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MAY 1990

Electronics

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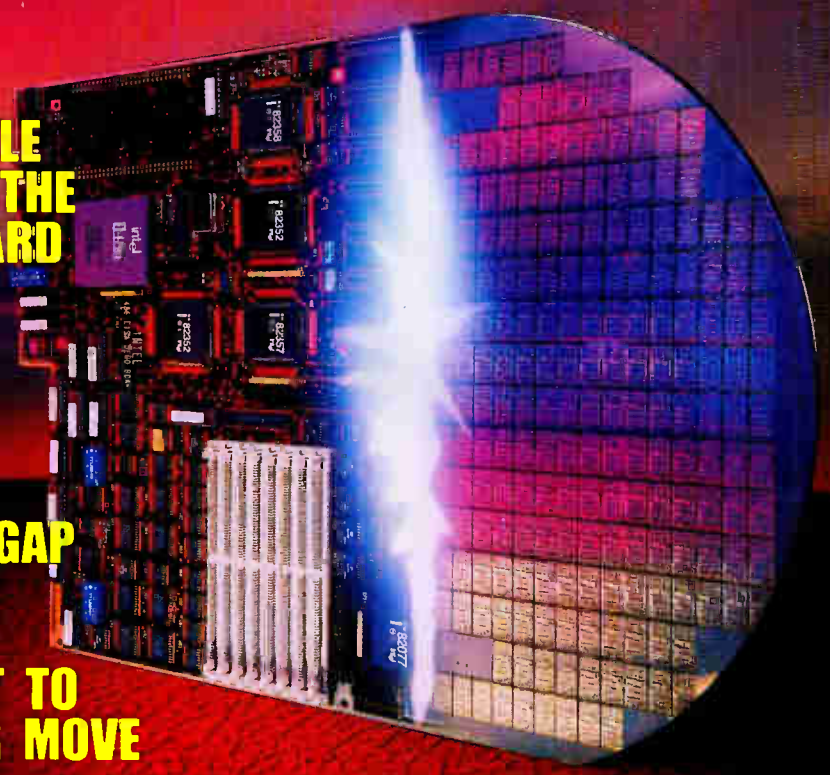

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DSPs START TO MAKE THEIR MOVE

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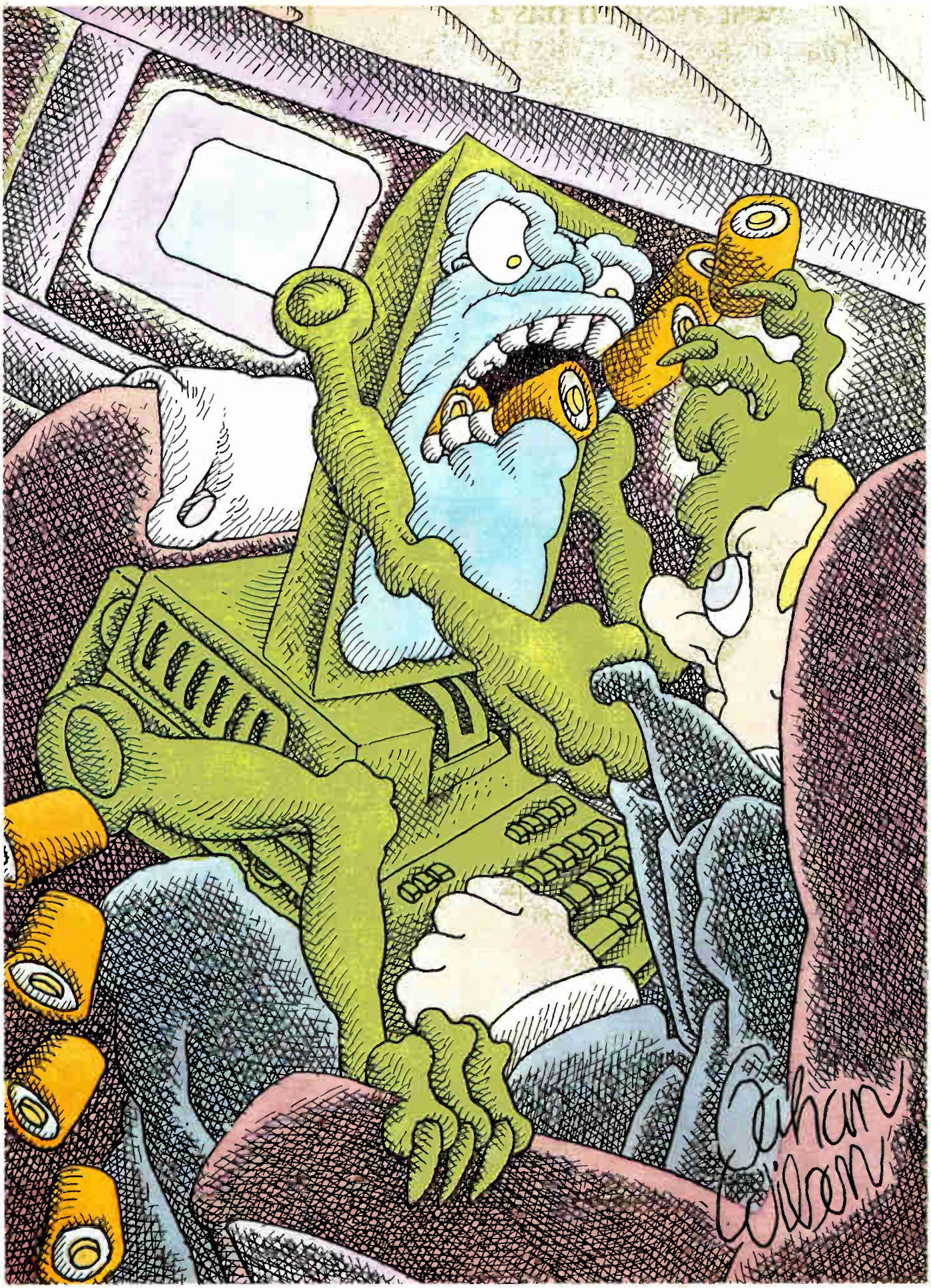

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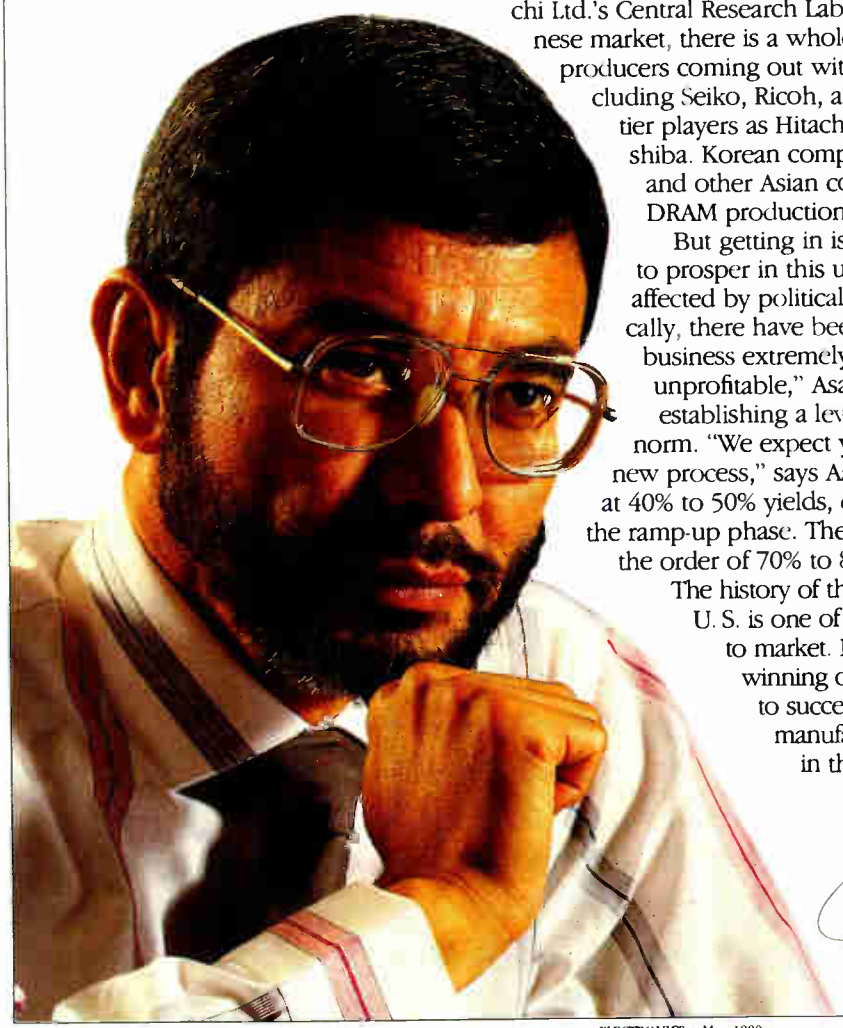
TO DRAM OR NOT TO DRAM

In the wake of U. S. Memories' demise, the unsettling question that still remains is, should the U. S. semiconductor industry return in force to the dynamic RAM business? The question is all the more pressing considering the number of companies in the Far East that have begun building state-of-the-art production facilities largely to manufacture DRAMs, compared with a mere handful in the U. S. that have remained in the business. Dataquest Inc., the San Jose, Calif., market research firm, estimates that 70% to 80% of the submicron fab capability is in Asia.

One reason U. S. companies have not played a large role is that they are innovators who move quickly into a market and make excess profits by being first with the next hottest product. As the series of articles on the PC's impact on the semiconductor industry shows (see p. 71), U. S. companies are innovating more and manufacturing less. Whole segments of the industry rely on excess fabrication facilities in the U. S., Europe, and the Far East to construct in silicon their unique designs.

"These companies have nothing other than their product differentiation," says Al Stein, chief executive officer of VLSI Technology Inc. in San Jose. "There is no global presence, no manufacturing capability, no technology, just good design and astuteness in being able to differentiate their products. If that is indicative of the U. S. industry, it is not enough."

Electronics agrees. To be competitive in the world market, a semiconductor company must have state-of-the-art process technology and be able to manufacture leading-edge products. Japanese and other Asian companies have accepted this premise and are building large fabs. To fill such facilities, these companies are all making high-volume commodity products—and today that means DRAMs. "DRAMs are a base-line process driver," says Shojiro Asai, deputy general manager of Hitachi Ltd.'s Central Research Laboratory in Tokyo. "In the Japanese market, there is a whole new generation of second-tier producers coming out with DRAM memory offerings, including Seiko, Ricoh, and others." They join such first-tier players as Hitachi, Mitsubishi, NEC, Oki, and Toshiba. Korean companies Samsung and Gold Star and other Asian companies are also developing DRAM production capability.



But getting in is only half the battle. The trick is to prosper in this unpredictable environment, one affected by political as well as market forces. "Historically, there have been factors that have made the business extremely profitable as well as extremely unprofitable," Asai muses. The key to winning is establishing a level of chip yields that exceeds the norm. "We expect yields on the order of 50% in a new process," says Asai. "We can start receiving profits at 40% to 50% yields, depending on the demand during the ramp-up phase. The ultimate yield we shoot for is on the order of 70% to 80%."

The history of the semiconductor industry in the U. S. is one of chasing easy profits by being first to market. But the world has changed. Now winning on the manufacturing line is the key to success. Those not willing to compete in manufacturing will not be a major force in the market in 10 years.

JONAH McLEOD
EDITOR

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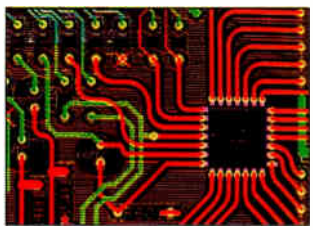

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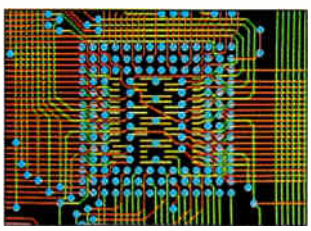

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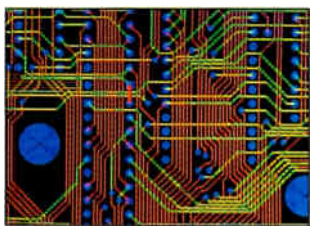

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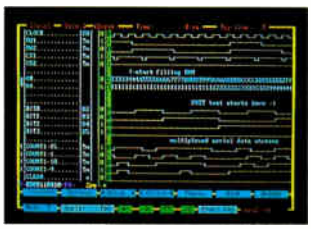

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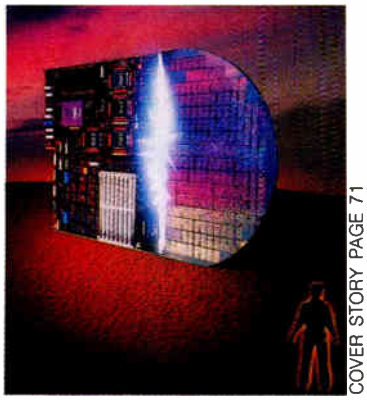

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DEPARTMENTS

NEWS ROUNDUP

WORLDWIDE NEWS

NEWSMAKERS

Companies covered in this issue, indexed to the first page of the article in which each is mentioned.

*International only

HARD TIMES FOR SOFTWARE

To the editor: The Counsel of the European Community has issued a proposed directive that, if adopted, will form the basis for the legal protection of computer software throughout the 12 EC countries—and possibly set a precedent for other countries all over the world. The potential also exists that the EC may exert economic and trade pressures to the point where even U. S. law may be altered.

There is great concern that the proposed directive, purportedly under the guise of conforming the EC laws to those of the U. S., in reality departs greatly from current U. S. laws and imposes great hardship upon the industry and end users of mass-market software.

Contained within the directive is a provision—Article 6, Section 2—which states that anyone who makes, imports, possesses, or deals with articles intended to facilitate the removal or circumvention of any mechanism designed to prevent the copying of a computer program shall be guilty of copyright infringement. This means end users will not have the right to make archival backup copies of copy-protected software for their own use. In the U. S., end users of computer software are expressly permitted by U. S. law to make a copy for archival purposes.

Laws such as those presently contemplated by the EC will serve only to promote a resurgence of copy protection and should be carefully considered by all. The U. S. Trade Representative is now accepting comments toward considering the U. S. government position on the directive. It is vital that the views of those opposed to copy protection be heard.

Michael D. Brown, Chairman
Central Point Software Inc.
Beaverton, Ore.

NOT EVEN CLOSE

To the editor: In your news brief on Mentor Graphics Corp.'s Falcon framework [*Electronics*, March 1990, p. 22], you said that "Falcon will have an installed base to rival that of Cadence Design Systems Inc." This is inaccurate. Mentor has more than 20,000 seats, to Cadence's 7,000. It's not even close.

We continue to be frustrated with inaccurate information being generated by our competitors. The industry numbers do not support the contention that we are the "challenger" against Cadence in computer-aided design.

Also, Mentor is not a company "whose software is closed to third-party design tools," as you said. More than 200 third-party tools currently work in the Mentor environment (pre-Falcon). And I would be happy to supply you with the names of some companies that have had little or no success working with Cadence's "open framework."

Will Anderson
Vice President, Public Relations
Karakas, VanSickle, Ouellette
Beaverton, Ore.

MORE ON AMIGA

To the editor: I was extremely disappointed with your magazine's multimedia coverage [*Electronics*, February 1990, p. 48], especially its coverage of Commodore Computer Inc.'s Amiga. The majority of your coverage read to me very much like Apple and IBM marketing hype. The Amiga is not an "also-ran" in the multimedia market, as one would gather from the 18 or so lines of text in which your magazine even mentioned it. It is in fact the pioneer in the personal computer multimedia field, and Commodore is working very hard to strengthen the position it has enjoyed, since its introduction of the Amiga in 1985, as the technology leader in that field.

If you are going to continue to report on this subject, I would strongly suggest that you look beyond the Apple and IBM marketing departments for your information.

Leland Hosford
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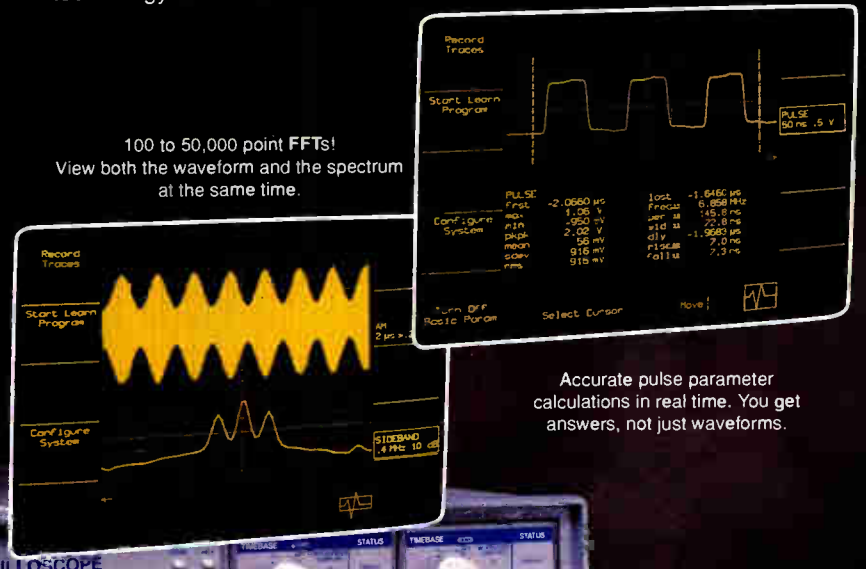

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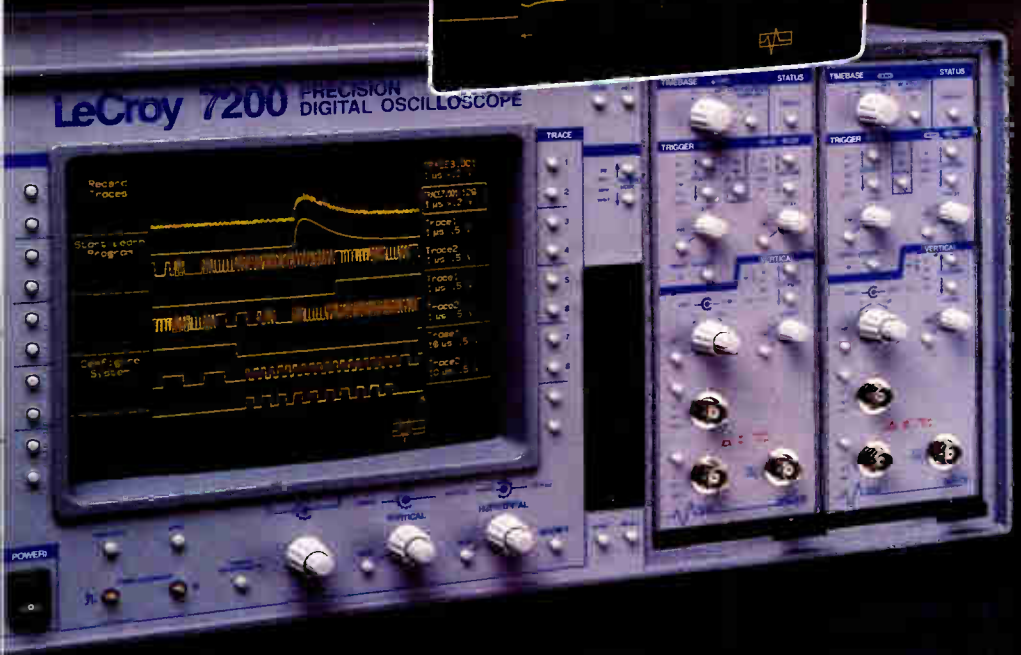

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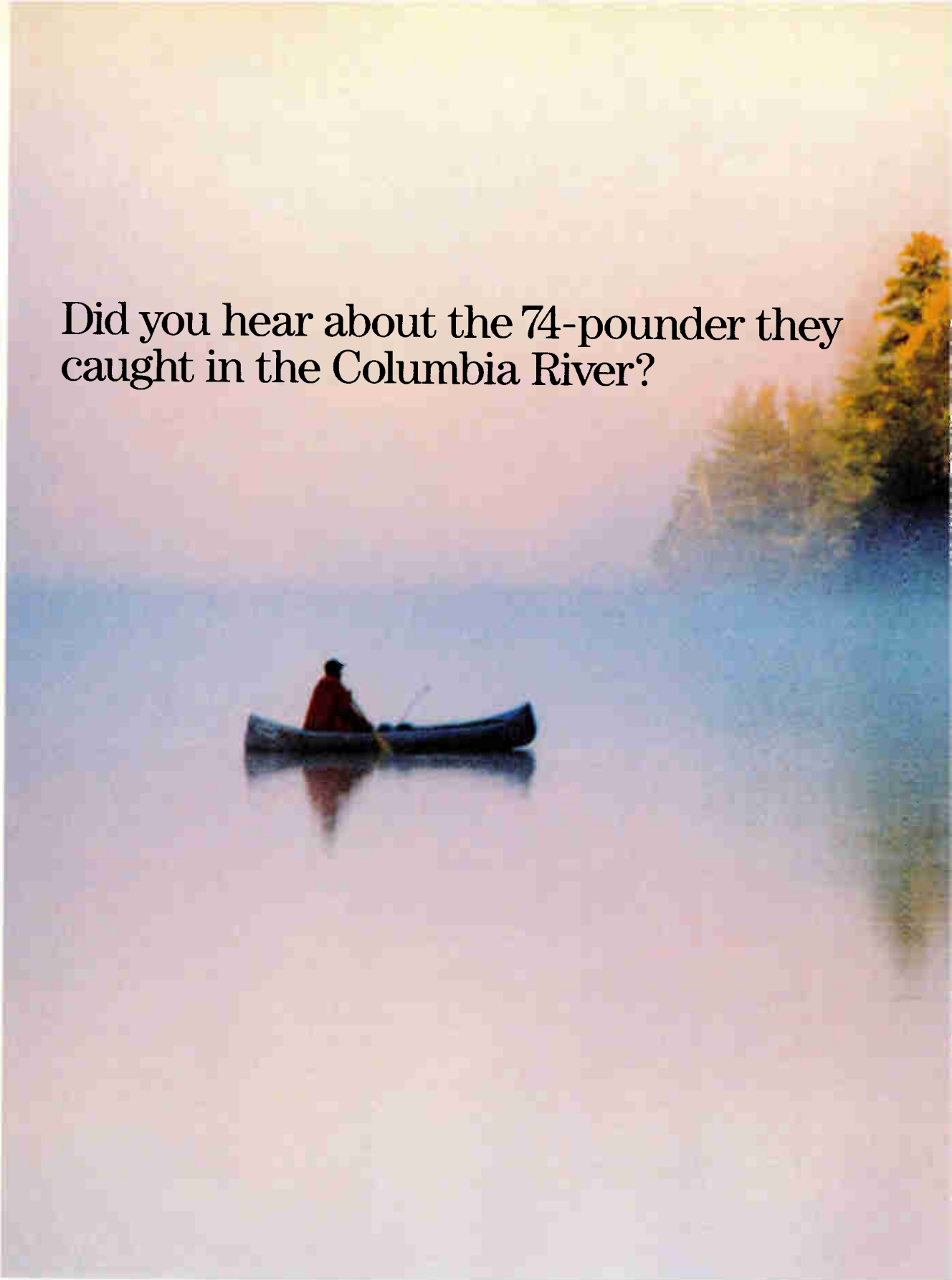

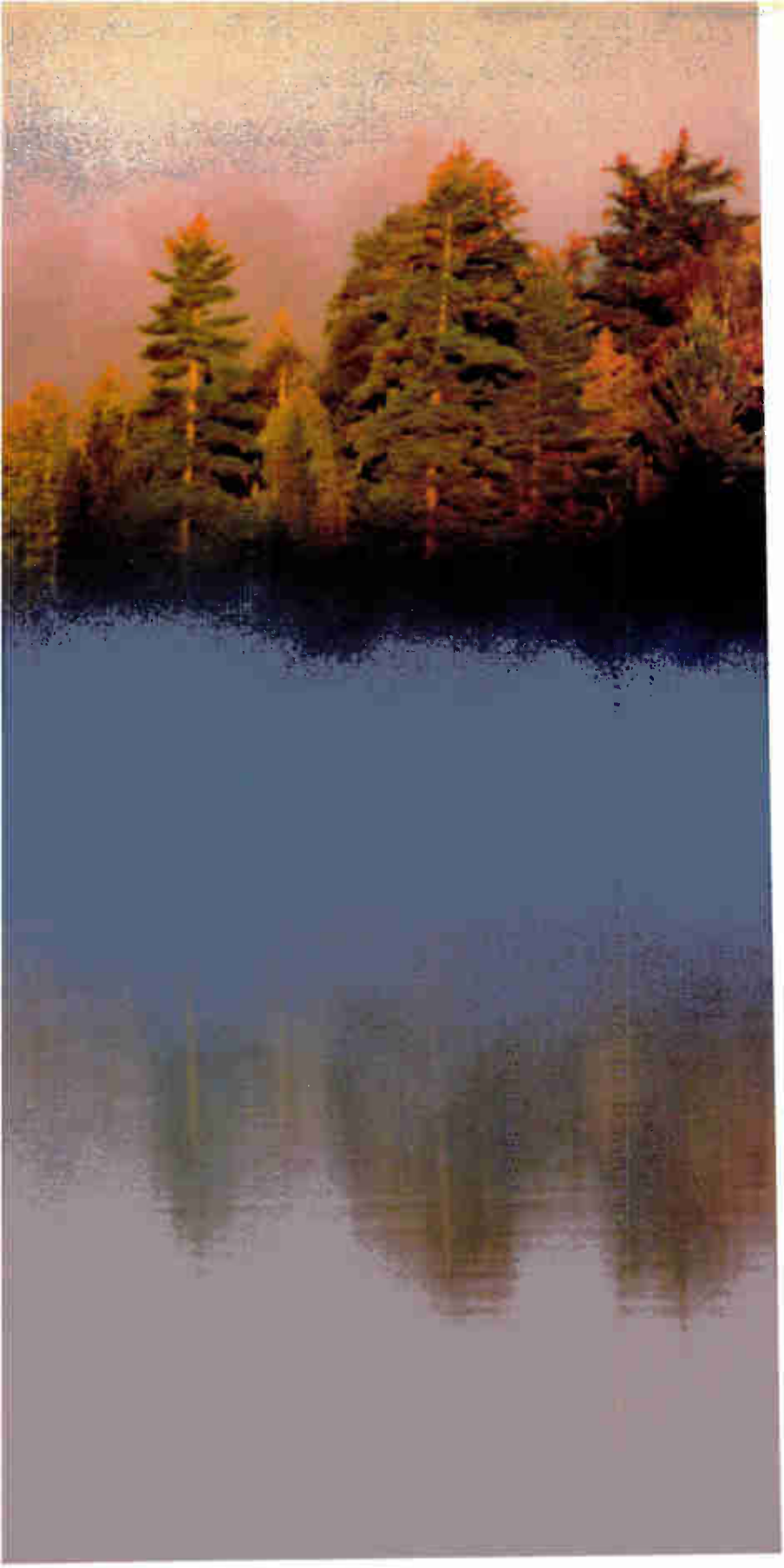

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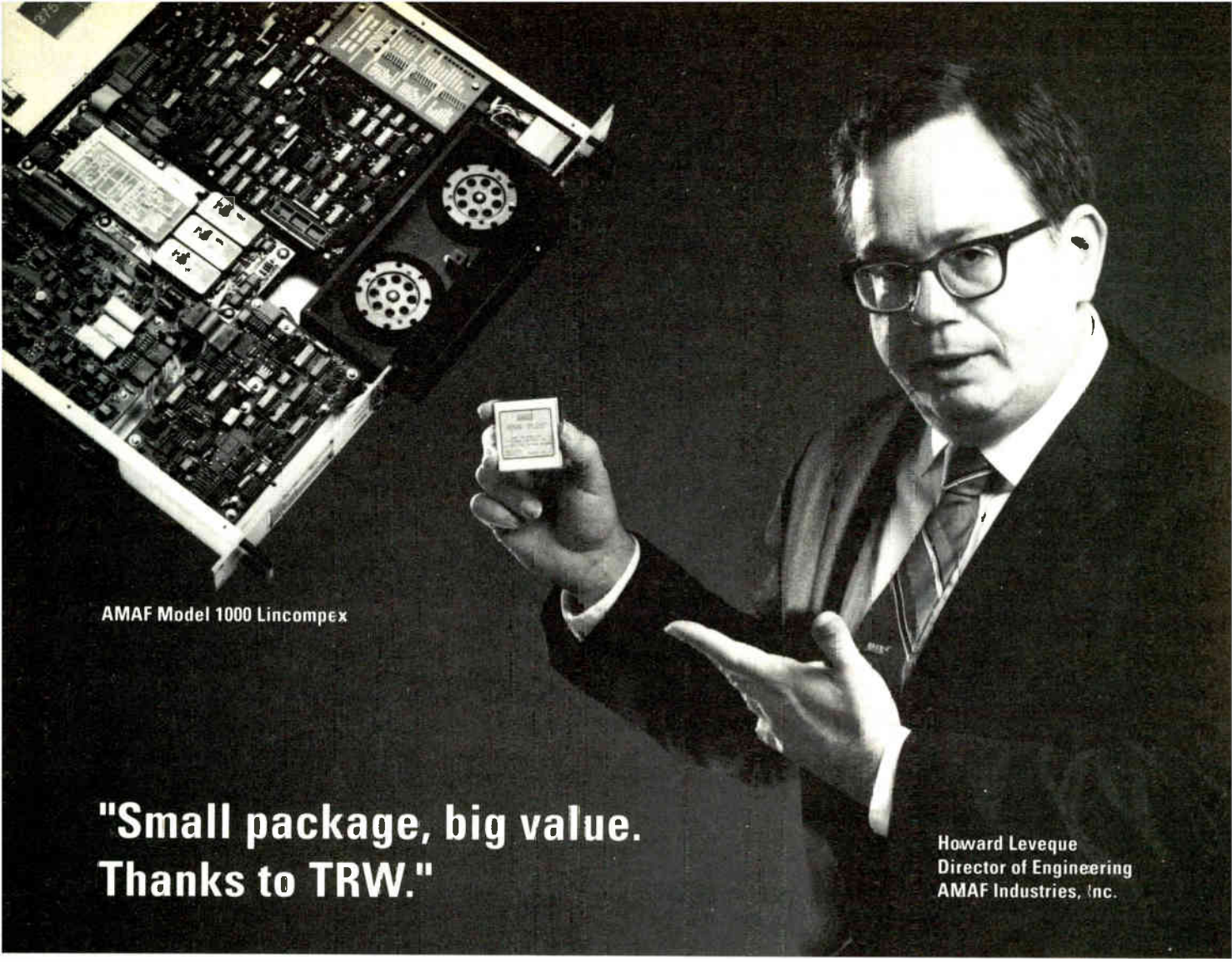

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CIRCLE 245

LETTER FROM

CLEVELAND

DIAGNOSTIC EQUIPMENT VENDORS CLUSTER IN A RUST BELT CITY

HERE, MEDICAL IMAGING THRIVES

BY FRANCIS LAVOIE

THE SHORES OF LAKE Erie aren't circled in red on most high-technology maps of the U. S. After all, the region around Cleveland is smack in the center of the Rust Belt, and the city itself has long suffered under the sobriquet of "the mistake by the lake." But the people who use the latest technology for their products have discovered the city and its environs, and the unlikely alliance shows every indication that it will be a successful one.

One technology in particular that appears to be prospering is diagnostic medical imaging. But this isn't really new for Cleveland; one of its oldest residents is Picker X-Ray—now Picker International Inc. and based in Highland Heights—a world leader in the diagnostic imaging field. The news is that Picker has been joined by a number of newcomers, making the area a center for the development and use of advanced medical-imaging technology. The industry is prospering even as it faces new challenges, both domestic and foreign.

Why has that part of northeastern Ohio attracted such a concentration of players in this ultrasophisticated game? One reason is that Cleveland has several world-class medical facilities; for example, foreign heads of state regularly come to the Cleveland Clinic for treatment of heart-related ailments. Also, it is an area of relatively low living costs when compared with either coast and an easygoing, unassuming life-style.

But that isn't the whole story. As one medical-imaging executive puts it, "This has become a great place to find people with the expertise to develop products like ours. In fact," he adds, "the only other place where you might find the concentration of talent necessary to develop such sophisticated products would be in Silicon Valley or the Boston area."

The growth of the medical-imaging business around Cleveland has not been without its casualties. Technicare was a large, highly regarded manufacturer of computerized axial tomography (CAT) scanners, magnetic-resonance imagers (MRI), and nuclear-medicine equipment. At its peak, the company, based in Solon, employed some 2,500 people. But by 1986, things had turned sour, and Technicare turned up its toes.

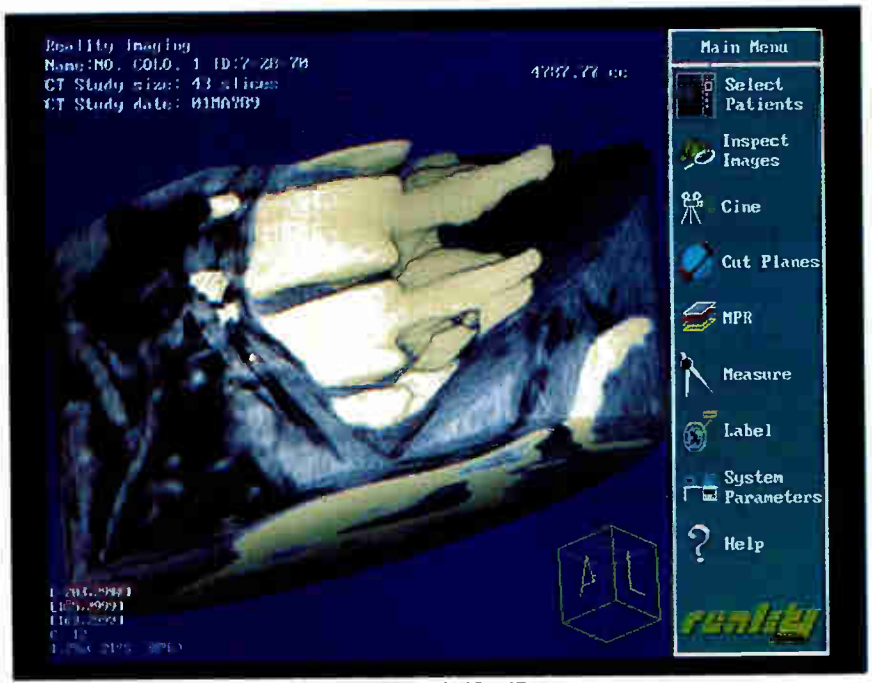
According to one ex-staffer, "Technicare was very good at being first with new products, but their 'Damn the expense, let's get the project out' philosophy, while great for R&D, never seemed to translate into a workable marketing plan."

Rob Spademan, director of communications for Picker International, sees Technicare's demise as part of a broader consolidation that occurred about four years ago. "There were actually a number of such 'adjustments' in the industry," he points out. "But for the last two years, things have been pretty stable. It looks like the situation and the players we have today are the ones we'll have for a number of years."

But Picker isn't taking any chances. It has just acquired a majority position in Ohio Imaging, a small Bedford Heights company. "We needed to upgrade our capabilities in nuclear imaging technology," says Spademan. "They had some innovative products, which we needed And they were at the stage where they needed financial muscle." Ohio Imaging is typical of several small entrepreneurial diagnostic imaging companies that have sprung up in the Cleveland area over the last few years, many of them formed by ex-Technicare personnel.

Another small area company, Reality Imaging Corp. of Solon, is also doing quite well. One of those established by ex-Technicare employees, it was founded in 1986 and produces a three-dimensional image-processing system that "stacks" the two-dimensional images—or slices—from a CAT or MRI scanner into a solid volume. The 3-d image can then be rotated or otherwise manipulated on the screen.

Dennis Hegler, Reality Imaging's sales and marketing vice president,



DIAGNOSTIC AID

With the Voxel Flinger 3-d imaging system from Reality Imaging Corp., the user can electronically "cut away" soft tissue to reveal the vertebrae.

says he feels that the outlook for small, highly specialized manufacturers of diagnostic imaging equipment is good. "The future of 3-d imaging, in particular, is very bright," he says. "As scanning equipment gets more and more complex, the best way to look at the growing volume of data is in three dimensions. It isn't uncommon, in an MRI study of the head, to take more than a hundred slices of data. In those cases, looking at the slices individually isn't always the best way."

Big or small, the imaging industry won't have as easy a road in the future as it's had in the past. For one thing, it will have to fight for a piece of a shrinking health dollar. And already, there are critics who feel that it has been claiming more than a justifiable share. Recently, it was estimated that for the fiscal year ended Sept. 30, 1989, Medicare had disbursed more than $40 million for a raft of sophisticated imaging techniques.

That report came amid studies showing that up to one fourth of America's health dollars are wasted on unneeded tests, many of them performed mainly because the facilities are available and, say critics, have to be paid for. Physicians counter that sophisticated and expensive tests are necessary partly because of the threat of malpractice suits; patients sometimes sue if they believe that they've been denied access to the "best available technology."

ONE THREAT COMES FROM CRITICS OF MEDICAL PRACTICE, WHO SAY THAT UNNEEDED TESTS ADD BILLIONS TO THE U.S. HEALTH BILL EVERY YEAR

But medical researchers and practicing physicians themselves are launching a direct attack on what has been termed "one of medicine's most troublesome problems—the epidemic of unnecessary procedures that compromise quality of care and add billions to U.S. health costs."

The American Medical Association, Rand Corp., and a consortium of academic medical centers are in the midst of jointly developing guidelines for dozens of procedures, so that physicians will know what diagnoses, tests, and treatments are effective for a variety of ailments. Proponents hope that such guidelines will cut down on the growing trend toward unnecessary tests that, according to the Rand researchers, add more than $50 billion to an already staggering $600 billion annual U.S. medical bill.

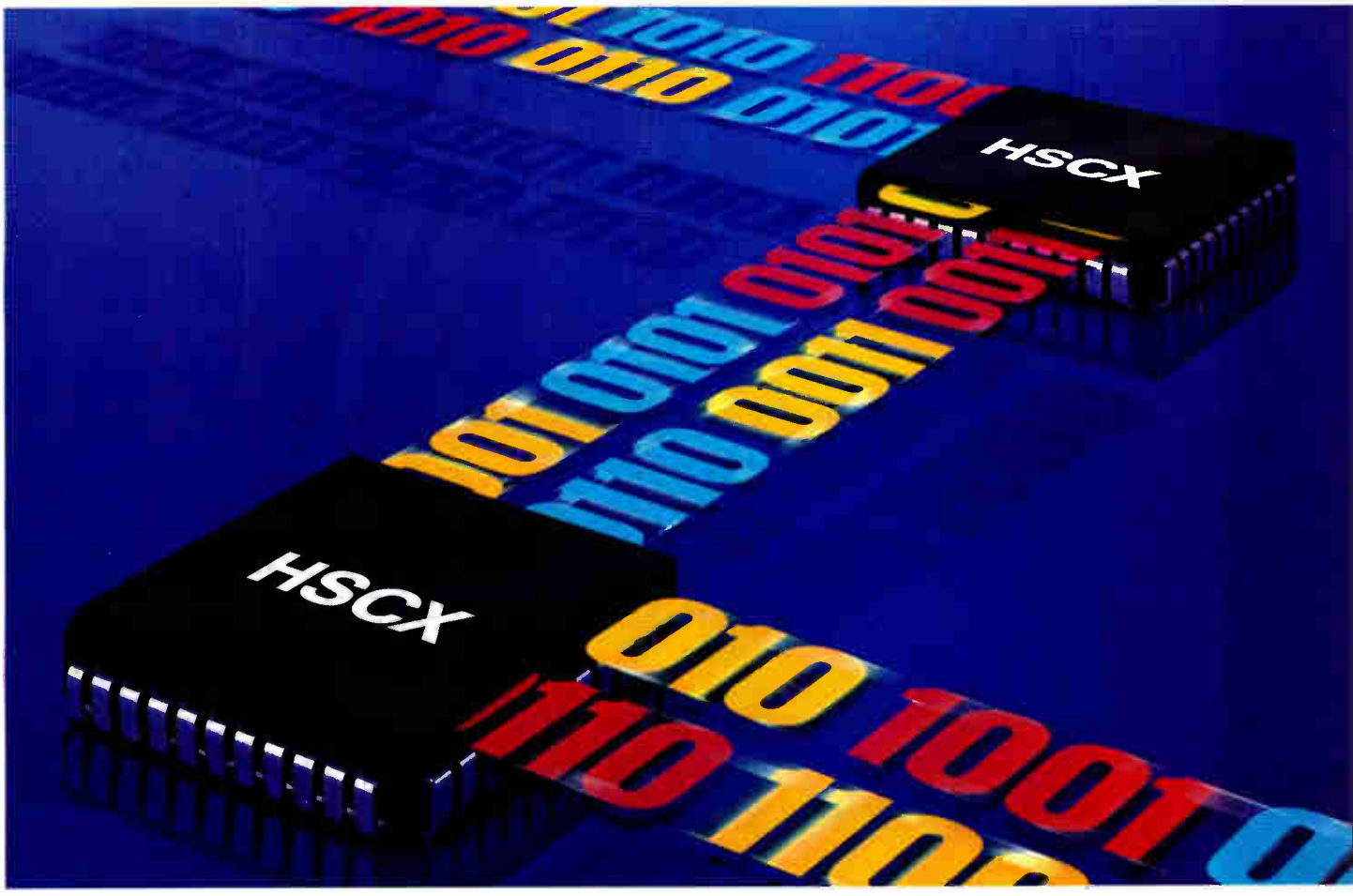
As if that weren't worry enough, there's another cloud looming on the horizon for the Cleveland medical imaging community: increased foreign competition. Officially, makers of sophisticated medical equipment say they aren't overly concerned with the possibility that, say, Japanese competitors might stage an all-out push and drive U.S. manufacturers out of business, as they did in some sectors of electronics.

A spokeswoman for the Washington-based Health Industry Manufacturers Association points out that U.S. makers of advanced-technology medical equipment currently provide a positive contribution to the balance of payments. And she expects the American manufacturers to keep their edge in the world marketplace. "Many of our member companies are rising to the [foreign] challenge and reorienting themselves to take advantage of the growing opportunities overseas," she says. "They expect global trade to be an important part of their future."

There are already several foreign players in the game. But by and large, they are known quantities—like Siemens AG of West Germany, a formidable presence in the U.S. for many years. The HIMA spokeswoman doesn't see the likelihood of an unknown suddenly emerging to dominate the industry, but not everyone is so sanguine.

Says Picker's Spademan, "Right now, the Japanese are only bit players. But they are doing just what they did with cars. They are getting established, selling only at the low end of the market—and learning. It's the classic Japanese strategy: start at the bottom and work your way up. Eventually, I think they'll be a force to be reckoned with." E

SIEMENS



High Speed Communication.

Siemens has opened a whole new line of communication which now makes it easier to successfully combine high-speed data transfer with high-level data-link control.
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And by inverting data into programmable time slots automatically, the HSCX considerably lowers your CPU overhead, as well as reducing external glue logic.
These features provide the potential for HSCX applications in a variety of fields, such as proprietary LAN controlling networks, assembly line LANs, fast diagnostic systems, and traffic systems), as well as standardized areas such as Switching Systems and ISDN (X.25, Terminal Adaptors, and Modems).
For easy access to the wide variety and complexity of synchronous data transfer, Siemens also provides a PC-based evaluation kit.
The HSCX has already made a name for itself by providing the power needed to drive even the most complex communications systems. In fact, the biggest names in the industry already rely on the HSCX – with a great deal of success. Finally the HSCX will be sourced also by AMD. It's amazing what you can accomplish with good communication skills.
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CIRCLE 201

MC&D

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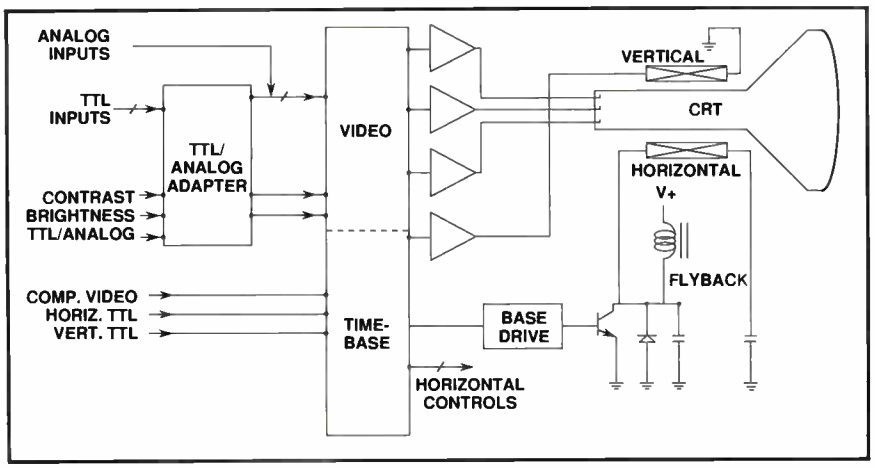

For personal computer monitors, single-chip ICs are available to reduce design complexity and system cost.

Horizontal Output.

A new family of Switchmode III bipolar power transistors and companion damper diodes, ranging from 1,000 volts to 1,500 volts, have been specially designed for high and very high resolution horizontal deflection circuits. The transistors are optimized for dynamic desaturation, fall times and storage times. Their companion diodes are optimized for forward recovery times, avalanche energy and reverse recovery times. Together, they're the perfect solution.

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The SCANSWITCH family includes two new high speed video amplifiers designed for ultra-high resolution graphics applications. These hybrid video amplifiers have a 130 MHz minimum bandwidth at 40V and 60V swings. Capacitive loads are driven directly or through transmission lines with no output tuning or need for critical external components. These amplifiers offer minimum power dissipation for all monochrome and color applications.

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THE LEADER IN VIDEO MICROTECHNOLOGY

CIRCLE 241

THE 20 MOST WANTED

Judging from the Defense Department's 1990 list of critical technologies, not much has improved in a year with changes mostly of a cosmetic nature. The list, first published last year, contains what the Pentagon deems the 20 most important technologies in which improvements are needed.

Fifteen of the titles are the same as last year. Two new ones—high-energy density materials and weapon system environment—have been added, and some others have been combined. Signal processing replaces automatic target recognition, and two others have been deleted with aspects of the technologies included elsewhere. The Pentagon has assigned priorities to the list, with pervasive technologies ranked first, enabling technologies next, and emerging technologies third.

Critical Technologies

PERVASIVE TECHNOLOGIES
- Composite materials
- Computational fluid dynamics
- Data fusion
- Passive sensors
- Photonics
- Semiconductor materials and microelectronic circuits
- Signal processing
- Software producibility

ENABLING TECHNOLOGIES
- Air-breathing propulsion
- Machine intelligence and robotics
- Parallel computer architectures
- Sensitive radars
- Signature control
- Simulation and modeling
- Weapon system environment

EMERGING TECHNOLOGIES
- Biotechnology materials and processes
- High-energy density materials
- Hypervelocity projectiles
- Pulsed power
- Superconductivity

SOURCE: DEPARTMENT OF DEFENSE

EXPORT LICENSES WILL BE EASIER TO GET FROM DOD...

Look for the Defense Department to pay closer attention to the health of the U. S. military industrial base when considering export license requests. That's the word from William Rudman, deputy Under Secretary of Defense for trade security policy.

The result will be that "there will be a hell of a lot more yeses than in the past," he said bluntly at a recent Washington meeting of defense suppliers sponsored by the Electronic Industries Association.

The new sensitivity at the Pentagon is caused by promised congressional cuts in the defense budget, as much as 2% annually through 1999. Worried defense industry executives have been pressing for a loosening of export restrictions to compensate for the declining defense market at home.

In addition to receiving some assurance from Rudman, they heard Alan H. Shaw, manager of international security and commerce programs in the congressional Office of Technology Assessment, say, "Policy decisions about sales of weapons are increasingly clouded by considerations of defense industry health."

The plight of the industry also is being viewed sympathetically by the Commerce Department, which also approves licenses. "One can only express amazement at how soon and how fast Europeans and Japanese have moved into the defense electronics area," said Dennis Kloske, Under Secretary of Commerce for export administration.

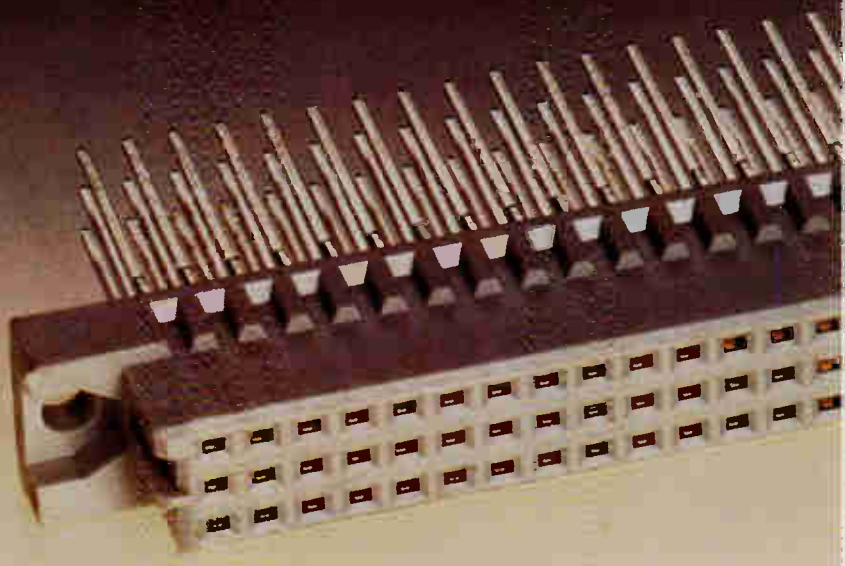
CANADIAN COMPANY HELPS HDTV GET INTO THEATERS VIA SPACE

While broadcasters and regulators fiddle over standards for terrestrial-broadcast high-definition TV, a Canadian film company will be burning up the sky in June with the first commercial use of HDTV on a 24-ft theater screen. HDC Communications Group Ltd. of Vancouver, B. C., will use a direct-satellite-broadcast system developed by Scientific-Atlanta Inc. to link its postproduction facilities in Vancouver with Los Angeles, says HDC president Lee Stringer.

The HDB-MAC system will be used to edit film being postproduced by HDC in Vancouver, but commercial programming is also being considered. Sporting events are high on HDC's agenda. For example, the HDB-MAC system (MAC stands for multiplexed analog component) was used last December to beam the Sugar Ray Leonard-Roberto Duran fight from Las Vegas to Los Angeles.

...AS DISK-DRIVE RESTRICTIONS ARE EASED

One immediate effect of the more relaxed feeling about technology exports from the U. S. is that American companies no longer will need licenses to ship hard-disk drives with a capacity of up to 45 Mbytes to most non-Communist nations. The move will "enable U. S. manufacturers to compete on an equal footing with foreign competitors who don't face any exporting constraints," says Dennis Kloske, Under Secretary of Commerce for export administration. The Commerce Department estimates that the value of U. S. shipments of that class of drives totaled $500 million last year.



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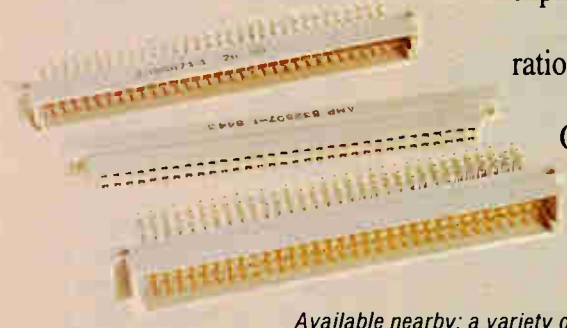
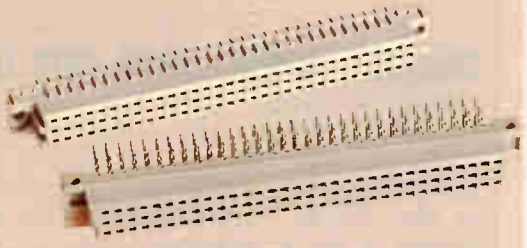


Available nearby: a variety of AMP Eurocard connector sizes and styles for packaging flexibility in DIN 41612 and IEC 603-2 applications.



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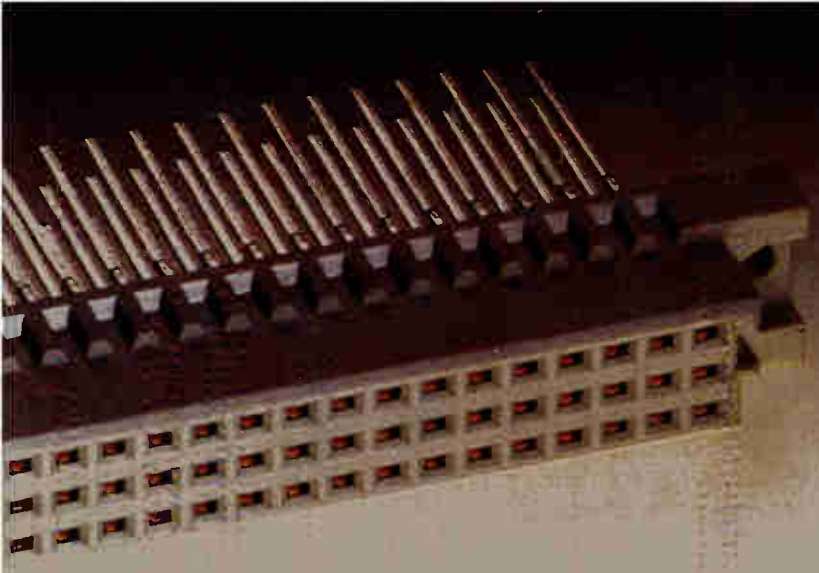

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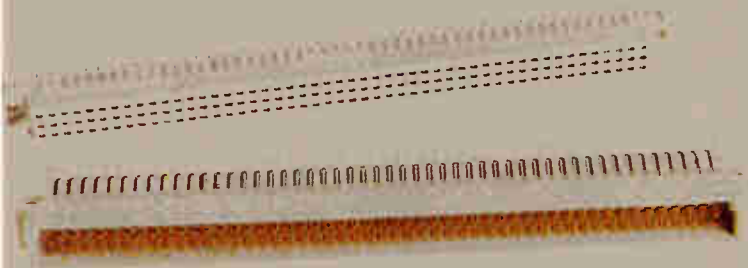

CIRCLE 211

DOES JAPAN LEAD THE WORLD IN THE SUPERCONDUCTIVITY SWEEPSTAKES?

Is the world about to see Japan take the lead in another technology? One answer will come around midyear in a report from the U. S. Congress's Office of Technology Assessment describing the status of superconducting technology in the U. S.

Interest in the report has been sharpened by a Japanese forecast on the status of superconductivity work in that country. The optimistic forecast, from the International Superconductivity Technology Center of Tokyo, has taken American experts by surprise. It says that although only two Japanese companies have introduced superconducting products since 1987, 18 will do so between 1991 and 1995. Then, according to the forecast, introductions in Japan will subside slightly from 1996 to 1999, but jump in the year 2000, when 19 firms will market products.

Another Japanese survey predicts that by 2000 superconducting materials will be designed into a wide range of products. It lists a magnetically levitated train, a free electron laser, nuclear-magnetic resonance scanners, sensors for geological exploration, military applications, a large-particle accelerator, and thin-film target material.

Japanese companies have already proposed to build levitated trains for a people-mover in Las Vegas, and for a route between Los Angeles and Anaheim, Calif. A Japanese firm has said it could build the Los Angeles-Anaheim train for around $30 million in five years.

IN THE U. S., SUPERCONDUCTOR WORK IS 'GROWING SLUGGISHLY'

An analyst in the U. S., Sheridan Tatsuno, president of NeoConcepts of Fremont, Calif., says it's uncertain who is ahead in the race to reach the marketplace first, though U. S. companies have introduced a handful of products, including medical equipment.

However, he adds, while the Americans are taking a wait-and-see attitude, the Japanese are creating new markets. Also, he says, around 90% of Japanese R&D funding comes from large corporations; in the U. S., 50% comes from the government and the military, and smaller firms can't afford to conduct studies for commercial applications. Also, Japanese researchers are concentrating on the material bismuth, while the Americans are looking at a wide range of materials. "If the Japanese are lucky, they'll probably hit it big," says Tatsuno.

More bad news: the electronics industry is an important market for superconducting materials. But Tatsuno describes superconducting efforts in the U. S. electronics industry as in "sluggish growth," while in Japan such endeavors are "No. 1 and growing faster," he says.

STRATUS BROADENS PRODUCT LINE TO INCLUDE MAINFRAMES

In a development aimed at showing that it doesn't intend to be a second-tier contender in the market for continuous-processing computers, Stratus Computer Inc. has introduced 13 models that extend the Marlboro, Mass., company's product breadth into the mainframe class for the first time.

The new fault-tolerant XA2000 family computers include two midrange, seven high-end, and four mainframe-class systems. They give Stratus a price spectrum from the $37,000 Model 30 uniprocessor introduced last year to the $9.1 million 48-processor Model 2860 mainframe.

Stratus president William Foster says the company has become a major force in critical on-line computing, a contention that few market watchers would contest. Foster says the Stratus line now includes models that challenge those of market leader Tandem Computer Inc.

DEC EXPANDS ITS COMMITMENT TO RISC AND TO UNIX

The most important nuggets in a blitz of products introduced at the same time last month by Digital Equipment Corp., Maynard, Mass., reinforce the company's expanding commitment to Unix-based RISC platforms. They are the DECstation 5000 Model 200 RISC desktop workstation, DECsystem 5830 and 5840 RISC-based multiprocessor systems, and a new version of the company's Ultrix operating system.

The four versions of the workstation, as well as the 5830 and 5840 systems, are the first from DEC powered by the 25-MHz R3000 processor and R3010 floating-point coprocessor from MIPS Computer Systems Inc., which deliver 24 million instructions/s. That's less than the 27.5-to-34.5-mips range in IBM Corp.'s RISC/System 6000 family [*Electronics*, April 1990, p. 32], but still provides powerful acceleration of graphics functions for both 2-d and 3-d applications—the target market for the workstations.

Ultrix version 4 is the latest DEC Unix variation, which is intended to boost the performance of the multiprocessor DECsystem 5800 series.

RISC PROCESSORS GO FOR HIGH VOLUME

The pace is heating up in the market for reduced-instruction-set computing as CPU makers look more and more to embedded applications for high-volume sales. The newest players are Cypress Semiconductor Corp. of San Jose, Calif., and LSI Logic Corp. of nearby Milpitas. Both have introduced slimmed-down and lower-cost versions of their Sparc RISC offerings, using the plastic quad-flat package that has become so ubiquitous in the PC world.

Cypress's new CY7C611 is an 18-mips, 25-MHz model packed into a 160-pin plastic quad-flat package and priced at $76 each in 1,000-unit quantities. LSI Logic's entry is a low-cost version of its Sparc processor, the LG4901 device.

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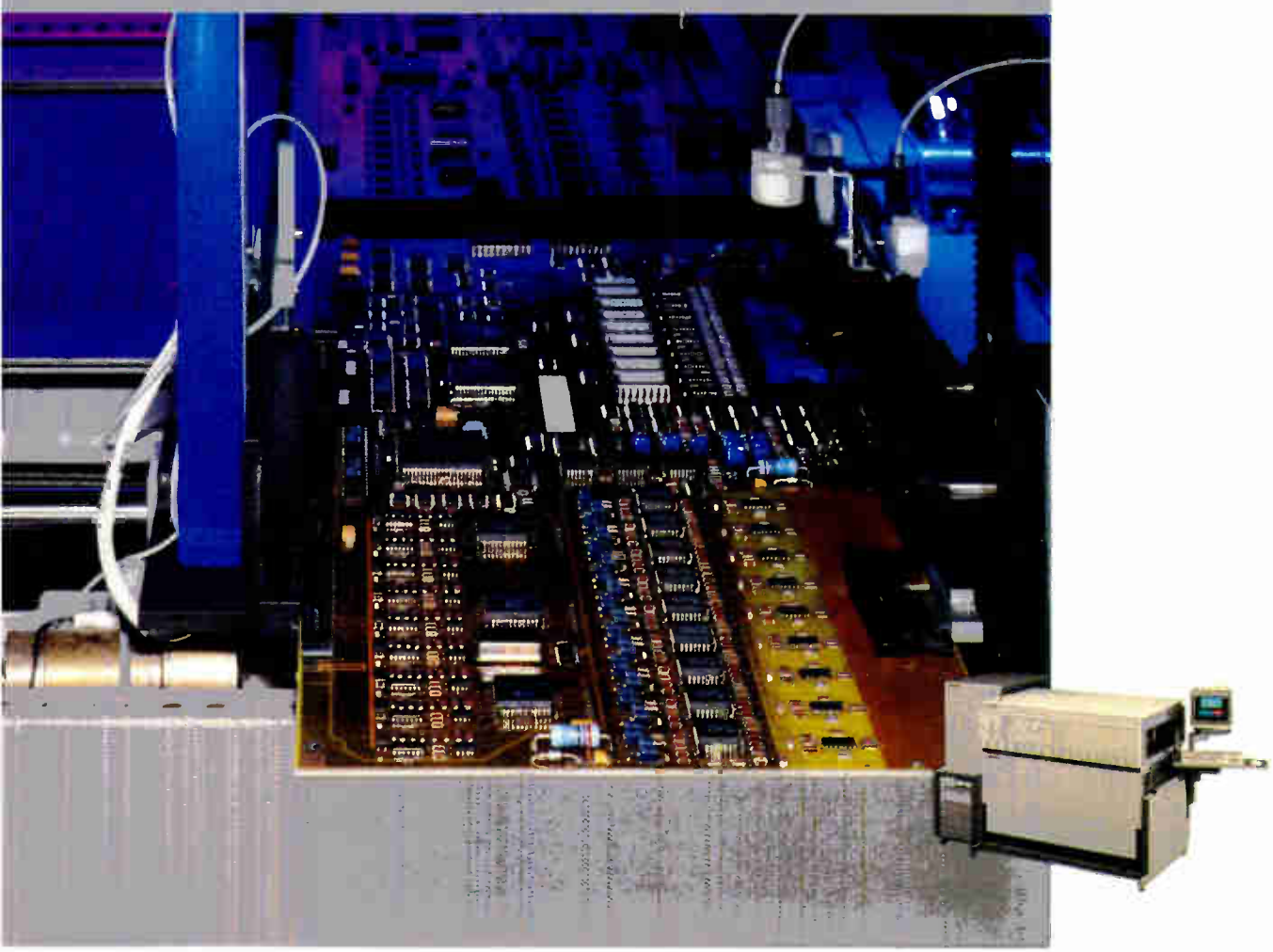

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CIRCLE 212

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CIRCLE 236

TO WATCH

EEsof LINKS ALL ITS SIMULATORS

The trend toward frameworks that link computer-aided engineering programs will get another convert this month when EEsof Inc. unveils its newly enhanced suite of CAE tools—Version 3.0—for high-frequency analog designs as well as microwave board-level designs.

The release links all of the Westlake, Calif., company's simulators under a single graphical design framework, called Academy. Engineers can now move freely and share files between simulators for linear-circuit analysis, nonlinear harmonic-balance analysis, nonlinear transient Spice analysis, as well as system/subsystem analysis.

Moreover, several support programs work as pop-up functions under Academy, providing circuit synthesis and transmission-line parameter calculations as needed. Academy itself features user-defined symbols, an interface for writing Academy layouts into IGES file format, and the ability to move sections of a schematic without breaking electrical connections.

In other Version 3.0 enhancements, EEsof has given Microwave Spice improved algorithms and a comprehensive set of transmission-line models that make it more applicable to microwave design. Touchstone 3.0, a linear simulator, now includes data redisplay without reanalysis, and the ability to read and write an unlimited number of s-parameter files of up to 20 ports. Version 3.0 will ship in the third quarter of 1990 with prices ranging from $5,000 to $34,000. E

NATIONAL'S FDDI CHIP SET IS POISED FOR EVEN HIGHER INTEGRATION

National Semiconductor Corp. has leveraged its advanced process capabilities in its Fiber Distributed Data Interface chip set. By using compatible biCMOS and CMOS, mixing analog and digital circuits on-chip, and following process-compatible design rules, the Santa Clara, Calif., company has laid out an easy migration path to higher integration and lower cost in future generations of chips.

The new chip set consumes about half the power and has a much smaller footprint than first-generation FDDI chip sets. In the logic design itself, additional registers and counters have been built in for advanced station management functionality.

Four chips are available now for $350 each in 100-unit quantities. In the second half of 1990, National will unveil its Basic Media Access Controller System Interface, which will link the FDDI chip set to the most popular computer systems buses, including the Sun Microsystems' S bus, IBM's MicroChannel and AT buses, along with the VMEbus.

The clock recovery device and the clock distribution device feature mixed analog and digital technology. The basic media access controller and the physical layer controller round out the set. E

AMD DELIVERS LOW-POWER ISDN

The integrated services digital network continues to attract more monolithic solutions, the latest being a terminal controller circuit from Advanced Micro Devices Inc. that can operate on telephone-line power during power outages.

The Am79C30A Digital Subscriber Controller is the first ISDN control circuit to conform to the CCITT's requirement for "restricted mode" operation—that is, less than 380 mW in active mode and 25 mW when deactivated, says the Sunnyvale, Calif., company.

It provides the standard 192-Kbit/s full-duplex digital path between the terminal and the PBX. It also supports Siemens AG's popular IOM-2 chip-to-chip interface.

The Am79C30A will be available in the third quarter of 1990, and will be priced at $10 each in purchases of 10,000-unit quantities. E

DATA GENERAL'S NEW EAGLE HAS LANDED

Data General Corp.'s first computers to use its 20-MHz, CMOS "washi" microprocessor outperform rivals from Digital Equipment Corp. and IBM Corp., says the Westboro, Mass., company.

The Eclipse MV/5500 DC and the midrange MV/9500 both deliver 5 million instructions/s, which translates into $11,400 per mips for the MV/5500 DC, compared with $24,000 per mips for DEC's MicroVAX 3800 and $31,000 per mips for IBM's AS/400 C25, says Data General. Both computers are available now.

Fabricated for Data General by Hitachi Ltd. [*Electronics*, February 1990, p. 72], the chip was code-named washi—Japanese for eagle. E

CATALYST SHRINKS DEFECT RATES WITH SOFTWARE

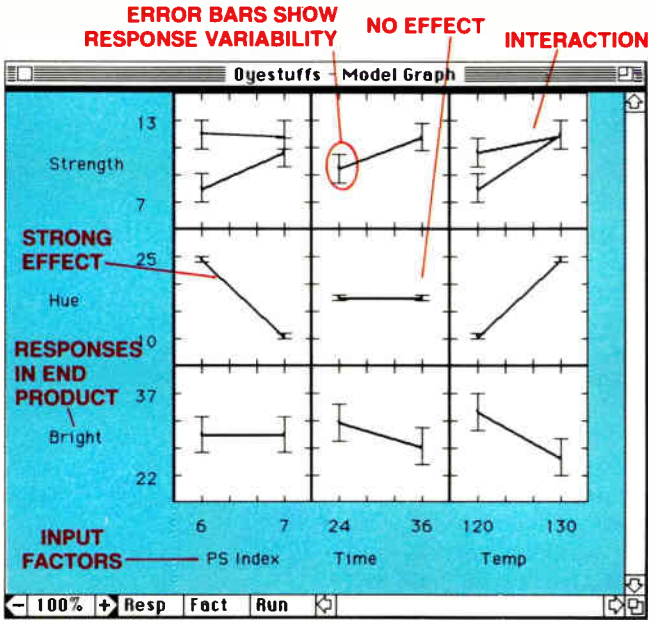
One reason why manufacturers have trouble pushing down defect rates to diminishingly small (six sigma) levels is that product quality often depends on how several factors interrelate.

Now, a software package that runs on the Macintosh II has been designed to improve manufacturing processes hampered by such problems. Called Catalyst/RPE, the program applies multivariate regression analysis to factors that affect the quality of end products.

Its developer, Catalyst Inc. of Littleton, Mass., says the package can help unravel manufacturing processes that simply can't be modeled by changing one input variable at a time. To use the package, engineers decide on the most important product qualities and the input factors that probably affect them.

The software calculates the minimum number of test runs needed to find optimal settings for the inputs and suggests trial values for each experimental run. Once the operator enters the result of the trials, the program determines which factors affect key responses most strongly and which factors have significant interactions.

The operator can vary any input setting to see the effect on responses. In beta testing, the package has already helped determine the optimum drying and curing time needed to bond ICs to substrates and is also being used to improve a semiconductor fabrication process.



THIS PLD CAN DECODE UP TO 48 BITS

A field-programmable logic device with pinouts specific to buses that are 32 bits wide or more is ideal for the new generation of high-performance microprocessors.

Designed by the Santa Clara, Calif.-based Signetics Corp., a subsidiary of North American Philips Corp., the 7.5-ns, CMOS decoder does the job of up to eight 20- or 24-pin programmable-array-logic devices. Signetics' PHD48N22-7 uses a pinout design that has 36 dedicated inputs and 12 bidirectional input/output lines. If the designer uses the 12 bidirectional I/O pinouts as inputs, up to 48 bits can be decoded.

Besides reducing component count, the device also cuts power consumption by 75%. And since interconnect delays are eliminated, propagation time is reduced by as much as two to three times. Available now, the 68-pin devices cost $22 each in 1,000-piece orders.

PLUG 450 MEGAFLOPS INTO YOUR PC OR MAC

If you need from 25 to 450 million floating-point operations/s on your desktop and are willing to pay $12,500 to $59,500, Dolphin Scientific Inc. has a deal for you.

Based on AT&T Microelectronics' DSP32C digital signal processor, the Long Beach, Calif., company's line of multipurpose desktop PC- or Mac-compatible platforms can replace current $100,000 solutions in some applications. Interfaces are available for the PC-AT or Macintosh II, but other interfaces are planned, including for the PS/2, Mac SE/30, Sun/VME and DEC/Q-bus.

The systems target a wide range of compute-intensive applications from robotics and sound processing to scienfitic and array processing and imaging. The DSI series can be configured with up to 18 DSPs.

CD AUDIO ARRIVES FOR PC COMPATIBLES

The compact-disk-quality audio capabilities of Next Computer Systems Inc.'s personal computer will soon be here on IBM Corp.-compatible PCs, thanks to two daughterboards from Ariel Corp.

The Highland Park, N.J., company's PC-56D and DAT-56 use the same Motorola Inc. 56000 digital signal processor used in the Next to transmit, store, manipulate, and re-create CD-level sound.

Priced at $895, the PC-56D does the audio manipulation. The DAT-56 is a DSP development system. It is priced at $1,995 and interfaces with digital audio tape, CD players, and professional digital audio equipment.

FIBER-TO-THE-HOME GETS A BIT CLOSER

The cost of fiber-optic telephone distribution systems can be brought down to earth using a family of single-mode optical-fiber tree couplers from Corning Glass Inc.'s Telecommunications Products Division in Avon, France.

The first products to hit the market are monolithic 1-by-4 and 1-by-8 couplers that allow simultaneous operation in the 820-, 1,310-, and 1,550-nm windows; a triple-window 1-by-2 unit; a double-window 1-by-2 device for the 1,310- and 1,550-nm operating windows; and a single-window 1-by-2 coupler optimized for low-loss 1,310-nm operation.

The units are bidirectional and can be used as passive couplers. Corning will introduce single-mode couplers as well as wavelength-division multiplexers this year.

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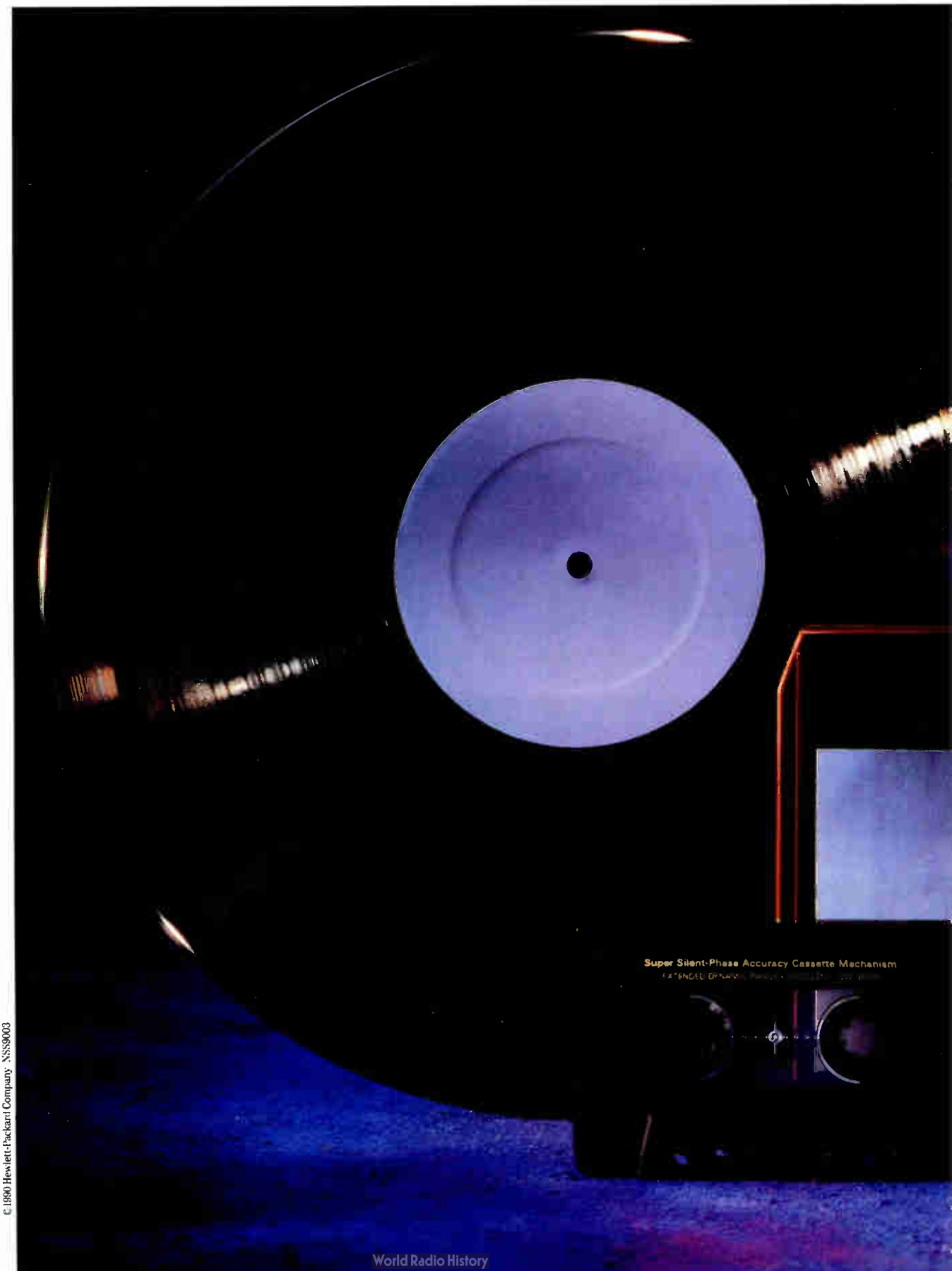
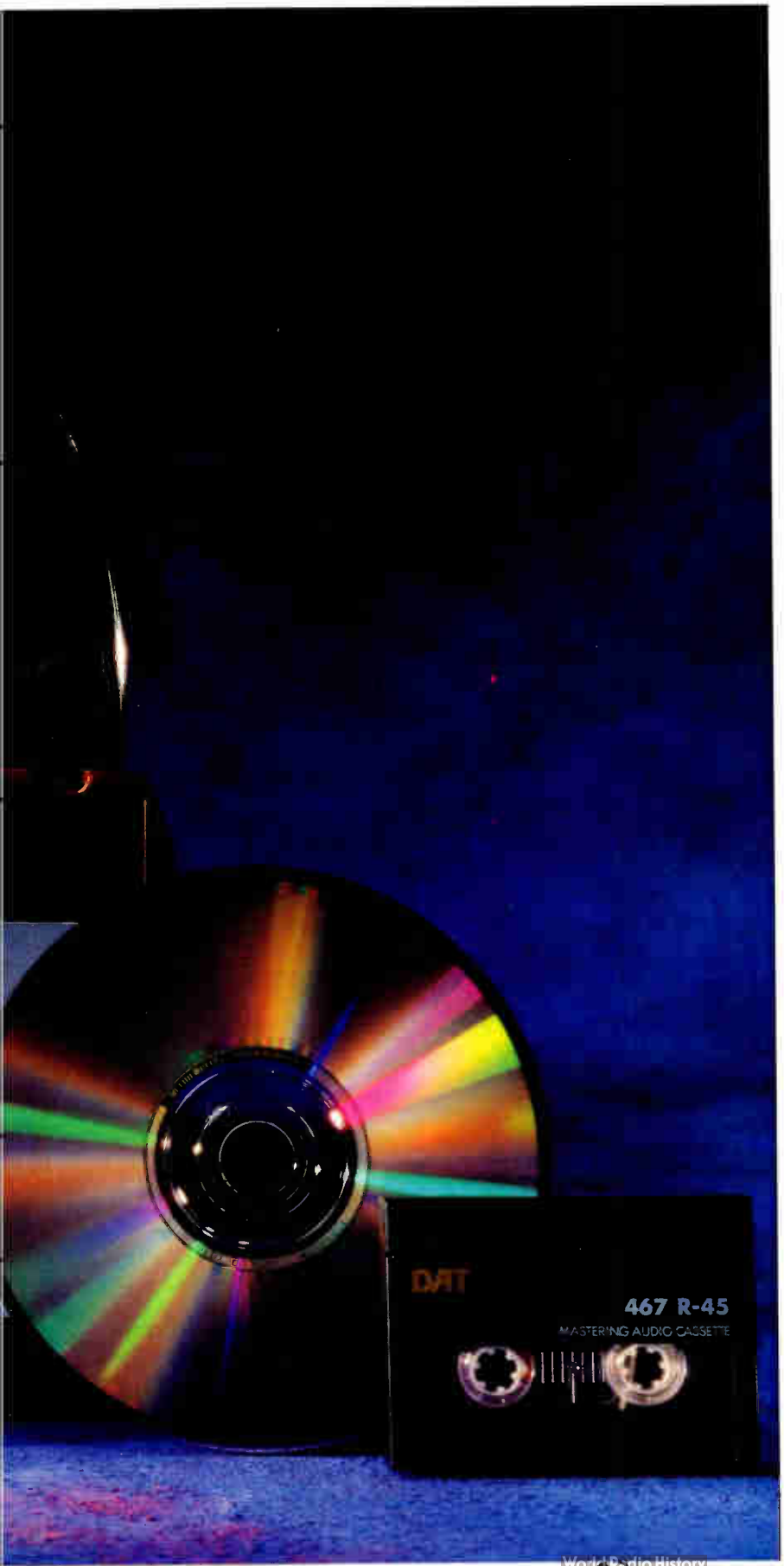
CIRCLE 266

What happens when the market



urns faster than your product?



In electronics, sometimes the life of your product is measured in months. But it can take years to get a product off the "drawing board" and onto the shelf.

Hewlett-Packard has a better way.

Solutions that combine computer products of the highest quality with industry-leading applications. Solutions that can dramatically reduce your design and manufacturing cycle times. Solutions that get your products to market before their best years are over.

In order to retain a leading position in an increasingly competitive semiconductor market, Texas Instruments looked to HP. An interactive network of HP Apollo Division workstations, running both proprietary and industry-standard design tools, helped TI reduce its design cycle time by over 50%. And it did so during a period when integrated circuit designs were doubling in complexity.

Even industrial-automation experts like Foxboro have turned to HP. Powered by HP computer systems, an underutilized Foxboro factory is now running with unprecedented efficiency. Inventory holding times have been slashed and production cycle time has been cut by more than 75%.

HP has achieved equally dramatic reductions in design and manufacturing cycle times for our own products, and our manufacturing and R&D managers would like to share their insights. To learn more about qualifying for an in-depth seminar at an HP manufacturing site, call **1-800-752-0900, Ext. 1029.** We'll start by sending you some informative case histories.

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HEWLETT PACKARD

NEW GE INJECTION-MOLDING TECHNIQUE PROMISES TO SPEED THE TRANSITION

PC BOARDS GO 3-D

BY JACK SHANDLE

FLAT IS NO LONGER WHERE it's at in printed-circuit boards. The industry, long confined to two dimensions, is steadily evolving toward bonding copper to curvilinear surfaces, and a new process from General Electric Co.'s Plastics Division in Pittsfield, Mass., promises to speed the transition.

There are several advantages to printing circuit traces on simple, geometrically curved shapes. The biggest gain is in manufacturing costs—that is, the simple matter of being able to put just one board in its end-product housing. As the size of electronic gear shrinks, it is becoming more difficult and more costly to squeeze flat boards into packages that have to be pleasing to the consumer.

A prime example is portable cellular phones, where circuits can be bonded directly to the inside of the handset. No pc board is actually involved. The circuit goes right on the housing.

Also, three-dimensional geometries eliminate wire connections and "play well in the design-for-manufacturing gospel that U. S. industry is adopting," says Jerry Podesta, electronics marketing manager at GE Plastics. "We have been trying to promote injection-molded circuit boards for a long time, but only in the past year have we seen it pick up steam," Podesta says. "Eventually, molding will be the way to go. The only question is: when?"

Although producing 3-d circuit boards is more expensive than making traditional two-dimensional ones, the technology can deliver reductions in the overall cost of producing the product by reducing the number of parts—and the labor needed to piece them together, says Podesta.

And the company's Ultem pc-board plastic can be injection-molded, which means that the plastic can serve double duty: first as the product's casing and second as its board.

GE's technology is actually the combination of two developments from the company's corporate research and development laboratory in Schenectady, N. Y.—a scheme for chemically bonding copper to plastic, and a sophisticated system of curing the resists, or lines, on the board.

A year ago, GE unveiled a process that chemically bonds copper to Ultem. The chemical bond is stronger than the traditional mechanical bond created by etching the board's surface, in which molten copper clings in the etch marks. The chemical bonding system has the advantage of not weakening the board itself, says Kenneth Browall, manager of the GE lab's metalization program. In the year since the bonding process was released, it has been improved by substituting chemicals with an aqueous base, which are more benign than the original baths.

But the process was of no great value until it could be used in a manufacturing environment, and GE recently announced just that: a photoimaging process that uses columinated ultraviolet light to cure the lines on simple geometric shapes. The problem with resists that run across 3-d shapes is that conventional ultraviolet exposure systems do not cure them evenly. Columinated light, on the other hand, can be focused directly on the resists for precisely the time for proper curing.

Three-dimensional boards are not new, but the other manufacturers working in this technology do not use chemical bonds to Ultem. Also, they have kept their systems proprietary. By contrast, GE has opened its specifications in the hope that it will sell more Ultem that way. The chemical copper-bond process works only with Ultem, according to the company.

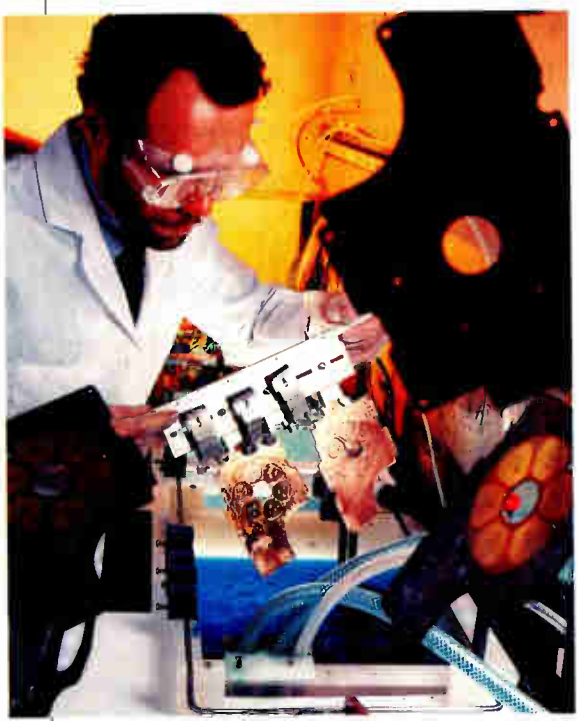
Columinated light systems use mirrors to minimize light dispersion. They are already commercially available and are being used in pc-board shops that specialize in narrow line widths, says Podesta. In general, however, they produce beams with 10% scatter; GE's system requires 1% scatter.

However, an additional capital investment is needed to implement the GE system. Users "also need a method for applying the resist," says Podesta. One option is equipment that precisely sprays the resist on the Ultem. The other is to use electroferric resists, in which the resists are electrically deposited from a photoemulsion.

In its current implementation, the technology handles only relatively simple 3-d geometries. "Limitations depend on light scatter and the energy needed to cure the resist," Podesta says. Present rules limit it to geometries in which each step is less than 0.3 in. deep—however, there can be more than one step or depression.

Angles must be less than 80°, and line widths and spaces must be greater than 0.01 in. GE expects to commercialize an imaging process for more complex geometries sometime later this year.

"We see large-scale applications in the computer and automotive industries especially," says Browall. "As the technology becomes more and more flexible, it will become a misnomer to call them circuit boards."



A GE technician prepares to dip a molded 3-d pc board into a fixing bath.

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CIRCLE 271

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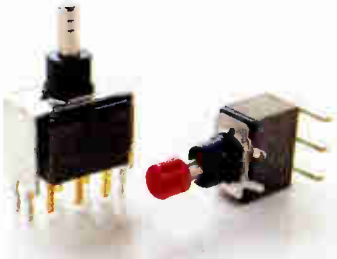

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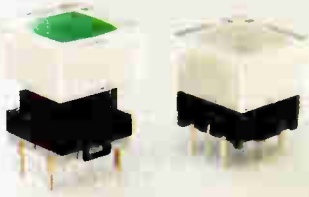

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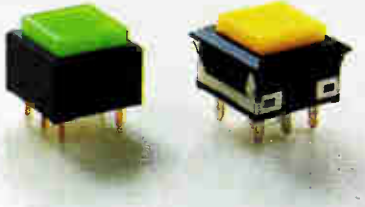

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CIRCLE 210

TEST-VECTOR-GENERATION SOFTWARE USES STRUCTURAL AND BEHAVIORAL MODELS OF ASICs

TESTING ICs TO THE MAX

BY JACK SHANDLE

IN THESE DAYS OF EVER rising quality consciousness, keeping bad chips out of the hands of good customers has become Job One in the executive suites of most semiconductor companies. Adequate testing is imperative.

But quality assurance has to compete with time-to-market considerations during boardroom debates. There is little sense in delivering a perfect product well after its time has come. Moreover, designing integrated circuit tests is a semidark art that is as time-consuming as it is murky.

That's why ExperTest, a Mountain View, Calif., startup, has created a new solution with a new approach by combining human intuition with the speed and power of automated test-vector-generation techniques.

The result is a software product called Test Design Expert, which ExperTest claims will pay for itself after being used for two or three designs. To conform to the new interest in CAE frameworks, ExperTest has also made Design Expert an an open architecture product that plugs and plays in virtually any computer-aided environment.

In case you haven't already guessed, ExperTest has embedded an expert system in Test Design Expert.

"ExperTest looks at the test problem the way a test engineer does," says Charles Miller, vice president of marketing. "If you give a test engineer any circuit, he can create a test program that offers 100% fault coverage. By understanding what the circuit is supposed to do and taking that into account, he looks at the problem differently than the assumptions inherent in automated test-vector generation."

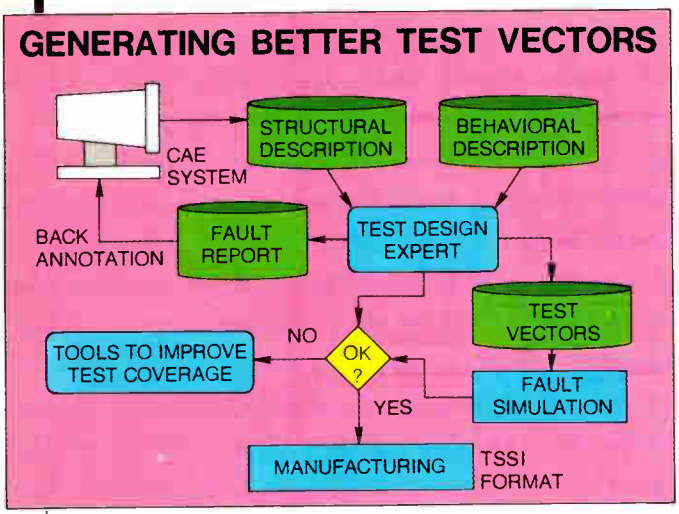
Other companies have products in the works, says Ron Collett, associate director of Dataquest Inc.'s CAD/CAM Industry Service in San Jose, Calif. "Crosscheck Technology and a couple of full-line suppliers are also looking at solutions," he says. Dataquest estimates that, on average, 20% of the product-development cycle is eaten up by testing—so the returns on faster, better tests can be significant. ExperTest's software is a "good sign," says Collett. "The problem needs to be solved."

A new approach is needed especially for complex application-specific ICs, which present knotty problems for automated software-designed tests that work just fine in instances where circuits can be segregated into automous modules. While automated-test-vector-generation techniques work well on such combinational circuits, says Miller, they lose much of their effectiveness when applied to unconstrained sequential circuits.

In sequential circuits, the ATVG software becomes trapped in illegal circuit states or fails to distinguish signal dependencies controlled by inherent circuit delays. Since the software has no knowledge of what the circuit is supposed to do, it has no way to distinguish between a likely solution and a dead end.

ExperTest claims that board-design houses, for example, can pay off the $150,000 price of purchase quickly when compared with a manual test-vector design that achieves a shipped-product quality level, or SPQL, of 75%. Test Design Expert delivers SPQLs of 93% or better, says Miller.

If it uses conventional functional testing, a typical company that designs two boards a year with two or more ASICs per board could easily find that 25% of the boards it sends into the field will be faulty On average, the ASICs might cost $50 each, reworking a board that fails the functional testing would cost $50 in additional labor, and a faulty board that makes it into the field and has to be returned for repair



costs the company $500. Those costs run up quickly if the company ships thousands of boards per year.

ExperTest claims its higher SPQL produces at least a 3 : 1 cost differential in these costs alone. In one example, if the hypothetical company mentioned above ships 2,000 boards a year, the cost of rework, returns, and bad parts would be $850,000 for conventional functional testing but only $170,000 when using test Design Expert, according to ExperTest.

Bigger savings accrue in the labor cost of designing the test. Here, ExperTest claims at least a 5 : 1 advantage. The Design Expert system requires additional purchases, however, which amount to $150,000 for the software (depending on the licensing agreement), $60,000 for a workstation, and another $60,000 per year for maintenance.

Dataquest's Collett points out, however, that time saved with products such as Test Design Expert depends on "how good the chip designer's simulation vectors were initially—that is, how much can they be applied to the test problem."

The magic of ExperTest's technology depends on its embedded expert system. Somehow, the software has to infer the circuit designer's intent—something that is almost intuitive with a human test designer. So in addition to a structural description of the circuit—that is, the gate-level information—the knowledge base needs a behavioral description of the ASIC. By including both descriptions in its expert-systems knowledge base, ExperTest's software, can—just like a human test designer—use particular operation codes or place the circuit in a specific state to identify illegal states or blind alleys in advance.

Test Design Expert uses the VHDL-T behavioral circuit model, a register-transfer level subset of the full VHDL (VHSIC High-Level Description Language). Modeling a circuit with VHDL-T requires that all latches and flip-flops be identified specifically. The model itself is built as a series of conditions on control signals followed by operations on registers. State machines can be modeled using case statements or if-then-else statements. But exact timing is not important as long as the relative sequencing is correct. Test Design Expert can derive timing information from the structural description.

Test synthesis with Test Design Expert is compute-intensive, but can usually be accomplished in overnight runs on a Sun Microsystems Inc. Sun 4/330 workstation, says Miller. ExperTest has developed a guide that correlates the complexity and type of circuits being studied to fault-coverage percentage and computation time.

Six circuit types have been defined: combinational circuits with full scan, such as a 32-bit multiplier; fully synchronous ICs with external clock, such as a full-scan CPU circuit; nearly synchronous chips with some internal clocks, such as a variable-length shift register; nearly synchronous circuits with control by counters or complex state machines, such as a reduced-instruction-set-computer CPU; "constrained" asynchronous circuits, such as a serial data formatter; and "unconstrained" asynchronous circuits, such as a Small Computer Systems Interface controller. Expected fault coverage is 100% for the first three types, 99.5% for the fourth, 97% for the constrained ICs, and 93% for the unconstrained. Computation times vary, but generally do not exceed an hour.

AN HP TEST LANGUAGE REEMERGES AS A STANDARD

PUTTING TOGETHER AND programming a test instrumentation system just got a lot easier. The reason is the recent release of SCPI, an extension of the IEEE 488.2 standard for GPIB-based automatic test equipment systems. The new specification, which was hammered out by an ad hoc working group of instrument manufacturers, defines a standard programming command set and syntax for instruments. At the same time, the group announced its intention to form a consortium to maintain the standard and provide future enhancements.

SCPI—which stands for Standard Commands for Programmable Instrumentation and is pronounced "skippy"—was hatched out of a comprehensive set of commands originally developed in 1989 and released by Hewlett-Packard Co. under the name TMSL (for Test and Measurement System Language). At first, HP retained some proprietary rights to TMSL and imposed licensing restrictions.

But other instrument manufacturers chafed under the restrictions and persuaded HP to rescind them with the proviso that a standards group or consortium would be established to manage the new standard. The 24 companies that had signed the license agreement were released in October 1989, and their fees returned. HP then turned over the intellectual property rights to the working group.

Six months later, after intense negotiation, SCPI emerged, combining TMSL with another standard developed by Tektronix Inc. called ADIF (for Analog Data Interchange Format). "The committee has been going through it and modifying some things to make it more general," says James Truchard, president and chief executive officer of National Instruments Inc. in Austin, Texas, which is represented in the working group. "We have been cleaning it up to make it more solid technically, without some particular company's interest skewing things for a particular application," he says.

SCPI will solve a number of problems that have plagued test system designers, says Fred Bode of Bode Enterprises in San Diego, who is technical chairman of the working group. "When IEEE 488.2 emerged, it standardized only about a dozen commands," Bode says, "but there was no standard vocabulary. You had to learn a new vocabulary for each instrument, even if you bought an upgrade to an existing instrument from the same company. It made software maintenance very difficult, and if you wanted to update for any reason, it was more trouble than it was worth."

The new extension will make life easier for test-system programmers because along with IEEE 488.2, it offers a higher degree of interchangeability of both the software commands and the instruments themselves. SCPI aims not only at interchangeability within a product line but also between instruments from different manufacturers. It defines the specific programming commands and syntax that each instrument class—such as multimeters, oscilloscopes, or function generators—from various manufacturers must obey.

"I think it will breathe new life into the General Purpose Interface Bus, in that it is a new level of capability," says Ron Wolfe, strategic marketing manager at National Instruments. "You'll be able to tell the difference between an old instrument and one that conforms to the new SCPI standard under 488.2. Users have been pleading for this kind of standard for 10 years, and all the problems, except perhaps data-transfer speed, have been addressed by these new standards."

According to Bode, who publishes the *VXI Newsletter*, SCPI will be a favorable development for VXI-based instrumentation systems as well. "VXI designers are finding that software costs are very high," he says, "and now we're giving them a standard way to command instruments themselves, not just the controller or host."—*Samuel Weber*

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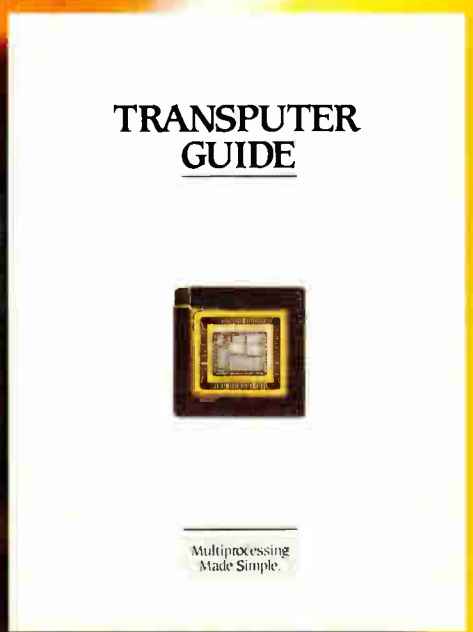

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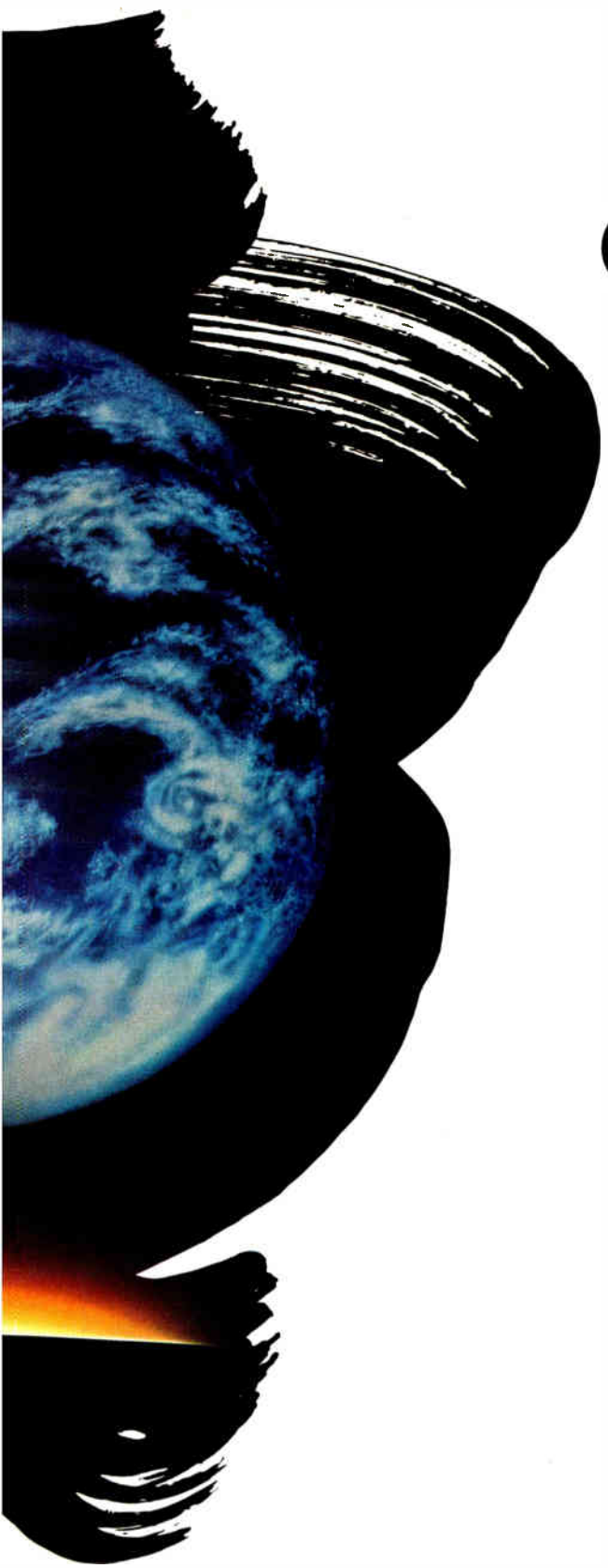
CIRCLE 216



Tiny Glitches Lead to Giant Wobbles

We take it for granted that the Earth rotates stably on its axis and that the stars are fixed in the sky above us.

Yet, Hipparchus discovered more than two millennia ago that there were very slight discrepancies in the measured positions of stars over the years. Compelled to look further, he found the difference to be greater than what could be attributed to error and analyzed it.

Hipparchus

Hipparchus realized that the position of the stars was actually shifting at a constant rate, year after year. This was later shown to be caused by the Earth slowly wobbling like a top as it turned on its axis.

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CIRCLE 279

NORWEGIAN STARTUP BUILDS AN OPEN-SYSTEM SUPERCOMPUTER AROUND THE 88000 RISC CHIP

1,000 MIPS OR MORE

BY PETER FLETCHER

BY COMBINING THE ARchitecture of the Motorola 88000 RISC processor with emitter-coupled-logic technology, a year-old Norwegian computer company hopes to break records for supercomputer price, performance, and, above all, software compatibility. The ECL version of the 88000, from Dolphin Server Technology AS of Oslo, is expected to yield a parallel processor module that operates at 300 million instructions per second when running unoptimized code. Peak performance should be 1,000 mips, says company president Per Christian Jacobsen. Up to 16 of the modules will be used in a machine that Jacobsen calls the Orion, scheduled to be unveiled in 1992. Target price is around $500,000, Jacobsen says.

Perhaps Orion's most significant feature is its "binary software compatibility," which means it will run what Jacobsen calls shrink-wrapped industry-standard software under the Unix System V operating system. He says that was the prime reason for striking a deal with Motorola Inc. for use of the 88000 reduced-instruction-set-computing architecture when development started.

The choice of the 88000 was made before Intel Corp. launched its RISC processor, Jacobsen says. "At that time the choice of a RISC architecture was limited to Sparc, MIPS Computer Systems, and Motorola," he says. "We evaluated all three chips and concluded that at that time the Sparc's technology would be difficult to scale to the performance we wanted. Motorola and MIPS were about the same technically, but we liked Motorola's commitment to industry standardization. That is very important to a small company like ours—we need to be able to surf on the waves made by the big computer companies and software houses."

Jacobsen sees computing power as more than a matter of mips. "We have designed the Orion as a fast transaction processor, and our simulations indicate that it will be able to handle more than 1,000 transactions per second, based on the industry TP1 benchmark standard," he says. That defines a transaction as fetching a record from a data base, processing and rewriting it. "There are other machines that can achieve this level of performance," Jacobsen concedes, "but most use specialized hardware, proprietary operating systems, and need specially developed software."

At least one supercomputer user, John Fitch, a professor at Bath University in England, agrees that adherence to open industry standards could be a

boon. "For users, a really open system would be very good news," he says. Proprietary architectures often require users to write their own operating systems and compilers, "which is not easy." Fitch says the Motorola 88000 architecture does seem "remarkably clean" and that through the 88 Open consortium it is rigidly defined.

Fitch has just bought two Stardent 3000 machines, for just over $200,000, to be used for a research project into the simulation of unpredictable events such as forest fires and battlefield management. With two R3000 processors from MIPS Computer Systems Inc. running at 32 MHz, he calculates they give about 100-mips performance (or 51,000 Dhrystones). That, he claims, is the equivalent of 1.5 times the power of a Cray 2 computer. By that yardstick, if Dolphin meets its targeted price and performance it would be well positioned in the market.

But Fitch points out that Dolphin is stepping into what is likely to become a highly competitive arena. He says he already has been offered processors based on ECL implementations of the MIPS processor architecture that can provide 100-mips performance and more. "That is an air-cooled system," he comments. "Liquid cooling could boost that considerably." At the same time, other companies, such as Data General Corp. of Westboro, Mass., are nearing market with ECL implementations of the 88000.

The secrets of Orion's speed and power lie inside a series of 11-cm² liquid-cooled modules. Each will contain eight Orion execution processors and two tiers of 4-ns cache memory also designed with ECL application-specific integrated-circuit technology.

"We have designed some hardware logic that takes care of task allocation among processors," Jacobsen explains. This allows instructions to be distributed automatically to the processors. Program-execution speed is further enhanced by a proprietary technique that, according to Jacobsen, allows program instructions to be executed "out of order" in cases where this would not affect the results. Just how this is achieved is one of Jacobsen's commercial secrets that he believes will give the company an edge.

Also, "Each module will be a self-contained processor, incorporating an instruction-folding capability that allows up to three instructions to be executed each clock cycle," he says. Clock rate will be 125 MHz. Development of the liquid-cooled package is being carried out in collaboration with Siemens AG of West Germany. The chips inside are designed with National Semiconductor Corp.'s ECL ASIC process.

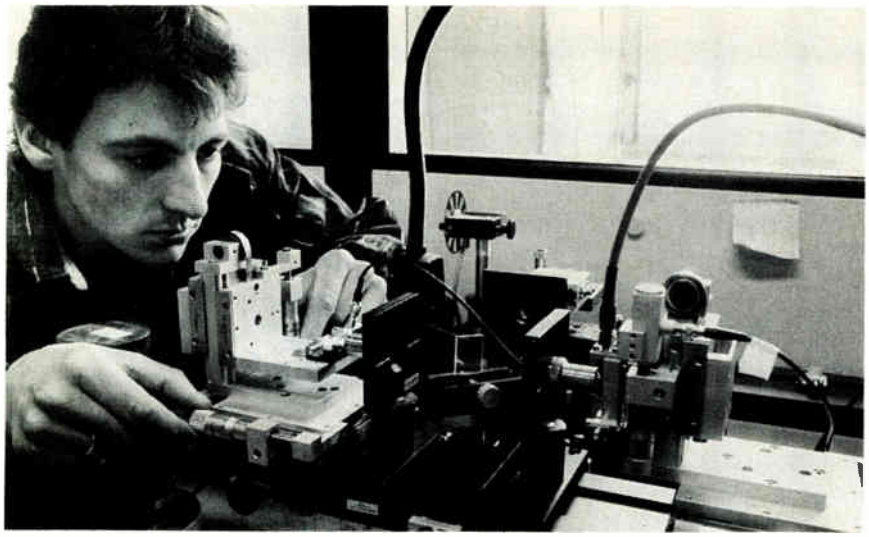
More ingenuity has gone into the design of the Orion's system architecture. This is based on a proprietary 16-bit parallel internal-ring data highway clocked at 1 GHz. Jacobsen claims it will be able to transfer data at a rate of 2 Gbytes/s between processor nodes. While the Orion's internal ring-bus structure will be strictly proprietary, interface to external peripherals will be by means of industry bus systems including VMEbus, FutureBus, or the newly defined IEEE 1596 scalable file-access interface standard.

MARKETS FOR THE SYSTEM are expected to be mainly in Europe, although Jacobsen expects to gain some revenues from U. S. companies that have military-equipment offset obligations to the Norwegian government. Jacobsen intends to sell the machine to original-equipment manufacturers and says that he is already in negotiation with "several big-name computer firms."

Ironically, the current depression in traditional mini- and mainframe computer markets provides the opportunity for Orion, Jacobsen says. With profit margins all but wiped out, most of the larger companies are opting to buy ready-built systems that conform to internationally accepted standards rather than commit scarce financial resources to developing their own hardware.

Jacobsen says that the mini makers are following the example of personal computer makers. "They have turned to systems integration, buying high-level components or complete systems and either assembling or relabeling as a more profitable method of bringing new products to market quickly," he says.

The minicomputer slump is also the background to Dolphin's own birth. The company was brought into existence as a result of the near collapse of Norwegian flagship minicomputer maker Norsk Data AS last year. Norsk Data reorganized to concentrate on systems integration rather than designing and building its own hardware; its 100-person R&D department then spun out to form the core of Dolphin Server Technology AS.



In the experimental data-transfer link, a laser beam is focused onto an on-chip transistor. Siemens researcher Josef Popp is adjusting the link.

OPTICS

SIEMENS USES TRANSISTORS, NOT DISCRETE LIGHT DETECTORS, IN OPTICAL COMPUTING

NOW, EASIER OPTICAL

BY JOHN GOSCH

OPTICAL COMPUTERS, THE kind that use light pulses rather than electrical signals to transport data and are potentially 100 to 1,000 times faster than today's most powerful supercomputers, are still years, if not decades, away. But researchers around the world are trying to shrink that interval, even as they attempt to miniaturize and simplify the elements of such computers.

For example, even as scientists at AT&T Bell Laboratories announce that they have managed to reduce the size of the components of their optical computer, the first one announced [*Electronics*, April 1990, p. 92], their counterparts at West Germany's Siemens AG have come up with a different way to process the data-carrying light beams in future information systems.

The Siemens method, developed by Ludwig Treitinger and Josef Popp at the Corporate Research Laboratories in Munich, stands out because of its simplicity: instead of employing special discrete light detectors, it exploits the photodetection properties of the transistors that are already part of the chips in the system. After detection, the chips process the data in normal fashion.

On-chip transistors well suited for the detection job are double polysilicon self-aligned bipolar or bipolar-CMOS types of the npn variety, Treitinger says. In such devices, the double polysilicon feature improves the light-detection properties, while bipolar or biCMOS designs as well as the self-aligning concept enhance device speed.

In principle, pnp transistors will also work, but npn versions—they are normally used in logic circuits—are faster. Since there can be no light detection if the transistor is covered with metal, the metalization steps must be altered slightly during chip manufacture. But it is not necessary to redesign the chip.

Besides allowing computer engineers to use existing chip designs, the new Siemens scheme offers another advantage: a substantial reduction in signal delay in the circuit. Ordinarily, in a chip measuring, say, 15 mm by 15 mm and moving data through the wiring at 50 ps/mm, it takes a bit about 1.5 ns to propagate from one corner of the device to the opposite corner—too long to suit designers of high-speed optical computers.

The delay can be cut to acceptable levels simply by coupling the light beam via optical fibers into a number of photodetecting transistors on the chip. This would not only solve timing and phase-difference problems, it would also eliminate the need for much wiring and thereby save real estate on the chip.

Further, microprocessor chips could do with far fewer bus lines. Less wiring would enhance device yield during chip manufacture and help cut circuit failure rates. The new technique also makes possible glass-fiber connections between transistors on different chips and component boards.

Treitinger, who says he has heard of no similar approach being pursued elsewhere, views his on-chip photodetection method simply as a proposal. "It's only one of the many possibilities for optically triggering components in future high-speed systems," he says. Because of its simplicity, the concept could find practical applications before the end of this decade.

To prove the method's feasibility, researcher Popp has put together a small data-transfer link using a gallium-aluminum-arsenide semiconductor laser with an 840-nm wavelength as the light source. In this setup, the laser beam is modulated with the output of a word generator and focused onto an on-chip vertical npn polysilicon self-aligned bipolar transistor with a surface area between 50 and 100 μm^2.

"We were surprised to find how well the transistor is suited for photodetection," Popp says. However, an on-chip silicon transistor does not reach the levels of sensitivity and bandwidth common for discrete GaAs photo devices, so it cannot be used as a detector in long-distance data-transmission links. But it is well suited for the short links inside an information-processing system.

Popp's experiments have shown that the transistor can be used for detecting optical signals with data rates up to 1.25 Gbits/s. With low-noise amplifiers and flip-flops, the high and low states of individual bits can be made clearly distinguishable. The transistor produces a photocurrent of about 50 mA with 1 W of optical power coupled into it. The transistors can handle much higher bit rates—up to 10 Gbits/s—if only their base-collector diode region is used for photodetection.

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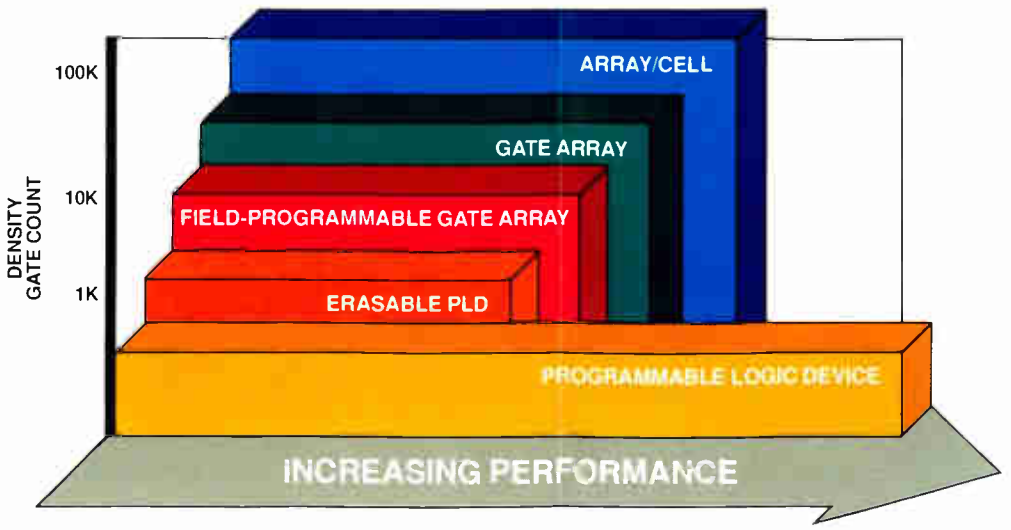
TI's ASIC PRODUCT SPECTRUM



For details about the support and service TI offers, please turn the page.

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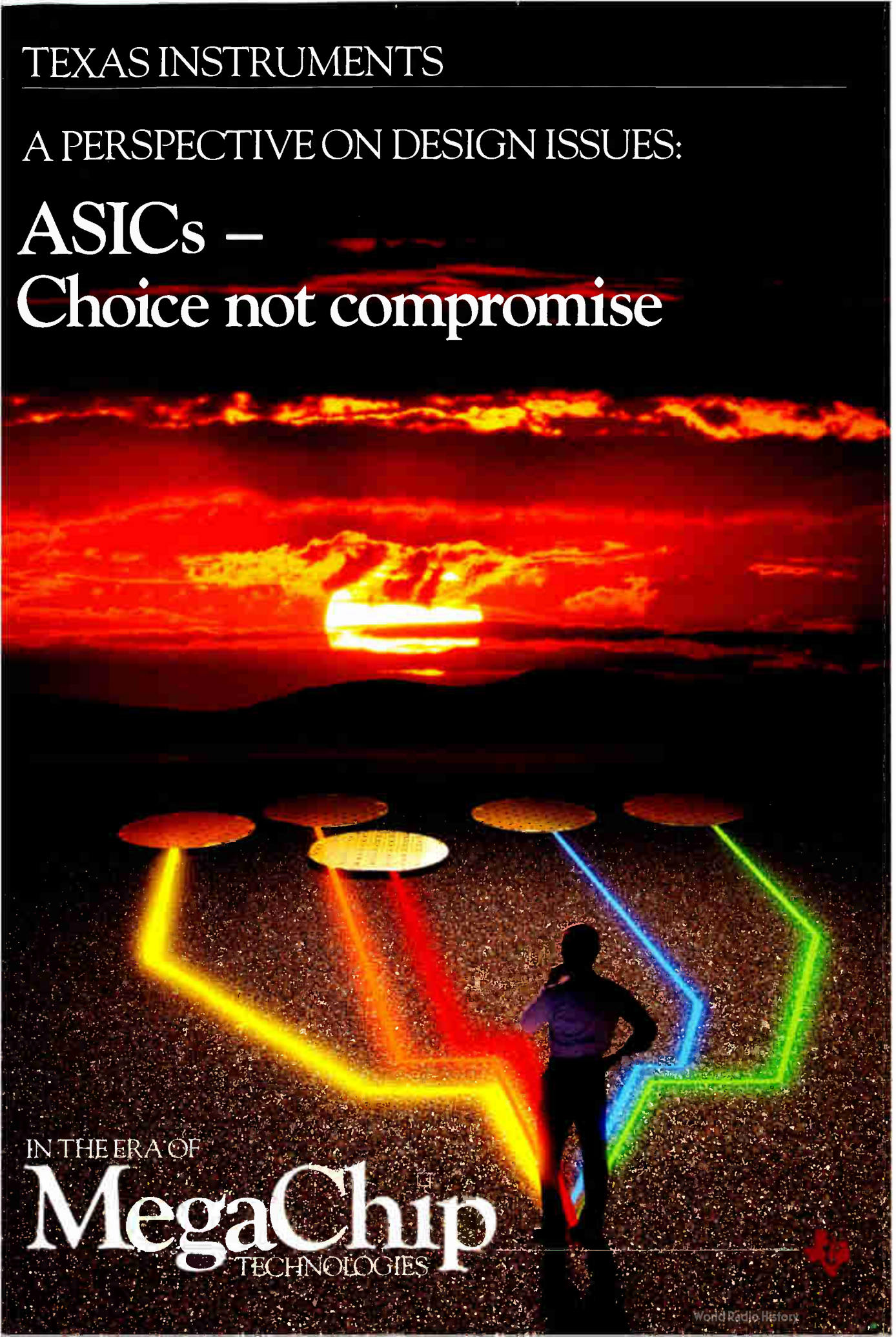
TEXAS INSTRUMENTS

A PERSPECTIVE ON DESIGN ISSUES:

ASICs – Choice not compromise



A PERSPECTIVE ON ASIC DESIGN

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"An ASIC solution is more than a choice of silicon. To keep you from compromising on a square peg for a round hole, an ASIC solution involves many considerations: Your performance needs. How much control you want to exercise. The amount of support you require. What you can spend. How narrow your market window is. It's the result of you and your supplier weighing all the choices and reaching a balanced decision. At Texas Instruments, that's the way we like to work.

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Executive Vice President, Semiconductor Group
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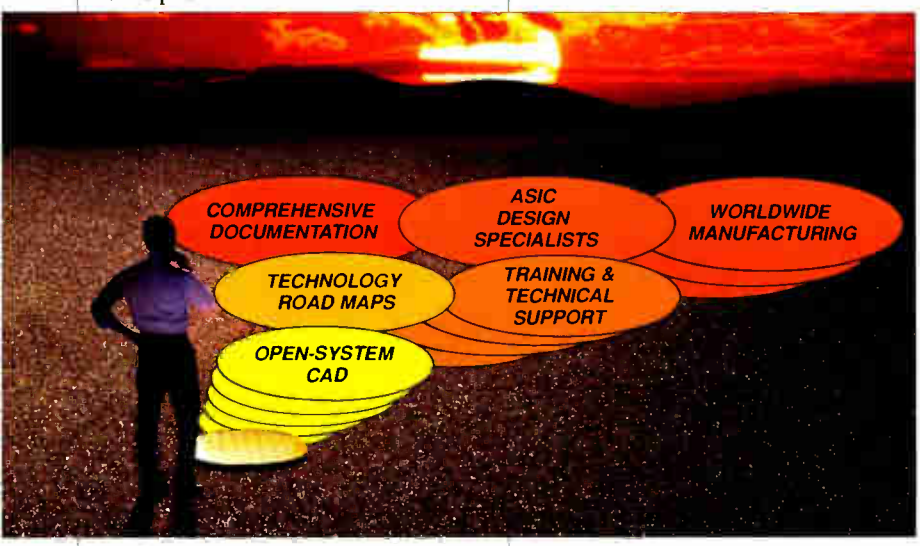

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TEXAS INSTRUMENTS

THE BIG PLAYERS ARE PLOWING MORE MONEY INTO RESEARCH AS THE EC URGES COOPERATION

EUROPE'S R&D PUSH

BY ANDREW ROSENBAUM

AS IF U.S. ELECTRONICS producers didn't have enough to worry about as Japanese and other Far Eastern competitors pour resources into R&D, now it's Europe's big companies that are closing the gap. Traditionally trailing U.S. investment by a wide margin, the Europeans have been gaining ground and now are almost neck and neck.

Between 1984 and 1988, the European research effort has doubled. In 1988, U.S. companies invested about 20% of sales in research, and European companies put in 18%. The gap has closed even more since then; although exact figures are not available, the European research and development expenditure is growing at about 13.5% a year, according to the Paris-based Bureau d'Informations et de Previsions Economiques. Not only that, but researchers of different nationalities and from different companies are learning to work together for the first time.

"In the last few years we have learned to collaborate," says Fillipo Demonte, senior vice president for research at Italy's Olivetti Systems and Networks SpA. "When I go to the U.S., I always get the feeling that everybody in IC research knows each other. In Europe this wasn't the case until a couple of years ago."

Fostered by the new collaborative spirit, which shows up best in European Community programs like Esprit, European R&D efforts are showing results. In areas like multimedia technology, workstations, and application-specific integrated circuits, Europe is coming up with very competitive products.

Take data compression. Philips International NV of the Netherlands is working together with Olivetti on the improvement of data compression for multimedia products—even though Philips plans to market its own Compact Disc-Interactive multimedia box in 1991, and Olivetti is working with Intel Corp. on competing Digital Video Interactive technology.

The work of the two companies is part of an EC project to increase the rate of picture compression for multimedia devices. The project is so new that details are not yet available; but it's clear that the Philips-Olivetti alliance is a formidable one.

Then there are workstations, an area where Europe has always been weak. Despite the size of the European market—expected to be worth about $20 billion in 1992 in the estimate of Dataquest Europe in London—European companies have been slow to enter the arena, and although some European-built machines are now available, the market is largely dominated by U.S.-built entries.

So in 1988, France's Bull SA, Germany's AEG Olympia AG, and eight other European companies completed work on the so-called Secure, Open, Multimedia Integrated Workstation, known as Metaviseur. Bull has already put commercial versions on the market under the trade names DPX 1000 and DPX 2000.

Since 1988, Esprit has supported the emergence of second-generation multiprocessor workstations using CISC and RISC chips and distributed processing, according to a spokesman for the Directorate General XIII, which is the computers and telecommunications division of the EC Commission. The processors used in the workstations are either general-purpose or specific to certain applications, like graphics or data-base management. Processing capability is expected to reach 20 million to 50 million inferences/s.

The current Esprit program attempts to build a family of third-generation workstations. The spokesman says that this family of upwardly compatible, interoperable, and scalable workstations is to run a standard software environment. Users should be able to work on any one of the family, whatever their

training. The Esprit panel obliges workstation proposals to comply with this attempt to reach a common environment. The panel even insists that the workstation projects be accessible in all European languages.

Computer-integrated manufacturing is another priority for European electronics research. "Systems engineering is a traditional strength of European industry," says Daniel Meyer, research chief for Siemens AG of Munich. "It results in a high standard of technique in areas like automated manufacturing." In fact, the EC pumped $50 million into CIM research in 1989 and will commit an even larger sum this year.

Europe's CIM research concentrates on applications that are accessible to small and medium-size enterprises. Two top priorities are education of the whole work force and technology enhancement of small and medium-size businesses. The key to both of them is the ongoing project, part of Esprit, that defines an open-systems architecture based on the ISO/OSI model for CIM. The scope of the project will be expanded this year to achieve European standardization in this area.

Other Esprit projects include the creation of communication networks for manufacturing systems, computer-aided-design interfaces for CIM applications, product design and analysis systems, product-life tracking systems, and open control architecture for robots and shop-floor systems.

Another area that Europe is devoting significant resources to is biCMOS technology. Chips that integrate bipolar and CMOS at a high speed have always been a European specialty, but the EC is putting another $80 million into the effort every year.

"Europe doesn't blow its own trumpet for this," says Dataquest senior analyst Jim Eastlake. "Yet it controls a large market for consumer and telecommunications applications for these chips, which incorporate analog and digital functions on the same circuit."

The success of Europe's marriage of government support and company collaboration is undeniable, but will the marriage last?

"The EC may not continue to support our research programs," says Eric Risness, research director at London based ICL Computers. "But the lessons learned by this collaborative effort should keep Europe in the forefront for years to come." E

BOSCH OFFERS TRANSISTOR-DRIVEN MOTOR

TIME FOR A TUNE-UP

BY JOHN GOSCH

IT WOULD SEEM THAT THE good old electric motor, which has been around for decades, could hardly be improved upon. But engineers at the West German automotive accessories maker Robert Bosch GmbH are demonstrating that the ubiquitous direct-current motor still has miles to go before it's perfected.

Aiming to simplify a d-c motor's control for use in cars and increase its operating life in trucks, the Stuttgart company has come up with a piece of high technology. One interesting part is that, although the motor is more complex than conventional d-c ones, it is more economical.

COMPARED WITH MECHANICAL COMMUTATION, THE ELECTRONIC ALTERNATIVE IS QUIET—SO QUIET THAT SOME CALL THE EC MOTOR 'THE WHISPER MOTOR'

The new motor does away with brushes and commutators. Replacing them are transistors which, taking over the commutation process, switch the current to the motor coils. This operation has given the motor its name: the electronically commutated, or EC, motor. Bosch has built a number of prototypes and is now preparing volume production.

Compared with mechanical commutation, the electronic alternative has several advantages. For one thing, the EC motor runs so quietly that experts have dubbed it "the whisper motor." The irritating brush noise, which is perceived as a high-pitched whine, is gone. So is the noise emanating from the motor structure. Besides its low noise, the new motor has other remarkable characteristics. High-frequency signal interference is minimized, and so is mechanical wear. Aggressive environmental conditions such as dust, salty air, and dampness are of no consequence. An air-gap winding eliminates all magnetic torque fluctuations, or detent torque.

There is nothing new about electron-

ic commutation. In fact, the principles behind the technique date back more than 20 years. But up to now production of the motors has been limited to sample quantities, and until the latest version that is emerging from the Bosch labs no EC motor has ever been built in great numbers. The reason is the age-old one of economy: the high cost of the electronic parts involved.

Hoping that costs would come down with volume production, the automotive accessories industry was waiting for household-equipment producers to make a start, while the household-equipment people were waiting for the auto-parts makers to go ahead and take the first step. Now the stand-off is broken as Bosch is doing just that. Volume production of EC motors at Stuttgart will begin this year.

The long-term market for EC motors is enormous. Worldwide, the demand for small d-c motors for use in automobiles is a staggering 400 million a year. Bosch alone produces some 180,000 of them a day at its plants around the globe. Within three years, about 5% of all d-c motors built for automotive use may be EC types, Bosch says.

The new motor easily implements a number of additional motor functions. One is reverse mode: that is, fast changes in direction for, say, servo motors. Another is soft-start, which involves starting the motor with reduced starting torque.

Rotational speed can be constantly regulated independent of torque. Off-state forward currents can be limited so that noncritical current values maintain a detent torque on the shaft. This can be crucial in restarting, for instance, frozen fan impellers.

BOSCH PLANS TO OFFER its EC motors primarily for heating and air-conditioning systems in vehicles. For example, a 200-W external-rotor version with a high moment of inertia and supporting quiet operation is suitable for, say, air blowers.

The smallest EC-motor version can be used in the same application as a sensor-activated blower with an output of less than 0.1 W. Its function is to supply air from the interior of the vehicle to the temperature sensor in the air-conditioning control unit. Another miniaturized nonstop motor is intended for seat backrest fans, which enhance a passenger's comfort. Like almost all of Bosch's EC motors, it is steplessly controllable and free of detent torque, a feature that further improves comfort.

A throttle-positioning EC motor drive also operates without detent torque. Its special feature is that it eliminates the need for a positioning potentiometer, since EC motors all have an integrated position detector.

Bosch experts have also proposed an EC water pump to supply hot water to the interior heating system. Here again, the advantages of the EC principle can be exploited. There is no need to transfer electrical energy to the rotor. Energy can therefore flow back to the conveyed fluid. The winding and the electronic parts remain dry, so the pump needs no mechanical seals. The result is longer life and higher efficiency. Moreover, the pump runs quietly and the fluid dampens rotor noise even more.

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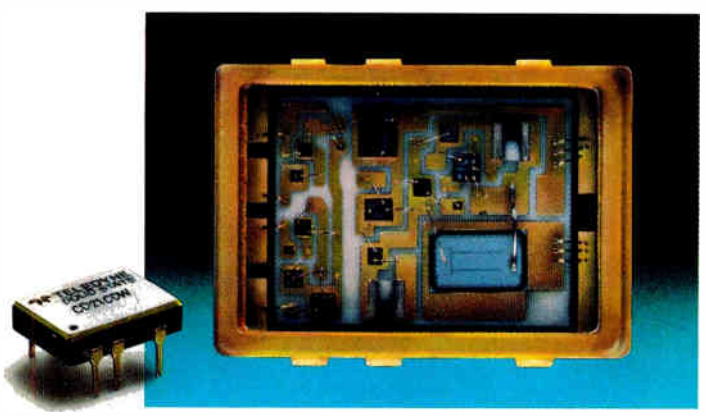


ACTUAL SIZE CERAMIC PACKAGE

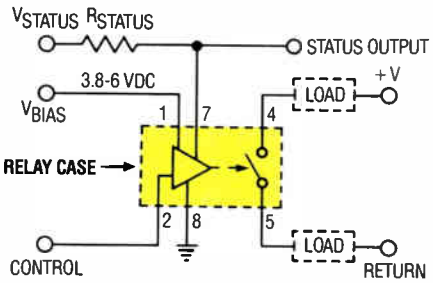
PART # CD21CDW

Review the electrical characteristics and call us for immediate application assistance.*

ELECTRICAL CHARACTERISTICS (–55°C to +105°C unless otherwise noted)				
	Min	Max	Units	
Bias Voltage (V_{BIAS})	3.8	6.0	V_{DC}	See Note 1
Bias Current (I_{BIAS})		15.0	mA	V_{BIAS} = 5 V_{DC}
Control Voltage (V_{IN})	0	18.0	V_{DC}	
Control Current (I_{IN})		250	µA	V_{IN} = 5 V_{DC}
Turn-Off Voltage $V_{IN\ (OFF)}$	3.2		V_{DC}	
Turn-On Voltage $V_{IN\ (ON)}$		0.3	V_{DC}	
Continuous Load Current		1.2	A	–55°C to +25°C
I_{LOAD} @ 60 VDC		0.7	A	–85°C
Output Trip Current (I_{TRIP})	2.4 (Typ.)		A	+25°C, 100ms
On-Resistance (R_{ON})		0.65	Ohms	
Turn-On Time (T_{ON})		1.5	ms	
Turn-Off Time (T_{OFF})		0.25	ms	
Status Voltage (V_{STATUS})	1	18	V_{DC}	
Status Current (I_{STATUS})		2	mA	$V_{SAT} \leq 0.3\ V_{DC}$ See Note 2

Notes:
1. Series resistor is required for bias voltages above 6V_{DC}. RS = (V_{BIAS} – 6 V_{DC})/15 mA
2. A pull up resistor is required for the status output. R_{STATUS} = (V_{STATUS} – 0.3)/I_{STATUS}
3. Output will drive loads connected to either terminal (sink or source).
4. Status circuit is a built-in test feature checking the input circuitry of the relay. Status output is low (on) when the input is on.

All power FET relays may drive loads connected to either positive or negative referenced power supply lines (source or sink modes).



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PBX SCHEME USES ANALOG MULTIPLEXING
AN ANALOG SOLUTION

BY PETER FLETCHER

SOMETIMES IT PAYS TO revisit old and long-abandoned techniques with new technology. That's what a British startup, Expander Systems Ltd. of Basingstoke, Hampshire, found when it wanted to make a low-cost, high-quality small private branch exchange.

The goal was a PBX that was nonblocking and easily expandable. Engineering director and company cofounder Greg Neal found that accepted wisdom in the PBX business offered only two options: crosspoint switching or digital time-division multiplexing (TDM). But the problem with conventional crosspoint matrices is that they follow a square law—that is, to double the number of ports means quadrupling the size of the switch matrix if the chances of a user finding the system completely occupied are to be reduced to zero.

And though digital TDM can do the job, it needs relatively expensive digital signal processing and analog-to-digital conversion stages.

So Neal's answer was to have another look at the analog time-division systems used by major central office switch manufacturers such as AT&T Co. 25 years ago. The result is the EX8-64 PBX, which provides 64 full duplex ports in its present form, but which can be doubled in capacity simply by adding a new set of printed-circuit boards. Neal also says that by using modern analog integrated-circuit technology, the system can provide better voice quality than equivalent digital switches, yet retain all their features at a much lower cost to the end user.

Neal uses a 12.5-KHz sampling rate providing a 1.25-μs time frame that is divided into 64 segments, one for each port. During each segment, the analog level of one pair of ports is sampled and transmitted through the system. "We have chosen relatively conservative timings that allow expansion to 128 ports without difficulty or impairment of quality," he says.

By comparison, in a digital TDM system, the analog levels sensed during a time slot are converted from digital and each is assigned a discrete binary code. The binary bit stream is then switched and must be reconverted to its analog form.

Neal also claims better speech quality for Expander's analog TDM PBX compared with a digital system. That's largely the result of the higher sampling speed—12.5 KHz compared with the 8 KHz used in most digital switches. Nyquist theory says that the upper frequency of the sampled signal should be no more than half the sampling rate. That means that for an 8-KHz digital system, maximum audio frequency is limited to less than the 4-KHz band-

width specified for telephone cables. And that is a limit set in the days of carbon granule microphones and cotton-covered copper wire, Neal says. Modern telephone microphones and wiring are capable of much better performance that can be exploited by Expander System's theoretical analog signal limit of over 6 KHz. At the same time, the audio quality provided by a digital system is limited by the number of discrete codes that it can assign.

Apart from overcoming a specific technical problem, Expander has also found that picking up and modernizing what some consider obsolescent techniques can prove beneficial in a marketing sense, too. Although just eight months old, the company has already picked up its first export contracts for the system, and has started shipping "several hundred" units to Poland.

"Because it does not use digital techniques, the EX8-64 falls well within the boundaries set by Cocom for exports to Eastern Bloc nations," Neal says.

The system did need some adjustment to meet Polish approval requirements, though. "It can sometimes take up to 30 seconds to get a dial tone from the Polish public network," Neal explains. And then, while dialing a call, there must be pauses for further dial tones as the call is routed through different public exchanges.

So he had to provide additional circuitry in the EX8-64 that will pause and listen for tones at the appropriate time before transmitting dial pulses. "The Polish network also differs from most Western systems in using 600-Ω balanced lines," he adds.

Ironically, it is in the UK that approvals testing has proven problematic. "The British Approvals Board for Telecommunications was not certain whether to specify analog or digital system test procedures," Neal comments, "since ours is obviously an analog system, but time-division systems are normally digital."

Finally, it was decided to treat the switch as a digital system for testing purposes. Now the system is almost through approvals testing and has progressed to what Neal calls "red-tape time." E

THANKS TO MODERN ANALOG CIRCUIT TECHNOLOGY, THE NEW EX8-64 PBX OFFERS BETTER VOICE QUALITY THAN EQUIVALENT DIGITAL SWITCHES AT A MUCH LOWER COST TO END USERS

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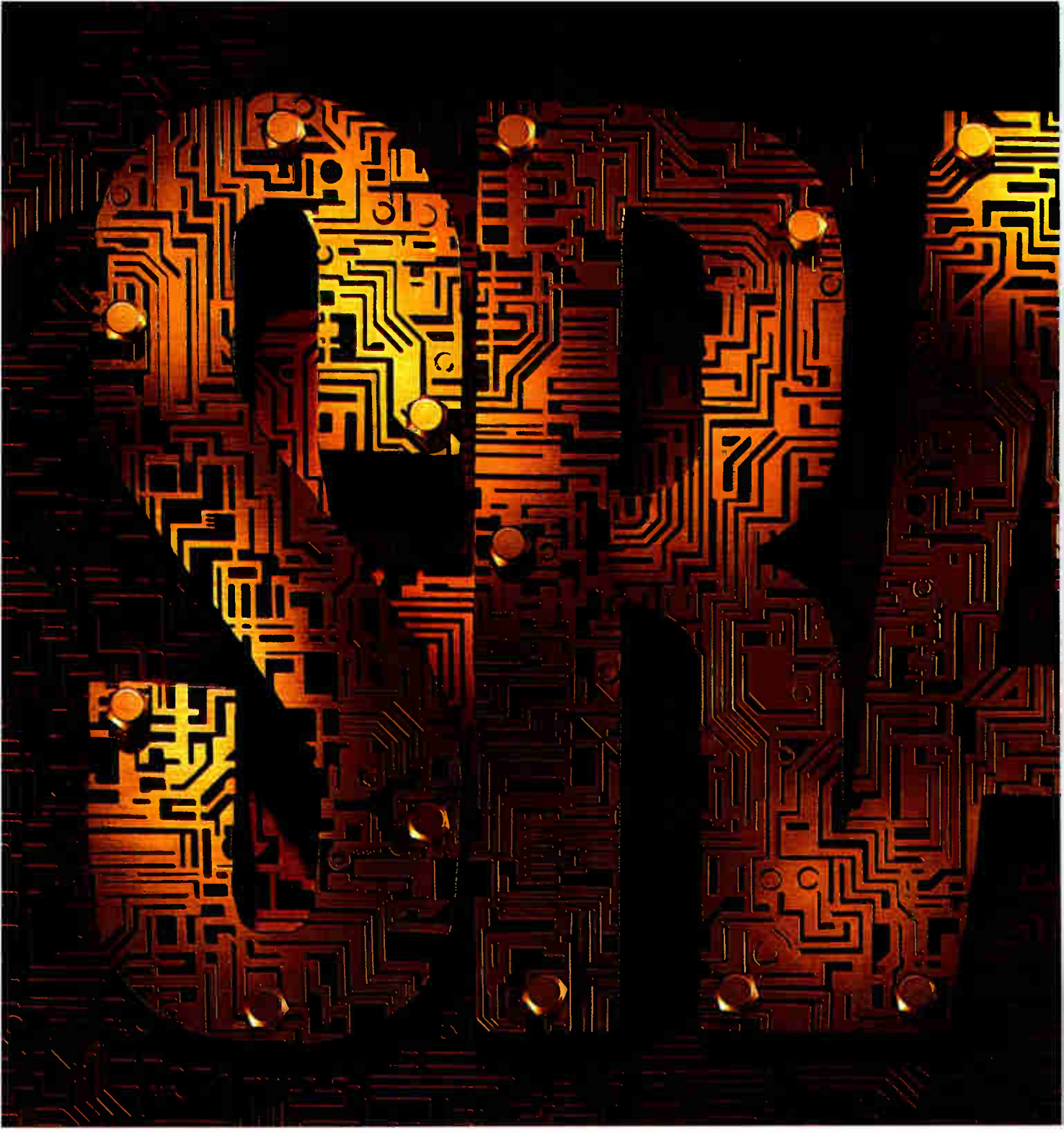

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	VT20C19	SRAM ($\overline{CS}$), Fast Chip-Select	2K x 8	12 ns
	VT20C68	SRAM ($\overline{CE}$), Auto Power-Down	4K x 4	15 ns
	VT20C69	SRAM ($\overline{CS}$), Fast Chip-Select	4K x 4	12 ns
	VT20C72	Separate I/O SRAM (High-Z Output)	4K x 4	15 ns
	VT20C78	SRAM ($\overline{CE}$), Auto Power-Down, with $\overline{OE}$	4K x 4	15 ns
	VT20C79	SRAM ($\overline{CS}$), Fast Chip-Select, with $\overline{OE}$	4K x 4	12 ns
64K SRAM	VT20C98	SRAM ($\overline{CE}$), Auto Power-Down	8K x 8	15 ns**
	VT20C99	SRAM ($\overline{CS}$), Fast Chip-Select	8K x 8	20 ns**
	VT6285H(L)	SRAM, Separate I/O, (O/P Track I/P)	16K x 4	15 ns**
	VT6286H(L)	SRAM, Separate I/O, (High - Z Output)	16K x 4	15 ns**
	VT6287H(L)	SRAM, Separate I/O	64K x 4	15 ns**
	*** VT6288	SRAM ($\overline{CE}$), 3-state I/O	16K x 4	25 ns
	VT6288H(L)	SRAM ($\overline{CE}$), Auto Power-Down, (low power)	16K x 4	15 ns**
	VT6289H(L)	SRAM ($\overline{CE}$), Auto Power-Down with $\overline{OE}$, (low power)	16K x 4	15 ns**
	VT6290H	SRAM ($\overline{CS}$), Fast Chip-Select	16K x 4	15 ns**
	VT6291H	SRAM ($\overline{CS}$), Fast Chip-Select with $\overline{OE}$	16K x 4	15 ns**
256K SRAM	*** VT6208(L)	SRAM ($\overline{CE}$), Auto Power-Down, (low power)	64K x 4	35 ns
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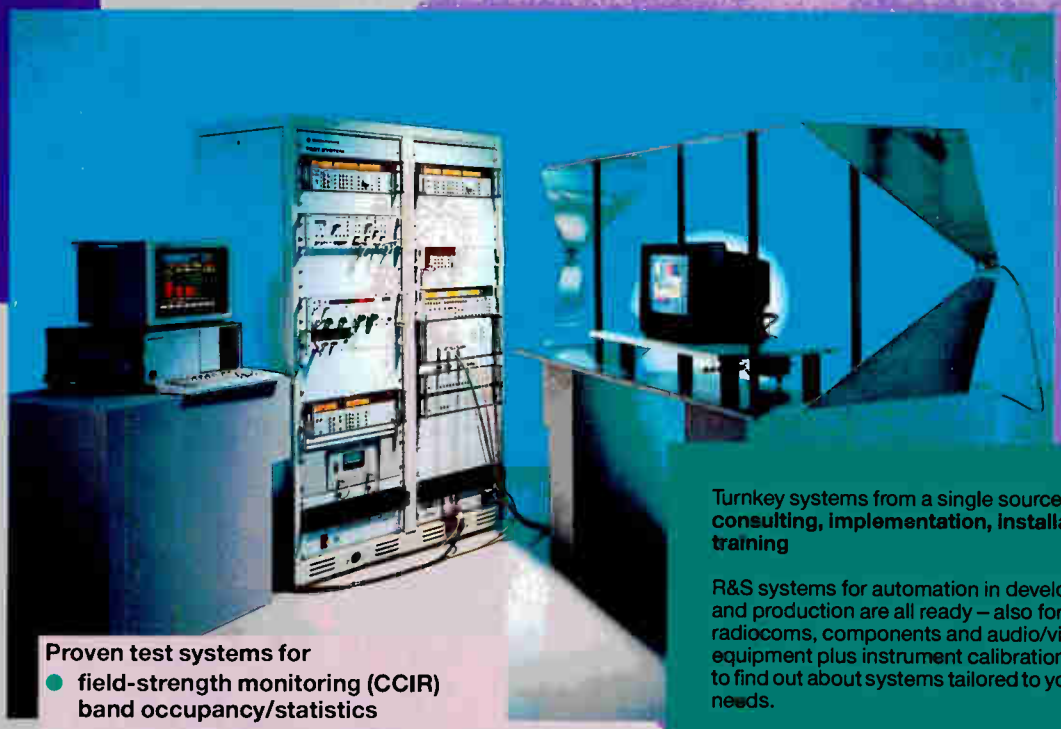

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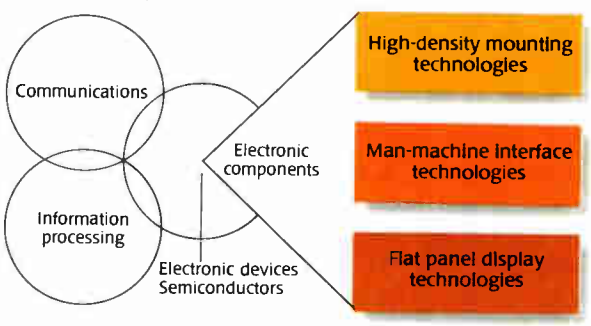

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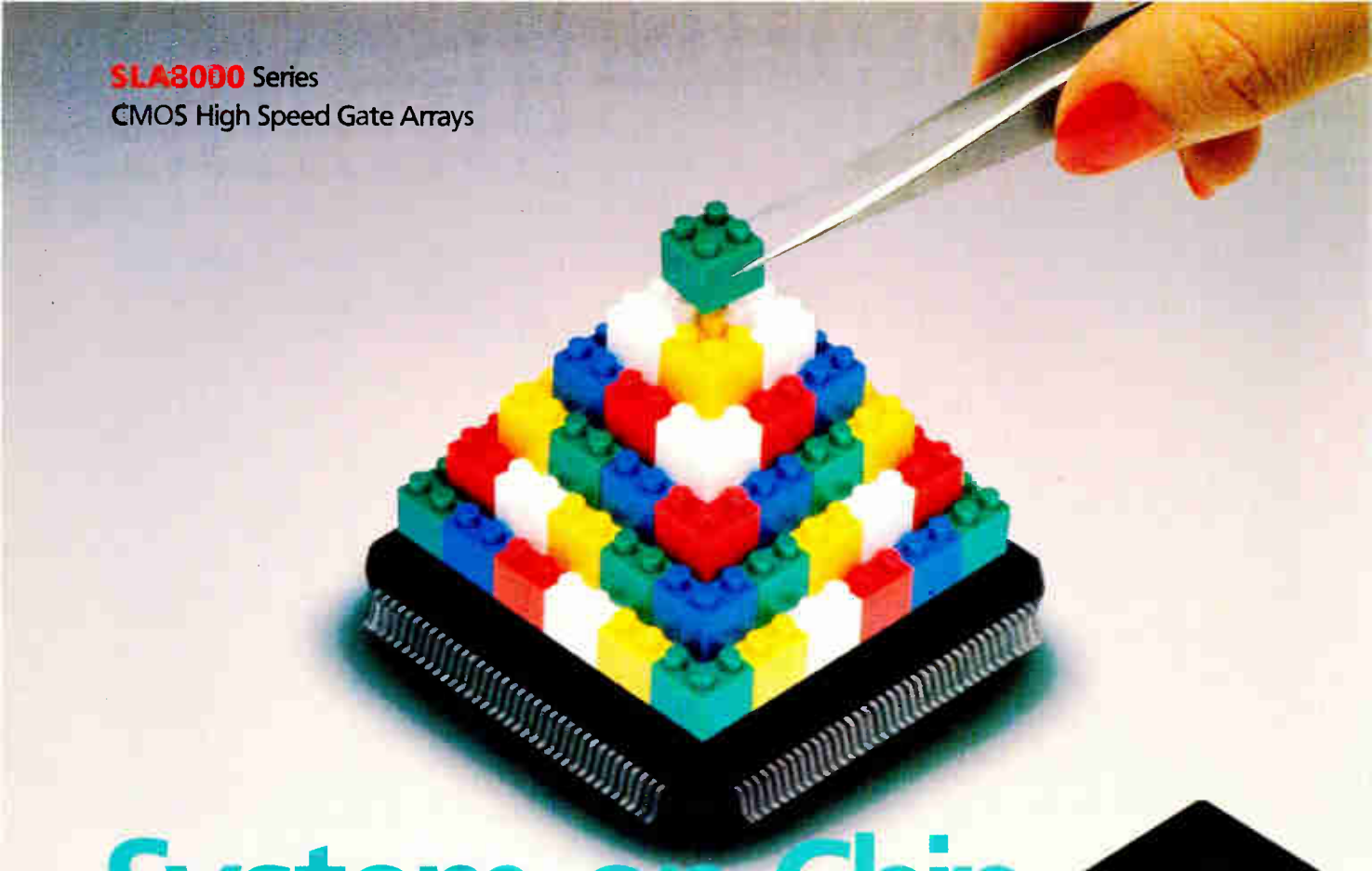

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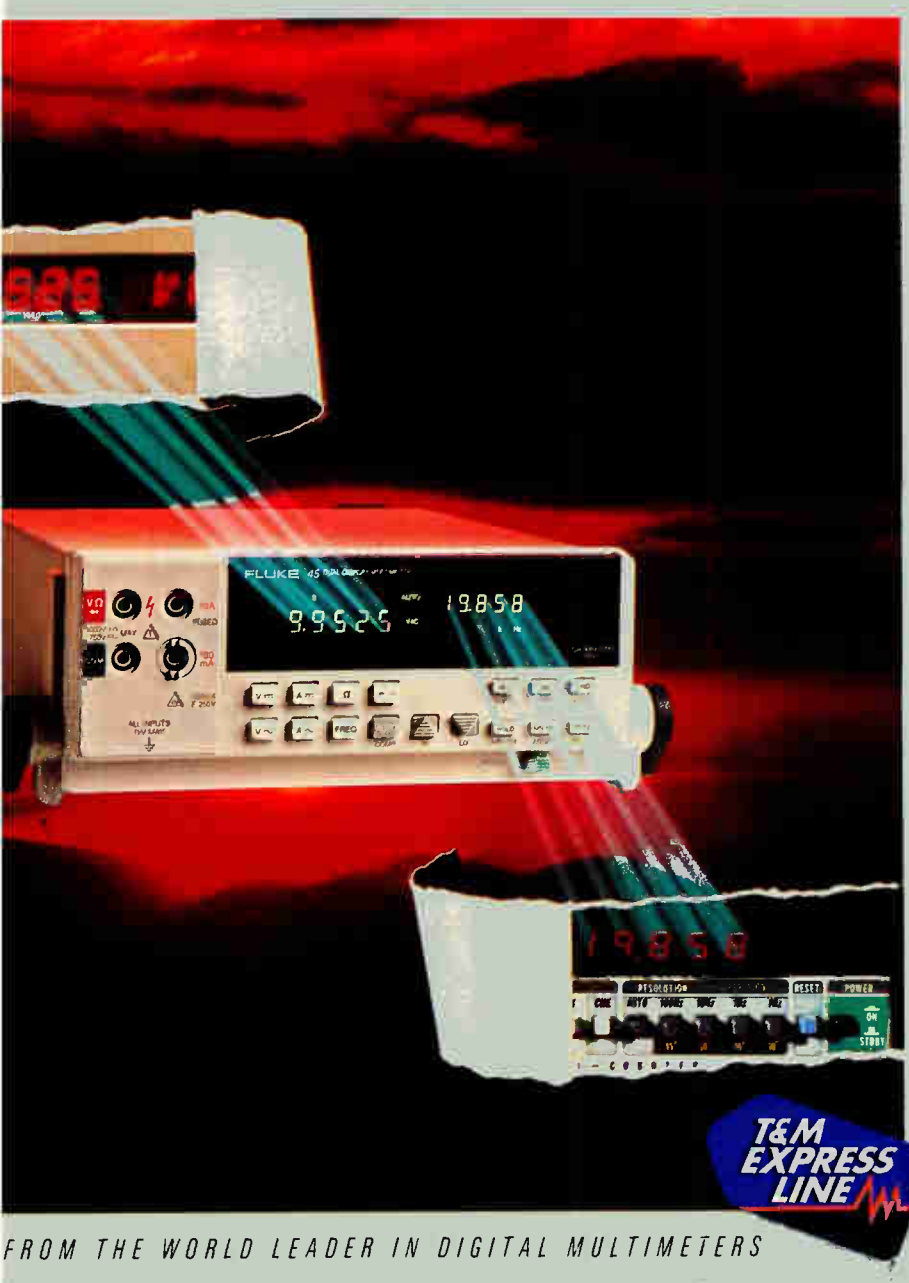

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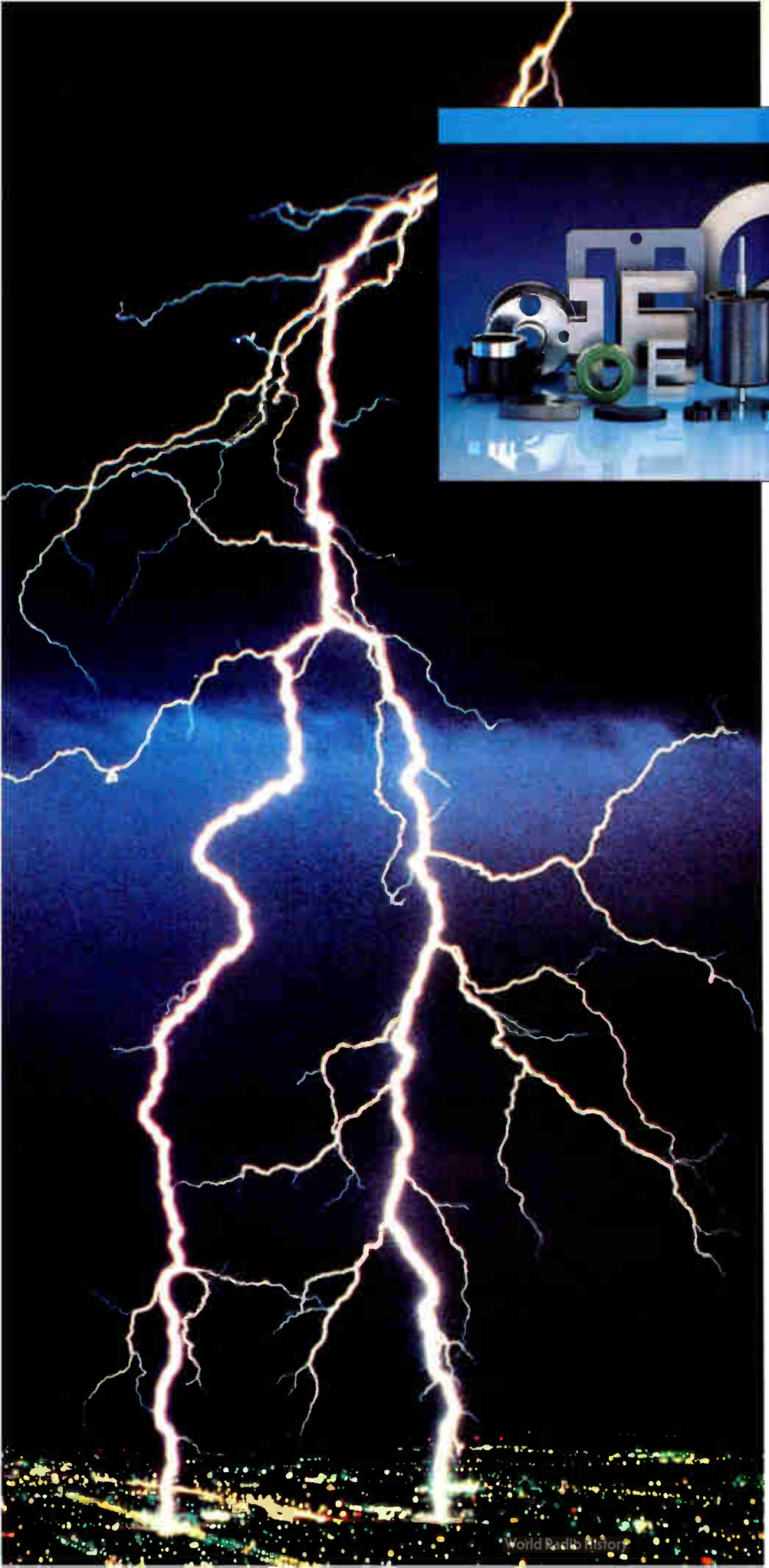

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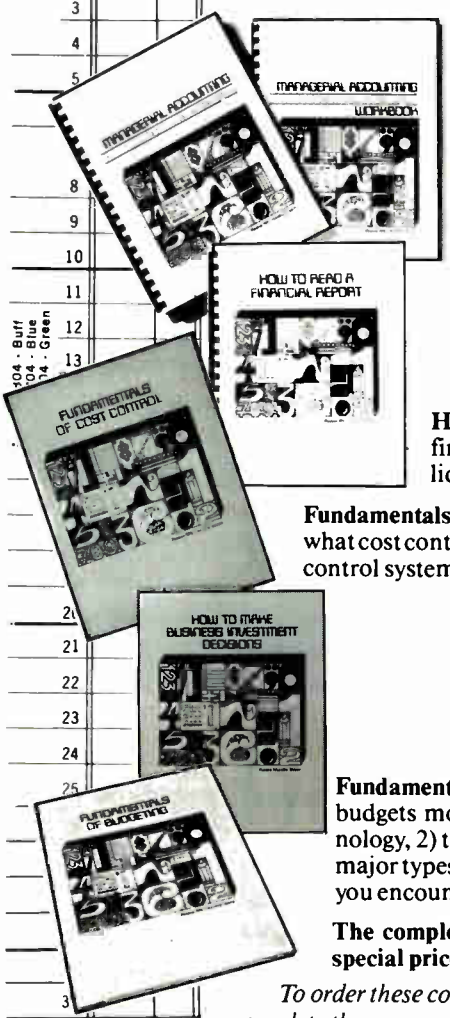

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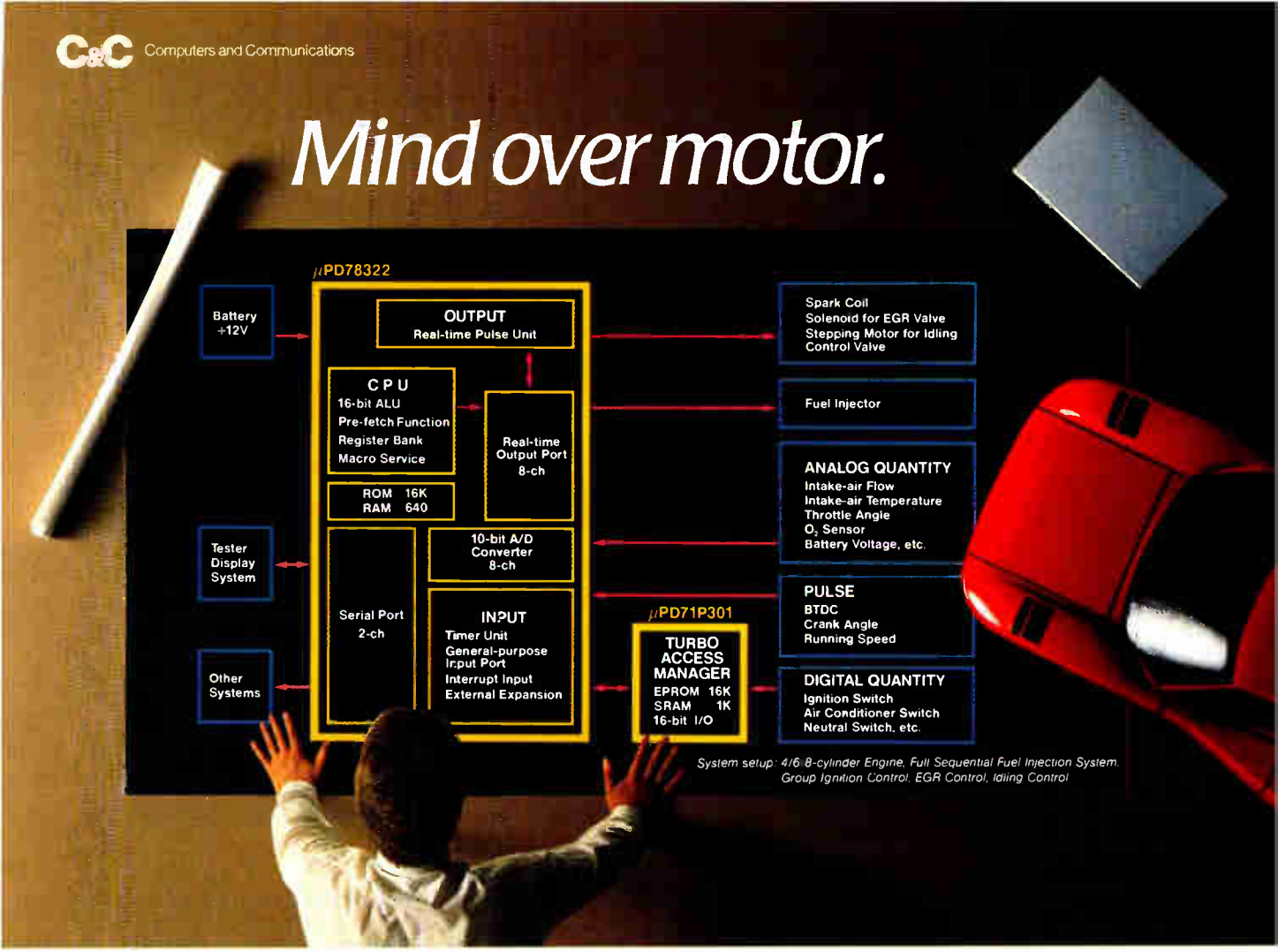

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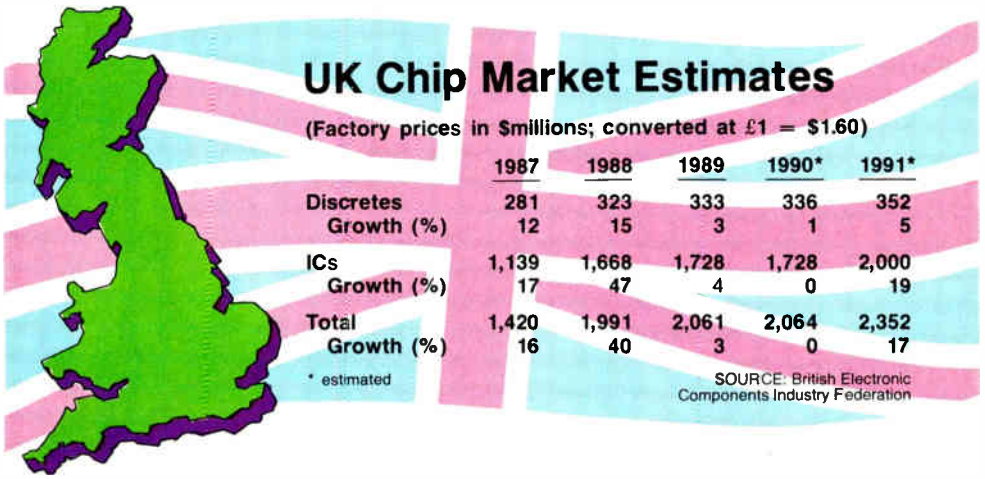
UK TRADE GROUP BULLISH ON CHIPS

For the British semiconductor industry, 1990 is not going to be so bad after all. A strong first quarter has taken industry analysts by surprise; they are now calling for a 1990 upturn of 5% to a total of $2.25 billion.

Those figures are from the British Electronic Components Industry Federation. Malcolm House, the trade association's chief economist and statistician, predicts total semiconductor sales in the UK in 1991 will grow 17% per cent to hit $2.5 billion.

"That compares with our earlier predictions of zero growth in 1990," House comments, with sales in 1989 and 1990 of some $2.16 billion. But he adds that this slowdown should be seen in the context of extraordinary growth of 40% in 1988.

"Expressed in dollars, growth was even higher, at 52%," House says. "A major part of this increase in 1988 can be attributed to the growth of the computer sector," he adds.



UK Chip Market Estimates

(Factory prices in $millions; converted at £1 = $1.60)

	1987	1988	1989	1990*	1991*
Discretes	281	323	333	336	352
Growth (%)	12	15	3	1	5
ICs	1,139	1,668	1,728	1,728	2,000
Growth (%)	17	47	4	0	19
Total	1,420	1,991	2,061	2,064	2,352
Growth (%)	16	40	3	0	17

* estimated

SOURCE: British Electronic Components Industry Federation

JESSI-SEMATECH DEAL SHOULD BENEFIT BOTH PARTNERS

It's official: a U. S. consortium is joining hands with a European consortium on semiconductor manufacturing projects. Few observers were surprised at the agreement forged between Sematech, based in Austin, Texas, and Jessi, the Joint European Submicron Silicon Initiative. The way had been paved in January when Jessi opened its doors to Sematech member IBM Corp., which then struck a pact with West Germany's Siemens AG to develop 64-Mbit dynamic random-access memory chips, one of Jessi's goals [*Electronics*, March 1990, p. 45].

For the two partners, the transatlantic link could spell faster progress in semiconductor manufacturing technology, the field on which Sematech is concentrating. It also means that work in Europe and the U. S. won't be duplicated—which should give the two organizations a better chance to succeed. In the final analysis, cooperation amounts to nothing less than a united front against the Japanese in chip-making technology, a sector in which they are world leaders, just as they are in DRAM chips.

According to a Jessi official, the two partners agreed to initially pursue two programs: standardization—for example, agreeing on common units of measurement, such as inches or centimeters—and competitive analysis, which entails determining what's available now in manufacturing equipment and which route the technology should follow in the years ahead.

Also, Sematech will draw up an "Equipment Improvement Program" paper that will serve as the basis for possible cooperation in developing semiconductor manufacturing systems and materials.

Finally, the two organizations will jointly explore computer-integrated manufacturing. At a meeting in Austin this summer, agreements on further endeavors may be reached.

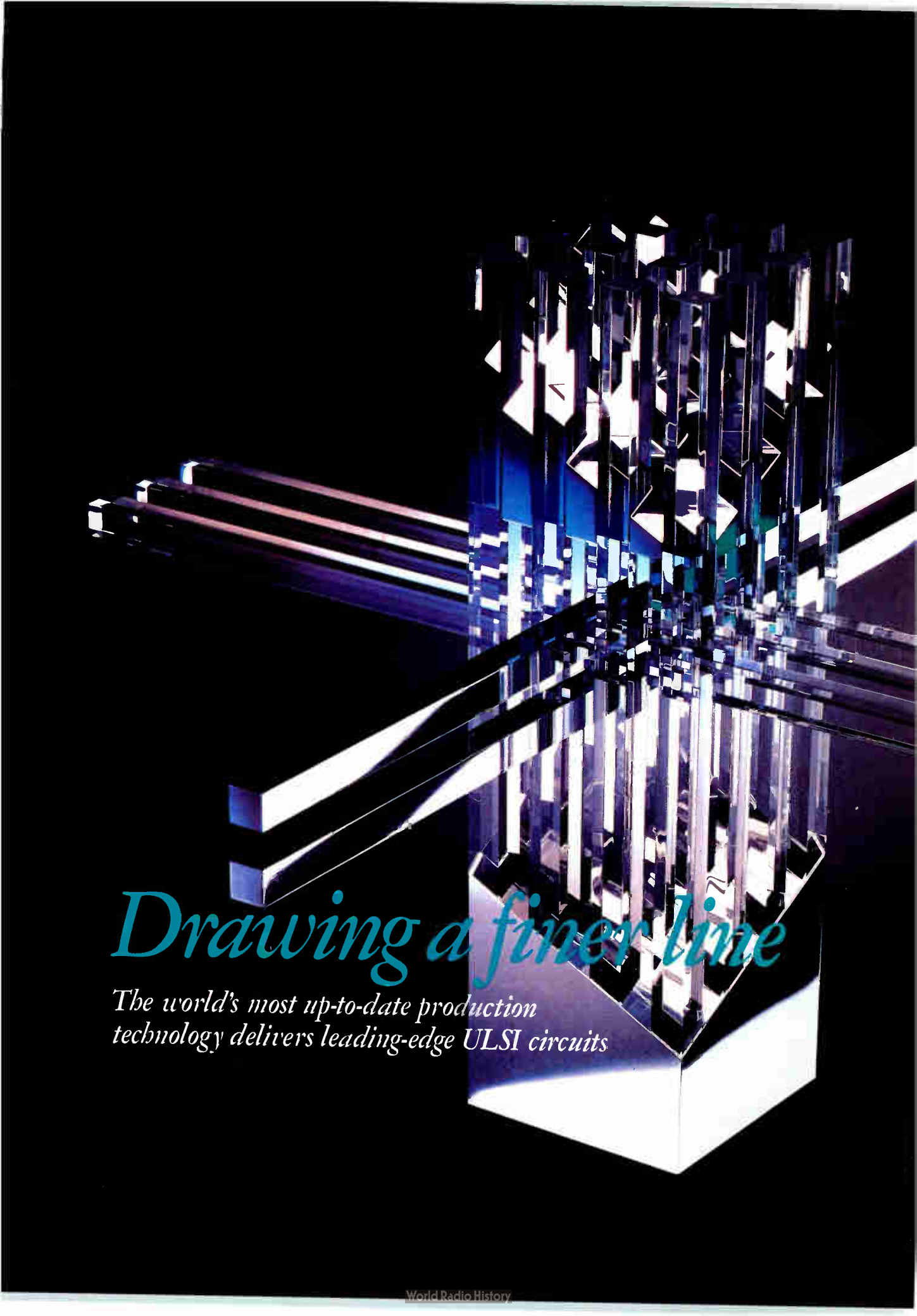
PHILIPS DEVELOPS TINY ALTERNATIVE TO BULKY HELIUM-NEON LASER

Smaller, more efficient, and more reliable lasers that produce the same red color as the familiar helium-neon versions are on the way. That's the result of work done by researchers at the Philips Laboratories in Eindhoven, the Netherlands. They have built what the company believes is the first semiconductor laser that emits light at the same 633-nm wavelength as HeNe.

Its laser length of only 0.3 mm compares with 300 mm for the HeNe type. The overall efficiency checks in at 1.5% and the differential efficiency (above threshold) at 30%, which means that a simple battery can power the laser. It can be produced in large quantities with standard semiconductor technologies, Philips says.

Until now, the 633-nm wavelength could not be achieved in semiconductor-type lasers for practical use because it resulted in excessive losses in the material. Philips has cut these losses so much that it has made 633-nm versions suitable for most applications. The firm, based in Eindhoven, the Netherlands, will offer engineering samples this summer.

In the new laser, a number of very thin layers of a compound crystal of the elements gallium, indium, and phosphorus form the light-emitting region. These layers—just a few nm thick—are grown from the gaseous state on a GaAs base layer.



Drawing a finer line

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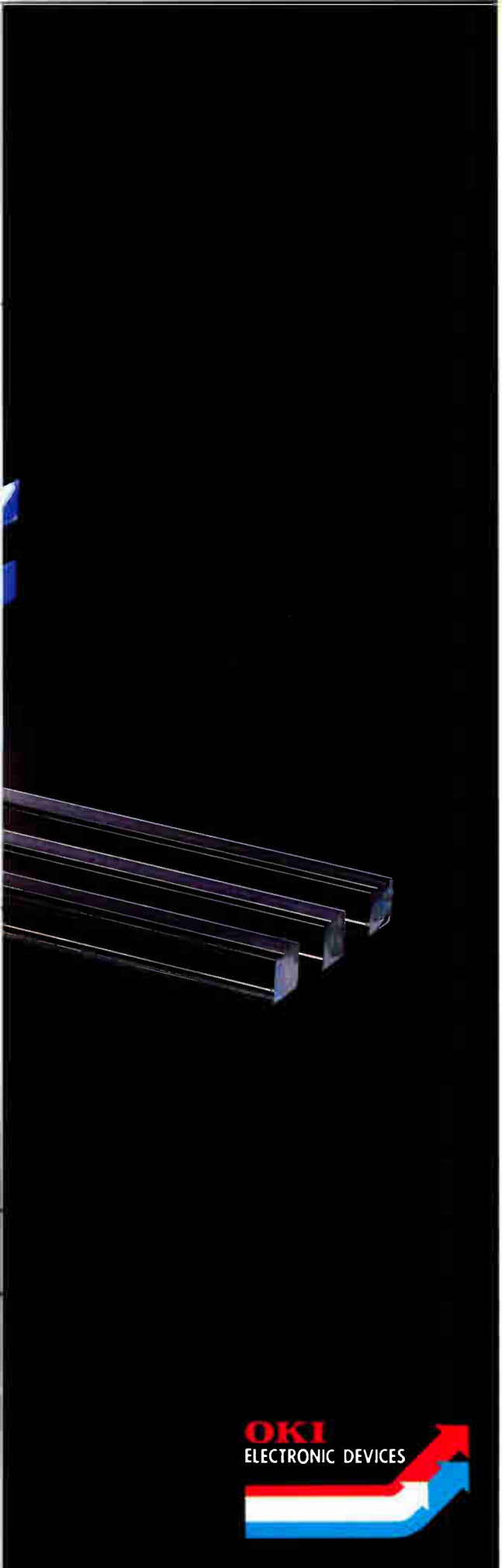

OKI SYSTEM TECHNOLOGIES.

Sub-micron production in full swing, bringing the new age of 4M DRAMs

Oki's Miyagi Plant, benefitting from the latest advances in the company's system technology, has already reached mass production and shipment of 1M-bit memories and has recently begun quantity production of 4M DRAMs. At the Miyagi Plant, broad utilization of ultra-fine process technology and state-of-the-art automation combine to assure the high quality of these products. Oki is already well underway with technological innovation enabling production of 16M-bit memories.

High-level automation with ultra-fine process production

Oki's 0.8μ process technology used in its second-generation 1M-and 4M-bit memories has been integrated into one of the world's most advanced production lines for reliable mass production of over 20,000 6-inch wafers per month.

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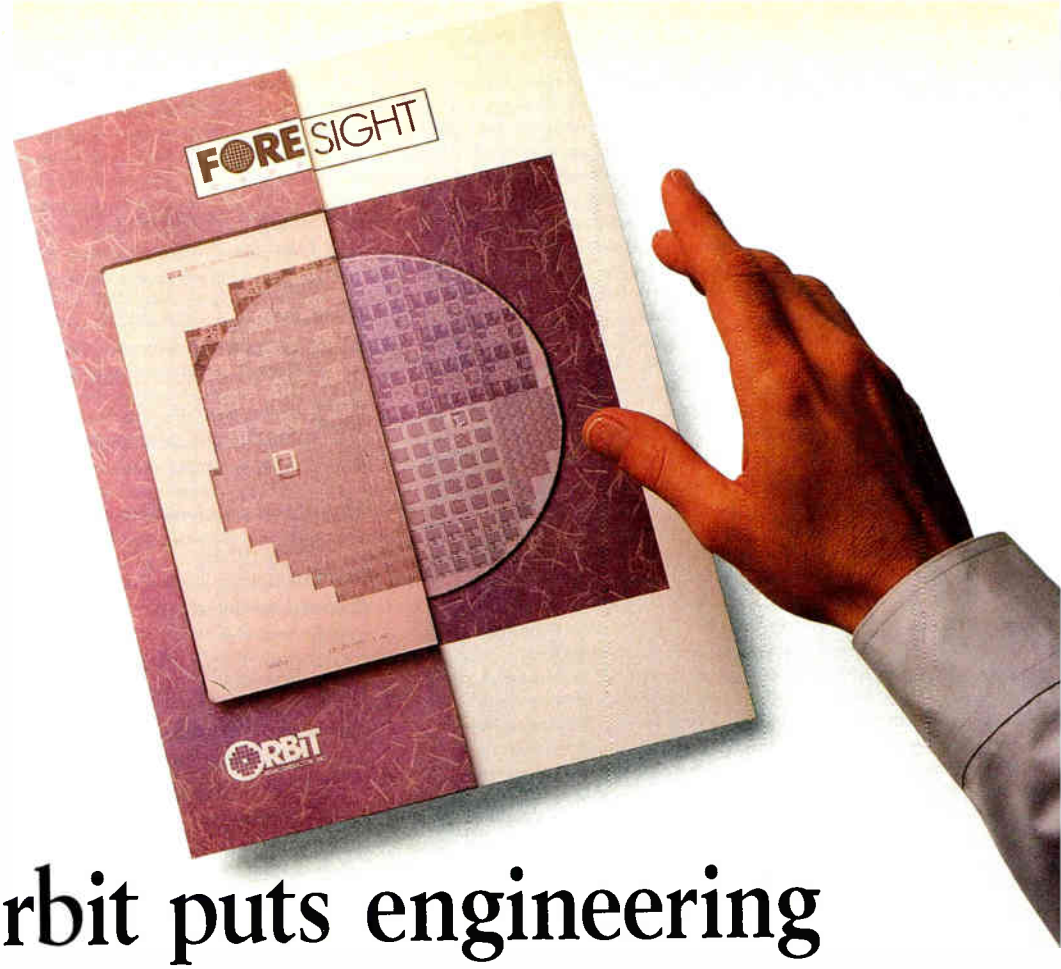

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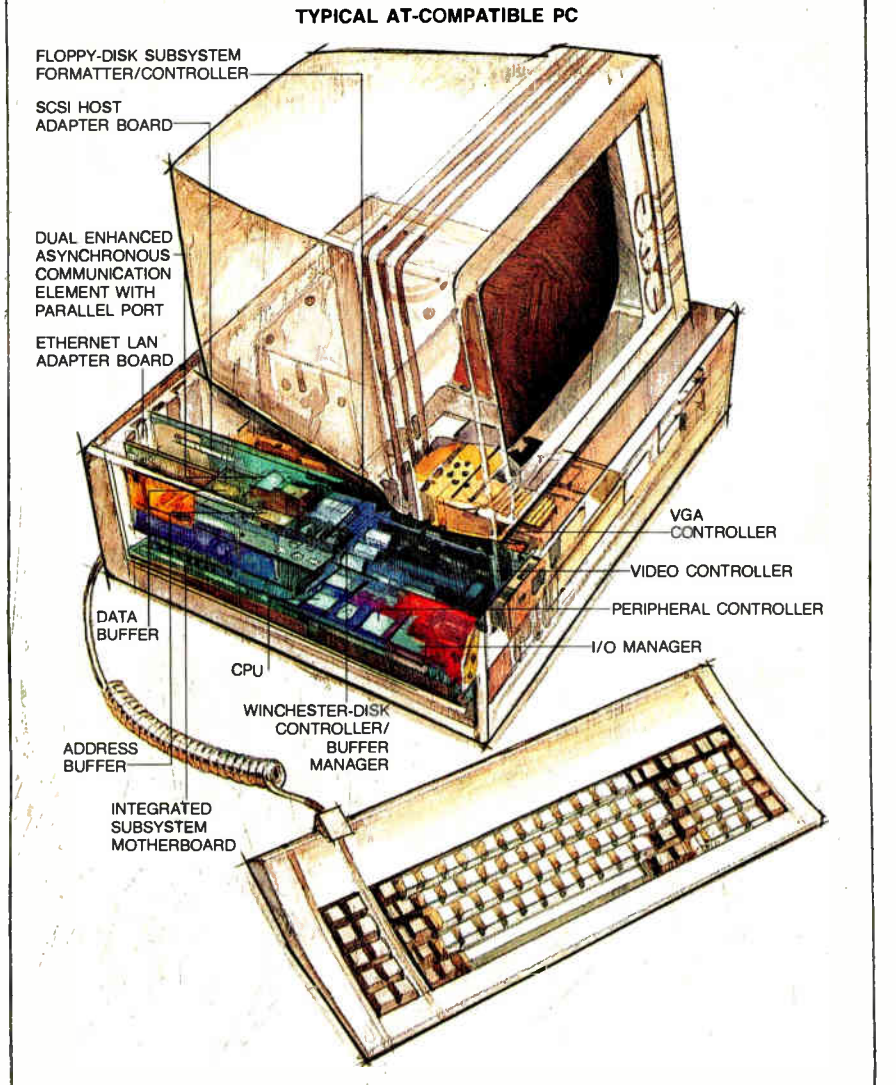
CIRCLE 225

HOW THE PC HAS RECAST THE CHIP BUSINESS

IC MAKERS PLOT THEIR STRATEGIES: FASTER TIME TO MARKET, MORE INTEGRATION, OR HIGH-VOLUME PRODUCTION

BY JONAH McLEOD



WHERE THE CHIPS ARE GOING

With the PC motherboard and add-in cards as the playing field, the game is now who can integrate the most functionality the quickest. The articles that follow explore this phenomenon in a variety of chip sectors.

IN A HIGHLY COMPETITIVE global semiconductor market, the personal computer has changed the way chip makers do business. Semiconductor companies have adopted three strategies to survive and prosper. The fabless semiconductor company lives by innovating new system products and getting them to market fast. Medium-size semiconductor companies, unfettered by the need to make behemoth $100 million investments in new production capacity, can wait for markets developed by fabless companies to become well defined and attack the market with more highly integrated, cost-effective solutions. Finally, larger, more capital-intensive semiconductor companies build high-volume commodity memories and microprocessors for PCs and workstations and make their money on volume of products sold.

BUSINESS

"In the past, semiconductor manufacturers added value in chip design and process technology," says Gordon Campbell, president and chief executive officer of Chips & Technologies Inc. in San Jose, Calif. "As system houses increasingly design their own chips, semiconductor manufacturers' value-added becomes process technology and manufacturing." Campbell sees fabless companies like his own as hybrids between the traditional semiconductor company and a pure system-design company.

By investing only in system design, fabless proponents can innovate new systems in silicon quickly to catch fast-moving market windows. "Time to market is as important as the ultimate cost structure," says Campbell. Wilfred

J. Corrigan, CEO at LSI Logic Corp. in Milpitas, Calif., acknowledges the agility of fabless system houses. His response was to establish one: Headland Technology Inc. in Fremont, Calif., a wholly owned subsidiary that is diving into the chip-set market (see p. 76). The advantage of this arrangement is that Headland is not burdened with the research and development costs of new process technology. It can invest in new chip designs instead.

The premise for the existence of fabless semiconductor companies is that the glut in worldwide semiconductor fabrication capacity will continue. "In general, above 90% is full capacity, and since the early 1970s only in 1973 and 1984 was the full capacity of the industry totally consumed," says G. Dan Hutcheson, president of VLSI Research Inc. in San Jose. But others are not so sure. "Specialty companies can survive as long as there is excess capacity in the market, but this is not going to last forever," says Al Stein, chairman and CEO at VLSI Technology Inc. in San Jose.

Moreover, specialty chip houses no longer have the element of surprise on their side. Everyone sees the playing field as the PC motherboard and its add-in cards. The game is now who can integrate the most functionality the quickest, says Bert Moyer, senior vice president and chief financial officer at Western Digital Corp. in Irvine, Calif. In this environment, time-to-market advantage begins to shift to companies that can use process technology and circuit design to come up with a more cost-effective solution.

"Since Intel owns the CPU, it can integrate more of the functionality provided by chip-set suppliers on the main processor," says Michael Slater, publisher and editor of the newsletter *Microprocessor Report* in Palo Alto, Calif. Indeed, Intel Corp. has stated it plans to produce a single-chip 386 PC by 1993. "This is the wave of the future," agrees a seemingly undisturbed Campbell. "But I believe system houses, including us, will have a single-chip low-end PC based on the 80286 well before Intel."

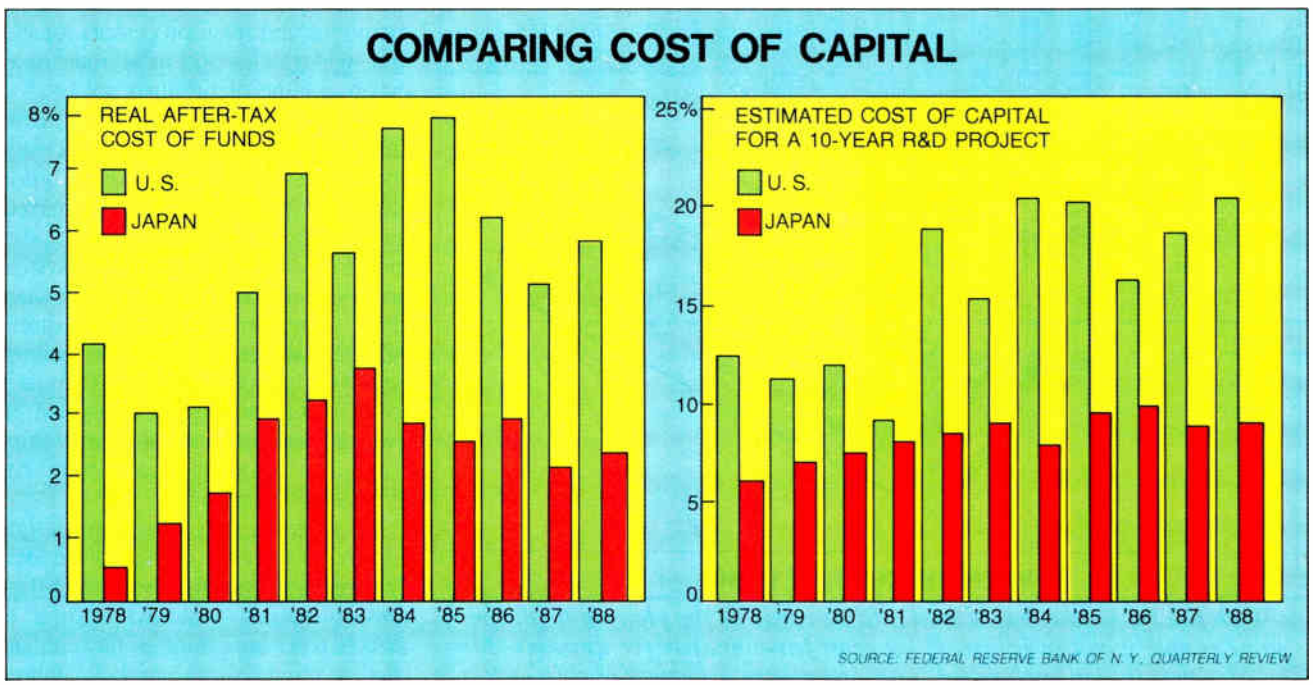
But companies such as Western Digital and Cypress Semiconductor Corp. of San Jose believe that the low-end market, which is integrating the entire PC on a single chip, belongs to smaller companies. Western Digital contends that companies best suited to take a known system design and integrate it onto a single chip are those with design expertise that can also make tradeoffs with process technology.

"Dollar per wafer is the key controlling element," says Barry Wiley, vice president of marketing and sales at Cherry Semiconductor Corp. in East Greenwich, R. I. "Specialty chip makers build more complex, proprietary chips that have no competition and receive higher gross margins that offset the inefficient chip size," he says. "Semiconductor houses build the smallest possible chip to get the largest number of dice off each wafer in building commodity products." Here, leading-edge process technology is the advantage.

Corrigan says that a specialty chip maker must have multiple sources of fab capacity to guard against one foundry going down and leaving the chip house without product. "They are forced into accepting the lowest common denominator in process technology, where excess capacity is plentiful," he says. Process technology with over 1.0-μm design rules is generally available. Only a handful of companies have state-of-the-art fabrication facilities with submicron processing capability.

WHERE THE SEMICONDUCTOR company has the advantage over the foundry-less chip supplier is its ability to better characterize the design tools for a given process line. The problem facing a semiconductor company coming out with a next-generation process is the inability to accurately simulate the behavior of circuits at the next smaller process geometries, says H. C. Arno Penzias, vice president of AT&T Bell Labs in Murray Hill, N. J.

"When bringing a new fab line up, we don't have sufficiently accurate three-dimensional models of the IC materials at the next smaller line widths to control a new manufacturing process with a high degree of certainty," he says. "In debugging the process, we tweak the models to more closely represent the behavior of devices at the smaller geometries. Without this interaction between the process facility and



model builders, outside chip vendors must wait until the process technology is sufficiently well understood that it is generally available in the marketplace from several foundries. This lag can be as much as a year or more."

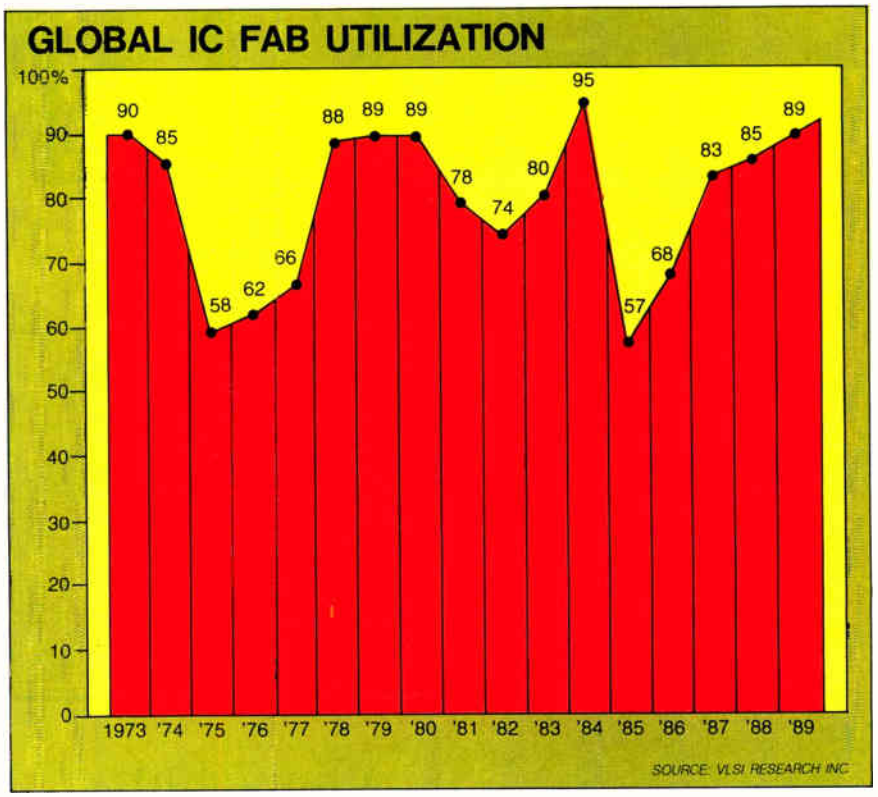
Cirrus Logic Inc. in Milpitas is a specialty chip company that built its product line using proprietary silicon compiler tools that enable fast design turnaround and very efficient silicon utilization. Though the company has no fab of its own, it interacts with its foundry's process to achieve higher yields.

Unlike other chip-set vendors, Cirrus does not buy finished chips, but rather supplies masks to its foundries and receives processed wafers. Cirrus then dices, tests, and packages the dice on the wafer. The company has developed test methods to monitor fab process quality and innovative testing techniques that enable it to squeeze higher yield from each wafer.

The strategy of smaller semiconductor companies is to be more agile than their larger competitors and exploit market niches too small to attract the giant foundries. However, large semiconductor companies produce dice at the lowest cost and highest yield. "As the volume of a product made by smaller fabs begins to rise—static RAMs is an example—it attracts big players," says analyst Hutcheson.

Though the investment climate in the U. S. argues heavily against it, to be competitive in the worldwide semiconductor market demands massive investments, says Michael Borrus, codirector of the Berkeley Roundtable on the International Economy, a University of California research project. This fact is driven home by companies in Japan and throughout Asia continuing to invest in new semiconductor fabrication facilities. Recently, machining companies such as NMB Technologies Inc., Chatsworth, Calif., and steel companies such as Kobe Steel Ltd. in Tokyo, among others, have made the several hundred million dollar investment it takes to be a world-class semiconductor supplier.

"The cost of building new fabrication facilities will nearly double with each next-generation process technology," says Shojiro Asai, deputy general manager of the Central Research Laboratory of Hitachi Ltd. in Tokyo. "We are estimating the cost of developing 4-Mbit DRAMs will be something on the order of $200 million." The chips are implemented in 0.8-μm design rules. "The cost will double to build a facility able to do 0.45-μm design rules."



Such fabs are being built to make high-volume commodity devices, and today that means DRAMs. DRAMs are the technology driver companies use to develop next-generation submicron process technology. But many U. S. companies, reluctant to enter the volatile DRAM business, are looking for other technology drivers.

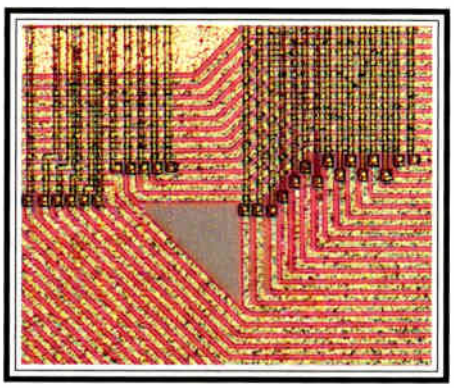
A BETTER ALTERNATIVE IN the view of Richard Pashley, general manager of Intel's Flash Memory Division in Folsom, Calif., is nonvolatile memory. Pashley concedes that DRAMs are a full generation ahead of nonvolatile memory in terms of lithography. But he does not believe U. S. companies need to build DRAMs to be on the forefront of semiconductor technology development. He thinks nonvolatile memory will catch up and surpass DRAMs as a more cost-effective storage technology.

Wally Rhines, executive vice president of the Semiconductor Group at Texas Instruments Inc. in Dallas, says U. S. companies approach capital investment differently than companies in the Far East. "The reason that U. S. producers have more advanced differentiated process technology is to squeeze out the last drop of performance for a given design," he observes. By contrast, Rhines says, Japanese producers generally strive to achieve the lowest possible cost in their production capital. The proof is in PCs and workstations. "Our customers want the most advanced processors available as soon as possible," he says, which is not true in Japan.

The differences in types of production facilities notwithstanding, the problem U. S. companies face is the high cost of capital. "A $100 million investment in Japan," says Rodgers, "costs $300 million in the U. S. because of differences in the investment climate." Borrus says one way around the problem is to tap the lucrative capital markets in Asia to fund next-generation investments, though he concedes there is some risk of losing technology. An additional advantage to building new state-of-the-art facilities overseas is to penetrate the complex Japanese market.

One good example of this is the deal between TI and Kobe Steel. The two will build a $382 million fabrication facility in Japan to make advanced logic chips for the Japanese market. Kobe will provide most of the funds and TI the technology. The interesting twist in this arrangement is that Kobe is a completely captive supplier to TI. It will sell TI the complete output of the facility; TI plans to resell the chips into the Japanese market beginning in 1992.

THIN LINES.



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CIRCLE 215

IT'S A BATTLE ROYAL FOR THE MOTHERBOARD

IN A FRAGMENTED MARKET, PC CHIP-SET VENDORS JOCKEY FOR A POSITION IN TOMORROW'S MACHINES

BY BERNARD C. COLE

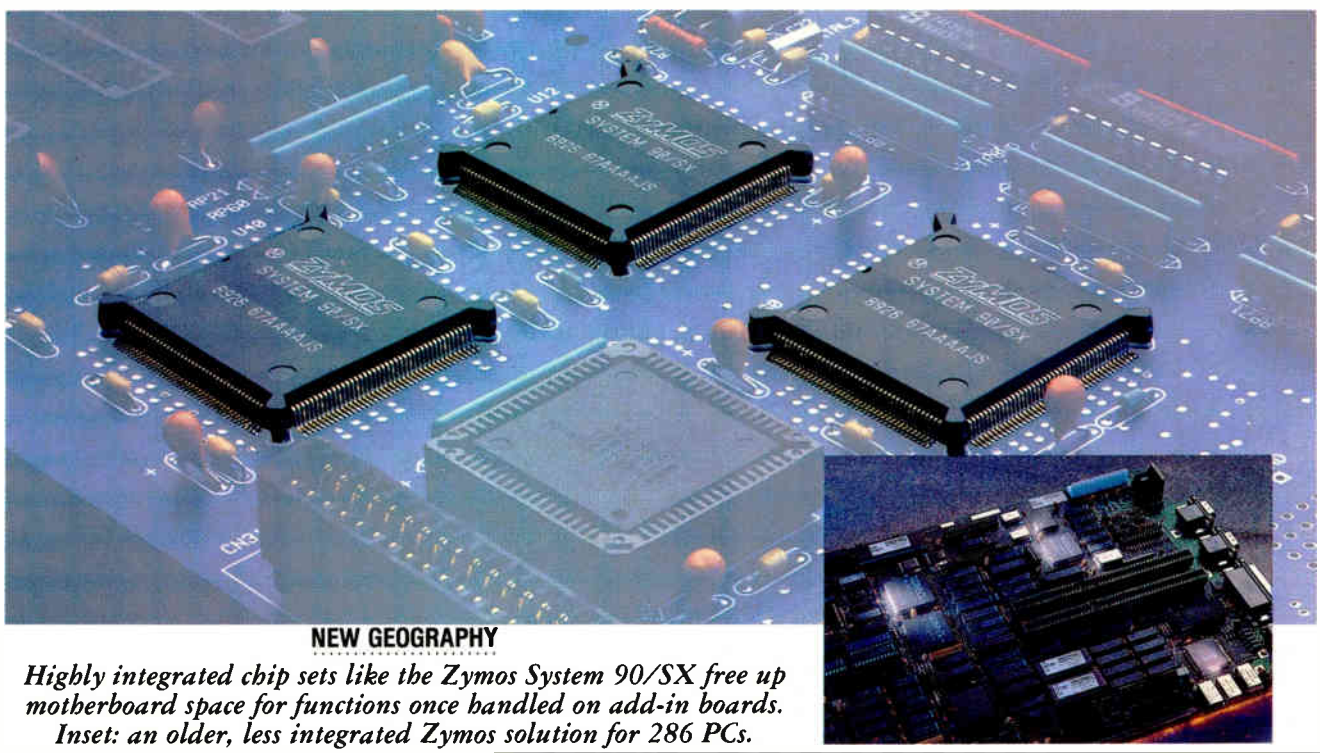
SEMICONDUCTORS

THE PERSONAL COMPUTER business is witnessing a bloody, no-holds-barred battle for the motherboard. At stake is who will survive and who will thrive in the computer and semiconductor industries of the 1990s, an arena that's seen vast changes over the past decade. If the first wave of chip-set makers servicing the IBM-compatible systems houses flourished in an atmosphere of architectural standardization, today's players look out on a fragmented landscape.

Where a single central processing unit once reigned supreme, today there are at least six. Where once everyone manufactured just a couple of types of PC, now there are multifarious machines, from high-end "personal workstations" to low-end laptops. Where MS-DOS was once the only show in town, now two operating systems must be taken into account—three, counting Unix. Even bus architectures are in question in high-end machines, as IBM Corp.'s MicroChannel contends with the Extended Industry Standard Architecture.

All the uncertainties are creating pockets of opportunity for agile vendors among the 20 or so systems-logic chip houses that supply PC chip sets. Some of them are narrowing their focus—say, on chip sets for laptops—and others are developing a broad sweep of products, trying to be all things to all PC vendors. Meanwhile, they're looking over their shoulders at the workstation gang, chip-set vendors that have been selling into workstations running reduced-instruction-set CPUs but are now setting their sights on PCs as performance rises to the low-end workstation range.

On the technical front, the vendors are, in effect, forcing a rethinking of the whole idea of the motherboard, says Mark Garetz of market leader Chips & Technologies ,Inc., which boasts about 60% of the PC chip-set market. Within the last six months or



NEW GEOGRAPHY

Highly integrated chip sets like the Zymos System 90/SX free up motherboard space for functions once handled on add-in boards. Inset: an older, less integrated Zymos solution for 286 PCs.

so, he says, single-chip logic solutions have come onstream, highly integrated devices that leave enough room on the motherboard for the migration of functions previously handled on add-in expansion boards. Some companies are calling this new breed of VLSI devices for PCs "superchips."

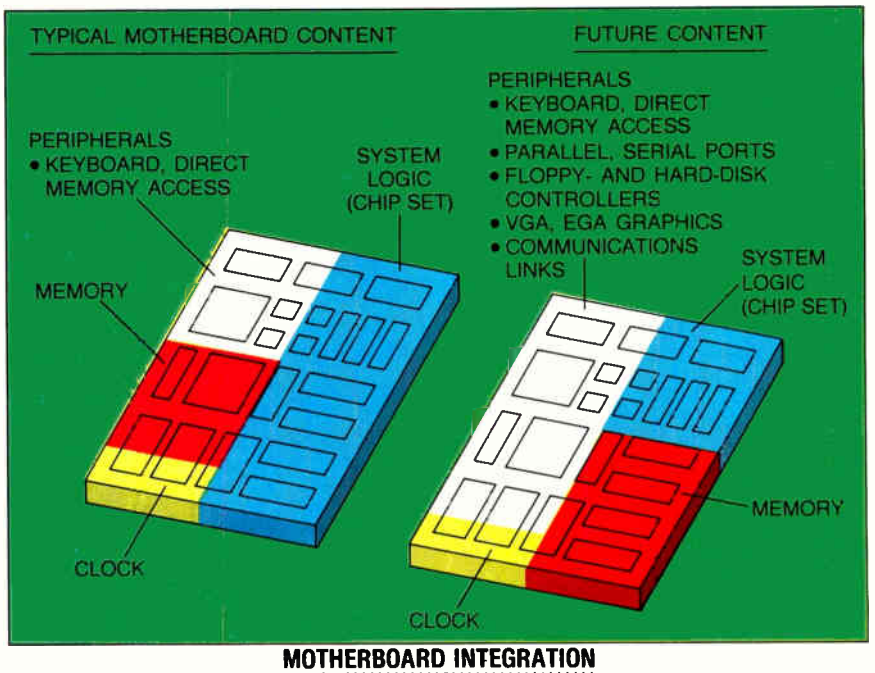
THERE'S A WILD CARD IN this already complex field: Intel Corp., whose microprocessors power the vast majority of PCs built worldwide. The Santa Clara, Calif., megacompany is attempting to force its ubiquitous, second-sourced 286 out of the marketplace and replace it with the sole-sourced 386 CPUs (see p. 78). In the process, it's throwing many a semiconductor maker's strategic plan into a cocked hat.

With so much activity, the PC motherboard is beginning to resemble a Go board in the classic Japanese strategy game, where players use a variety of maneuvers to encircle board territory—and/or their competitors' chips—in order to win.

The one point of agreement for most of the chip makers is that the 16-bit AT architecture will continue to dominate for at least the next few years. "The only question in many of our customers' minds is whether it will be the 16/32-bit 386SX or the full 16-bit 80286," says Brian Sullivan, vice president of marketing at Zymos Inc. in Sunnyvale, Calif. "The second uncertainty is when 286 sales will peak, as no doubt they will."

Various market studies reflect this uncertainty. According to Infocorp of Santa Clara, unit sales of 286 ATs should hit 6 million this year, a 50% gain over 1989, as the 386SX garners 1 million to 1.5 million in unit sales. By 1992–93, however, Infocorp sees the two processors running neck-and-neck, at about 2.5 million units apiece. But the figures from International Data Corp. of Framingham, Mass., tell a different story: IDC expects about 8 million 286 and 6 million 386SX shipments this year, with the 386SX inching ahead by 1992–93.

"Because of the uncertainty, and despite the fact that a much more optimal solution is possible by focusing on one or the other [processor], PC makers are asking for systems-logic solutions that will allow them to shift to one or the other, depending on availability," says Randy Bachman, product marketing manager at Via Technologies Inc. in Fremont, Calif. The idea, he says, is that if Intel is successful in its kill-the-286 campaign, a PC company can simply take the 286 out of its socket and plop in the 386SX. At the same time, hedging their bets means that if the current shortage of 386SX chips continues, a vendor could fall back on the 286, adds Jack Ordway, vice president of marketing at Headland Technology Inc. in Fremont, a subsidiary of LSI Logic Corp.



MOTHERBOARD INTEGRATION

Peripheral functions in graphics, communications, and storage control are gravitating to the motherboard. One result: smaller-footprint PCs.

By and large, the strategy of many players is to stake out a piece of the PC chip-set market and protect it, expanding slowly from that base of strength. Some companies—such as ACC Microelectronics of Santa Clara, Trident Microsystems in Sunnyvale, and Silicon Integrated Systems of San Jose, Calif.—have solid relationships with PC system vendors throughout the Pacific region. These manufacturers are building chip sets for the XT and low-end AT market based on 8088 and 8086 processors to move into laptops and transportables on one end, and scaling up into 80286- and 386SX-based implementations on the other.

In a move that Jack Yuan, ACC's director of marketing, believes will break his company out of the pack, ACC has established a second-source/foundry and strategic relationship with semiconductor giant Motorola Inc. across ACC's entire PC chip-set product line.

"The combination of our expertise in this portion of the market and Motorola's high-volume production capability will open up parts of the market we have barely addressed to date," Yuan says. (Ironically, Motorola is the progenitor of the 680XXX series, the processors in the non-IBM-compatible computers that make up some 28% of the PC market.)

Alternatively, in its first entry into PC systems logic NCR Microelectronics of Colorado Springs, Colo., has chosen to focus on 386SX systems with its Summit chip set. NCR's edge is that virtually every major function in its three-chip offering is also contained in its standard-cell library, says Gene Patterson, director of semiconductor products. "This will allow us to easily customize a chip set to particular system requirements, if volumes justify it," he says.

ALSO BETTING ON SYSTEM customization as the best entree is S3 Inc. Backed by $6 million in venture funding, the Santa Clara company's strategy is to focus on 386 and 486 systems with a family of modular standard products that allow a mix of input/output types, performance levels, and cost. In an unconventional move, S3 will let original-equipment manufacturers add their own integrated circuits using a predefined chip-interconnect scheme developed by the company.

By comparison, the strategy of market leader Chips & Technologies is ex-

HOIST WITH ITS OWN PETARD, INTEL STRIKES BACK

THE MERCHANT ENTREpreneurs of the 18th and 19th centuries had it easy: all they had to worry about was the "invisible hand" of competition to inhibit their actions in the marketplace. By comparison, the freewheeling PC chip-set makers of the late 20th century have it a whole lot tougher: they have the very visible hand of Intel Corp. placing limits on their activity.

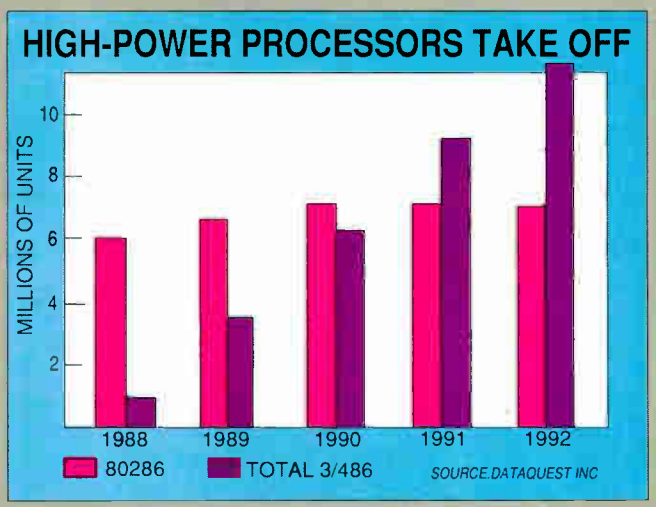
But today's crop of semiconductor vendors working in the personal computer marketplace could learn a thing or two from Adam Smith, the laissez-faire economist who defined competition as a stabilizing influence on the economy. When one company becomes dominant to the point where it is able to drive all competition from a market, it turns into a destabilizing force, Smith held.

This is the very scenario the chip makers fear as Intel embarks on a determined, well-funded effort to drive its own 16-bit 80286 central processing unit out of the market, thereby upsetting the strategies of the many companies that supply the logic and memory chips that surround this workhorse CPU in a PC. Intel wants to replace the 286, currently the CPU of choice for PC-AT machines and compatibles, with a slimmed-down version of its 32-bit 80386, the SX, with an external 16-bit bus.

For the reason, you need only look at the market numbers Intel executives have watched with dismay over the past several years. During the early 1980s, when the microprocessor powerhouse was still struggling to establish its iAPX86 architecture, Intel entered into second-sourcing licensing agreements with other semiconductor vendors. At the 16-bit 80286 level, the main beneficiaries were Advanced Micro Devices Inc. of Sunnyvale, Calif., and Harris Semiconductor of Melbourne, Fla.

By the end of the decade, it became clear that the Intel strategy was working all too well. According to Dataquest Inc. of San Jose, Calif., AMD's share of the overall 80286 market grew from 12% in the first quarter of 1987 to 33% by the first quarter of 1989. During the same time frame, Intel's share of the market shrunk from 83% to only 50%.

In efforts to regain its own ground, the Santa Clara, Calif., company has embarked on an aggressive campaign, including a $4 million advertising blitz targeting billboards in 10 major U. S. cities and full-page newspaper and magazine ads nationwide. In all the ads, the number 286 is crossed out as if with red paint and "386SX" inserted.



On a more concrete level, Intel has during the last eight months driven down the costs of producing the more complex 386SX to a rough parity with the 286, says Jean Claude Cornet, vice president of high-end processors. It has also boosted the processor's performance. Even as AMD struggles to move into production with a 20-MHz version of the 286, Intel has introduced in the last six weeks not only a 20-MHz 386SX but also a complete family of comparably clocked system-logic chips. Finally, aside from an agreement with IBM Corp., Intel has turned thumbs down on second-source licenses for either the 386 or 486 processors.

Intel is beginning to see some of the results it wanted: by the end of January, says Cornet, the company had identified 168 manufacturers that had incorporated the 386SX into their products. But other results are not so promising for Intel. In fact, it seems that instead of introducing more stability in the market, as Intel had hoped, the company's actions have thrown the PC market out of kilter.

For one thing, demand for the 386SX has outgrown Intel's ability to supply chips, leading, says Cornet, to double and triple ordering by original-equipment manufacturers trying to insure their supply. Responding to the uncertain supply, systems houses are forcing semiconductor vendors to develop system-logic chip sets flexible enough to be used with either the 286 or the 386SX.

On the horizon is a bigger threat to Intel's efforts to become the sole source of PC processors as the industry moves to full 32-bit implementations: clones. Some competitors are reverse-engineering the high-end 386DX and 486 chips in order to build legal, if unauthorized, versions. One up-and-coming contender in this arena is NextGen Microsystems Inc. of San Jose, which is developing a five-chip set that will emulate 386 and 486 instructions. It will go into a workstation scheduled for introduction later this year. Houston PC maker Compaq Computer Corp. lent NextGen some much needed respectability by investing in the firm.

Another company that has announced its intention to produce a device compatible with Intel's 32-bit processors is Integrated Information Technology Inc. of Santa Clara, Calif.

A third contender is VM Technology Ltd. of Tsukuba, Japan, which has developed what it calls a virtual microprocessor architecture and is using it to build Intel-compatible CPUs. The first such device, in limited production now, is the VM8600S, which implements the 386 instruction set.

This is bound to cause some hand wringing at Intel, because VM Technology was founded and the chip designed by Masatoshi Shima, who as an engineer at Intel in the early 1970s designed the 8-bit 8080, mother of all the iAPX processors. While at Zilog Corp., Shima designed the Z80, which nearly stole the nascent PC industry away from Intel in the mid-1970s.—*B. C. C.*

pansive. The San Jose company is moving out on all fronts, high end and low end, and in all formats: ATs, XTs, the so-called "baby ATs," portables, transportables, and laptops. It supports all the PC processors from the 8088 to the 80486, and all the various PC configurations—XT, AT, EISA, and MicroChannel—across a variety of clock speeds, from 6 to 25 MHz.

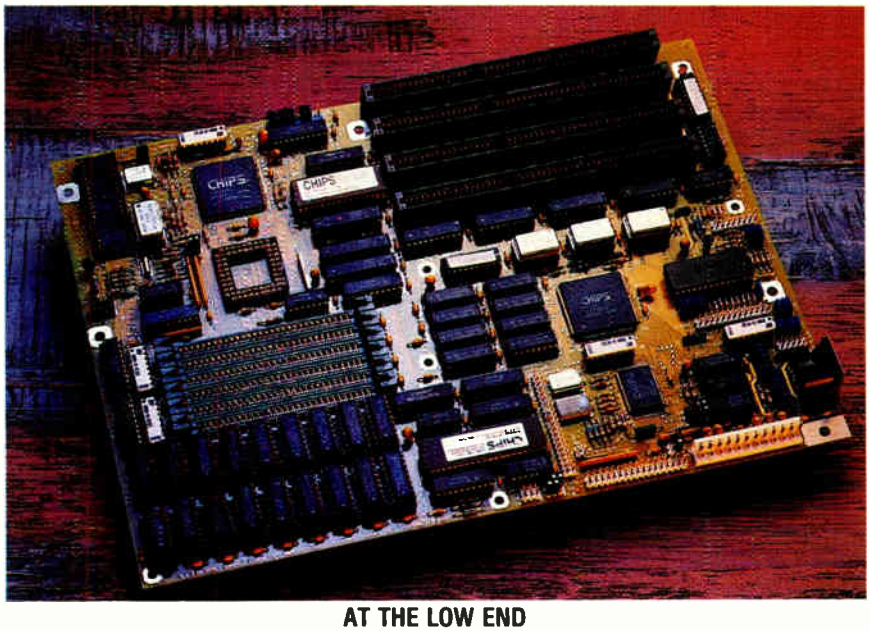
AT THE LOW END, AN arena marked by spiraling price pressure and competition, Chips is throwing down a gauntlet in the form of the entry-level Enhanced AT (Eleat) family aimed squarely at the low-end AT-type PC market. Eleat grows out of SCAT, the company's single-chip logic solution, says Garetz, the Eleat product line manager.

Using the 82C235 SCAT chip as the starting point, Eleat integrates system logic, I/O functions, mass-storage control, and video graphics into three or four VLSI devices, depending on I/O configuration. Targeted at the high-volume market for computers priced under $1,000, Eleat eliminates the necessity for add-in boards, which are needed in "the vast majority of PCs to provide even basic levels of functionality," Garetz says.

With this kind of functionality at the motherboard level, a system designer has a number of options. On the one hand, he can reduce the desktop PC's footprint from the traditional 12 by 14 in. to 10 by 11—the footprint of a baby AT—and still have room to add expansion slots for more memory and other peripheral functions. Or he can retain the classic configuration and have even more functionality available.

Another market linchpin is No. 2-ranked Western Digital Corp. of Irvine, Calif., with a share of about 15% to 20%. Through acquisitions, internal development, and strategic alliances, it has built a broad base of PC product offerings that Everett Boswell, vice president of worldwide marketing, thinks will be hard to beat in the increasingly price-sensitive environment to come.

The culmination of the company's efforts was last month's introduction of three new chip sets addressing virtually every segment of the PC business: the WD7500 for 80286-based desktops, the WD7600 for 80286- or 80386SX-based PCs, and the WD7600LP for 286 or 386SX notebook and laptop machines.



AT THE LOW END

Chips & Technologies' Eleat chip set makes it possible to build an under-$1,000 PC that's comparable to an AT on a single board.

Integral to the Western Digital approach, Boswell says, is the concept of "interarchitecture," a process by which core systems logic, video, communications, and disk drive are integrated into two or three system-specific motherboard superchips.

Targeting mainly systems with performance requirements in excess of 20 MHz is VLSI Technology Inc., whose Topcat family of PC systems-logic chips is also being marketed by Intel along with its 20-MHz versions of the 386SX processor. The San Jose company is offering two versions: the two-chip VL82C286, for use with 286/386SX designs below 25 MHz, and the three-chip VL8C386, for designs above 25 MHz.

Three companies are finding a niche in high-end systems based exclusively on the 386SX/DX and 486: startups Headland and Via, along with Opti Inc. of Santa Clara. Headland's approach, says product manager Joseph Nance, is a series of high-integration chip sets targeted at specific system configurations. The HIT486, for example, is a four-chip solution optimized for 25- or 33-MHz ATs. Via's newly introduced FLEX-II family contains two chip sets, one for 386DX- and 486-based personal workstations that require cache, and another for the lower-performance 286 and 386SX desktops and laptops that do not need cache. Opti's approach is a chip series designed exclusively for high-end 25-MHz-and-above cache-based applications.

As if the field were not crowded enough, Texas Instruments Inc. is making waves at the high end with its 83000 family in a move that may cause many a fabless PC chip company to reevaluate its market strategy. Until recently the Dallas-based semiconductor giant treated the PC systems-logic market as a regional business, servicing mostly Pacific Rim companies with its original 286-based TACT82000 family, says Amad Nawaz, worldwide manager of PC chip-set marketing. The TACT83000 marks a shift. With the three-chip set, which is aimed at 386SX, 386DX, and 486 processors, TI will begin addressing the PC market as a worldwide phenomenon, Nawaz says. In its initial offering it is focusing on the high-performance portion of the market, 33 MHz and above.

Many of the players on the motherboard address the laptop market with options reconfiguring their general chip sets for the low-power and low-component-count requirements. But Oak Technology Inc. of Sunnyvale is targeting this segment with a specific offering: the OTI-050 OakHorizen, a five-chip set that is directly competitive with the leading laptop chip set, Chips's LeAP family. The $3.5 billion laptop-and-smaller segment is the fastest-growing PC market, says Sukkin Fong, vice president of marketing at Oak. And it's expected to keep growing 25% to 30% annually, he says.

Motorola is also targeting laptops

IN THE BEGINNING WAS CHIPS . . .

BACK IN THE EARLY 1980s, the nascent personal computer market was worth $1 billion a year. Today that figure is $35 billion and growing, with some analysts predicting as much as $65 billion in sales by 1992–93. With every increase in clock rate and every expansion in market size, new PC chip companies come onstream to take advantage of the widening opportunities. The first wave emerged to reap the rewards of the standardization created by the introduction of the granddaddies of all PCs: IBM Corp.'s 8088-based Personal Computer and 8086-based PC-XT.

The progenitor was Chips & Technologies Inc. of San Jose, Calif., which repartitioned the systems logic and reduced chip count from about 50 or so circuits to less than 25. Among Chips's first-wave competitors were Faraday Electronics, now a part of Western Digital, VLSI Technology, and Zymos.

A second generation sprang up around the 286 processors, including ACC Microelectronics, Edsun Laboratories, NCR Microelectronics, Silicon Integrated Systems, Trident Microsystems, and Western Digital. The third wave, piggybacking off the 386SX and 386DX, includes Acer, Headland Technology, National Semiconductor, Oak Technology, Texas Instruments, United Microelectronics, and Via Technologies. Also diving into chip sets at this point were the two microprocessor mavens, Motorola Inc., whose 680XXX series goes into non-IBM-compatible PCs, and Intel Corp.

And with the move into volume production of Intel's latest offering, the 80486, a fourth generation of PC chip companies is in the offing. Formed over the course of the past year or so and just now entering the market with their first products are companies such as Elite Microelectronics, Opti, and S3.

In terms of broad strategy, the systems-logic companies have divided into two camps around one question: to fab or not to fab. Fabless companies prefer to invest in computer-aided-design and systems expertise, gambling that the days of excess capacity at the IC foundries will continue. More traditional semiconductor firms are betting that low-cost production capability will pay off in market domination in the long run.

In the first category stands the company that has had the most commercial success with the fabless approach: Chips & Technologies. According to Gordon Campbell, founder, chief executive officer, and president, the cofounders had a choice at the start: "We could play the game the way everyone else does and lose," he says. "If we went the way of traditional IC startups and invested in our own fab, we would not have had the money to invest in what we do well—systems design and CAD tools—to move into the market quickly." Instead Chips manufactures more than 100 types of circuits at 11 different foundries.

Many vendors follow the same course, among them a few chips off the old block—S3, Elite, and Opti, all founded by Chips & Technologies veterans. Others pursuing a fabless strategy include ACC, Acer, Oak, Silicon Integrated Systems, Trident, Via, and Zymos. But rather than shop around to different foundries, some rely on strategic relationships: ACC with Motorola, Acer with National Semiconductor, and Zymos with Daewoo and AT&T. And even though Western Digital has its own fab, it too has struck up a foundry deal with AT&T.

But traditional IC houses such as Motorola, National, NCR, and TI see their manufacturing clout as a strength that will pay off in the long run. "As the unit volumes in the PC business climb into the tens of millions, and as competition increases at the system level, it is the company with the lowest cost of manufacture that will be successful in the long run," says Amad Nawaz, worldwide manager of PC chip-set marketing at TI in Dallas.

However, just fab capability alone isn't enough, says Gene Patterson, director of semiconductor products at NCR Microelectronics in Colorado Springs, Colo. A semicustom capability that is tied closely to standard products is also important in order to meet the application-specific requirements of many large PC system houses and at the same time meet critical market windows.

So are state-of-the-art processes, says Doug Fairbairn, vice president of the ASIC Division at VLSI Technology. "If Intel goes for a 1.0-μm process for its processors and periperal logic," he says, "you had better be pretty sure you can match it."—*B. C. C.*

and palm-size PCs. Building on its technology-exchange agreement with ACC, the company has committed extensive resources to defining a next-generation laptop chip set, says James Bennebose, customer-specific-products marketing manager at Motorola's Semiconductor Products Sector in Austin, Texas. Motorola is also looking at the possibility of a family of chips for a palm-size unit that incorporates extensive communications capability, Bennebose says.

WHETHER PLANNING A laptop, a portable, or a desktop PC, system makers are faced with a critical decision at the 386DX or 486 level: how best to take advantage of the full 32-bit architecture these processors offer. Currently the market is split between two standards: the MicroChannel bus defined by IBM, which Big Blue hopes will become a de facto industry standard; and the Extended Industry Standard Architecture. EISA, developed by Compaq Computer Corp. of Houston, has the backing of the 10 largest PC systems companies (excluding, of course, IBM).

Both architectures revolve around the concept of bus masters, add-in cards based on the use of powerful coprocessors to replace the traditional slave processor. A slave processor can respond only to bus transactions controlled by the CPU. By contrast, a bus-master chip set allows the adapter to generate its own bus transactions, operating roughly in parallel with the CPU.

After an initial burst of activity in MicroChannel, which offers a much higher performance level, attention seems to have shifted to EISA, says Randy Wilhelm, 32-bit chip-set marketing manager at Intel's Folsom, Calif., operation. Still, performance concerns are a big issue. Where the best the EISA standard offers is a throughput of about 33 Mbytes per second—assuming system designers fully utilize the 32-bit architecture of the 486—IBM has demonstrated MicroChannel cards that operate at about 40 Mbytes/s. By comparison, the AT's top throughput rating is 10 to 15 Mbytes/s.

So far about a dozen MicroChannel system-level products have been introduced along with chip sets from Chips & Technologies, Intel, and PLX Technology Corp. of Mountain View, Calif. Intel has developed another chip set for EISA and NCR has introduced a chip set that supports both of the standards. But the

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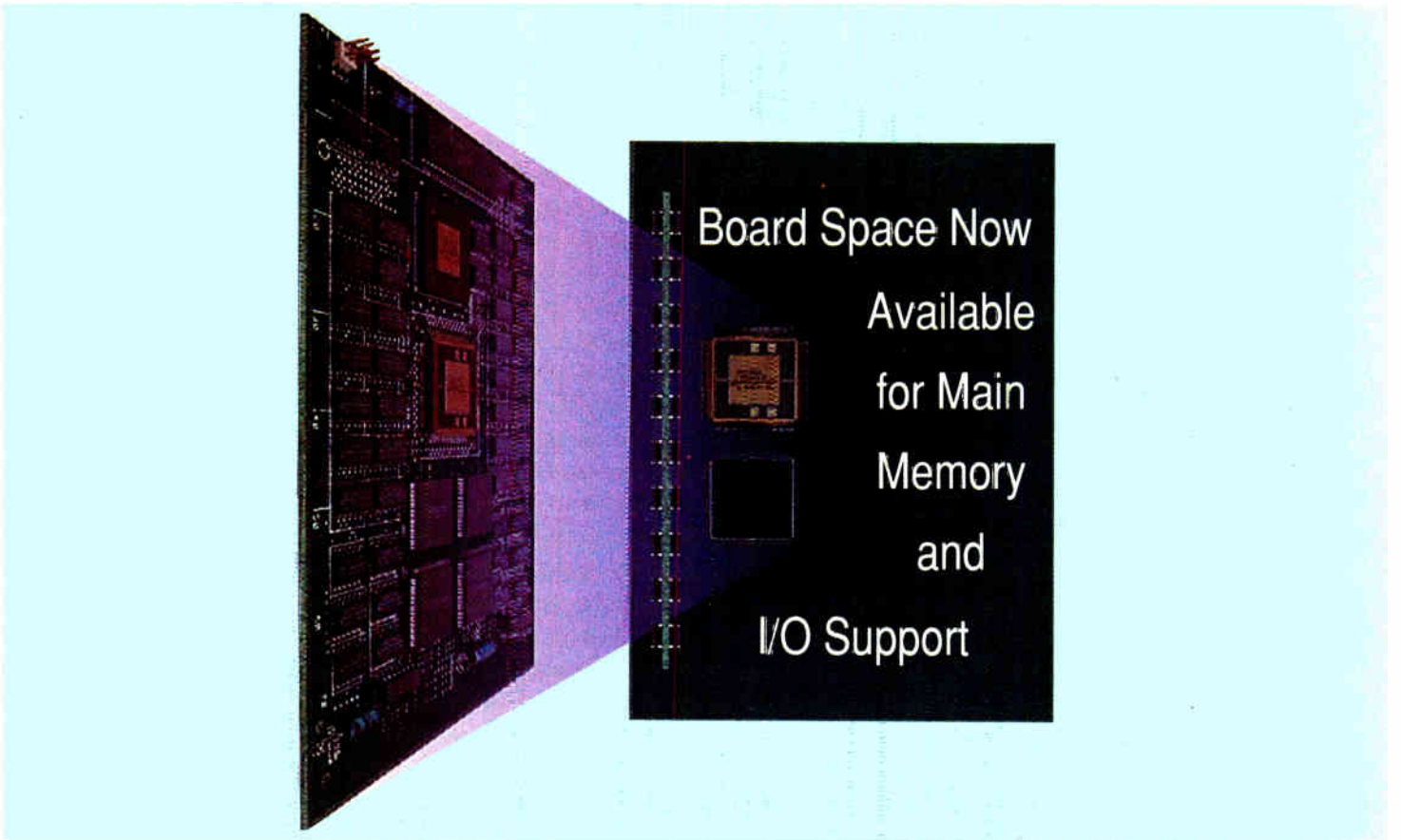

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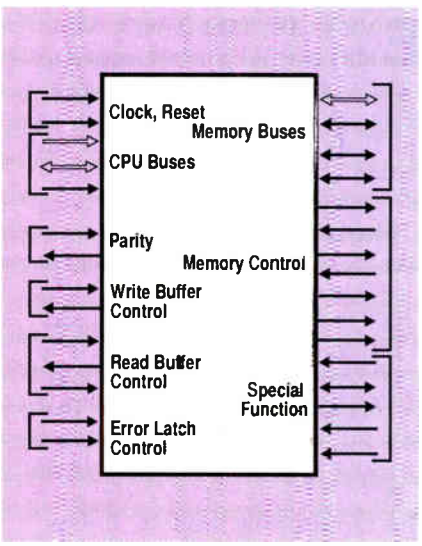

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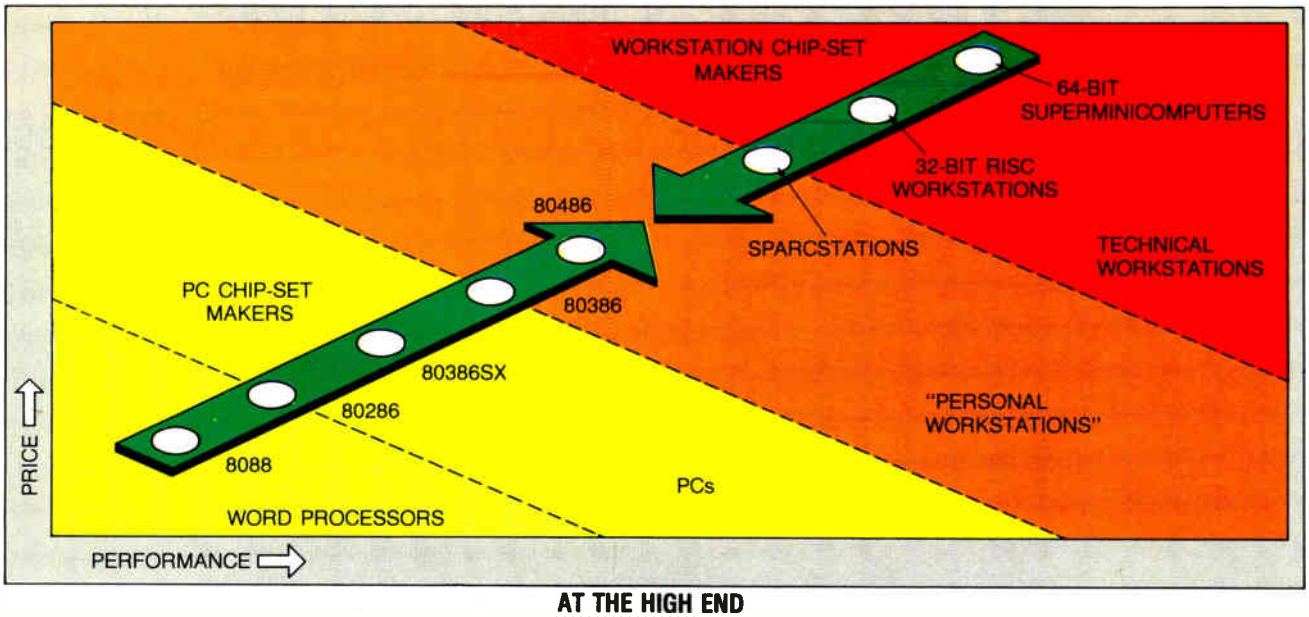

AT THE HIGH END

Chip-set vendors track the evolutionary path of the processors. With the 486 they're rising into the performance range of RISC-based workstations to create a new type of machine, the so-called personal workstation.

EISA ball is rolling for two very good reasons, says Intel's Wilhelm.

"First, unlike MicroChannel, EISA is a completely open architecture, requiring no liscense fees" he says. "Second, where IBM sacrifices compatibility with the AT bus to get higher performance [in MicroChannel], the EISA bus sacrifices some performance to achieve downward compatibility."

This stalemate may be broken by upcoming products. TI is jumping in on the side of EISA, introducing a chip set later this year. While Nawaz says the company may ultimately unveil a MicroChannel set as well, "we have conducted extensive market studies and talked to literally hundreds of potential chip-set customers. We believe that EISA is where the high-volume market is going to be for the near future."

Offering an interim solution that does not require a commitment to either bus is Zymos, the No. 3-ranked PC chip-set supplier with 8% to 10% of the market. Zymos has devised a new AT chip-set architecture that lets 386SX, 386DX, and 486 designers take full advantage of the 32-bit resources available to them in these chips. It's based on a totally new local-bus architecture, says marketing vice president Sullivan.

The first such product is the System 90/SX for 386SX machines. Like Zymos's upcoming introductions, it removes the slow address and data paths associated with using 32-bit processors in the 16-bit AT-bus environment without giving up full AT compatibility. "In essense, we are able to offer cachelike performance without cache expense," says Sullivan.

"In benchmarks we have run, we have observed an average of 0.1 to 0.3 wait states per cycle," he says, using industry-standard 100-ns dynamic random-access memories and a 16-MHz processor or 80-ns DRAMs with a 20-MHz CPU. "Rather than having to make an abrupt break with the past by going to MicroChannel—or a somewhat less drastic one with EISA—going our route makes the transition a very gradual one," Sullivan says.

EVEN AS THE UNIT VOLume of PC shipments soars into the tens of millions, competition is increasing and unit price continues to drop. That's happening even with an extension of the PC into performance levels traditionally associated with RISC-based workstations. Based on estimates for PC unit and dollar volumes, the average selling price of a PC today is $2,000 to $2,500. By way of comparison, the workstation market sold only 300,000 systems in 1988, but dollar sales approached $4 billion. That makes for a $13,333 average selling price—four to five times that of a high-end PC.

This explains why many PC makers, particularly in the U. S., are developing 486-based systems edging into a territory many are calling personal workstations or workstation PCs. Such machines boast system throughputs of about 8 million to 10 million instructions per second, close to to the minimum 10 to 15 mips possible in a RISC-based workstation, with comparable clock rates.

Only one company so far has moved into the workstation midstream: Compaq with its SystemPro. Compaq uses the EISA bus it helped define to build a loosely coupled multi-486-based system capable of a minimum of 40 mips.

Never one to ignore a significant trend, Chips & Technologies has unleashed for this market a new chip set, the MPAX (for multiprocessing architecture extension), which allows up to six 486s to operate concurrently [*Electronics*, March 1990, p. 29]. Such a setup results in an overall system performance approaching 70 mips.

In response, at least two manufacturers of RISC processors based on Sun Microsystems Inc.'s Sparc are turning the tables. They are going after the PC's Achilles heel—price—using the chip-set strategy that worked so well in the PC world to push down costs in Sparc-based workstations.

LSI Logic in Milpitas, Calif., has just introduced a Sparc chip set that it believes will make possible RISC-based systems for around $5,000 apiece [*Electronics*, April 1990, p. 26]. What's more, Fujitsu Ltd. of Tokyo is working with Via Technologies to develop a VME-bus-compatible peripheral-logic chip set for its implementation of the Sparc architecture.

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CIRCLE 367

SPECIALTY SRAMs ARE FILLING THE SPEED GAP

TODAY'S FASTER PROCESSORS DEMAND HIGH-SPEED SRAMs AND APPLICATION-SPECIFIC MEMORIES

BY SAMUEL WEBER

MICROPROCESSORS THAT zip along at 33 MHz place serious demands on memory. The dynamic RAMs that formed most of the memory in the first generation of personal computers can't keep up the pace, and these chips—largely Japanese-made—are being augmented in today's PCs by specialty parts: specialized high-speed static random-access memories and a new breed of application-specific memories, the bulk of them produced in the U. S.

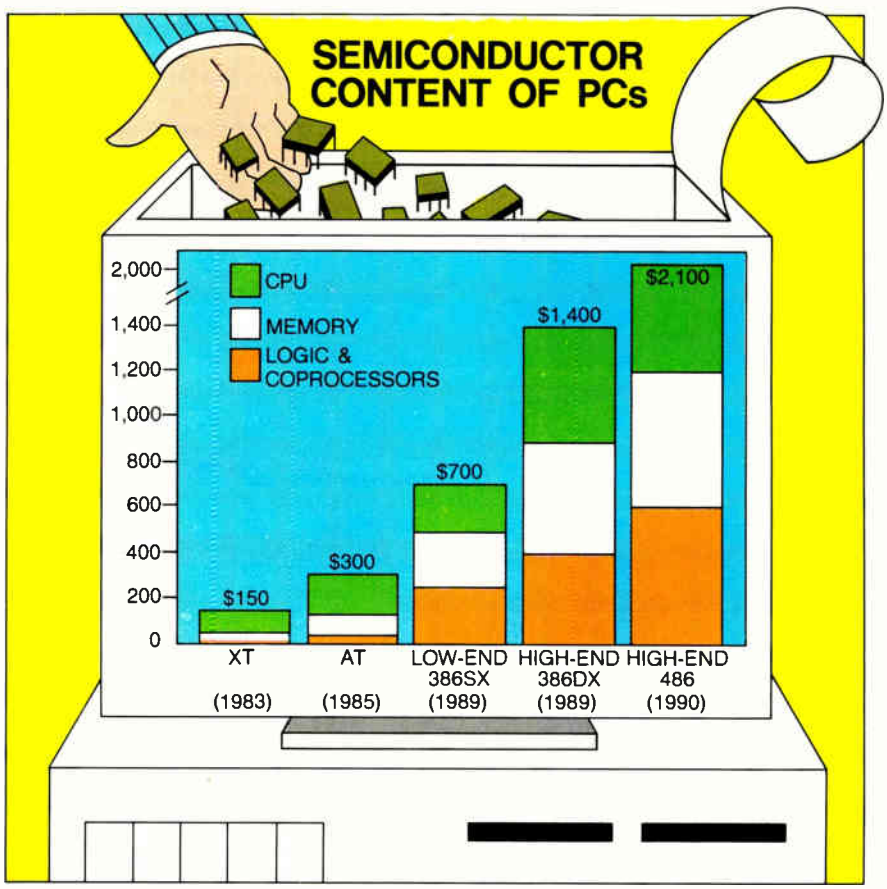
These devices are going into PCs running at 16, 20, 25, and 33 MHz—the 32-bit 386SX, 386DX, and 486 designs—and they're eating into DRAM market share. Since memory constitutes about a third of the overall semiconductor content of a PC, the result is a market that's far from inconsequential. The market for fast SRAMs (70 ns and below) should hit $975 million this year and $1.6 billion by 1993, says Richard Eiler, strategic marketing manager for application-specific memories at chip maker VLSI Technology Inc. in San Jose, Calif.

For the standard-parts vendor, wading into this territory is tricky business, says David Sear, vice president for Fujitsu Ltd.'s standard-parts operations in San Jose. "As you go from clock rates of 25 and 33 MHz to 50 MHz, you can use CMOS technology for access times in the range of 25 ns or so—possibly even 15 ns. But after that you need biCMOS to take you down to 5 to 8 ns, and beyond that you must go to emitter-coupled logic. You have to plan correctly to achieve the right kind of speed to match the speed of the processors coming out."

Another option to avoid the use of an exotic technology, says Sear, is a slower part that's been especially geared to mesh with, say, the 486, by matching the input/output and using synchronous timing. "But it's important we don't end up building custom memories," he says. "It has to be specific to the application, but the volume requirements have to make it worth our while to have a standard part." Fujitsu makes both bipolar self-timed ECL and biCMOS ECL SRAMs with speeds in the sub-10-ns range.

MEMORY

But another group of companies is all too happy to jump into the market with application-specific memories. For these vendors—companies such as Advanced Micro Devices, Alliance, Cypress, Integrated Device Technology, Mosel, Motorola, SGS-Thomson, Vitelic, and VLSI Technology—PCs and workstations are prime targets for a wide variety of specialized



parts. Generally these are data- and cache-tag devices, which fill the speed gap between rather slow 90- and 120-ns DRAMs and processors with clock rates of 30 MHz and climbing.

Another way to fill the speed gap between processor and DRAM is with processor-specific memories, devices tailored to, say, Intel Corp.'s 80486 or Motorola Inc.'s 68040. Such parts add features that enhance the processors' access times. What's more, they offer a cache solution involving fewer chips than when implementing cache memory in standard fast SRAMs. "It's no longer a two-man band out there, not just Motorola and Intel," says Curt Wyman, marketing manager for Motorola's fast static RAMs. "You've got six or seven processors out there that are being bred into significance. Add that to your current designer's attitude that 'I want a special solution tailored to my particular problem,' and you come up with a very complex situation."

Motorola's answer lies in "engine-specific" devices, such as the company's MCM62990 SRAM, a 16K-by-16 synchronous SRAM that plays with the 68040, and its 8K-by-24 part that's geared to Motorola's digital signal processor. "But we also have specialty RAMs that play with the MIPS Computer and Intel parts, and to some extent the [Sun Microsystems] Sparc processor," Wyman says.

SPECIALTY MEMORIES

Since DRAMs are too slow to service today's processors, the way is open for specialty memories to augment them.

One niche is in high-speed static RAMs with speeds of 25 ns or below.

Another is in application-specific memories, notably in parts optimized for particular processors.

One of these is the recently introduced MCM62995, a latched address designed for the MIPS R3000. These and the forthcoming 64-by-4 M62980 sport a unique feature called "late write abort," which allows the processor to correct data-stream errors by aborting late write cycles if they are "false" during the low period of the clock.

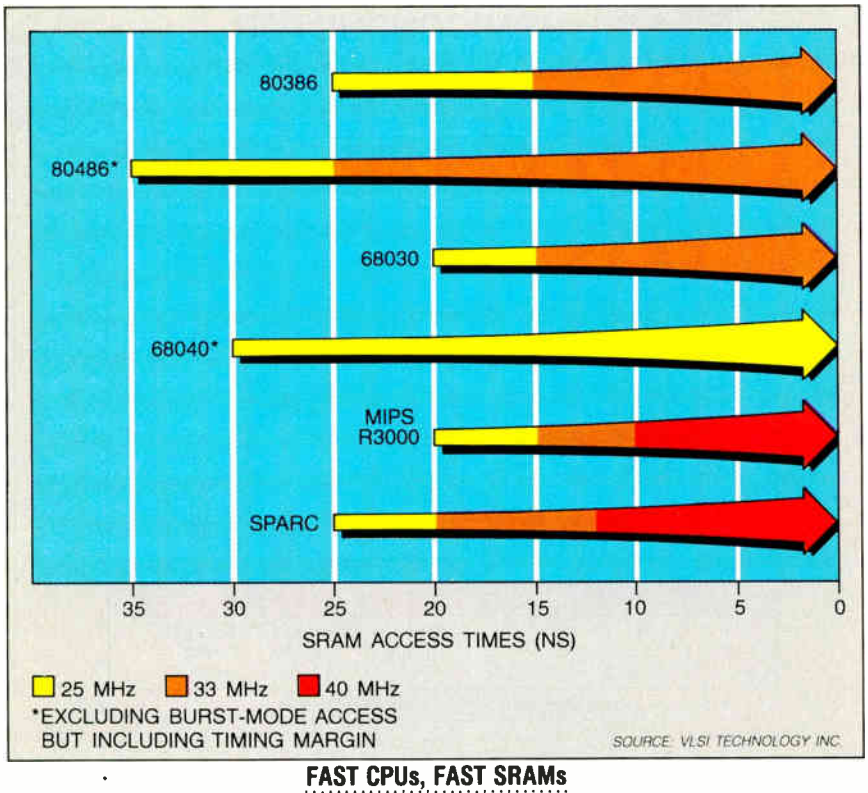
Cypress Semiconductor Corp., too, is supporting the individual processors with specialty memories. The San Jose company's 8K-by-16 CY7C183/184 cache RAM in 35- and 25-ns versions is geared to the 386 processor, and the CY7C157, a 16K-by-16 device in 24- and 20-ns versions, is designed to function with the Cypress edition of Sparc, the CY7C601. The philosophy is to let the designer interface cache RAM and processor with no glue logic whatsoever and no wait states at the processor's full rated clock speeds, says Stewart Sando, Cypress's marketing manager.

"That's extremely difficult to do," Sando says, "and it calls for architectural innovation to further performance beyond 33 MHz. We are developing a 32K-by-9 cache RAM for the 486, with on-board burst-address counter and address-load pins for the 486 and separate load pins for the cache controller. This configuration will support not only the current 25- and 33-MHz 486s, but one of its speed selections will support future 486s up to 50-MHz performance." In development now, this part is set for introduction early next year.

VLSI TECHNOLOGY IS TELLing the same story: processor-specific fast SRAMs, says Bill DeMatteis, director of operations for the Memory Division. The company's microprocessor-specific cache-data SRAMs typically include I/O latches or multiplexers, and special inputs such as clocks, address-latch enables, mode selects, and address-status inputs, which allow them to interface directly with a given microprocessor without glue logic.

Among the offerings is an 8K-by-16/18 device for the 80386, the dual 8K-by-20 for the MIPS R3000, and the synchronous 128K-by-8/9 for the Advanced Sparc processor. VLSI Technology also supplies a line of generic SRAMs ranging from 16 Kbits to 1 Mbit that are used in cache applications. They range in speed from 15 to 35 ns. Additional SRAM-based application-specific memories include dual-ports; first-in, first-out devices; and cache-tag SRAMs. The company is producing these devices in conjunction with its Japanese partner, Hitachi Ltd.

All of the higher-speed processors "are forcing us to do specific things to produce cache that works better with them," says Gene Cloud, marketing manager at Micron Technology Inc. in Boise, Idaho. "These include going from asynchronous to synchronous styles of SRAMs or adding features such as self-timed write or latched addresses." The upshot, he says, is "a general moving toward clocked sys-



FAST CPUs, FAST SRAMs

At 80 to 120 ns, the traditional SRAM is too slow for today's processors. Vendors are now developing specialty SRAMs in the sub-15-ns range.

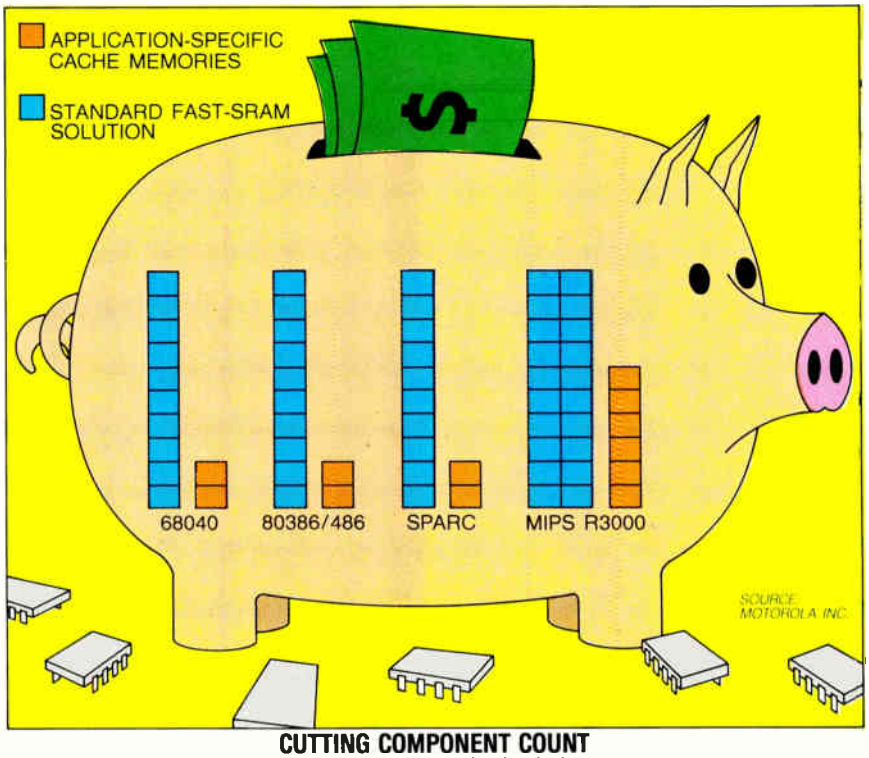
tems." In addition to 256-Kbit, 20-ns SRAMs, Micron offers the CMOS MT56C0816 dual 4K-by-16 or single 8K-by-16 SRAM, a 25-ns part designed to work specifically as data-cache RAM with the 386 processor. Soon to be released is a 25-ns 1-Mbit device.

MANY OF THE NEW MEMory types, be they general-purpose or application-specific, had their genesis as workstation devices. "Now we are finding that the lifetime of the products has been extended considerably as PCs rise in speed," says Thomas Tyson, memory products manager at SGS-Thomson Microelectronics. The Carrollton, Texas, company's high-performance cache-tag and data SRAMs are general-purpose devices "designed originally for the workstation market," he says. Among them is the new MK41S80, a 12-ns, 4K-by-4 cache-tag RAM.

IDT has seen the same phenomenon its its general-purpose data and tag RAMs, says Larry Jordan, vice president of marketing at the Santa Clara, Calif., company. But IDT is covering all its bases: it has developed a family of tag and data RAMs specifically designed for use with the 80386SX and DX, the central processors used in most PCs now on the market.

Still another niche that semiconductor manufacturers are mining is cache controllers, specialized coprocessors that reside in a tightly coupled arrangement with the CPU. Cache controllers contain the interface logic—and, sometimes, the on-chip SRAM—required to bring the processor and main memory into sync. This market initially emerged at the 80386 level with Intel's introduction of the 80385 cache controller. Unable to meet the demand for that part and for even more highly integrated circuits, Intel has in recent years begun to share that market with a number of new competitors, including Austek Microsystems and Matra Semiconductor of Santa Clara, as well as Chips & Technologies of San Jose.

Even though the next-generation 32-bit processor from Intel, the 80486, incorporates this first level of cache control and SRAM onto the same chip as the CPU, a new cache-controller market is emerging, says Jordan of IDT. There's now a need for a second-level cache of even higher density than the first, he says. This second level will be as much as eight times as large as the first—256 to 512 Kbytes, compared with 32 to 64 Kbytes on the 386 part, says Eiler at VLSI Technology.



CUTTING COMPONENT COUNT

By incorporating logic on-chip and reconfiguring the memory array, application-specific memories cut component count by two thirds or more.

One of the first manufacturers to move into the 486 environment with an alternative solution was Matra Semiconductor Corp. Its cache-interface adapter allows designers to implement a second level of cache control with two external circuits.

FOR PCs AND WORKSTAtions that don't aim for blazing speed, a good choice is the pseudo-static RAM, says Noel Scoggins, marketing manager for Motorola's general static RAM operations. "We chose to market the pseudo-static RAM in direct response to PCs and workstations, because we felt it was a real good match—especially for portables and handheld models—because of its low power consumption," he says.

A pseudo-static RAM uses a DRAM memory cell with on-board refresh circuitry. Like a DRAM, it's a one-transistor, one-capacitor cell with direct addressing. "The pseudo-static and the DRAM will typically fall within the same technology generation," Scoggins points out, which is one leap ahead of full-static RAMs. "For access times of 70 ns or greater, the advantages are you get a comparable speed to a slow SRAM and much lower cost. Also, if you design a pseudo-static into a system, more often than not it can be replaced by an SRAM of comparable density at the point when they achieve price parity." One popular example is Motorola's MCM518128, a 128K-by-8 CMOS family running from 80 to 100 ns.

The escalating demands of graphics workstations are another area of opportunity for semiconductor vendors. Here smaller companies like Brooktree, Micron, and Vitelic can compete with the big old-line houses. "Graphics workstations are an area where we are seeing a lot of activity," says Cloud of Micron Technology. "They are demanding more functionality in video RAMs," which can be seen as specialty DRAMs that have grown into commodity parts in their own right. Micron expects to release within a few months some new devices, including a whole set of Jedec-approved video RAMs, Cloud says.

To meet the demand for better graphics in workstations and also in high-end PCs, video RAMs must be denser and have wider configurations and greater bandwidth. The critical issue here is how to maintain the same access time through the denser parts while also maintaining the bandwidth, says Joe Hartigan, marketing manager for video RAMs at Texas Instruments Inc. E

Additional reporting by Bernard C. Cole

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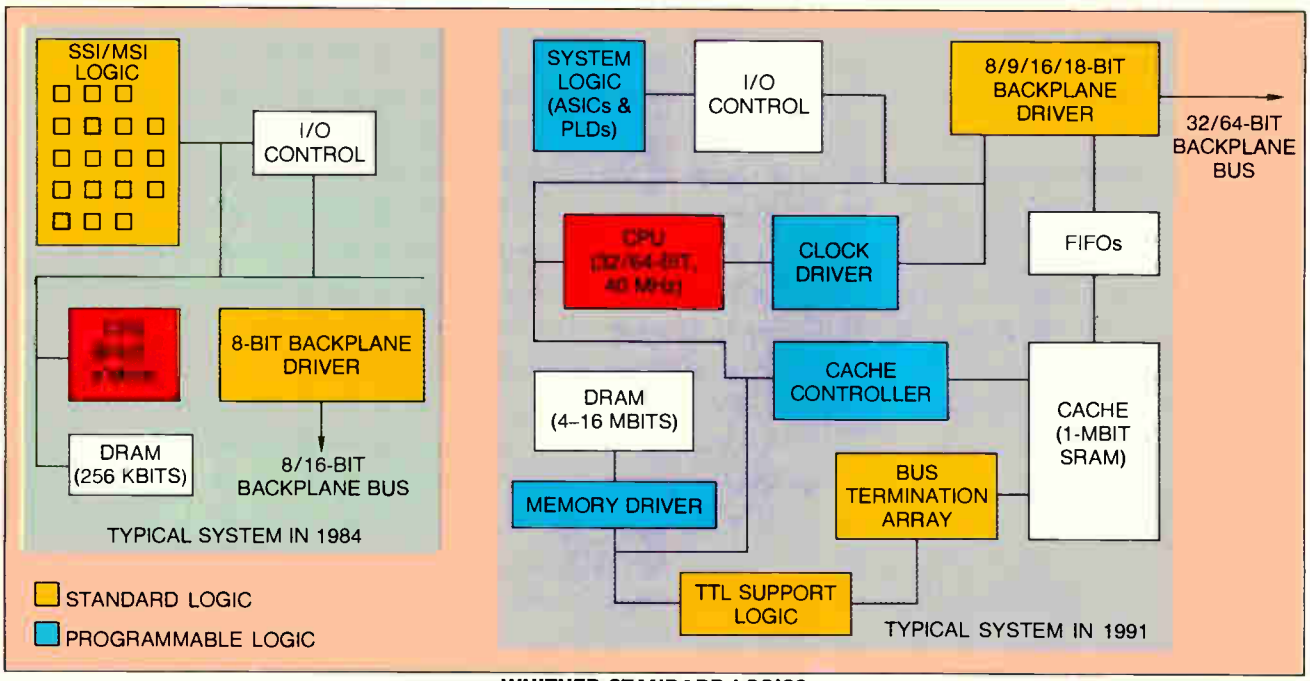


WHITHER STANDARD LOGIC?

The random SSI and MSI logic once found in a PC (left) is gradually being replaced by PLDs and ASICs. The general-purpose logic that remains must be faster to support speedier microprocessors and more memory.

IN STANDARD LOGIC, IT'S A WHOLE NEW BALLGAME

WITH PLDs AT THE FOREFRONT, MAIN-LINE LOGIC VENDORS ARE DIGGING INTO SPECIALTY NICHES

BY SAMUEL WEBER

LOGIC

ONCE SOLD PRIMARILY AS commodities from catalogs, standard logic functions used to be offered on a take-it-or-leave-it basis. In effect, semiconductor manufacturers would tell their customers, "Here, this is what we can make. Do what you will with it." No more. The advent of gate arrays, standard cells, and programmable logic devices—all offering the designer increased flexibility and the opportunity to impose his prerogatives on device functions directly—was the kiss of death for traditional logic.

Chip makers are turning instead to specialty and bus-type logic parts designed to keep pace with the feisty microprocessors that power today's personal computers and workstations. And some vendors are concentrating on PLDs, which are replacing MSI- and SSI-type glue logic and even VLSI peripheral logic functions in systems. The technological task for all logic makers is to boost speed—the logic around a processor must be twice as fast as the processor itself. In effect, then, the system designer is driving logic evolution, and the logic market has undergone a sea change.

"The era of the general logic family is over," says Arthur Woodward, director of advanced bipolar logic for National Semiconductor Corp. in South Portland, Maine. "I think it's unlikely there will ever again be any general-logic-family introductions. I think what you see today is the proliferation in the logic world of subfamilies that are focused on specific applications."

Perhaps in no other segment of the semiconductor industry has the PC exerted such a profound effect. Before the microprocessor and the dynamic random-access memory, standard bipolar logic families like TTL, emitter-coupled logic, and their CMOS counterparts were product-line mainstays and stalwart revenue producers for the big chip houses. But now, "It's no longer enough to define a family of products like low-power Schottky and rely on people to pick it up," says Tom Wise-

man, marketing manager for general-purpose logic at Texas Instruments Inc. "With the advent of semicustom and programmable logic, it's imperative to be more applications-driven."

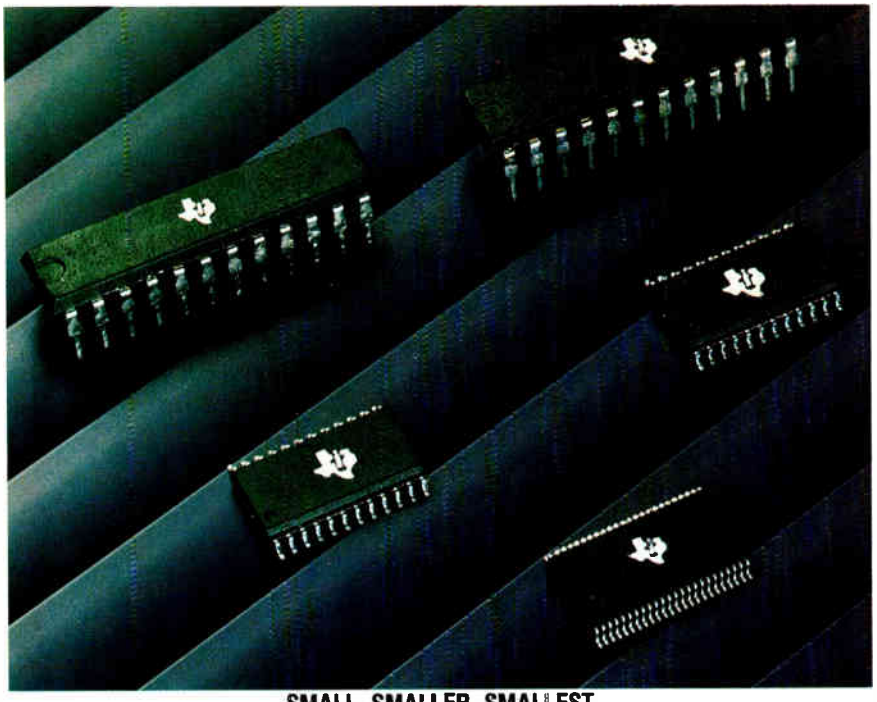
THE MARKET FIGURES TELL the story. According to TI's estimates, the worldwide market for general-purpose logic has dwindled from a peak of $2.8 billion in 1986 to around $2.4 billion last year, with projections of continuing slow decline. By contrast, PLD sales should hit $1 billion this year, up from just $475 million in 1987, according to estimates from Integrated Circuit Engineering Corp. of Scottsdale, Ariz. As a result, the suppliers of standard logic families have been compelled to find new avenues, aiming at functions that are not implemented easily or cost-effectively by PLDs or gate arrays but which still serve volume applications.

"When ASICs, gate arrays, and PLDs came out, we found ourselves with a lot of competition," says Pete Groth, marketing manager for advanced bipolar products at National Semiconductor. "So we went to our customers and said, 'Okay, you're using programmable products of various types. Where are they not doing the job for you? Where can we develop products—not to replace those, but to partition your system more effectively?' "

Often, the solution is to concentrate on integrated bus-driving functions and high-performance bus applications—those where logic performs optimally and where a discrete circuit works better than an application-specific IC. That is National's strategy, Woodward says.

Evolving out of National's advanced CMOS logic line of SSI/MSI functions, known as FACT, is a group of enhanced TTL-compatible functions aimed at higher-speed applications. Dubbed FACT FCT and FACT FCTA, the family will eventually comprise about 60 device types. The FCT buffer/line drivers and transceivers will have current-handling capability of 64 mA and 7-ns maximum delay time. The FCTA family, which targets the reduced-instruction-set computing environment, has switching time of 4.8 ns and 64-mA current drive.

"One change is in the level of integration that we offer, moving from 8-bit products to the 16-bit widths, and within those widths offering more functionality, such as parity generation and checking," says Keith Jackson, National's director of advanced CMOS logic. Attention must also be paid to "not just upgrading speed and power, but also reducing noise and increasing reliability," he says.



SMALL, SMALLER, SMALLEST

For optimal performance, TI's ACL Widebus comes in a very-small-outline package. In the background are SOIC packages (center) and DIPs.

Clock distribution represents one big limit on system performance. "You now have very functionally complex systems all timed over a common system bus," Jackson says. "A major focus and opportunity for us is to distribute those clock signals from the clock generators over the motherboard and to the peripheral systems with minimum skew. The need is to combine that with high speed and low noise generation."

One solution is the F100115 low-skew ECL clock driver, part of a new National family of ECL parts. "With the advent of 33- and 40-MHz RISC and CISC central processing units, some of the bus and clock drivers need more than TTL speed to keep up," says Groth. "Our ECL product line will make it easier for designers to integrate ECL into pockets in their system where they need the higher speed."

National is offering ECL/TTL translators to ease the transition, he says. "A high-performance workstation might have an 80486 or 68040 CPU in CMOS, and now one of the local buses might have to run at 30 or 40 MHz or higher using our parts to keep up with the CPU," Groth says. "We see customers translating ECL to a TTL backplane, and we're carrying our product line in that direction."

Dallas-based TI is also adapting to the new realities. The major technological thrust imposed by PCs and workstations is to go faster and smaller, says Tracy Holmes, strategic marketing manager. To get there, TI, like National, is focusing on the bus interface. The company recently introduced the ACL Widebus series, a family of 16-to-20-bit bus interface functions fabricated in TI's 1.0-μm EPIC CMOS process: line drivers, transceivers, flip-flops, registers.

PACKAGED IN VSOPs—FOR very-small-outline packages—with 48 and 56 pins on 25-mil centers, the family enables designers to place twice the input/output or twice the functionality in the same board area previously occupied by conventional small-outline IC packages.

To keep up with higher-speed microprocessors with larger data widths, TI is also developing the biCMOS SN74BCT logic family. It now comprises more than 60 bus-interface functions and ultimately will embrace about 90, including most of the standard octal functions. Combining the high speed of bipolar and the low power of CMOS, these devices also provide the higher drive currents needed for today's wider words and the

THREE NAMES ARE STACKING UP BIG IN THE BUS BUSINESS.

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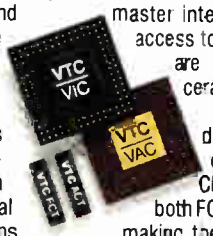

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In PLDs, all eyes are on CMOS, a necessity for the small-footprint desktop and laptop PCs and increasingly used in PLDs destined for workstations. But as processors reach for 50 MHz and above, the speed places very stringent requirements on CMOS. "Designers still want CMOS for power savings and ease of design," says Al Graff, programmable logic marketing manager at Cypress Semiconductor Corp., San Jose, Calif. "But they don't want to give up performance either. Which presents a dilemma, since the logic around the processor must operate at least twice as fast [as the CPU itself]. So if you have a 30- or 50-MHz processor, the PLD must operate at 60 to 100 MHz."

To address these requirements, the company has developed its CYC300 family of pipelined PLDs, the most recent of which is the CYC361. This device hits 125 MHz with little or no boost in power consumption, using just 700 mW. Key to the performance is a radical architectural departure, namely, the use of a split-plane architecture and an independent delay path for the latch-enable signal.

Similarly, Intel Corp. is wringing more speed from its CMOS PLDs, says Dave Statasaitis, PLD product marketing manager for Intel in Folsom, Calif. Intel takes an architecture-specific design approach, he says.

One of its first efforts in this direction was the 85C508, a CMOS programmable address decoder introduced last year to support 386 designs. Its delay time of 7.5 ns equals that of more power-hungry bipolar PLDs. More recently, Intel took the wraps off the 85C220, a pipelined CMOS PLD that sports an 80-MHz clock rate when using an external feedback and a rate of 100 MHz or more using an internal-feedback scheme.

Altera Corp., the company that pioneered the concept of CMOS PLDs, is also in the forefront of function-specific PLDs. These parts combine a programmable logic array with specific logic functions to address particular problems of microprocessor-based systems. The Santa Clara company's first such device was the EPB1400 for microprocessor peripheral-logic integration.

More recently it has addressed the time-to-market issue with devices to speed the design of add-in cards for the IBM Corp. MicroChannel bus. One is the EPB2001, a user-configurable adapter interface that lets designers quickly develop PS/2 MicroChannel-compatible expansion cards for modems, graphics, data communications, and memory. The EPB2002 is a bus-arbitration chip that works closely with the 2001 to integrate the logic necessary to add direct-memory-access capability. This allows high-speed transfers to and from the PS/2 memory, without disturbing the processor.

"What we've brought to the marketplace is very synergistic with the PC marketplace," says Stan Kopek, Altera's strategic marketing manager. "Our technology's performance has increased markedly over the last five years. Our first product back in 1984 was at 80 or 90 ns. Now we've got chips that operate at 12 to 15 ns—the kind of performance needed to keep up with a 386 or RISC processor."

A CASE IN POINT IS Altera's EPM5016 MAX (multiple-array matrix) EPLD, a logic array that allows propagation delays of 15 ns, system clock rates of 66 MHz, and counter frequencies of 100 MHz. It can be programmed to perform several functions, such as a bus controller in a 386-driven system.

At Advanced Micro Devices Inc., "we're being driven hard by our customers to continually upgrade our basic devices," says Tim Propeck, vice president of corporate marketing. In March, the Sunnyvale, Calif., company introduced the PAL16R8-5 family of four 5-ns devices aimed at 40-MHz systems. AMD also recently unveiled a high-speed, high-density series of CMOS PLDs dubbed the MACH family (for macro-array CMOS high-speed/high density) featuring 900 to 3,600 gates [*Electronics*, March 1990, p. 75]. That's the equivalent of 32 to 128 PAL macrocells. Fabricated in the company's 0.8-μm electrically erasable CMOS process, they boast 15-ns speeds.

The MACH family is evidence of customers' clamor for higher density with no sacrifice in performance. This demand is pushing the lithography down into the 0.8-μm region, says Scott Pickett, applications manager for National Semiconductor's PLD group. Also, he predicts, "you're going to see new architectures that are specifically defined for state machines or high-speed decode functions." And a number of makers will soon offer PLDs configured for certain bus sizes—8, 16, or 32—reflecting their increased use in bus-interface and processor/cache-memory-interface applications.

Additional reporting by Bernard C. Cole

FASTER LOGIC

As the standard-logic market dwindles, vendors are turning to specialty parts, notably in bus arbitration.

They're also rallying around PLDs, which have largely usurped the standard families' place in systems.

In both arenas, the task is to boost speed: the logic around a processor must be twice as fast as the CPU.

GAASING UP PCs: THE NEXT WAVE?

IN THE THROUGHPUT VS. power dilemma facing logic vendors, does gallium arsenide offer a solution? Two GaAs vendors think so. Gazelle Microcircuits Inc. and Vitesse Semiconductor Corp. say they are finding pockets of opportunity in high-end PCs and workstations.

The new breed of PC is looking to GaAs for TTL-compatible replacements for programmable logic devices, says Dave McMillan, vice president of Gazelle in Santa Clara, Calif. The company offers the 30,000-gate VSC30K, a pin-for-pin replacement for existing PLDs. The initial market for such devices was in workstations, McMillan says, but now PC makers see this speedy material as a way to boost system performance, especially in cache-control applications. Indeed, at last year's Comdex in Las Vegas, rumors were flying that at least four designers of high-end PCs were using GaAs at critical nodes in their systems.

Vitesse upped the ante last month by introducing a 2,400-gate TTL-compatible GaAs gate array. The Camarillo, Calif., company's PLR2KT can replace multiple PLDs in cache control. It can also be used in peripheral control and bus arbitration.—*B. C. C.*

DSPs START THEIR MOVE TO THE MOTHERBOARD

AS PC MAKERS EYE SPEECH, VIDEO, AND MUSIC, THESE PROCESSORS TAKE ON NEW IMPORTANCE

BY JACK SHANDLE

IN 1988, STEVE JOBS AND a cadre of futurist engineers implanted a digital-signal-processor chip on the motherboard of the Next computer. Now the question is, when will the rest of the personal computer and workstation industries follow suit? The answer is quickly unraveling from a familiar nexus of variables: cost, chip architectures, applications development, tools, and market need.

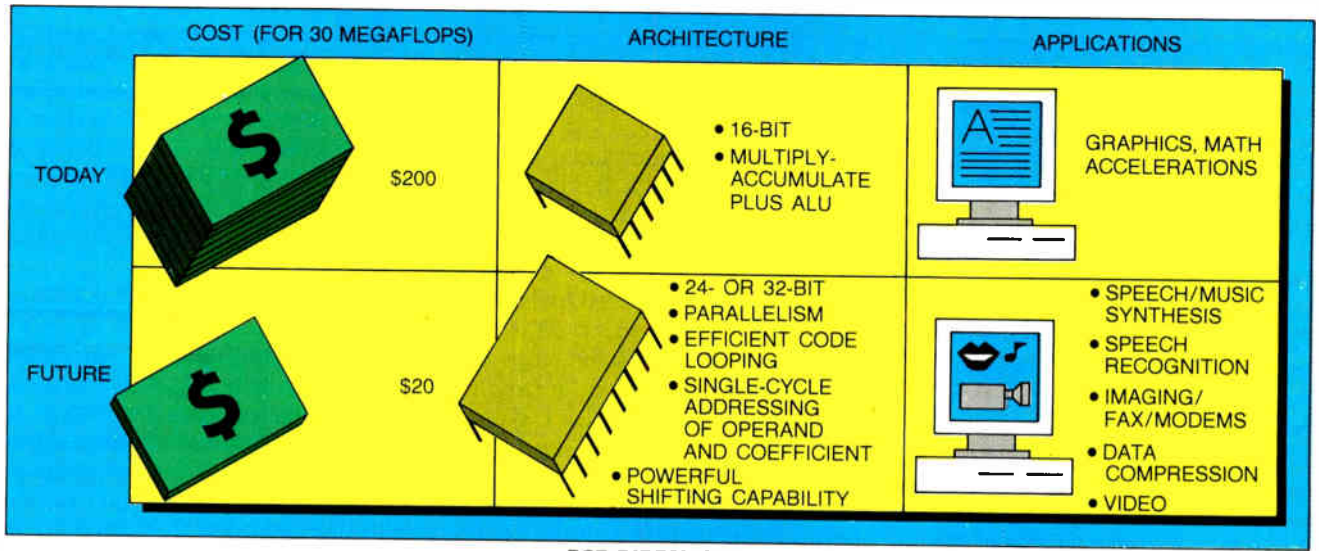
Industry experts estimate that DSPs will start commonly showing up on motherboards within the next one to four years, depending on the price of the platform.

"Virtually every major PC and workstation vendor is working on a multimedia platform," says Richard Rinehart, program manager for DSPs in Texas Instruments Inc.'s Semiconductor Group in Houston. And although they all have different ideas about what multimedia is—"most are talking about audio," he says—DSPs will undoubtedly play a role. Scott Robertson, DSP product marketing manager for Analog Devices Inc. in Norwood, Mass., has also seen a high level of interest in DSPs. "All major PC makers are looking at the technology," he says.

DSPs

DSPs are computational engines. Optimized to do multiply-and-accumulate functions, they are ideally suited to execute input/output-intensive algorithms at speeds microprocessors know only in their silicon dreams. DSPs are attracting attention because of the growing library of algorithms for the synthesis and manipulation of real-world information—speech, music, still and video images—in the digital domain.

In Next's case, "We were looking for an accelerator for functions such as music synthesis and sound," says Rich Page, vice president of engineering at the Palo Alto, Calif., company. "We can use that type of computational power with data communications too, such as a fax modem." Will the DSP make it as a mainstream part? "It's hard to predict," he says. "DSPs have to keep pushing their performance up. A year or two down the road, RISC processors will have the same power." Intel Corp.'s i860 reduced-instruction-set-computer chip makes the design environment "fuzzy,"



DSP DIRECTIONS

Prices will have to drop drastically and architectural improvements be made if DSPs are to fill PC and workstation applications in multimedia and data communications.

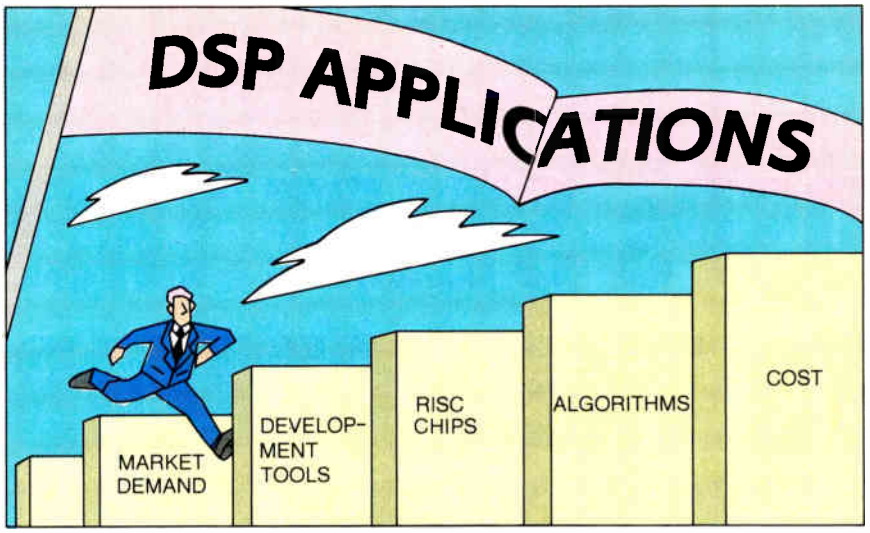
concedes Robertson of Analog Devices.

To break out of its role as a niche solution for such applications as standalone CCITT V.32 modems and find a place on or near the motherboard, the most recent generation of DSPs has made considerable architectural strides. More are still to come for both the chip and the system it serves. Cost, as always, is a factor. A DSP crunching 30 million floating-point operations per second costs at least $200. To move into the PC arena, that price will have to drop to $20 to $40, says Robertson.

Architecturally, the general-purpose DSP has been recast by many major vendors—Analog Devices, AT&T Microelectronics, Motorola, and TI, for example—to deliver real-time performance in many applications and keep one jump ahead of RISC engines. "Basically, early DSPs offered multiplying in hardware and some shifting capability," says Robertson. The new generation—Analog Devices' ADSP2100 among them—is more optimized for signal processing.

For example, two data-address generators running in parallel let the floating-point chip address the mantissa and exponent in the same clock cycle. More powerful shifting capability is being built in, while retaining some general-purpose features in the arithmetic logic unit. "High performance also requires more efficiency in code looping," says Robertson. When the execution of a particular program sequence is repeated many times, the new DSP architectures do the loops with zero overhead, he says—that is, successive loops are executed without breaking into a branch or condition statement each time.

Just as the chip architecture has changed, DSP designers are looking at ways to improve the motherboard interface. "When a DSP is integrated into a PC, the bus is a natural bottleneck," says Frank Ferro, senior applications engineer at AT&T Microelectronics, Allentown, Pa. Next's use of Motorola's 56000 DSP as a coprocessor represents just the first generation of systems architectures. Next uses local fast memory to download instructions from the microprocessor to a parallel bus and then to the DSP. "The DSP doesn't communicate directly with system memory," says Ferro. "We want to remove that bottleneck and utilize its full 32-bit bandwidth." A bus-master solution is most appropriate, he says. Both the Extended Industry Standard Architecture and IBM MicroChannel buses can accommodate bus-master architectures.



HURDLES TO DSP APPLICATIONS

Some see DSPs becoming omnipresent in PCs by 1994, but a number of obstacles to growth, some of them technological, must be overcome first.

The obvious first step in the march to the motherboard is to use DSPs on add-in cards. AT&T Microelectronics is working with 35 to 45 board companies in applications such as speech, graphics, imaging, sesimic analysis, and industrial control. "Silicon is just one-third of the solution," says Ferro. Another piece of the DSP puzzle lies in creating the algorithms the chips execute. The third is the need for tools to develop specific applications.

Ferro believes AT&T Microelectronics is one step ahead of silicon designers in algorithms because AT&T Bell Laboratories has chosen its chips as platforms for Bell Labs' algorithm development. It is working in a number of areas including speaker-independent speech recognition, neural networks, imaging, and graphics. AT&T Microelectronics intends to integrate these algorithms into its microcode library.

DSP application-development tools represent a very high hurdle for the chip makers. "Say, for example, that you want to do fax, a modem, and speech recognition all on the same PC," says Ferro. "You need tools to put it together. We're working on a high-level environment, something well above assembly language." It has only been over the past year that C compilers for DSPs have entered the market. TI and Motorola offer them with their DSPs, but even these tools are in the first generation. "They could be better," says Next's Page. "Programmers need a good development environment and that takes time. Tools for a new architecture generally take a long time to develop."

Sky Computers Inc., Chelmsford, Mass., has been making DSP accelerator boards for six years, says senior vice president Gerald Shapiro. Until the most recent generation—TI's 320C30—Sky was writing its own C compiler. Shapiro points out that a C compiler for a DSP is a tricky business. "DSPs had the original Harvard architecture—separate program and data memory," he says. Moreover, the data memory is usually segmented as well. "You can have a lot of memory reads and writes in the same cycle," he says, "and that would be very difficult for a straightforward compiler to do."

ON THE OTHER HAND, A high-level-language compiler is not even desirable for all the code. Coding an algorithm calls for assembly language because executing the algorithm is what the DSP does 90% of the time. Efficiency is paramount. The remaining code, which takes up a majority of the coding effort, is where a compiler comes in handy, Shapiro says.

In the case of general-purpose DSPs—as opposed to those dedicated to specific tasks—there is still debate over the virtues of floating-point versus integer architectures and when to choose 16-, 24-, or 32-bit internal buses. "If you want high-quality audio, you need a 24-bit integer chip such as the [Motorola] 56000," says Michael Collins, marketing manager for Motorola's DSP operation in Austin, Texas. Sixteen-bit integer DSPs can deliver au-

dio approximately equal to a telephone's quality. The 24-bit integer—or fixed-point—chip runs audio applications faster than a floating-point DSP because it does not have to operate on a mantissa and an exponent.

"You start to need floating-point for very sophisticated number-crunching applications such as graphics and color, where you need a lot of dynamic range," says Collins. Motorola will introduce its 32-bit floating-point 96000 this month. The 96000 addresses the integer-versus-floating-point design option in an interesting way: it is software-compatible with the 56000, and so provides a relatively simple migration path. The 96000's designers managed this feat by using a 24-bit mantissa and an 8-bit exponent, as defined by the IEEE floating-point standard.

WHILE SOME OF THE large semiconductor houses are busy building general-purpose programmable DSPs, other companies are taking a different route. For example, C-Cube Microsystems Inc. has integrated the International Standards Organization's standard for still-image compression into a DSP that possesses a 328-stage pipeline. Such massive parallelism—general-purpose DSPs have four or five stages—executes the Joint Photographic Experts Committee data-compression standard in real time [*Electronics*, April 1990, p. 95]. The choice between programmable and dedicated DSPs is most likely to be decided on cost. The C-Cube part, which is priced at $155, is most likely to find applications in digital cameras, desktop publishing, and digital video cassette recorders, where there is no need for programmability.

LSI Logic Corp., Milpitas, Calif., has set its eye on the dedicated DSP market and intends to customize the core processor expertise it gained in application-specific ICs to provide quick-turnaround solutions in consumer as well as computer markets. "We can define a chip set in the mold that was used for the PC," says Simon Dolan, DSP marketing manager. LSI is interested in customizations for multimedia PCs, video telephone chip sets, digital still cameras, color facsimile, and, further along, digital VCRs and digital TV.

SGS-Thomson Microelectronics is working both sides of the street. While it markets a general-purpose DSP, it has also customized chips for use in image-compression applications. These include discrete-cosine-transform ICs, motion-estimation chips, and color-space conversion ICs, which transform signals based on the YUV chrominance/luminance coding scheme to RGB coding, says Teri Lasley, image-processing product marketing manager.

In another move toward motherboard integration, SGS-Thomson has also come up with a 16-bit programmable DSP that can handle most modem standards, from the 300-baud Bell 103 to 9,600-baud CCITT V.32. Although its architecture is optimized for modem applications, it also offers the flexibility of being programmable from memory, says Jean Jacques Vey, product marketing manager for the ST18930. The chip is also being used as a hard-disk controller and in satellite applications.

INTO THE REAL WORLD

DSPs are attracting attention because of their ability to synthesize real-world information—speech, music, still and video images.

But RISC processors, such as Intel's i860, are fast attaining the same power.

To keep one step ahead of the RISC chips, DSPs are undergoing architectural boosts and price cuts.

No one expects the general-purpose versus dedicated DSP debate to stop soon. "The interest we see on the part of the PC makers is not to optimize a particular function but to have an overall cost-effective solution," says Rick Rinehart, DSP program manager for TI's Semiconductor Group. "You have to provide a solution with very few chips." In most applications other than video, real-time processing is not a system requirement. By loading different algorithms into a general-purpose DSP, a PC or workstation vendor can offer audio, modem communications, and acceptable image performance.

There is, in fact, a relatively long list of useful algorithms. In the audio world they run the gamut from 2,400-bit/s vocoders to 64 Kbits/s for long-line phone service. CD-ROM-XA—an audio standard for CD-ROM applications—has its own compression algorithm. Facsimile uses CCITT Group 3 and Group 4 standards, and modems require still another set. In imaging, the JPEG standard will someday be augmented by the Motion Picture Experts Group (MPEG) video standard.

Although there is still a lot of sorting out to do in hardware and software, most industry observers speak with one voice on the subject of applications. "Most people have a system-integration approach," says Motorola's Collins, "so first they are going to think of putting a V.32 modem in the box. Once that's there, they can do fax, and they start thinking about speech compression for voice mail and on-line documentation."

As a follow-on to "New Age" systems—workstations and software customized for specific jobs such as brokerage houses or insurance-claim adjusters—Andersen Consulting is prototyping a system that will store both still images and audio. "Very often, an insurance claim starts with a phone call," says Hugh Ryan, an Andersen partner based in Chicago. By combining audio images and transaction-processing technology, Andersen will be able to store the compressed audio on optical disk and index it to images of documents right at the user's personal workstation.

TODAY'S PCs AND WORKstations are essentially mute, and so it is not surprising that Analog Devices' Robertson sees plenty of action in speech recognition. The primary motivating force for this technology will be its universality. "It would be a value-added feature across a broad range of tasks," he says. "It can be used almost the same as a keyboard for input." Board-level speech-recognition products are already on the market but have not caught on because they do not offer speaker independence and have limited vocabularies. Most of the current applications utilize fixed-point DSPs to keep costs down. That is likely to change in the near future. "People are planning to use floating-point chips to do speaker-independent applications and recognize connected speech [i.e., the speaker does not have to stop between words]. Then there will be no limit to what the user can do," Robertson says.

To achieve that level of functionality, however, the high-end chips will have to double their 30-megaflops performance and drop drastically in price. Nevertheless, Robertson expects speaker-independent, continuous-speech products to be available in workstations in one to two years and in PCs within four years.

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SURVIVAL STRATEGIES FOR THE LAN ERA

VENDORS THAT INTEGRATE FUNCTIONALITY IN SILICON ARE CHALLENGING THE OLD-LINE CHIP HOUSES

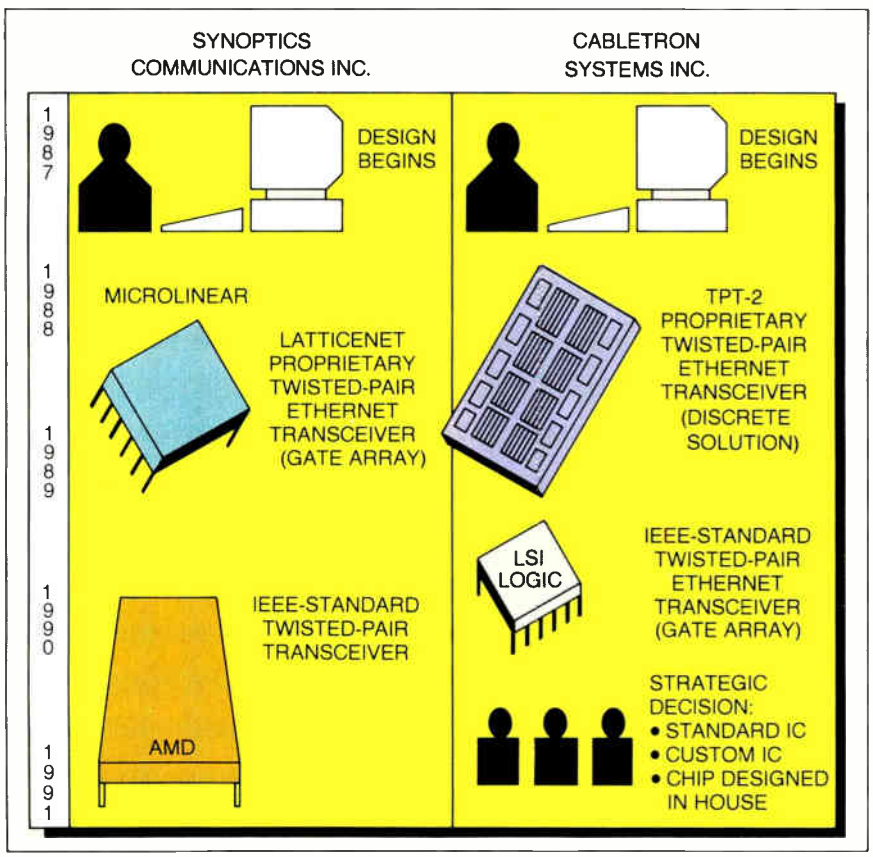
BY JACK SHANDLE

NETWORKS

WHEN THE DECISION makers at In-Net Corp. reviewed the Fiber Distributed Data Interface being forged by the American National Standards Institute, they were more interested in seeing what the various committees had left out of the standard than what they had put in.

The reason: In-Net's business is filling in the blanks with silicon. "We knew there were a number of companies building workstations that will handle real-time images and voice," says Daniel Sze, president of the San Diego company. "We wanted to address those special functions in our FDDI chip set."

To do so, the company's chip designers added circuit-switching and asynchronous time-division-multiplexing capability in their three-chip FDDI chip set. Both features are typical of telecommunications systems, where efficient circuit switching is essential. Now, with working silicon ready to be shown at the International Communications Association show in New Orleans later this month, In-Net acknowledges that success depends on a delicate balance between standards and special effects. "We didn't want to deviate too far from the standard," Sze says. "We embrace FDDI's media-access protocol."



Faced with the same market challenge, Cabletron and SynOptics chose distinctly different paths to twisted-pair Ethernet transceivers.

In-Net's strategy of combining its systems expertise with application-specific integrated circuits to design chips is just one of many instances of networking companies stealing some of the thunder from full-service semiconductor houses. But the chip makers have a game plan of their own. Together, they still account for 90% of sales in communications chips, says Tom Gates, product marketing manager for local-area networks at AT&T Microelectronics, Allentown, Pa. "We have access to systems-level, manufacturing, and design expertise," he says. "That's why we have dominated the field and will continue to do so."

In the FDDI arena, for example, In-Net is looking for a niche while several big chip makers seeking high-volume markets in the 1990s have fashioned FDDI solutions much more narrowly based on the standard. The presence of the In-Nets of the world has, however, forced the big IC houses to radically recast their approach. Now, the chip makers need strategies that go beyond IC design. They must assure their customers that plenty of systems expertise has gone into designing the silicon, and that the

A SPECTRUM OF EXPERTISE

	Standards Involvement	System Design	Chip Design	Advanced Packaging	Fabrication Technology
Systems Houses	Primary focus for early market entry	High level of expertise	Typically uses ASIC technology for in-house designs	Dependent on IC supplier	Dependent on fab
IC Design Houses	Frequently observer status	Varies from company to company	High level of expertise	Dependent on IC supplier	Uses superset design rules of several fabs
Full-service Semiconductor Companies	Becoming more involved and earlier in the process	Acquired by close working relationships with systems houses	High level of expertise	Frequently offers substantial cost savings	Primary strength in the market

Three types of companies have emerged offering different strengths in five areas that affect overall performance. They are network-systems houses, IC-design houses, and full-service semiconductor companies.

solution is flexible enough for small—or even large—systems houses to build in specific added value.

True to the new gospel that holds system functionality supreme, Advanced Micro Devices, Motorola, and National Semiconductor have each addressed the market with more than silicon in their FDDI chip sets. Advanced Micro Devices Inc. has an extensive design-in effort under way with its multicompany Advanced Networking Group. National Semiconductor Corp. also solicited the views of systems houses and has purposely segmented its standard chip set to allow them to add functionality with a gate array. And Motorola Inc. has teamed up with Digital Equipment Corp. to assure its entry to the systems market.

THIS CORNUCOPIA OF DESIGN options leading to a semiconductor strategy for a LAN system is a far cry from the "standard-parts and glue-logic" approach that characterized the LAN industry less than a decade ago. It may also be enough to set the heads of systems-house executives spinning—but it is the wave of the future.

The key factors influencing their decisions are familiar enough. They are time-to-market, which is especially important as new LAN standards takes shape; marketing and distribution channels; and cost, which becomes increasingly important as any particular LAN technology matures. The companies that are offering solutions fall into three major categories: network-systems houses, IC-design outfits, and full-service semiconductor manufacturers. Each brings particular strengths and weaknesses in a number of key areas, including standards involvement, systems expertise, chip-design savvy, fabrication, and advanced packaging.

How deeply a company becomes involved in standards creation is largely a matter of choice. But the decision is limited by the manpower available to attend the meetings, which means smaller firms must be more selective about which technologies they pursue. Systems expertise is largely the province of the systems houses, and partnerships between them and semiconductor firms to meld the two domains are becoming more common. Chip-design expertise is a more contentious issue, with full-service chip companies vying with foundry-less design houses for the best talent. Process technology and packaging are mostly the realm of the semiconductor manufacturers.

WHILE EACH SPECIALTY HOUSE TOUTS ITS BETTER MOUSETRAP, THE BIG IC OUTFITS COUNTER WITH OTHER SERVICES, INCLUDING ADVANCED TECHNOLOGIES

The first LAN technology to evolve in this new semiconductor/systems environment was a variation of Ethernet that runs on conventional, unshielded, twisted-pair telephone lines. Specifications for the IEEE 10-BASE-T standard were not clear until mid-1989, yet several companies—among them Cabletron Systems Inc. of Rochester, N. H. and SynOptics Communications Inc. of Mountain View, Calif.—were convinced that twisted-pair Ethernet would become a big market.

ALTHOUGH THEY FACED the same market challenge and are approximately the same size—Cabletron had $55 million and SynOptics $40 million in sales during the last fiscal year—the two companies have followed distinctly different paths in devising a semiconductor strategy.

To get to market early, in 1987 each began designing an Ethernet solution that ran on twisted-pair wiring. Since the 10-BASE-T standard was far from stable at the time, both solutions were proprietary: they looked like Ethernet, they quacked like Ethernet, but they weren't 10-BASE-T. The similarity ends there. Cabletron opted for a discrete solution to implement its proprietary twisted-pair transceiver, while SynOptics went for a gate array.

At the time, "chip vendors were hesitant to develop a semiconductor-based solution because the standard was not firm enough," says Chris Oliver, Cabletron's director of engineering. Volume shipments of the proprietary TPT-2 began in April 1988. Meanwhile, SynOptics chose to implement its transceiver

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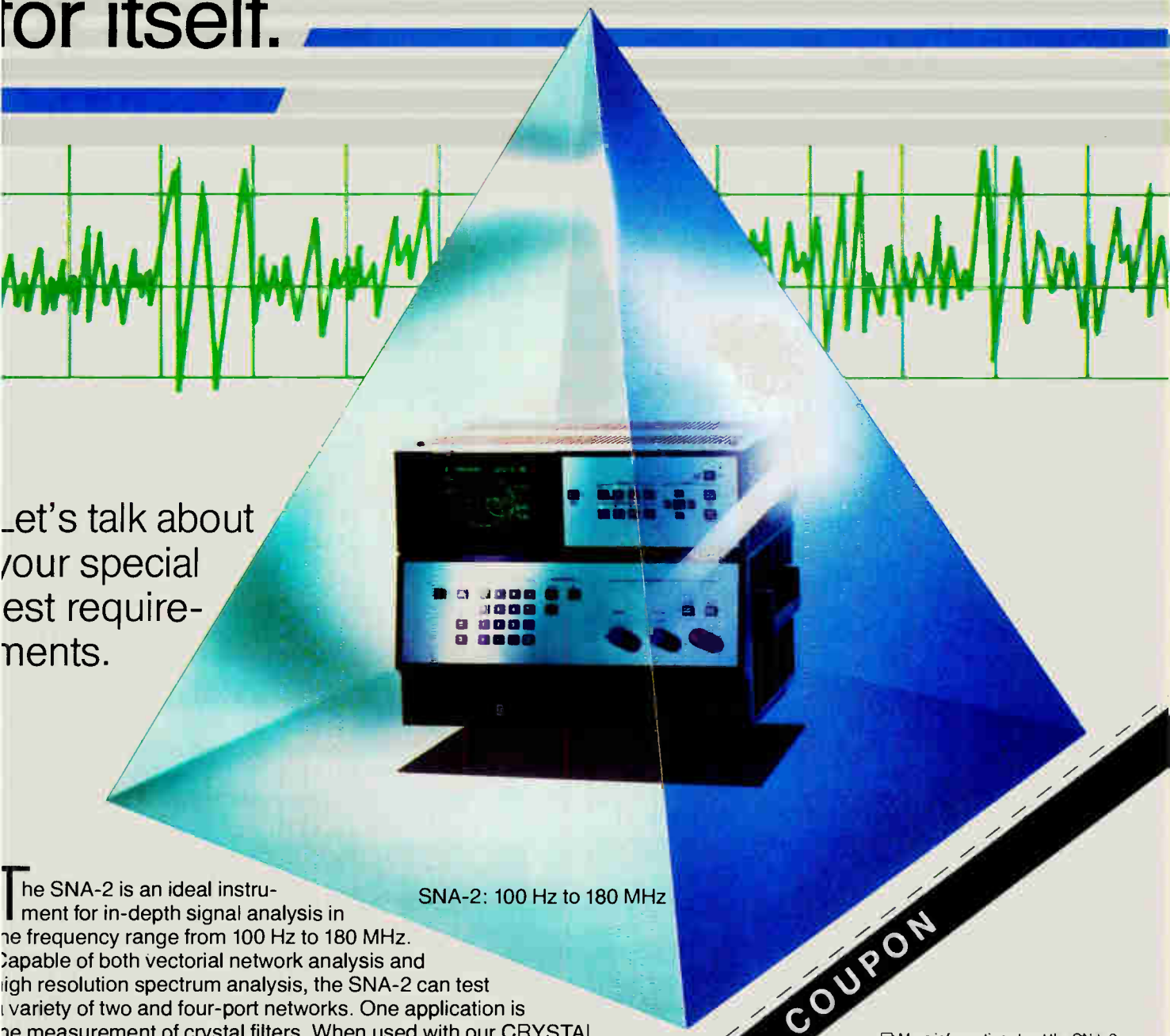

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using Microlinear Inc.'s gate-array technology. "Our strategic goal at that time was to get to market and see what we could do to lower the cost of connections to the desktop," says William Lanfri, vice president for business development at SynOptics. LatticeNet began shipping in volume in January 1988.

CABLETRON'S TPT-2 WAS ON the market less than six months when the company's design team started on a standard 10-BASE-T solution, this time using LSI Logic Inc.'s gate-array technology. Since the standard was still being hashed out, the chip's design was changed five times in 12 months to track the committee's efforts, says Oliver. Beta testing started in August 1989 and Cabletron was shipping a 10-BASE-T solution by November, he says. Meanwhile, SynOptics continues to sell LatticeNet and instead of introducing another gate array, it has opted to go with a standard part produced by AMD, which will be available in mid-1990. "Retrofitting will be a relatively simple procedure," says Lanfri.

The decision to wait until a standard-part transceiver was available was "not technology-driven," Lanfri says. "Infrastructure, distribution, and support factors drove it. We are not in the right spot in the sales cycle to reach the design engineers at the right time." SynOptics has more than a vendor-customer relationship with AMD, he adds. It lent its expertise in design verification and testing as well as its knowledge of the application to AMD. "We have a lot of experience making Ethernet run on phone wire," he says. "That is something that AMD would have had trouble with."

Meanwhile, Cabletron, with a standard gate-array solution in the market, is not convinced it wants to go the standard-part route. "It may be a full-custom chip just for us, or an in-house development, or a standard part," says Oliver. "We're looking at what the semiconductor companies will have; it could be better from a cost perspective." In any event, Cabletron will decide in July and be in production with its third-generation solution by February 1991. Like SynOptics, it has been deeply involved with specifying the design of 10-BASE-T silicon with major semiconductor companies. "We can influence their designs greatly and get a better-performing chip," says Oliver.

But the teaming of systems houses with chip makers is not the end of the evolutionary path in 10-BASE-T. Design houses such as Level One Communications Inc., Folsom, Calif., strongly believe they have something special to bring to the party. "We have more design engineers with this particular focus than there are at the larger companies," says François Crepin, vice president of marketing. "This is a commodity product and we have to do it better if we want to win."

Level One integrated on-chip pre-equalization and harmonic suppression filters. "That is something we think no one else will have," says David Wong, manager of the LAN Division. "And we can do it in a cost-effective way." Level One also mixes analog and digital circuits on-chip rather than the more common method of segregating the two on separate chips.

A FULL FIELD OF VENDORS

The big chip makers still account for 90% of sales in communications chips; they're selling design and manufacturing expertise and now are scurrying for systems savvy too.

But they're facing a big challenge from smaller systems-oriented vendors that are adding value to their LAN chip sets by designing in special functions.

Level One clearly thinks it has designed a better mousetrap, but the big IC houses are no slouches at design either, and they have other services to sell as well. One is a migration path of advanced technologies. "Systems houses and design houses do not have immediate access to leading-edge biCMOS and emitter-coupled-logic technologies," says Gary Johnson, strategic marketing director at National Semiconductor Corp., Santa Clara, Calif. "They are our crown jewels. We use them in our most forward-looking products."

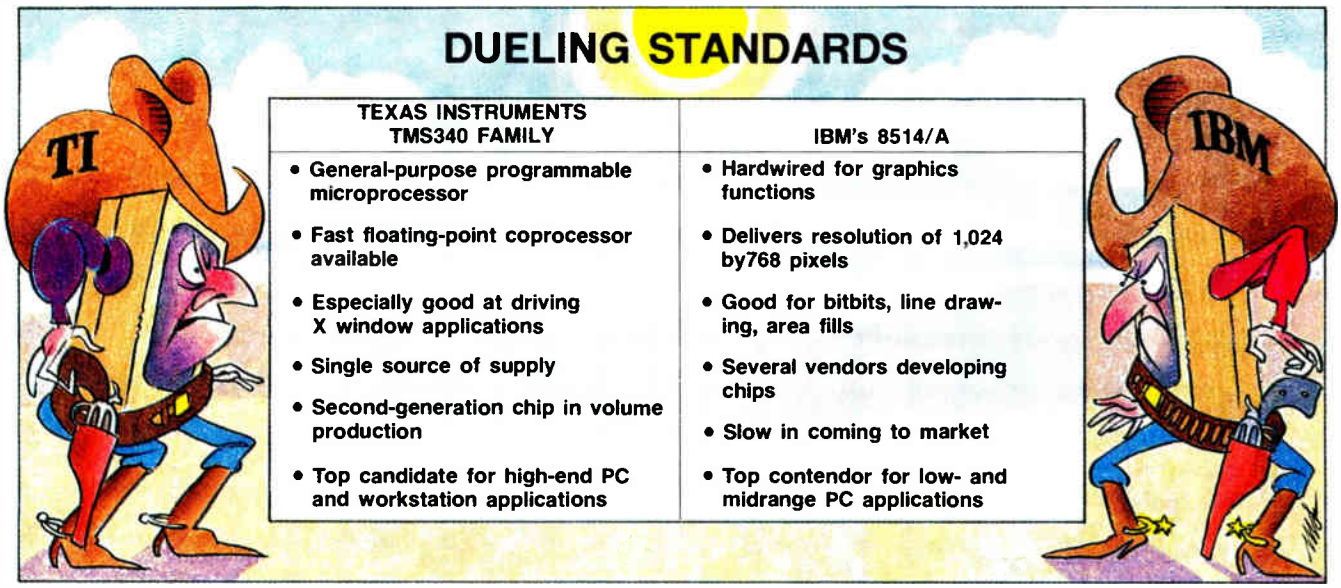
Level One's Crepin does not agree that access to advanced process technologies is the design houses' Achilles heel. He even considers it something of a virtue. "We deal with several foundries," he says, "and our design rules are supersets of the design rules of the foundries. And we are using standard 5-V CMOS, not exotic biCMOS."

National's strategic response to the rising tide of design houses and systems houses that design their own chips was to reorganize into autonomous business units that address specific markets such as communications. The result, says Johnson, is an operation as agile as a small company's, but with access to National's technology infrastructure. To acquire systems expertise, it teams up with systems houses. To get a handle on LAN standards, it participates actively in standards-making bodies. Even though they are defining a system, not a chip, the LAN standards committees these days are overrun with chip company representatives. "National generally works with a number of key players," says Johnson. "We get into standards participation early. When you look at the big investment you need, it makes sense to have a number of partners."

National's strategy is typical of the way the semiconductor industry is being recast. The shining example of early participation in standards formation was AMD's FDDI effort, which produced a chip set at least a year before the competition. "It was intense and painful," says Tim Propeck, AMD's vice president of corporate marketing. "In a complex area such as networking it really pays to team up with a system manufacturer that understands network management. In our case [with FDDI], we had access to systems-house customers very early on who were also members of the committee."

ONE LUCRATIVE SPINOFF from the restructuring that the chip companies have accomplished over the past few years is a new group of products that AMD refers to as semistandard parts. "We are making quite a business of it," says Propeck. Systems houses begin with the core of an IC design—the Ethernet controller, for example—and ask AMD to build customer-specific functions around it. "We coined the term semistandard," he says. "Eighty percent of the part is standard and interoperable and the other 20% is defined by the customer."

Whether it be Ethernet, FDDI, or some other type of networking, the PC and workstation have changed forever the silicon strategy of both chip makers and chip consumers. "PCs are far and away the No. 1 target market in semiconductor networking products," says TI's Adams. National's Johnson adds: "It is interesting to see how many of our products today come out of the back of a PC."



IBM AND TI SQUARE OFF IN POST-VGA GRAPHICS

CHIPS IMPLEMENTING BIG BLUE'S 8514/A STANDARD ARE FINALLY ARRIVING TO COMPETE WITH THE TMS340 FAMILY

BY LAWRENCE CURRAN

WITH THE ADVENT OF high-performance graphics chips, personal computers are evolving into graphics workstations, driven by add-in cards that execute graphics functions much faster than the host processor can. Now PC users with applications ranging from desktop publishing to computer-aided design and medical imaging want ever higher resolution, prompting chip, board, and monitor makers to push beyond the 640-by-480-pixel standard embodied in IBM Corp.'s Video Graphics Array.

Less than a year ago, developers of graphics boards were contemplating as many as four approaches to achieve resolutions greater than VGA's [*Electronics*, July 1989, p. 66]. Since then, the industry has done some sorting out and appears to be settling on two primary performance niches. Those niches will be filled by hardwired chips and boards implementing IBM's 8514/A hardware standard or by Texas Instruments Inc.'s TMS340 family of programmable graphics microprocessors.

GRAPHICS

The niche for the 8514/A standard is characterized by displays having 1,024-by-768-pixel resolution and needing fast execution of bit-boundary block transfers (bitblts), line drawing, and area-fill commands. But there's no need for heavy computation. Those requirements make 8514/A especially suitable for executing CAD programs such as Autodesk Inc.'s popular AutoCAD.

The TMS340 family and its related architecture, on the other hand, are resolution-independent. TI's solution appears to be winning favor to drive high-performance displays used in CAD and imaging, applications that usually call for resolutions at least as great as 8514/A. Some, such as combined graphics and imaging, also require extensive computation, for which a general-purpose microprocessor is well suited. TIGA—for Texas Instruments Graphics Architecture—is described by TI as an interface that manages communications between the PC and the 340 processor. An interprocessor communications protocol links an application program or software-environment driver to a library of standard TIGA or custom-graphics functions that run on the 340.

TI is winning sockets because of the availability and performance of its TMS34010, TMS34020, and TMS34082 chips. The 40-to-60-MHz TMS34010, introduced in 1986, has gained substantial software support and market momentum. Its very availability has established TI in PC and workstation graph-

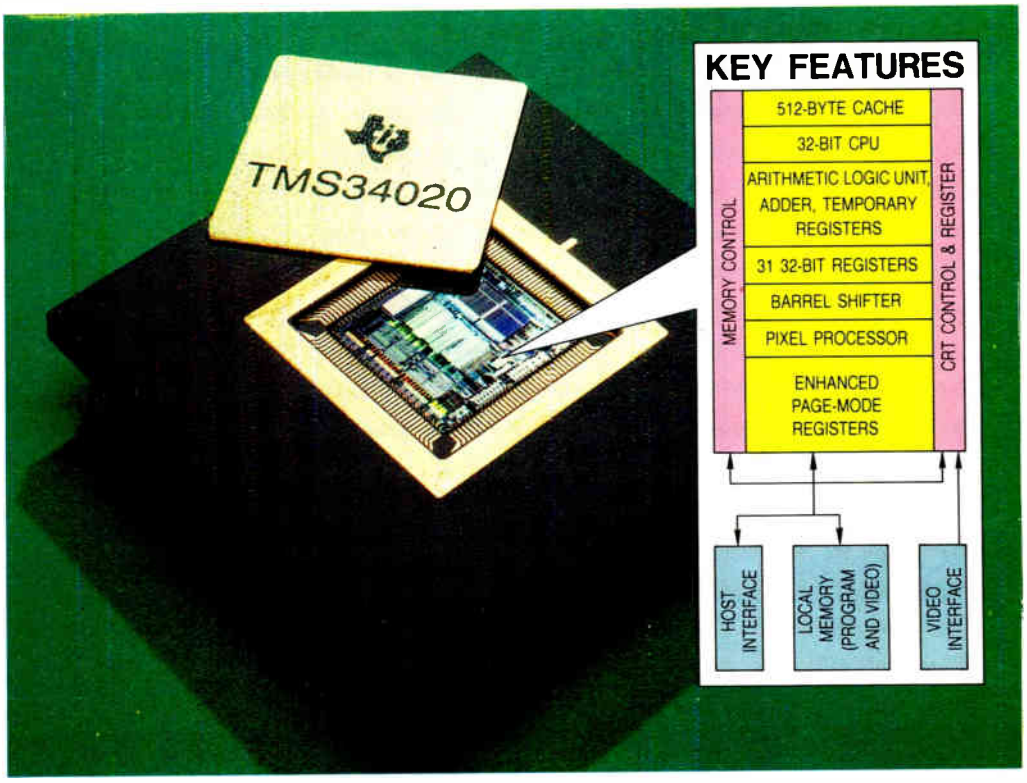
ics. Two months ago, TI unleashed the 32-MHz 34020, and the company cut prices for both processors, further enhancing their appeal.

At least one close observer, however, isn't convinced there's yet a substantial market for beyond-VGA resolution, simply because prices for graphics boards and monitors still haven't provided enough incentive for PC users to go beyond 640 by 480 pixels. Michael Slater, editor of the *Microprocessor Report* in Palo Alto, Calif., says that both 8514/A and TMS340 backers "are concerned about how to get people to move out of VGA into either of those. I see a reluctance to go beyond VGA, because prices need to come down." Slater points out that PC users pay about $1,000 for a VGA board and monitor today versus $1,000 for an 8514/A monitor and $500 for a board.

The latest graphics boards using the TMS340 family sell for almost $4,000, but those are for high-performance, high-resolution (1,280-by-1,024-pixel) applications that combine graphics with real-time imaging. TI is promising pricing that will result in 34010-based boards selling this year for less than $600 and 34020-based boards for less than $1,000.

Meanwhile, only one company—Western Digital Corp.—is known to be delivering chip sets that implement 8514/A, even though it's been almost three years since IBM advanced the standard. The need to address the 8514/A standard through a set of on-chip registers has hampered chip development, because IBM hasn't provided public definitions of the registers it uses in its own 8514/A devices.

Further, rumors that IBM will cripple 8514/A advocates by coming out with a standard that goes beyond it have contributed to delays in both chip and board development. The 8514/A camp, however, appears convinced that IBM isn't ready to curtail the market with a beyond-8514/A announcement this year. In fact, they say, IBM showed substantial support for the standard in its exhibits both at last fall's Comdex show and at the National Computer Graphics Association show in March. "IBM dedicated about 25 feet of counter space to 8514/A at Fall Comdex," says Jim Anderson, director of graphics product marketing at Headland Technology Inc. "Everything I see suggests that IBM hasn't done anything to modify its 8514/A support."



WINNING SOCKETS

TI has a leg up on IBM because its TMS340 family has been out longer than 8514/A implementations; the second generation is the just introduced TMS34020.

HEADLAND IS ONE OF several firms developing chips that implement 8514/A. Rumors have circulated since Comdex that the Fremont, Calif., company had dropped its 8514/A effort, but Anderson says otherwise. He's not happy that Headland's chips won't be ready until late this year, but insists "we're going ahead with the project. A lack of focus had caused some delays, but we're now going forward."

As the only chip vendor delivering 8514/A silicon in production quantities, Western Digital is offering a chip set based on the company's PWGA1 graphics controller chips. Western Digital expects this to be the year 8414/A takes hold in the market, says William Chu, vice president of engineering at the company's Mountain View, Calif., facility—assuming IBM doesn't throw a monkey wrench in the works.

The remaining silicon vendors known to be developing 8514/A chips sets are ATI in Toronto, Canada; Chips & Technologies in San Jose, Calif.; Integrated Information Technologies in Santa Clara, Calif.; and Trident Microsystems in Sunnyvale, Calif.

The next 8514/A chip expected to reach volume production will come from Chips & Technologies Inc. Roger Reak, director of graphics marketing, says the company will have silicon out this month and should be in volume production soon after that. The single-chip design is the 82C480 graphics controller. Reak points out that because of the number of players coming into the chip segment, the competition will result in 8514/A boards priced in the $500 ballpark. "There's a sizable market window for an add-in board at that price," he says.

Having chips available from multiple sources should help to fill the 8514/A pipeline this year. Dataquest Inc., the San Jose, Calif., market research organization, estimates that some 930,000 chip sets for beyond-VGA applications will be

sold this year. Of that total, some 400,000 are expected to be 8514/A chips, with most of the remainder from the TMS340 family. However, Dataquest projects a shift by 1993, with 3.1 million 8514/A chips shipping against 1.7 million TMS devices. The estimate "is based on our expectations that the 1,024-by-768 market is ready to start growing," says Sohail Malik, Dataquest's graphics specialist. "The supply of chips has been limited until now."

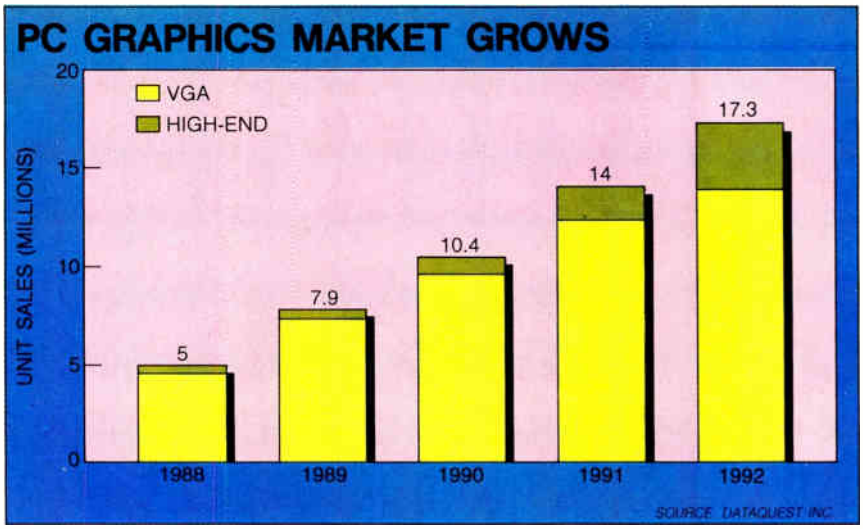
Meanwhile, TI's top-dog position with the 34010 has generated important early acceptance for the faster 34020. At least three firms have announced high-performance boards that use the 34020 and TMS34082 floating-point coprocessor. For example, Matrox Electronic Systems Ltd., Dorval, Canada, has built its Image series—which combines high-performance graphics with real-time imaging—around the 34020/34082 [*Electronics*, October 1989, p. 102].

OTHER COMPANIES THAT have committed to the 34020/34082 are Imagraph Corp. of Chelmsford, Mass., and Univision Technologies Inc. of Burlington, Mass. Imagraph's approach is to offer its 34020-based ITX-1210 board and an optional daughterboard housing the 34082 for high-perforfmance combined graphics and imaging applications.

Univision is also addressing dual graphics-imaging needs, but has put both processors on the same board to get 1,280-by-1,024-by-32-bit resolution. Univision's price of $3,895 is $100 less than Imagraph's, but both are in a price region that's well above the mass market for PC graphics.

So while 1990 should be the year that 8514/A chips begin to flow to board users in substantial numbers, TI has already moved into its second-generation graphics microprocessor. Nor does it appear that TI will be content to focus primarily on the high-performance, high-resolution graphics applications that begin where 8514/A ends. The company has an aggressive strategy intended to make the TMS340 family and the TIGA architecture the next PC graphics standard.

The TMS340 family is designed into more than 200 products to date, says Karl Guttag, graphics strategy manager for TI's Microprocessor Division in Stafford, Texas. Industry sources estimate that TI has already shipped well over



500,000 TMS340-family chips this year, with a growing number of them being 34020s. TI's TIGA products directory includes a partial list of more than 40 software applications for which universal TIGA software drivers are or soon will be available.

Importantly, that TIGA directory also numbers more than 260 applications that run via the Microsoft Windows environment. That market "is a whole new animal," says TI's Guttag. "There may be 100,000 of them shipped this year, and we're designed into every X Window terminal we know of." That list includes terminals from Digital Equipment, Hewlett-Packard, Tektronix, and—significantly—IBM itself, with the IBM Xstation 120 X server terminal. This unit is part of IBM's new RISC System/6000 [*Electronics*, April 1990, p. 32]. Guttag says that 8514/A isn't easily compatible with X Window applications because the chips "don't accelerate pixels properly. Even IBM didn't use 8514/A in its X terminal."

Some in the industry see appropriate niches for each kind of chip. Western Digital's Chu, for example, sees 8514/A becoming the beyond-VGA PC standard and the TMS340 more appropriate for high-performance workstation graphics. "At 1,024-by-768 resolution, users are happy with a 14- or 16-in. screen, which is more a PC product," says Chu. "Going to 1,280 by 1,024 dictates a 19-in. screen. That's the workstation market, and TIGA will play very well there."

Slater of *Microprocessor Report* believes that 8514/A vendors "have a chance to get some of the business-graphics market as it moves up from VGA, though that's happening slowly. But 8514/A won't be the high-resolution standard. The 340 series will be far more important than 8514/A in the high-performance high-resolution market."

Indeed, says Dataquest's Malik, the lower- and midrange machines constitute the mass market, "where buyer behavior favors the 8514/A." But he sees TI competing for more business there than some 8514/A backers do. The three issues that influence the mass market are price, performance, and standards-compatibility.

"No matter what anyone tells you, pricing for TI and 8514/A will be a wash," Malik says. "There's a [price] comfort level that TI is already meeting." As for performance, "the issue is bandied about a lot, but 8514/A chips will perform well, too, so performance will be a wash, as well." An intangible is IBM's clout in setting a standard, which Malik believes will sway buyers to 8514/A. "Multisynch monitors will drive the retail part of the mass market, and users will ask what kind of graphics board goes with those monitors. And there will be five shrink-wrapped 8514/A packages for each TI package."

POST-VGA GRAPHICS

To get higher resolution than VGA's 640 by 480 pixels, the industry is turning in two directions.

IBM's 8514/A standard handles 1,024-by-768-pixel resolution but can't do heavy computation. TI's TMS340 processors can provide higher resolution plus extensive computation, suiting them for combined graphics and imaging.

HARD-DISK CONTROLLERS GET READY TO RUMBLE

AS BUSINESS HEATS UP, MARKET LEADERS LOOK TO HORN IN ON ONE ANOTHER'S TERRITORY

BY JONAH McLEOD

STORAGE

MAKERS OF EMBEDDED controllers for hard-disk drives are gearing up for what promises to be an intense and protracted contest for market share. Chip makers that now dominate the various market segments that make up the hard-disk controller business are setting their sights on one another's territory. Meanwhile, new players—some of which boast impressive credentials—are hoping to claim big portions of the market for themselves.

At stake is a market that will experience heady growth for the next few years, most observers say. William P. Tai, an analyst in the San Francisco offices of investment firm Alex. Brown and Sons, predicts double-digit growth for the next few years. Adaptec Inc. of Milpitas, Calif., one of the companies competing for the hard-drive controller market, expects unit shipments of hard drives with embedded controllers to jump from 14 million units this year to 25 million units in 1992.

Hard-disk controllers for personal computers and workstations generally fall into one of three categories. The first includes controller chips that work with drives connecting directly to the bus of the IBM Corp. Personal Computer AT and compatibles. The other two segments involve controllers for drives based on the Small Computer System Interface (SCSI) standard; one segment provides the host-adapter chips that are placed on the computer's motherboard, and the other makes the controller chips to be embedded in the SCSI hard drive.

Recently, a fourth market segment has started to form: embedded controllers for hard-disk drives adhering to IBM's MicroChannel architecture.

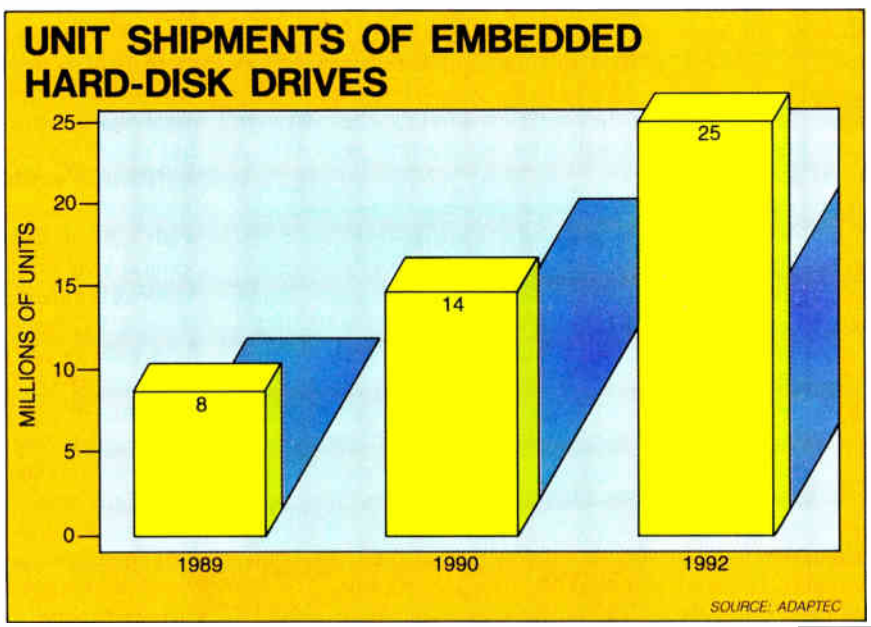
Disk controllers consist of a data separator, which extracts digital data from the continuous analog signal detected by the disk drive's read/write head; a serializer/deserializer, which converts bits to bytes and vice versa; and the disk controller itself, which directs the mechanical operation of the drive. A microprocessor on the controller interacts with the host computer bus, doing such tasks as directing overall controller operation and performing error correction.

Currently, Cirrus Logic Inc. of Milpitas leads the market for PC AT hard-drive controllers, says Kevin Landis, an industry analyst at Dataquest Inc. in San Jose, Calif. Adaptec's AIC-6110 is the leading embedded-controller product for SCSI drives, he says, while NCR's Microelectronics Product Division in Colorado Springs is on top in the SCSI host-adapter business.

Adaptec recently has made forays into both Cirrus's and NCR's territory, as well as into the fledgling market for MicroChannel-compatible controllers. Adaptec's new AIC-6060 is a direct challenge to Cirrus's dominance of the PC AT controller market, and the AIC-6260 is a SCSI host-adapter product geared toward the burgeoning market for laptop computers.

Cirrus, meanwhile, recently released the CL-SH265, an updated version of its SH260 PC AT controller, and is returning Adaptec's fire with the new CL-SH255, an embedded controller for SCSI drives.

The three market



leaders have more than one another to worry about. Western Digital Corp. of Irvine, Calif., is posing a strong challenge to NCR's hold on the SCSI host-adapter market with its second-generation offering, the WD33C93A. Chips & Technologies Inc. of San Jose now offers products for all three segments. National Semiconductor Corp., Santa Clara, Calif., has been hinting at a move into the hard-disk embedded controller market as well.

And a number of disk-drive manufacturers, including Seagate Technology of Scotts Valley, Calif., and Milpitas-based Quantum Corp., are building their own controller chips using foundry services from such vendors as Texas Instruments Inc. of Dallas.

Because of the increased competition, Landis doesn't see boom times ahead, even if unit sales grow sharply. "The hard-disk controller market will be worth $400 million in 1990," he says. "Because average selling prices will fall, revenue growth will be flat by 1993." G. Venkatesh, marketing manager at Adaptec, agrees that prices will begin to fall, but not nearly enough to flatten revenue growth. "There will be a drop in average selling prices on the order of 20% to 25% a year, but there will be revenue growth on the order of 50% to 60% per year," he says.

Adaptec is counting on that revenue growth to help sustain its aggressive moves into other market segments. The company's new AIC-6060 is pin- and register-compatible with the Cirrus CL-SH260, which now reigns as the de facto industry standard for PC AT embedded hard-disk controllers. Venkatesh claims that the AIC-6060 outperforms the SH260 by 50% and offers additional write-only branch registers that give makers of controller boards and hard drives more flexibility in programming the device.

According to Venkatesh, Cirrus has about 60% of the embedded PC AT controller market. With the AIC-6060, Adaptec hopes to wrest half that market share away from Cirrus, he says. Cirrus, of course, isn't ready to relinquish its position; this month, the company is slated to roll out the CL-SH265, an enhanced version of the SH260.

Mike Liccardo, marketing manager for Cirrus, says the SH265 is built to handle the variety of new performance demands brought on by faster central processors and quicker, more powerful disk drives. Newer hard drives pack more bits inside each track and use encoding schemes to compress even more data inside each track. Combine this with the fact that the new drives rotate at higher speeds, and the result is higher data transfer rates.

"The SH265 can handle data rates up to 25 Mbits/s," Liccardo says; previously, data rates of 7.5 to 10 Mbits/s were the norm. The chip also features an improved proprietary error-correction code (ECC).

"As data rates rise, better ECC is needed to detect and correct errors," he says. "The code must allow the controller's embedded microprocessor to correct the error on the fly and still handle data coming off the drive."

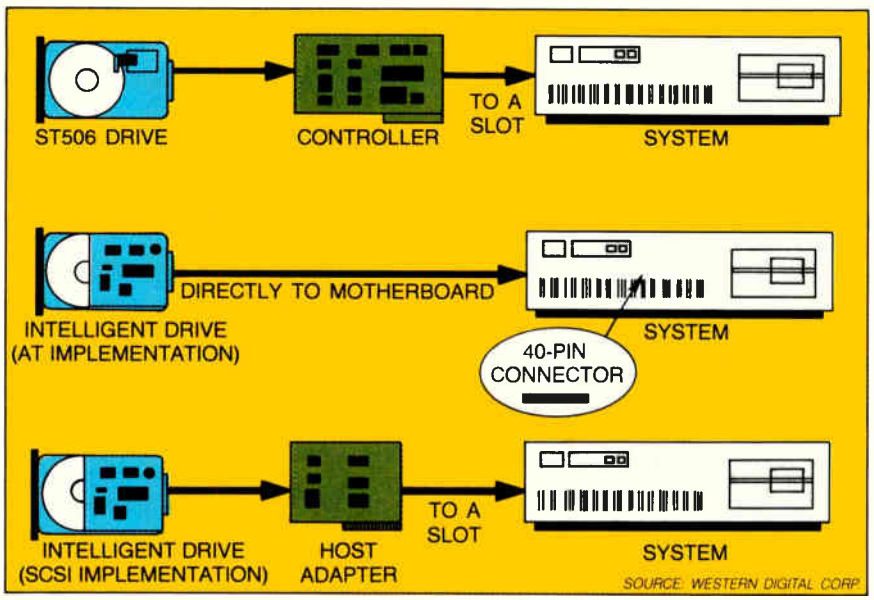
Disk-drive makers are also increasing storage capacity by cramming more tracks onto the disk surface. In such designs, keeping the read/write head accurately positioned over a narrower track that is positioned closer to adjacent tracks is a problem, particularly if servo information is located between sectors. Newer drives now put servo information inside the sectors, along with data. The SH265 is the first low-cost chip that supports this feature.

The SH255 is aimed at the low end of the PC product line rather than high-end systems like workstations. "The chip sells for tens of dollars, not hundreds," says Liccardo. He sees the new low-cost asynchronous SCSI chip doing well in small systems, including laptop computers, fax machines, and other office equipment.

Along with Cirrus and Adaptec, Western Digital has a major stake in the PC AT embedded controller business. Western Digital uses its WD42C22 controller in the hard drives that it manufactures itself. Liccardo estimates that Western Digital ships several hundred thousand drives a quarter. "Because we're in the disk-drive business, we don't have a large OEM base," says Rich Rutledge, marketing manager of the Storage Products Division at Western Digital.

While Cirrus continues to focus on the AT market, Adaptec has jumped aggressively into the embedded drive market for the MicroChannel bus as well. The AIC-6190, unveiled last September, is the first mass-storage controller for the MicroChannel architecture. The AIC-6190 was designed to handle the complex I/O activity between the MicroChannel bus and disk drives. It features a programmable sequencer that enables it to be used with hard, floppy, tape, and optical drives, Venkatesh says. The $30 chip can emulate all three PS/2 disk-control register set and enables the user to implement all of the disk-control interface of the PS/2 Models 50 and 80.

One drawback of having embedded controllers that are designed for a specific computer bus, whether it be the PC AT, MicroChannel or, EISA (Extend-



HARD-DISK OPTIONS

In early ST506 drives, controller functions were assigned to a separate board; newer PC AT and SCSI drives include controller functions.

ed Industry Standard Architecture), is that each drive requires a unique software driver that may or may not change with each new generation of embedded drive. A less restrictive solution is to build a SCSI port on the motherboard and then daisy-chain as many as eight different peripherals on the SCSI bus.

With its AIC-6110, Adaptec accounts for about 75% of the market for embedded SCSI drives, Venkatesh says. However, just as Adaptec is invading Cirrus's turf in the embedded PC AT market, Cirrus is going after the SCSI market. Last November, the company rolled out its CL-SH350 chip, which is aimed at the workstation market; this month, it is set to unveil the CL-SH255, a SCSI chip for the PC market.

The CL-SH350—which is based on SCSI-2, the latest implementation of the SCSI standard—employs synchronous and asynchronous initiator and target protocols and can handle data transfer rates of up to 5 Mbytes/s in synchronous mode. SCSI is a master-slave architecture that requires an initiator on the host side to direct I/O requests to target SCSI devices on the device side. The chip can be embedded on the drive as a target processor—it cannot initiate SCSI bus operations—or it can serve as an initiator on the host adapter that interacts between the host's system bus and all peripherals.

Also in the SCSI arena, Western Digital offers the WD-33C93A. Western Digital boasts two impressive customers: IBM is using the chip in the 320-Mbyte, 3.5-in. drive it has announced for its R6000 Unix workstation, and Exabyte Corp. of Boulder, Colo., is using the WD-33C93A in its EXB-8200, the 2.3-Gbyte tape drive that is being sold with the IBM workstation. In addition to endorsing SCSI for its R6000, IBM has embedded SCSI drives for its PS/2 Models 60 and 80.

CONTROLLER WARS

Makers of controller chips for hard drives are challenging one another's market strengths.

Although unit sales of embedded controllers for hard drives will grow, prices are expected to fall sharply.

For makers of SCSI controllers, laptop computers and workstations represent major opportunities.

The battle over the host-adapter portion of the SCSI design may become as intense as the market wars regarding PC AT drive controllers and embedded controllers on SCSI drives. NCR achieved the first big design win in this market, when Apple Computer Inc. of Cupertino, Calif., chose the NCR 53C80 as the host adapter for its Macintosh computers. The 53C80 or an equivalent is found in all Macintoshes.

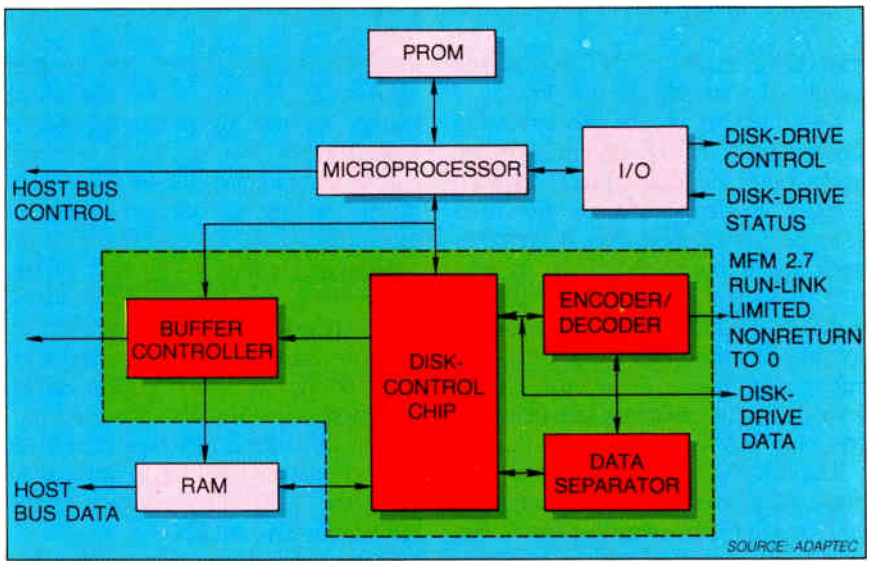
The market for host-adapter chips is splitting into two segments: one for lower-end PCs, the other for workstations. For example, last August NCR rolled out the 53C700 SCSI host-adapter chip designed specifically for workstations. The main difference between the 53C700 and chips targeted at PCs is speed. "The 53C700 does all the commands for getting on and off the SCSI bus in microseconds instead of the milliseconds of other devices," says David Skinner, NCR product manager in Colorado Springs. Instead of connecting into a computer's I/O bus, the 53C700 is designed to plug into the much faster processor-to-memory bus, which enables very high-speed data transfers.

At least one NCR competitor thinks NCR's approach is less than ideal. "Plugging directly into the processor-to-memory bus could create problems for system design," says Jeff Miller, vice president of marketing at Adaptec. "The chip has to steal processor cycles from the CPU to perform those high-speed transfers."

NCR's main competition in the SCSI host-adapter business for PCs and workstations so far has come from Western Digital, with its 33C93A, and Adaptec, with its AIC-6250. Both companies see an opening to topple NCR from the top of the pile. "The 53C80 needs microprocessor intervention, while the 33C93A has a state machine on-chip to manage the SCSI interface," says Rutledge of Western Digital. "What takes other chips up to 12 interrupts to do, the 33C93A does in only three interrupts."

Adaptec is introducing its newest offering for the SCSI host-adapter market, the AIC-6260, this month. The company hopes to dominate this business for PCs and laptop computers just as NCR established its position in the Macintosh. The AIC-6260 can sustain synchronous or asynchronous data transfer rates as high as 4 Mbytes/s. It supports second-part direct memory access transfers and has a 128-byte buffer for programmed I/O operations.

The low price tag of the chip (under $30), its high level of integration, and its special power-down features make the AIC-6260 well suited for laptop computers, Miller says. He believes SCSI will find greater acceptance on the motherboard in portable products because the lack of plug-in cards demands one port to drive a variety of different peripherals. In Miller's view, the company that wins the battle for the PC motherboard will win the embedded-control market war. E



CONTROLLER FUNCTIONS

In a disk controller, a data separator extracts digital data via the read/write head, and the microprocessor interacts with the host's bus.

LOTUS DEVELOPMENT

ALLIANCE YIELDS BROADER SOFTWARE PRODUCT BASE, STRONGER MARKETING REACH FOR EACH

LOTUS-NOVELL MERGER SURPRISES INDUSTRY

BY LAWRENCE CURRAN

IF THE BEST merger is one that equally benefits both sides, then the recent Lotus-Novell marriage is an ideal match. In one surprising leap, Lotus Development Corp. by merging with Novell Inc. overcame any lingering image that it's a one-product company, and at the same time put itself on a near-equal footing in competition with arch-rival Microsoft Corp. of Redmond, Wash.

Lotus is tailoring 1-2-3 release 3 for multiple platforms; this version runs on Sun workstations.

The resulting corporation, whose two sides should benefit from being able to market each other's products, will top $1 billion in revenues this year. The combined catalogs encompass a range from application programs to operating systems, and from spreadsheets through data bases to the critical networking environment. Being able to offer that spectrum will only heighten Lotus's ability to compete with Microsoft, which by itself will crack $1 billion this year using a similar product breadth.

Novell, the Provo, Utah-based supplier of the NetWare network operating system software, will become a wholly owned subsidiary of Lotus under terms of the merger, which is expected to be blessed by the boards and stockholders of both companies in July. Novell had 1989 revenues of $422 million, mostly through value-added resellers and systems integrators.

Lotus, based in Cambridge, Mass., had revenues last year of $556 million, derived primarily from sales of the company's ubiquitous application software, the 1-2-3 spreadsheet. Lotus has a substantial direct-sales force that handles corporate accounts and retail computer stores. The merged company is expected to have 1990 sales of some $1.2 billion. Analysts project Microsoft's 1990 sales to come in at about $1.1 billion at the end of June.

When the intent to merge was announced last month, Jim Manzi, Lotus chairman, president, and chief executive officer, termed it "an absolute merger of equals." Manzi retains those titles; Ray Noorda, formerly Novell's chairman, president, and CEO, becomes vice chairman of Lotus and remains CEO of Novell. Manzi says the two organizations will remain as two stand-alone businesses because "it would be ludicrous to disrupt that."

Noorda sees the world as one of changes, which companies can resist, adapt to, or cause. He and Manzi de-

cided together to cause a change, "but our corporate mission at Novell has always included a dedication to growing the industry, and this merger will do that," Noorda concludes.

But the move caught industry watchers by surprise. Steven Frankel, a longtime Lotus watcher, says he wasn't expecting a merger, "but when you sit back and think about it, it makes sense." Frankel, who is vice president of Adams, Harkness & Hill, a Boston research brokerage firm, points out that application software and networking functions are rapidly merging, "and the degree to which application products are 'networkable' is a very important selling point" for both Lotus and Novell. He sees the merger "leveling the playing field for Lotus vis-a-vis Microsoft."

LOTUS HAS BOUNCED back after a 1988 drop in earnings that resulted mainly from an 18-month delay in getting 1-2-3 release 3 to market. Net income dipped 18%—from $72 million on 1987 revenues of $395 million to $58.9 million a year later, when revenues reached $468.5 million. Then net income jumped 15% last year to $67.9 million. Novell also entered the merger from a position of strength, zooming from below $200 million in 1987 sales to $281 million in 1988 and then topping $400 million last year.

"Networking and the desktop are a significant part of what our customers are worried about, so our ability to integrate desktop tools across a network makes our conversations with our customers more compelling," says Robert Schechter, Lotus's senior vice president and chief financial officer. Those tools include the various versions of 1-2-3, Lotus data-base software, as well as a newer product, Lotus Notes.

The latter allows the exchange of information among popular word-processing, spreadsheet, graphics, and data-base application programs [*Electronics*, January 1990, p. 23]. Notes runs on IBM, 3Com, and Novell personal computer networks, selling for $62,000 in a configuration that accommodates up to 200 users. Schechter says Notes is especially well suited to be sold through the Novell VAR and system-integrator distribution channels.

On the Novell side, Kanwal Rekhi, Novell's executive vice president for development, expects that one of the merger's chief benefits to Lotus will be the access it provides to those very distribution channels. Rekhi says Novell needs the VAR/SI channel because a network product requires a sophisticated sell. "These are high-end people who add value, and the merger gives Lotus access [to them]."

Manzi has no quarrel with that view, pointing out that Novell has targeted small and medium-size companies through the reseller channel. "We hadn't been strong there and had wanted to develop that channel. The merger gets that for us," he notes.

On the other hand, Lotus has strong overseas sales, and has developed a market in Japan that will benefit Novell. "We have a strong presence in Japan, where Novell is just getting started," Manzi maintains. "We can assist with that." Schechter adds that PC networking is "at a very nascent stage there, and Novell should be able to leverage our strong base."

The glitch in the Lotus earnings growth curve two years ago was a symptom of fast growth and too little control of product development. Since then, Manzi has hired Frank King from IBM Corp., whom Manzi says has no equal in running a large-scale software-development organization. King is senior vice president and head of Lotus's Software Business Group.

Lotus has also launched its cross-platform strategy, which is to offer 1-2-3 for important standard platforms. The strategy is paying off. Versions for Sun Microsystems Unix workstations, IBM mainframes, Digital Equipment VAX computers, and for OS/2 and Presentation Manager have been introduced. Still to come is 1-2-3 for the Apple Macintosh. Having Novell as a partner and NetWare as a product should augment sales of all these products.

KONTRON ELEKTRONIK

WEST GERMANY'S KONTRON SEEKS SUCCESS IN THE EXACTING U. S. COMPUTER MARKET

HERE'S THE BMW OF INDUSTRIAL PCs

BY JOHN GOSCH

FEW, IF ANY, EUROPEAN computer companies have made it in the U. S. Even the likes of Siemens AG and International Computers Ltd., although successful at home, have shied from the world's most demanding computer market because their products lack the extra punch that American users are looking for. So when a small West German firm is poised to aggressively compete in the U. S., it must have something special up its sleeve.

Kontron Elektronik GmbH, a $190 million company in Eching, near Munich, is convinced that it has. Recently acquired by Bavarian Motor Works—the BMW of car fame—Kontron has readied a 32-bit PC that it claims is the first portable system for industrial applications built around an Extended Industry Standard bus architecture.

The IP LITE—for industrial, portable, and lightweight—will hit global markets this month. The system is to the industrial PC world what a BMW is in autos, says Wolfgang Aurich, a former BMW executive whom the carmaker picked late last year as general manager of Kontron.

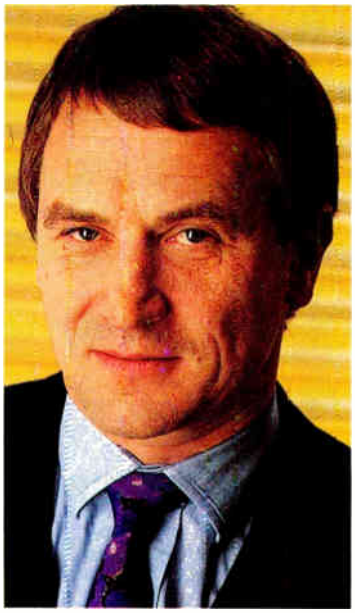
Aurich supports his comparison with the argument that the IP LITE sets new standards in quality and performance for industrial PCs, standards that put the machine ahead of competing systems and therefore give it an excellent chance to become a winner even on the exacting U. S. market.

"Other companies have thrown their weight behind laptops and are busy making them smaller and lighter for commercial applications, right where the volume is," says Klaus Trox, Kontron's marketing manager for industrial computers. "We, by contrast, are gunning for industrial applications, a selec-

tive PC market with not many firms competing in it so far."

Although industrial PCs are a niche sector, they have enormous growth potential—45% annually for the forseeable future, according to Trox. He figures that sales of industrial PCs will by far outpace those of PCs generally in the years ahead.

Trox's projections are close to those of Advanced Manufacturing Research, a Cambridge, Mass., market research organization that tracks industrial computers. There will be about a million PCs on factory floors worldwide this year and 1.4 million next year, says Ted Rybeck, an industry analyst at AMR. By 1993, AMR says, the total will be 2.75 million.



General manager Wolfgang Aurich.

Meanwhile, back in its home market, Kontron is determined to hold its No. 2 spot behind Siemens, the Munich-based electronics giant. And in the U. S.—where one of its competitors will be IBM Corp.—"we want to grow faster than the 45% average and rank among the first five suppliers within three years," Trox says.

The IP LITE is the vehicle that's to do it. Designed for rough industrial environments, the machine comes in a die-cast housing of magnesium, which shields it from electromagnetic interference and makes it mechanically sturdy. The system can take considerable abuse—it will still work after a 3-ft drop.

About the size and weight of an upmarket laptop, the 22-lb system fits under a plane seat. It operates in a 50°C environment, compared with about 30°C for a laptop, Trox says. International norms together with integrated safety functions such as temperature and voltage control make the IP LITE a highly reliable system.

The Kontron-designed central-processing-unit boards are based either on the Intel Corp. 80386SX or 80386DX 32-bit processors. The company is now designing a version based on the 80486, which will put the IP LITE in the performance class of high-end computers. In the U. S., the initial versions will sell from $8,395 to $9,995, depending on processor and hard-disk capacity.

Kontron is no newcomer on American markets. But it has kept a fairly low profile so far with its IP286/386 portable industrial computers and IR286/386 industrial workstations.

With the IP LITE, however, "We want to go aggressively after the U. S. market," Trox says. Given the system's quality and performance, Trox thinks Kontron now has a good chance to get firmly established. Its three U. S. operations will provide sales, service, and marketing support.

Kontron is not a computers-only firm; it's active in instrumentation and image analysis as well. Among its products are industrial computers based on the Z80 microprocessor and the European Computer Bus, which Kontron defined, high-performance logic analyzers, emulators, transient recorders, and digitizers. In 1989, Kontron made big news when it became Europe's first company with a board based on a reduced-instruction-set processor, the Intel i860. It also became the first company in the world to offer a universal emulator for Intel i486 chips.

Kontron's resolve to demonstrate more strength in the U. S. is in line with the strategy that BMW has mapped out for the company it bought from Hoffmann LaRoche, the big Swiss pharmaceuticals manufacturer, last summer. "BMW wants Kontron to develop into an independent and internationally competitive firm," Aurich says. "We want to grow faster than the average in electronic markets." Kontron's sales of $190 million last year were up about 14% from 1988's revenues.

For the big automaker, Kontron is to contribute to BMW's know-how in electronics and develop certain automotive components. "But Kontron will engage in such development and production only if it agrees with its own product planning and philosophy," Aurich says. "In no case will Kontron become just an extension of BMW's assembly line." E

Additional reporting by Lawrence Curran

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HERE'S WHERE IDEAS BECOME PRODUCTS

BY JACK SHANDLE

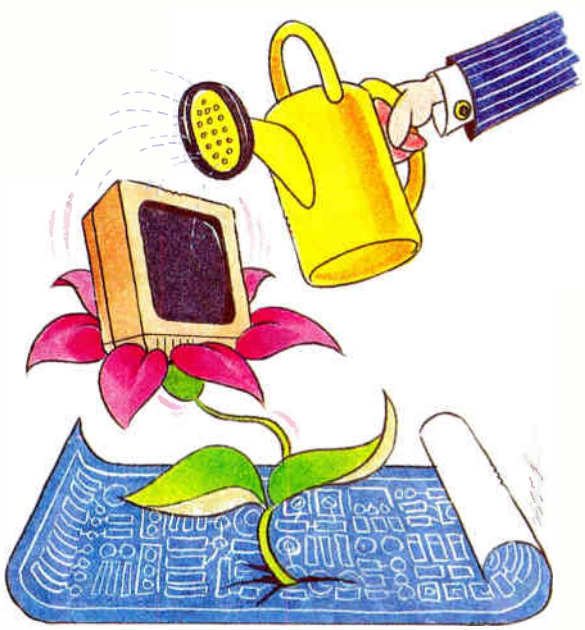
ENGINEERING HOUSES OFFER SERVICES FROM SOUP TO NUTS, BUT THERE AREN'T MANY OF THEM

EVEN THOUGH THE BACK pages of many electronics industry magazines are chock full of advertisements for engineering services of one sort or another, few companies offer truly one-stop shopping. "You have an idea and we bring it to production," says Tom LePera, vice president of marketing for 4th Generation Systems, Newtown, Pa. "You could get a consulting engineer, but then they would have to go to someone else to build a prototype and somebody else to manufacture it."

Such soup-to-nuts engineering houses are rare birds, but the legions of would-be entrepreneurs who have good ideas but not the foggiest notion of what to do next are looking for just that. "They find us in the damnedest ways," says LePera. "Sometimes it is word of mouth, but a large proportion of the people we do business with have worked for larger companies that are also our customers."

Big systems houses—often companies with easily recognizable names—account for the lion's share of 4th Generation Systems' customers, but that formula does not hold true across the board. One competitor, NewConcepts of San Diego, counts about 10% of its customers as large international companies, says Don Millerd, NewConcepts president. Another 50% are small to midsize companies with revenues of $250,000 or less. Another 30% are startups and the remaining 10% are inventors and entrepreneurs, says Millerd.

Besides having a full complement of design and prototyping services, NewConcepts offers all its customers confidentiality and substantial cost savings. NewConcepts has a very small in-office staff. Most of its engineers and designers work out of their homes or private offices and telecommute. "There are some who I only see once a year," says Millerd. The result is a reduction in NewConcepts' overhead costs of 25% to 30%, a savings that Millerd passes on to customers in the form of competitive pricing.



Among the services offered by concept-to-completion engineering companies include circuit design, printed-circuit-board design, embedded systems software, packaging, mechanical design, thermal analysis, and designed-for-manufacture prototypes. In some instances, the work—for example, chip design—is subcontracted, but that is transparent to the customer.

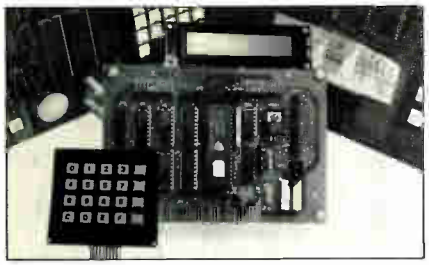
Making sure that the prototype can be efficiently manufactured and comes into the market at a competitive price is a key focus for both 4th Generation and NewConcepts. Often, a startup company "will want to use the latest and greatest of every technology," says LePera. "We will try to talk him out of that if his product does not need all that performance. For example, [Intel Corp.'s] 386s are still not that plentiful and they cost a fortune. A more mature processor might cost just a few dollars and be all he needs."

Millerd typically assists the customer beyond the prototype stage. "We handle the bidding process for our clients rather than have them source it themselves," he says. By having NewConcepts source the contract under its own name, says Millerd, contract manufacturers cannot bias their bids depending on whether Millerd's client is a large company or a startup.

A large company—presumably with deep pockets—that used its own name would be likely to see high bids. On the other hand, a startup that used its own name could have a credibility problem with manufacturers.

Although concept-to-completion businesses are growing fast and welcome new customers, especially smaller companies, both LePera and Millerd make the point that they are not venture capitalists. "At least once a month, somebody comes in and wants to trade us a piece of the action instead of paying for our services," says LePera. "We are not a venture house here. We have to weed customers out by their checkbooks."

A successful product is the result of a successful collaboration, says Millerd. "When someone wants to propose an idea to a contract manufacturer," he says, "he has to realize that he [the contract manufacturer] may have a five-year plan of his own and that he's also getting ideas from his employees all the time. We give our clients the ammunition to answer that, and that includes a prototype, manufacturing costs, and even profit margins. If you don't have those things, the contract manufacturer won't have any time for you."



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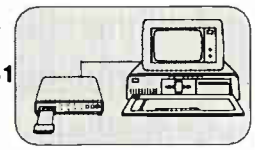

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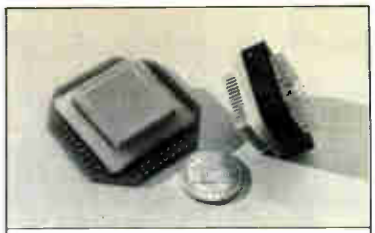

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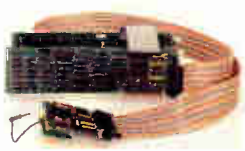

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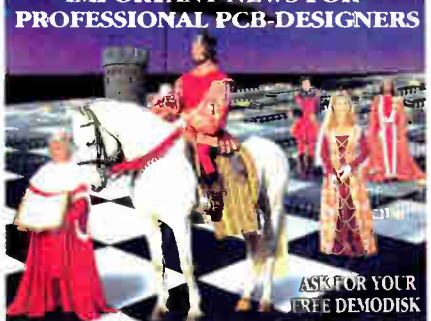

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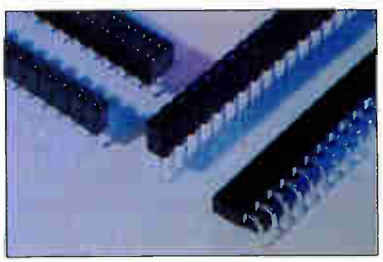

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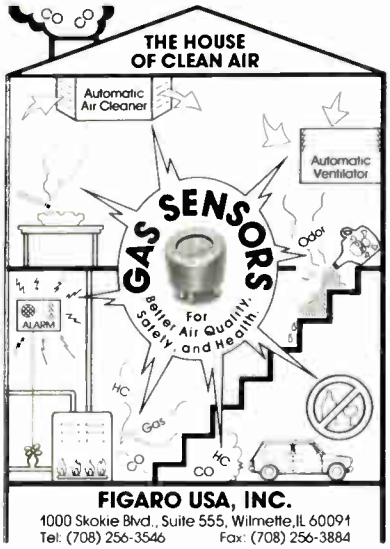

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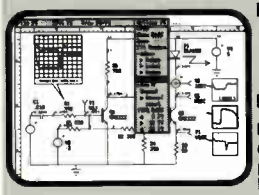

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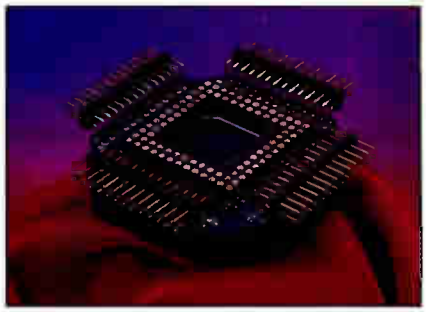

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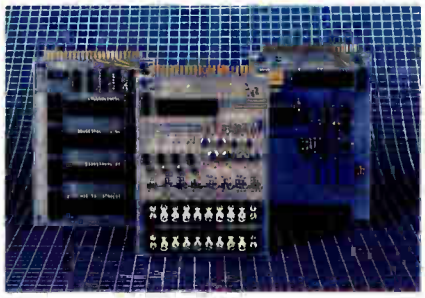

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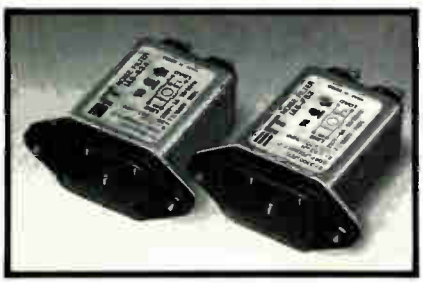

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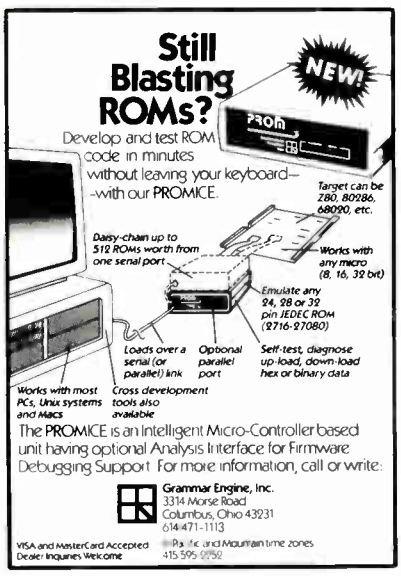

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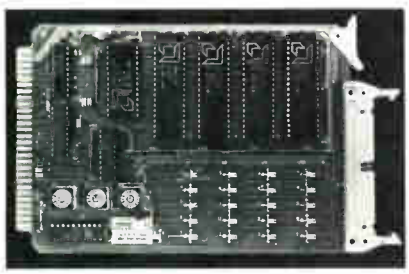

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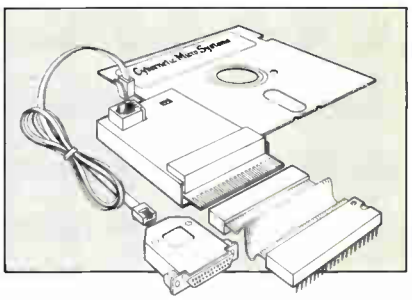

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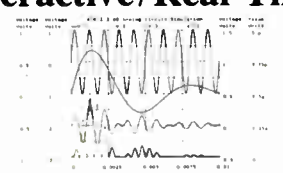

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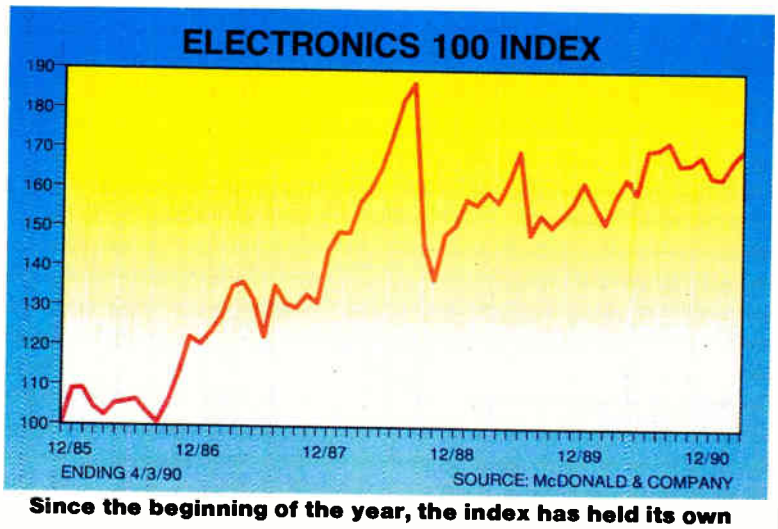
UPTURN ISN'T MUCH, BUT IT IS LIKELY TO KEEP ON GOING



Since the beginning of the year, the index has held its own against a slightly down market.

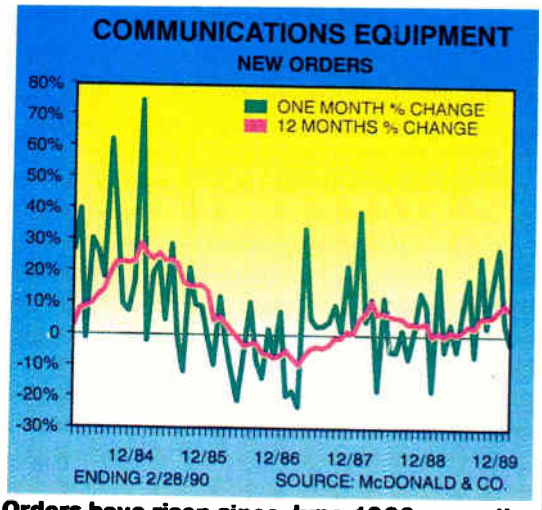
OEM SUPPLIERS SEEM TO EXPECT A continuation of the modest seasonal upturn seen thus far into the second quarter. Although the strength of this rise has been nothing to write home about, it certainly is better than nothing. The second half of 1989 was particularly weak, so improved earnings are likely by fall if business just keeps up its current pace. Pricing in commodity markets remains difficult, but spot shortages of leading-edge chips indicate demand is not falling apart.

In addition, some encouraging pockets of strength are beginning to appear among the ranks of the distributors. Anthem, Pioneer Standard, Avnet, and others report better March order patterns.

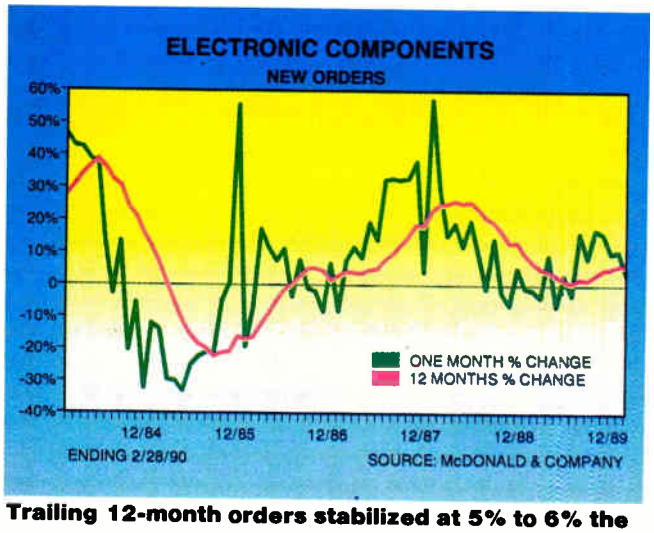
Electronics stocks outperformed the market smartly in January, February, and March. What's more, Commerce Department data also shows nothing to indicate that there are any major problems on the horizon. There will be a recession eventually, but it looks as if 1990 is not the year for it.

Meanwhile, worldwide trends in interest rates have been worrisome, but the consumer has been building up what several economists have labeled war chests. What this means is that the consumer is far from tapped out, and just appears to be catching his breath. The dollar is strengthening versus the yen, but at the same time it has been weakening quietly against the West German mark and the French franc. Because U. S. trade with European countries is still much larger than with those of the Far East, the trade-weighted dollar has barely budged in the face of double-digit appreciation of the yen. Further, news reports indicate that there is the possibility of an improving outlook for trade with Japan. E

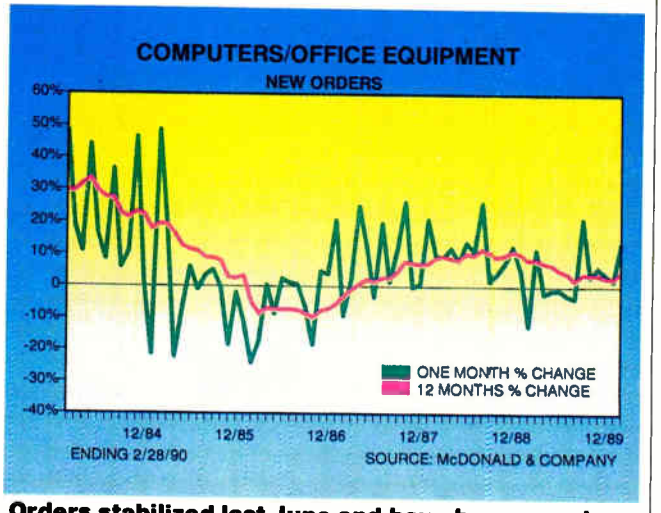
The index is prepared by Mark Parr of McDonald & Co., Cleveland.



Orders have risen since June 1989, recently 8% to 10%. But February dipped 3%.



Trailing 12-month orders stabilized at 5% to 6% the past four months. In February, they rose 3%.



Orders stabilized last June and have been growing 1% to 4%. But February is up 14%.

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Taking BiCMOS SRAM technology to 0.8 microns is our business.

Exploiting it is yours.

Rev up your system clocks.

Here are the world's fastest 8K x 8 SRAMs, leading our family of 64K BiCMOS SRAMs, with access times of just 12 ns.

Rev up your assembly. This is production BiCMOS with proven production yields, run on the same Cypress Semiconductor fab lines that have been cranking out millions of 0.8 micron CMOS parts for years.

Save on cost and real estate.

World's Fastest.

These parts are available in 300-mil-wide plastic DIP, as well as ceramic DIP, SOJ, and LCC.

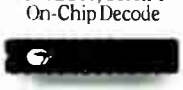
Simplify expansion. The CY7B160, with on-chip memory decoding, lets you build memory 64K deep with no speed, space or power penalities.

Save on power. You get our proven, cool, low-power, high performance CMOS, integrated with bipolar gates in the critical speed paths, for a part that sets new records in high density SRAM performance.

Simplify your qualification process with our complete family of highest performance CMOS and BiCMOS SRAMS. Including seven different 64K BiCMOS parts, in 16K x 4 and 8K x 8 organizations.

CY7B160, 16K x 4
On-Chip Decode

CY7B161, 16K x 4
Separate I/O



CY7B162, 16K x 4
Separate I/O

CY7B164, 16K x 4
Common I/O

CY7B166, 16K x 4
Common I/O, OE

CY7B185, 8K x 8

CY7B186, 8K x 8

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