A PENTON PUBLICATION OCTOBER 1991

Electronics®

BUSINESS / TECHNOLOGY PERSPECTIVES FOR GLOBAL ELECTRONICS MANAGEMENT

SEPARATING THE INNOVATORS FROM THE ALSO-RANS

CHANGE

As the industry enters the commodity age, here are the secrets of how the companies that turn out product winners blend the technological dazzle of the R&D lab with the reality that is the sum of those hard numbers that define today's marketplace. This is the way they ensure that change becomes the servant and not the master; how they manage it, prosper from it, and keep from being left behind.

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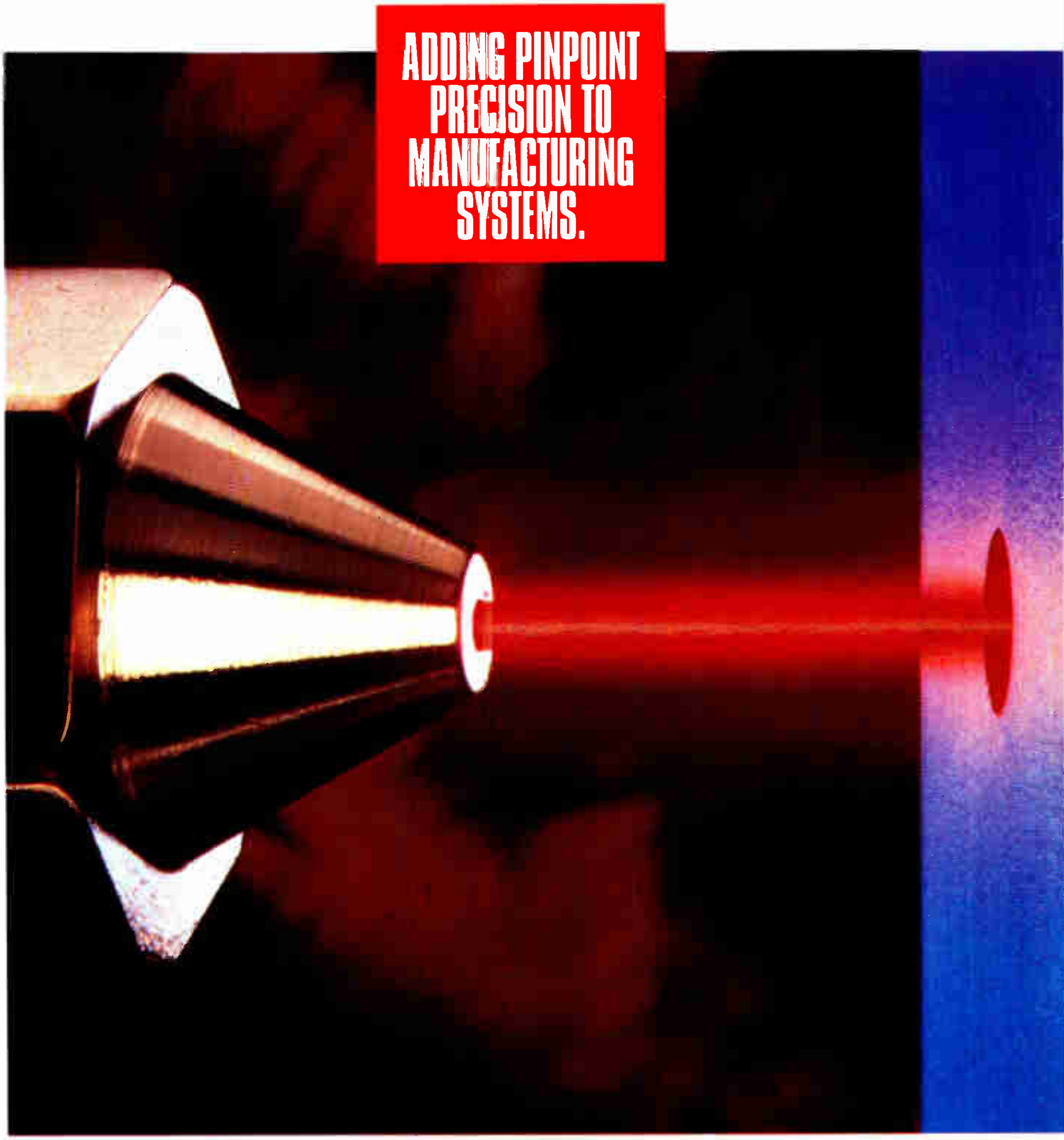

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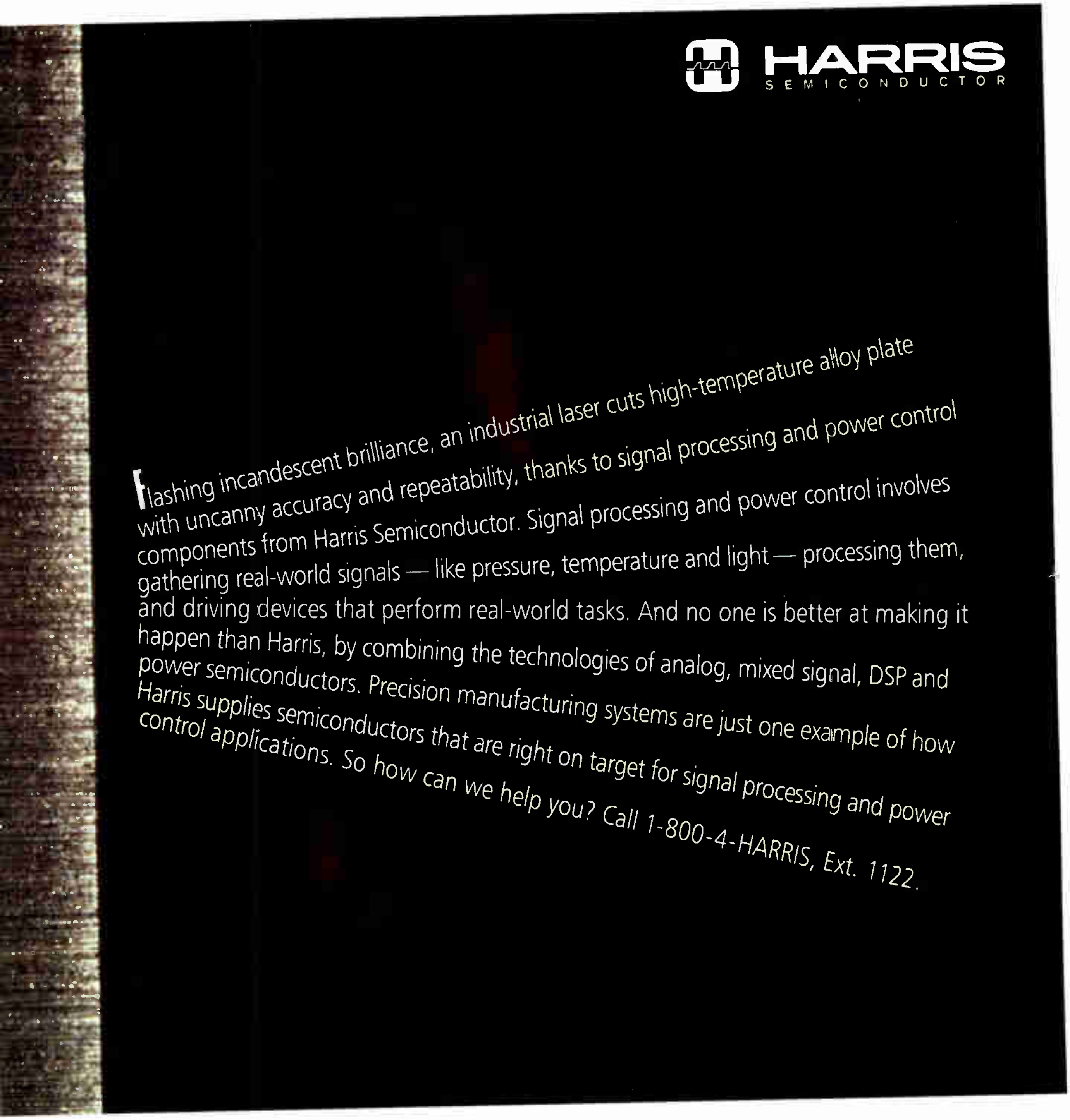

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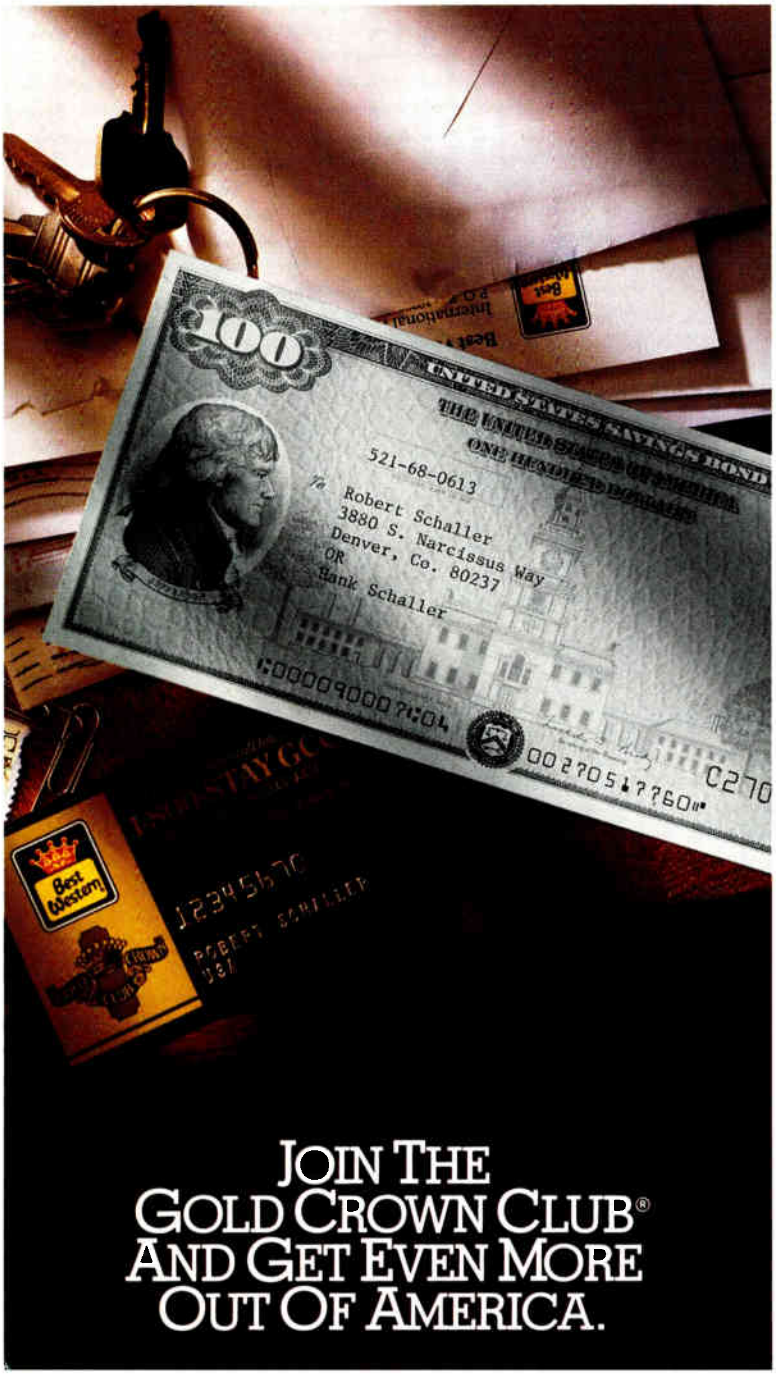

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October 1991 Volume 64, Number 10

Electronics (ISSN 0883-4989) is published monthly by Penton Publishing, Inc., 1100 Superior Ave., Cleveland, OH 44114-2543. Second class postage paid at Cleveland, OH, and additional mailing offices.

Editorial and advertising addresses: Electronics, 611 Route #46 West, Hasbrouck Heights, NJ 07604. Telephone (201) 393-6060. Facsimile (201) 393-0204. San Jose, Calif.: Telephone (408) 441-0550. Circulation (1100 Superior Ave., Cleveland, OH 44114-2543): (216) 696-7000.

Microfilm of issues or articles can be ordered from University Microfilms, Ann Arbor, Mich. 48103. Telephone: (313) 761-4700.

Subscriptions free to qualified managers. All others: $60 for one year in the U.S.; $70 in Canada; $136 in all other countries. For subscriber change of address and subscription inquiries, call 216-696-7000.

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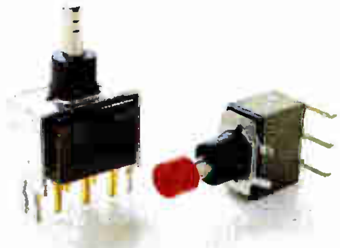

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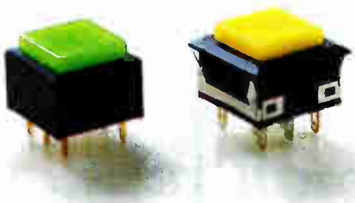

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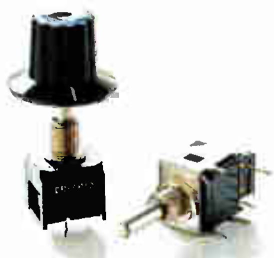

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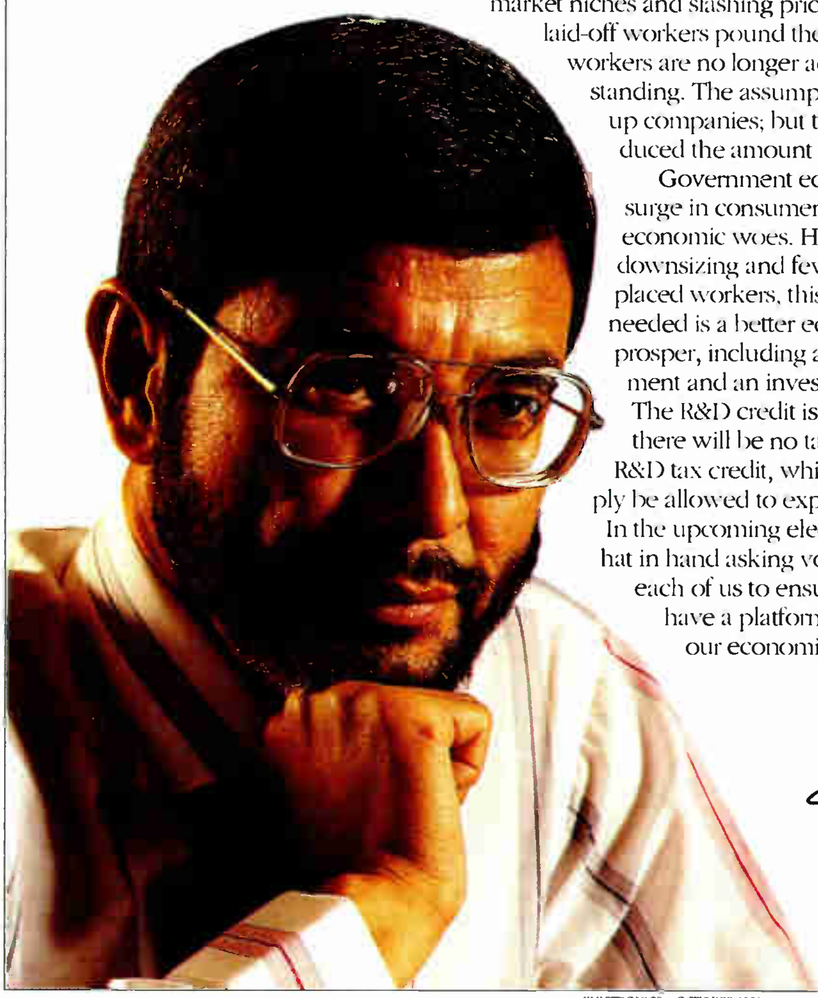
UP
FRONT

THE CAT KEEPS CHASING ITS TAIL

The electronics industry is universally embracing downsizing. A case in point: I recently spoke with a representative at Hewlett-Packard Co. in Colorado Springs, Colo., who described how the company was slimming down by offering attractive furloughs and early retirement to its employees. "This HP division is a $100 million entity that is struggling to downsize to $50 million," she said. All the big players are taking the same tack, as witness the well-publicized layoffs at Apple, Digital Equipment, IBM, and others, resulting in a large number of unemployed skilled factory and white-collar workers. Downsizing's benefits are a leaner company that produces a large amount of revenue per employee. But the trend somewhat resembles a cat chasing its own tail.

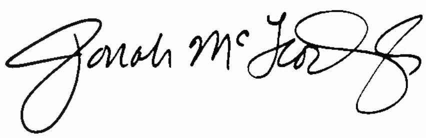
The U.S.—indeed the world—has enjoyed a long stretch of prosperity that has given consumers large amounts of disposable income with which to propel the economy into many consecutive years of growth. Now, though, the consumer is tapped out. Just as shoppers are putting off big-ticket purchases, so corporations that once bought large numbers of computers have become much more tight-fisted. Computers are being consigned to capital budgets, and capital spending is down to a trickle. On the home front, the consumer is hard-pressed to justify new purchases. The average U.S. household already has several TVs, telephones, cars, radios, and stereos. Who needs more? On seeing the next-generation 16-bit Nintendo mainframe needed to run the newest games, budget-conscious parents interviewed on a TV news show vowed they would "just say no" to this latest electronic siren song.

Manufacturers facing such stubborn resistance are reacting by producing items they hope consumers cannot resist: laptop computers, higher-performance workstations, smaller cellular phones, and so on. But none of these products represents a radical break with the past; each is an enhanced version of something else. So as the industry struggles to employ an enormous production capacity by exploiting market niches and slashing prices, the downward spiral accelerates as laid-off workers pound the pavement looking for work. These workers are no longer active consumers, lower prices notwithstanding. The assumption is that they will find work in start-up companies; but the tight economic conditions have reduced the amount of funds available for new ventures.



Government economists are predicting that a strong surge in consumer spending will pull the U.S. out of its economic woes. However, given the combination of downsizing and fewer new startups to absorb the displaced workers, this scenario seems unlikely. What's needed is a better economic climate in which to grow and prosper, including a tax credit for research and development and an investment tax credit to spur new startups. The R&D credit is already in jeopardy as legislators hint there will be no tax bill this pre-election year. If so, the R&D tax credit, which must be renewed yearly, will simply be allowed to expire.

In the upcoming election year, public officials will come hat in hand asking voters for support. It is incumbent upon each of us to ensure that those asking for our votes have a platform for reversing the downward spiral in our economic growth. ❑



JONAH McLEOD
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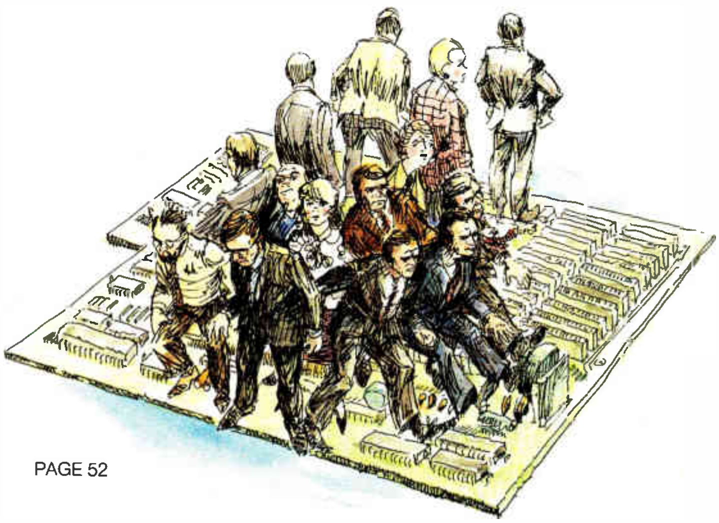
Jesse H. Neal
Editorial Achievement Awards

1956 Merit, 1965 First
1975 Merit, 1976 Merit
1977 First, 1978 First
1988 Merit, 1990 Merit



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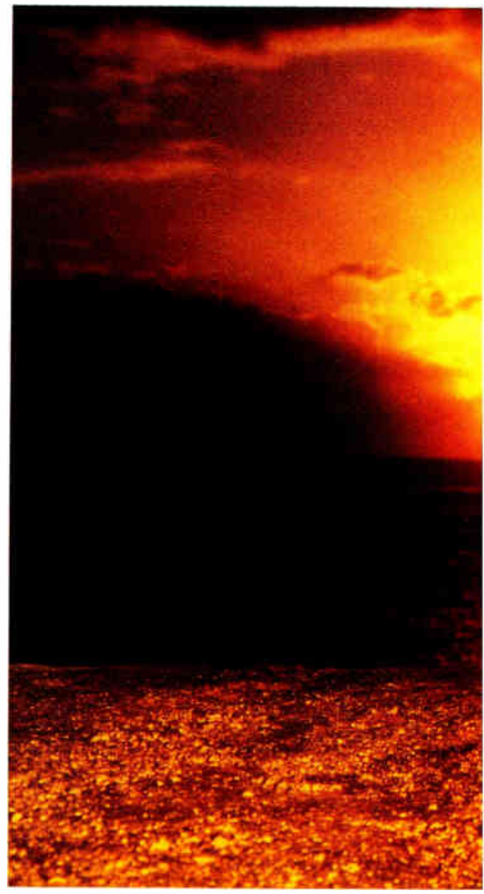

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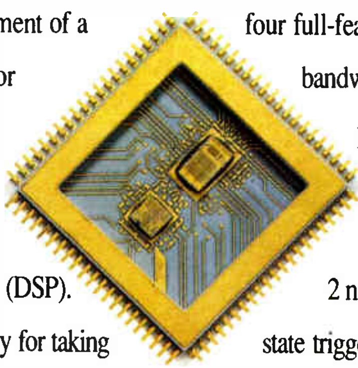

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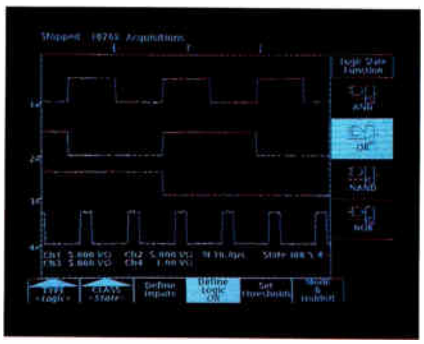

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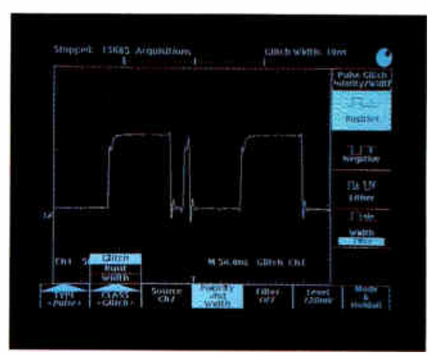

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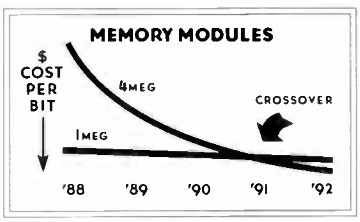

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CIRCLE 182

MILAN

THE NORTHERN ITALIAN CITY PLAYS HOST TO AN IC CONFERENCE

RENAISSANCE ART MEETS HIGH TECH

BY JOHN GOSCH

Mention Milan, and what comes to mind for the art-conscious traveler is images of places and objects. There are the famed La Scala opera house; the city's wedding-cake Gothic cathedral; the Castello Sforzesco, where Michelangelo's last work, the unfinished *Pietà Rondanini,* can be seen; or the many places where the Renaissance painter, sculptor, architect, and inventor Leonardo da Vinci left his mark.

But the Milan area is also Italy's commercial and industrial capital. It is home to production and research facilities of such major electronics companies as IBM, Italtel, Marelli, SGS-Thomson Microelectronics, and Telettra.

So it follows that for about 400 electronics engineers, researchers, academics, and industry representatives, Milan's main attraction—at least for three days last month—was the European Solid State Circuits Conference. This year's Esscirc, the 17th, was held Sept. 11 to 13 in Milan's Palazzo della Stelline—just across the street from the monastery of Santa Maria della Grazie, where da Vinci's masterpiece *The Last Supper* hangs.

First held in 1975, Esscirc is Europe's answer to the annual International Solid State Circuits Conference staged in the U.S. Although it doesn't have quite the visibility and exposure of the ISSCC and doesn't draw as many people, Esscirc matches the U.S. event in the quality of papers presented, conference officials maintain—and it is often chosen for first announcements of new technology.

What city has LaScala, works by Michelangelo and da Vinci—and last month had the European Solid State Circuits Conference? It could only be Milan.

For example, last year in Grenoble, France, Japan's Hitachi Ltd. first presented circuit concepts for its 64-Mbit dynamic random-access memory. And the event is becoming more and more international in that it increasingly attracts speakers from non-European countries.

At Milan, 72 papers were contributed by authors from 13 countries, with 20% from the U.S. and Japan. An indication of the papers' quality is that they were selected from more than 170 submitted. "We tried to pick papers representing avant-garde developments in microelectronics," says Rinaldo Castello of Italy's University of Pavia and technical committee chairman of Esscirc '91.

This year, the 400 attendees encountered something new for Esscirc. That was a series of invited papers by representatives of industries that use certain components and of companies that make them. "In these presentations, the component users inform producers about the direction their field is expected to take in the years ahead," says Bruno Murari, 1991 conference chairman, "and device makers tell users where they stand in technology and what microelectronics holds in store."

For example, a paper from Johan Danneels of France's communications group Alcatel NV represented telecom chip users, and one by Pietro Erratico of the Italian-French microelectronics company SGS-Thomson spoke for producers of telecom chips. Danneels pointed to communications systems the industry envisions for the next few years, whereas Erratico described the resources circuit makers will have at their disposal for such systems.

Another pair of papers came from Erich Geiger of France's Thomson Consumer Electronics group—he represented TV chip users—and R.P. Kramer of Philips Semiconductors, who took the chip makers' side. A third pair was from Joachim Melbert of Germany's Siemens AG and Ettore Panizza of Italy's Fiat, who represented automotive chip producers and the car industry, respectively.

Invited papers were also presented on other topics of current interest. Henry Baltes of the Technical University of Zurich, Switzerland, reviewed the state of the smart sensor art, Dimiter Driankov of the University of Linkoping in Sweden discussed fuzzy logic, and Satyen Mukherjee of the Philips Research Labs in Briarcliff, N.Y., talked about smart power technologies.

As VLSI chip complexity increases to several hundred thousand transistors, aspects of testing become ever more important. So Eckhard Wolfgang of Siemens reviewed the state of the art of three contactless testing techniques: electron-beam and laser-beam testing, and emission microscopy. Wolfgang described why contactless testing is crucial for chip verification and failure analysis.

While the invited papers given by the gurus in their fields were tutorial in nature, the contributed papers from

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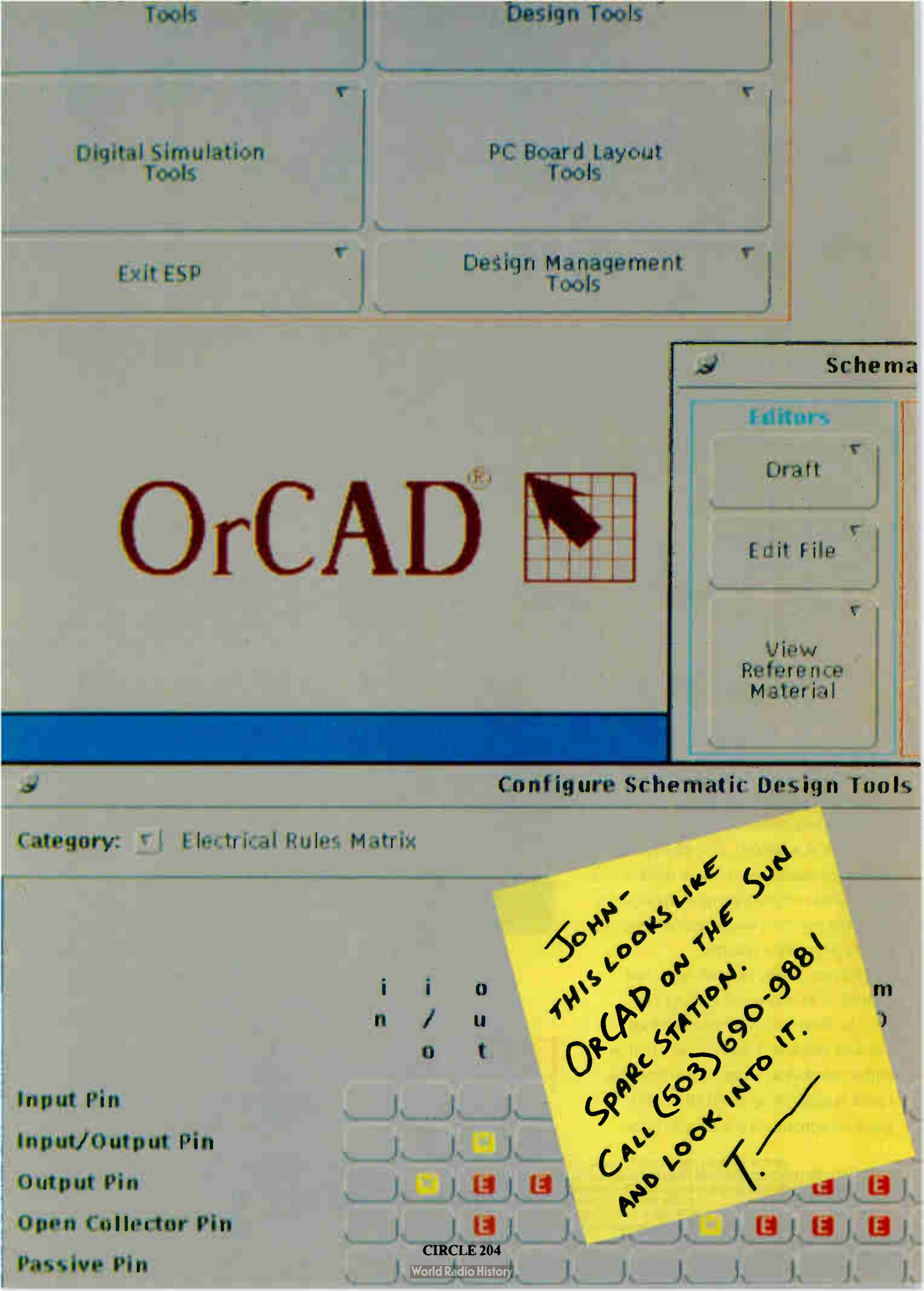
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CIRCLE 204

technology and design specialists reported on the latest developments. One example: a CMOS image-sensor array that integrates an electronic aperture and an exposure controller. From the University of Edinburgh, Scotland, the chip achieves exposure control over a range of 40,000:1, which is equivalent to 15 stops of a mechanical iris system. This compares with an equivalent of eight stops for on-chip electronic apertures reported so far. The device is aimed at applications ranging from single-chip video cameras to smart vision systems, such as burglar-alarm verification cameras.

For applications in data communications between printed-circuit boards within a system and for interoffice transmissions is a directly driven transmitter-receiver circuit for twisted-pair cables. Presented by experts from Hitachi, the circuit handles 320 Mbits/s, an incredibly high speed for a twisted-pair cable up to 10 meters long. To realize the high data rate, the circuit uses low-swing 0.3-V differential signal levels. The transmitter and receiver of the so-called ALTS—for advanced low-level transmission system—are contained in a 0.8-μm gate-array device.

A fast multichip CMOS RISC processor with low-voltage-swing inputs and outputs was described by Intergraph Corp. Believed to be intended for a new line of workstations from the Huntsville, Ala., firm, the processor has a propagation delay under 1.7 ns. The input buffer is designed with a setup time of 0.4 ns in the differential mode and 0.75 ns in the single-ended mode.

A tunable continuous time-filter cell from the University of Pavia boasts remarkable performance even though it uses conventional 2.0-μm technology. The key is the biCMOS design that the second-order low-pass filter cell employs. The device can be tuned over an 8-to-32-MHz range and has a quality factor of 2. Its total harmonic distortion is below 42 dB for an output signal up to 2.4 V peak-to-peak at 5 MHz. Intended for disk drives, the device will soon be marketed by SGS-Thomson.

High speed and performance are the hallmarks of a latched comparator from the Fraunhofer Institute for Integrated Circuits in Erlangen, Germany. Thanks to a design that combines 0.5-μm gallium arsenide and high electron mobility transistor (HEMT) technologies, the comparator operates at up to 4 gigasamples/s. Its sensitivity is 10 mV. The device can be used for the parallel comparison of input analog signals in a flash analog-to-digital converter and as an input driver for a high-speed digital-to-analog converter.

A fourth-order sigma-delta converter was presented by the UK's University of Southhampton. The circuit avoids the problems of switched-capacitor samplers with a self-tuning continuous-time noise shaper. The device, made in 1.6-um CMOS and operating from a single 5-V supply, is unconditionally stable and recovers immediately from overload without resetting integrators.

A new floating-point cell library featuring high flexibility and performance and suiting the logic synthesis of image signal processors was described by experts from Toshiba Corp., Japan. The library's 32-bit arithmetic logic unit and 32-by-32-bit multiplier support IEEE 754-format floating-point operations as well as fixed-point logical operations. A new vector processor was synthesized with a logic synthesis tool using the library. Designed in 1.2-μm CMOS technology, the processor checked in with a peak performance of 100 megaflops at 33 MHz.

For applications in hand-portable terminals is a codec discussed by specialists from Belgium's Alcatel Bell. The device, using 1.2-μm CMOS technology and occupying a die area of only 14 mm², has a dedicated processor serving digital filter calculations. An interpolator and sigma-delta modulator transform incoming signals to an oversampled 1 Mbit/s pulse-density modulated signal that is converted to obtain the earpiece signal.

Whether the engineers enjoyed Leonardo and the opera as much as the technical papers is unknown. ❑

Correction

The right product

In the White Paper on digital video technology (August 1991), an RGB Spectrum product was misidentified. The screen on p. A3 shows the Berkeley, Calif., company's RGB/View, a video-windowing program. ❑

GENRAD CARVES A NEW PATH

GenRad's GR9000 automatic-test system is aimed at the telecommunications market.

Facing shrinking markets, the automatic-test-equipment industry is looking for someplace to grow. One answer: telecommunications, where the rack-and-stack systems put together in house are a target for advanced ATE replacement—and that's where GenRad Inc. of Concord, Mass., is aiming its new GR9000 telecom ATE system.

"The uniqueness of the 9000 system is that it is the first one focused for telecom test," says Adam Bogue, product marketing manager at GenRad. The company has developed what it calls a VXIscan scanner subsystem to connect the VXIbus (for VMEbus extensions for instrumentation) directly to the unit under test with a cableless interface.

This, in effect, turns the standard into an ATE-like system and, with the scanner backplane, allows routing of signals with another instrument. "The 9000 offers the modularity and openness of rack and stack," says Bogue, "but the high performance and speed of ATE."

GenRad is emphasizing to potential buyers the value of integration versus the purchase price of individual instruments and the time it takes to put them together. With companies looking to downsize, the 9000 affords a chance to offload support functions by buying outside—an opportunity, says Bogue, that telecommunications companies have never had before. ❑

SURPRISE! SUN, IBM RANK LOW IN SERVICE

Workstation vendors looking to get a foot in the door of corporate MIS departments (see p. 38) had best pay attention to an important aspect of doing business today: service. A customer-satisfaction survey conducted by Dataquest Inc. holds a few surprises for the workstation crowd. Chief among them: market leader Sun Microsystems Inc. and computer giant IBM Corp. have not won many hearts and minds.

In asking 3,600 workstation users 34 questions on quality, ease of use, delivery, and other measures of satisfaction, the San Jose, Calif., research firm found Silicon Systems Inc., Mountain View, Calif., No. 1 with customers. Then came Next, Digital Equipment, Solbourne, and Hewlett-Packard. IBM was No. 6, Sun No. 8. ❑

WANTED BY JAPAN: LCD FABRICATION GEAR

In the wake of the bitter antidumping suit in flat-panel displays (see p. 27), much has been made of the fact that the Japanese have this lucrative and fast-growing market pretty much to themselves. But their hegemony doesn't mean there isn't any room for U.S. outfits to do some business.

Take the case of Applied Materials Inc., the giant Santa Clara, Calif., vendor of semiconductor production equipment. The company announced last month that it will leverage its expertise in vapor deposition, etching, and sputtering to build manufacturing systems for thin-film transistors (TFTs), which are crucial components in active-matrix LCDs.

Active-matrix displays will be a high-growth market in this decade, with sales predicted by various market watchers to hit $3.1 billion by 1995. Laptop PC makers are eager to use them for color screens, and they will likely move into high-definition TVs and other applications as well. The displays are built like huge integrated circuits, with the TFTs—which must be defect-free—controlling every pixel.

Japanese LCD vendors have "urged us very strongly" to develop equipment for manufacturing TFTs, says a spokesman for Applied Materials. "It's a natural business for us; a lot of the fundamental technologies are transferable from semiconductor production." R&D and initial fabrication will be in Santa Clara, but the company is setting up a Japanese subsidiary to run the project and handle additional development. ❑

BEHIND THE IBM GRAPHICS DEAL

Last month's XGA chip-set agreement between IBM Corp. and SGS-Thomson Microelectronics could herald the arrival of graphics products with enough muscle to handle today's advanced PC applications. It also promises to hasten agreement on an industry-wide XGA standard. The agreement represents two firsts for IBM: it is offering the chips to other board and system vendors, and it is working within an industry group—the Video Electronics Standards Association.

The deal calls for the manufacture, marketing, and distribution of a two-chip set that handles IBM's XGA architecture. Initially, chips fabricated by IBM will be sold by SGS-Thomson, whose Inmos Ltd. subsidiary will then make them itself. ❑

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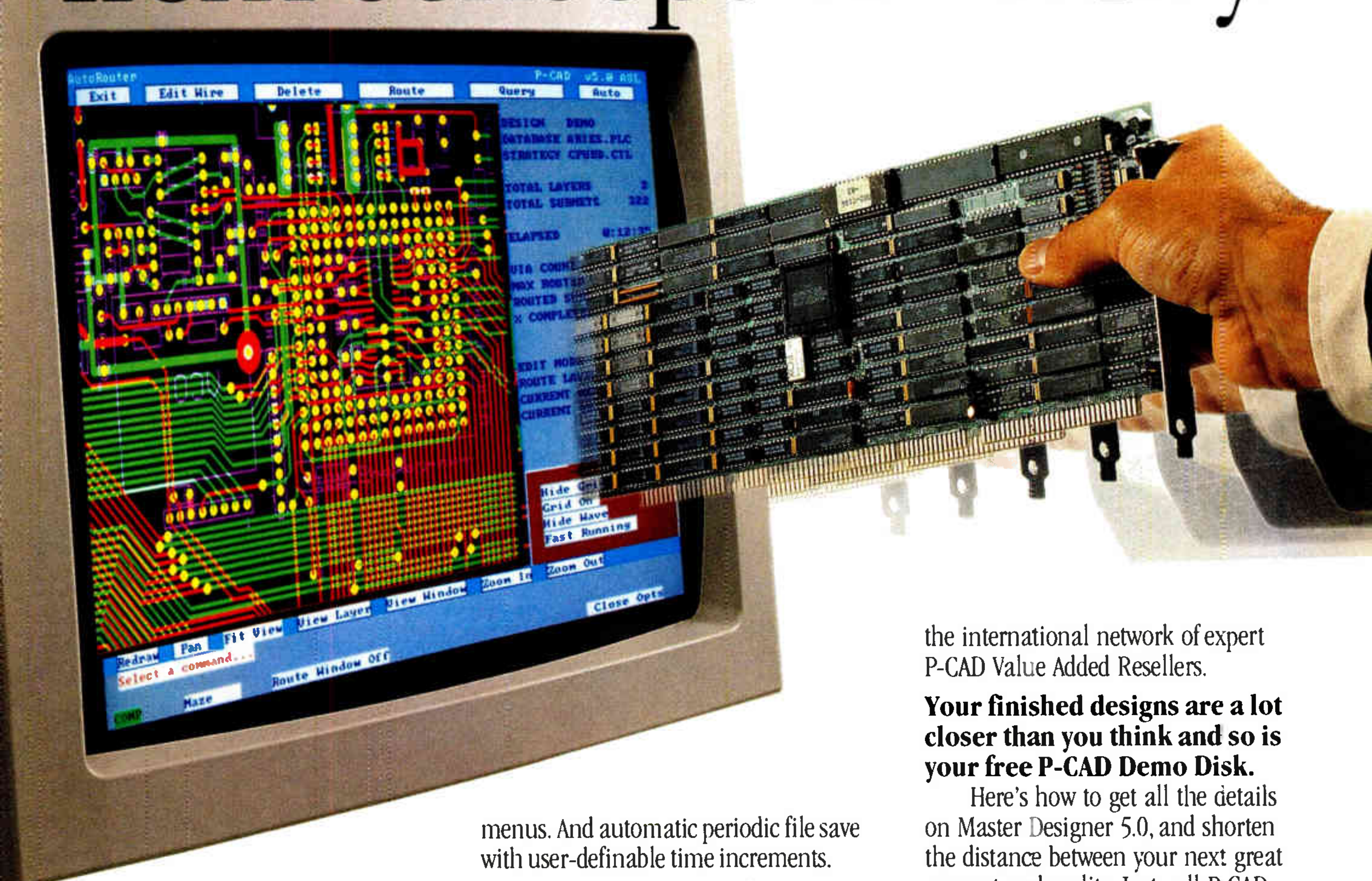

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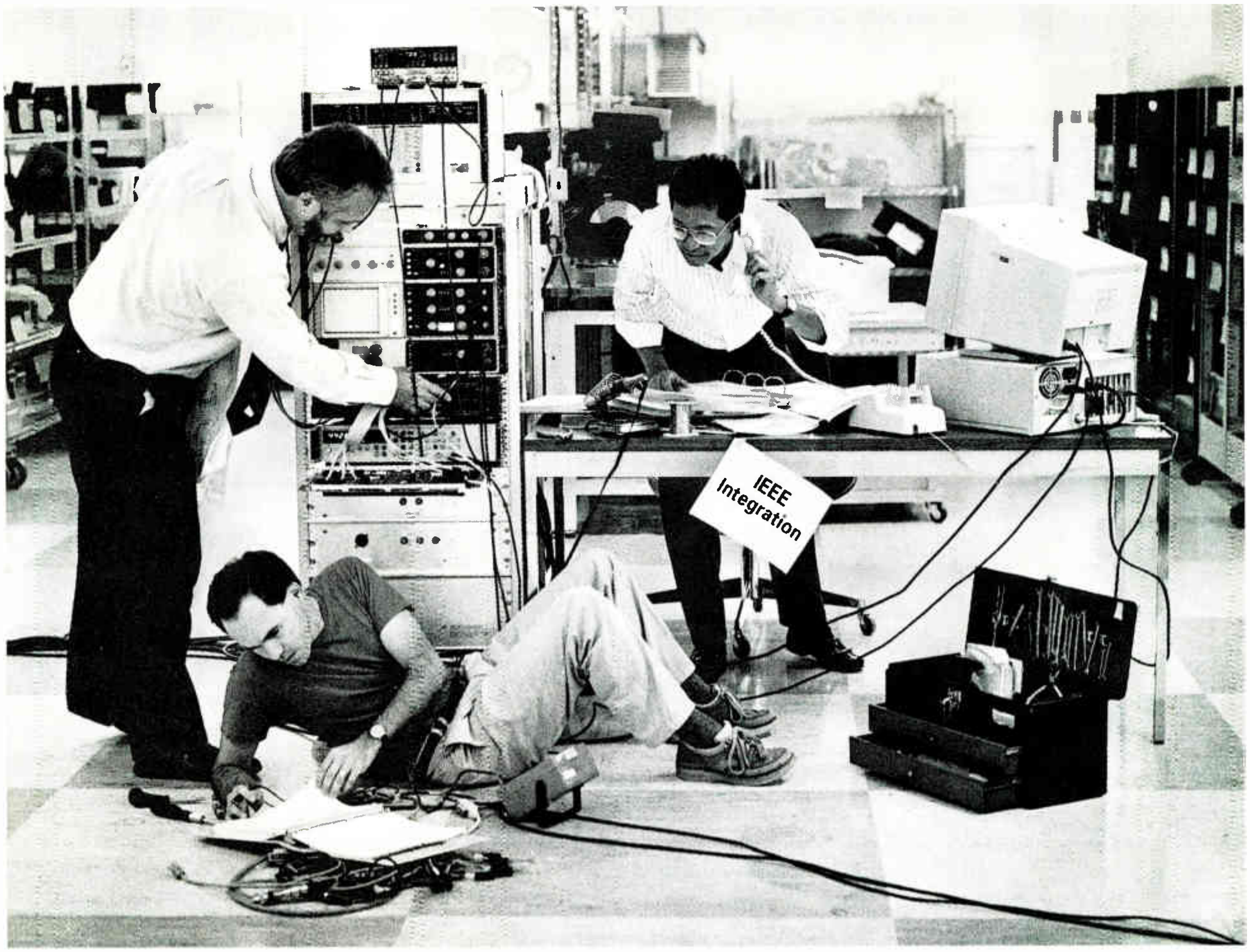
CIRCLE 213

The big difference between rack and stack telecom



Very costly hours

Hours that run into days, weeks and months of delays, and huge cost overruns to get an in-house rack and stack system on line.

For example, you thought you could design and build a test system that would be ready in June and now it's October. And now you need another two or three months because engineering just added DSP and a new ASIC to your line card.

Now you need more money, too. You estimated it would cost about $75,000. But you've already spent $120,000 and can't predict how much more you'll need.

And don't forget the typical problems that come with in-house rack and stack systems...instrument integration headaches, early obsolescence, maintenance problems, slow test speed and through-put, programming delays, and less than optimum fault coverage. Problems your time-to-market efforts don't need.

GenRad has the solution

GenRad's new GR9000 Telecommunications Test and Measurement System can help put this all behind you. It's a next generation system that provides accurate, comprehensive, functional tests for telecommunications line/transmission cards. Full voice frequency compliance tests, transmission and BERT tests from DS-0 to DS-3 are supported in powerful yet simple-to-program screens. And additional interfaces are supported by adding new instruments.

The GR9000 features a standards-based open architecture that supports a wide variety of instrumentation standards including VXIbus, GPIB and RS-232 so you can add test instruments from a number of suppliers or install your own, internally-developed instruments

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and eliminates the programming and integration problems associated with VXIbus grounding, front panel connections and too few slots.

VXIscan features an advanced performance-scanner subsystem that connects the system's instrumentation directly to the card being tested without the need for costly, unreliable cabling. This cableless interface provides a direct, low-noise connection to the unit under test for more accurate measurements.

Plus industry-standard software

GenRad's advanced software is joined with National Instruments® LabWindows® which combines standard programming languages with a development environment that simplifies programming. The software tools in LabWindows save you time in all phases of your development and permit easy integration of additional instruments, any time in the future, without the concern for programming problems. And telecom test libraries are included to help further reduce programming time and costs.

Put our hours to work for you

Your hours are better spent designing and building better telecommunications products. Now you can take advantage of the hours we've spent on R & D to bring you the next generation telecom test system. Its open architecture design is your assurance of comprehensive testing for years to come.

We have more information for you about this advanced system. Call 1-800-4-GENRAD for your copy of the GR9000 brochure.

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CIRCLE 211

IBM SHIPS 1-GBYTE DRIVE

IBM Corp. has set a new technology target for its competitors: a disk drive boasting 1 gigabyte of storage in a 3.5-in. form factor. Volume shipments to original-equipment manufacturers began last month.

The drive is the industry's first application of magnetoresistive recording. This technology delivers an areal density of 132 million bits per square inch, a 25% advantage over competing drives.

Developed at IBM's Storage Systems Products Division in San Jose, Calif., the drive's read/write head is about one-sixth the size of conventional heads. It also contains separate read and write elements, instead of a single dual-purpose element.

Smaller geometries mean that more sliders, the devices that carry the read/write head, can be produced on a wafer. Separate read and write elements provide faster data transfer.

The drive is available with 9.8-ms and 11-ms access times. A 865-Mbyte model is also available. Both drives integrate read-ahead caching and automatic sector allocation. They are rated at 400,000 hours meantime between failure. Evaluation units with an SCSI interface cost $1,470 for the 1-Gbyte model and $1,335 for the 865-Mbyte model. ❑

Separate read and write elements in the head of IBM's 1-Gbyte drive deliver faster data transfer.

125-MHz PLD GETS VHDL COMPILER

Cypress Semiconductor Corp. has taken an important step in rationalizing high-speed design by introducing a VHDL compiler for its 125-MHz CY7C361 programmable-logic device.

The San Jose, Calif., company's Warp1 compiler lets designers create state machines in a high-level language. The CY7C361's advanced architecture includes concurrency and parallel hot-coding.

VHDL, the VHSIC high-level description language, is well on its way to becoming the standard for high-speed parts. Warp1 is available now bundled with Cypress' PLD Toolkit for $195. ❑

BROOKTREE ENTERS MULTIMEDIA ARENA WITH VIDEO ENCODER CHIP

Brooktree Corp.'s first foray into desktop multimedia is a single-chip encoder that goes a long way toward letting systems houses treat video like a computer peripheral.

In particular, the Bt858 eliminates the analog tweaking required for competitive solutions, according to the San Diego, Calif., company. Tweaking slows manufacturing lines and raises labor costs.

A decoder chip to complement the Bt858 is due early next year. Brooktree says it will, over time, develop a complete family of video chips using its mixed-signal technology.

The Bt858 lets computer users output studio-quality images to low-cost composite-video monitors or videotape in all popular formats, including NTSC, PAL, and Super VHS.

The chip also corrects distortion created by the difference between a 1:1 aspect ratio (square pixels) of a computer pixel and TV's 3:4 aspect ratio. It does this with a variable clock range for 12 to 18 MHz. The chip is priced at $67 each in 100-unit quantities. ❑

ONE-CHIP SOLUTION FOR VIDEO WINDOWS

Pixel Semiconductor is delivering a one-chip solution for real-time scaling of high-quality video windows on personal computers and workstations.

The CL-Px0070 offers a glueless interface to NTSC decoder chips and a 16-pixel deep output first-in/first-out memory. It supports 16- and 24-bit inputs and offers variable outputs between 8 and 24 bits per pixel. The Plano, Texas, subsidiary of Cirrus Logic Inc. will specialize in video chips and has an extensive product line under development that will provide a standard video solution.

The Px0070 is compatible with NTSC, PAL, Secam, or S-Video input formats. It also supports the CCIR 601 format for digital video.

Samples of the chip are now available and are priced at $55 each. ❑

YAMAHA CHIP DOES VOICE, DATA, FAX

Transmitting facsimile, data, or voice can be accomplished over a single phone line using Yamaha Systems Technology Division's YTM403 FAX VOdem chip.

Capable of transmitting and receiving at up to 9,600 bits/s in binary-data-transfer mode, the chip supports modem standards up to 2,400 bits/s, Group 3 facsimile, and ADPCM voice coding. It also offers a caller-identification capability.

A companion chip, the GTM407 FAX VOdem controller, runs an extensive selection of accompanying firmware and controls the various functions. A sample package of both chips will be available from the San Jose, Calif., company before the end of the year. The YTM403 will be priced at $40. ❑

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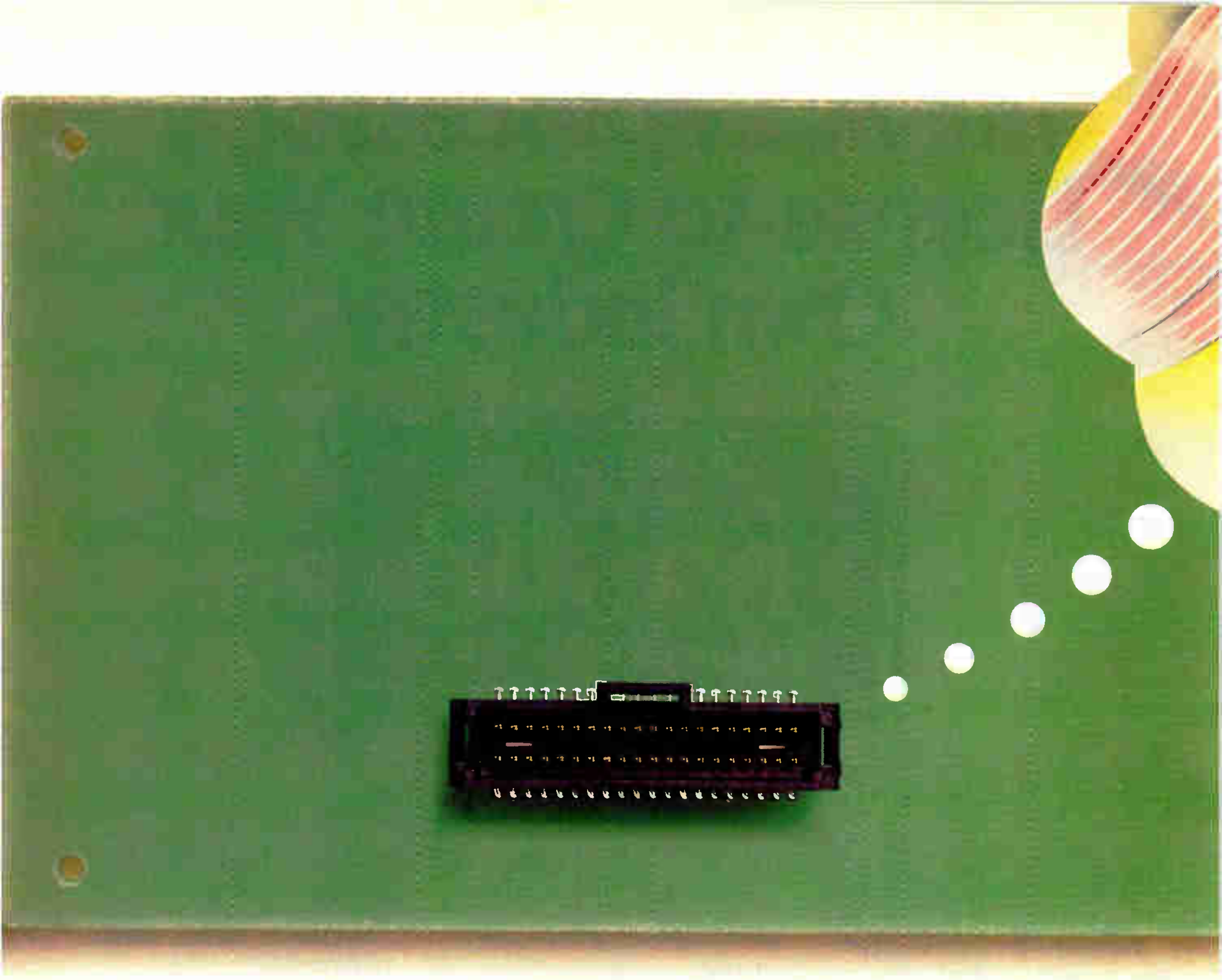

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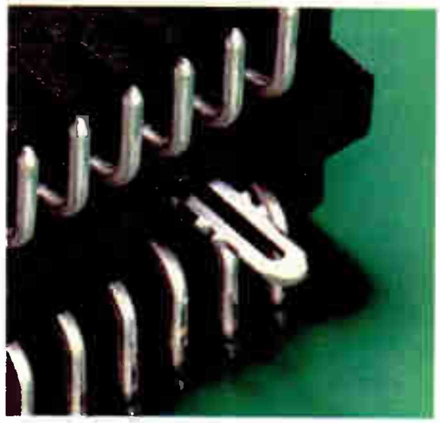

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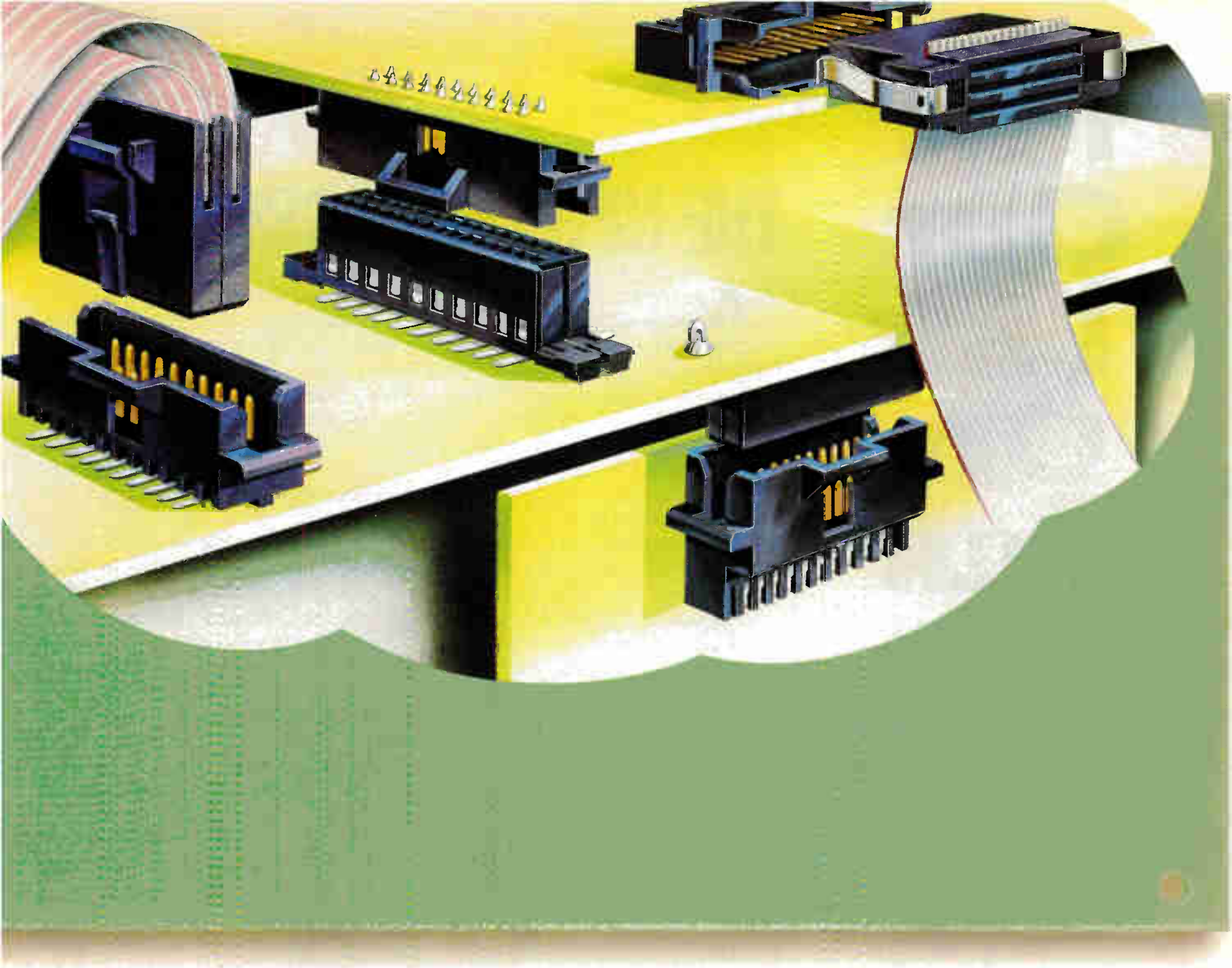

Think system.

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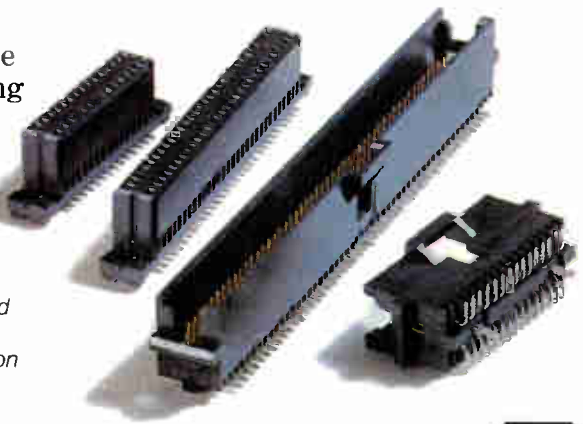

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CIRCLE 183

FACE **OFF**

THE NEW CHIP AGREEMENT:

A prominent 19th-century military theorist once said that politics is war by other means. In the 1990s—when global business is being driven by managed trade and industrial policy—politics is economics by other means. The recently signed semiconductor trade agreement between the U.S. and Japan is a good case in point. Remarkable for the lack of controversy it stirred up in an area usually fraught with tension, it is a monument to cooperation motivated by political considerations.

Cooperation was needed within the U.S. electronics industry to move our government to act. It was also required between U.S. and Japanese semiconductor companies. Cooperation usually means compromise, and in this agreement, everybody had to give a little to get a lot.


WILFRED J. CORRIGAN

The Semiconductor Industry Association stood little chance of getting the U.S. government to push for a new trade agreement unless we broadened the industry base of support beyond semiconductors. So in late 1989, talks began between the SIA and the Computer Systems Policy Project, a group composed of executives of major U.S. computer companies. Our agenda was to resolve disagreements between the chip and computer industries. We had to reach a consensus first on whether a 20% target market share was reasonable. Then we needed to address the specific mechanisms used to determine if dumping was taking place.

The starting point was the realization by both groups that their fate is inextricably linked. Without a healthy U.S. computer segment, U.S. chip makers would lose their closest customers. Without a healthy chip segment, computer makers would be forced to rely on foreign suppliers that also compete against them in computers. To maintain a strong "food chain" meant compromising on important issues.

U.S. computer makers came to understand that without fair-market access to Japan—the world's largest consumer of semiconductors—U.S. chip makers would be on a flatter learning curve than our Japanese competitors. That, in turn, would mean we could not drive costs down and quality up, nor generate sufficient investment capital for R&D and plant and equipment. As a result, the CSPP agreed to support a target 20% market share by the end of 1991.

For its part, the SIA showed flexibility on the mechanism to be used to deter dumping. The 1986 agreement required Japanese companies to sell above minimum price levels—or foreign market values (FMVs)—set by the Commerce Department. When prices for a product covered by an FMV rose steeply in 1988, many U.S. computer makers were hurt and felt that FMVs were contributing to the problem. Although the SIA disagreed, we were ready to find a more agreeable antidumping mechanism. We proposed a fast-track procedure in which the Japanese companies would keep records of their costs and prices and quickly turn the data over to the Commerce Department if suspicions of dumping arose.

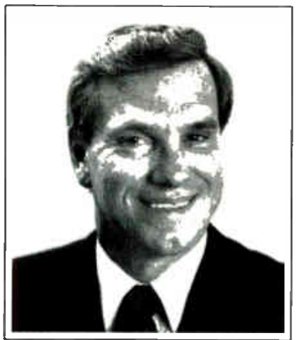
The SIA/CSPP plan received widespread support from industry associations and the government. The only question that remained was how the Japanese would react. Rapid progress was made because over the term of the 1986 agreement, Japanese and U.S. companies had learned to work together. The mechanisms—task forces, seminars, and market access plans by Japanese firms—were in place to achieve the 20% goal. The Japanese also understood that the new antidumping proposals were, if anything, less onerous than FMVs.

The agreement is in place, but to ensure success the U.S. government must be vigilant and apply strong measures if needed. No less important is the perseverance of a united U.S. electronics industry.—*Wilfred J. Corrigan, chairman, Semiconductor Industry Association*

DOES IT GO FAR ENOUGH?

Now that the semiconductor agreement has been renegotiated and renewed, the $64,000 question is, will it work? To answer that question it may be well to review some recent history. The agreement that was just renewed is not the first semiconductor trade accord, nor was the 1986 pact. Prior to those agreements came two other lesser-known ones relating to semiconductor trade between the U.S. and Japan.

The first was concluded in 1983, at a time when U.S. producers were still dominant and still in the DRAM business in a significant way. Beyond a lot of boilerplate about the wonders of free trade, the evils of dumping, predatory trade activities, and piracy, there were two main points in this agreement. The first was the first mention of market openness being measured by sales results; the second was creation of the so-called data-collection system to provide a kind of early warning of export surges as a way of providing for a certain discipline on dumping.



CLYDE V. PRESTOWITZ

This system required the U.S. and Japan to agree on data categories and definitions, and both countries collected data on shipments and exchanged it from 1983 until the fall of 1986. Data was collected on the basis of merchant production and shipments only, and the concept of the "total available market" was accepted by both sides, as were the respective market shares calculated thereby.

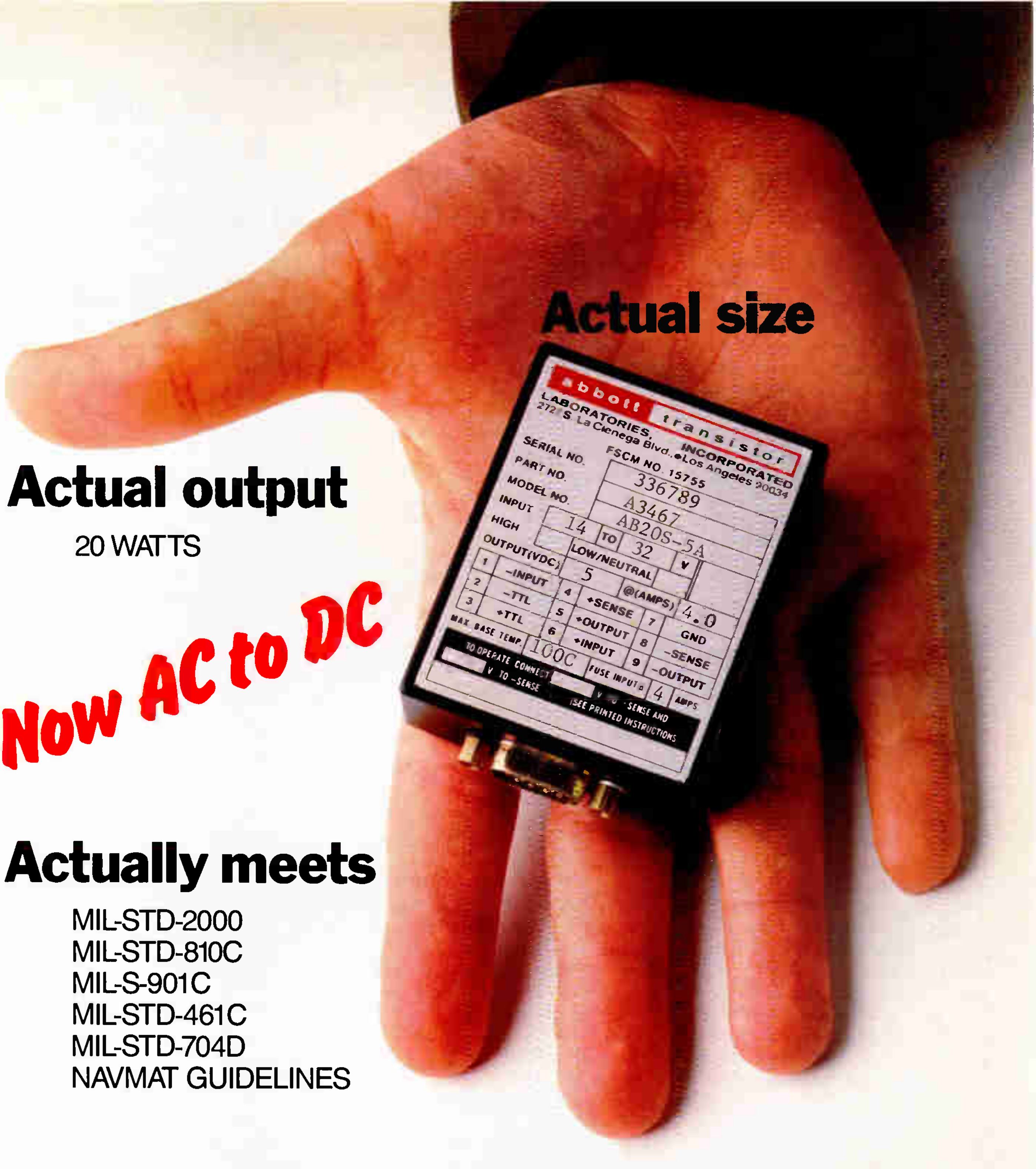
The second semiconductor agreement, concluded in 1984, contained one significant new aspect—a secret "side letter" in which the Ministry of International Trade and Industry agreed to "encourage" Japanese chip users to conclude long-term supply arrangements with U.S. producers. This agreement seemed to work for a while. In the tight supply situation of 1984 the U.S. share of the Japanese market rose a notch or two while MITI and the Commerce Department religiously exchanged data on world market shares.

But it all fell apart in 1985, when overcapacity glutted the market. U.S. shares sank as prices nosedived. When this resulted in charges of dumping, MITI suddenly halted the whole data-exchange program, claiming that the basis of the numbers was somehow invalid and introducing its own new calculations of market share.

This history is relevant today because the same issues are still at the core of the new agreement. The new pact has taken the secret side letter that accompanied the 1986 deal (not to be confused with the secret side letter of 1984) out of the closet. So the market share goal of 20% of the Japanese market for U.S. producers is now explicitly stated. This is a plus, but only a very small one, because the new pact accepts two ways of counting market share—the old, previously agreed-upon way and the new MITI way.

In the new deal as in the various old ones, MITI has either explicitly or implicitly undertaken to "welcome" expansion of U.S. market share. This means that large Japanese companies will be under some obligation to make buys or joint-development deals with U.S. suppliers and for a time, at least, the U.S. share of the Japanese market should rise a bit. This is, of course, desirable from the U.S. standpoint, but it is likely to be a limited result. The U.S. share is unlikely to rise to what U.S. analysts would consider 20%. MITI may count it as 20%, but by American accounting it would only be 15% or 16%. Meanwhile, the Japanese share of the U.S. and world markets is likely to rise.

The new agreement is certainly better than no agreement at all, which was the likely alternative. However, it is weaker than the 1986 accord and is unlikely to halt the continued erosion of the U.S. industry position in world chip markets.—*Clyde V. Prestowitz, president, Economic Strategy Institute*



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CIRCLE 219

IT'S UNLIKELY THE BIG LCD VENDORS WILL SOON PRODUCE ACTIVE-MATRIX DISPLAYS IN THE U.S.

JAPAN TO THE RESCUE?

BY SHIN KUSUNOKI

Don't look for the Japanese to ride to the rescue of the U.S. computer industry by manufacturing active-matrix liquid-crystal displays in the U.S. any time soon. That's the message now current in Japan as the big Japanese LCD vendors, hit recently with stiff antidumping duties, reel from the blow dealt by the International Trade Commission as the result of a bitterly disputed suit that divided the U.S. electronics industry down the middle [*Electronics*, August 1991, p. 16].

"Local production in the U.S. is 99% impossible," says Tsuyoshi Kawanishi, vice president of Toshiba Corp. "If the U.S. users cannot stand the price hike, we will have to ask for the customers to shift their personal-computer-assembly production out of the U.S."

Many American industry watchers have been voicing the hope that Japanese vendors would set up active-matrix LCD production in the U.S. No U.S. company has the large-scale manufacturing facilities needed to supply these sophisticated screens in volume, and the ITC ruling in late August means that importing them now involves paying a whopping 63% tariff.

But Japanese observers say that manufacturing full-size active-matrix screens is so difficult that no company will be in a position to transfer production to the U.S. for at least five years. "We have our work cut out for us just getting mass-production plants on their feet in Japan, and we have not given a thought to overseas production," says Hideo Nakao, managing director of NEC Corp.

That leaves American laptop vendors in the catbird seat: unable to buy the screens they need in the U.S. but effectively priced out of imports, a number of manufacturers have publicly said they may have no other choice but to transfer at least some laptop production offshore. The dumping duty is on displays only and does not affect imported laptop PCs using them.

DISPLAYS

Especially hard-pressed is Apple Computer Inc., currently the only U.S. manufacturer using the active-matrix screens in a product, the Macintosh portable. Its supplier, Hosiden, has already announced it will no longer ship displays to Apple's Fremont, Calif., factory but is instead sending them to facilities in Singapore and Cork, Ireland. The vast majority of Apple's portables are now built in Fremont, says William P. Fasig, manager of international and government affairs, and the remainder in Cork.

"We're looking for any way possible that we can still manufacture these products in the U.S.," says Fasig, but the ITC decision will likely "force us to have to go offshore." The move will be costly, since the Cork and Singapore plants "are not initially configured" for high-volume production of these machines.

The rest of the U.S. laptop industry is now using passive-matrix screens, which escaped tariffs, but "everyone had active-matrix on the drawing board or in immediate product plans," says Jack Roberts, director of graphics and displays at Dataquest Inc., the San Jose, Calif., research house. That's because this technology can supply crisp color and high performance—mouse-driven commands, windowing, and quick screen refresh—along with low power consumption, he says. "This ruling has definitely put a crimp in everyone's [product] plans." Roberts calls the ITC decision "a major threat to the U.S. personal computer industry."

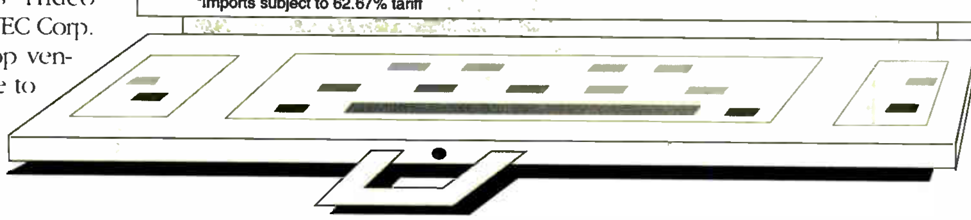
But active-matrix technology is so new that even in Japan, few display makers have begun full-scale mass-production. Analysts estimate 1991 production at 15,000 to 20,000 displays per month, and yields tend to be low. As a result, the screens are costly—$400 to $600 for the laptop size (excluding tariffs), says Roberts, against around $200 for a passive-matrix LCD. Larger screens can run as much as $2,000.

The Japanese have poured billions of dollars into active-matrix R&D. According to one source, one top Japanese corporation has sunk $730 mil-

PORTABLE-PC VENDORS MULL THEIR OPTIONS

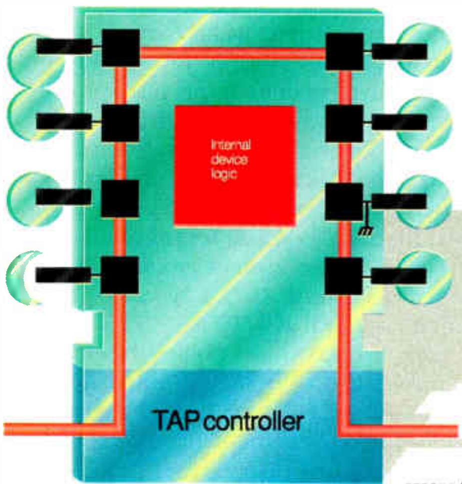
	Plant Location	Type of LCD	Contemplating a Move?
Apple	Fremont, Calif.; Ireland; Colorado Springs, Colo. (planned)	Active matrix*	Considering building all portables in its Cork, Ireland, or Singapore plants
Compaq	Houston; Japan	Passive matrix	Considering its plants in Erskine, Scotland, or Singapore for future generations
IBM	Raleigh, N.C.; Scotland; Japan	Passive matrix	Evaluating the possibility
Tandy	Fort Worth, Texas	Passive matrix	Not in near future

*Imports subject to 62.67% tariff



The ITC ruling on active-matrix LCDs—which one company calls "an eviction notice from the U.S. government"—may drive laptop production offshore.

People say boundary
in low cost, high quality
Now you can test that



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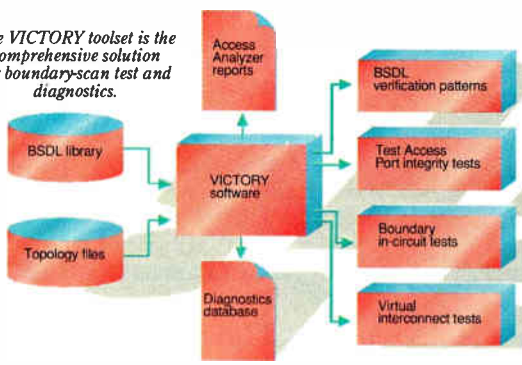
The VICTORY toolset is the comprehensive solution for boundary-scan test and diagnostics.

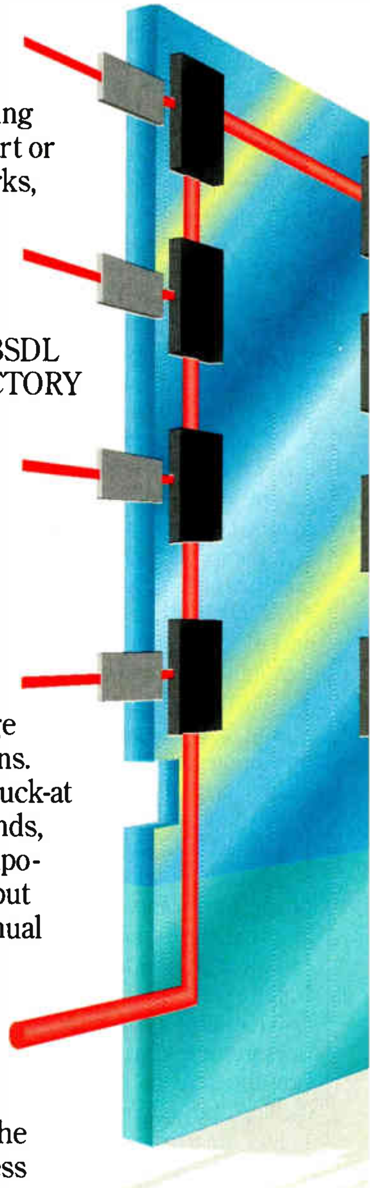


Delivers high fault-coverage.

Whether you're testing one boundary-scan part or boundary-scan networks, VICTORY software automatically gives you 100% pin-level fault coverage. Using the IEEE 1149.1 and BSDL standards, it takes VICTORY only a minute or two to generate test patterns. It would take a programmer days, even weeks to deliver the same fault coverage for conventional designs.

Concurrent engineering takes on new meaning when you use VICTORY's Access Analyzer to optimize board layout for testability and cost-efficiency.

Now you can find stuck-at faults, broken wire bonds, wrong or missing components – even open input pins – all without manual diagnostic probing. VICTORY's fault diagnostics clearly spell out both fault type and fault location. And that's just the manufacturing process

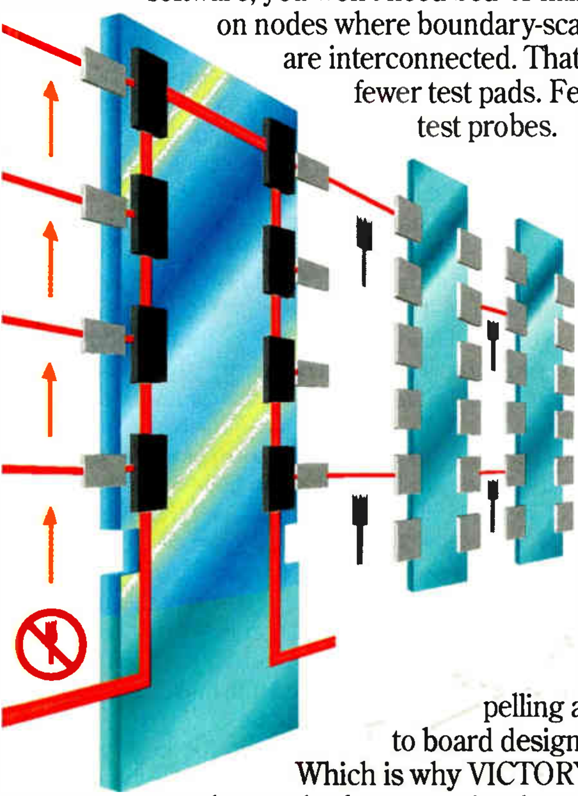


scan is a breakthrough board testing. theory.

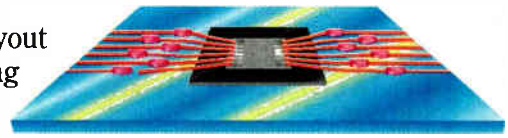
feedback you need to eliminate defects where it's most cost-effective – at the source.

Helps solve the test access problem.

With boundary-scan design and VICTORY software, you won't need bed-of-nails access on nodes where boundary-scan parts are interconnected. That means fewer test pads. Fewer test probes.



That's a compelling advantage to board designers. Which is why VICTORY's Access Analyzer was developed. With this concurrent engineering tool, designers get testability information early in the design process. They can easily see where test points are required for visibility and where they can be dropped, for optimized board layout without lowering fault coverage.



Boundary-Scan Intelligent Diagnostics identify faults by type and location without physical probing – even on high-density SMT assemblies

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TERADYNE

CIRCLE 199

lion into research in the past three years alone; it is estimated that each of the companies in the top supplier group has invested more than $73 million annually in recent years. The classic Japanese view is that they must initially keep OEM prices as low as possible to develop the market and stimulate demand, recouping over the next 10 years as mass-production drives down costs. From this perspective, strategic pricing is not aimed at damaging competitors, as the U.S. complainants maintained; rather, the Japanese say, it is risk-taking to open up the virtually unlimited consumer market.

This view is widely adhered to by the U.S. computer industry as well, which loudly and publicly opposed the handful of tiny American display makers that brought the ITC suit. The display makers held that Japanese pricing practices had damaged their businesses and their chances in the developing market. Japanese observers found it curious that the U.S. government would take steps to protect a weak industry—displays—at the expense of a strong one, computers, and many U.S. computer manufacturers would agree. It's worth noting that sophisticated displays made their way onto President Bush's recent strategic-technologies listing.

Meanwhile, both the Japanese vendors and their U.S. customers are weighing their legal options. An appeal to the U.S. Court of International Trade "is under very active consideration" by Hosiden and some of its customers, says Louis Mastriani, that company's Washington-based lawyer. Deadline for filing a summons was Oct. 4. Another avenue being mulled, he adds, is requesting a Commerce Department review of the decision, but by law that can't happen for at least 12 months.

In the meantime, U.S. computer makers will have to plot their strategies for the next generations of laptops taking the LCD vacuum into account. "This ruling will make it very difficult for American companies to manufacture future products using [active-matrix LCDs] in the U.S.," says a spokesman for Compaq Computer Corp. in Houston. "What we've done is basically taken away some [U.S. job] opportunities for the future." Or as an IBM Corp. spokesman tersely puts it, the ITC decision is "an eviction notice from the U.S. government." ❑

Additional reporting by Jacqueline Damian

CHIPS

HOW TO WIN THE GIGABIT RACE WITHOUT BUSTING BUDGETS

THE GREAT LEAP

BY JACK SHANDLE

When the National Advisory Committee on Semiconductors releases its third annual report early next year, the stage will be set for an era of unprecedented cooperation among all segments of the electronics industry. The question is whether the industry can produce The Great American Manufacturing Revival.

Optimistic is Ian Ross, NACS chairman and president of AT&T Bell Laboratories. He says that reaction has been positive at private briefings on the initiative, which has its roots in a workshop—Micro Tech 2000—where chief scientists from top electronics companies and the national laboratories tried to determine if U.S. chip makers could win the race to gigabit density. The conclusion: yes.

Their preliminary study says that the U.S. can leapfrog its international competitors by three years and develop the core technologies needed for 0.12-µm devices. Moreover, Ross believes that if the $4.5 billion R&D efforts of corporations, Sematech, and the government laboratories are synergistically coordinated, the Micro Tech 2000 goal can be achieved without additional long-term budgeting. "I think the climate is right for the industry to cooperate," says Ross.

He is less optimistic that a manufacturing base can be created to exploit the technology in high-volume markets. This will require patient, inexpensive capital, and "on the capital formation issue, the report card for the nation is not that good." Changing the tax laws may be harder than creating 0.12-µm features.

So look for next year's final report to call the electronics industry to arms. "The industry has to exercise leadership," Ross says. Segments "have to identify the places where they can approach the government and administration together in their common interest." ❑

ETHERNET PUT ON MAC'S MOTHERBOARD; TROUBLE AHEAD FOR ADAPTER-CARD MAKERS

MILKING LAN SALES

BY JACK SHANDLE

COMPUTERS

Apple Computer Inc.'s decision to put Ethernet on the motherboards of some of the models it unveils at Comdex this month is just the beginning. Look for local-area-network chips to pop up on IBM-compatible motherboards next year, and for the trend to grow as fast as the percentage of networked PCs.

The driving force is the never-ending quest for revenue growth. The computer industry may be in the doldrums, but the LAN market is robust. So computer makers are looking for ways to siphon sales from LAN adapter-card companies. As the number of networked computers approaches 50% of the installed PC base, offering out-of-the-box LAN capability looks better and better.

The first step in milking the adapter-card cash cow is easy enough: put a LAN chip on the motherboard. After that, the questions get tougher. Which models in the product line should be included? Which LAN chip to use? What are the system-design and manufacturing implications? Where does the board space come from? How fast can the product get to the market?

Cost "is a problem we continue to wrestle with. How far down the product line do you push it?" says Bill Brown, Apple's product manager for communications. Apple's Macintoshes are already 70% networked, but for the time being, higher-end Macs alone will get the Ethernet capability. Apple is strong in the education market, and although schoolroom computers need networking, the Cupertino, Calif., computer maker has decided this market is too cost-sensitive to be included now.

Apple has offered plug-and-play networking on the Mac for a long time, but since AppleTalk was deemed too slow for multimedia applications, Apple went with a standards-based Ethernet solution instead of a faster version of AppleTalk. Earlier this year, Apple introduced an Ethernet adapter card for the Mac that uses the Sonic chip (for systems-oriented network-interface controller) from National Semiconductor Corp. Brown calls the Sonic "a very clean implementation of Ethernet," and it was Apple's motherboard choice. "Going from the card to the motherboard is easy," he says. As peripheral devices move along with the machines, the chip will be integrated in more Apple products.

Computer designers are typically not well versed in LAN technology, says Edwin DeSousa, National Semiconductor's Ethernet product manager. "Apple wanted a glueless interface between its system and the Sonic chip. Its engineers design a CPU and memory system, and you have to fit into it." The Santa Clara, Calif., chip maker tuned the system interface as Apple provided more information on how it worked.

Sonic may have been just right for Apple, but DeSousa says IBM-compatible PC makers are looking for a different solution. They want a chip that interfaces with the input/output bus—not the systems bus. Ethernet controllers such as National's ST-NIC [*Electronics*, July 1991, p. 27] are more appropriate.

Just as chip makers are making it easier to integrate LANs, so computer-aided design companies are coming up with simulation tools that speed time to market. The integration problem is not trivial. For example, a motherboard running at 33 MHz has to handle 1-ms interrupts from the network, says Lorne Cooper, senior technical consultant for Viewlogic Systems Inc., a Marlboro, Mass., system-simulation specialist.

Generally, the design must be characterized on the functional, electrical, and mechanical levels. VHDL is being used increasingly for functional characterizations, while JTAG—Joint Test Action Group—standards are being adopted by many companies to ensure that between-chip connections are correct. At the mechanical level, integrated design packages such as the one from Viewlogic now include cross checks between component specifications and manufacturing criteria, says Cooper. ❑

SEMICONDUCTORS

GERMAN RESEARCHERS HAVE TRIMMED CHIP SIZE FIVEFOLD AND PRODUCED PRACTICAL CIRCUITS

VLSI TECHNOLOGY IN 3-D

BY JOHN GOSCH

German researchers have taken VLSI technology a quantum leap forward. Using a three-dimensional CMOS design approach, scientists at the Institute for Microelectronics Stuttgart (IMS) have slashed VLSI circuit size two to five times beyond the limits attainable with the two-dimensional CMOS techniques used today. Seven years in development, the Stuttgart-based institute's vertically integrated Epilog technology has now reached a point where the industry could take it over to build commercial 3-d VLSI devices. IMS researchers presented first silicon of practical circuits at the European Solid State Circuits Conference in Milan (see p. 12).

The man behind it all is IMS director Bernd Höfflinger, 52, who in 1977 at Germany's University of Dortmund invented the ion-implanted n-well technology that makes CMOS compatible with bipolar techniques. He began work on the Epilog technology in 1984 when he headed the School of Electrical Engineering at Purdue University in Lafayette, Ind.

For all their advantages of high functionality, low cost per function, and high speed, today's 2-d VLSI circuits suffer from a number of drawbacks. With transistors closely spaced side by side, the interaction of these devices can cause catastrophic latchup. What's more, the large area that the interconnections occupy can lead to high load capacitance, diminished speed, increased power dissipation, and, worst of all, electromigration (whereby the ions in the aluminum interconnections can produce disastrous short-circuits).

A way out of this dilemma is 3-d, or stacked, CMOS technology. Pursued for about 12 years, such schemes have been based mainly on polycrystalline silicon films on oxide. But efforts to recrystallize the films have not led to any practical products.

Given the factor 2 to 5 jump in density that Epilog provides, the new technology is a milestone in VLSI circuit development. Interestingly enough, some of the key steps the Stuttgart group uses—namely selective epitaxy, lateral overgrowth, and chemo-mechanical polishing—have recently been adopted by some companies, among them IBM Corp., to build 2-d high-density submicron logic circuits and dynamic random-access memories. "These firms may finally bring true 3-d CMOS closer to volume production," Höfflinger says. He believes the industry could be using the Epilog technology commercially within two years.

In all likelihood it will first be used to fabricate static RAMs, since Epilog lends itself to getting the high density that the six-transistor cells of such devices require. It could also be used on logic circuits, where avoiding latchup and electromigration is crucial. ❑

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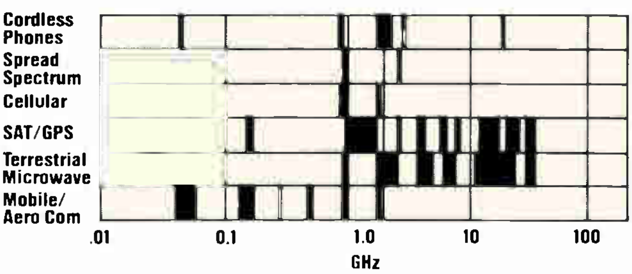

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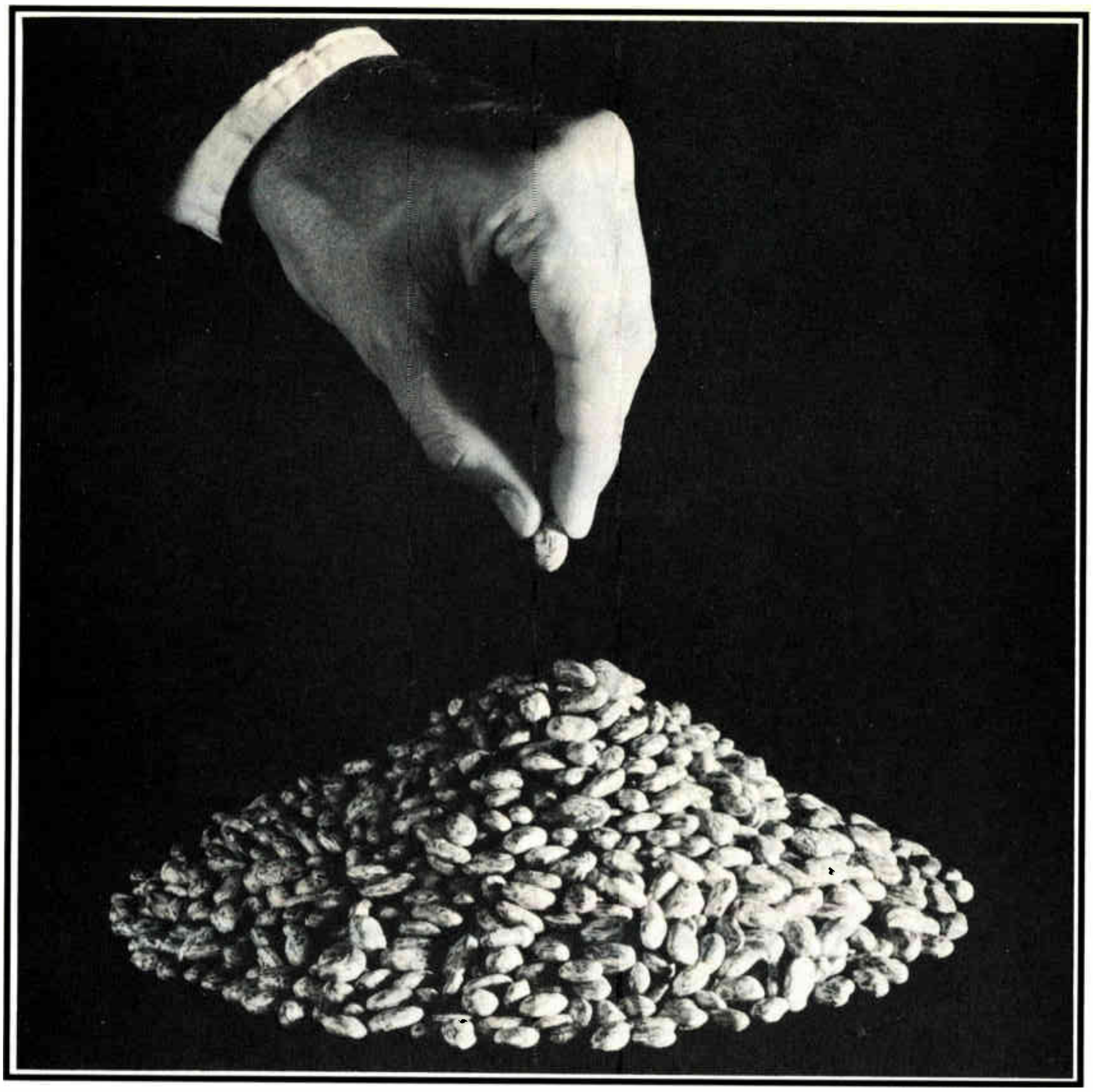
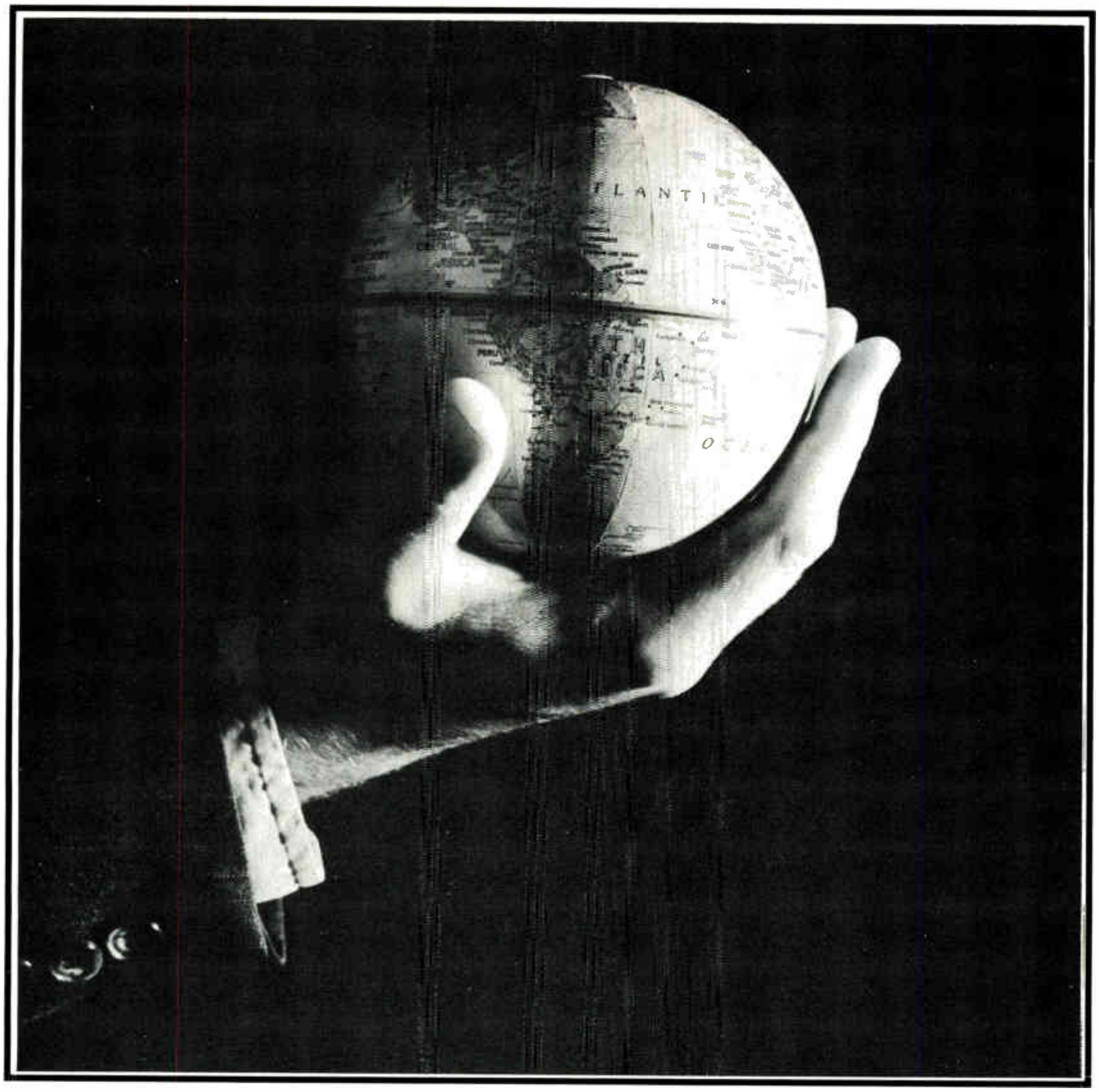
ABSOLUTE VALUE



ESTIMATE



CERTAINTY

There's more to electronics industry management than counting beans - much more. The typical electronics CEO wouldn't be typical in any other field. Unlike his colleagues in traditional industries, a career crunching numbers didn't get him that corner office - and neither did smooth-talking salesmanship. 71% of electronics industry management got to the top through

the engineering/technical side of the business - and once they've arrived they combine a current, experienced understanding of technology change with the analytical business skills of a seasoned pro. They run their companies hands-on – and you need to reach them in the pages of ELECTRONICS if you want your hill of beans to amount to something.

Electronics

Business/Technology Perspectives For Global Electronics Management

A Penton Publication

FEISTY WORKSTATION VENDORS ARE BRINGING OPEN SYSTEMS INTO CORPORATE DATA CENTERS

CAN IBM HOLD OUT?

BY JONAH McLEOD

COMPUTING

There is an old-fashioned street brawl going on in Fortune 1,000 companies for the hearts and minds of MIS managers. On one side stands IBM Corp., intent on maintaining client control in its home turf. On the other is a gang of upstart workstation companies, including Sun Microsystems Inc., starting to bring a new brand of open-system computing into the data-processing center. Workstation market leader Sun launched an attack on Big Blue Sept. 30 with the introduction of its next generation of multiprocessor servers, the SPARCserver 600MP.

Of course, IBM itself is no slouch. In mid-September—almost, it seemed, in anticipation of Sun's announcement—the Armonk, N.Y., computer giant rolled out seven new mainframes in its Enterprise System/9000 series, along with advanced networking software that allows all IBM mainframes to more easily transfer information to the desktop. The move was clearly aimed at making IBM more competitive in an industry that is now demanding open systems.

IBM's hold on the MIS department stems not just from the quality of its mainframes but also from the customer service that has become part and parcel of selling to Fortune 1,000 companies, says Lisa Thorell, associate director of technical computer systems at Dataquest Inc., the San Jose, Calif., market research firm. The combination has conspired to keep open systems based on Unix out of commercial applications. Unix's lack of field-tested commercial features, such as automatic backup and security, have made MIS managers forgo the price/performance advantages that Sun and others afford.

But the picture is changing, says Thorell, as Unix gets more commercial features, applications developers begin porting packages to it, and the price/performance gains of workstations and servers keep rising.

Corporations are not satisfied that they are getting the most out of the information technology they now possess, says Anil Gadre, vice president of systems-product marketing at the Mountain View, Calif.-based Sun, and are looking for solutions that will make the data contained on mainframes available to the desktop. So Sun's strategy is to approach IBM the way it approached minicomputer giant Digital Equipment Corp. of Maynard, Mass., says Thorell. Instead of attacking the minicomputer directly, Sun offered workstations that "talked" to these machines. Similarly, the new Sun servers are positioned as intermediate computers directing information transfer between mainframe and desktop and providing network services that users have come to expect—electronic mail, network and file management, and so on.

Also, Sun is introducing multiprocessing capability on this generation of server. In multiprocessing, different processors share the load to achieve a significant performance boost without a significant jump in price. "Multiprocessing is how servers—and eventually workstations—will be built from now on," says Thorell. Among the offerings are three networked servers—the SS630MP, SS670MP, and SS690MP—that offer symmetric multiprocessing with up to four processors apiece. In addition, the company introduced SunOS 4.1.2, a multiprocessing-capable update of its operating system seen as an intermediate step before SunOS 5.0. SunOS 5.0 will offer multithreading, a technique to make the operating system handle more than one task simultaneously, as well. Finally, Sun rolled out three server-management facilities that offer commercial services Fortune 1,000 companies are demanding.

IBM's preemptive attack stole a little bit of light from Sun. Big Blue is offering data-base enhancements that allow DOS, Windows 3.0, and OS/2 applications to more effectively and securely access data stored in IBM mainframes. All of these systems also can interact with Unix systems on an IBM network. IBM also brought out new networking software that helps workstations and PCs operate more easily together. Finally, it announced distributed file management and data distribution for Netware servers, enabling them to access data and storage through the central computing resources. ❑

Sun's new, multiprocessing SPARCserver 600MP machines aim squarely at the corporate computing arena, long the stronghold of IBM.

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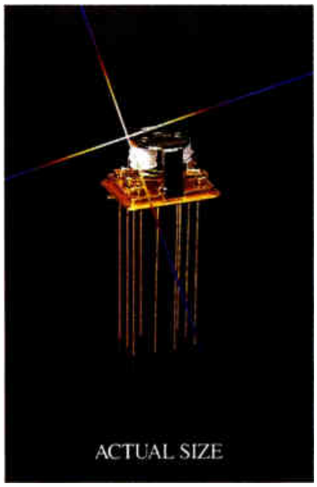

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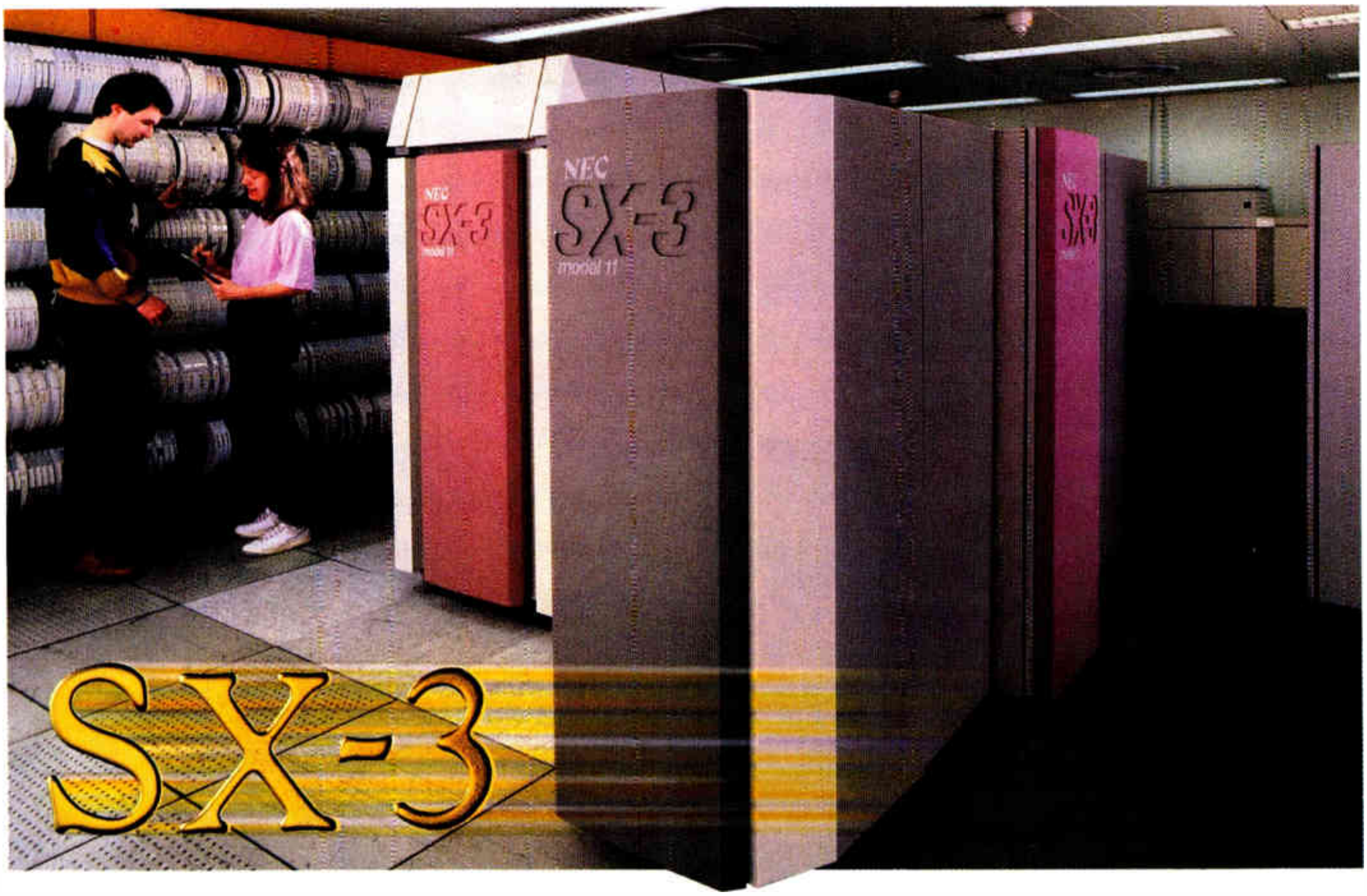


SUPERCOMPUTER STARTS UP AT THE UNIVERSITY OF COLOGNE.

An NEC supercomputer — SX-3 Model 11 — has just started service at the University of Cologne, Germany. The supercomputer system integrates resident LANs, mainframe computers, workstations and terminals. With 1.37GFLOPS speed, the SX-3 Model 11 is serving as a powerful core for inter-collegiate scientific computing services.

The SX-3 Series of supercomputers includes eight models ranging from a single-processor type with 0.68GFLOPS speed to the top-end, 4-processor 22 GFLOPS model. The world-class speed of SX-3 Series supercomputers comes from advanced system architecture, VLSIs with 70 picosec gate switching speed and high-density packaging.

The SX-3 Series supports the SUPER-UX operating system — a sophisticated UNIX-based OS designed for multiprocessor supercomputer applications. Extended functions for supercomputing permit efficient program development and the use of a wide variety of applications software.

Recent orders for the SX-3 Series include a 2.75GFLOPS Model 12 to the National Aerospace Laboratory, the Netherlands; and a two-processor, 5.5GFLOPS Model 22 to the Swiss Scientific Computer Center.

UNIX: Registered trademark of UNIX System Laboratories, Inc. in the U.S.A. and other countries.

NUMBER 146

2.4G OPTICAL TRANSMITTER/ RECEIVER MODULES.

NEC is now offering transmitter/ receiver modules for 2.4Gbps fiber optic transmission systems — vital trunk lines of global-standard SDH/SONET digital networks.

Transmitters are available for 1.3μm and 1.55μm wavelengths. The 1.3μm NDL5803P and 1.55μm NDL5853P are both distributed feedback (DFB) laser diode modules with single mode fiber pigtails.

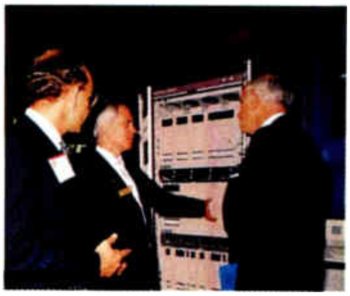
The DFB laser diodes provide extremely stable oscillation in a single longitudinal mode because they feature a unique diffraction grating and a double-channel planar buried heterostructure (DC-PBH). Both modules incorporate an optical isolator to reduce reflection noise. Matching impedance is 50 or 25 ohms.

These transmitters mate with two matching receivers. The NDL5520P and 5522P are InGaAs avalanche photo diode modules featuring extremely high sensitivity and a wide dynamic range.

The NDL5522P incorporates a pre-amplifier IC.

NEAX61 ATM BROADBAND SWITCH FOR SMDS.

Switched Multimegabit Data Service (SMDS) is a public high-speed, packet-switched, connectionless data service now emerging in the U.S. A stepping stone to broadband ISDN and synchronous optical networks, SMDS uses fiber lines to connect far-flung LANs, workstations and host computers.



The NEAX61 SMDS Service Node employs a high-speed, Asynchronous Transfer Mode (ATM) switching platform to offer efficient connectivity over wide areas at speeds up to 45Mbps. The ATM switching platform uses 155.52 or 622.08Mbps transmission paths to break data down into 53-byte "cells." The system multiplexes and switches these information packets at high speeds.

The SMDS Service Node is ideal for networks integrating high-resolution image communication and high-speed data transmission.

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SEPARATING THE INNOVATORS

IT'S ALL IN HOW WELL THEY MANAGE TECHNICAL CHANGE, AN ART THAT DEMANDS EQUAL PARTS VISION AND CORE TECHNOLOGY

BY JONAH McLEOD

It's a given that the electronics industry exists at the heady precipice where science and business meet—the place where the dazzling discoveries of the R&D lab are actualized as groundbreaking products. This picture is true enough as far as it goes, but it isn't the whole story. Alongside the companies leading the technological march stand plenty of outfits that keep milking the same old tired technologies. The industry has entered the commodity age, where all manner of products—from personal computers and memories to disk drives and chip sets—compete on price, not innovation.

COVER STORY

The commoditization of the industry creates fierce and crowded markets, as in PC motherboards (see p. 52). In such an environment, technology often takes a back seat to issues of cost. For companies that manage it well, though, technology can be a servant, not a master. These firms use their expertise to produce significant advances in functionality rather than modest advances in features. They differentiate their products on proprietary technology, not commodity value. They are economically healthier than their competitors, and weather the bad times better.

What separates the innovators from the also-rans is the ability to manage technical change effectively. The process is far from simple to master, and many companies miss the mark. Common to those that succeed more often than they fail are a pair of phenomena: a proprietary core technology that is parlayed into a panoply of applications, and a company visionary (or visionaries) with an intuitive feel for how this technology—or a new one—can best be used. Smart companies encourage their visionaries, even allow them to stumble; after all, what appears to be a blind alley may actually be a new avenue for a technology to take. And these companies nurture their core technology—this goose that lays the

FROM THE ALSO-RANS

golden eggs—cultivating it in several successive generations of products.

Visionaries are people with the rare knack for seeing technology as a solution to a problem that affects the man on the street. They are neither scientists investigating the outer limits of the physical world nor MBAs looking for a new angle on the next quarter's bottom line. Kazuma Tateisi, the late founder and chairman of Omron Tateisi Electronics Co. of Kyoto, Japan, summarized the idea this way in his book *The Eternal Venture Spirit:* the objective is to foresee society's needs and be the first to develop the technology, products, and systems to satisfy them.

In recent years, one product that has had a far-reaching impact on today's mobile society is the cellular phone. Motorola Inc.'s MicroTac is the world's first truly handheld cellular phone, and its development required an intuitive leap that synthesized diverse technologies into a final product. The visionary behind it is Robert N. Weisshappel, corporate vice president and general manager of Motorola's North American Subscriber Division in Arlington Heights, Ill.

In 1985, the handheld phone was a clunky item that resembled a compact walkie-talkie. In considering the next generation, Weisshappel realized that within Motorola he could find all the technologies needed to reduce the unit's size, weight, and power consumption. "I had access to the best filter, packaging, and computing technology available," he recalls. He halted work on the product then under development and told his designers to build a phone that would be three years ahead of the competition. Enter the MicroTac.

Recently, the company rolled out a new and improved version, MicroTac Lite, which weighs in at just over 7 oz and measures a little over 11 cubic inches. Beyond size and weight improvements, this offering boasts a new technology called Narrowband Advanced Mobile Phone Service, or Namps, a cell-splitting scheme that addresses a pressing problem confronting the cellular market: overloaded circuits. Namps increases system capacity threefold with little pain to provider or subscriber. It's a perfect example of taking a solid core technology to the next plateau and leveraging a second-generation product off a successful first.

While some visionaries, like Weisshappel, see how to apply known technology to a perceived need, others envision using totally new technology in their mainstream business. This was true for Omron's Tateisi, who "embraced fuzzy logic when it first appeared in the early 1980s," says Frank P. Newburn, senior vice president of the firm's U.S. arm, Omron Electronics Inc. in Schaumberg, Ill.

In creating the MicroTac, "I had access to the best filter, packaging, and computing technology available."
ROBERT N. WEISSHAPPEL, Motorola

"He saw the application of this new form of computing to electromechanical control systems," Newburn says. "Since then his instinct has been validated. Fuzzy logic is in everyday items such as camcorders and in Japanese cars for engine control, giving them an edge against U.S. cars in fuel efficiency." The U.S. unit uses fuzzy logic in its control-instrument and automation systems.

If companies don't have a resident genius like Tateisi, they can still make it their business to nurture good ideas and encourage creative thinking. SGS-Thomson Microelectronics Inc. in Carrollton, Texas, musters a technical review board to oversee research and development, make long-term evaluations, and then determine where to invest. It selects core technology and has, like Omron, settled on fuzzy logic as one that's applicable to a wide variety of uses, says Daniel Queyssac, president and chief executive officer.

Texas Instruments Inc. in Dallas is experimenting with yet another technique in its Vision program, whose aim is to encourage visionaries with new ideas inside TI to make proposals to upper management just as they would to a venture-capital firm. "If the TI executive staff deems the idea has merit and it is in a business the company wants to participate in, the group gets some funding," says Eugene W. Helms, vice president of the corporate staff and manager of strategic planning. "A panel of TI experts advises the new venture on how best to develop the idea."

Sometimes the visionary's view of the world is ahead of its time. Either the customer base balks or the technology has a tougher time than expected moving from the R&D lab to the factory floor. In the former category is Echelon Corp. of Palo Alto, Calif., which created a product that it felt would usher in the era of smart buildings and factories—a low-cost, intelligent distributed-control system. But getting it off the ground took some doing.

The unit allows elements such as light switches, security sensors, thermostats, and so on to communicate over an inexpensive network such as ac power lines. From a central computer, the networked system provides intelligent distributed control. But the market wasn't ready. "Though customers knew distributed computing, they did not understand the level of distribution we were expecting to do," says Ken Oshman, chairman, president, and CEO of Echelon. "In some sense what we are doing is a threat to designers of control systems. If I buy Echelon, do I have a way to differentiate my product—and do I have a reason for a job?"

Educating the market to Echelon's vision took several years, but now that the message has sunk in, the company has begun moving its technology into the mainstream. Last month, Echelon signed Arthur D. Little Inc. of Cam-bridge, Mass., as its first independent developer of Echelon's technology.

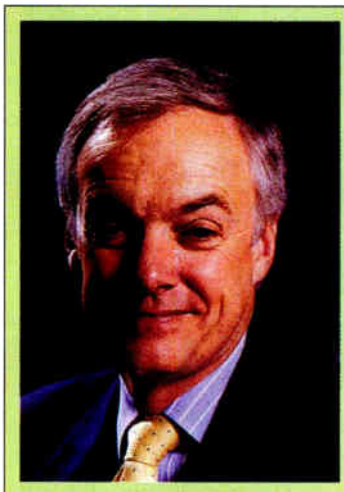
The disk-drive industry has numerous examples of startup companies carving out a niche by adopting new technology. But sometimes it's tough getting that technology into production. Areal Technology Inc. of San Jose, Calif., is the first company to ship glass-media removable hard disks—a 60-Mbyte, 2.5-in. unit. The unit is lighter than the conventional disk drive—just 5 oz, against 9 to 10 oz—and it is 2 to 4 mm shorter than the standard. What's more, comparable drives using aluminum platters can hold only 40 Mbytes per disk.

Finding a reliable supplier of glass disks was no easy matter, says Mike Kirby, president and CEO. Areal solved it by partnering with Nippon Sheet Glass Corp. of Tokyo, which later became an investor. The next hurdle was finding a way to ship tens of thousands of units a month, as the market demands. Kirby solved this problem by linking up with Sanyo Electric Co. Ltd. of Tottori, Japan, which is now producing 10,000 drives a month.

Though he aimed at and missed the 3.5-in. market window, Kirby hit the entry-level 2.5-in. window square on. Drive demand is just now taking hold, fed by the upsurge in notebook computers, most of which need the storage capacity of a fully equipped desktop machine in a much smaller size. So Kirby's bet has paid off, and Areal has already signed one small OEM, Tusk Inc., a Lake Park, Fla., manufacturer of ruggedized notebook computers.

Sometimes a company starts work on a new technology with a particular application in mind only to end up serving an entirely different market demand. In his book, Omron's Tateisi recalled one such effort. In July 1965, the company built a vending machine that would accept credit cards for Canteen Corp. in Chicago. It was a flop, and it took another 20 years before such products began to appear in Japan. But waste not, want not. Tateisi recounts how in October 1969, Omron used the same basic technology to create a cash-dispensing machine for Sumitomo Bank. And in June 1971, it built the first automatic teller machine for Mitsubishi Bank, thus ushering in the ATM age.

Sometimes the pressure of competing in a crowded commodity field is what spurs a company to embark on a new technology. Buffeted by the fluctuations of the random-access memory business, Dallas Semiconductor Corp. set out on a new mission: to develop a nonvolatile dynamic-RAM alternative to the bar-code label.



"Use well-understood technology and add value to it that creates a unique technology of its own."

VIN PROTHRO, Dallas Semiconductor

Michael Bolan, vice president of marketing at the Dallas company, says the original idea was to build a memory that could be written to and read from without a contact—but there was no way of making a completely contactless silicon memory. So Dallas Semiconductor came up with a "touch" memory—one that could be read or written in a few milliseconds when contacted with a wand. The DS199X Touch Memory, powered by an on-board lithium battery, debuted in August.

The path to the Touch Memory was directed by a need to escape the vicissitudes of DRAMs—a savage business, as Dallas chairman Vin Prothro learned when he was head of Mostek (now SGS-Thomson Microelectronics). That was in the heyday of DRAMs, the late 1970s and early '80s.

In one quarter, Mostek lost $200 million, more than it had made in 12 years of operations, and Prothro learned the value of selling a diversity of differentiated products instead of a few commodity parts. The other hard-learned lesson was never to depend on technology evolution alone to bring a product to market in a given time. "Rather," Prothro counsels, "use well-understood technology and add value to it that creates a unique technology of its own."

With the Touch Memory, Dallas Semiconductor may well have devised the kind of proprietary core technology needed by any company that hopes to manage technical change efficiently—technology to which new functionality can continually be added. Another example of this strategy is Integrated Information Technology Inc. of Santa Clara, Calif., which is building its reputation on math coprocessors. IIT, whose president and founder is Chi-Shin Wang, has integrated-circuit design expertise as well as a wealth of knowledge about high-performance math processing. The company sells a line of Intel-compatible math coprocessors.

In early September, IIT announced the Integrated Vision Module, a programmable video compression module that can handle all existing video standards as well as proprietary compression algorithms. Portions of the module are being shipped in the Rembrandt II/VP teleconferencing system from Compression Labs Inc. in San Jose. Wang believes he can apply the company's core competencies to the worldwide merging of computers, consumer electronics, and communications equipment that's now going on.

Artificial Linguistics Inc. in Dallas also has a proprietary core technology that can serve a variety of developing applications. Company cofounder Kelly J. Wical, vice president of R&D, is a programmer and self-taught linguist who spent 15 years creating and refining a software program that is an intelligent text engine. The software uses chaos math, which is based on chaos theory, to understand the vast array of word relationships and rules of grammar in the English language.

"What we have is a core technology," says president Douglas Kramp. "From this we can develop a long series of products. The first is a grammar checker, called PowerEdit, but this one really works. It can find your grammar errors."

Another application is for an intelligent, context-based text search and retrieval program—a package that would understand the difference between river bank and First National Bank, for example. Ultimately, such an intelligent text engine can be linked to multimedia packages on the personal computer and perhaps be used as well to perform perfectly coherent language translations. ❑

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CIRCLE 178

WILL IT BE OPTICS OR X RAYS FOR CIRCA-2000 MEMORIES?

AS THE SEMICONDUCTOR INDUSTRY BEGINS PLANNING FOR 1-GBIT DRAMs, LITHOGRAPHY STANDS AT A CROSSROAD BY LAWRENCE CURRAN

LITHOGRAPHY

In the semiconductor industry's headlong race to fabricate ever denser, ever feistier devices, one of the pacing technologies is the ability to produce ever smaller circuit features using step-and-repeat cameras. Steppers that expose the wafer with X rays are beginning to catch on in semiconductor research and development, but the consensus among device and equipment makers is that optical steppers will dominate, at least through most of this decade.

That's because optical steppers continue to confound chip makers as each succeeding generation exceeds the resolution limits believed possible with optics. Most authorities now see 0.1 to 0.15 μm as the smallest feature size that's practical to produce with an optical stepper. But most of them also agree that circuit features with such fine resolution won't be in volume production until at least the turn of the century—a requirement triggered by the advent of the 1-Gbit dynamic random-access memory.

Nonetheless, alert semiconductor manufacturers are positioning themselves to be ready for the DRAM business, circa 2000; they're beginning to buy X-ray steppers to check out in R&D labs or prototype production. (Some industry watchers are looking beyond X rays; see opposite.) At least three well-known device makers have ordered X-ray steppers from Hampshire Instruments Inc., a 1984 startup in X-ray lithography based in Rochester, N.Y. They include two large-volume silicon fabricators—AT&T Co. and Motorola Inc.—and one of the hottest young companies in the business, Cypress Semiconductor Corp. It's also known that Hampshire president Moshe Lubin has visited Boise, Idaho, in recent months. That's the home of Micron Technology Inc., one of only two remaining U.S. manufacturers of DRAMs. He won't discuss the visit.

Significantly, IBM Corp., probably the largest nonmerchant semiconductor manufacturer in the world, is also doing R&D work in X-ray lithography, but with its own system, which uses a synchrotron light source to produce X-rays. Hampshire, by contrast, employs an excimer-laser source.

X-ray lithography isn't new; its roots go back to the 1970s. More recently, Perkin-Elmer Corp. and Micronix Corp., neither of which is still in business, sold early-model X-ray steppers to both U.S. and Japanese silicon fabricators. One of those was Intel Corp. Until the advent of Hampshire's stepper, however, X-rays have been regarded as a relatively esoteric and costly alternative to optics.

X-ray steppers were expected to come into their own when optical steppers could no longer generate circuit features as small as about 1.0-μm. But that was a couple of device generations back; now optical steppers with i-line or deep-ultraviolet lenses are producing line widths in the 0.35-μm region, and this technology may continue to be effective—aided by advanced lens and mask technology—right down to 0.1 μm.

Optical steppers use visible or UV light to expose circuit features on a wafer. Shorter wavelengths produce smaller circuit features. I-line lenses produce finer lines than today's widely used g-line lenses, and deep-UV lenses produce even smaller geometries than i-line. X rays, on the other hand, have even shorter wavelengths than UV radiation, making them attractive for the sub-0.25-μm lines required for advanced DRAMs.

In a point-source X-ray stepper, a laser light source creates plasma that generates X rays, which then are directed through masks to expose a wafer. In contrast, in the IBM synchrotron-source storage-ring system, a collection of superconducting magnets arranged in a ring suspend and concentrate a beam of electrons. As the electrons whirl around the ring at tremendous speed, they produce X-radiation, which can be tapped off at each of several stepper

AFFORDABLE X RAYS

Hampshire's X-ray stepper is priced to compete with conventional units: $4 million.

stations that can be attached to the ring. The steppers transfer the X rays through masks to a wafer.

None of the X-ray proponents is touting this technology as a near-term production technique. "It's still a fairly esoteric and high-risk path to 0.25-to-0.35-µm geometries," says Tony Alvarez, vice president for R&D at Cypress, San Jose, Calif. That's why Cypress is also evaluating other approaches, including excimer-laser optical steppers. Alvarez points out that X-ray lithography has had a small beachhead in semiconductor R&D circles "for a number of years, but Hampshire represents the first viable option for a relatively small semiconductor manufacturer, such as Cypress."

The reason: Hampshire's system is priced at $4 million, which is comparable to the price of a deep-UV optical stepper. Besides the Cypress unit, Hampshire has sold steppers to AT&T Bell Laboratories, Murray Hill, N.J., and the Advanced Products Research and Development Laboratory of Motorola Inc., Austin, Texas. The AT&T system has been delivered.

Although Cypress doesn't manufacture DRAMs, the firm is monitoring advanced production techniques for CMOS and biCMOS logic and memory devices. Alvarez hopes to have the Hampshire X-ray stepper by the first quarter of next year, at which time "we'll be looking to mix and match it with optical steppers, probably mostly in static-RAM production" in a prototype program to use X-ray steppers in volume manufacturing.

Cypress's current systems, "based on optical wafer steppers, support our plans to shrink the technology from our current 0.8-µm minimum feature sizes down to 0.5 µm," he says. "Below that, the X-ray lithography system is one of the key candidates we're pursuing." Alvarez says the X-ray stepper may be able to shrink feature sizes to 0.25 µm.

IBM's synchrotron-source storage-ring system differs greatly in complexity and cost from the Hampshire approach. It's been estimated that such a storage ring costs $25 million to $40 million to implement, without any step-and-repeat stations. Each of those—and the synchrotron can support as many as 15 stations—may add another $1 million. That's why storage rings are the choice of only the behemoths of the electronics industry.

Besides IBM, that includes Siemens and Philips in Europe, "and every major Japanese company, including NEC, Mitsubishi, Toshiba, Hitachi, and NTT," says William Tobey, president of ACT International, a Burlington, Mass., consulting firm in management and technology marketing. Tobey says most X-ray work being done today is in such storage-ring systems.

But actually using this marvel in production is "a couple years down the road" at IBM, says Dan Fleming, director of the IBM Advanced Technology Center, East Fishkill, N.Y., where the synchrotron is located. Nevertheless, Fleming is bullish on the technology. "While we haven't perfected associated technologies, such as steppers, masks, or resists, we're far enough along to be confident of eventually smoothing out all the wrinkles," he says.

Fleming is convinced that IBM's X-ray work is on the right track toward cost-competitive DRAM production "by the mid-'90s. We're convinced that the technology is the most promising for patterning in environments of less than 0.25 µm." Although optical lithography continues to improve, he says, the technology leaps come "at an ever increasing price in associated processing, materials, and equipment. We expect that the [industry] demand to reduce this complexity will trigger the switch to X-ray lithography."

Hampshire president Lubin agrees. He doesn't expect optical lithography to "hit the wall" any time soon, but

IS THE X-RAY WINDOW CLOSING BEFORE IT OPENS?

One authority on both optics and X rays isn't endorsing either as the way to generate the tight line widths required for 1-Gbit DRAMs 10 years hence. Electron beams may outpace them both, says William Tobey, president of ACT International, a Burlington, Mass., consulting firm. Tobey says that although X rays look attractive, their window of opportunity may be narrow. In the future, it may be more practical to "write" circuit features directly on the wafer with electron beams rather than use wafer steppers of any sort.

Tobey says the semiconductor industry is preparing for the R&D phase of 256-Mbit DRAMs by 1996, and that while deep-ultraviolet optical lithography will probably be able to handle those geometries, the size limits of the exposure field may dictate a different technology, including X rays. A point-source stepper will be able to handle 64-Mbit DRAMs "nicely with two chips in the field," he says, "but at 256 Mbits, that begins to present problems for a point source. If the semiconductor industry will accept one chip per exposure, optical lithography will go to 256 Mbits, but I don't think the industry will accept that."

Tobey—who worked with both optics and X rays as a senior executive at GCA Corp., Andover, Mass., and at Micronix Corp., Los Gatos, Calif.—describes the Hampshire Instruments X-ray stepper as "a good point-source system." In such a setup, a laser light creates a plasma that generates X rays, which are directed through masks to expose the semiconductor wafer. As for the other X-ray choice—a storage-ring synchrotron—Tobey points out that its multimillion-dollar cost is prohibitive for all but Fortune 500 firms. Further, "having each stepper dependent on the storage ring is a detriment" in the event the ring fails, he says.

In the U.S., IBM Corp. is the only company known to be experimenting with a storage-ring synchrotron. "IBM is thinking about 1-Gbit DRAMs," says Tobey, "and while optics will probably get to 0.18-to-0.20-µm line widths using deep-UV, that's about the limit." The optical field size will stop you at 256 Mbits."

He looks for the Japanese industry to use optical lithography for 64-Mbit chips and X rays beyond that. "But beyond 1 Gbit, the choice may be direct writing on the wafer with electron beams or ion-projection lithography. The window is closing on X-rays," Tobey concludes.—*L.C.*

DEVICES GET MORE DEMANDING

	Mbits	Area (mm^2)	Feature size (µm)	Lithography system demands
1986	1	50	1.0	30% reduction on minimum feature size per generation
1989	4	80	.7	
1992	16	127	.5	
1995	64	207	.35	
1998	256	320	.25	
2001	1,000	500	.18	

SOURCE: ULTRATECH STEPPER

rather to price itself out of the competition eventually. Lubin characterizes the competition between optical and X-ray lithography as "a classic situation of one technology [X ray] displacing another over time as it proves itself. We're at the beginning of that now with X-ray lithography."

He sees an analogy in the way diesels replaced steam locomotives: "There was a time when steam and diesel engines coexisted, but diesels are much simpler, more cost-effective, and reliable." And that's the route he expects X-ray steppers to take. Lubin foresees optical lithography continuing to serve down to the 0.25-µm level, at which time optical and X-ray lithography will coexist, but optical will become "an ever-higher-cost option."

But while X-ray lithography expands its beachhead, optical lithography is progressing as well. One of its advocates is John Bruning, president of the Tropel Division of GCA Corp., who is also executive vice president of GCA, Andover, Mass. GCA makes advanced i-line and deep-UV optical wafer steppers. One of its latest production systems—the deep-UV model 7600—delivers geometries as fine as 0.35 µm, well below what many believed was the floor for optical systems five years ago. And that's the rub: optical steppers keep on exceeding the resolution limits believed possible. Like reports of Mark Twain's death, their demise has been greatly exaggerated.

There is a limit, however. Bruning believes X-ray lithography will take over in production in the 0.1-to-0.125-µm region about the year 2000. "The window for X rays has been continually shifted in width and pushed out in time," Bruning notes, "and the decision [about adopting the technology] will be an economic one."

Bruning is familiar with the IBM synchrotron approach and describes the system as "incredibly costly." Further, the fabrication and repair of masks "is very expensive." Nevertheless, Tropel is already doing advanced lens work with AT&T Bell Labs to extend optical imaging techniques into the soft-X-ray portion of the spectrum. The program, which Bruning says "is very much in the research phase," has produced 0.2-um features.

For his part, GCA's Peter DiSessa, director of marketing, says that 80% to 90% of the entire lithography market for semiconductor manufacturing in the next five years will be in optical steppers—a portion than may drop to 70% from 1996 to 2000. There's no argument with those numbers from ASM Lithography, Tempe, Ariz., another manufacturer of optical steppers. X-ray lithography "will become a production technique because it has enough physics behind it and support to make it," says Mark Bigelow, manager of marketing communications and a former engineering manager. "But it may be 2000 to 2004 before it becomes a cost-competitive production reality," triggered by the advent of 1-Gbit DRAMs.

Bigelow says that most forecasters see that time line for those devices, and believe that 0.1-µm line widths will be needed to get to that density. "Deep UV may be able to do that, but that may be the crossover point" between optical and X-ray systems, in Bigelow's opinion. ASM in May delivered the first of its PAS 5500 stepper family to IBM's semiconductor operation in East Fishkill, which has placed an order for "additional systems," according to Bigelow. The 5500/60 model delivered to IBM is an i-line system specified for 0.45-µm resolution at a throughput of more than 80 wafers per hour.

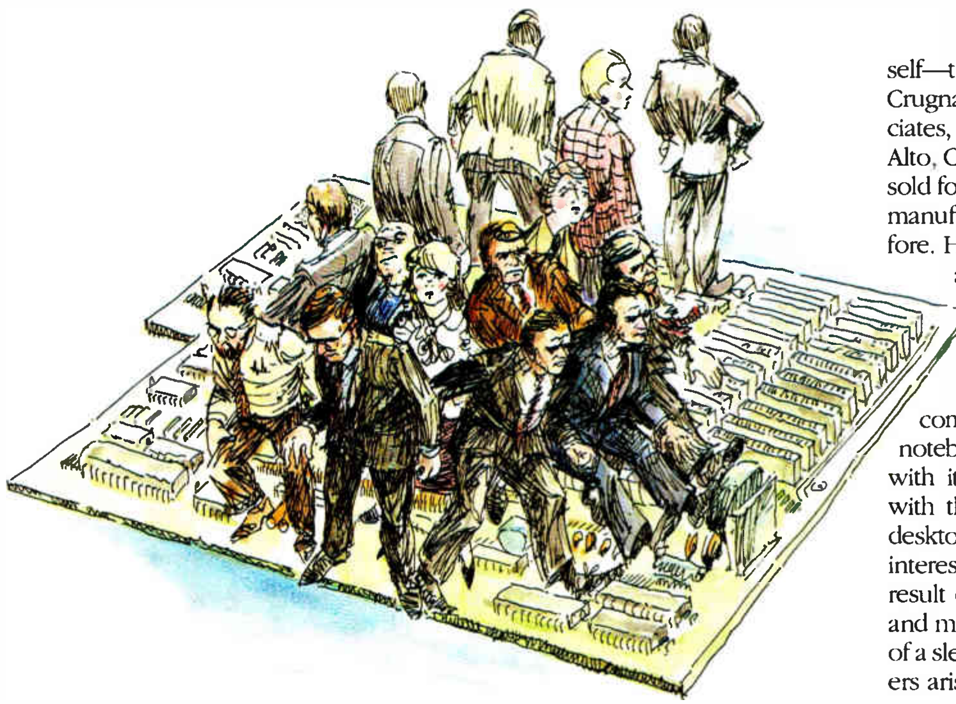
However, optics may pack still a few more surprises. Executives at Ultratech Stepper, a Santa Clara, Calif., supplier of optical steppers, say the window for X rays is even farther out than ASM's Bigelow suggests. Arthur Zafiropoulo, president, and Dave Markle, vice president of advanced technology, predict flatly that optical lithography, not X rays, will be used to produce 1-Gbit DRAMs in about 2000. And they're equally adamant in their view that X-ray lithography will never be cost-competitive with optical methods.

Both acknowledge that optical lithography will eventually be overtaken as geometries get ever finer, but they say that point is somewhere around 0.1 µm. "When optics run out of gas, X rays may be a viable choice, but never cheaper than optics," Zafiropoulo says.

Markle acknowledges that "no one has a good enough crystal ball to distinguish whether the practical limit for optics is 0.1 or 0.15 µm, but we don't need to get down there, even for DRAMs, until 2005 or 2006." And DRAMs are still the pacing vehicle for submicron requirements in semiconductors, Markle adds. Ultratech, however, isn't ignoring X rays. Zafiropoulo points out that the company supplied some of the initial staging for Hampshire Instruments' initial X-ray systems, and still has an informal relationship with Hampshire.

Perhaps a chip maker's perspective is more valid than an equipment vendor's in predicting the lithography winner. Assuming that 1-Gbit DRAMs show up in 2000—a reasonable date "based on extrapolating current trends," says Alvarez of Cypress—X-ray lithography looks to be the solution, he says.

"The semiconductor industry is producing 64-Mbit DRAMs now using i-line optical steppers and phase-shifting masks," Alvarez says. "A 1-Gbit DRAM is two device generations away, but it's highly unlikely the industry will be fabricating those chips with optical lithography. The geometries for those devices will be at 0.15 to 0.2 µm, which could very well require something like X-ray lithography." ❑



ON THE BOARD, IT'S THE BIG SQUEEZE

CHIP-SET VENDORS ARE BUFFETED BY COST AND TECHNOLOGY CONSIDERATIONS AS THEY VIE FOR SPACE ON THE MOTHERBOARD

BY SAMUEL WEBER

SEMICONDUCTORS

The battle of the PC motherboard is being fought in an ever more crowded arena—literally and otherwise. The board itself is becoming prime real estate as higher levels of integration shrink its size. And the liberation of the microprocessor from the solitary grasp of Intel Corp. means more motherboard suppliers—and more possibilities for the chip-set vendors elbowing one another to find a space on that small board.

These vendors are buffeted by the slump in personal computer sales and seem to be pulled in two opposing directions to cope with it: competing solely on cost, or building in functionality in an attempt to meet the needs of the computer manufacturers, which themselves are torn between lowering prices or differentiating their products by adding new features.

Opportunities to add functions like multimedia, sophisticated communications and networking, high-definition displays, and optical storage will soon result in a very fertile period of PC design, says industry watcher James I. Magid, senior adviser to Needham & Co. in New York. Vendors are just bidding their time till the recession is over. "We haven't yet seen the implementation of this technology," Magid says.

Indeed, "The PC as we know it is going to fly apart and resegment itself—the way cars did," says Matthew P. Crugnale, president of Crugnale & Associates, a marketing consultant in Palo Alto, Calif. "More and more PCs will be sold for special applications. The classic manufacturer never had to face that before. He just made it bigger and faster, and there was price differentiation based on performance—not functionality from a user's point of view."

Additional chip-set ferment comes in the form of laptop and notebook PCs, a fast-growing sector with its own special demands, along with the expansion of RISC onto the desktop and a still nascent but growing interest in multiprocessing for PCs. One result of this rich mix of technological and market-driven stimuli is the onrush of a slew of young chip-set manufacturers arising to challenge the primacy of veterans like Chips & Technologies Inc. and LSI Logic Corp., or to take advantage of new opportunities.

Meanwhile the availability of 386 central processing units from sources other than Intel has given rise to a host of new motherboard manufacturers. That would seem to be good news for the chip-set crowd, but the plethora of choices has resulted in a price squeeze, especially at the low end.

"The availability of the CPU is changing the market," says Ron Mazza, vice president of sales at Symphony Laboratories, a Santa Clara, Calif., chip-set supplier. "Anybody can get a CPU now. People who had an advantage last year by being able to obtain the CPU from Intel had a huge leverage point, and now that's taken away. That's put a lot of pressure on [board manufacturers] to lower prices." Some of the new board vendors are only marginally profitable. "There's some saturation for sure," says Mazza, who anticipates a shakeout.

"Every mom and pop shop in the Far East that can get its hands on the product is building a board, and that's helping to trash the whole motherboard market's pricing," says Hans Schwartz, director of product marketing for Chips & Technologies' systems logic group. "They're relegating it to simply a manufacturing cost issue." But with customers demanding the 386 for performance, Schwartz says, costs can be lowered just so much, and then "it becomes a manufacturing game."

Chips itself has made a bold move to up the ante by appealing to the system

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vendors' major concern—product differentiation. For the first time, the San Jose, Calif., company has entered the processor arena with a flurry of announcements late last month, including a single-chip PC, a family of high-performance 386-compatible processors and 387-compatible math coprocessors, and a new architectural concept called SuperState that overcomes hardware/software incompatibility problems in system design.

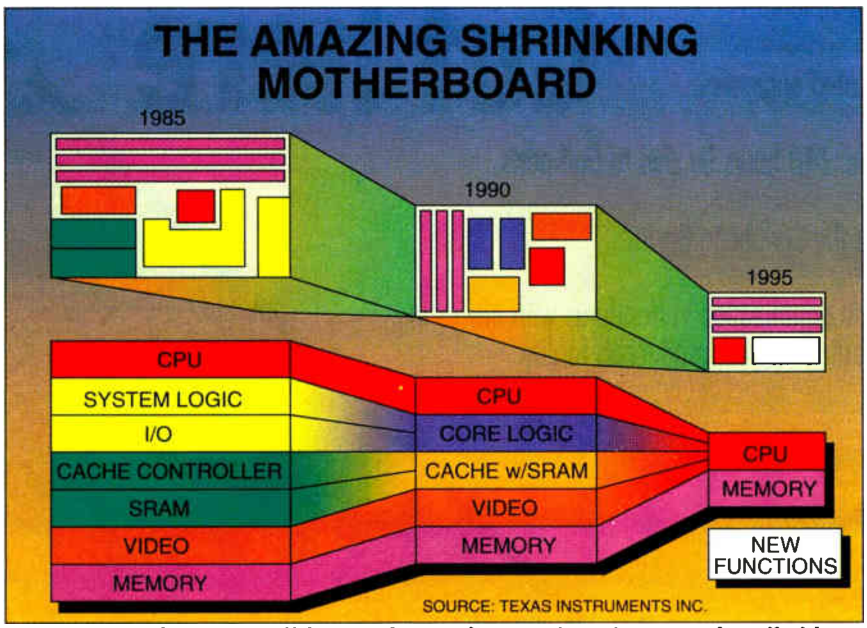
Chips's entry into the processor game adds to the stew stirred up when Advanced Micro Devices Inc. challenged Intel with its own versions of the 386SX and DX last year. For its part, Intel remains confident that it will maintain its strong hold on the motherboard, but analyst Crugnale believes the giant Santa Clara chip manufacturer may be whistling in the wind. "Intel doesn't have a track record of being cost-competitive," he says.

Chips's PC/CHIP F8680 integrated PC embodies an 8086-compatible microprocessor running up to 14 MHz, IBM XT equivalent logic, a CGA-compatible display controller, a serial port, and built-in power management. At $35 in the 10,000-quantity range, the 8680 is liable to establish a new price point for low-end PCs, as well as diskless workstations, notebook and palmtop PCs, and embedded control.

At the same time, Chips introduced four microprocessors in two families and two fast math coprocessors. They include the pin-compatible 38600SX and DX series of microprocessors, featuring 10% higher performance than standard versions; extended-pin versions, the 38605SX and DX, with up to 40% greater performance; and 38700DX and SX floating-point math coprocessors that are pin-compatible with Intel's 80387 counterparts, but offer what Chips claims is a 600% performance gain.

The chip architectures on all these parts support what the company has dubbed SuperState, a suite of programmable system-management tools that enables system vendors to differentiate their designs while retaining compatibility. It is a transparent layer that resides between the hardware and software platforms with which manufacturers can create customized designs, says Schwartz—for example, by accelerating the operation of Windows or other application programs.

Chips's single-chip PC may soon have company, as other vendors drive toward higher levels of integration. Texas Instruments Inc., for example, hinted at a recent technical seminar for the press that it intends to participate in the evolution toward single-chip PCs, which the Dallas concern calls "semicomputers." Rumors also abound that IBM Corp. is leveraging its right to produce the Intel CPUs by developing a high-performance 386 with an extended "superset" of instructions and peripheral functions built around the CPU core.



By 1995, the CPU will have subsumed many functions now handled by separate ICs, making room on the board for new features.

Intel, meanwhile, has mounted a two-pronged strategy: CPUs tailored for the laptop and desktop arenas. For the laptop, notebook, and palmtop market, the company specifically designed the 386SL, which, says Jim Chapman, director of marketing for the entry-level products group, offers a rich feature set for power management plus new bells and whistles. "It's a powerful enabler for adding special communications features, managing the higher power of a color liquid-crystal display, and other features," he says.

Analyst Magid is enthusiastic about Intel's 386SL processor. "As a platform, the 386SL is grossly underestimated," he says. "It's not just a processor, it's a chip set. A whole host of precise and subtle features can be developed around those chips. Its power-management features are ideal for an office machine as well as a portable."

In the desktop arena, Intel keeps on driving the price-performance ratio with a strategy centered on the 486SX. This CPU offers "attractive price-performance migrating down the mainstream of the desktop," says Chapman. "Another important element will be upgradability—the ability to support follow-on generations with a socket on the motherboard," he says.

Intel no doubt will carefully examine the competitive implementations of the 386 for violations of its proprietary rights. (Chips is fighting back on the legal front as well: claiming patent infringement, the firm last month filed a complaint with the International Trade Commission to ban imports from rivals Elite, Eteq, Opti, and Sun Electronics.)

But it also plans to stay ahead of the crowd in technology and product development. "We want to lead," says Chapman, "so we'll see how other situations in the marketplace develop. But we're aggressive about maintaining our position." He points to a $1.6 billion capital and research expenditure in the past year as a symbol of how seriously Intel takes its primacy.

Meanwhile, other chip makers are as eager for integration as giants like Intel, TI, and IBM. Via Technologies Inc. of Sunnyvale, Calif., is one. It too is aiming at the burgeoning portable market as well as the desktop. Early this year the company unveiled the SL9252 and SL9353 single-chip controllers for 20-MHz 386SX and 386DX-based systems, respectively. System designers can implement a complete PC/AT-compatible computer with only one additional VLSI chip—a peripheral controller—plus minimal TTL logic and the CPU. Via is already moving to the next generation with the SL8280, now being evaluated in engineering samples. Production will begin late this year.

According to Hal Stone, Via's director of marketing, the new chip is aimed primarily at portable systems but could function equally well on the desktop. Designed to support both Intel and AMD versions of the 386SX, the 8280 performs at 25 MHz and boasts an on-board peripheral controller along with page-mode control and power-management circuitry.

Under its former name, Zymos Corp., Appian Technology Inc. of Sunnyvale pioneered in the chip set market with its line of Poach chips for 286 systems. Now the company is taking a multichip-module approach to winning the battle of the notebook motherboard. Its 386 chip set missed the market window, but instead of scrapping the development, Appian crammed a memory controller, power-management unit, peripheral AT coprocessor, and expansion bus buffer into a single module and called it the A90 notebook controller. With a few other components, computer designers can now put a complete PC system on a 5.5-by-4-in. motherboard.

At the Comdex show, Appian will preview a chip set for 486 systems. Since it employs a local-bus architecture, the set essentially eliminates the need for a cache subsystem. Eventually this product, too, will become a module, says company spokeswoman Nancy Hartosch.

Meanwhile, other companies are putting their money and efforts on the opportunities afforded by the growing interest in reduced-instruction-set computing. The market-leading Sparc architecture will account for $10 billion in sales by 1994, according to Tera Microsystems Inc. of Santa Clara, of which 40% will go to Sparc-compatible systems. In pursuit of the possibilities those numbers represent, the company recently introduced its first product—microCORE, a four-chip set for developing low-cost, high-performance systems based on the Sparc architecture.

It utilizes a proprietary high-speed local chip-level interconnect called microBUS that demands about half the number of pins of competing solutions. Tera is aiming at "the lower end of the Sparc marketplace. We're looking to support very low-end workstations, laptops, notebooks, and embedded control," says product manager Sue Markowski. Tera, she agrees, is setting out to be the Chips & Technologies of the RISC world.

"We think there's a big market for RISC boxes right next to DOS boxes on the desktop," Markowski says. "For example, people in offices who have had DOS machines on their desks for so long will also want RISC Unix machines there to hook up with people in the company who may not have gone the DOS route—engineering, for example."

At $5,000, she says, the upcoming breed of RISC machines will be comparable in price to PCs but pack more power and memory. "We expect the first workstation to come out in the laptop format in a couple of years," she says, "and we think people will start using it for more than they used to. Traveling salesmen use [laptops] now—we think engineers will start using them on the road as well."

Cypress Semiconductor Corp. of San Jose also has developed Sparc modules. The line is called Sparcore and is manufactured by Ross Technology Inc., a wholly owned subsidiary of Cypress based in Austin, Texas. The company offers three versions, one with a single Sparc CPU and the other two multiprocessing setups. Each CPU contains a high-speed integer unit, floating-point unit, cache controller, memory-management unit, and 64 Kbytes of cache memory.

"We see the Sparc side really taking off now," says Joe Nichols, director of marketing at Ross Technology. "Sparc has become an accepted standard, and customers are learning what it means to design in the world of 40 MHz. We see a lot of people getting started on a wide variety of prototypes of both workstations and servers. You can make an awfully powerful server by using two multiprocessor modules, and getting four processors per server."

Nichols thinks the future of the CPU business is in modules. "You've got to get more processing capability, and if you try to do that with giant pieces of silicon you're going to have processing problems," he says. "On the other hand, by using modules you can get reasonably close to the density of large pieces of silicon without being penalized by the capacitance and inductance you get going across large areas of trace lines on boards."

George White, president of Corollary Inc. in Irvine, Calif., has firmly committed his company to multiprocessing as the way for high-end PCs to take over the traditional role of the minicomputer. The market so far is small, but Corollary is profitable. The company doesn't market a complete computer; it provides core subsystems to PC and minicomputer manufacturers, value-added resellers, system integrators, and distributors. A multiprocessing chip set will be available early next year. "We don't think of ourselves as a chip-set company," says White. "We're really focused on multiprocessing. We look on the chip set as an implementation vehicle for multiprocessing machines."

Previous generations of the Corollary hardware were based on a design implemented with programmable-aray logic, and licensees include such industry stalwarts as Compaq, Digital Equipment, NEC, and Zenith. "We hope the next generation, which squeezes our PAL-based design into a chip set, will really drive standardization," says White. This is badly needed in the multiprocessor arena, he says.

"Up to now manufacturers that have built multiprocessor PCs—other than those using our current technology—are all different from one another. If everybody does it a different way it doesn't really promote multiprocessor applications. Our success in getting a list of customers with names like DEC and NEC using a PAL-based design makes us believe we really have a shot at making our next generation successful." ❑

WHO'S ON FIRST?

Chip-set leader Chips & Technologies is getting into the CPU business with a single-chip PC, 386 processors, 387 coprocessors.

CPU leader Intel is getting into the chip-set business with the 386SL, a chip set aimed at laptops and packing a host of sophisticated features.

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CONTRACT Manufacturing

Sometimes, it pays to let someone else make it. When contract manufacturing first hit the scene a few years ago, it was seen mainly as a backup or supplemental service. However, its many advantages, along with the emergence of highly sophisticated, multiple-capability firms, have made contract manufacturing one of the fastest-growing areas in the electronics business.

The growing complexity of IC designs is one of the major reasons behind the surge. Smaller firms, especially, find that keeping up with the latest in assembly and test equipment and procedures is beyond their financial—and, often, technical—capabilities. On the other hand, because contract manufacturers spread their costs over a wide range of customers, they can afford to invest in the latest equipment and techniques. Gaining access to this technology is a major reason why many companies feel that contract manufacturing is a very

(CONTINUED ON P. 62)

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THE TUCSON FIRM OFFERS A WIDE SPECTRUM OF SERVICES, FROM CAD LAYOUT TO SHIPPING

The value of sophisticated technology is lost without innovative thinking and dedication. MiNT's dedicated pros are experienced in statistical process control, surface-mount processes, electronic assembly, electronic test, P&IC procurement, and configuration management.

MiNT provides a wide range of customized services, from pc-board layout utilizing CAD to material procurement, assembly, test, burn-in, and shipping. This enables MiNT's customers to select from highly advanced technologies. Whether automated through-hole or surface-mount technology is required, you can depend on MiNT to deliver a superior product on time and within budget. A wide range of testing options, from in-circuit and functional test to static and dynamic burn-in, ensures that customers' product requirements are met.

Above all, quality is utmost at MiNT Corp. It is the most critical measure: all management levels are trained to continually review quality in all areas. MiNT's dedication to quality culminates in the timely delivery of the lowest-cost products, with quality that always satisfies customer requirements.

MiNT Corp. also provides material procurement, and production- and inventory-control capabilities. Material planning, procurement, and handling are customized through our highly experienced materials staff working in partnership with suppliers. MiNT's sophisticated Class A MRP II System helps plan, track, and issue all materials with precision. Materials are inventoried and accurately controlled to guarantee component quality and availability. MiNT Corp.'s CAD capabilities provide the option of converting existing through-hole designs to surface-mount, or laying out through-hole or surface-mount products from customer schematics. Shipping, from product packaging to drop shipping direct to your customers, completes the diverse capabilities available.

Why MiNT Corp.? It is fully equipped to offer you the very best in service and technology; the quality of workmanship is outstanding. MiNT strives for continuous improvement in all areas. The goal is to have virtually no defects in the products shipped and in services provided. MiNT offers the most economical costs and consistent quality that always meet customer requirements, as well as on-time delivery. These tasks are accomplished through service-oriented customer partnership that emphasizes proactive and open communication. MiNT Corp. has an experienced and dedicated staff that takes a teamwork approach to customers' exacting requirements: the results are quality and superior performance at all levels.

MiNT Corp. is expanding its surface-mount capabilities to meet challenges posed by changing technologies and increasing customer demands. It is entering long-term relationships with customers and suppliers, which enable customers to reduce capital equipment spending, inventories, and manpower, and maximize material-cost reduction via leveraged buying. Reduced overhead costs are realized through savings in procurement, receiving, inspection, shipping, warehousing, and accounting. Further cost savings are realized by customers in material attrition, which is totally eliminated with full turnkey contract manufacturing. These savings result in greater profitability for MiNT's customers, enabling them to concentrate on product design, marketing, and distribution. ■

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EXPERIENCE, WORK FORCE, TALENT ARE KEY

GOT a million-dollar idea, but not a million dollars to invest in producing it? Can't keep up with the faster time-to-market demand? Competition intensifying? This can be a tough puzzle to solve. That's why so many companies, both large and small, are increasingly turning to contract manufacturing services like Senior Systems Technology (SST). They can manufacture part or all of a product often more efficiently and cost effectively than the product company can.

In 1982, when SST was incorporated, most of the contract manufacturing customers were in the computer and computer peripheral business. Today, the customer base is much more diverse, ranging from telecommunications, security systems, and medical equipment to toys and games. Contract manufacturers have become so appealing because they offer the alternative of utilizing their experience, work force, and talent pool while avoiding costly investments in capital equipment, personnel, and inventories to the product company.

SST, by becoming the remote manufacturing department, serves not only the overall product company but each of its departments. SST provides tremendous support for the purchasing, stock room, inspection, production control, manufacturing, and testing departments. This removes an immense burden from the company's shoulders.

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At the beginning of April, SST relocated its Southern California facility to a new 30,000-ft² building to accommodate all facets of its expanding operation. Every department has doubled in size, resulting in higher yield and much greater efficiency. The move has also made room for the unique complete-product-build operation. This fully equipped facility can handle a wide variety of manufacturing needs, whether through-hole, surface-mount, or mixed technology.

The auto-insertion department has the latest equipment, including Dynapert to handle axial-leaded components, Amistar to handle DIP ICs, and three Zevatech Pick and Place machines to meet surface-mount requirements.

Customer service is the most important part of the contract-manufacturing business. While SST is classified as a manufacturer, what it really provides is a service. SST's main goal is to develop a partnership with its customers by providing cost-effective, quality, and responsive manufacturing services on a timely basis. Long-term success comes only by doing everything possible to help the customer bring a cost-effective, quality product to the market on time. This goal is met by providing quality above and beyond customer requirements; pricing assuring that the customer remains competitive; and continual growth in the number of services.

The ability to provide turnkey assembly is a given. The same is true for offering both surface-mount and through-hole assembly. However, SST is uniquely capable of providing complete product build (or box build). For several customers, SST builds complete product—even putting it into the customer's shipping carton. A full complement of advanced technology testing—including in-circuit, functional, and burn-in—is also available.

Along with UL and CSA approval, SST has been awarded facility approval by the British Approvals Board for Telecommunications (BABT) as a manufacturing site for Data Control Equipment. All approved DC equipment destined for the UK must be built and tested at an approved manufacturing facility. SST is the only BABT-approved contract manufacturing facility in Southern California.

SST offers manufacturing engineering services to assist its customers in designing a board or product. Most contract manufacturers, like SST, do not offer product-design services: they feel that the customer should be responsible for the product design and the contract manufacturer for the workmanship. SST has a total commitment to contract manufacturing and does not have any product of its own to compete with its customers'.

Only a few contract manufacturers have additional facilities outside the U.S. These resources keep labor costs low and productivity high. SST has sister offshore facilities in Singapore and Malaysia, ensuring that onshore/offshore projects carry the workmanship and quality of the U.S. facility. ■

(CONTINUED FROM P.57)
attractive alternative to an in-house capability. Since contract houses typically have high capacity utilization, cost per component is usually lower. A large contract manufacturer might offer a fully loaded ship rate of $25/hr, while an OEM could easily reach $100/hr for an in-house capability. Changing market dynamics are also working in favor of those contract manufacturers that can provide the quick turnaround needed to hit target market windows.

Testing services are also becoming more popular with companies that farm out their manufacturing. It is not uncommon for a product to undergo stress screening, in-circuit and functional testing, environmental stress screening, and final system testing. With ever-increasing silicon integration and board functionality, the sheer time and expertise required are beyond most small manufacturers.

Smaller contract houses tend to specialize in prototype and surface-mount conversion services, while others focus on military applications or assembly of large boards. Some large concerns have broadened their activities to the point where they will do everything from designing to shipping finished parts to the client's customer.

The level of involvement between contract manufacturer and client can be as shallow or deep as desired. At one end of the spectrum is consignment manufacturing, simple assembly. At the other end is turnkey manufacturing, responsibility for the entire project.

The turnkey trend causes David Bowman, vice president of Chatsworth, Calif.-based Senior Systems Technology Inc., to feel that customers increasingly expect that their contract manufacturer will be able to offer a wide range of services, including both surface-mount and through-hole assembly. In addition, he feels that a house should offer a full menu of testing services, including in-circuit functional, and burn-in.

"Complete product build [or box build] is becoming more common," says Bowman. "We have several customers for whom we build the product and ship it. The end user, not the customer, is the next one to open the box."

Some contract manufacturers offer engineering and design services, while others feel that this is best left to the customer. Some, like SST, do not offer a full range of design services, but they do provide manufacturing engineering help.

Typical of turnkey contract manufacturers is MiNT (Manufacturing in New Technology), which offers a full range of services. The Tucson, Ariz., company offers design, assembly, and testing as well as turnkey services, including manual assembly, through-hole, auto insertion, and SMT services.

Some contract firms have opted to concentrate on production rather than design. One is International Microelectronics Inc. of San Jose, Calif. Last year, the company decided to drop out of the design end and concentrate its 400-employee work force on contract manufacturing, along with its own standard product line.

Others have found specialized niches. ExperTest Inc., founded in Palo Alto, Calif. in 1988, has developed expert software that automatically generates test vector programs from behavioral and structural circuit descriptions. The technology is said to work for all design-for-testability approaches. Among the advantages: improved productivity, reduced test time, and lower rework cost.

A number of firms specialize in assembly. Typical is Hutronix Inc., a Tucson-based company that does product assembly and cable and harness assembly, but also offers as well as turnkey services.

But whatever is covered, a contract-manufacturing agreement should be more than a simple financial arrangement; it should be a partnership. For this reason, says Walter Wilson, vice president at Solectron, evaluating and choosing a manufacturer should be "an in-depth and detailed procedure."

This reference to a partnership is heard more and more often around contract manufacturers and their clients. Solectron, one of the major players in the game, feels that this emphasis on the close relationship with the client is essential for success. "The CM should be seen as a full partner," says Wilson.

Because of the close working relationship between client and contract manufacturer, and the high degree of trust that must prevail, certain key factors must be evaluated by the prospective client. Among them are the manufacturer's service and quality record, its financial stability, the services available, the cost, and the likelihood of reducing time to market.

Quality standards are crucial to the maintenance of a satisfactory long-term relationship. Says Wilson: "You should evaluate a contract manufacturer's track record for implementing quality into their own processes. For example, do they use zero defect, statistical process control, and total quality control approaches? Have they won any awards from their customers for outstanding performances?" It is also important to look into performance in reducing defect levels.

In the final analysis, cost is the most important factor. As Solectron's Wilson points out, "The partnership should be profitable for both parties." But he cautions that manufacturing rates are not the only consideration. As an example, a typical OEM with $50 million in annual sales can spend $5 million for a surface-mount capability; with the cost of a supporting inventory, the cost can easily reach $8.3 million. A large manufacturer can provide the same level of service for $1.3 million.

The manufacture of high-reliability components or systems is a different ball game, one where standards are far more stringent than those for commercial products. Although specifics may vary with the application, there is usually a common need for close adherence to high standards for materials, test procedures, quality control, and so on.

Jack Calderon, vice president of Group Technologies Corp. in Tampa, Fla., suggests three areas to consider. First, to what level of reliability does the manufacturer's capability bring the finished product? Second, what kind of selection criteria for suppliers are in place? And third, what kind of facilities, test capability, and technical staffing are available?

Materials control is crucial; understanding the nuances between standard commercial parts and their higher-reliability derivatives is crucial in pricing and buying. In addition, all incoming parts must be tested.

Supplier selection is just as important as material selection. The goal must be the highest-quality material, and the work must be delivered on time.

Testing and calibration are significantly different in high-reliability manufacturing. In addition to standard tests, high-rel requires testing to meet the stress associated with various extreme environments. This means special test instruments and setups, properly maintained.

Process control is crucial. From incoming inspection to final shipment, allowable upper and lower limits must be strictly adhered to. SPC is essential.—*Francis J. Lavoie*

INVENTORY OUTLOOK IS GOOD, BUT NOT THE ORDER PICTURE

There is a modest sampling of good news to go with the bad as the economic signals continue to be mixed for the electronics industry. The good news is that inventory productivity is continuing; the other side of the coin is that order patterns overall have been weaker than expected.

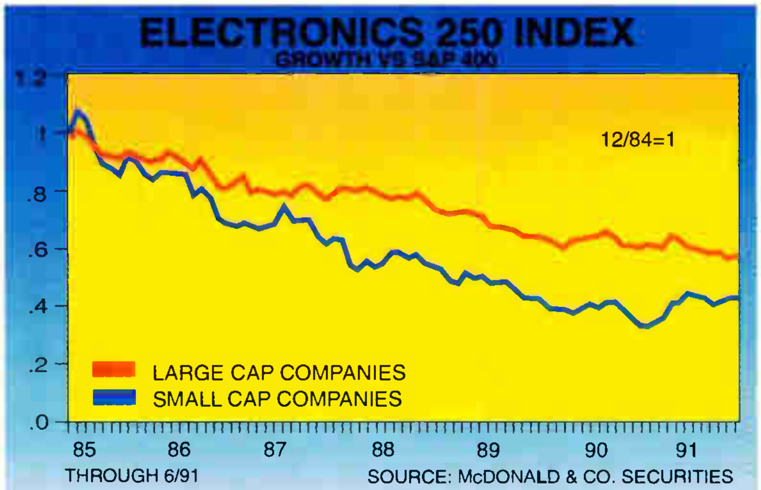
In the effort to battle back from the recession, continuing progress is being made on the inventory front. Inventory—or the lack of it—is improved in just about every capital-goods industry area. That category includes aerospace, communications equipment, components, computers, and electronic and electrical equipment, all of which have exhibited improved inventory productivity over the past nine months.

In the rest of the industry, overall durable-goods inventories have increased in relation to sales in the last six months, but some liquidation of inventories is occurring as orders begin to show signs of life. Though some of that reduction might be caused merely by improved asset-management practices by companies, a modest pickup in demand could still result in some pipeline filling in the next three to six months.

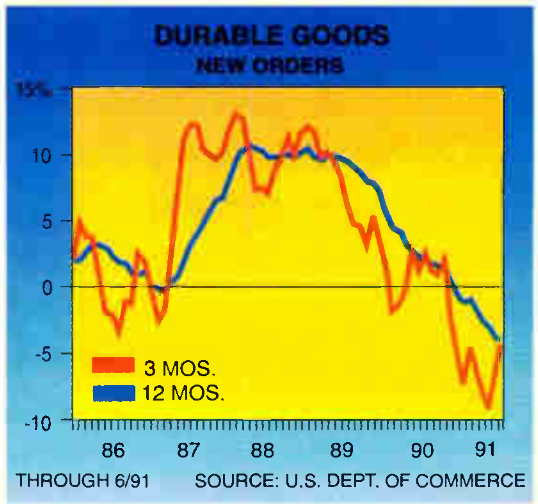
Meanwhile, order patterns are disquieting as price competition accelerates. Demand for computers is the weakest of all the capital-goods sectors of the electronics industry. Even as prices come under severe pressure, lack of software to effectively utilize existing processing power may stunt the growth of the hardware market for the foreseeable future. In fact, the only segment showing consistent growth is distribution.

So it might be that the adage stating that electronics always leads the capital-goods sector out of recession may not hold true this cycle due to the rapidly maturing state of the industry. ❑

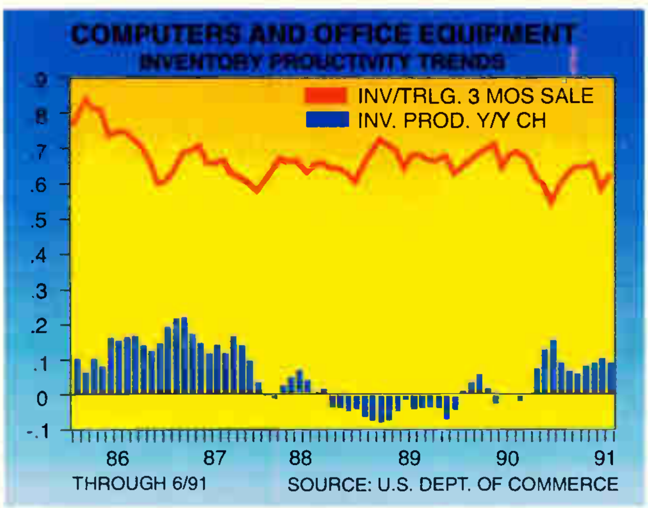
By Mark Parr, McDonald Securities Inc., Cleveland (216-443-2379)



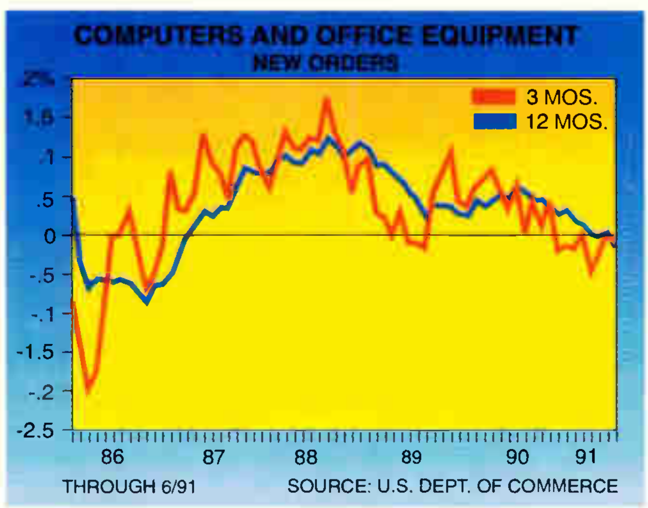
Overall, order activity is still depressed. On the bright side, the inventory picture is somewhat improved.



After 10 straight months of decline, orders for durable goods are showing some improvement.



The computer industry is able to reduce inventories despite continuing weak demand patterns.



Computer orders are weak as price patterns are coming under a great deal of pressure.

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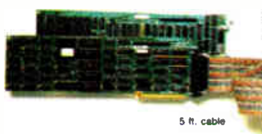

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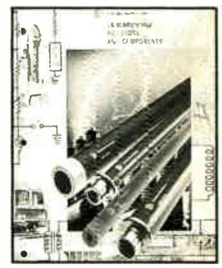

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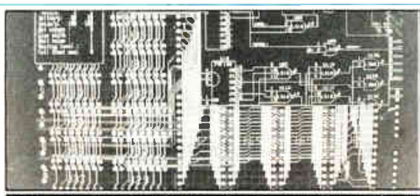

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WHAT MAKES A VENTURE WINNER?

The question is often asked in venture capital, "How much better than the competition does a product have to be to get funded?" Do you need technology improvements that are orders of magnitude ahead of the current market? The answer is tied to the rate of change in the industry in question and the markets being served. A startup can't expect its competitors to stand still; thus, for example, if the industry is moving ahead technologically at 40% a year, and the startup needs two years to complete its project, the startup's management team has to assume the competition will introduce products with twice the performance of today's versions by the time its entry comes to market. A startup must usually be a year or two ahead of its competitors to reward its customers for the risk inherent in buying from a newcomer. That means it must look as much as four times better than current offerings to be considered for backing by most venture-capital firms. This gap between present capability and a future product's potential is often called "headroom."

But entrepreneurs know that superior products are no assurance of success. Customers ultimately determine if the new idea was right or wrong, too little or too much, worthy of VC support or not. In the case of Hampshire Instruments Inc., a company specializing in lithographic equipment for the semiconductor industry, the early adoption of the firm's X-ray lithography system by AT&T Co. for advanced semiconductor work was extremely valuable because it required that the technology be developed into a practical, production-worthy product (see p. 48). Hampshire, with facilities in Rochester, N.Y., and Marlboro, Mass., is an interesting example of venture financing backed by Kleiner Perkins Caufield & Byers beginning in late 1986. When we first considered investing, we saw some of the ingredients we require: a knowledgeable management team, proprietary technology that was orders of magnitude better in certain parameters than any approaches now being used, plus access to a very large market that requires ever finer tolerances. There was a potential drawback, however. Hampshire's products are capital equipment selling for seven-figure sums, making it likely that positive cash flow would be a few years away.

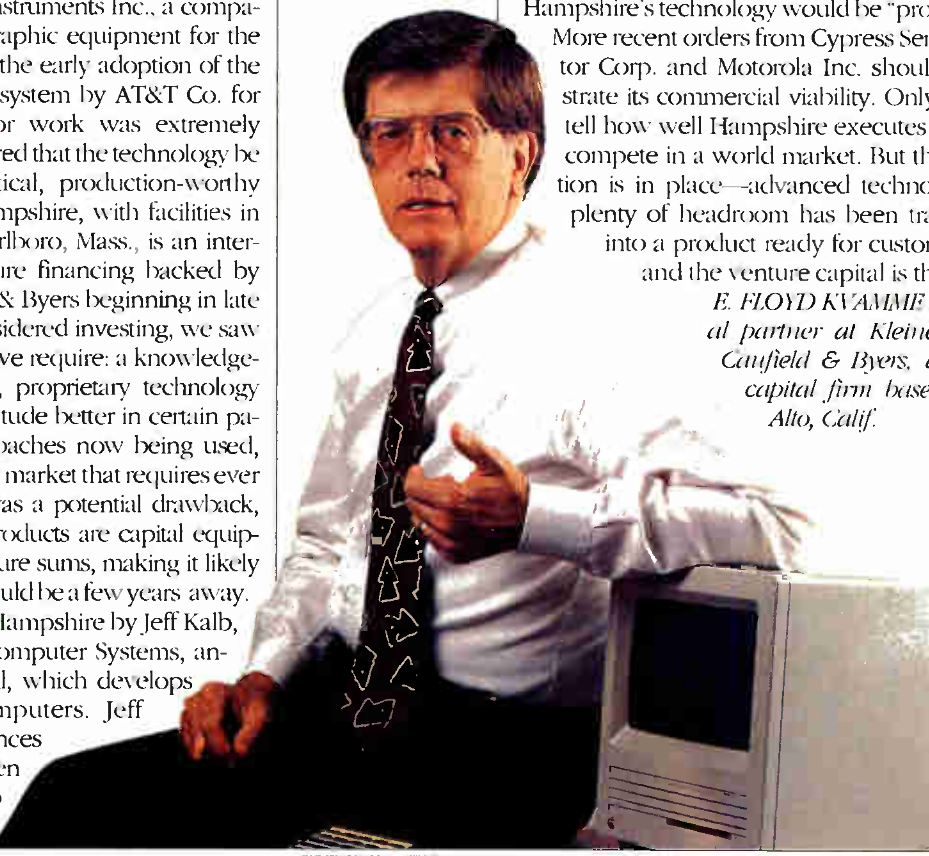
We were referred to Hampshire by Jeff Kalb, who founded MasPar Computer Systems, another firm we've backed, which develops massively parallel computers. Jeff views technology advances from this principle: when things get too difficult to do using current methods and the rate of progress slows, the time has come to look for new methods that open order-of-magnitude increases in technology advancement; i.e., Jeff looks for vast increases in headroom.

A STARTUP MUST BE A YEAR OR TWO AHEAD OF EVERYONE ELSE IN TERMS OF ITS TECHNOLOGY.

Parallel processing is one example. And if thousands of processors working in parallel make more progress on compute-intensive problems than coaxing the next nanosecond of performance out of a uniprocessor, the same principle can be applied to Hampshire's using X-rays to write lithographic lines on silicon. X-rays with 1.4-nm wavelengths are two orders of magnitude shorter than the 250-nm optical wavelengths used to write 0.5-μm (500-nm) lines. The shorter wavelengths are necessary to take chip geometries below the limitations of optics. But a complete lithographic system had to be developed to accommodate X-rays and harness the improved contrast ratio inherent in X-ray printing. So while lots of headroom was available, technical challenges in lithography, mask making, and photoresist technology had to be overcome. Hampshire had the skills to attack these problems—and the market seemed to be saying that it was a matter of "when" rather than "if" X-rays would be applied.

The initial order from AT&T assured that Hampshire's technology would be "productized." More recent orders from Cypress Semiconductor Corp. and Motorola Inc. should demonstrate its commercial viability. Only time will tell how well Hampshire executes its plan to compete in a world market. But the foundation is in place—advanced technology with plenty of headroom has been transformed into a product ready for customer use—and the venture capital is there.

E. FLOYD KVAMME is a general partner at Kleiner Perkins Caufield & Byers, a venture-capital firm based in Palo Alto, Calif.



LAST WORD

THE HIGH COST OF FEEDING RUSSIA

The crumbling of empires invariably spawns bloody local wars, and one doesn't have to go back to the Roman Empire to find examples. So it seems logical that the breakup of the Soviet Empire will be followed by a series of nasty local wars among the inhabitants of the various newly minted republics.

In the meantime, attention has already become focused on the need to ship massive amounts of food to Russia and its neighbors to forestall widespread famine and the possibility that the KGBniks could come back into power along with their nuclear weapons. It seems clear enough that the U.S. and Western Europe will provide that aid; after all, we recently found out that even very short, very one-sided wars can be inordinately expensive. It's much cheaper to ship food, even without considering the humanitarian aspect.

Every time we end up feeding the Russians, the price of food at home rises significantly. That is particularly true if crop yields for the most recent harvest have been unusually low (true this year) and periodic abnormal warming reduces the supply of anchovies (expected next year). So the major short-term effect of the Russian revolution on the U.S. economy will be to raise food prices.

The amount of aid needed by Russia and the new republics to raise their standard of living to that of the U.S. is so mind-boggling that any conceivable amount of aid offered is a mere drop in the bucket. The capital stock of the U.S. economy is currently about $17 trillion; excluding the value of land, it is probably around $12 trillion. Even supplying 1% of that per year would be $120 billion annually, far beyond the scope of even the most utopian planners.

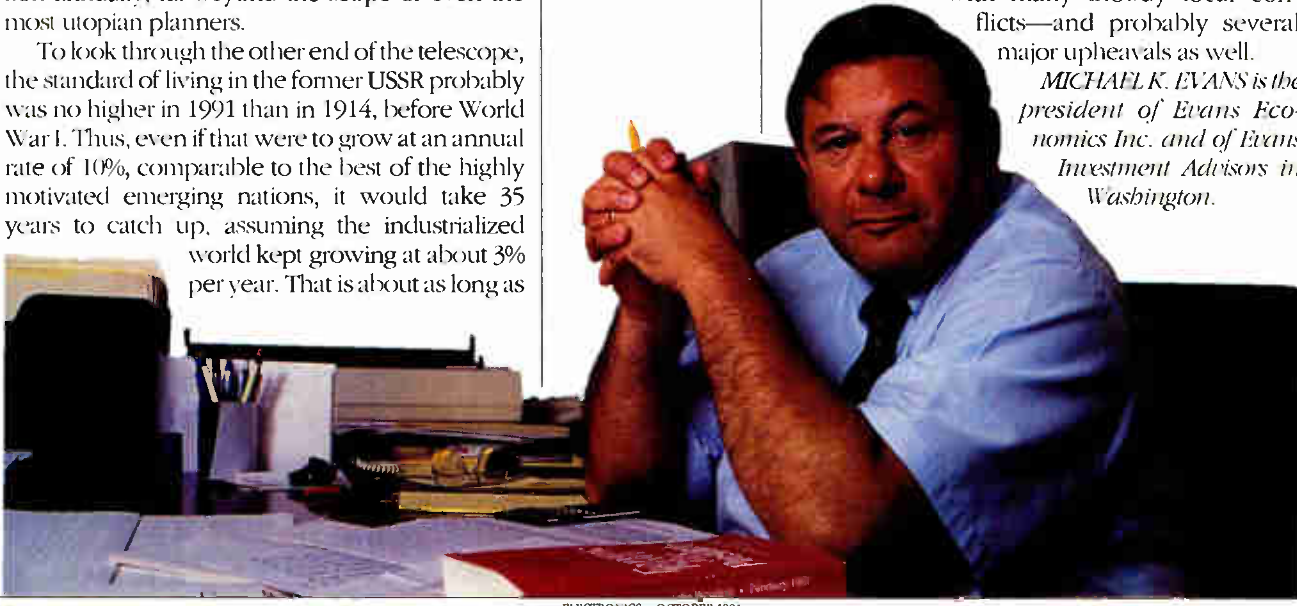
To look through the other end of the telescope, the standard of living in the former USSR probably was no higher in 1991 than in 1914, before World War I. Thus, even if that were to grow at an annual rate of 10%, comparable to the best of the highly motivated emerging nations, it would take 35 years to catch up, assuming the industrialized world kept growing at about 3% per year. That is about as long as it took Western Europe and Japan after World War II to match the U.S. living standard.

THE EFFECT ON THE U.S. ECONOMY? LIKELY AN INCREASE IN THE PRICE OF FOOD.

Maybe that doesn't sound so long, but Western Europe and Japan had a solid history of capitalism and, in the case of Germany, a benevolent American dictatorship that made all the right moves. At a bare minimum, a 10% growth rate would require that Russians embrace capitalism, a step that the Poles, Czechs, and Hungarians have found difficult to take. It would also require that all the newly formed nations work in harmony without any armed conflict, which does not seem likely, and a phenomenal amount of saving.

U.S. gross national product is currently about $6 trillion. If the Soviet economy has not progressed at all since 1914—assuming it was roughly equal to those of Western Europe and the U.S. at the time, although that may be an exaggeration—the current standard of living would be about 10% of ours, or about $2,000 per year per capita, which is in line with the very poorest countries in the rest of Europe. That means that using realistic conversion rates for the ruble, the Soviet GNP is currently around $600 billion. A 10% growth rate would require a 20% saving rate, or about $120 billion per year. But even if such funds were forthcoming, which currently seems impossible, a 10% growth rate would still require a 180° turn to capitalism. Thus, an extended struggle will be required for the former Soviet Union to take even the first meaningful step toward enjoying the economic benefits of the Western world. Until then, we will keep the populace from starving. Even so, the path toward progress will be strewn with many bloody local conflicts—and probably several major upheavals as well.

MICHAEL K. EVANS is the president of Evans Economics Inc. and of Evans Investment Advisors in Washington.



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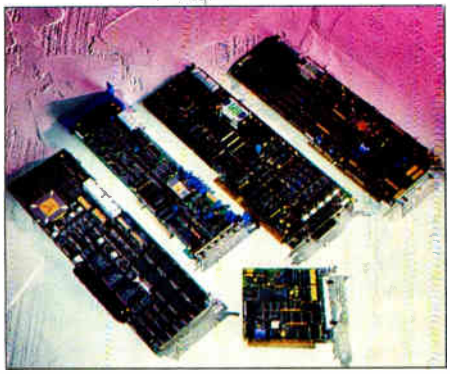

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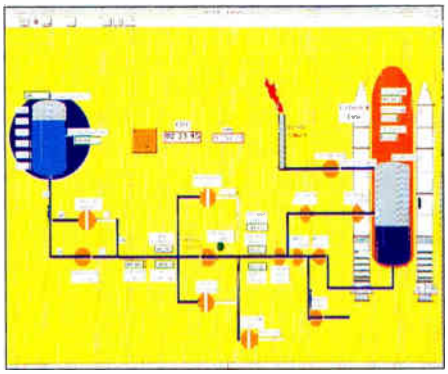

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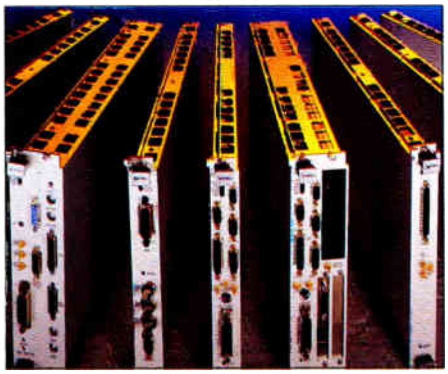

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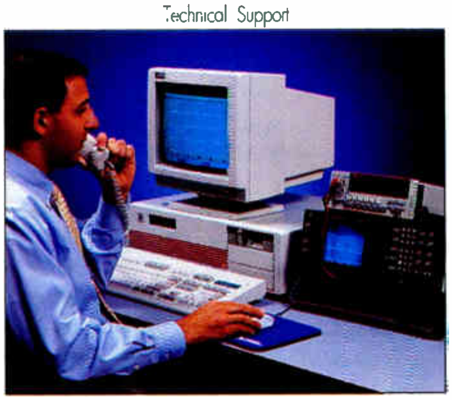

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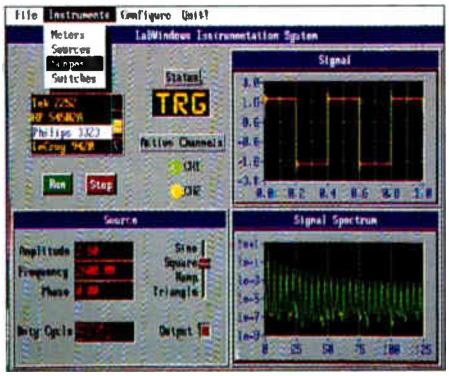

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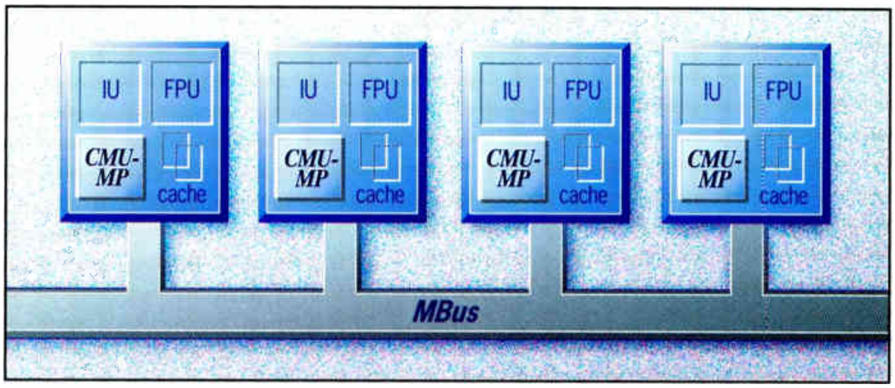

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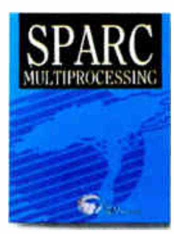

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