electronics PC-7000 and PC-4500 series computers. *–Dave Bursky*

EARLY-BIRD RETIX PROFITS FROM OPEN SYSTEMS

SANTA MONICA, CALIF.

When a group of leading computer companies demonstrated interoperability at last month's Enterprise Networking Event in Baltimore, they were using software from Retix Corp., a three-year-old Santa Monica company that has quietly carved out a dominant position in the market for software linking disparate hardware and networks.

One key to Retix's new prominence is the rush of major computer vendors, long mired in the proprietary-systems trenches, to embrace the Open Systems Interconnection standard and its seven-layer protocol stack. The joint endorsement by a dozen of the world's largest computer moguls in May [*Electronics*, May 12, 1988, p. 21] capped that process.

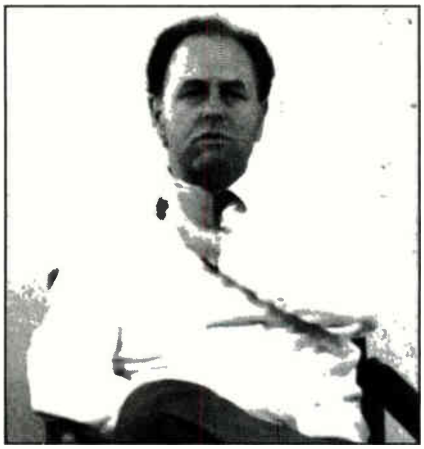
Success surfaced before that, however, and data-com watchers say the best way to understand Retix's heady balance sheet—nine consecutive black-ink quarters driven by a doubling of sales to $22 million this year—is to take company President Andy De Mari's word: "In terms of basic technology [for computer interoperability software], people have to come to Retix," he says confidently.

More than 85 blue-chip companies around the world apparently agree. The company's biggest customer is Italy's Olivetti, which already has some 30,000 computer nodes, and has a contract to buy up to $10 million worth of products over the next two years. Others include IBM Corp. and Boeing Corp., as well as other computer, networking, and industrial firms in the U. S. and Far East.

While interoperability software can be supplied on disk, Retix increasingly sells it integrated onto printed-circuit boards and embedded into such equipment as bridges and routers, which translates to an expanding hardware business, too—50% of its sales, in fact.

By all accounts, Retix's 1985 implementation of OSI's protocols into workable products was a first. Since then, it has steadily expanded the line into dozens of offerings.

Financial analysts tagged the company a winner early on. "It has the key technology for the major players," says Mary McCaffree, an analyst at New York's C. J. Lawrence. What's more,



For interoperability, says president Andy De Mari, "people have to come to Retix."

Retix's fastest-growing market—linking personal computers to larger machines—is expanding 40% a year, says Alice Bradee, an analyst at Hambrecht & Quist, San Francisco. The only threat would be a slowdown in the overall market, which she doesn't foresee.

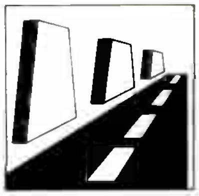
Original-equipment manufacturers launching new lines, or large organizations needing to upgrade communications, have few competing products from which to choose. Nor do they choose the expensive route of developing the products in-house. "They know exactly what they want and only need two to four months to port Retix [protocols] into their products. Otherwise it could take three years," says De Mari. Retix designs boast portability, or the capability of running on any kind of computer, so OEMs can easily adapt it across all their product lines.

Retix began life as a spinoff from another Santa Monica firm, CompuCorp, which builds hardware for data communications. De Mari and a core group of eight networking specialists set up shop and began writing protocol software on commission.

Although Retix has upped its growth momentum to the point that this year's sales should reach nearly $22 million, about double 1987, even bigger things lie ahead, in the view of De Mari and the analysts. The company has just introduced its first products for the X.400 electronic mail standard, that allows interconnection of different public and private systems and services. Use of electronic mail is booming and the Retix founder expects that within four years 50% of all this kind of service throughout the world could be based on the X.400 standard. *–Larry Waller*

MILESTONES

LOTUS ABANDONS MODERN JAZZ



Modern Jazz, the integrated software package Lotus Development Corp. was touting as the successor to its Jazz program for Apple Computer Inc.'s Macintosh, turned out to be nothing but the blues. Modern Jazz, which would have combined six applications in one package, apparently hit so many sour notes—including missing its scheduled May debut—that Lotus now says the program no longer fits its long-term strategy. Instead, the Cambridge, Mass., company says it will design a Macintosh version of Lotus 1-2-3.

HUGHES STAYS HOME BY POPULAR DEMAND

California roots are deeper than Hughes Aircraft Co. bargained for. Hughes had planned to consolidate its Missile Systems Group at the same site as the unit's manufacturing facilities, in Tucson, Ariz., but something got in its way: its employees. When 3,000 workers, including 1,400 engineers and scientists with advanced degrees, refused to move from Canoga Park, Calif., a Los Angeles suburb, Hughes decided to let everyone stay put. Playing a key role in the reversal was new Hughes chief executive Malcolm R. Currie [*Electronics*, June 1988, p. 154], who ran the Missile Group in the early 1980s. Currie says Hughes couldn't risk losing so much technical talent.

SIEMENS-INTEL VENTURE TO BUILD COMPUTERS

New computer firms arrive every week, but not many spring from such giants as Intel Corp. and Siemens AG. The two companies formalized a four-year-old development effort last month with the launching of BiiN, a joint venture aimed at real-time applications in automation and computer-integrated manufacturing. BiiN (it rhymes with wine) will be headquartered in Hillsboro, Ore., under the leadership of Joseph Kroger, former vice chairman of Unisys Corp. His job is to mold Intel's expertise as a microprocessor leader with Siemens' systems-engineering talents and European market strength into a successful line of parellel-processing, fault-tolerant computer systems. That's going to happen fast: manufacturing will begin in Hillsboro and Nuremburg, West Germany, before the year is out.

PEOPLE TO WATCH

IMAGE DATA'S PIERCE IS DRIVING TO SUCCEED WHERE AT&T FAILED

He's making a success of Photophone—and he's repacking the technology into new products

SAN ANTONIO, TEXAS

Chances are that Glenn Pierce won't be making an American Express "Do you know me?" TV commercial anytime soon. But that's fine. Unlike the average corporate honcho, the genial president of Image Data Corp. has access to another kind of a video network.

Pierce, a 14-year veteran of IBM Corp.'s marketing and management team, joined Image Data last year, and has led the five-year-old San Antonio maker of Photophone into the black, with effective management and imaginative repackaging of the company's technology. There are now more than 2,000 Photophones transmitting still images and voices around the globe at high speed. Actual transmission is over conventional telephone lines courtesy of AT&T Co.—which once failed in the same business with a system called PicturePhone—and other telecom authorities, including one in Moscow.

THE WHITE HOUSE? There are persistent rumors, which go unconfirmed by Pierce, that at least one Photophone is in the White House. "All I can say is that there is a significant amount of effort going on that will allow communications that are not now possible," says Pierce enigmatically.

The main uses of the Photophone are more prosaic than political. They involve transmitting documents, images of circuit designs, CAD/CAM drawings, X-rays, and a variety of other business-oriented graphics. And the market is there—Image Data's sales are up 40% over 1987, and expenses are under control, a welcome relief after a few rocky startup years. Projected profits for 1988 are $250,000 on sales of $6.8 million.

How has this tiny startup succeeded where megacorporation AT&T failed? In Pierce's view, one key is Image Data's recognition that transmitting moving pictures means little to the typical corporate customer, but costs a whole lot more. A cool $250,000 is not unheard of for moving-picture videophone studios. By contrast, Photophone is priced at $9,000 and can be plugged into any phone jack.

"My background is with IBM," says Pierce, "and I very often found in dealing with customers that large corporations can't shift resources and put their focus on specific new applications." But tiny Image Data has "been able to look at emerging applications. We saw a tremendous need for high-quality gray scale and color still images while others were chasing the expensive teleconferencing market," he says.

With an eye toward keeping hardware and transmission costs down, Image Data developed much of its key technology in house. For example, data compression and proprietary error-correction systems mean it takes 15 to 20 seconds to transmit a typical line drawing, as compared with three or four minutes without the new technology.

Much of Image Data's technology drive comes from founder Gerard Cullen, now the vice president of business development. "Like many technology companies, we needed an evangelist in the beginning to get everybody excited and convinced of our idea," says Larry Buerk, a company spokesman. "Then you need a long-term manager to implement the strong marketing and financial disciplines." Enter Pierce.

Pierce has brought Image Data more than profitability; he also has brought a new kind of strategic thinking. "It's the way he sees things," says Buerk. "Before he arrived, we saw ourselves strictly as a Photophone company. He saw all the technology we had developed—video board, image-compression algorithms, and modem board—and started thinking about how we could use it in new ways."

The first product of Pierce's technology-stretching is the Image Terminal, which uses Digital Equipment Corp.'s VT100 terminal emulation to access large data bases from distant locations. One application among many, says Pierce, is in real estate firms, which can give prospective buyers a "tour" of available homes in San Antonio, for example, from a sales office in New York.

Image Data is also spinning off new companies. One of the first, Photo Telesis Inc. of San Antonio, is concentrating on government business. David Monroe, formerly Image Data's head engineer and president of the spinoff, put together a ruggedized, militarized version of Photophone. Photo Telesis's lastest product is a Tempest version.

Pierce is set to use Image Data's technology in different ways. The company already has a spinoff aimed at government sales.

Pierce refers to an old time clock—the kind once used to punch in and out of work—in his office, to help illustrate his idea of corporate growth. The clock was manufactured by International Time Recorders, IBM's predecessor. "My perspective is simple," he says, pointing. "That is where IBM started out, but it's certainly not where they are today, and that's because they were able to move on to new opportunities."*–Jack Shandle*

WHY KUNDE IS THE FIRST YANK NAMED TO EPSON'S BOARD

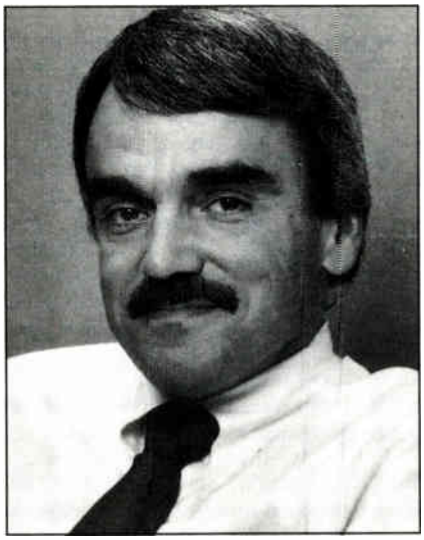
TORRANCE, CALIF.

When Epson America Inc.'s first personal computer—the QC-10—fell flat on its face, executives at the company's Japanese parent, Seiko, decided that weak marketing had killed it. They had a problem and the solution they came up with was decidedly un-Japanese.

They put an American, Eugene R. Kunde, in charge of setting things right. Kunde had earned his computer-marketing stripes at his Minneapolis-based company, Great Northern Data Systems, before its acquisition by Epson in 1985. Now Kunde has breathed robust life into the Epson Equity PC family, so Seiko should be patting itself on its back for its departure from Japanese corporate strategy. Kunde exercised unrivaled autonomy for an American head of a Japanese firm's U.S.-based unit. His election last May to Epson America's board of directors was unprecedented: he's its first non-Japanese member.

Under Kunde's command, Epson's PC market share has grown large enough to vie for a spot just below the top-ranking U.S. sellers led by IBM, Apple, Compaq, and Leading Edge. "Gene is a very important part of Epson's success," says Epson president Yasuhiro Tsubota.

"The only way you can survive [in PCs] is to be close to the customer," says Kunde, whose title is executive vice president and general manager of Epson America. "In the case of the late and lamented QC-10, Epson America's original Japanese manager ignored that commandment, endowing the machine with Japanese-conceived features that did not include IBM compatiblity."



"To survive in PCs, stay close to the customer," preaches Epson's Gene Kunde.

Seiko's senior executives gave him great freedom, he says, and the firm soon launched its first models in the Equity Series of PC-compatibles. Since then, Epson has regularly added timely hardware, including a popular laptop computer. It also started designing some of its products in 1986 at a San Jose, Calif., center and producing them at a plant in Portland, Ore.

Lessons learned in the hard-fighting U.S. arena are starting to pay off in the Japanese PC market, which Kunde calls "a whole different ballgame." Some of the software applications and features honed for the U.S. market have been introduced into machines for Japan, helping the parent company spring into the No. 2 spot behind NEC Corp. in personal computer sales. Kunde says he expects further synergy—and a further rise in Japanese sales. For those who would duplicate his role, he notes the need for recognizing "that we are not the same, and that the differences in culture" can cause glitches. "Be very sure that everyone understands things in the same way." *–Larry Waller*

How fast is fast?

To the editor: We at Lattice read with interest your cover story, "Programmable logic devices: the next generation" [*Electronics,* May 12, 1988, p. 61]. However, we must point out that great care must be taken in discussing device speeds. In the Altera story, for example, describing the MAX as a 60-MHz device does your readers a disservice since it implies that the chip could be used in the data path of a 60-MHz system. That is clearly not the case. In fact, the 60-MHz number derives from the toggle frequency of a single internal flip-flop. (Ours toggle at 80 MHz!)

Your readers deserve to know whether the products they're reading about are available. The Lattice products that I wish you reported on are at least as far along as either the Altera or TI products. Nonetheless, we indicate availability in calendar 1989. Lattice has shipped more CMOS programmable logic devices than all the other makers combined. We are also the only supplier of CMOS devices at 15 ns; over half of the one million units a month we build are 15 ns. All this should point out that we're the speed and volume leader in CMOS PLDs, and that's not to say that we're not pushing density, as well.

Raymond P. Capece
Lattice Semiconductor Corp.
Hillsboro, Ore.

• Toggle frequencies were used in the report to describe the speed of PLDs because they present the least ambiguous measurement of performance that is not tied to how devices are used in a particular system application or to chip densities. The internal clock frequencies focus on the speed of the process and circuit design, presenting a figure of merit that allows engineers to calculate a rough measure of system performance for an application. It was not intended to imply that toggle frequencies were the same as system frequencies.

Welcome to N. J.

To the editor: I enjoyed your April 28th Editor's Letter for its quick information on the magazine's change in ownership, the future of *Electronics,* and your change in commute from New York City to New Jersey—even though the "wilds" of New Jersey might become rather domestic all too soon.

We are proud of the fact that Bellcore [Bell Communications Research, the research and development operation shared by the seven Bell regional operating companies] has come a long way in its 4-1/2-year life. "Welcome to New Jersey" from a Garden State neighbor.

John E. Lucas
Bellcore
Bell Communications Research
Livingston, N. J.

Corrections

In the article on first-in, first-out registers [Electronics, *June 1988, p. 42*], *the illustration gave an incorrect breakdown of the market for 1988. The correct figures are $55 million for RAM-based FIFOs, $20 million for shift-register-based ones, and $5 million for those based on smart RAMs.*

In the same issue, p. 29, the megabit static RAMs article incorrectly reported the Inova device's standby power. It's 4 mA.

In the May 12th issue, in the article on Texas Instruments Inc.'s erasable PLDs, p. 71, the name of one of the design engineers was misspelled. He is Shailesh Kadakia.

BOOK REVIEW

TURNING 'MADE IN U.S.A.' INTO A PLUS AGAIN

GLOBAL COMPETITIVENESS: Getting the U. S. Back on Track
Martin K. Starr, ed.
New York: W. W. Norton & Co., $9.85 paper, $19.95 hardcover

When I was growing up in the 1960s and '70s, the phrase "Made In Japan" meant "Made Like Junk." When something broke down, a transistor radio or a portable TV or an electric mixer, the excuse was always the same: "What did you expect from the cheap Japanese thing, anyway?"

We're not saying that anymore. Today, when something breaks down, we're more likely to damn a U. S. manufacturer. Japanese quality is renowned world-wide, and "Made in the USA" just doesn't carry the same weight as it used to. The tides, as we all know, have turned.

Can we turn them back again? The authors of *Global Competitiveness: Getting the U. S. Back on Track* say we can, but that it won't be easy. They say fundamental changes in the way we do business, in our legal system, and in the way Americans view their jobs will be necessary to bring the U. S. out of its steep decline. And they remind us that great nations do indeed fall, and that "the verdict of history is always *suicide*."

The book, a collection of essays by some of the nation's leading political and social thinkers, takes the reader on a trip through Hell: the U. S. in the 1980s. Each of 10 articles drags us through yet another array of disturbing and discouraging figures: that U. S. productivity gains, a paltry 0.06% since 1980, are less than half as good as West Germany's and only a quarter as good as Japan's; that our crime rate outstrips any other in the Western World; that our $2 trillion national debt is bigger than the gross national product of most of the nations on Earth; that the average American family takes home less money today, when adjusted for inflation, then it did 20 years ago.

This is not easy bedside reading. It makes you angry, it makes you sad, and it makes you want to do something about it. And although much of the material is heavy going—with the most notable exception being "Crisis: The Uncompetitive Society," by former Colorado Gov. Richard D. Lamm—this is not just another collection of hand-wringing testimonials blaming all of America's economic problems on the shortsightedness of Big Business, Big Labor, or the evil crowd on Wall Street.

Authors like Lamm and Columbia University professors A. Blanton Godfrey and Peter Kolesar paint a picture of a place where society itself is to blame. Management has lost its competitive instinct, labor has failed to offer an honest day's work, and quality isn't even a word in our vocabulary. We have failed to maintain our schools, we haven't done enough to nurture fledgling businesses and industry, and we have failed as marketers, unable to exploit technology in the most lucrative commercial markets. Instead, we have let the Japanese and others take over one market after another, high-tech and low-tech, clothing and televisions, hand tools and semiconductors.

But Godfrey and Kolesar don't blame the Japanese. And they don't accept the easy explanations to Japan's dramatic success—that they can copy, but cannot innovate, or that the U. S. gave them everything in the first place. Their point is simple: "The root cause of the Japanese sucesss is that in industry after industry the Japanese have consistently been able to produce higher quality and lower cost goods." And the only way the U. S. economy can hope to survive, they warn, is by learning to produce goods as well or better than the Japanese.

There is reason to think we can. For although the U. S. economy is "saddled with public and private debt, and plagued by sluggish productivity growth and a massive trade deficit," writes Joseph Duffey, chancellor of the University of Massachusetts at Amherst, "at the same time, it enjoys the advantages of a highly skilled labor force, a well-developed research and development infrastructure, and the world's largest market."

Global Competitiveness is something unusual: it's intelligent, it's insightful, and it's not full of bluster. This isn't Lee Iacocca ticking off clever one-liners. This is a management book with something to say. *–Tobias Naegele*

WASHINGTON NEWSLETTER

DO THE LITTLE GUYS GET SQUEEZED BY THE PENTAGON'S SPENDING FREEZE?

Deputy Secretary of Defense William Taft IV relaxed the six-week moratorium on research and development spending June 30, putting to rest fears that the freeze might be extended through September. Taft froze spending May 20 for new R&D contracts and a range of other spending, such as overtime pay and business travel, to try to bring defense spending outlays in line with appropriations. Beginning in March, the Pentagon had been running $1 billion or more over budget each month. The freeze brought a flood of mail from small defense contractors, who claimed they were unfairly being forced to shoulder the burden of the Pentagon's budget crunch. The Council of Defense and Space Industry Associations—which includes the American Electronics Association, the Electronic Industries Association, and the Aerospace Industries Association, among others—warned that, "If sustained, the current policy will result in business failure, job loss, and most importantly, loss of valuable capabilities." Even now, however, Taft has only authorized contracting officers to spend 75% of the appropriated funds for the year's final quarter. The Pentagon will process contracts as if the contractors had been lining up since May 21, so it could be months before some companies see any federal money. Taft is trying to help the little guys, though. In lifting the ban he advised that "special consideration should be given to small and minority business contracts to avoid unnecessary hardships." □

THE ARMY WILL FUND THE LHX AFTER ALL

The Army's $37 billion program to develop the LHX, or Light Helicopter Experimental, a next-generation combat helicopter, is back on track. The LHX seemed all but dead last December, but the Defense Resources Board in June approved a modified LHX program for which development could begin by fall. A request for proposals describing the downsized 7,500-lb. aircraft is already out, and 18-month contracts worth about $165 million are expected to go to each of two teams, one headed by Boeing Helicopters and Sikorsky Aircraft Co. and the other led by McDonnell Douglas Helicopter Co. and Bell Helicopter Textron. "We'll produce a cockpit, but mostly paper," says a spokesman at McDonnell Douglas, which will handle the mission-equipment package, including all on-board computers, avionics, and communications systems, for the McDonnell/Bell team. "It could even be a full-scale mockup. But it won't be a fly-off sort of thing." Even so, the Army will pick a winner at end of that phase for one of the biggest Army programs around: 2,100 helicopters worth $7.5 million each. □

CONVEX BUILDS AN ADA COMPILER FOR HIGH-SPEED VECTOR APPLICATIONS

Military and aviation engineers have struggled to meet Pentagon rules requiring the use of Ada while taking advantage of advances in computer hardware, such as high-speed vector facilities. That's why Convex Computer Corp., a Richardson, Texas, maker of minisupercomputers, developed what it says is the first vectorizing Ada compiler. The Ada Joint Program Office has already certified the compiler, which can speed up Ada applications running on Convex computers by a factor of 8 to 10 or more, says Brian Christianson, a support specialist for Convex in Greenbelt, Md. The compiler automatically recognizes the parts of a task that can be vectorized, he says, and then generates vector assembly instructions instead of scalar instructions. The compiler won't help much with existing software, however, "because Ada is a richer language and has more constructs than Fortran or C to prevent vectorizing," Christianson says. But if an Ada programmer writes his program more like he would in Fortran—simply, that is—"he can optimize for vectorization" and realize the potential speed advantages. □

WASHINGTON NEWSLETTER

INDUSTRY PUSHES CONGRESS FOR TWO-YEAR DEFENSE BUDGETS

Skin-tight defense budgets in the years to come are stirring more interest in multiyear defense budgets, which would offer greater stability to the defense industry but take away some fiscal flexibility from Congress and the Pentagon. "With the federal budget deficit and the corresponding need to hold down spending, the DOD will do well to get a zero-percent real-growth budget in coming years," says Sen. Jeff Bingaman (D-N. M.) of the Senate Armed Services Committee. And that will require better planning. The U. S. is the only nation worldwide with a one-year defense budget, says Jacques Gansler, senior vice president and director of Analytic Sciences Corp., a Washington consulting firm. "We need greater line-item stability," he says. "Congress changes 50% of the line items in the defense budget every year, which is inexcusable, and the DOD changes 100% of the line items every year, which is twice as inexcusable." Defense procurement has been a hot topic in Washington since last fall, and the 1989 Senate Defense Authorization Bill includes some reform legislation, Bingaman says. But these address other issues, such as over-regulation of contractors and training for military procurement personnel [*Electronics*, March 31, 1988, p. 83]. Whether Congress is willing to lock itself into a two-year defense spending plan is another question—one that probably won't be answered until after the fall elections. □

HOW WILL CHEROKEE MEET DEMAND FOR ITS RUGGED CD-ROM DRIVES?

Interest in compact-disk read-only memories for military applications has spurred a number of companies to build ruggedized versions of commercial CD-ROM drives, but only one firm has built a rugged version from the ground up. The Cherokee Tracker from Cherokee Data Systems Inc. combines industrial components, custom hybrid circuitry, and a modified write-once, read-many-times optical head in a rugged package that complies with military standards for lightning, static control, and electromagnetic and radio-frequency emissions. Now the company is preparing to test the unit to meet the Pentagon's Tempest specifications for emi and rfi emissions, says David Moracco, product marketing manager at the Boulder, Colo., company. Four-year-old Cherokee has been shipping small quantities of the drives, which cost $12,806 in single-unit quantities, since the fall. But with firm orders in hand for volume shipments starting in September, Cherokee now has to worry about meeting demand that Moracco estimates at 800 units a month by the second quarter of 1989. That's going to be tough. Cherokee's current maximum annual capacity of 3,000 units is less than 33% of what's needed. □

ALPHASIL BRINGS A COLOR ACTIVE-MATRIX LCD TO MARKET

It's no secret that aircraft designers would like to rip out the bulky CRT displays in today's cockpits and replace them with lighter flat-panel displays instead. But flat panels have their problems, not the least of which has been their inability to produce color graphics that can be read in bright sunshine. So most experts have said monochrome flat-panel liquid crystal displays would have to come first. But Alphasil Inc., a six-year-old supplier of custom flat-panel displays in Fremont, Calif., is trying to leapfrog the competition by offering a color active-matrix display for avionics. The displays, available in 4-by-4-in. and 4-by-5-in. versions, incorporate 13 layers of silicon processing. A liquid crystal acts as a shutter like a typical LCD, but Alphasil adds polyimide dyes to provide color and a neon-fluorescent cold-cathode backlight for night visibility. "We're the only people making large-format active-matrix displays," says Thomas D. Stahl, marketing director at Alphasil. "There are some Japanese firms using them in small color TVs, but not this size." Alphasil is selling a three-color development system built into a laptop computer for $4,995. □

The Siggraph '88 Conference on Computer Graphics and Interactive Techniques Aug. 1-5 will include panel discussions ranging beyond narrow technical applications into the standards and strategies that should be of special interest to engineering managers.

One panel will examine the strengths of X-Windows—a rapidly emerging windowing standard—in the context of sophisticated computer-aided graphics systems. Among the topics for discussion will be the adequacy of the X-Windows tool kit, possible three-dimensional extensions to X-Windows, and its relationship to other windowing systems.

Following up on the graphics world's recognized need for standards, another panel discussion will devote its energies to extending existing standards to meet industry requirements. Topics will include the likelihood of multiple coexisting standards forced by user preferences, and the upward compatibility of de facto standards, as well as strategies for improving the standards-making process.

Sponsored by the Association for Computing Machinery's Special Interest Group on Computer Graphics, Siggraph '88 will be held at the Georgia World Congress Center, Atlanta, Ga. For more information about the technical program, contact the conference managers, Smith, Bucklin and Associates Inc., 111 E. Wacker Drive, Chicago, Ill. 60601; (312) 644-6610.

TESTING. In September, the 1988 International Test conference will explore a broad range of technology topics in varying depths, but the keynote address will be of special interest to managers.

Speaking on "Managing Quality: Today's Opportunities and Tomorrow's Challenges," A. Blanton Godfrey, president of the Juran Institute, Wilton, Conn., will examine a mix of corporate experiences with quality management systems, placing special emphasis on successful strategies.

The conference will be held Sept. 12-14 at the Sheraton Washington, Washington D.C. For more information, contact ITC at P.O. Box 264, Mt. Freedom, N.J. 07970; (201) 895-5260.

A listing of other key conventions, shows and expositions on the *Electronics* calendar include:

1988 International Conference on Parallel Processing, Aug. 15-19 on the campus of Pennsylvania State University, University Park, Pa. For more information, contact T. Feng, E.E. East Bldg., The Pennsylvania State University, University Park, Pa. 16802.

The Conference and Exhibition for Optical Storage and Digital Document Image Automation, Sept. 7-9 at the Sheraton Washington Hotel, Washington, D.C. Marilyn Reed, Meckler Corp., 11 Ferry Lane West, Westport, Conn. 06880; (203) 226-6967.

Diskcon '88 Technical Conference, Sept. 20-21 at the Santa Clara Convention Center, Santa Clara, Calif. Contact Julie Sunseri, Disk Equipment and Materials Association, 710 Lakeway, Suite 170, Sunnyvale, Calif. 94086; (408) 720-9352.

Fourteenth European Solid-State Circuits Conference (ESSCIRC '88), Sept. 21-23 at the University of Manchester, Manchester, UK. Contact Dr. Peter Hicks, Department of Electrical Engineering & Electronics, UMIST, P.O. Box 88, Manchester M60 1QD UK; 061 236 3311.

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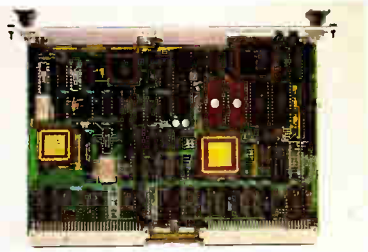

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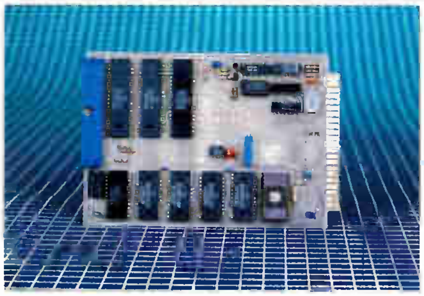

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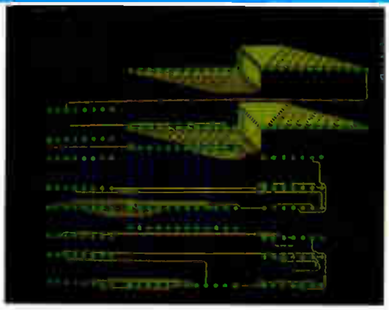

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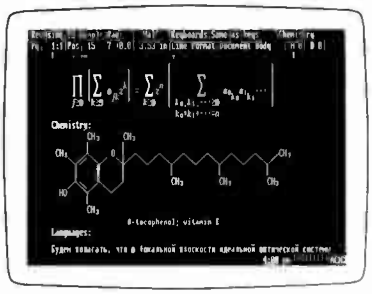

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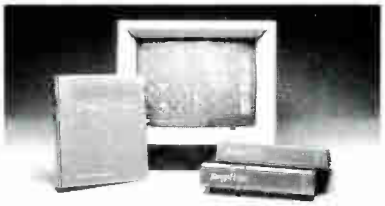

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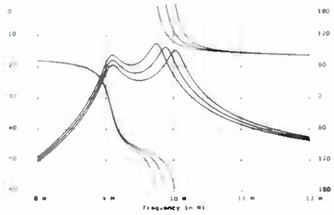

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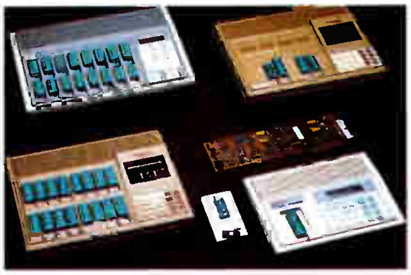

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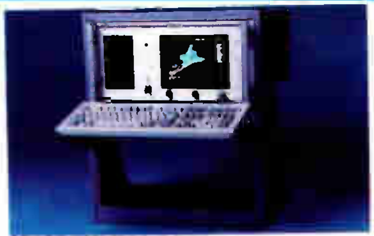

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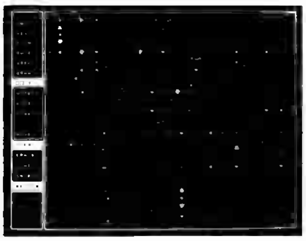

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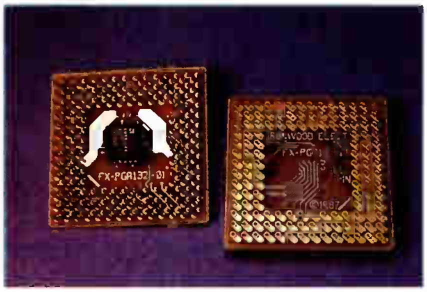

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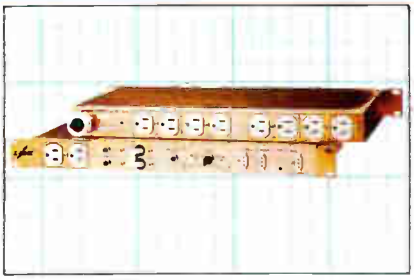

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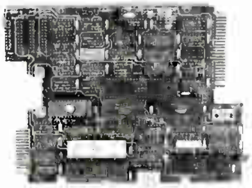

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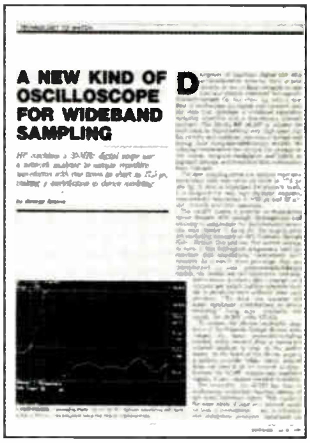
UPDATE: WIDER BANDWIDTH SOLVES HP SCOPE DRAWBACK

With the exception of a few market segments, Hewlett-Packard Co. got just about what it expected in good customer response to its 54120T wideband sampling oscilloscope, which was introduced last summer [*Electronics*, July 9, 1987, p. 72].

The scope's 20-GHz bandwidth attracted much interest from companies developing high-speed digital and data communications systems. But the instrument—which has the unique capability of combining wideband repetitive-sampling capabilities with time-domain network analysis—fell short of HP's hopes in some ways because of its 500-MHz triggering bandwidth.

"We found that its 500-MHz triggering bandwidth was a limitation for those folks working in the lightwave portion of telecommunications and data communications, and portions of the radar area," says Lynn Camp, product marketing manager at HP's Colorado Springs, Colo., division. The division expanded the 54120T's ability for those market segments by introducing in May the 54118A, a companion trigger unit for the scope. It increases the trigger bandwidth to 18 GHz.

"That will open a substantial portion of the potential market that previously wasn't too interested in the instrument," Camp says. "People doing development or research work in lightwave communications or research in light waves often want to visualize 'eye patterns'—an opening in a stream of 1s and 0s on a communication line. They also make bit-error-rate measurements. And when the bit-error rate falls below the specified goal, they like to view the 'eye' to find out what's going on. Prior to the introduction of the 18-GHz trigger, what people would have to do is provide a countdown clock, and trigger off a lower frequency—which you can do at the transmitter but not at the receiver."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The higher bandwidth makes the 54120T more effective in development of gallium-arsenide integrated circuits as well, with GaAs chips running in the 1-to-2-GHz range. With the combined scope and trigger, GaAs IC developers can trigger off the chip itself and actually look at 2-GHz signals running in GaAs chips.

A year after introduction, the price of the 54120T scope has held steady at $27,825. The new 57118A trigger costs $8,925 loaded with accessories, or $7,650 by itself. *–Samuel Weber*

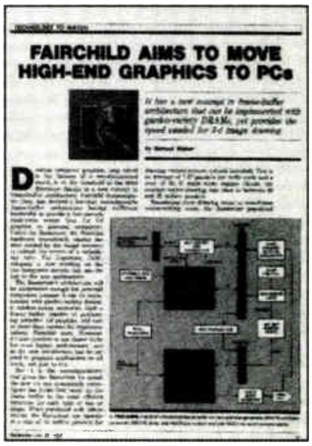
UPDATE: RASTER WORK BY FAIRCHILD IS NOT WASTED

A year ago, Fairchild Semiconductor Corp. signalled its intention to move aggressively into the chip markets for personal-computer graphics by launching a low-cost reconfigurable frame-buffer architecture called the Rasterizer. The architecture was fast enough to be able to produce three-dimensional graphics on desktop computers without resorting to premium-priced high-speed memories [*Electronics*, July 23, 1987, p. 57].

Good graphics could be had with garden-variety 100-ns dynamic random-access memories, according to advance specifications from Fairchild issued just months before the Cupertino, Calif., subsidiary of Schlumberger Ltd. was acquired by National Semiconductor Corp. in nearby Santa Clara.

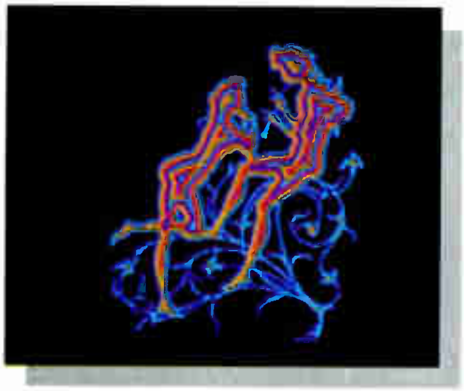
A year ago, Fairchild was pushing ahead with the development of two chips that were to make up the heart of its Rasterizer architecture. One was an address generator chip, called AGEN, and the other was a data generator chip, known as DGEN. But things quickly changed with National's takeover in the fall of 1987.

"There had been quite a lot of interest in the Rasterizer concept, particularly at the high end of the workstation market," says Roger Reak, director of graphics marketing at National. "But, it [Rasterizer] was a bit complex to learn how to use," he says. "Making use of the technology involved products that were still a couple of years away. What's more, National already had a pair of chips in the works that did what the AGEN and DGEN were designed to do and did it as well or better."


FAIRCHILD AIMS TO MOVE HIGH-END GRAPHICS TO PCs

The National chips, the DP8500 raster graphics processor and the DP8511 BitBlt processor, were introduced early this year [*Electronics*, Jan. 21, 1988, p. 55]. Consequently, National decided to drop the work on Rasterizer.

But Fairchild's work was not wasted. National continues to expand and improve its graphics chip family by utilizing some of the Fairchild's know-how. The company has just increased the speed of its 16-bit video-shift registers, the DP8515 and DP8516, from 225 MHz to a blazing 350 MHz, by utilizing a geometry shrink and judiciously combining bipolar and CMOS on the same chip. They also have video digital-to-analog converters for the family under development. *–S. W.*



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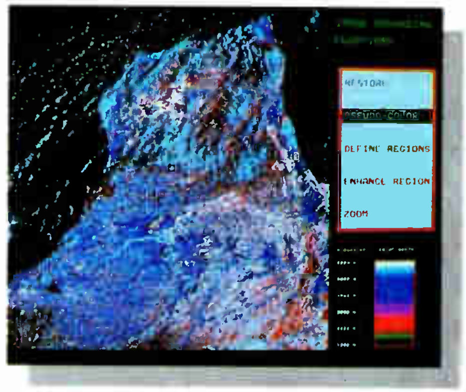

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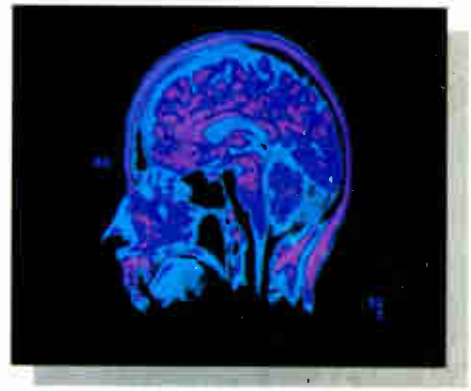

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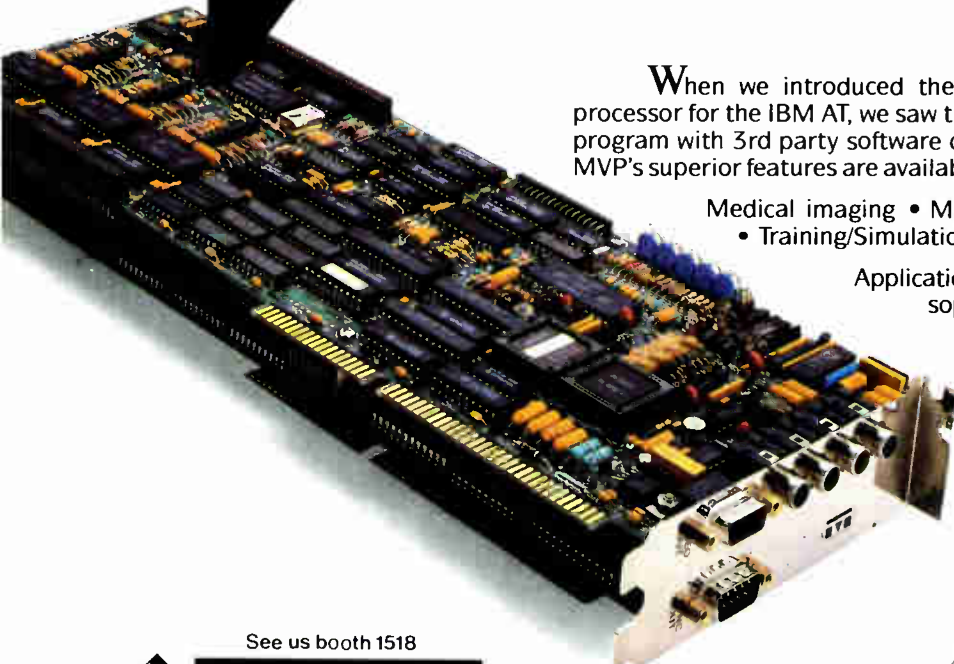

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