A PENTON PUBLICATION JULY 1991

Electronics

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ENDANGERED SPECIES: THE VANISHING U.S. FAB

PAGE 36

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CIRCLE 212

Electronics

EDITOR
Jonah McLeod
MANAGING EDITOR
Howard Wolff
SENIOR EDITOR
Lawrence Curran
EDITOR-AT-LARGE
Samuel Weber
914-428-3595
ASSISTANT MANAGING EDITOR
Jacqueline Damian
DEPARTMENT EDITORS
Communications:
Jack Shandle
201-393-6228
System Technology:
(San Jose) **Jonah McLeod**
408-441-0550
EDITORIAL PRODUCTION MANAGER
April Messina
STAFF ARTIST/DESIGNER
Anthony White

BUREAUS
Boston: **Lawrence Curran, Manager**
508-441-1113
Midwest Correspondent: **Francis J. Lavoie**
Mid-Atlantic: **Jack Shandle, Manager**
201-393-6228
Frankfurt: **John Gosch, Manager**
011-49-61-71-53834
France Correspondent: **Andrew Rosenbaum**
011-331-4236-1867
Italy Correspondent: **Andrew Rosenbaum**
011-331-4236-1867
Japan: **Shin Kusunoki, Consultant, Nomura Research Institute**
011-81-45-336-7604
UK Correspondent: **Peter Fletcher**
011-443-226-64355
Electronics Index: **Mark Parr**

VICE PRESIDENT-EDITORIAL
Perry Pascarella
COMPUTER SYSTEMS ADMINISTRATOR
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GROUP ART DIRECTOR
Peter Jeziorski
EDITORIAL ADMINISTRATION
Bradie S. Guerrero, Tina A. Montone

Director of Circulation: **Bruce Sprague**
Manager of Circulation: **Bob Clark**

Production Manager:
Doris Carter
(201) 393-6259
FAX: (201) 393-0410
Order Entry
Beverly Desbiens

PUBLISHER
John G. French
617-890-0891

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CIRCLE 185

PASSING ON THE TORCH

At commencement ceremonies throughout the country last month, speakers stood before graduating classes and spoke passionately of this generation of young people taking over the reins of power in years to come. At about that time—the last week of May—Charlie Sporck, who for the past 24 years was the guiding force behind National Semiconductor Corp., retired. In a way, Sporck's departure makes the message of those commencement addresses particularly apt for a semiconductor world in which the torch is being passed on. The old-liners have reached maturity, and their positions in the industry are being challenged by the new breed—the graduates, if you will—with their different world view. It has always been thus, but the process leaves the tantalizing questions of who these new managers are and what they will do differently.

One answer is provided by James C. Collins and William Lazier in *Reaching For Greatness: Turning Your Business into an Enduring Great Company.* They maintain that the traits of today's young managers are no different from those they are supplanting. Indeed, say the authors, who are faculty members at the Stanford University Business School, modern management practices are really age-old concepts. That's why there are companies around now that were started in the 1800s. The Stanford pair declares that the stereotypes of managers being either engineering or marketing driven are not relevant. Good managers are those who are good at both. A high-tech industry begins with a technical innovation; to stay competitive requires good business management.

Gilbert F. Amelio, the new president and CEO of National, agrees. He says that many companies know how to build state-of-the art devices, and so technology is less an art and much more a well-defined science. The CEO must be more conscious of issues such as quality, customer service, time-to-market, cost of capital, and so on. Today's young companies are headed by managers well aware of these business issues. Collins and Lazier cite T.J. Rodgers, president and CEO at Cypress Semiconductor Corp., and Bob Miller, chairman and CEO at MIPS Computer Systems Inc., as examples of engineers who have become good businessmen.

One common trait among those on Collins and Lazier's list of great companies is they are all manufacturers. Although the authors stop short of making manufacturing a requisite for greatness, the list calls into question the phenomenon of the "fabless" semiconductor company, which is discussed in our cover story on page 36. The great industrial builders provided the U.S. with the economic backbone on which it grew. Whatever the future may hold for the 1991 graduates—and for the successors to the semiconductor industry's Charlie Sporcks—let's hope they become the great builders of the 21st century. ❑

Jonah McLeod

JONAH McLEOD
EDITOR

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CIRCLE 177

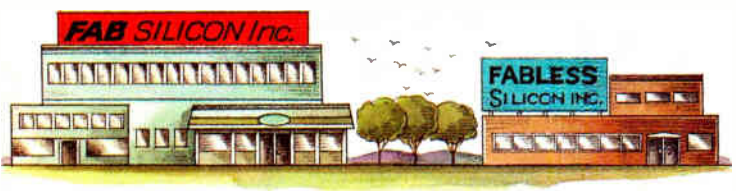
JULY 1991 VOLUME 64, NO. 7

Electronics

60 YEARS OF GLOBAL LEADERSHIP.

COVER STORY PAGE 36

FEATURES



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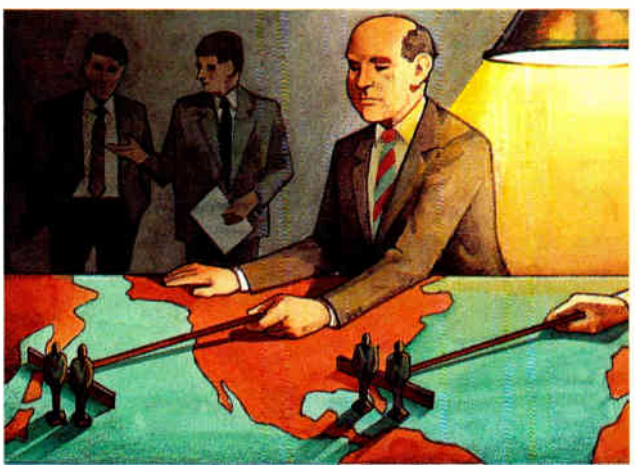

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DEPARTMENTS

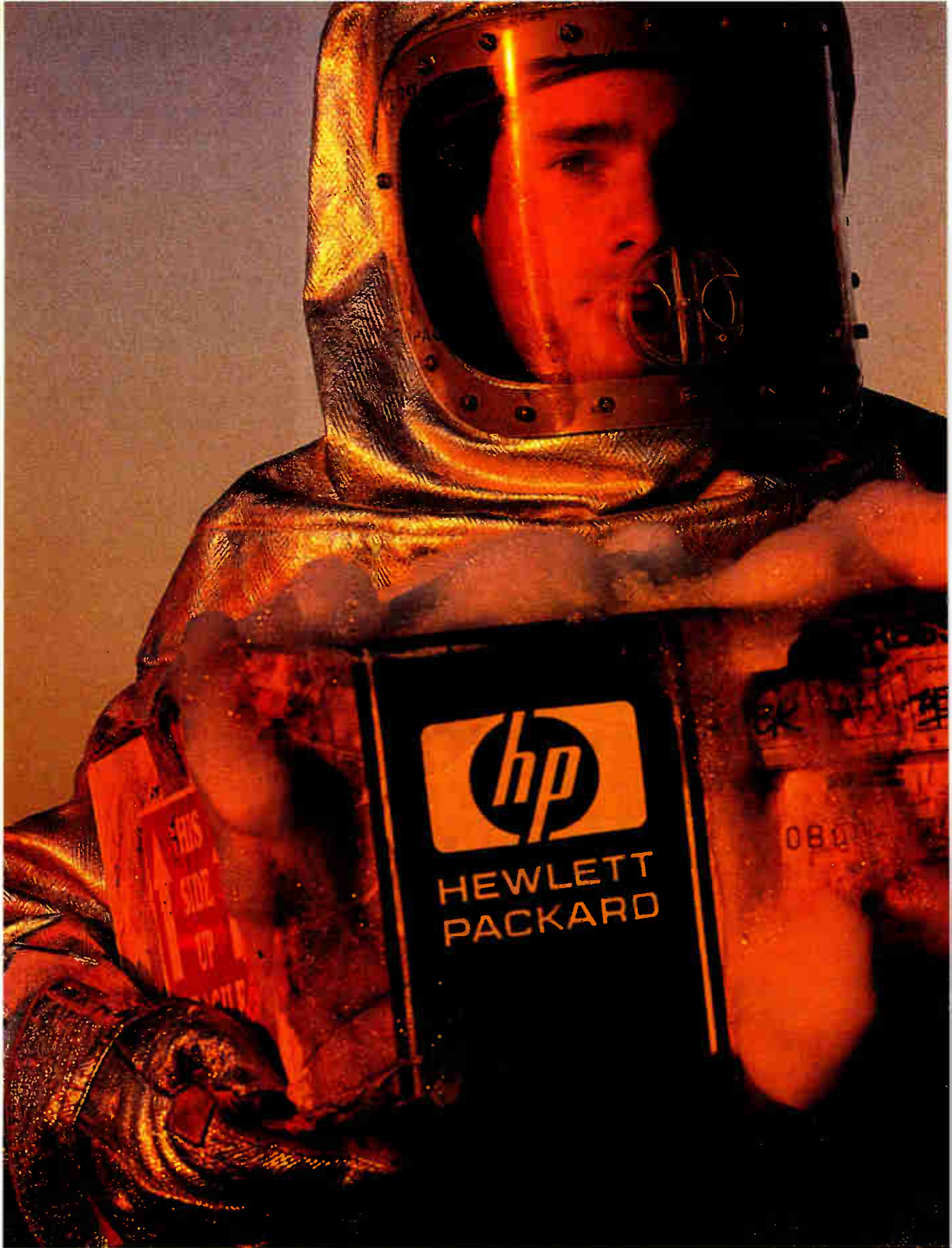
NEWS ROUNDUP

WORLDWIDE NEWS

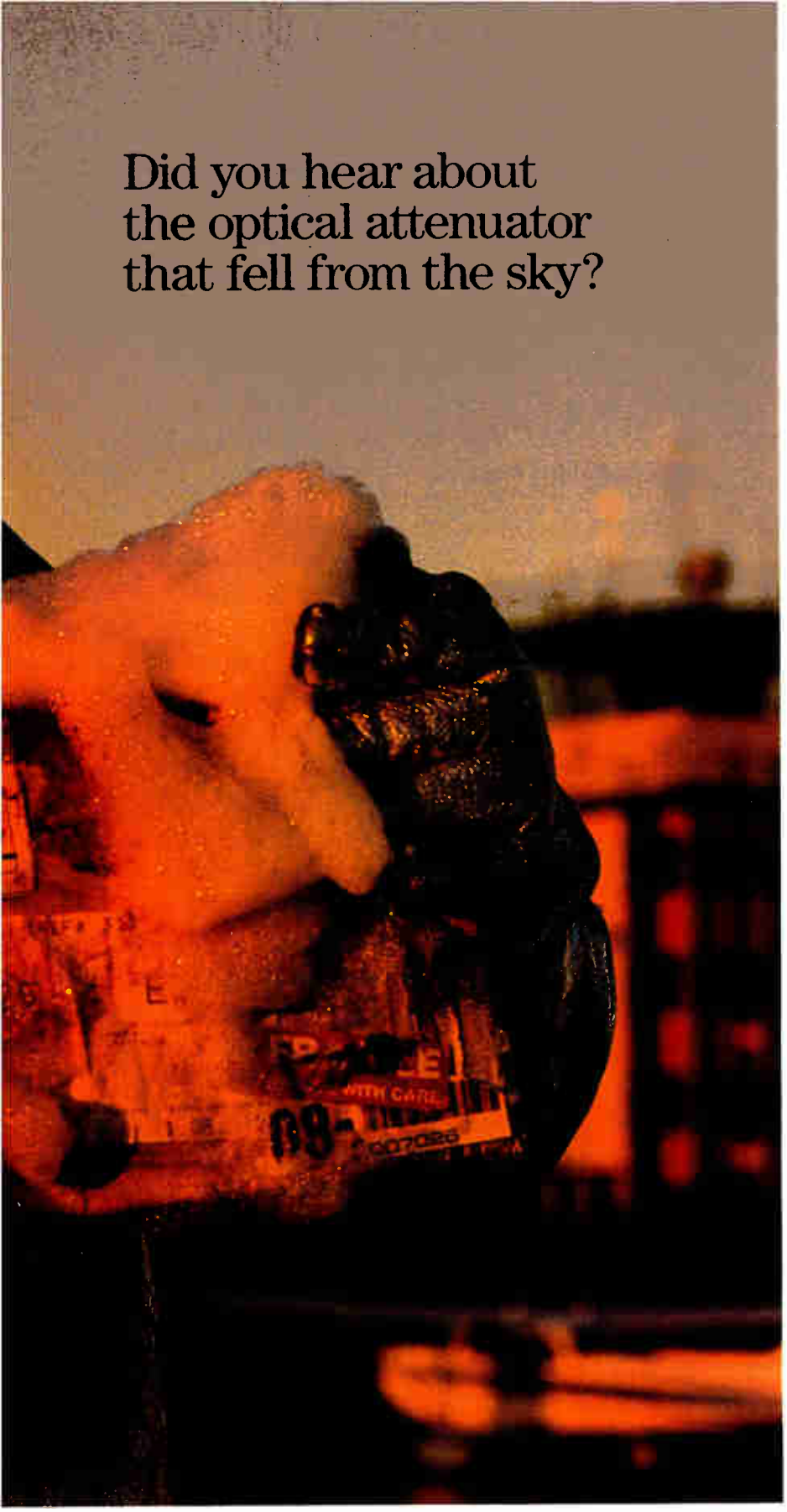
Jesse H. Neal
Editorial Achievement Awards

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

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



Did you hear about the optical attenuator that fell from the sky?



It hit the ground running.

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CIRCLE 199

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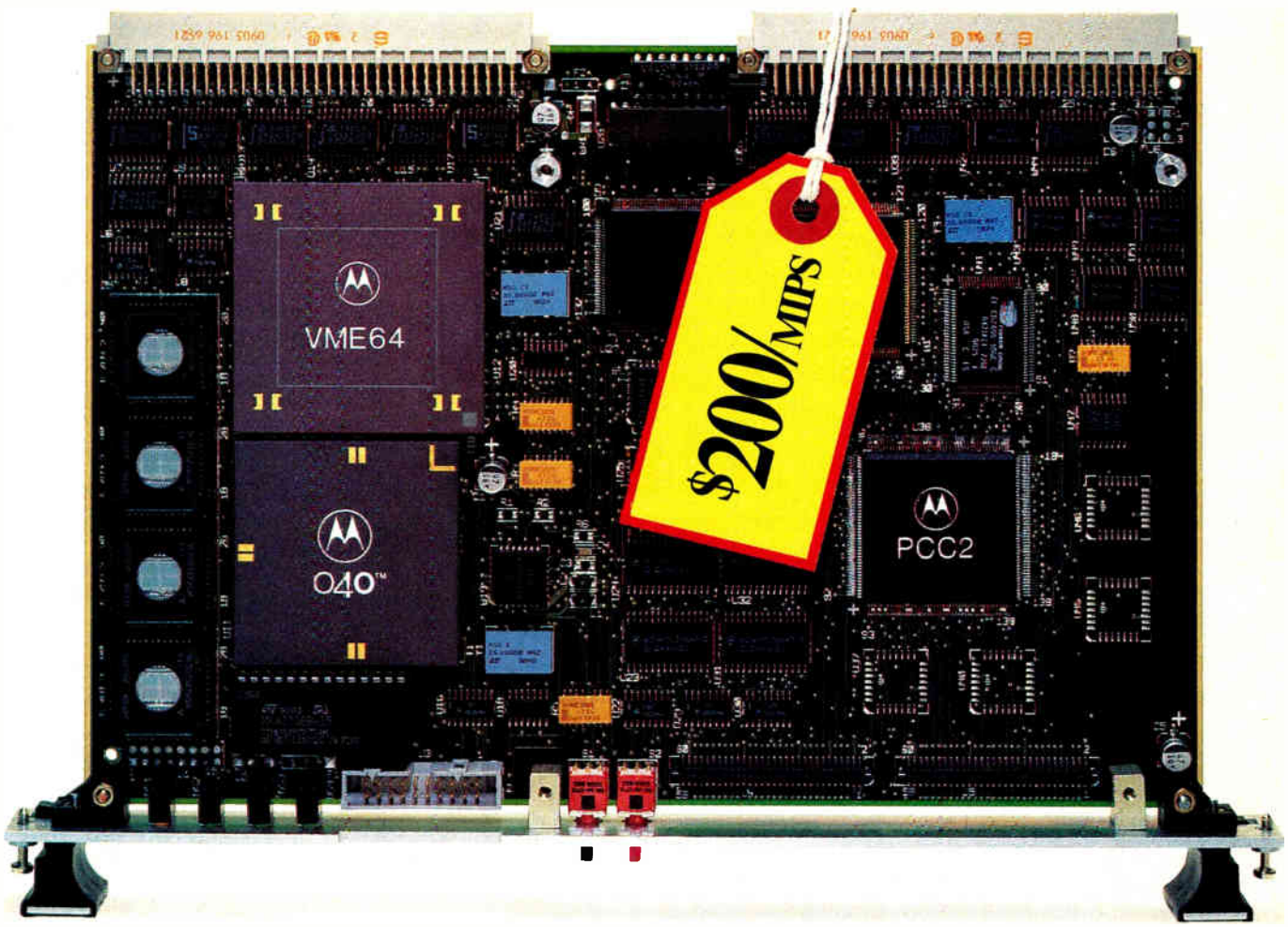

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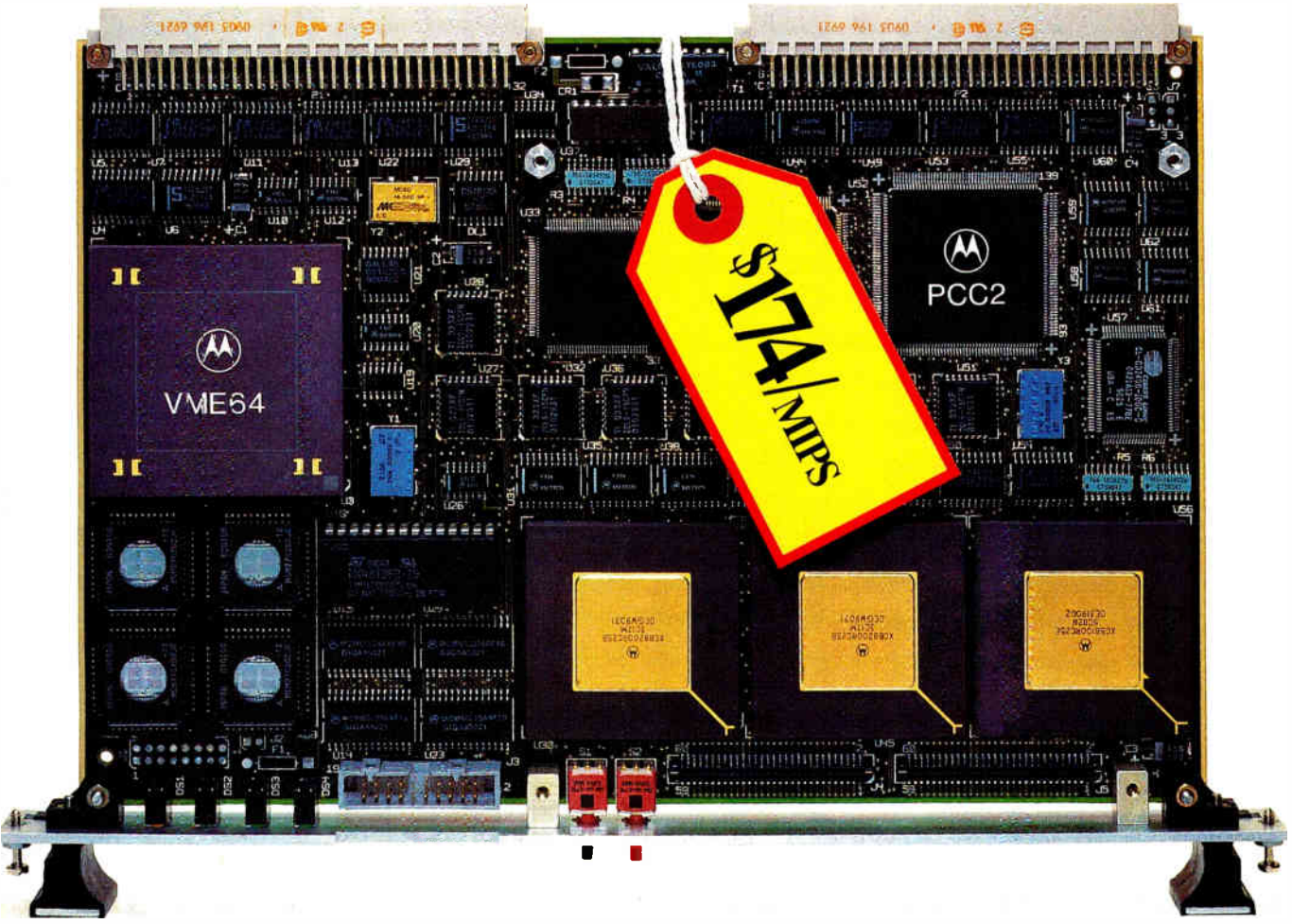

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CIRCLE 175

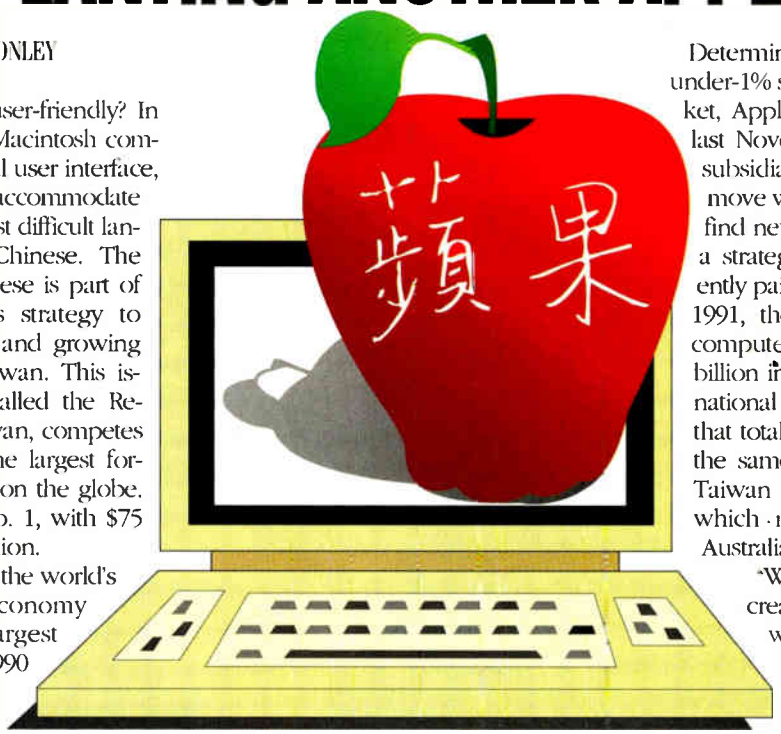
LETTER FROM

TAIWAN

THE U.S. COMPUTER MAKER HOPES TO TAKE A BITE OF A LARGE MARKET

PLANTING ANOTHER APPLE

BY KRISTA M. CONLEY



How friendly is user-friendly? In the case of the Macintosh computer's vaunted graphical user interface, it's friendly enough to accommodate what is arguably the most difficult language in the world: Chinese. The Mac's migration to Chinese is part of Apple Computer Inc.'s strategy to edge in on a lucrative and growing market in cash-rich Taiwan. This island nation, officially called the Republic of China on Taiwan, competes with Japan in having the largest foreign-exchange reserves on the globe. Right now Taiwan is No. 1, with $75 billion to Japan's $70 billion.

Taiwan also ranks as the world's 13th-largest trading economy and America's sixth-largest trading partner, with 1990 commerce between the two countries estimated at $34 billion. Taiwan's per capita income hit $8,000 in 1990, the fourth-highest in Asia, and government planners hope that figure will reach $14,000 by the end of this year.

But this Pacific Rim tiger isn't satisfied with an economy based on low-value-added "Made in Taiwan" products, such as shoes, textiles, toys, and electronic components, which have long been its mainstay exports. Hit last year by an economic slowdown that cooled the overheated growth of the 1980s, the Taiwanese government has just embarked on a massive, six-year national development plan aimed at propelling this tiny country, which is roughly the size of Connecticut, into developed-nation status. Taiwan will spend a staggering $313 billion building up its infrastructure—roads, railroads, airports, harbors—and funding 10 high-value-added industries, including telecommunications, automation, semiconductors, and pollution control.

The economic bustle is good news for Taiwan's personal computer industry. Unlike the U.S. and western Europe, where PC sales are toddling along at single-digit growth rates, Taiwan's computer market is set to expand 15% to 20% a year through 1993, according to the American Institute in Taiwan, the U.S. government's official, quasi-diplomatic agency there. (The U.S. does not formally recognize Taiwan; America normalized relations with the People's Republic of China in 1979.)

"By 1995, Taiwan will install cumulatively a total of 30,000 large [computer] systems and 2.3 million PCs," says analyst Shirley Wang in a recent American Institute report. "Taiwan is entering into an information era. Not only are private business firms increasingly making use of computer systems to facilitate business affairs, the authorities are also aggressively taking steps to modernize administrative work to provide better services for the public," Wang says.

Apple wants a piece of the action, and it is poised to make inroads on what is currently a DOS domain occupied by Taiwanese-built IBM PC clones from companies like Acer and Mitac. Its means of entry: ZhongwenTalk, or ChineseTalk, a Chinese version of the Macintosh computer.

Determined to improve Apple's under-1% share of Taiwan's PC market, Apple Computer International last November established a new subsidiary, Apple Taiwan. The move was part of Apple's push to find new international markets—a strategic thrust that has apparently paid off. In the first quarter of 1991, the Cupertino, Calif.-based computer giant reported $1.676 billion in net revenues, with international sales representing 45% of that total—an increase of 9% over the same period last year. Apple Taiwan is part of Apple Pacific, which maintains subsidiaries in Australia and Japan as well.

"We felt we needed to increase our investment in Taiwan in order to provide more leading-edge Chinese-language solutions on the Macintosh platform to sustain our anticipated growth," says Louis Woo, Apple Taiwan's general manager. "In opening the new office, we will also be able to bring Apple closer to the customers and enhance their user benefits." Woo's goal is to triple the number of units Apple sells this year over the 1990 total and increase market share to 2%.

Thanks to its graphical user interface, the Macintosh has an advantage in handling the complex script systems of Asian languages. Each Mac sold in Taiwan comes with enhanced ZhongwenTalk, seven built-in Chinese fonts, and TurboWriter, a word-processing system developed to handle English and Chinese in a single program. A computer that can accommodate Chinese as well as a Chinese-English mix would seem to have a special competitive edge, and some Taiwan hands believe the Chinese Mac will find many willing buyers.

For his part, Woo believes the machine will have broad appeal. In his view, there is no meaningful difference among competing PC clones. "There's not that much difference in functionality

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and performance. PCs are like a commodity, where price is the only differentiation," Woo says. He believes that Taiwan's economic development has reached the point where businesses and consumers are now looking for "quality and comfort, as well as service and support"—all of which the Chinese Mac amply supplies.

Importantly, Apple Taiwan is committed to forging partnerships with local developers to provide more inventive Chinese solutions for Mac users. "Apple cannot do it alone," Woo says. "It must rely on innovative third-party companies to round out leading-edge applications that best fit our customers' computing needs." One such deal was with a Taiwanese company called Dynalab, which developed Dynafont, one of the Mac's Chinese-language fonts.

In addition, Apple's dedication to the Taiwan market is revealed by the company's active procurement on the island. During 1989 and 1990 combined, Apple purchased $250 million worth of components from Taiwan, including integrated circuits, monitors, printed-circuit boards, and power supplies. This sourcing activity, in which Apple is joined by other U.S. computer makers buying components in Taiwan, is expected to continue.

Apple Taiwan oversees five core areas, with a startup staff of 15 employees: finance/administration, marketing, sales, distribution, and software development. There is no manufacturing arm. The company relies on direct distribution, working with 12 dealers on the island in an effort to reduce the number of levels between Apple and its Macintosh customers.

Several marketing approaches have emerged. Apple Taiwan is encouraging awareness of the Mac through advertising and the press, and attempting to prove that Apple is a long-term player in the Taiwan market. In addition, it has targeted two likely customer groups: people in creative industries, such as advertising and marketing, and people who have never used computers before. "We want to create a market where no PC has gone before," says Woo.

For the advertising industry and other creative businesses, Apple produced a seminar to illustrate how the Mac can enhance innovation and productivity. Its next project is a "Personal Workshop" geared to small creative groups. The idea is to sell the Macintosh as a tool for productivity.

And what's it like to do business in Taiwan? "The economy of Taiwan speaks for itself," says Woo, who is very bullish on Taiwan's future despite the current slowdown. "By all means it's not paradise yet," Woo says, but he urges U.S. managers to view Taiwan's economic and political changes with a long-term perspective. One advantage to doing business in Taiwan, he says, is the plethora of highly qualified technical personnel, a skilled labor force that is supported by a competitive—and sophisticated—educational system.

There are some operational risks, however. Because the banking system is still government-run, not commercially operated, smaller companies may enjoy less access to financing than bigger ones. But the bank system is gradually opening, and industry watchers expect steady improvement in this area.

Another hangup may arise in communications: Apple Taiwan, for example, experienced a little glitch in the telecommunications area when applying for a leased line. Phone lines leading out of the country are still closely scrutinized, Woo says—"40 years ago it made sense for national security." After some bureaucratic haggling, Apple got its leased line.

On copyright matters, Woo says the government recognizes the importance of intellectual-property rights—in fact, it has raided and fined several Taiwanese companies for violations. Now that the government is committed to helping local companies develop application software, it is interested in having that software protected, says Woo. For U.S. companies, the challenge is to prove the benefits of buying original software.

Apple Taiwan represents a strategic effort by a U.S. PC manufacturer to gain market share not only through direct distribution, but through sourcing, developer partnerships, and consumer education. Woo offers this advice on doing business in Taiwan, not only to U.S. companies, but to companies operating worldwide: "Do it now," he says. "Any company interested in taking advantage of the exploding market, do it now. You'll need to position your product, nurture your business image, and cultivate relationships with your end-user. All of that takes time." ❑

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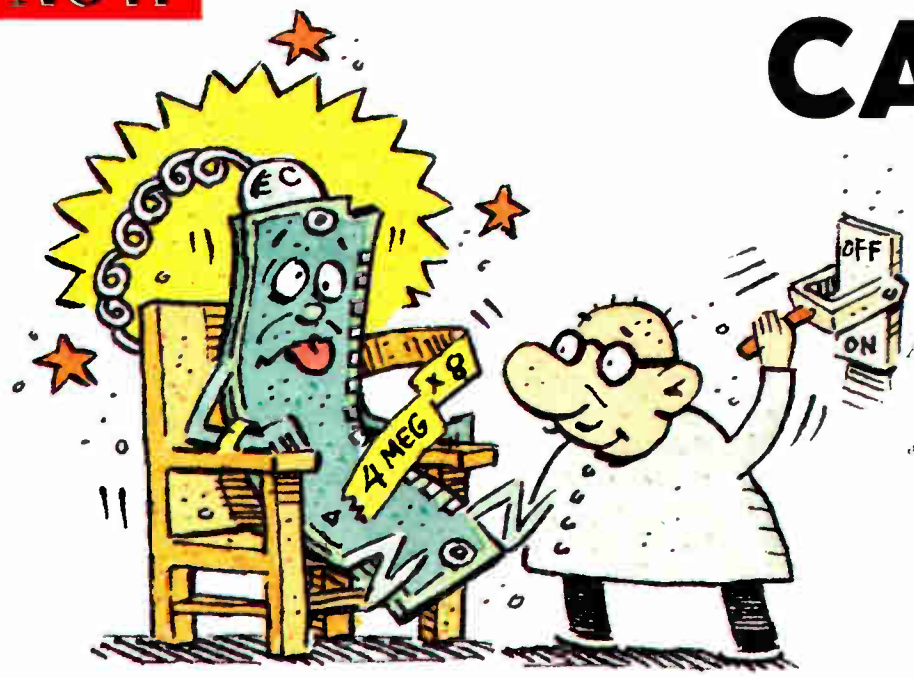

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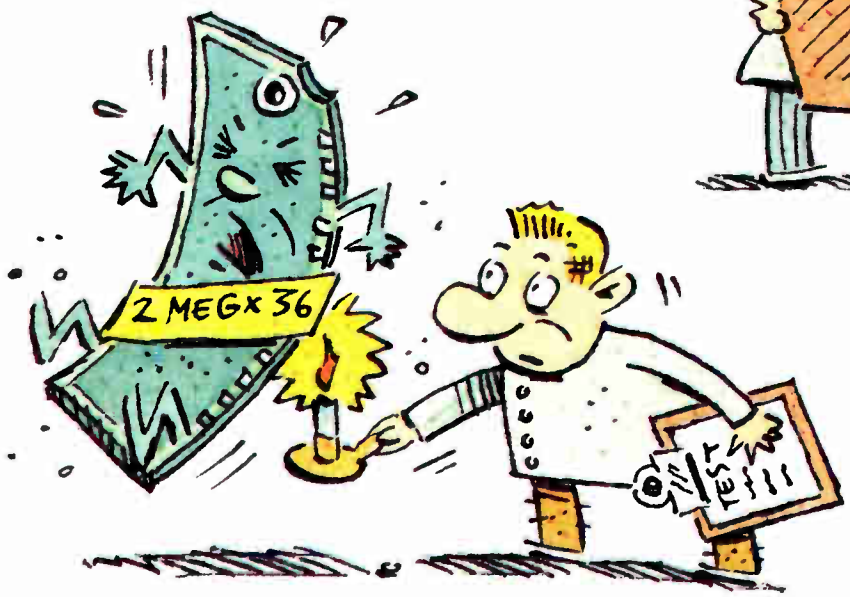

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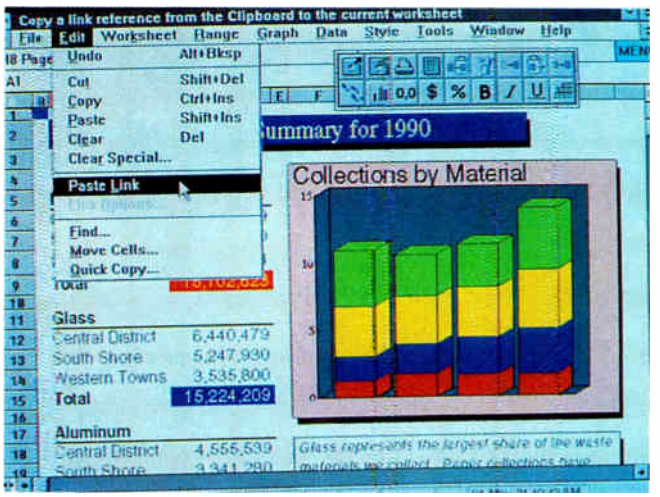
CIRCLE 182

LOTUS EXPANDS 1-2-3 TO MAC

Lotus Development Corp. is busy extending its strategy to provide versions of the 1-2-3 spreadsheet for all major computer platforms. The Cambridge, Mass., firm last month finally hit the street with 1-2-3 for the Apple Macintosh after considerable slippage, and announced that a version for Microsoft Corp.'s Windows 3.0 environment will be available this summer. In another June development, Lotus brought out an updated 1-2-3 for Sun Sparc workstations, and added Lotus Realtime to its line. Realtime on Sparc workstations enables users to integrate real-time information from other data bases into 1-2-3 for immediate analysis. ❑



The Lotus 1-2-3 for the Macintosh has finally arrived, along with a version for Sun Sparcs.

THIS PC BOARD 'LOOKS' LIKE A SHIP

Problem: simulate a control system for an antisubmarine-warfare training, modeling, and tactics suite. It must look to a computer like a ship, complete with a raft of sensors, weapons, and navigational data, as well as be able to process I/O operations in real time.

For the people at Antares Group Inc. in San Diego, Calif., the solution was to use bit-slice architecture for an I/O processor that is fast enough to keep up with a real-time processor. And with that, Antares also provided the software to tie its processor together with the old and slow Navy's AN/UYK 43 computer using the Naval Technical Data Systems interface.

But with speed of execution the most important attribute, the Antares processor is the only one that can do the job. The Antares board is based on AMD 2901 processors; the others, Motorola 68000s. It runs at 10 million instructions/s. ❑

COALITION CLOSES IN ON SOFTWARE SOLUTION TO DESIGN PROBLEM

The people who are trying to develop more reliable and manufacturable designs are making progress. On one front—elimination of 3-d tolerance stack-up problems—manufacturing software vendors Applied Computer Solutions Inc. and Valisys Corp. have allied with a coalition of U.S. firms to develop a state-of-the-art package that analyzes the difficulties. The partner list is an impressive collection of blue-chip American manufacturers: Chrysler, Eastman Kodak, Ford, General Dynamics, and IBM.

Stack-up problems can materialize when the manufacturing tolerances of assembled parts total up to yield assemblies that have large variations in their dimensions. The goal of the newly formed coalition is to shepherd the definition, development, and testing of advanced software that minimizes such difficulties.

The software would have applications in consumer, aerospace, and automotive electronics. It would also enable design engineers to quickly perform difficult tolerance-analysis studies.

The key benefit of the new software would be its ability to produce final designs that are desensitized to process variations, "a trick that the Japanese have mastered through many years of process control and process manipulation," says Valisys CEO John Clancy.

Real-time manufacturing data, supplier data, and other process capability statistics will feed directly into the tolerance analysis process. The new system is also expected to help perform what-if tolerance trade-offs based on actual process capabilities. ❑

HOW TO SEE MANUFACTURING DIFFERENCES

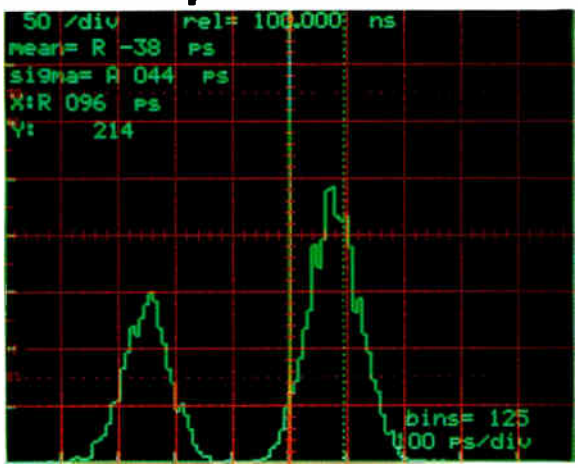
Are U.S. semiconductor companies failing to compete with overseas semiconductor companies on a worldwide basis? If so, could it be because their manufacturing is less efficient than that of their overseas rivals?

Up to now, the only way to measure that difference has been to judge acceptance of their products in the market. But that could change after a new study initiated by the University of California at Berkeley to research the international semiconductor industry. Members of the university's business and engineering schools have combined to develop standards for comparing manufacturing performance in different companies worldwide, explains Prof. David Mowery of the Walter Haas School of Business. "We are developing a list of indices, such as utilization rates, downtime, etc., of specific pieces of equipment in the process," says Mowery. "Is there a difference in these variables among U.S., European, and Asian firms?"

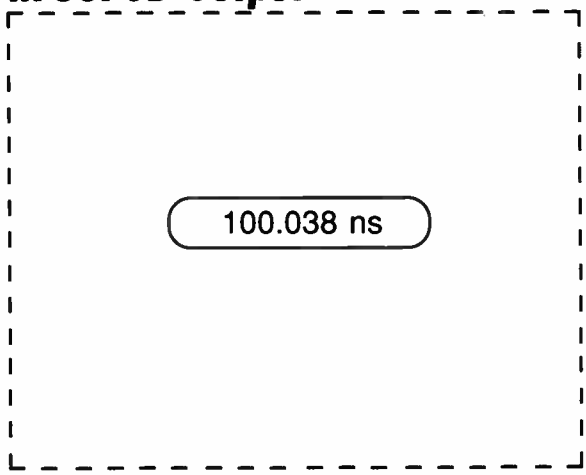
Mowery says an industry advisory board composed of representatives from semiconductor companies has been formed to consult on the project. The university will publish the results once the study has been completed. The effort is being funded by the Alfred P. Sloan Foundation of New York, which the Berkeley group approached for support. ❑

A picture is worth a thousand points in a time interval measurement.

SR620 Output



HP5370B Output



The SR620 brings graphic statistical analysis to time interval and frequency measurements. The SR620 shows you more than just the mean and standard deviation - multimode frequency distributions or systematic drift for example. Histograms or time variation plots are displayed on any X-Y oscilloscope, complete with Autoscale, Zoom, and Cursor functions. Hardcopy to plotters or printers is as easy as pushing a button.

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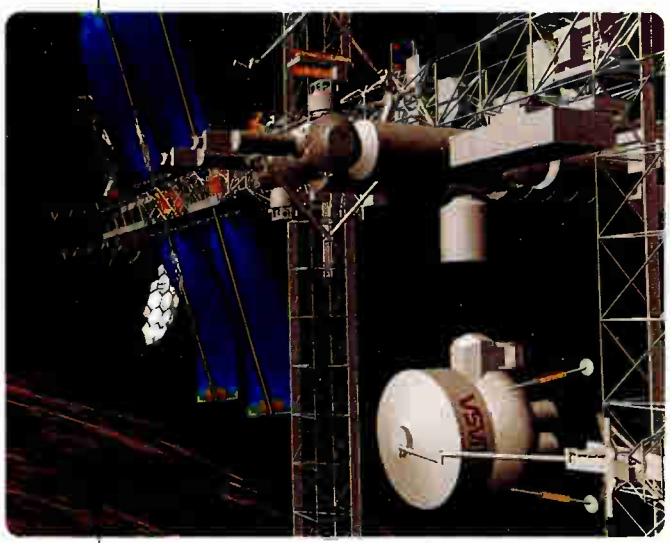
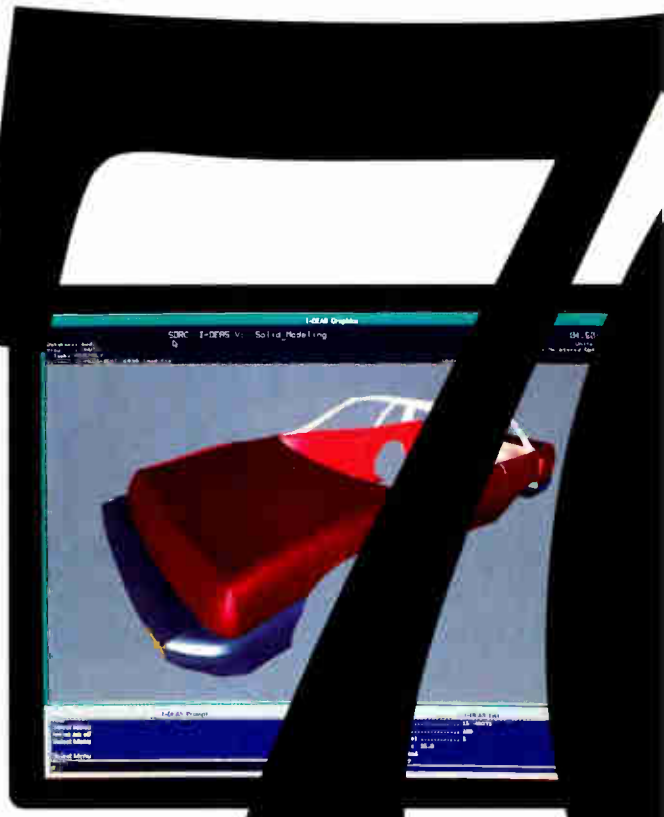


CASE and AI solutions include HP's SoftBench; Interactive Development Environments; Intellicorp; Inference; and Neuron Data.



Mechanical CAD solutions include SDRC; HP ME 10 and 30; McDonnell Douglas; Parametric Technology; and PDA.

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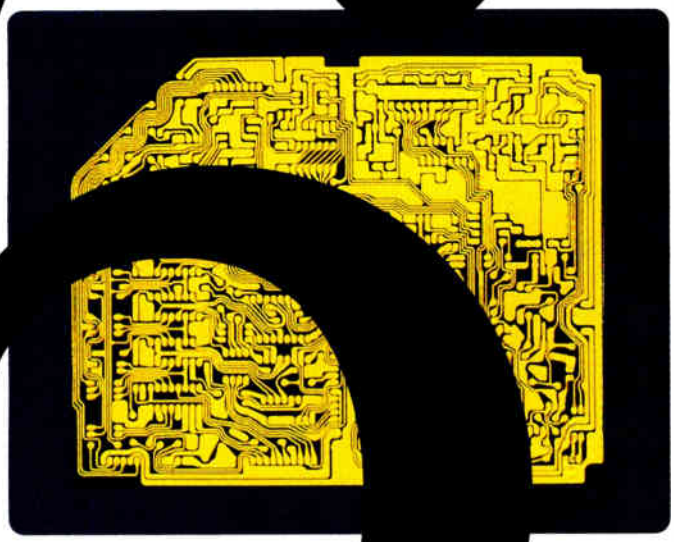
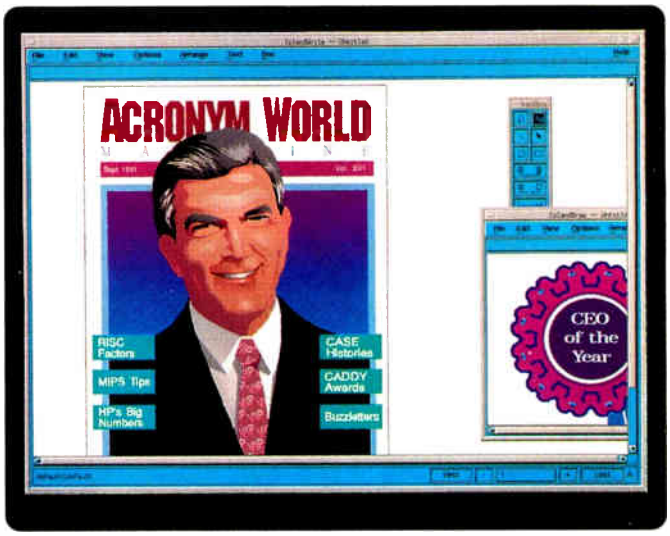


For electrical CAD, software is available from Cadence Design Systems; Mentor Graphics; Zuken; Racal-Redac; and VLSI, among others.



For Electronic Publishing, Desktop Productivity and Database, available software includes Informix; Oracle; ASK/Ingres; Interleaf; and Island Graphics.

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CIRCLE 190

TO WATCH

IBM GRABS THE OPTICAL LEAD

IBM Corp. is making a strong bid to set a new data-storage standard with a 3.5-in. optical drive that operates in both the read-only and read/write modes.

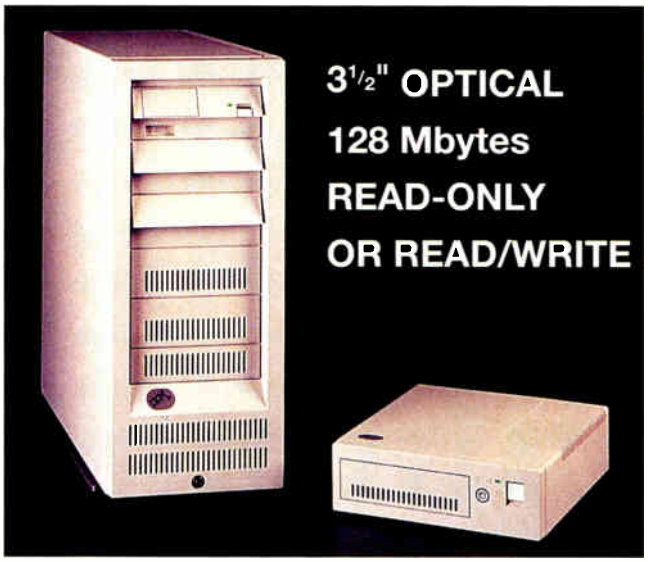
The PS/2 Rewritable Optical Drive is the first to fit into the 3.5-in. form factor. It accepts 128-Mbyte removable disc cartridges that conform to physical standards already adopted by the International Standards Organization. IBM is promoting its file format as an ISO standard as well.

Early adopter Verbatim Corp., Charlotte, N.C., is shipping both the rewritable and the O-ROM (for optical read-only memory) discs that run in the drive, which features a SCSI interface and a 66-ms seek time. Verbatim will offer O-ROM authoring services that use the 3.5-in. writable disc as the source for the O-ROM master.

Although IBM appears to have a time-to-market as well as a technology lead on other systems houses, it is not alone in the small-format optical-drive race. Sony Corp. has a similar technology that utilizes a file format fairly close to IBM's. It appears likely that IBM, Sony, and ISO can reach agreement on a single file-format standard.

O-ROM applications include the distribution of application software, data bases, and reference works. The erasable discs, on the other hand, can be thought of as 128-Mbyte floppy disks that can store data, sound, graphics, animation, and video.

Priced at $1,795, IBM's drives are available on mid- and high-end PS/2 models that use the MicroChannel bus architecture. ❑



IBM's 3.5-in. drive comes in MicroChannel PS/2 models or can be stacked in an SCSI enclosure.

FLUENT DEBUTS ITS AUDIO/VIDEO BOARDS

A pair of circuit boards and system software called the Fluency family enable system integrators to bring full-motion digital video as well as synchronized audio to stand-alone or networked 386-based IBM AT-compatible personal computers.

The products from Fluent Machines Inc., Framingham, Mass., run on DOS-based PCs running Windows 3.0 [*Electronics*, February 1991, p. 49]. The boards perform compression, decompression and display; in addition, the software includes tools to help developers integrate the data into Windows applications. ❑

AMD REVS ITS MACH1 FAMILY TO 1,800 GATES

By extending the density of MACH1 family of programmable-logic devices to 1,800 gates, Advanced Micro Devices Inc. is making the trade off of speed for density less of a headache.

The MACH130-15's 15-ns speed makes it a good match for 50-MHz system designs, says the Sunnyvale, Calif., company. It features 64 macrocells organized into four programmable array logic blocks connected by a switch matrix. ❑

INTEL'S i860 XP IS A TURBO PROCESSOR

High-performance-computer architects are probably looking at the 50-MHz version of Intel Corp.'s i860 family of reduced-instruction-set-computing microprocessors and thinking "massively parallel computers."(See p. 24.)

While Intel agrees the i860 XP's architecture qualifies it for use in massively parallel processors, the company points out that the XP is also suitable for commercial computing, including financial forecasting and on-line transaction processing.

The chip executes 100 million floating-point operations/s versus 80 Mflops for a 40-MHz i860. It has a bus bandwidth of 400 Mbytes/s compared with just 160 Mbytes/s, and a 16-Kbyte instruction cache versus 8 Kbytes. Its 2.55 million transistors compare with about 1.2 million for the most complex previous i860.

Samples of a 50-MHz XP are available now from the Santa Clara, Calif., company at $699 each; 40-MHz units are $560. Full-scale production is set for the fourth quarter of this year. ❑

APPLE TO DELIVER ITS MULTIMEDIA ARCHITECTURE IN LATE 1991

A system software architecture from Apple Computer Inc. will pave the way for third-party developers to more easily integrate multimedia data types into a broad range of applications.

QuickTime is the first software extension to the Cupertino, Calif., company's System 7 operating system, which was rolled out in May. It includes a tool box of software services specifically for multimedia and an image compression manager, as well as a component manager for handling external system resources such as digitizer cards. QuickTime will permit new applications including low-cost video editing and CD-ROM magazines. It will be available at year end ❑

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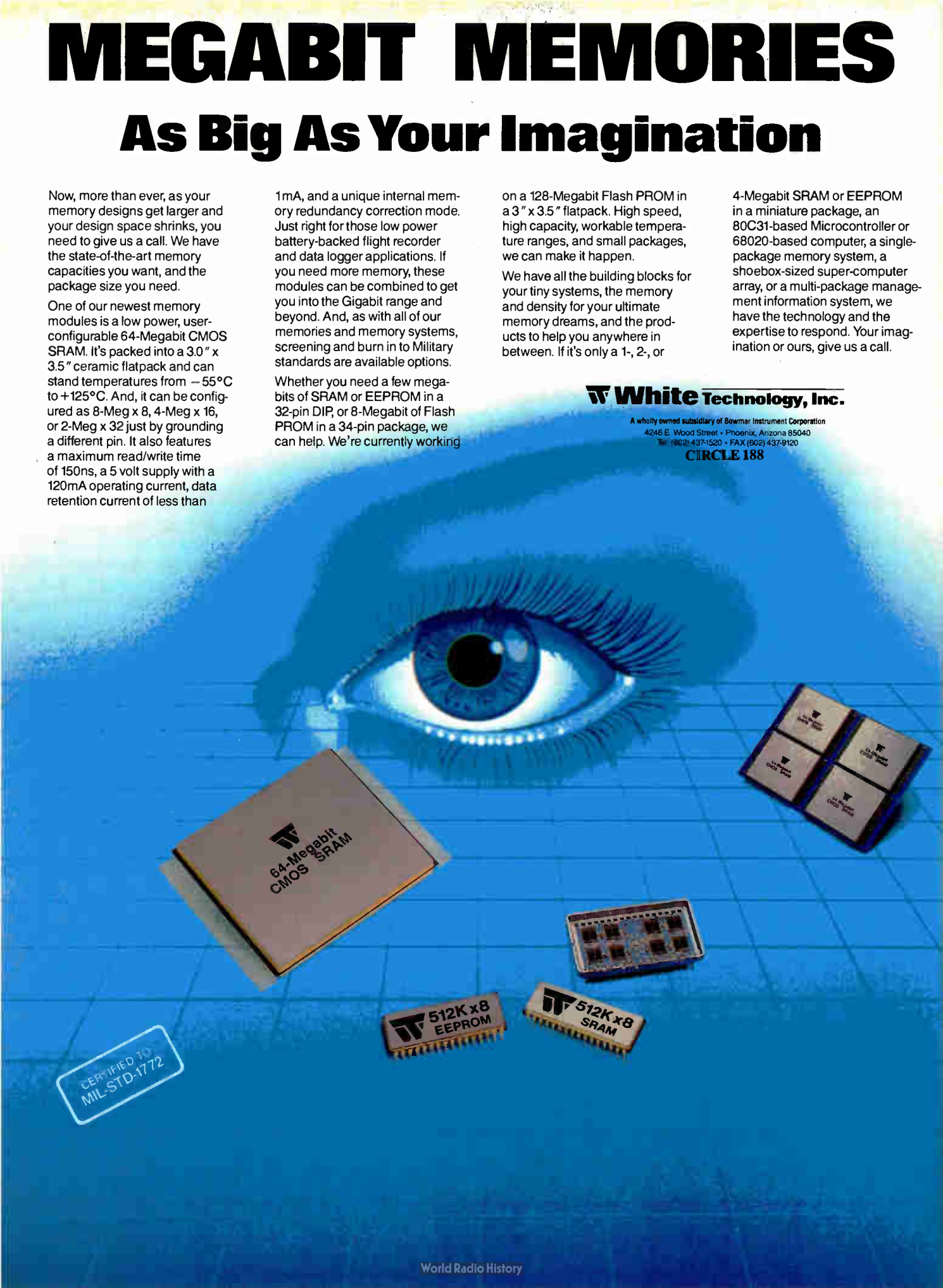


EUROPEAN CHIP MAKERS PREPARE FOR A NEW ERA AS MERGER TALK ABOUNDS

CAN BIG BE BEAUTIFUL?

BY ANDREW ROSENBAUM

SEMICONDUCTORS

For European semiconductor makers, big can still be beautiful—as well as necessary. "By the year 2000," says Jurgen Knorr, senior vice president of Siemens AG, "the middle-size players will be out of the semiconductor market. You will either be a relatively small niche-player or a very large company."

Speaking in Marbella, Spain, at the recent Dataquest European Semiconductor Industry Conference, Knorr agreed with the other top executives from the world's principal chip makers. The big companies have the $10 billion needed to invest in services, which will determine market share in the coming decade. Small players, which have well-defined market niches, can also find a way to stay profitable.

The big-is-beautiful theme was particularly apt because the conference was the eye of a storm of rumors that are swirling over the continent about possible mergers of Europe's three principal manufacturers of chips. Thomson SA, France's state-owned conglomerate, is reportedly trying to interest Europe's big three—Philips, SGS-Thomson, and Siemens—in getting together. But Philips Electronics says it is not interested. And Siemens AG executives say they want to deepen their ties with SGS-Thomson Microelectronics without going through a full merger.

However, it became clear to observers at the conference that mergers won't happen in the near future despite the advantages of size as well as political pressure to make such moves. Mitigating against any consolidations are the important differences among the companies, putting each in a position to exploit different market trends.

In the case of Philips, in the past few years the Eindhoven, Netherlands-based giant has maintained its position in the consumer electronics market while suffering heavily in computers and ICs. But the overall so-called "consumerization" of electronics puts Philips in a strong postition again, analysts say.

"Personal computers remain the largest growth area in European electronics—set to grow 18.3% between now and 1995—as well as the principal technology driver," says Jonathan Drazin, manager of the European Semiconductor and Design Automation Group for Dataquest Europe Ltd. But, thanks to the continuing transition to multimedia that the European PC will enjoy, Drazin predicts that European chip consumption will rise dramatically from about $50 million today to about $900 million by 1996.

In addition, as the prices of liquid-crystal-display modules fall, capabilities like image compression, video conferencing, and wireless communications will all be integrated into the PC. What's more, says Drazin, the user in all likelihood will buy the PC at a large retail outlet. "There are a lot of European consumers who have not yet approached a PC, but who will want a 'personal companion' that will integrate sound, video, and telephone," he adds.

Philips is positioning itself at every level to reach this new market, as Peter Draheim, director of the Semiconductor Product Division, showed at the conference. At the chip level, Philips is beginning production of a microcontroller with an operating voltage below 2 V. That puts less demand on the batteries, Draheim points out, making the personal companion much more portable. And at the product level, Philips is preparing for the production of laptops that will integrate these media.

Even as Philips concentrates on the consumer connection, Siemens is betting on a rise in prices for big-production ICs. According to senior vice president Knorr, the Munich-based company already can produce 50 million 1-Mbit dynamic random-access memories a year, and is preparing large capacity (he would not say how much) for the 4- and 16-Mbit models.

For Knorr, the DRAM will be the technology driver in the 1990s. Comparing projections for unit price against production volume, he showed that volume would reach a peak worldwide in the next five to 10 years. Then, DRAM prices will rise again as demand outstrips capacity.

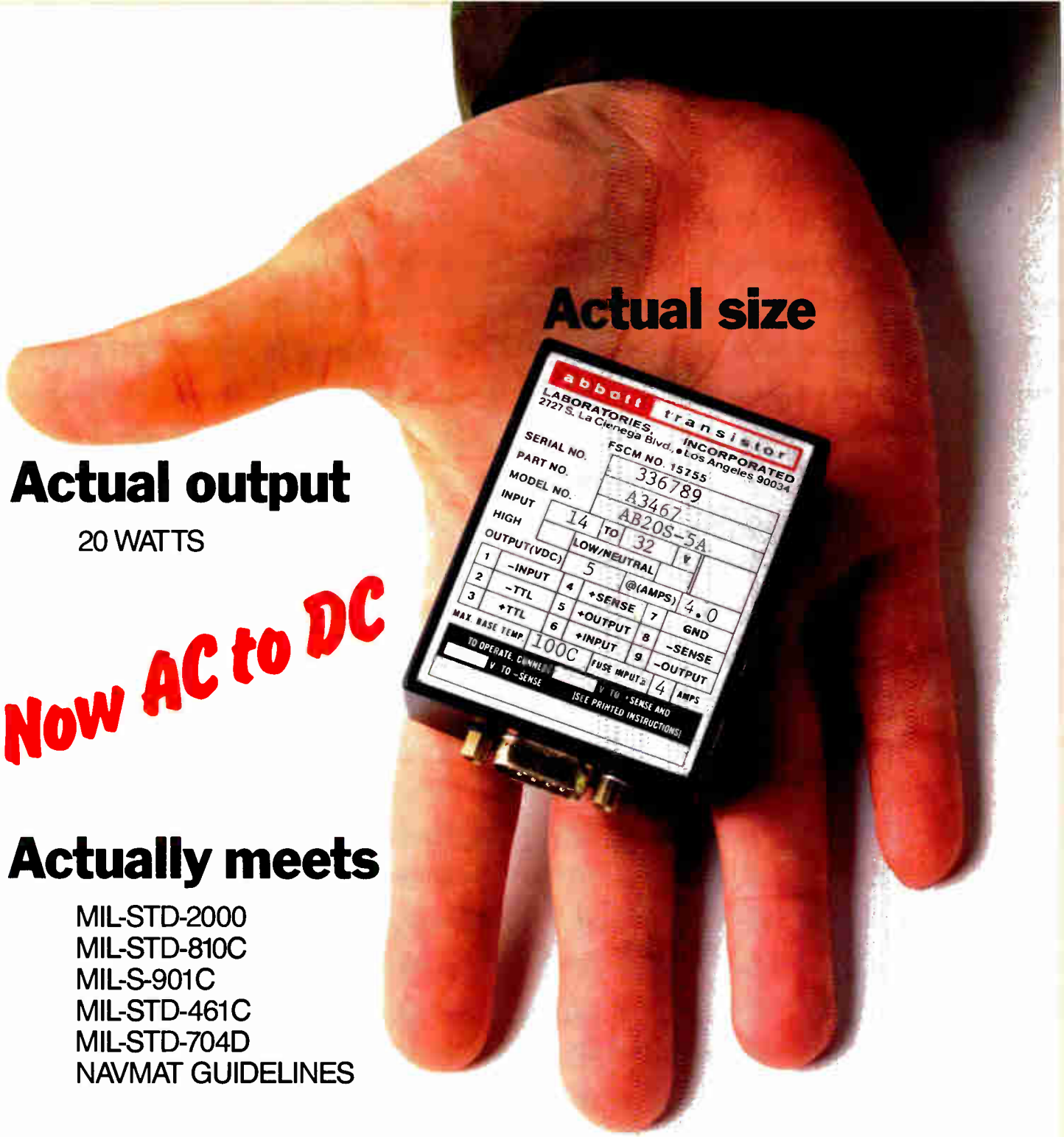
Siemens has been slower than other Europeans to open foreign markets. An-

THE VIEW FROM EUROPE

IN MILLIONS OF EUROPEAN CURRENCY UNITS (1 ECU = $1.15)

	1990	1991	AGR%	1995	CAGR%
TOTAL SEMICONDUCTOR	8,383	9,206	9.8	15,573	13.2
Total IC	6,547	7,226	10.4	12,854	14.4
Bipolar digital	454	428	-5.6	302	-7.8
Memory	46	43	-6.3	24	-12.0
Logic	408	386	-5.5	278	-7.4
MOS digital	4,248	4,847	14.1	9,568	17.6
Memory	1,694	1,928	13.8	3,855	17.9
Microcomponent	1,444	1,669	15.6	3,635	20.3
Logic	1,111	1,250	12.5	2,078	13.3
Analog	1,845	1,951	5.8	2,984	10.1
Discrete	1,506	1,634	8.5	2,236	8.2
Optoelectronic	330	347	4.9	484	7.9

SOURCE: DATAQUEST INC.



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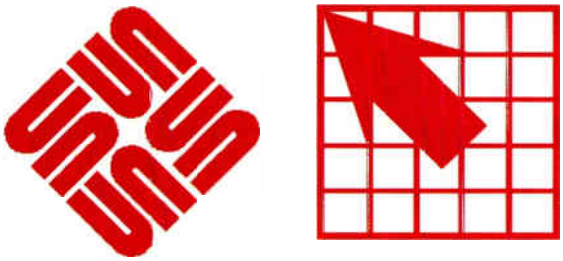

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CIRCLE 184

alysts at the conference emphasized the need for Europe's semiconductor industry to achieve a global presence, but offer excellent local support.

The binational SGS-Thomson Microelectronics, based in Agrate Brienza, Italy, as well as Paris, is taking a totally different approach to the changes of the 1990s. Company president Pasquale Pistorio describes them as "the marketing phase" of microelectronics. So SGS-Thomson already has a number of key multimedia components developed—like discrete cosine-transform and motion-picture-estimation ICs, the latter with an eye to high-definition TV.

SGS-Thomson is also well-positioned to take advantage of what will be the most promising semiconductor market in Europe in the coming decade: mixed-signal ASICs. "Europe is world leader in telecom manufacturing," says Dataquest analyst Mike Glennon, "and telecom calls for high-performance mixed digital and analog functions."

SGS-Thomson's Pistorio also insisted on the importance of service in the coming decade. Indeed, its emergence was a common thread in the conversations among Europe's semiconductor executives at the conference. "When we meet here again 10 years from now," says Motorola Inc. vice president Barry Waite, "the companies that have survived and are sitting around this table will be the ones who have met the service challenge of the '90s."

Asked, however, to explain how semiconductor producers are to cope with the cost of these services, the executives from the big companies were rather vague. "The cost doesn't matter," declared Kazuo Kimbara, senior managing director at Hitachi Ltd. ❑

SINGLE-CHIP ETHERNET CHECKS IN

THE NEW BREED

BY JACK SHANDLE

NETWORKS

Single-chip solutions are almost as old as Silicon Valley itself. But now an increasing number of them go beyond simply squeezing two or more existing chips onto a single die. Rather, the new breed addresses specific systems-level problems, uses combination technologies, and often includes circuits that solve problems that systems developers anticipate seeing as markets evolve.

A good case in point is National Semiconductor Corp.'s single-chip Ethernet solution for twisted-pair wiring. National had plenty of feedback from systems houses, including Hewlett-Packard, Cabletron Systems, Xircom, and Eagle Technology, in designing in new features. It also has taken the commendable step of using its mixed-signal semiconductor technology to put an analog transceiver on what is mostly a digital CMOS controller chip.

The single-chip Ethernet DP83902 integrates the functions of three chips: an Ethernet controller, an encoder/decoder, and a 10-BASE-T transceiver (which connects Ethernet to twisted-pair wiring). Although aimed primarily at the twisted-pair market, the ST-NIC (serial network interface controller for twisted pair) chip also offers the option of interfacing with an attachment-unit interface, or AUI, for coaxial cable installation. "It sets the stage for us to provide a complete Ethernet adapter on a single chip," says Edwin DeSousa, National's product marketing manager for the ST-NIC.

Using the ST-NIC cut the design time to convert Eagle Technology's NE2000 Ethernet card to a twisted-pair card from six months to just a month, says Ken Lamneck, managing director of Eagle Technology of San Jose, Calif. Eagle also unveiled a module that connects to the attachment-unit interface of an old Ethernet card and converts it to a twisted-pair card.

The changeover from coaxial cable to twisted pair in the U.S. will be relatively rapid—from less than 10% twisted pair in 1990 to greater than 80% by 1995, according to the Gartner Group of Stamford, Conn. Since five years is well within the planning cycle of many com-

panies, savvy Ethernet vendors are using the ST-NIC chip to provide customers with interfaces to multiple media, says National's DeSousa.

Over the next months, Eagle will take even greater advantage of the chip's flexibility with designs that give the customer more media options. For example, users with definite plans to migrate from a coaxial-cable version of Ethernet to twisted-pair Ethernet can buy just one board. The ST-NIC chip also gives Eagle itself a chance to keep manufacturing costs down. The integration of functions means customizing boards at the board-stuffing end instead of designing and manufacturing a different board for each transmission medium, says Lamneck.

The simple reduction in real estate made the ST-NIC attractive to Xircom Inc. of Calabasas, Calif., a manufacturer of pocket LAN adapters the size of garage-door openers. Aimed at laptop and notebook computers, Xircom's products connect to the network through the machine's parallel port, since laptops do not have LAN ports. "Size and weight are clearly an issue for us," says Steve Magidson, vice president of marketing. New markets that will also benefit are those for palmtop and pen-based computers, where space is at a premium. Still another option is to add more functions.

As might be expected, CMOS ST-NIC offers significant power savings over multiple n-MOS parts. In particular, it will be useful for developing systems using IBM Corp.'s Micro Channel bus. The total bus power budget is 1.8 A. Solutions based on ST-NIC will eat up about 140 mA, or just under 8%. By contrast, multiple-chip Ethernet solutions can consume 440 to 755 mA, or 24% to 45%. This leaves considerably more headroom to hang other adapter cards on the bus.

Besides its low power budget, the chip anticipates—and solves—a problem that laptop and notebook users will encounter as they try to plug in and out of different Ethernet nodes. Unlike coaxial cable, twisted-pair wiring has a polarity and if the wires are switched, no communication takes place. The ST-NIC, however, senses wiring polarity and adapts automatically. ❑

MASSIVELY PARALLEL

FAST WORK, SLOW SALES

BY LAWRENCE CURRAN

COMPUTERS

They're checking their stopwatches in the massively parallel computing event of the supercomputer olympics: this is one of those heated-up periods when vendors are claiming blazing speed records for their latest models.

Unfortunately for them, sales of massively parallel processors aren't growing at anywhere near the rate at which technology moves. It could take three or four more years before these machines, which string together 1,024 to 64,000 microprocessors to work on massive problems, make a dent in commercial

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Test it against your #3 wood. If it doesn't give you 30 more yards (if you are a fairly good golfer), send the club back for a refund.

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CONTROLLER®	220 yards
#3 Wood	190 yards
#4 Wood	180 yards
#5 Wood	170 yards

Now test the Controller's accuracy against your 3-iron. Purposely hit a shot off the *toe* of each club and watch what happens. Your 3-iron will *hook* the ball violently—the Controller will keep it down the middle! The same is true with *heel* shots. Your 3-iron will *slice* the ball violently—the Controller will automatically keep it on course!

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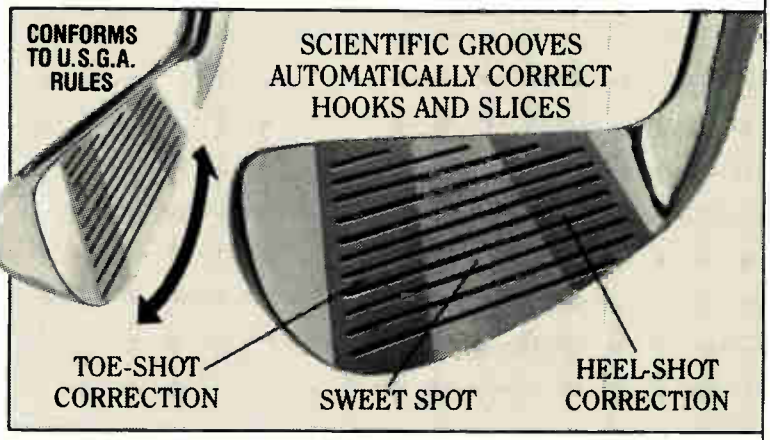

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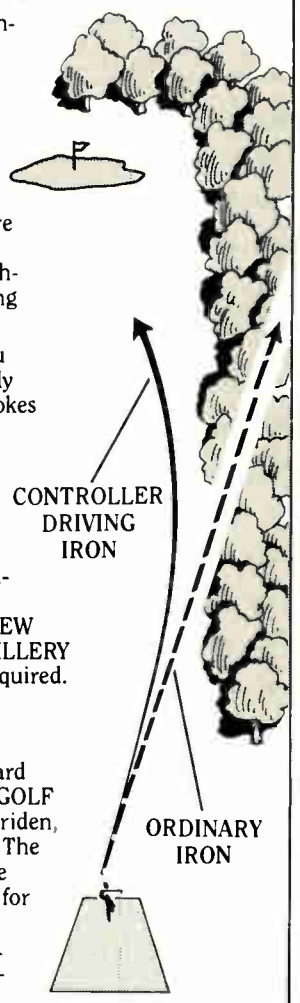
- its 17° loft gets your shot up faster than a #3 wood...
- its smaller head size (versus a wood) boosts clubhead speed...
- its boron-graphite shaft model adds even more clubhead speed...
- it lets you carry more wedges and putters without exceeding the 14-club limit (by eliminating your #3, #4 and #5 wood)...

The Controller is new and supply is limited. You must act now and remember, you are completely protected. If the Controller doesn't cut 5-10 strokes off your score, you may return it (undamaged, of course) for a prompt refund of its price.



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...just for trying the Controller! Keep your new power pin-high with a $15.00 Rangefinder! It's yours to keep FREE! even if you return the Controller for a refund. NOW YOU CAN RANGE YOUR NEW DISTANCE LIKE AN ARTILLERY OFFICER. No batteries required. Clips to belt.

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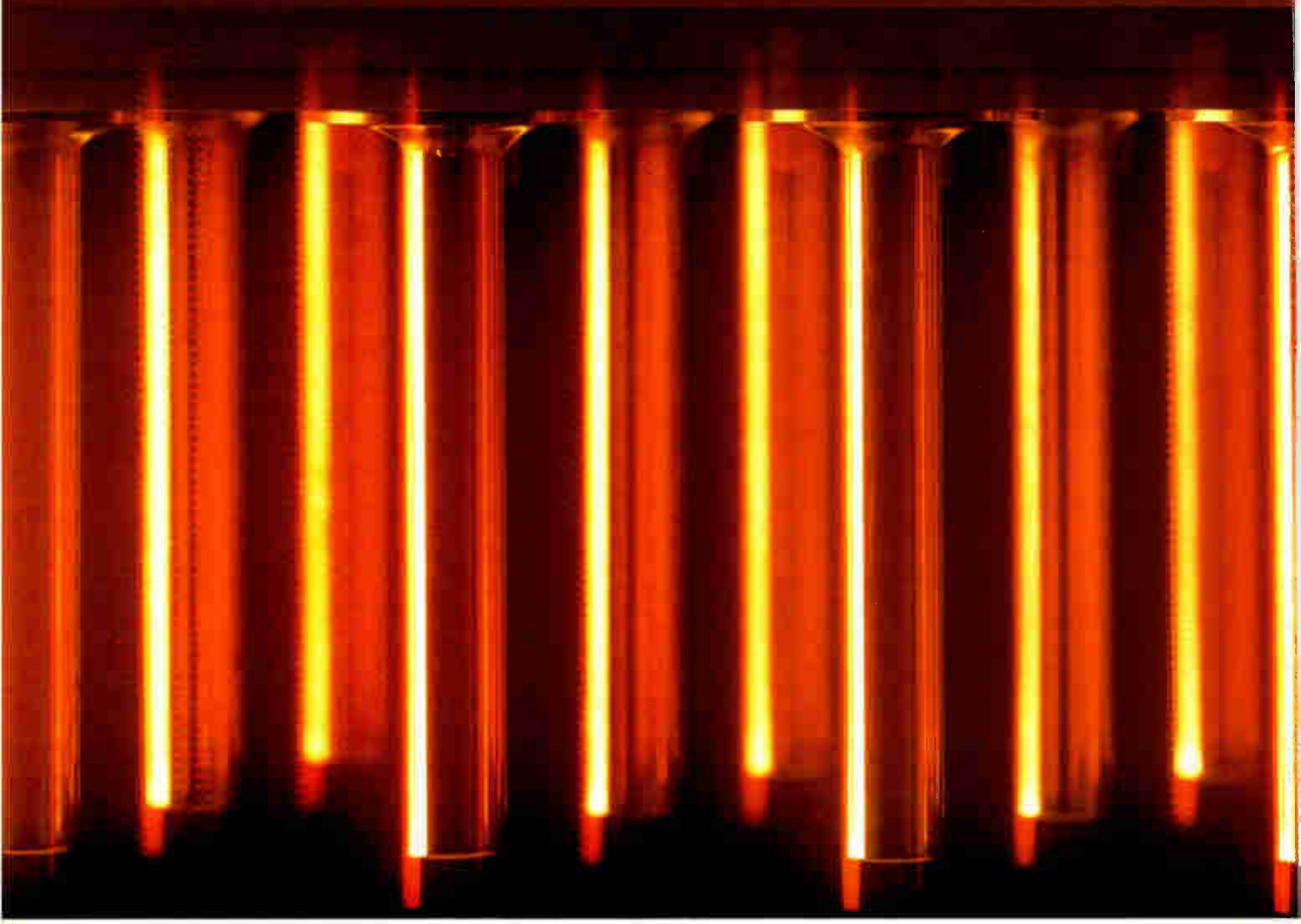
Send your name, address and check (or credit card number and expiration date) to the NATIONAL GOLF CENTER (Dept. DR-147), 500 So. Broad St., Meriden, CT 06450. Or call 203-238-2712 (8-8 PM, M-F). The steel-shaft CONTROLLER costs only $59.00; the carbon-graphite model costs $89.00. Add $4.75 for s/h/ins. CT and NY must add sales tax. Specify regular or stiff flex, right or left-handed. No P.O. boxes, all deliveries are UPS. A refund is guaranteed if a club is returned undamaged within 30 days. Clubs are also available in ladies size, steel or graphite, same prices.

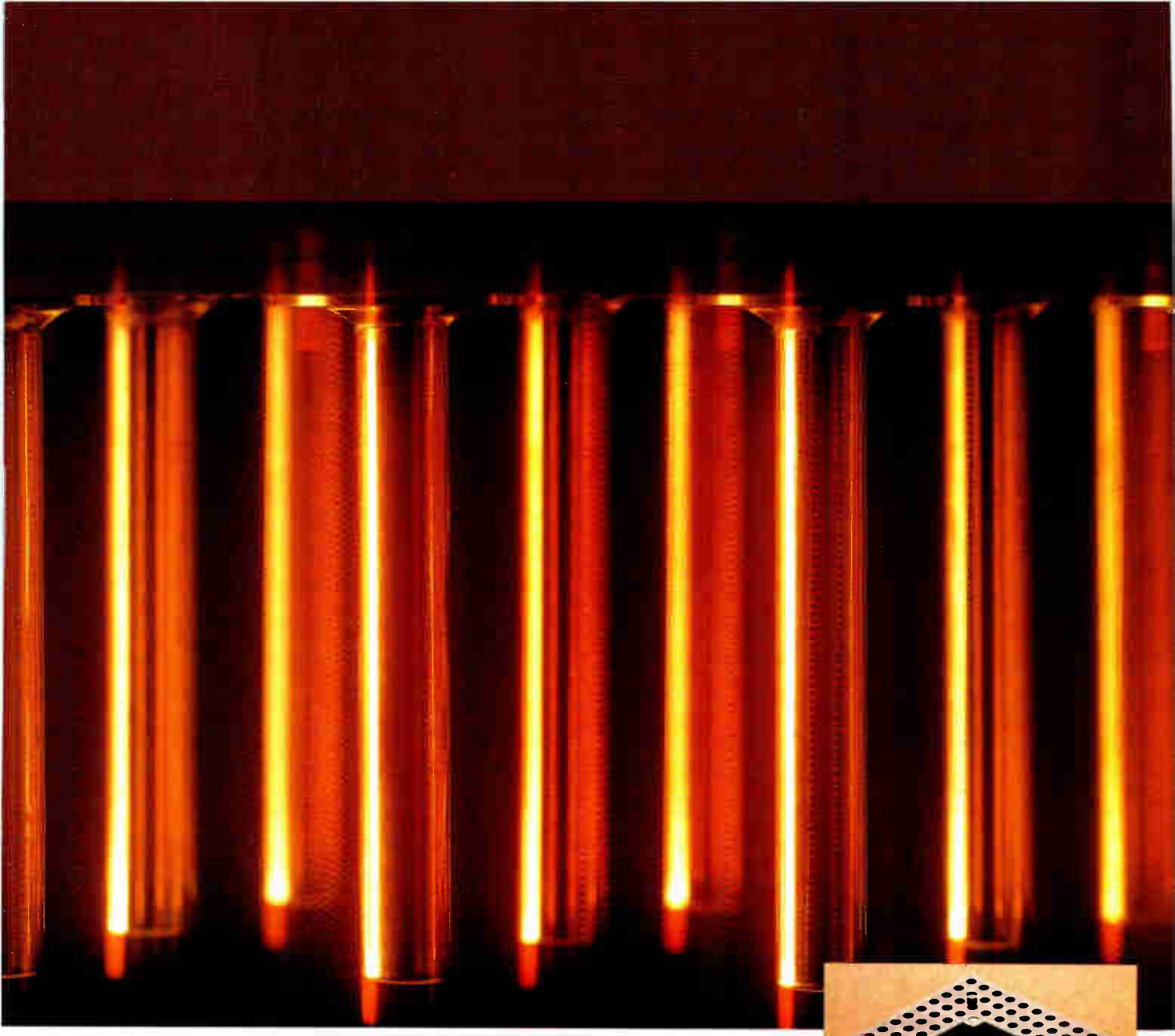
THE CONTROLLER HITS LONGER AND STRAIGHTER THAN ANY OTHER CLUB IN GOLF. IF IT DOESN'T CUT 5-10 STROKES, YOU OWE US NOTHING! ACT NOW!

Helping production cope with the pressures of high pincount packages.



THIS IS AMP TODAY.

*J. B. Cullinane, "A User's Evaluation of Pin Grid Array Sockets", *Connection Technology*, June 1990.



As PGA pincounts go up, so do the insertion/withdrawal forces required to socket them. When counts reach about 121, conventional socket contacts put your total insertion force in the 28 to 50 pound range—hardly conducive to efficient manufacturing.

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And our exclusive design provides excellent normal contact force as well—the contacts utilize a long beam geometry, providing ample deflection with no compromise between normal force and insertion/extraction force.

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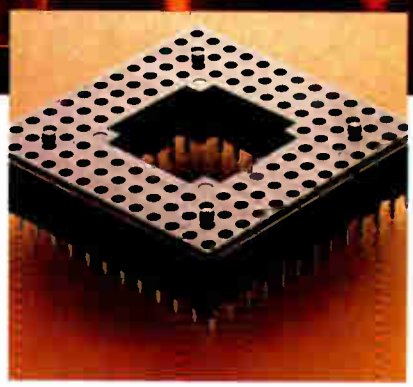


Dual-beam contact LIF PGA

AMP

CIRCLE 174

Does it meet Six Sigma

Can it do true

mixed-mode

testing?

What tools have been developed?

Before the A500 started testing Motorola's mixed-

"Motorola has adopted a Six Sigma initiative which focuses attention on approaching zero-defect performance in everything we do, including our test systems. Our purchase of the Teradyne A500 test system supports our Six Sigma initiative and our competitive leadership challenge."

Director of Marketing

Motorola knows you can't have a Six Sigma process unless you can test to Six Sigma standards. That's why Motorola's MOS Digital-Analog Integrated Circuits Division chose the Teradyne A500 Analog VLSI Test System. Because, in addition to proving the A500 could handle the complex technical requirements of Motorola's advanced ISDN interfaces, we also demonstrated that we could perform to Motorola's stringent quality levels.

"Can it do scan testing? Digitize high-frequency waveforms? Do true mixed-mode testing? Does it have a flexible architecture? Can you give us the support for a Six Sigma process? Applications expertise? Complete documentation? The right tools? In each case, Teradyne answered yes."

Manager, Advanced Test Technology

signal technology, Teradyne had to pass a few tests.

With the A500, Motorola had the ability to digitize waveforms at 20 MHz, plus the high pin count necessary to guarantee that their ISDN U-Interface worked the way it was supposed to.

Best of all, the A500's full tester simulation and powerful IMAGE™ software provided the design flexibility and rapid debugging Motorola needed to deliver defect-free parts on time.

"The A500 gave us the resources we needed, in one place, to be able to have a functioning test program very quickly – at least two to three times faster than any other test system. This type of support is just what we need to get our complex circuits, such as the U-Interface transceiver, to the marketplace ahead of the competition."

Operations Manager

To Motorola, delivering Six Sigma quality is not just a promise. It's a way of doing business. And it's a test that must be passed by suppliers as well.

To see how our A500 family of test systems can help you deliver quality, call Beth Sulak at (617) 482-2700, ext. 2746.

Or call your nearest Teradyne sales office, or write: Teradyne, Inc., 321 Harrison Ave., Boston, MA 02118.

TERADYNE

CIRCLE 194

supercomputing applications.

Early last month, Intel Supercomputers of Portland, Ore., trumpeted "a new supercomputer performance milestone"—8.6 billion floating-point instructions/s in executing the double-precision massively parallel Linpack benchmark on the Intel Touchstone Delta. The machine is installed at the California Institute of Technology in Pasadena. Then, within a week, Thinking Machines Corp. of Cambridge, Mass., claimed 9.03 gigaflops for the same benchmark using its just-introduced CM-200 massively parallel machine.

But that's not the end of it. Waiting in the wings to introduce a new entry in the race is a Waltham, Mass., startup named Kendall Square Research Co. The first product from Kendall Square is expected to be a massively parallel processor "whose software looks to be very creative in that it has a friendly user interface," says Debra Goldfarb, senior analyst at International Data Corp., the Framingham, Mass., market-research organization. "This will be an interesting vendor to watch because they're trying to straddle the scientific and commercial domains," Goldfarb adds.

Henry Burkhardt, president of Kendall Square and one of the founders of Data General Corp., says he prefers not to comment about the product "until we have a machine in the field." However, he indicates that the event isn't likely until after July.

But the champagne toasts hoisted to salute new records come against the backdrop of a market segment moving along at a snail's pace—one that most analysts say won't overflow its narrow technical/university computing niche into commercial applications until several obstacles are overcome.

IDC's Goldfarb lists as the major hurdles the lack of third-party application software, standards and networking, the difficulty of using the machines, and customer concerns about vendor viability. Nevertheless, she regards the massively parallel-processing (MPP) market as "one that will be dynamic and fun to watch" as new models come along from several vendors.

IDC estimates that 1990 revenues from MPP systems reached about $154 million, and that Thinking Machines had the largest market share. Shipments in 1989 were valued at $102 million.

There's a long row to hoe before massively parallel processing appeals to a broad user audience instead of those "who buy the hottest top-end box—those who are attracted by the macho-flops," as Goldfarb puts it. That audience is willing to spend substantial time developing application software for MPP architectures.

A recent IDC survey of 45 massively parallel user sites showed that "the majority of MPP applications are homegrown and highly proprietary," Goldfarb points out, but "the average user wants real software and front-end friendliness." Goldfarb concludes from the survey that "moving beyond the cloistered R&D and university environments into the commercial market will require major initiatives in third-party software development, networking, standards, and the development of a nonhostile user environment."

The leading vendors of MPP systems include Active Memory Technology, BBN Advanced Computers, Intel Supercomputers, Maspar Computer, NCube, and Thinking Machines. Those who responded to the IDC survey are concerned about the staying power of those vendors "ill-equipped to dedicate the appropriate resources to advance the state of the industry."

Goldfarb says that while MPP technology faces fairly slow adoption rates over the near term, "we expect significant improvements in the software domain" from 1992 to 1995 that will substantially reduce system costs, "resulting in more rapid integration of this technology into more mainstream high-performance computing environments."

Meanwhile, Danny Hillis, chief scientist at Thinking Machines, says his firm's new CM-200 goes a long way toward overcoming many of the software obstacles. He says it's the first massively parallel supercomputer that provides a full general-purpose software environment. A 64,000-processor version of the system, designed to integrate into workstation networks, sells for $8 million to $10 million. The CM-200's operating system is Unix-compatible, and is "the first in the supercomputer industry whose interface is built on the standard X Window System and OSF/Motif workstation protocols," says Hillis. ❑

EC COMPUTER FIRMS MAKING HAY

European computer makers are pulling ahead of their U.S. rivals in the race to dominate the East European market.

Last month, France's Paris-based Bull SA concluded an important contract with the Czechoslovakian finance ministry, one that followed hard on the heels of a similar deal with the Polish government. Germany's Siemens AG of Munich is dominating the former East German computer market, and ICL Ltd. of London has been successful in negotiating with the Hungarian government. Of the U.S. vendors, only IBM Corp. has been able to keep pace with the EC companies, boasting important deals in Poland and Hungary.

The problem that daunts smaller companies that would like to break into these markets is simple, analysts say: customers without cash. "Anything you do on these markets is for the long term," says Martin Oertel, a Dataquest Inc. analyst who specializes in Eastern Europe. This gives companies like Bull, funded by the French government, and ICL, which has the deep pockets of Japan's Fujitsu Ltd. to depend on, an enormous advantage.

On the other hand, Ing. C. Olivetti & Co. SpA, which had great success in Eastern Europe, had to back off because of funding pressure. The Ivrea, Italy-based company shipped about $3 million worth of units to Czechoslovakia and Hungary last year. But the slow payment both there and in the USSR, where Olivetti is a traditional partner, has kept it from agressively following up those sales. ❑

WHO'S AHEAD IN THE EAST

(1989 shipments in $ millions)

	CZECHOSLOVAKIA	HUNGARY	POLAND
IBM	---	2.5	4.8
ICL	5.7	1.5	3.7
Siemens	5.7	---	4.2
Olivetti (as of 6/90)	0.95	2.7	---

SOURCE: INDUSTRY FIGURES

JESSI AND ESPRIT GET A NEW MISSION LIMITED TO CMOS TECHNOLOGY

Jessi is being revamped. The Joint European Submicron Silicon Initiative, which is Europe's only hope for cooperative research among various European Community nations and companies, is radically narrowing the range of its research projects.

The original purpose of Jessi was to gather funds for a European effort like that of Sematech in the U.S. for semiconductor research. Now, Jessi and its partner program Esprit, which governs cooperative efforts in every area of microelectronics, will focus strictly on CMOS technology. "The purpose of this new effort," an EC official says, "is to create flagship programs in an area that has been too broad up to now."

Some observers believe that the new effort comes because of political pressure for results. The EC semiconductor industry has come under heavy criticism recently for its failure to regain market share from the U.S. and Japan. Many observers feel that Jessi and Esprit were not nearly enough to recoup. For example, French Prime Minister Edith Cresson has called for mergers among the three major European chip makers in an effort to stem the tide. The new effort is intended to answer those criticisms and avoid the political problems that a merger of EC chip makers would entail. ❑

ANOTHER DEAL: SEL AND CZECHOSLOVAK FIRM

West European firms are continuing their drive into the potentially lush markets for communications equipment in East Europe. Among the latest moves is a joint venture between Standard Elektrik Lorenz AG (SEL), the German member of the French telecommunications group Alcatel NV, and Tesla Liptovsky Hradok of Czechoslovakia. In its first phase, the deal will involve production of SEL's System 12 digital switch in Czechoslovakia.

The aim is the annual production of System 12 switching equipment for 250,000 subscriber lines at a plant in Liptovsky Hradok. Production will start during the second half of this year. The venture calls for initial investments of about $11.5 million, and SEL has offered to fully finance it for 10 years.

The second phase envisions extending the cooperation to encompass the manufacture of private switching equipment and telephone sets. The German-Czech agreement provides for Stuttgart-based SEL to transfer manufacturing technology to its partner, train personnel, and set up a software center. ❑

USSR TO WORK ON DIGITAL RADIO

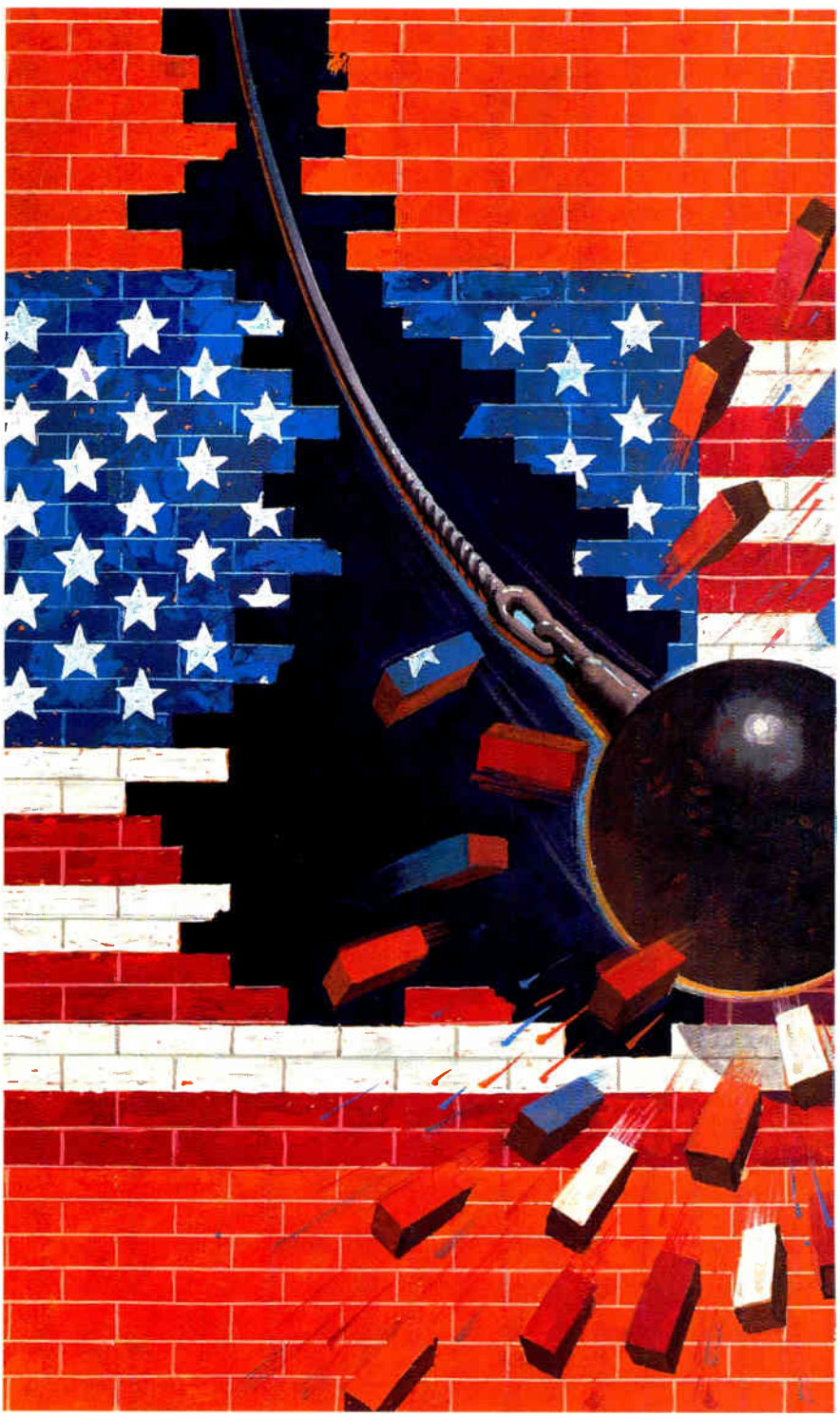
Soviet experts in radio broadcasting have joined their counterparts in Western Europe to develop and test a digital radio system. The Soviet partner is the Popov Institute in Leningrad, Russia's leading organization for developments in radio and TV. It will work with companies and similar institutes in France, Germany, the Netherlands, and the UK.

Soviet participation should strengthen Europe's position to push for a worldwide standard for digital audio broadcasting, a promising candidate to replace FM radio. Its quality not only equals that of a compact-disk system, but it provides interference-free reception in vehicles riding through areas where reflections are common. Also, both text and pictures can be transmitted, and DAB accommodates more programs in a given frequency range than does FM radio. ❑

A NEW ENDANGERED SPECIES:

NOT MANY U.S. SEMICONDUCTOR HOUSES CAN AFFORD TO MANUFACTURE; IS COMPETITIVENESS AT RISK?

BY SAMUEL WEBER



COVER STORY

Is the U.S. in danger of not only losing semiconductor market share but also the ability to maintain the sophisticated infrastructure required for manufacturing? Concern over the chip industry's ability to keep up is rising in pace with the price tag of a state-of-the-art wafer-fabrication facility, now well over $300 million and climbing. As more and more U.S. outfits turn to overseas facilities for fabrication, the question keeps coming up: is the U.S. giving up on manufacturing? Within the industry, the answer varies from "yes" to "no" to "who cares?" But almost all semiconductor executives bewail the failure of the U.S. government to establish a more favorable environment for capital formation.

For all but the largest U.S firms, raising and allocating the necessary capital for investments of this magnitude is extremely difficult for a variety of reasons. The oft-cited problem of satisfying the short-term appetites of stockholders is one. High interest rates that impose heavy tolls on borrowed capital is another, along with a tax structure that provides little or no incentive to businesses for making such investment domestically. The hurdle is especially difficult for small startups in an environment where venture capitalists are becoming increasingly wary of semiconductor investments (see p. 41). And the situation is not helped, some observers say, by a government that is seemingly indifferent to the importance of high technology to the economic well-being of the nation.

The fabless phenomenon has given birth to a variety of strategies to obtain manufacturing capability. Many of them exacerbate the problem, say industry observers, who view with alarm the increasing shift of manufacturing to Japan and elsewhere in the Pacific Rim, with the concomitant loss of U.S. jobs and manufacturing expertise.

Despite the worry, though, some believe that the dispersion of manufacturing is the inevitable consequence of the

MULLING A FABLESS FUTURE

dramatic changes taking place in the semiconductor marketplace. "Over the last 10 or 20 years, the market for semiconductor products has shifted from the U.S. toward the Far East, and so one phenomenon is the movement of manufacturing capacity in order to stay close to where the market is," says Wally Rhines, executive vice president of Texas Instruments Inc.'s Semiconductor Group in Dallas.

What's more, says Rhines, "fear of trade barriers is causing capacity to increase in Europe, and there's a general feeling among most major manufacturers that you need to spread your manufacturing around and not be at risk in any one geography. Next is the fact that government incentives have driven the development of undeveloped areas, which tend to attract wafer fabs to places where there hasn't been manufacturing in the past." Finally, Rhines says, "the generation of cash for investment has increasingly drifted toward the Far East over the last 15 years or so. There are more investors available in the Far East now."

One result of the difficulty of ponying up $300 million for a fab has been the spawning of the so-called "fabless" company, which does only product development and marketing, contracting its manufacturing to foundries or other semiconductor vendors with excess fab capacity. Other companies are joining together in alliances and partnerships that enable them to share the cost of process development and manufacturing.

Some question the long-term competitive clout of a fabless company. If a chip house depends on outsiders to make its wafers, does it surrender control of the process and consequently the quality of its product? What happens when market demand cuts excess capacity? How do you keep up with advances in process technology?

"You can philosophize a lot about why you're fabless, and what are the positives and negatives," says John East, president and chief executive officer of Actel Corp., a vendor of field-programmable gate arrays in Sunnyvale, Calif. "But the truth is there is no choice—a startup, by definition, will be fabless."

The 1980s saw the emergence of the fabless semiconductor company, which contracts its wafer manufacturing to outside foundries.

Chips & Technologies Inc. of Milpitas, Calif., is possibly the quintessential fabless semiconductor house. Since 1985, Chips has parlayed its chip-set designs for personal computers into a highly successful business now being emulated by others. Keith Lobo, vice president and chief operating officer, pooh-poohs the idea that his company lacks control over process and calls the concern over reduced U.S. fab capacity a myth that stems from "a lot of hysteria from ill-informed individuals."

"I take issue with the concept that manufacturing large volumes of semiconductors is disappearing from the U.S.," Lobo says. "That's because there is a significant amount of investment being targeted toward the U.S. and to some extent in Western Europe by Far East companies." He cites NEC Corp.'s facilities in Roseville, Calif., and plans by Fujitsu Ltd. and Toshiba Corp. to bring up large facilities in Oregon. "The subject of ownership of that capacity is an emotional issue for debate in the U.S. economy," Lobo says, "but if you look at the issue in terms of talent utilization, job creation, capacity availability, and closeness to the customer base—and disengage all that from corporate ownership—you have a significant investment being made in the U.S. to increase that capacity. It just happens to be coming from the other side of the Pacific." Adding to that, he says, is substantial investment in fabs in the U.S. and abroad by the American Big Three: Intel, Motorola, and TI.

As to the issue of process control, Lobo points to construction and civil engineering firms like Bechtel as a paradigm for Chips & Technologies. "They don't own steel mills, cement plants, or tile factories—they specialize in architecting and building designs for very large civil engineering contracts, utilizing sources for all these skills, and have taken that concept to a very successful level on a global scale." Lobo implies that Chips is doing the same thing on a smaller scale.

But other semiconductor executives point to inherent disadvantages of a fabless company that Lobo tends to over-

look or ignore. LSI Logic Corp. of Milpitas started out fabless and now has a substantial wafer-fab facility in Japan, in partnership with Kawasaki Steel, and smaller ones in the U.S. and Canada. Going fabless works only for a startup, says Robert Blair, senior vice president of LSI Logic's ASIC product group. A fabless company can't control the market price of its product, "and if you can't control your manufacturing cost at the appropriate rate," he says, "then margins decline and it starts to impact your bottom line."

East of fabless Actel agrees. "It's not too hard to convince people to build $50 million worth of wafers for me, but I expect it would be impossible to convince them to build $1 billion worth. At some point, other people are just not going to spend their money to build a facility to build wafers for us, so by definition, success will eventually force a startup to build a fab. The only argument is at what point."

Jerry Sanders, CEO of Advanced Micro Devices Inc., once famously declared that "Real men have fabs." If so, manhood comes at a substantial price. It isn't surprising that with few exceptions, the major investments in new U.S. fabs are being made by Japanese firms with deep pockets, or by the U.S. semiconductor megacompanies. Even the latter are hedging their bets with overseas manufacturing facilities and foreign partners. TI, for example, is using a variety of strategies to beat the high price of fabs (see p. 43).

Motorola Inc. is one company that is investing heavily in fab capacity in the U.S., although it is a partner with Toshiba in a joint venture in Japan and has made a major investment in Hong Kong. It recently completed the $650 million MOS XI project in Oak Hill, Texas, and is building a $325 million fab in Chandler, Ariz. Intel Corp., meanwhile, continues to upgrade its four domestic fabs and is building an advanced logic facility in Ireland.

Not quite in the same league as the Big Three, feisty memory manufacturer Micron Technology Inc. is strongly committed to fab independence in its home base in Boise, Idaho. "We've always had fabs and continue to build," says Kitt Bedard, vice president of industrial relations. "One distinct advantage is that whether there is over- or undersupply, you always have a guaranteed output. In other words, in times when there is enough capacity, people who are fabless have no trouble finding capacity. But when the market is tight, the pendulum swings, and it swings in a hurry. Perhaps more important, we control our process much better than anyone else could. We don't let anything get through that isn't up to the quality our customers demand." Nevertheless, Bedard says Micron would consider putting excess demand on someone else's fab, and would also consider offering unused capacity to outsiders.

T.J. Rodgers, the voluble president and CEO of Cypress Semiconductor Corp. in San Jose, Calif., is another who sees inevitable constraints on a fabless company. "You can get along fabless for a short period," he says, "but that's a short-term strategy. I don't see any fabless company getting over more than a few hundred million dollars before it has to grapple with its own manufacturing."

Dealing with a foundry, he says, takes a lot of effort and a lot of communication. "You have to develop an interface organization that is a lot larger and more expensive than that in a company with its own fab. When you're small it doesn't matter, because Japanese wafer yields are good and your production-control cost is dwarfed by the cost of owning a fab. But then you grow and you need a second source and another, and eventually you're dealing with nine sources, and suddenly your cost of control and engineering dealing with all these fabs gets very expensive." A believer in self-reliance, Rodgers takes pride in the fact that Cypress has had its own fab from its inception.

The fab vs. fabless controversy bespeaks a transformed semiconductor industry over the last decade, in which the entrepreneurial spirit is as strong as ever but the capital to nurture it is not, and where profitable operation almost dictates going offshore. As Actel's East puts it, "We were almost beaten off to Asian companies." Almost to a man, semiconductor executives decry the lack of government efforts to stem the tide. None wants handouts; they want a revision of the tax structure that will encourage capital formation and investment. High on the list of desires is a capital-gains tax to give investors an incentive to hold on to stock and make an attractive return without paying a heavy tax penalty.

"Right now," says Rodgers, "there is no differentiation over time. If you buy it and sell it or buy it and hold it, you get burned the same. Therefore the government incentivizes short-term thinking. If the government changed the capital-gains tax, you'd have investors asking a new question, not required now: which company is going to be doing better two years from now?"

Another suggestion comes from G. Dan Hutcheson, president of VLSI Research Inc., a market-research firm in San Jose. A study published by his company indicates that if depreciation schedules for capital assets were reduced from the five- or six-year cycle now standard in the U.S.—or eliminated altogether and counted as an expense—a company would be profitable longer, even during bad years, and would remain an attractive investment.

A Japanese manufacturer has fully depreciated its costs after only three years of the product life cycle, the study says. It can then move into a market-share-acquisition mode using profits to fund a new generation of products.

A much higher degree of cooperation may also be demanded, if the recently released preliminary report of the National Advisory Committee on Semiconductors is to be believed. The report sets a 10-year goal for reaching 0.15-μm manufacturing, which will require major technological advances. Projecting that the cost of a foundry, process development, and equipment to build these advanced chips would cost billions of dollars, NACS is calling for a "new culture of cooperation and sharing" in the industry worldwide. Whether such cooperation can be achieved in a business long known for ferocious competition is problematical. ❑

NOT MADE IN THE U.S.A.

With the cost of a wafer fab at $300 million and rising, few U.S. chip makers can afford one.

Fabless companies contract their manufacturing overseas, usually to Japan and the Pacific Rim.

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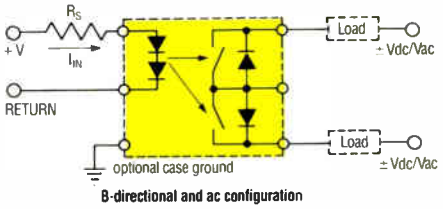
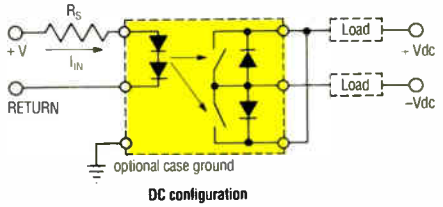
INPUT ELECTRICAL CHARACTERISTICS (–55° to +105° unless otherwise noted)			
	Min	Max	Units
Continuous Input Current (I_{IN})	10	50	mA_{DC}
Input Current (Guaranteed On)	10		mA_{DC}
Input Current (Guaranteed Off)		100	μA_{DC}
Input Voltage Drop at (I_{IN}) = 25mA		3.25	V_{DC}

OUTPUT ELECTRICAL CHARACTERISTICS (–55° to +105° unless otherwise noted)				
Part Number	**FB00CD**	**FB00FC**	**FB00KB**	**Units**
Bidirectional Load Current (I_{LOAD})	±1.0	±0.50	±0.25	A_{DC}/A_{PK}
DC Load Current (I_{LOAD})	2.0	1.0	0.5	A_{DC}
Bidirectional Load Voltage (V_{LOAD})	±80	±180	±350	V_{DC}/V_{PK}
DC Load Voltage (V_{LOAD})	80	180	350	V_{DC}
ON-Resistance (R_{ON}) at (I_{LOAD}) max.	0.72	1.8	12.9	Ohms
Turn-On Time (T_{ON})	800	800	500	µs
Turn-Off Time (T_{OFF})	300	600	500	µs

Notes: 1. A series resistor is required to limit continuous input current to 50mA (peak current can be higher).
2. Rated input current is 25mA for all tests.
3. Loads may be connected to any output terminal.
4. ON resistance shown is for the bidirectional configuration. The DC ON resistance is ¼ of these values.



B-directional and ac configuration



DC configuration

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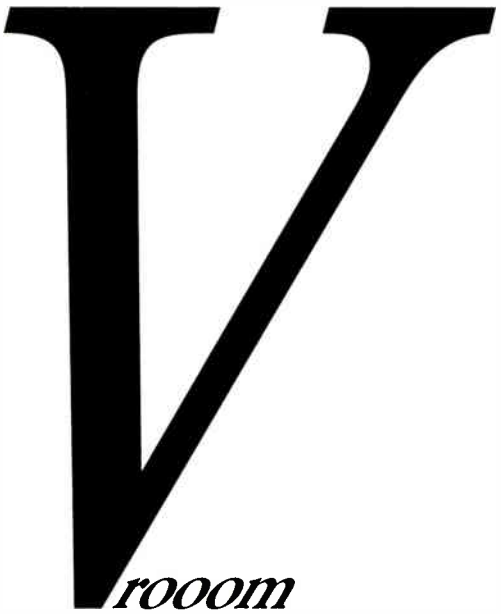

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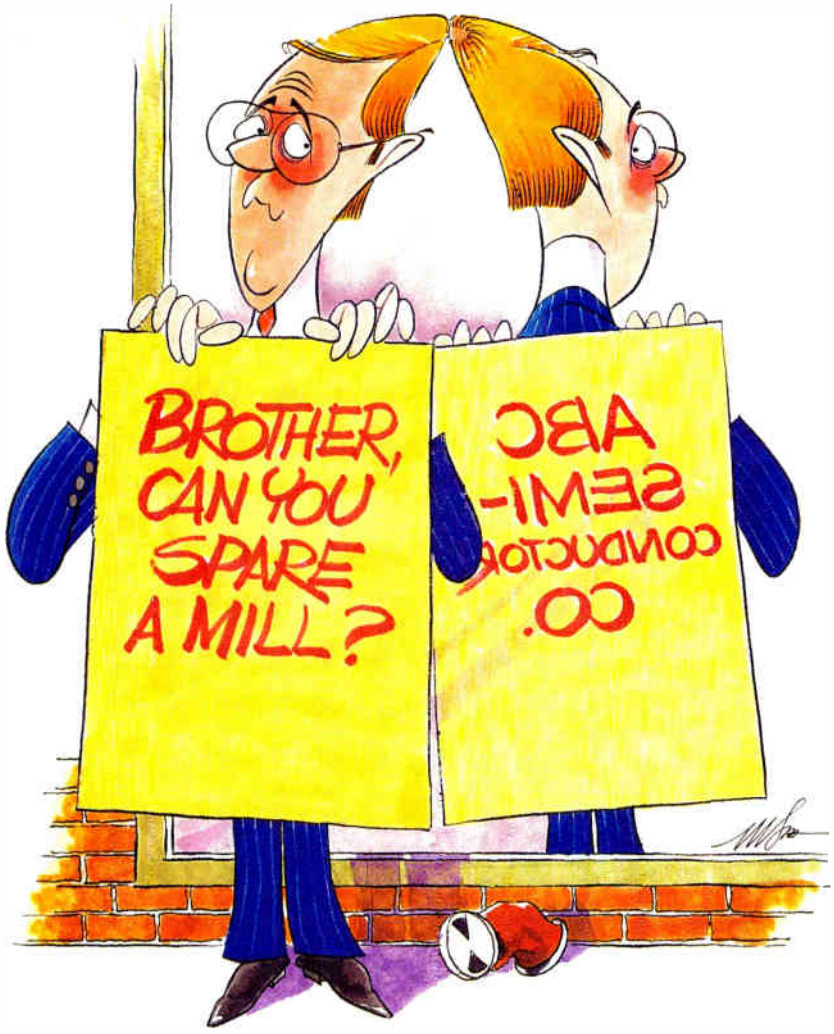

THE VENTURE POOL IS SHRINKING...

...AND THERE'S NONE AT ALL TO FINANCE A WAFER FAB

BY LAWRENCE CURRAN

If you're a would-be entrepreneur ready to approach a venture-capital firm with a business plan for a semiconductor startup, be prepared for a dash of cold water in the face. The funds managed by venture firms have been cut in half in recent years, and none of the remaining $1.5 billion to $2 billion per year is going into semiconductor startups that anticipate building a wafer-fabrication facility. That's because the cost of a state-of-the-art fab can exceed $250 million.

The good news is that the venture pool is still well above the levels of earlier periods, and fabless semiconductor startups can get financing if they bring to the deal marketable intellectual property—proprietary design or process innovation that gives them a competitive advantage. Increasingly, however, both fledgling and established semiconductor firms are raising money through joint ventures with partners that either help fund new foundries or provide wafer fabrication in exchange for licenses to advanced design or process technology (see p. 43).

The annual flow into venture funds has been halved from the oversaturated $4 billion of a few years back, says E. Floyd Kvamme, a general partner in the Palo Alto office of San Francisco venture firm Kleiner Perkins Caufield & Byers. Kvamme suggests that that lofty peak, reached in 1987, was way too high, resulting in a black eye for the venture industry and many doomed beginnings. "That led to a situation that was described as startup fratricide," he says. "The return on investment [for VCs] wasn't very good, but now it's better than during that period."

From that all-time high, about $1.5 billion will be committed this year, says Robert Pavey, a general partner at Morgenthaler Ventures in Cleveland and chairman of the National Venture Capital Association (NVCA), a lobbying body with a membership of 220 U.S. venture firms. Pavey emphasizes, however, that the money available now is still far greater than in the mid-1970s, when less than $100 million was invested in some years.

Pavey says the average individual investment by a venture fund is a few million dollars. "But our industry is just the tip of the iceberg," he points out, because for the first half of the 1980s, an average of another $55 billion per year was invested in entrepreneurial enterprises by private individuals. Those investments tend to be in much smaller chunks, however, averaging about $100,000 apiece.

Money is tight for two main reasons, according to Pavey. One is the cyclical nature of financial markets, which spawned easy-money cycles peaking in 1969 and 1983, alternating with tight periods centered around 1974 and about now. The second is that the return on venture-capital investments is driven by the over-the-counter stock market, "which peaked in 1983 and hasn't been very exciting since," Pavey says. "We don't get paid as well now for our winners," he adds.

CAPITAL

Nor does the current capital-gains tax rate of 28% encourage investment,

Pavey says. The stock market's current sluggishness was caused in part because that rate was boosted 40% in 1986 from the 20% level, he says. Noting that private individuals invest in new ventures in order to make money, and that "young companies reward investors with capital gains," the higher rate hampers private investments.

Donning his NVCA hat, Pavey says he'd like to see "a significant reduction in the long-term capital-gains tax, and I'd try to sell that idea by showing that it would pay for itself. Even if that doesn't sell, I'd like to convince [Congress] to quit worrying so much about income-distribution issues" and back measures that would tax consumption by the rich but encourage them to invest.

It's because of the high capital-gains tax that "funds are going elsewhere," says Charles Phipps, a general partner who specializes in semiconductors at the Dallas-based Sevin Rosen Bayless Venture Fund. "Funds dried up in the late '70s and opened again in the early '80s," he notes, because of more favorable capital-gains rates then. "The [Bush] Administration and venture capitalists would like to see a substantial differential between that [current 28%] rate and the 31% ordinary income tax maximum to make it more attractive for investors to put money into venture funds."

Kvamme at Kleiner Perkins is also concerned about capital gains. But his worry is that the tax, rather than discouraging potential investors, stops entrepreneurs from undertaking startups, since they can't count on a substantial payoff for their own risk after the company succeeds. Says Kvamme, "More ventures were started in the days when people would accept a cut in their current compensation" in return for a higher payback later.

Even if favorable tax legislation prompted a flood of investment dollars, however, the venture-capital industry speaks with one voice in saying that semiconductor startups can't plan to build wafer fabs because the tab for a state-of-the-art fab is too high: $100 million to $250 million. "That's the domain of very big companies, who then have to fill the fab and keep it filled," says Steve Coit, general partner in the Waltham, Mass., office of venture firm Merrill Pickard Anderson & Eyre. "We're not seeing any plans to finance a fab, such as [the one from] T.J. Rodgers at Cypress, which envisioned having a better fab than anyone else," Coit says. Merrill Pickard was one of the early backers of Rodgers's Cypress Semiconductor Corp. in San Jose, Calif., in the early 1980s. "And we're not likely to see more with that strategy," Coit maintains.

Kvamme agrees: "I was asked recently about the number of investments by the venture industry in fabs in the last few years, and I couldn't think of one. Capital really isn't available for fabs." Kleiner Perkins was an early investor in both Cypress and LSI Logic Corp. in Milpitas, Calif., both of which now have fabs but were launched without them. "They used venture money to get their designs going," Kvamme says, "then built fabs with money [raised] in initial public offerings. Wafer fabrication has become a service the way assembly went years ago," he says. "If you're not adding value in fabrication, a lot of people will do it for you. Like others, I worry about that" (see p. 36).

Mohr, Davidow Ventures, Menlo Park, Calif., is investing in semiconductor startups. But general partner William Davidow stresses that they're fabless companies—"firms that create intellectual property around semiconductors," he says. That approach is part of "a new formula for semiconductor ventures that stresses heavy emphasis on design, marketing, and sales, using an outside fab to produce wafers," says John Bayless, general partner at Sevin Rosen Bayless. "It's not realistic to ask venture-capital guys to fund a fab," Bayless says flatly, "but if a guy has a good idea and it looks like a good business, he would probably get funded. If we come to believe you have a unique process, we can help with some sort of alliance with a fab."

What are examples of fabless startups funded because of their ownership of intellectual property? Michael Child, general partner in the Palo Alto office of TA Associates, a Boston-based venture organization, says financing is available for "concepts that are design-intensive and application-specific."

One such firm that attracted TA is Paradigm Technology Inc., a 1987 San Jose startup that planned on being fabless but has since had to build a fab. Paradigm is the only semiconductor company TA has backed in the last three years, according to Child, and TA went in for the second round. The company meets TA's guidelines in that Paradigm's strength is its proprietary design for a very small memory cell that yields very fast static random-access memories that are conventionally processed and are now shipping.

After reaching agreement with an outside foundry, Paradigm soon found it couldn't rely on the fab to control the process properly and ended up building a fab of its own. Importantly, Child says, "we think their technology has application for devices other than SRAMs."

Sevin Rosen Bayless has invested in Cyrix Corp. of Richardson, Texas, from its third fund. Bayless says Cyrix has an innovative architectural approach to an Intel Corp. 80386 coprocessor that allows better performance in a lower-power device. It's also caught Intel's attention; the Santa Clara, Calif., microprocessor giant is suing the firm over intellectual property issues, but Phipps adds that Cyrix has filed for patents on its architecture. Part of SRB's due diligence included an "intensive assessment before they went to market" that convinced the VCs to proceed. A

VC FUNDING FOR SEMICONDUCTORS

	Total Deals	Total Investment*	Startups	Startup Investment*	
1985	17	$143.1	10	$51.5	(36%)
1986	26	134.4	6	16.6	(12%)
1987	33	155.6	8	33.5	(22%)
1988	32	160.6	3	6.0	(4%)
1989	33	133.0	3	5.3	(4%)
1990	35	128.3	13	32.1	(25%)

*Millions of dollars

Source: Technologic Partners (Based on Quarterly Survey of Venture Capital Investors)

It's too soon to tell if 1990, which saw greater investment in chip startups, represents a new trend or a statistical blip.

PARTNERING: A CAPITAL IDEA

Corporate partnering is growing in popularity as a way for semiconductor companies—from startups to established leaders—to underwrite wafer fabrication. The practice has been fueled by the astronomical cost of building a foundry.

Among the industry leaders, Dallas-based Texas Instruments Inc. launched an aggressive campaign three years ago to raise outside capital. And 1988 start-up Quality Semiconductor Inc., Santa Clara, Calif., has obtained financing and fabrication facilities through its licensing partners—not through VCs.

TI and its partners have committed about $2 billion, mostly to new foundries both in the U.S. and overseas, through arrangements that will cost TI only half that amount. The company cut the cost of capital via advanced customer payments, government partnerships, and joint ventures, says Rick Clemmer, senior vice president and controller in TI's Semiconductor Group. Since 1988, TI has collected about $200 million in advance payments from customers, who are assured a long-term component supply at guaranteed prices. That money has helped expand the DMOS IV fab in Dallas.

The government partnership involves a four-year, $1.2-billion program with the Italian government, which is providing grants and loans to help underwrite upgrading and expansion of facilities in Avezzano, including submicron CMOS fab space for dynamic random-access memory devices (see p. 45).

Three joint ventures are part of the TI campaign—in Singapore, Taiwan, and Japan. In Singapore, TECH Semiconductor Singapore Pte. Ltd. will produce CMOS DRAMs beginning in 1993 in a new fab that includes Hewlett-Packard Co., Canon Inc., and the Singapore Economic Development Board as partners. Total investment in the new company is about $330 million.

The first DRAM wafers are expected soon from a joint venture in Taipei that links TI and Acer Inc., the Taiwanese manufacturer of personal computers. And ground was broken in February for a fab in Nishiwaki, Japan, being built as KTI Semiconductor Ltd. by TI and Kobe Steel Ltd. Various ownership and product-assignment formulas apply to the joint ventures.

Clemmer says these innovative ways of financing fabs sprung from TI's realization of the urgency of having wafer fabs in strategic locations to serve a worldwide semiconductor market that is estimated to reach $200 billion by 2000. "And we needed a more favorable cost of capital in relation to our Far East competitors than we had," he says.

The opposite side of the partnering coin is represented by Quality Semiconductor, which owns a key ingredient to success without a fab—marketable intellectual property. QSI designs and sells high-speed CMOS logic and memory devices for microprocessor-based systems. Its proprietary process attracted two "household-word Japanese companies that have state-of-the-art fabs but needed process technology," says Steve Hanley, QSI's director of corporate planning and general counsel.

Instead of raising large venture funds, QSI licensed its process and certain products to its Japanese partners in exchange for "significant operating funds," Hanley says. QSI stations its own engineers at the foundries to maintain process control.

Since obtaining the initial funding, QSI has raised a second round that includes the original partners plus some Pacific Rim venture capital firms. "We spoke with several of the leading venture firms in Silicon Valley, but we'd developed beyond the seed stage, and their internal hurdle rates priced them below and out of a deal like ours," Hanley says.—*L.C.*

trial date of late 1992 has been set.

Many semiconductor startups seek Far Eastern fabs, which is a concern to TA's Child. In fact, he says U.S. foundries are missing a good bet in not being more responsive to partnering with U.S. chip-design houses. "Established U.S. firms are much less aggressive in partnering with young companies than Japanese companies are," he says. "You can't get the attention of the U.S. guys, and that's sad. There's either a not-invented-here syndrome or they're too busy with their own problems."

Kleiner Perkins's recent semiconductor industry investments include Xilinx Inc., a San Jose supplier of H-CMOS logic arrays, which Kvamme describes as "extremely successful" and a good example of a design-based startup. Another is Rambus Inc., Los Altos, Calif., which may be the prototype for numerous coming semiconductor-related startups.

Kvamme says Rambus is too new to discuss in detail, but the company intends to function the way Microsoft Corp., the Redmond, Wash., software behemoth, does in its business: "They're a design company that will make money the way Microsoft does—by licensing and royalty fees, not by making chips," Kvamme says.

For his part, Merrill Pickard's Coit suggests there's a need for a new definition of what constitutes a semiconductor company, citing MIPS Computer Systems Inc., Sunnyvale, Calif., as an example. MIPS designs reduced-instruction-set-computing microprocessors that are fabricated by other foundries, and also manufactures and sells RISC-based computer systems, but the company has never had a foundry of its own.

"In the early days, you could tell what is or isn't a semiconductor company by whether the company had a fab line or not," Coit says. "But now we're seeing a merging of intellectual property, design automation, traditional semiconductor technology, and computer systems to the point where we have to ask what is a semiconducor company," Coit maintains. "Is MIPS a semiconductor company?"

The model semiconductor company Coit envisions is one that may specialize in communications hardware, for example, "and have an aggressive program to design chips [for that function] but license the designs to a foundry" to manufacture. The communications company may also sell the chips.

"As we get into the '90s," he says, "companies like this do as little as possible that's capital-intensive. They distill out precisely what they're good at, and let the industry infrastructure do what they don't need to do," such as fire up diffusion furnaces. ❑

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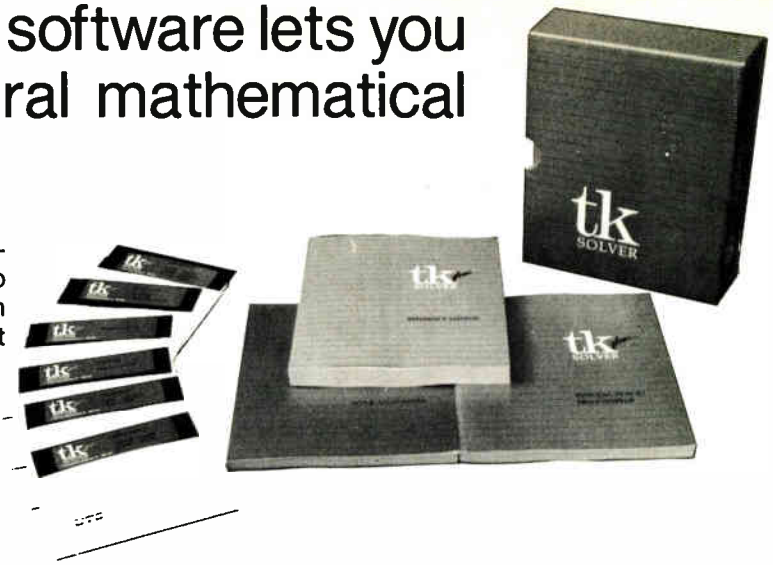

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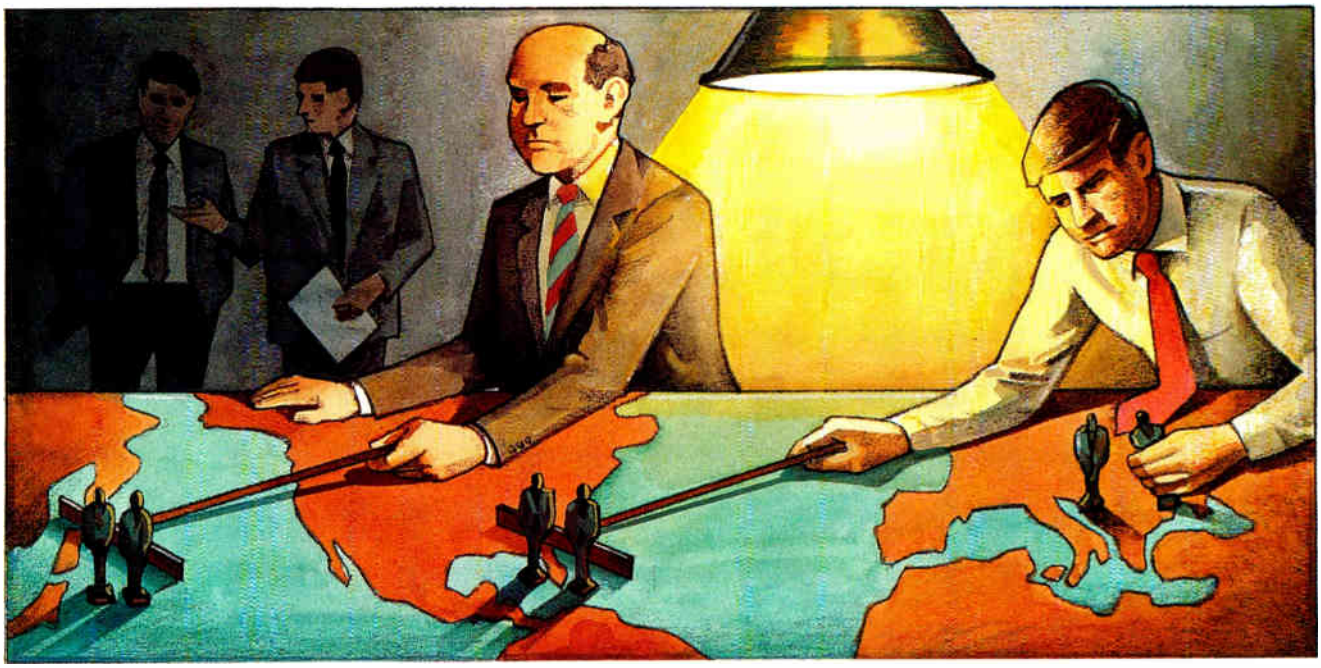

DEPLOYING LABOR ON A GLOBAL SCALE

FINDING, TRAINING, AND RETAINING A SKILLED WORK FORCE POSES A STRATEGIC CHALLENGE FOR U.S. CHIP MAKERS

BY JACK SHANDLE

Despite quantum leaps in technology, the biggest change for the semiconductor business in the 1980s was undoubtedly cultural. Chip makers stopped waiting for customers to come to them and began chasing markets as if their survival depended on it. In fact, it does. Their world will never be the same.

In this decade, the multibillion-dollar chase for markets will become increasingly global and the three classic factors of production—capital, technology, and labor—will have to be increasingly flexible. Labor poses a unique problem. Unlike capital and technology, it cannot be shipped around the world without protest. It requires an ongoing benefits-and-support infrastructure that varies from country to country. It forms unions. Finding, training, and retaining a skilled labor force indigenous to emerging markets will be a major preoccupation—and a major element in the cost equation—in the 1990s.

"While the largest single cost factor in semiconductor manufacturing relates to capital equipment, putting that equipment to effective use is crucially related to the skill set in the labor pool," says Michael Morrissey, vice president of NCR Corp.'s Microelectronics Products Division, Fort Collins, Colo. Companies like NCR, AT&T, Texas Instruments, and Motorola are painfully aware that a half-billion-dollar fab is of little use without people to run it efficiently.

How does a U.S. company find such people in developing countries on the Pacific Rim? How does it lure the best people away from domestic manufacturers in Japan and Europe? Both questions are being pondered daily in the board rooms of U.S. chip houses.

LABOR

At a strategic level, a distinction must be drawn between global companies and international ones, says Dick Koeltl, chief operating officer of the MOS business unit at AT&T Microelectronics, Allentown, Pa. International companies export U.S. nationals to run foreign operations. Global companies hire local people who are integrated into the parent firm—a Spanish engineer hired to help manage AT&T's Madrid fab, for example, may someday run one in the U.S. To be global requires understanding cultural issues: managers should be intimate with local customs and mores; they should have local roots and local contacts in the economic and technical community. On the other side of the coin, says Koeltl, the plant's hierarchy

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When TI opened a fab in Avezzano, Italy, it found there were no schools for the children of Japanese and American employees—so it set up one of its own.

must know the strategy of the overall business and have a stake in its success.

As important as labor issues are, they are not the determining factor in siting a fab or other manufacturing facility, says Steve Thomas, human resources director for Texas Instruments Inc.'s World Memory Products Division in Dallas. Usually, a chip maker decides it needs a manufacturing presence in order to participate in a geographic market, he says. Come 1992, for example, Europe will place economic restrictions on firms that do not employ people within the EC.

The other key site-selection factors are capital availability and investment incentives offered by the local government. For example, TI opted to build a MOS fab in Avezzano, Italy, in part because of the development package the government offered. Similarly, Motorola Inc.'s decision to build its Silicon Harbor design and packaging center in Hong Kong hinged on the deal it got on the land, says James Norling, president of the firm's Semiconductor Products Sector.

Once the strategic decision is made, the job of staffing begins. Unlike banana plantations, chip-making facilities are seldom hacked out of the jungle. The markets vendors are chasing are likely to be in nations that have at least a trainable work force and would love to have a fab. "The criterion for siting a plant in a particular country is that you want to sell there," says AT&T's Koeltl. "These tend to be developed countries anyway."

Moreover, the inexorable march of technology requires higher skill levels even of hourly workers. "I don't think you will see people chasing labor rates from one country to another the way they used to," says NCR's Morrissey. As the hourly worker's job becomes less and less a matter of transporting wafers from one processing line to another, new skills will kick in. "Automation will require more computer skills," says Dennis Hill, vice president of manufacturing for AT&T's MOS operation. "A tremendous amount of training has to go on and be maintained. Flexibility is important. We will need people who can do many difficult things."

The skill level at all positions will increase over the next five years, says Morrissey. "From an historical perspective," he says, "people who were on the production line are now doing things that used to be done by technicians. Technicians are doing things that engineers used to do and the margin for error is much smaller."

Training is taking up an increasing percentage of labor cost, but exactly how much seems to be each company's secret. AT&T's Hill, for example, called it "not an insignificant expense. In any given year, people are getting a couple of weeks to four weeks training on average." At AT&T's Madrid fab, training has accounted for as much as 50% of the employees' time. Similarly, when TI started gearing up its Avezzano fab, it trained 175 to 200 engineers and technicians at its Dallas, Lubbock, and Miho, Japan, CMOS memory fabs, Thomas says.

A town of 40,000, Avezzano had neither an American nor a Japanese school for the 38 children of TI employees. So TI established its own school for both the children from Texas and from Miho. Japanese and American pupils have separate classes but meet for recess, field trips, and other activities. In TI's latest joint-venture fab in Singapore, however, there was no need for a school, since an existing foreign-service contingent of about 100,000 had long since justified an American School and a Japanese School there.

The availability of labor is a problem in some Pacific Rim countries, including Singapore, Taiwan, and Hong Kong. "Local companies in Taiwan are looking to import workers from the Philippines," says Thomas. "We were concerned about the availability of engineers because of the tremendous growth in Taiwan [see p. 12]. We attracted people by emphasizing that this was submicron technology; we beat that drum rather hard and were very pleased with the reception."

Union and government relations can sometimes be one and the same, says Thomas. "In Italy, the government plays a big role. There is a lot of trilateral decision making [company, union, and government] on work hours, shift changes, shift premiums, and pay scales." A fab typically has 12-hour shifts four days on and three days off. TI knew it had to do some real campaigning so the unions would know the rationale for a 24-hour operation—Avezzano is only Italy's second fab. That was not a problem in Taiwan, where "the government is committed to making the electronics business the leading industry."

Benefit packages are very country-specific. "We know all these things from being an international company," says Thomas. "But I think a Silicon Valley startup must go through a real culture shock." Core benefits—pension and vacation—are common, but after that, variations abound. In Japan and Taiwan, many domestic factories build dorms for fab operators, he says. "It is a unique perk. And in Japan, companies provide commutation allowances." In Thailand, says AT&T's Hill, firms are expected to provide a meal for employees.

What's the next big labor issue? AT&T's Koeltl thinks it will be the environment: "The U.S. is leading relative to setting goals for the workplace," Koeltl says. But that is going to become a bigger and bigger issue on a worldwide basis." ❑

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NiCAD BATTERIES: FINDING A NONTOXIC SUBSTITUTE

WITH CONCERN ABOUT CADMIUM GROWING, THE ELECTRONICS INDUSTRY LOOKS TOWARD NEW BATTERY TECHNOLOGIES

BY JACQUELINE DAMIAN

ENVIRONMENT

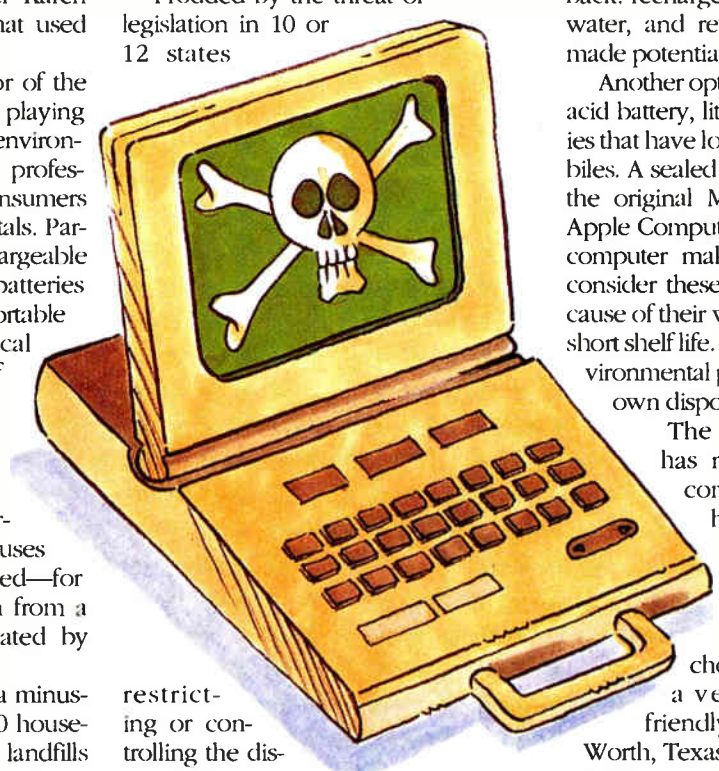
Back in the middle of a cold New England winter, the residents of Randolph, Vt., population 4,800, began depositing their used household batteries at 20 drop-off points around town. By Feb. 25, with some 4,500 dead batteries in hand, members of the town's solid-waste committee started sorting them by manufacturer and packing them away in boxes to send back to their makers. "We did it to draw attention to the problem," says committee member Karen Odato—the problem being that used batteries are hazardous waste.

The Boston Tea Party flavor of the protest was a pointed way of playing up a growing concern among environmentalists, waste-management professionals, battery makers, and consumers about the disposal of toxic metals. Particularly worrisome are the rechargeable nickel-cadmium, or NiCad, batteries used in laptop computers, portable communications gear, medical equipment, and a variety of other electronic products, among other items.

That's because cadmium, which is a byproduct of zinc mining, is highly toxic. It's carcinogenic when inhaled and causes kidney damage when ingested—for example, by eating fish taken from a stream that's been contaminated by tainted groundwater.

NiCad units make up only a minuscule portion of the 167,000,000 household batteries tossed into U.S. landfills and incinerators with other garbage every year. But their impact on the environment is anything but small. "A very conservative estimate is that NiCad batteries equal only 0.1% of the total U.S. waste stream by weight," says David Hurd, recycling operations specialist with the Bronx 2000 environmental group in New York. "Yet they represent over half the total cadmium—54%—in the waste stream." The Environmental Protection Agency has found excessive amounts of this metal in ash from a number of municipal incinerators, and in its 1989 position paper on solid-waste disposal, the agency singled out cadmium and lead as the two toxic substances that most need to be cut back.

Prodded by the threat of legislation in 10 or 12 states restricting or controlling the disposal of cadmium, battery makers are looking into new technologies to replace the metal in their rechargeables. "The research was going on long before the environmental movement decided to focus on the word cadmium," says Frederick E. Nicholson, executive director of the Battery Products Alliance trade group in Washington. "But it did have a catalyst effect."



The substitutes will most likely be nickel-metal-hydride batteries, which should move into volume production next year, or lithium varieties, which are still in the R&D phase. Because of lithium's tremendously long shelf life, researchers continue grappling with this extremely reactive metal's main drawback: rechargeable lithium explodes in water, and reports of accidents have made potential users wary.

Another option is the venerable lead-acid battery, little brothers to the batteries that have long been used in automobiles. A sealed lead-acid battery powers the original Macintosh portable from Apple Computer Inc., for example. But computer makers—including Apple—consider these units far from ideal because of their weight and their relatively short shelf life. What's more, from an environmental perspective, lead poses its own disposal problems.

The anti-NiCad movement has not gone unnoticed by computer makers. "We've been looking at the issue for a long time," says Ed Juge, a spokesman for Tandy Corp. "NiCad is certainly the battery of choice right now, but it's not a very environmentally friendly metal." But the Fort Worth, Texas, company has made no decisions yet about replacing NiCad in future products, Juge says. "That decision is going to be made on the fly—you can't plan for something that doesn't exist yet."

The same holds true at Compaq Computer Corp. "While we're keeping

on top of it, it hasn't come up as an action issue yet between Compaq and its battery vendors," says John Sweney, a spokesman for the Houston-based computer giant.

Far less glamorous than microprocessors or DRAMs, the prosaic battery is nonetheless an essential component in system design. To make a switch to a new type of battery, vendors must take into account any voltage and discharge-curve differences between the NiCads they have been using and potential replacements. However, both Sweney and Juge say that the design changes involved in a battery switch are not difficult to accommodate. "Our product life cycles are just a few years anyway," Sweney says. "Every product starts from scratch, and all our batteries are custom-made."

LAPTOP MAKERS ARE KEEPING BATTERY PLANS CONFIDENTIAL, BUT SOME SEE NICKEL METAL HYDRIDE AS THE HEIR APPARENT TO NiCAD

Although the laptop makers are keeping battery plans confidential, Juge votes for nickel metal hydride as the probable heir apparent to NiCad in computers. "I think it's the coming thing," he says. A new Toshiba Corp. laptop is powered by a Japanese-made nickel-metal-hydride battery, and computers and communications gear from U.S. suppliers are expected late this year or early next. A number of companies are working on nickel metal hydride, among them hydride pioneer Ovonic Battery Co. The Troy, Mich., outfit is already producing small volumes of rechargeables and manufacturing the proprietary hydrogen-based metal alloy its approach demands.

Ovonic has also licensed the technology to five battery manufacturers in the U.S., Europe, Japan, Hong Kong, and the Soviet Union. Two of them—Gates Energy Products Inc. of Gainesville, Fla., the largest North American NiCad maker, and the French giant Varta Batterie AG—are producing batteries now and expect to ramp up to volume shipments by late this year or early next. Gates products "are being sampled by all the major players in portable computers and communications," says spokeswoman Julie Vastano.

This technology appears to be safe: an independent environmental-impact study by researchers at the Teledyne Wah Chang Albany lab in Albany, Ore., found that while "cadmium will leach from NiCad batteries at hazardous levels," the new nickel-metal-hydride batteries "are less of an environmental risk" and "would not be considered a hazardous waste." They could be safely thrown into the garbage along with potato peelings and empty cat food boxes.

Another plus is that the Ovonic entry is "made to be a drop-in replacement" for NiCad batteries, says Bill Orabone, director of corporate development at Ovonic, and thus would require only minor design tweaks on the part of system builders. That's because the Ovonic technique simply replaces the cadmium used as the negative electrode of NiCad batteries with its patented metal-hydride substitute. The nickel positive electrode remains the same as in NiCads.

Moreover, the new batteries are lighter than NiCads and deliver more power than the traditional rechargeables to boot. Gates reports that its nickel-metal-hydride AA battery offers 1,100 mA/hr of capacity and could reach 1,400 mA/hr in a few years as the technology scales the learning curve and production volumes rise. That compares with 700 to 800 mA/hr for today's high-performance NiCads of the same size (a standard AA NiCad packs 500 to 600 mA/hr).

That 20% to 30% capacity gain gives computer makers two options, says John Eager, product manager for new technologies at Gates. They can keep the same size battery they were using with NiCads but add more features to their machines to take advantage of the additional power; or they can downsize both the battery spec and the machine, an important consideration in the world of the ever shrinking laptop. Finally, unlike NiCads, the new nickel-metal-hydride batteries do not suffer from memory effect, an annoying glitch that keeps NiCads from fully charging if users fail to totally drain them before attempting to recharge.

The downside is that system builders—and consumers—will be paying a premium for these benefits for a while. At least initially, Gates expects that the hydride units will be double the price of the NiCad batteries they are designed to replace. "If the batteries cost more it's going to force the cost of the product up," says Juge of Tandy. Another drawback, he adds, is that nickel-metal-hydride batteries can't be recharged as often as NiCads, which can take as many as 1,000 charges before they finally must be disposed of. The current crop of Gates hydride batteries can be recharged 300 to 500 times, says Eager—"we're approaching the cycle life of NiCads but obviously we're not there yet."

Even if nickel-metal-hydride or lithium rechargeables sweep into the market in a big way, however, NiCads won't disappear overnight. For one thing, hydride batteries can't be used in every rechargeable application: technical hurdles must be overcome to enable them to handle such equipment as portable power tools, which rely on short bursts of high power unlike the long, slow drain of a computer.

Most of the cadmium legislation now being considered takes this fact into account. The bills aim not to ban cadmium outright but to ensure that products using it are designed so consumers can easily remove their battery packs for safe disposal. Most portable computers are among the scant 20% of NiCad-powered products in which the battery is readily accessible, not sealed inside.

Besides replacing cadmium in products wherever possible, the EPA also recommends recycling. But that option is made difficult by the fact that only one significant cadmium-recycling plant is operating in the world today—Savam, in Viviez, France. A number of organizations, including the Battery Products Alliance and the Bronx 2000 group, are looking into strategies to collect used NiCads and safely dispose of them—or send them to Europe for recycling. ❑

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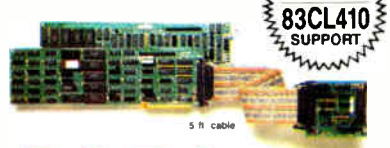

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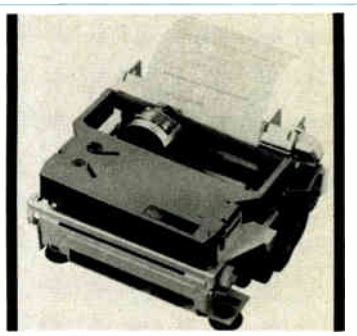

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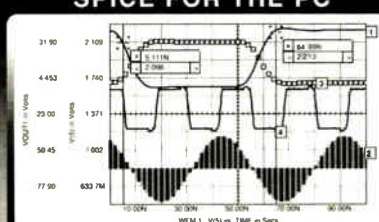

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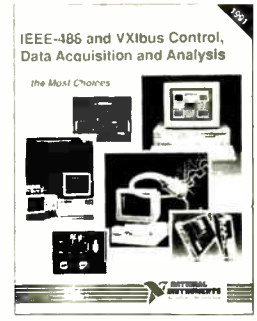

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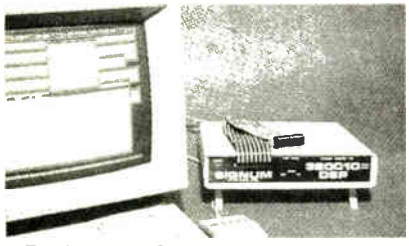

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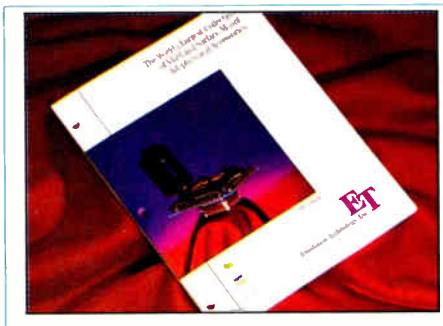

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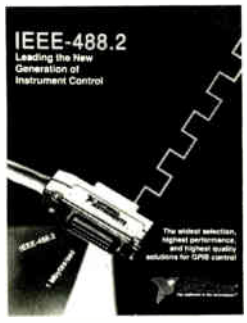

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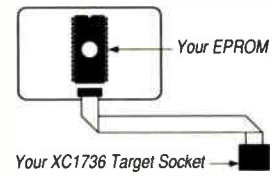

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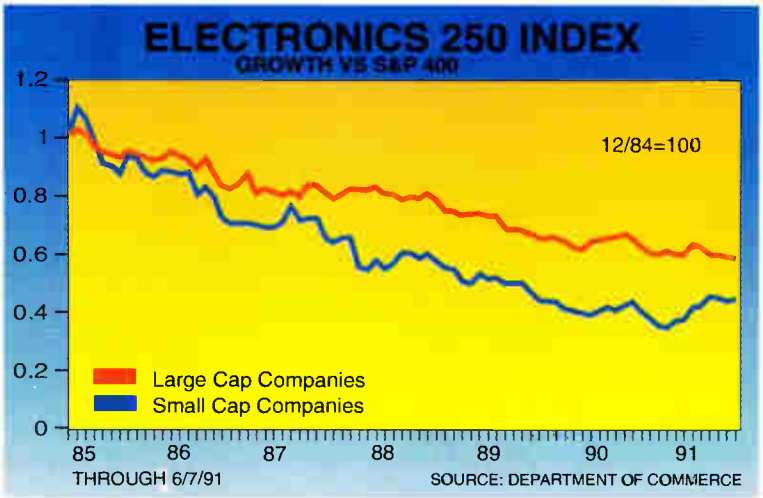


Though it will be easier to tell in the fourth quarter, it appears that electronics will recover better than the economy as a whole.

It appears we have passed the trough of the recession. Encouraging signs of renewed strength in the consumer sector, a modest pickup in housing demand, and some signals of improving capital availability should result in gradual improvement in durable and capital spending demand by the end of this year.

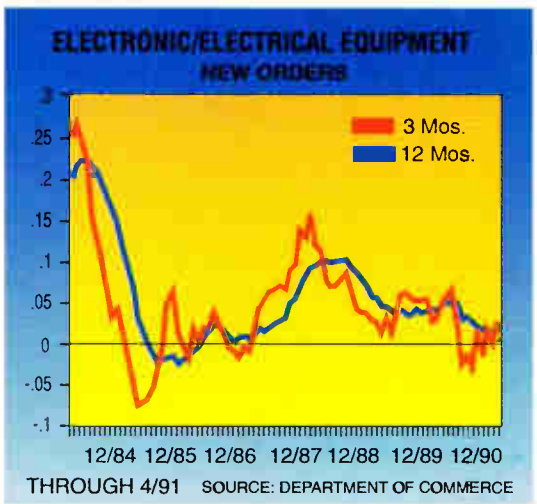
Comparisons will get much easier by the fourth quarter. But new mainframe product cycles, emerging availability of next-generation memory chips, continuing acceptance of enhanced networking software, and further penetration of automotive electronics all point to a much stronger recovery for the electronics industry next year than the economy as a whole.

Although the most recent data from the Commerce Department offers little to get excited about, it is not unusual for the cyclical pickup in capital goods and durable categories to lag behind the consumer sector upswing by as much as three to six months. We have witnessed a gradual improvement in electronic-component demand since early this year, and the significant weakness in the May semiconductor book-to-bill ratio suggests an earlier than usual seasonal order peak.

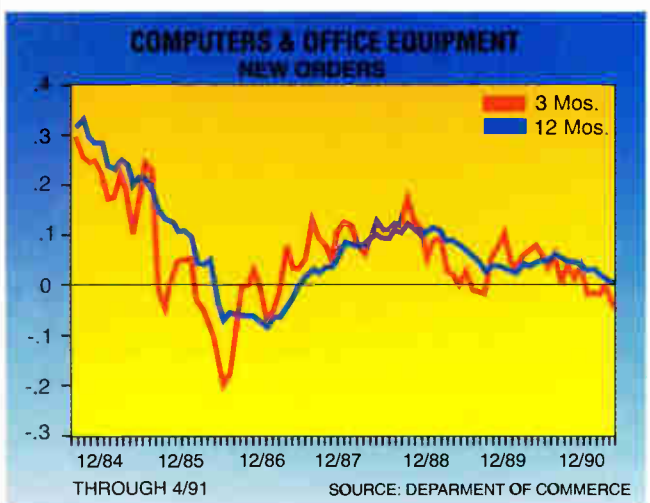
Computer order patterns actually worsened in April, reflecting renewed price discounting, to overshadow a modest recovery in unit demand. Small-computer price wars and the rapid transformation of PC distribution will continue to pressure margins at the manufacturing level. Electrical/electronic equipment demand is showing gradual improvement.

There is some improvement in small-business activity off the war-depressed levels of January through March. In particular, office-product demand and computer retrofit and upgrade activity are up. ❑

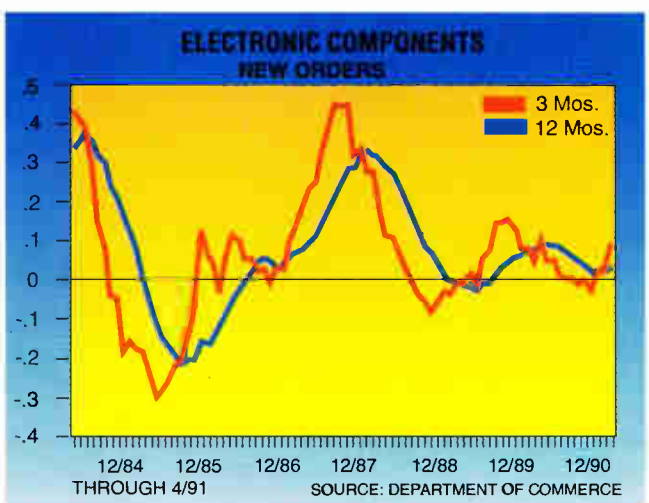
By Mark L. Parr, McDonald Securities Inc., Cleveland (216-443-2379)



The increase in demand for equipment matches the improvement in the general economy.



Computer orders have been affected by price cutting, but office-product demand and retrofit activity are up.



Component demand has improved gradually. Chip sales may see an earlier seasonal peak than usual.

MIKE EVANS

LAST WORD

A DOUBLE-DIPPER? NOT THIS TIME

On April 1, I declared that the recession was over. According to a survey published shortly afterward, only 11% of economists agreed with that. Now the shoe is on the other foot, and only about 11% of them don't believe it. But wait.

The same wizards who confidently told us that no upturn was in sight and the recovery would last until the fourth quarter, if not all year, are back with a new twist. All right, they concede, the recovery is here, but it won't last. We are in for a double-dip recession starting by the end of this year. Would you buy a used forecast from these guys?

In fact, there have been several double-dip recessions in the past 20 years. But in all cases, the Fed boosted interest rates at least 3% shortly after the recovery had gotten under way. Short-term rates will remain steady for the rest of this year, although long-term rates are likely to rise about 0.5% in the second half. But that's clearly not enough to stall the recovery.

Both optimists and pessimists agree that the key will be whether consumer spending rises. In my view, that's already an open-and-shut case. Discretionary retail sales rose 4.4% in the past three months, an annual rate of almost 19%. While that pace can't continue indefinitely, it clearly points out that consumers shucked off their worries about the war and the recession and came out spending. The naysayers' approach points to the published figures showing that consumer spending in constant prices rose 1% in March but fell 0.3% in April; therefore, they say, the initial war euphoria has worn off and consumers are going back into their shells.

However, most of that April drop occurred in sales at grocery stores and gas stations. Excluding those two sectors, retail sales rose 0.4% in both March and April. Furthermore, domestic new car sales, after languishing in the dust for most of the year, bounced back to an annual rate of 6.7 million in late May. One 10-day period does not a summer make, but it cuts the legs out from under those who claim consumer spending peaked in March and then started to decline again.

Then we have the credit-crunch bears. No one would deny that credit restrictions were tightened last year, and that many builders are being forced to pay back their existing loans instead of borrowing more money for new projects. As a result, housing starts probably will increase only about half as much this year as they usually do in the first year of recovery. However, that's a far cry from saying they won't rise at all. Housing starts and building permits have both risen 13% over the past three months, and Fed surveys show that credit restrictions are gradually easing, although they remain tighter than was the case in the late 1980s. Even commercial construction, which was supposed to be the Death Valley of the economy this year, posted a surprising gain from $92 billion to $96 billion in April.

THE KEY IS CONSUMERS, AND THEY'VE SHUCKED OFF THEIR WORRIES AND COME OUT SPENDING.

The major factor that should boost income, consumption, and gross national product later this year is the gain in jobs, and that is already well under way—providing you read the right set of statistics.

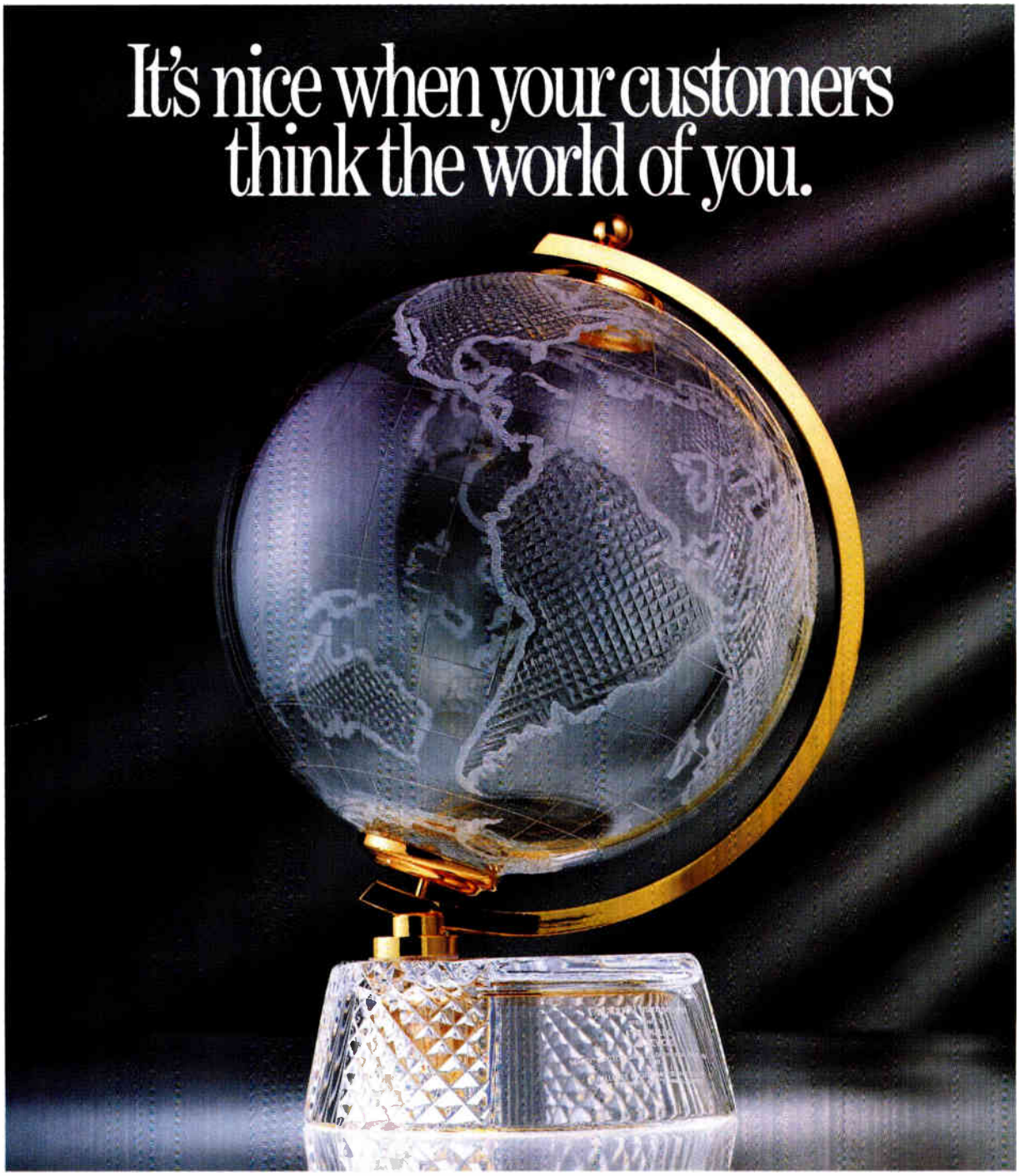
Over the past 20 years, there have been several well-regarded studies showing that virtually all the new jobs are created by small businesses. On balance, firms that are already large tend not to increase their payrolls. This situation is particularly true during recessions, when most of the layoffs represent reductions at larger firms.

There is no particular reason that this should present a statistical problem except that due to budget cuts, the Bureau of Labor Statistics' payroll-employment survey is increasingly out of date. It includes "old" firms that have been laying off workers, but does not yet cover "new" ones that are adding employees. Thus, the gain in employment is drastically understated as the economy begins to improve.

As a result, the survey that measures employment directly by contacting households shows a gain of 476,000 jobs over the past three months, while the survey that measures them through examining payrolls shows a loss of 651,000. However, the household survey figures decline earlier, providing adequate advance warning of a recession, and then recover earlier, providing an advance signal of an upturn. By this summer, payroll employment will also be rising steadily.

Obviously, no one has a perfect forecasting record, but the double-dip-recession scenario does not even make common sense. It ignores the fact that the Fed will not tighten later this year; that credit restrictions have already eased and construction has rebounded positively; and that employment has already turned up. The economy is on the road to recovery, and unless Saddam goes back into Kuwait, it will pick up more steam as the year advances. ❑

MICHAEL K. EVANS is president of Evans Economics Inc. and Evans Investment Advisers in Washington. His views will appear regularly on this page.



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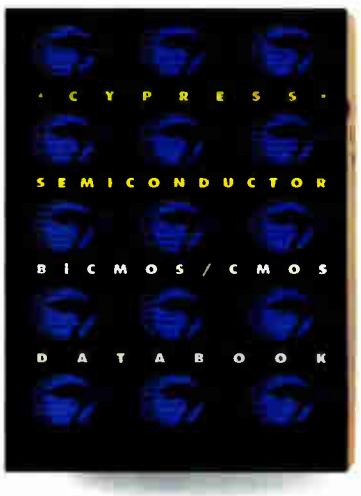

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