THE 1990 ACHIEVEMENT AWARD PAGE 49

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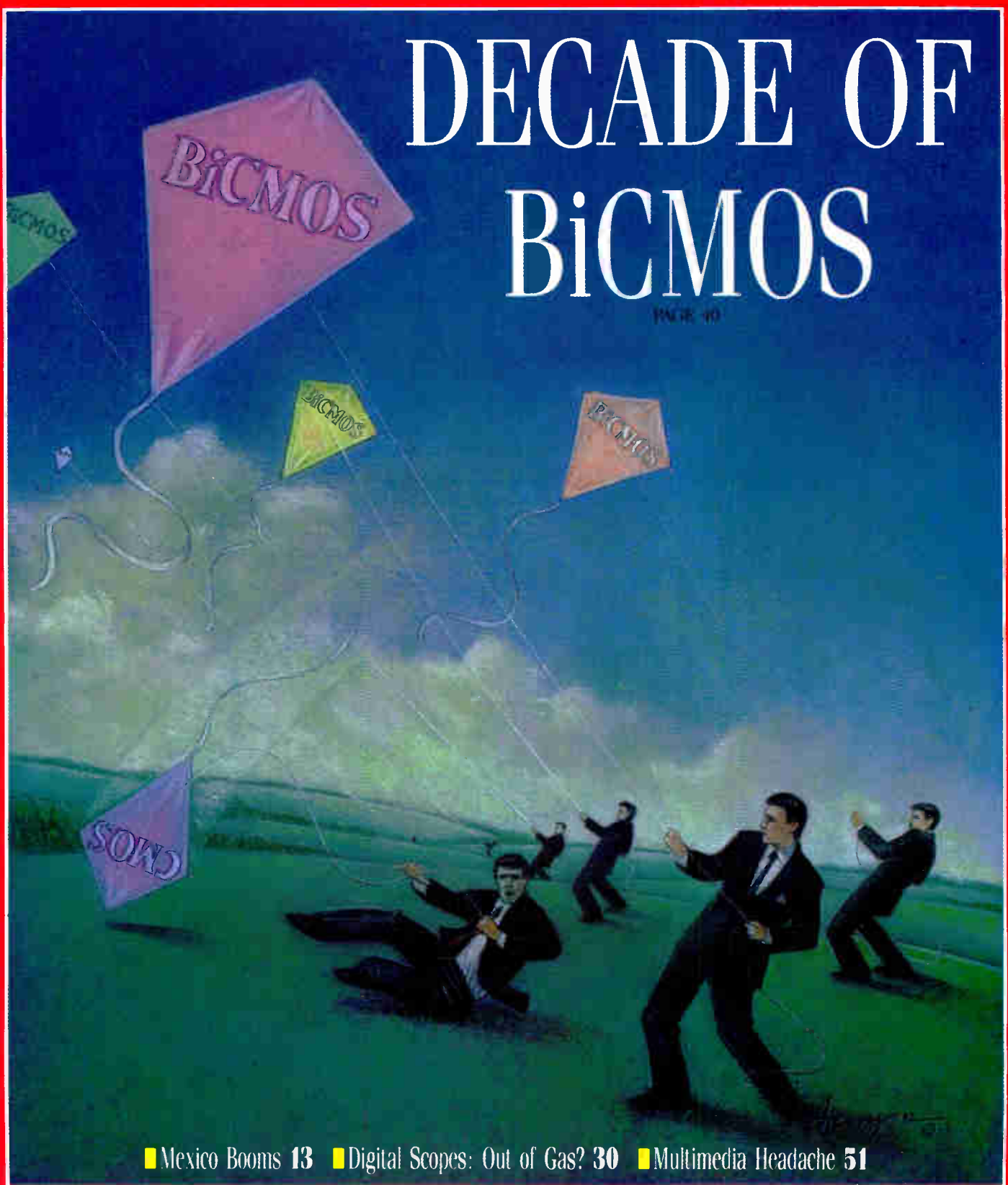
Electronics

FIRST MAGAZINE OF GLOBAL ELECTRONICS MANAGEMENT



DECADE OF BiCMOS

PAGE 40

SLIM, LIGHTWEIGHT CELLULAR PHONE: THE P3 SERIES.

One of the fastest growing products in telecommunications is the portable cellular phone. Already a powerful business tool, it will soon be at the heart of personal communications. NEC has developed a new generation of portable phones for AMPS and ETACS systems, using leading-edge circuit and chip technologies.

The P3 Series cellular phone features outstanding portability. It measures 58mm wide, 25.5mm deep and 184mm high (2.3" x 1" x 7.2"). It weighs only 400g (14oz) and has a 270cc (16.5 cubic-inch) displacement, including a built-in battery. The antenna flips down to facilitate storage and carrying.

The P3 Series also gives users an exceptionally long period of continuous talk – 80 minutes: and its rechargeable NiCd battery offers an 18-hour standby period.

Compact design results from remarkably reduced component count through custom LSIs and thorough surface mounting. The P3 slashes power consumption with a highly efficient GaAs FET PA module, a low-power prescaler and a 3-CPU scheme for the logic block.

P3 phones have many convenient features including a 30-character LCD screen, a 99-number speed-dial memory and a built-in clock/timer.

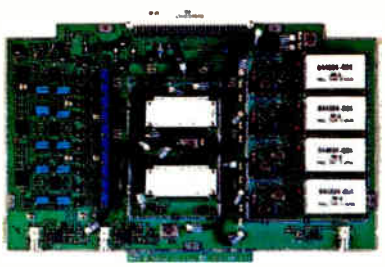
NUMBER 144

XPIC DOUBLES MICROWAVE RADIO CAPACITY.

Radio frequencies are a limited resource. That's why designers of digital microwave systems constantly strive to provide more bits per RF channel.

One efficient solution is cross-polarization, co-channel operation. It more than doubles capacity by transmitting vertically and horizontally polarized signals for the same frequency. Economical dual-polarization radios are made possible by XPIC, our cross-polarization interference canceller. Incorporating a precision transversal equalizer and controller, the XPIC module minimizes interference by generating reverse-phased cancellation signals.

XPIC is also the right choice for overlaying a new system on an existing one. For example, a 64QAM 140Mbps system or SDH radio with STM-1 capacity can be added to the same RF channel of an existing 16QAM 140Mbps system. NEC has already installed many digital microwave systems incorporating XPIC modules.



XPIC unit

HONG KONG AUTOMATES MAIL PROCESSING.

The Hong Kong Post Office has introduced an advanced mail processing system that works without postal or zip codes.

Hong Kong's Mechanized Letter Sorting System (MLSS) incorporates OCR/coding systems, computer-aided video coding machines and multi-selection letter sorting machines. Installed in two major mail centers and seven district mail delivery offices across the territory, the MLSS speeds the processing of millions of letters every day.

The multi-line OCR/coding machine is an outstanding feature of MLSS. It reads the alpha-numeric information of typed or machine-printed addresses, then prints a bar code on the envelope for further sorting right down to the postman's delivering beat.

The machine has a scanning height of 120mm and a throughput of 32,000 letters per hour.

All the mechanized letter-sorting equipment are linked on-line to a computer system which acquires, collates and edits data for use by operational and engineering managers.

Hong Kong's MLSS project is one good example of NEC's ability to offer a total solution geared to the needs of individual customers. NEC has 29 years of experience in mail automation, and our products are now serving in 34 nations.

WORLD'S FASTEST 1-MEGABIT VIDEO RAM.

High-end graphics systems require greater speed and higher resolution. Our new high-density video RAMs meet these needs with faster access and enhanced functionality.

NEC is introducing a 1-megabit, dual-port graphics buffer in a 128K x 8 configuration. The μPD42275 features an 80ns RAS access time and numerous convenient functions.

Flash Write instantly clears the full screen and Block Write permits high-speed window fill. The Split Data Register simplifies real-time data transfers with relaxed timing. The Persistent Write Per Bit feature provides compatibility with popular graphics processors.

NEC is the originator of the 256K video RAM. We now offer an exceptionally broad choice of video RAMs at the 256K and 1-megabit densities.

NEC

Electronics

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If you're in video development chances are, you're wasting your time.

Why waste time and money on tedious, expensive computer simulations that require large volumes of data processing to produce only a few seconds of video display?

Why invest in hardware solutions that cost a lot to develop and which can't be re-used?

From now on you won't have to, because now there's **VSP** - a processor that is continuous, real-time, flexible, reprogrammable and easy to use.

The VSP is a signal processor chip specifically designed for video applications. It has a full suite of workstation-based tools which enable you to enter an algorithm as a signal flow graph, map it on to VSP hardware, simulate, test and automatically produce program code. Once developed the program can be downloaded to the VSP for execution.

The flexibility of the IC, hardware and software tools means that many algorithms (whatever the application) can be implemented within hours. Modifications can be carried out in minutes and effects viewed immediately.

Introducing the revolutionary Video Signal Processor (VSP). Designed specifically for video development, this reprogrammable processor can save you days by providing rapid implementation and real-time evaluation of algorithms.

Silicon and Software Systems (S3) is a Design Company that uniquely brings together the techniques of VLSI and software design to exploit the full potential of digital signal processing.

The VSP gives you the power to rapidly develop algorithms and introduce increasingly advanced products to the market quickly. For a demonstration or more information on this revolutionary processor, call, fax or write to:

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CIRCLE 188

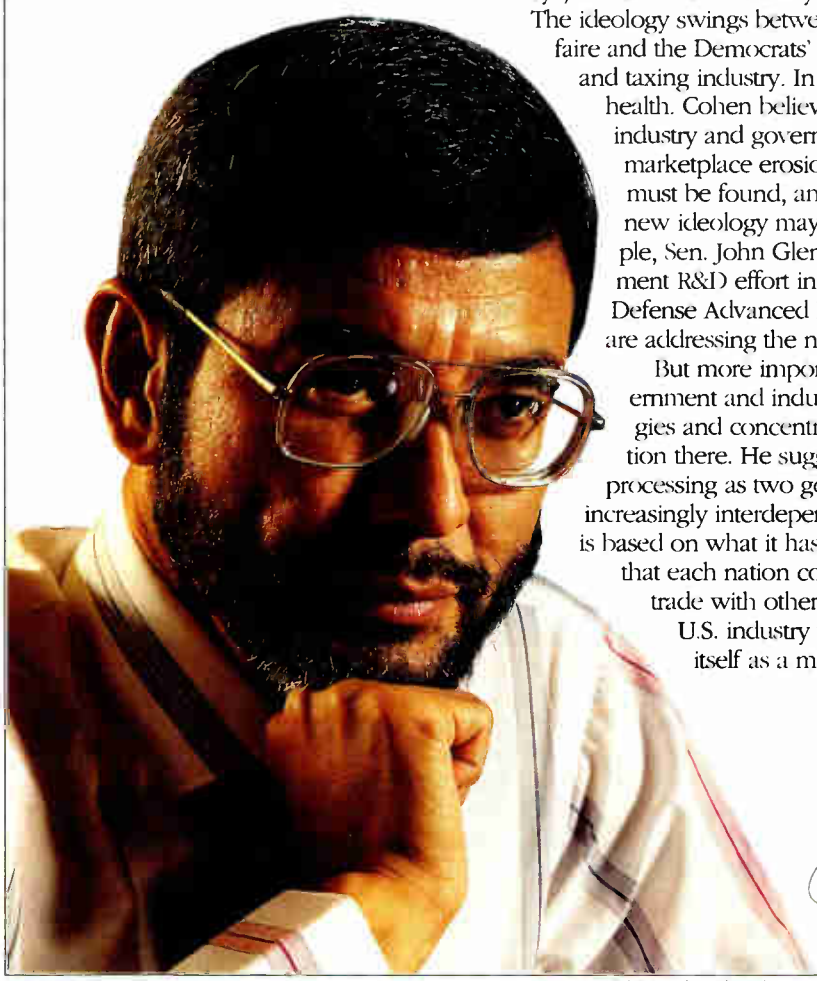
PROMETHEUS BOUND

Like a tethered Prometheus, the once mighty U.S. electronics industry continues to lose strength in the international marketplace. The mythical Greek hero was set upon by Zeus for stealing fire from heaven and giving it to man—the original creative act. For all of its technological creativity, the U.S. electronics industry now finds itself similarly bound—by a government too ideologically rigid to unfasten the chains that keep the industry down.

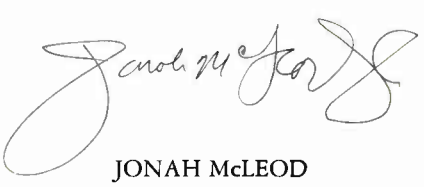
At the beginning of the 1980s, U.S. electronics companies had a dominant position in almost every market segment except consumer. But today, the battered U.S. industry has lost the initiative in the production of most integrated circuits and may well lose it in computers and communications, too. Why? One reason is the ascendancy of Asian electronics companies. In the last decade, Japan entered the market in a big way, and in the decade to come, Korea, Taiwan, Singapore, and other Pacific Rim nations will undoubtedly follow. The united Europe will be a force to contend with as well.

The appearance of strong competitors by itself does not automatically displace an incumbent power. But in this case, the challengers are aided by symbiotic relationships with their governments. These governments recognize that high-tech industries will provide the economic base their countries need to thrive. They have selected the winning industries instead of waiting for the marketplace to make that determination. Asian governments have protected their domestic markets from outsiders. And their assistance goes further. The Taiwan government, for example, helped develop a world-class submicron IC production facility in that nation. There are increasing signs that the European Community and the newly emerging East European countries are taking a similar tack.

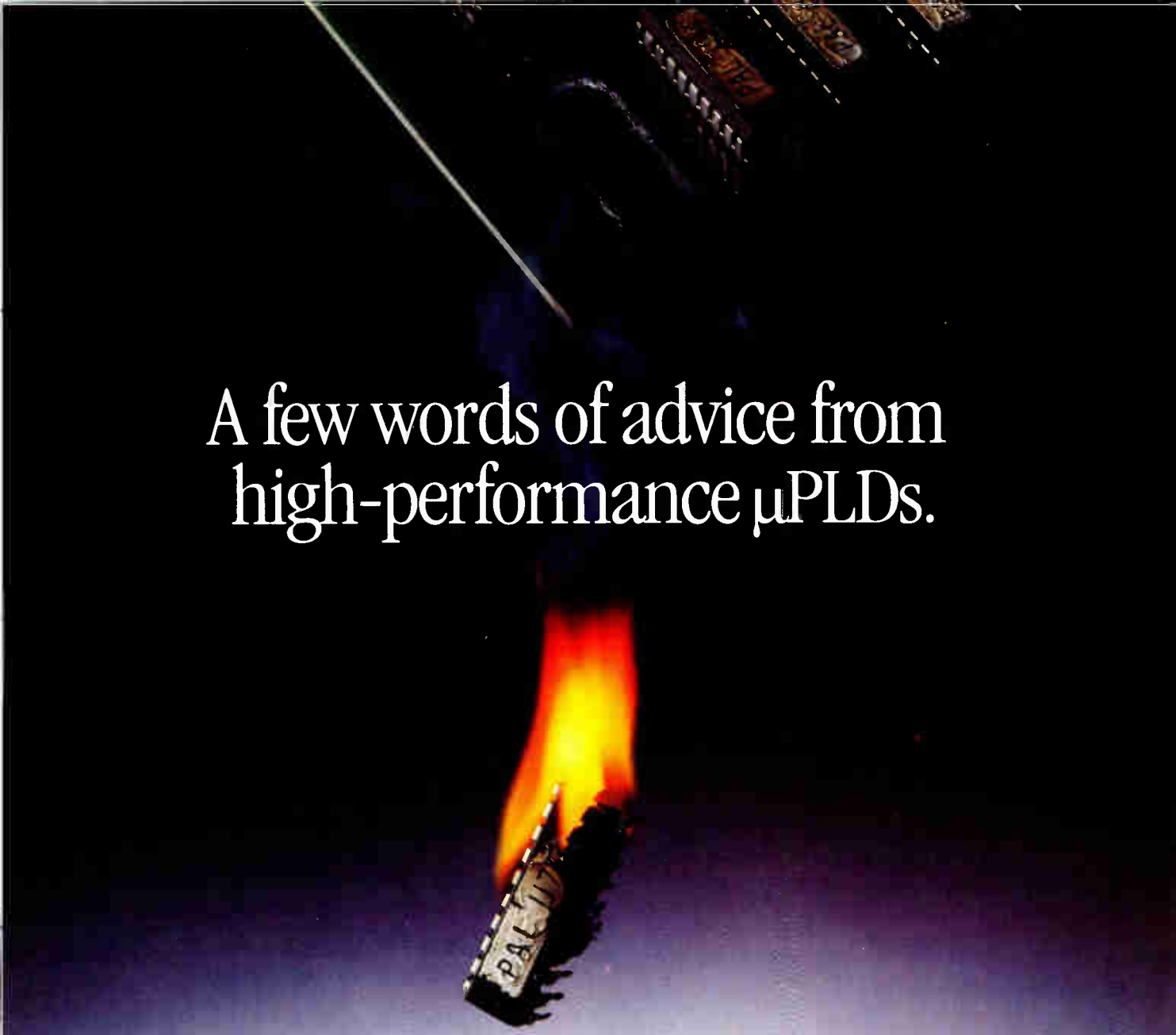
Why has the U.S. failed to see this compelling trend and act upon it? One reason is ideology, says Steve Cohen, an economist with the Berkeley Roundtable. In hewing rigidly to an ideological line, Cohen says, the U.S. is second only to governments in the Middle East. The ideology swings between the Republicans' love of laissez-faire and the Democrats' New Deal commitment to regulating and taxing industry. In 1990, neither leads to industrial health. Cohen believes the uneasy relationship between industry and government must change dramatically if the marketplace erosion is to stop. New ways of thinking must be found, and there are a few hopeful signs that a new ideology may indeed be taking shape. For example, Sen. John Glenn (D., Ohio) is pushing for a government R&D effort in the form of a civilian version of the Defense Advanced Research Projects Agency, and others are addressing the need for a U.S. industrial policy.



But more importantly, Cohen says that the U.S. government and industry need to target specific technologies and concentrate on establishing a dominant position there. He suggests flat-panel displays and signal processing as two good choices. *Electronics* agrees. In an increasingly interdependent world in which a nation's worth is based on what it has to offer in the market, it is imperative that each nation controls key technologies that it can trade with others on an equal basis. It is time for the U.S. industry to cast off its shackles and rebuild itself as a major force in the world market. E



JONAH McLEOD
EDITOR



A few words of advice from high-performance µPLDs.

Chill out, PAL.

Many designers have hot, high-performance designs. Literally.

Fortunately, Intel has a simple way to reduce system heat and still get incredible performance. The µPLD Family of programmable logic devices.

Take, for example, the 85C220 and 85C224. They operate at 80MHz (100 MHz internally) with only a 10ns total propagation delay.

And since µPLDs are manufactured using Intel's CHMOS* technology, they require just 1/4 the power of their pin-compatible bipolar PAL* alternatives. Which means they can lower system heat by 35 percent and help reduce board-level failures, too. So they're certain to give your high-performance system a boost. And send chills up the spine of your motherboard.

Learn more about Intel µPLDs and receive a µPLD/PAL heat comparison. Call (800) 548-4725 and ask for Literature Packet #IA28.

Otherwise, you could take some heat over your system design.

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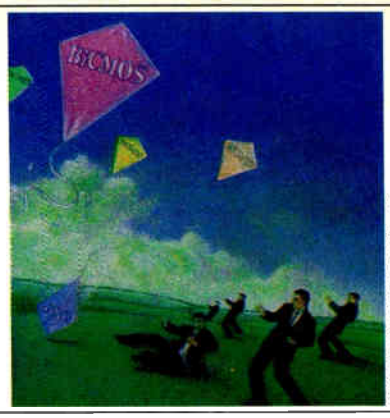
DECEMBER 1990 VOLUME 63, NO. 12

Electronics

60 YEARS OF GLOBAL LEADERSHIP



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DEPARTMENTS

NEWS ROUNDUP

WORLDWIDE NEWS

EXECUTIVE BRIEFING

SUPPLEMENT

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

*International only

It happened on a freezing Saturday in February.

Joe Reiley, a Hewlett-Packard test and measurement support engineer, was at a wedding in Pottstown, Pennsylvania. The office was the furthest thing from his mind, when suddenly his beeper went off.

In minutes, Joe was on the phone to Travis Field, the support engineer for Smith Corona in Cortland, New York. An HP test system crucial to Smith Corona's production line had gone down. Suddenly, Joe's thoughts turned to figuring out how to get Smith Corona's production line back up. Joe bid the other guests goodbye and ran to his car.

After driving through a blinding snow storm over icy mountain roads, Joe pulled into Smith Corona at 10:30 pm. A thorough analysis of the problem made it clear they needed extra parts, so Joe called another HP support engineer, Pete Nahrgang, in Valley Forge. Working through the early morning, Pete took parts from a back-up HP system, then flew them to Cortland by special courier. By Sunday afternoon, just 24 hours after Joe's beeper first went off, Smith Corona's production line was up again.

True stories like this prove HP's dedication to responsive customer support throughout the world. We'll tailor our hardware, software and education services to your test and measurement needs. With one of the largest support organizations in the industry, we're committed to keeping your production line up and running. For more information, call your local HP sales office or circle the reader service number.

There is a better way.

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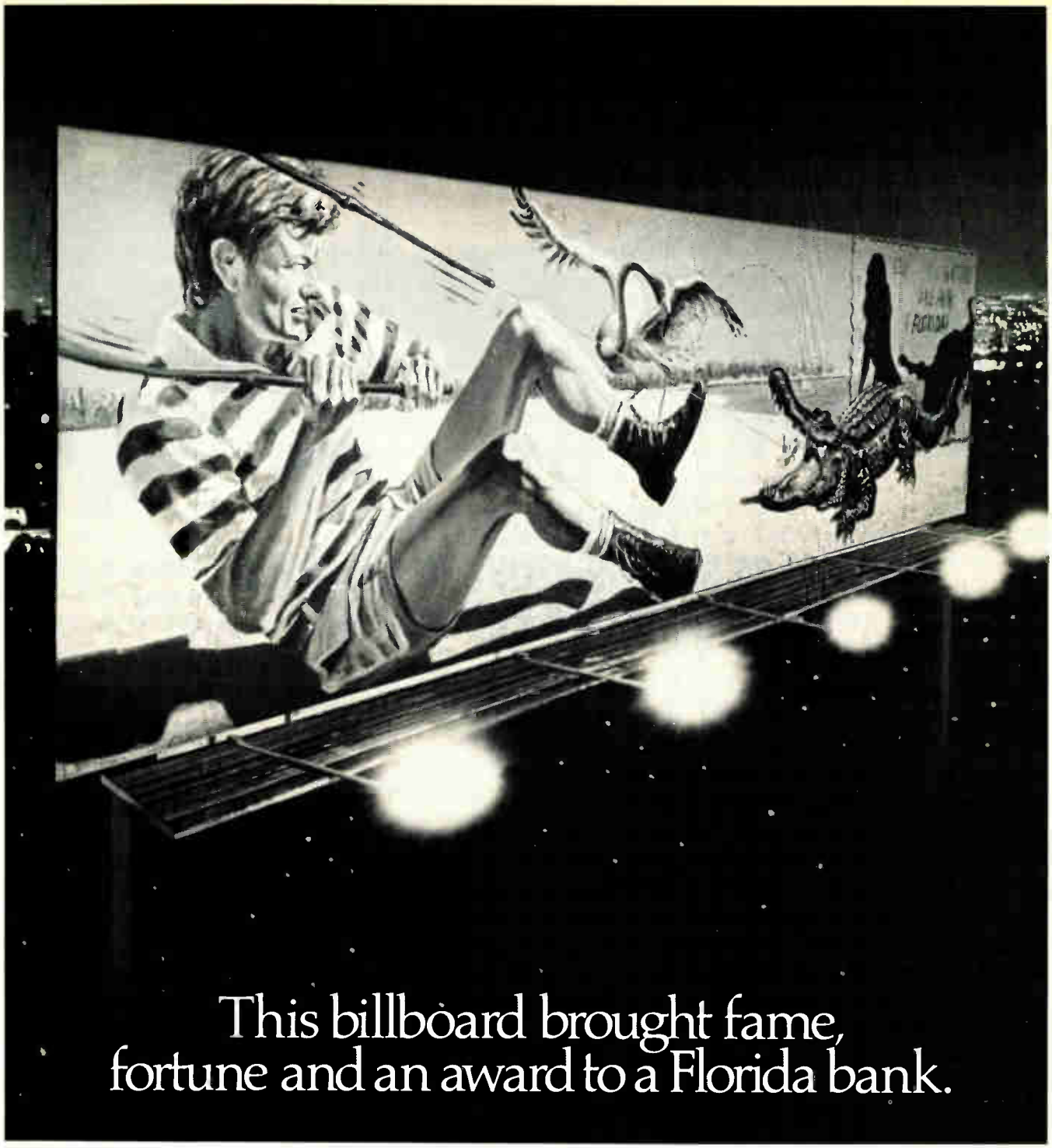
CIRCLE 226



This billboard brought fame, fortune and an award to a Florida bank.

Along the expressways of Jacksonville, Barnett Bank sponsored a series of billboards that showcased the talents of local Florida artists. This focused public attention on Barnett Bank, helping them win new depositors and a Business in the Arts Award—an accolade that comes complete with local and national recognition.

The competition is open to businesses of any size that contributed dollars, personnel, goods or services to the arts.

To nominate your business—or someone else's—write the Business Committee for the Arts, Inc., 1775 Broadway, Suite 510, New York, New York 10019. Or call (212) 664-0600 for nomination information.

The deadline for entry is May 31, so enter soon. And perhaps you, too, can put your company on the road to fame and fortune.

BUSINESS COMMITTEE FOR THE ARTS, INC.

This advertisement prepared as a public service by Ogilvy & Mather.

LETTER FROM

MEXICO

WITH FREE TRADE A POSSIBILITY, MEXICO IS LURING ELECTRONICS FIRMS

MORE THAN 'SCREWDRIVER' SHOPS

BY AMY ROSEWATER

MEXICO HAS MORE TO offer than sunshine and margaritas. This land south of the Rio Grande also proffers a newly thriving economy and a supply of cheap labor that are luring U. S. electronics companies, among others, to set up shop there. With the U. S. and Mexican governments now in the first rounds of discussions on a free-trade agreement, Mexico is looking better and better as an electronics manufacturing and assembly site.

Thanks to the forward-looking economic policies of president Carlos Salinas de Gortari, U. S. companies and a sprinkling of other foreign concerns have entered Mexico in a big way. The initial thrust was in the border plants known as *maquiladoras*, where Mexican workers assemble products for a fraction of the salary demanded by U. S. workers.

Today, with the scent of free trade in the wind, companies are heading for the interior of the country as well, setting up regional operations that are more than just "screwdriver" shops. Guadalajara, in central Mexico, has become something of a Mexican Silicon Valley, home to Hewlett-Packard, IBM, Wang, and other computer makers.

As a result, any stereotype of Mexico as the lazy land of *mañana* just isn't true, says Samuel Araiza, Hewlett-Packard Co.'s manager of marketing and communications for Latin America. "Mexico, regardless of the image, produces quality goods," says Araiza. "The quality of goods can be competitive with [those of] any country in the world." HP Mexico produces personal computers and minicomputers at its two facilities in Guadalajara.

Indeed, "the [negative] image that Mexico has had will go the way of Southeast Asia and Japan," says Jim Moore, general manager of Texas Instruments Inc.'s factory in Aguascalientes, in central Mexico. The factory builds a variety of integrated circuits, including 256-Kbit and 1-Mbit dynamic random-access memories, along with components for motor protectors and relays. "All these companies [in Mexico] produce high-quality products," Moore says.

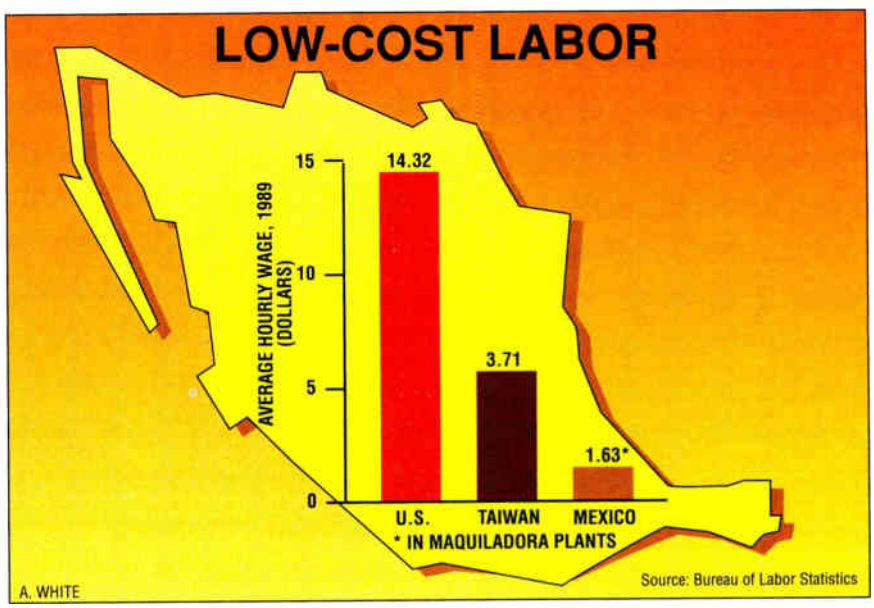
The bulk of Mexico's foreign-owned industry is clustered along the Rio Grande—which forms the 2,000-mile Mexico-U. S. border—in the maquiladoras (mah-kee-la-DOR-ahs). In 1988, the border region was home to 1,400 maquiladoras, producing everything from electronic goods and automobiles to fabric and toys. Today that number has swelled to almost 1,800 plants employing 500,000 workers, and experts expect the border business to keep growing. The reason: a U. S. Commerce Department code that allows maquiladoras to import raw materials duty-free from the U. S. They pay duties only on the value added in the manufacturing process when the finished product is exported to the U. S.

Mexico has been promoting investment in maquiladoras since 1965, when it enacted legislation to encourage U. S.-Mexican economic activity. But the trickle of business has become a flood tide under Salinas, a Harvard-trained economist. Business incentives, tax abatements, and a liberalization of regulations regarding foreign ownership have helped draw industry at an ever quickening pace.

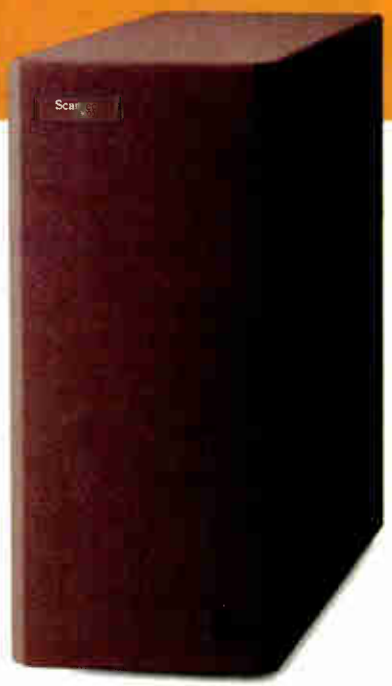
In the process, they have cut Mexican unemployment to 18% (still, of course, outrageously high by U. S. standards). Under Salinas, the Mexican inflation rate in 1989 fell to its lowest point in years, 19.7% (it has been as high as 150%), and the exchange rate has stabilized at about 348 pesos per $1. The literacy rate of Mexican workers is 87%, high for a developing country. As the icing on the cake, Mexico is, for U. S. concerns, a lot closer to corporate headquarters than, say, Singapore or Taiwan.

But the overriding lure remains the abundant supply of low-cost labor. One source estimates that U. S. businesses save, on average, $16,000 per worker per year by employing Mexican rather than U. S. factory workers. The going wage at the maquiladoras is sometimes as low as $3 to $5 a day; often, factory employees may earn $1 or so an hour.

Any corporation setting up shop in a Third World country comes in for its share of criticism for exploiting cheap labor. Even the word "maquiladora" smacks of feudalism: it originally referred



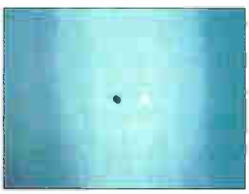
FOR UNSURPASSED PROCESSING CAPABILITIES!



Scantec 3000

DISTRIBUTORS ARE URGENTLY NEEDED!

The SCANTEC 3000 is a high-speed digital image-processing computer designed for use in the high-speed, accurate inspection and detection of minute flaws and foreign objects, and for high-resolution image processing in conjunction with a microscope.
The SCANTEC 3000 processes image data entered from line sensors to measure image position and determine image shape and size.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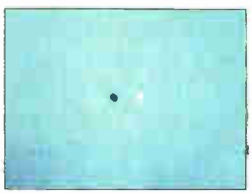
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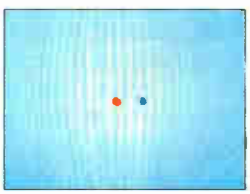
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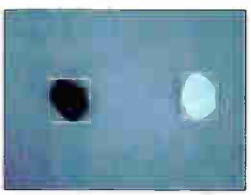
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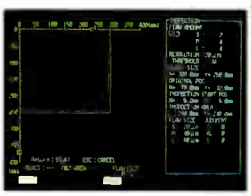
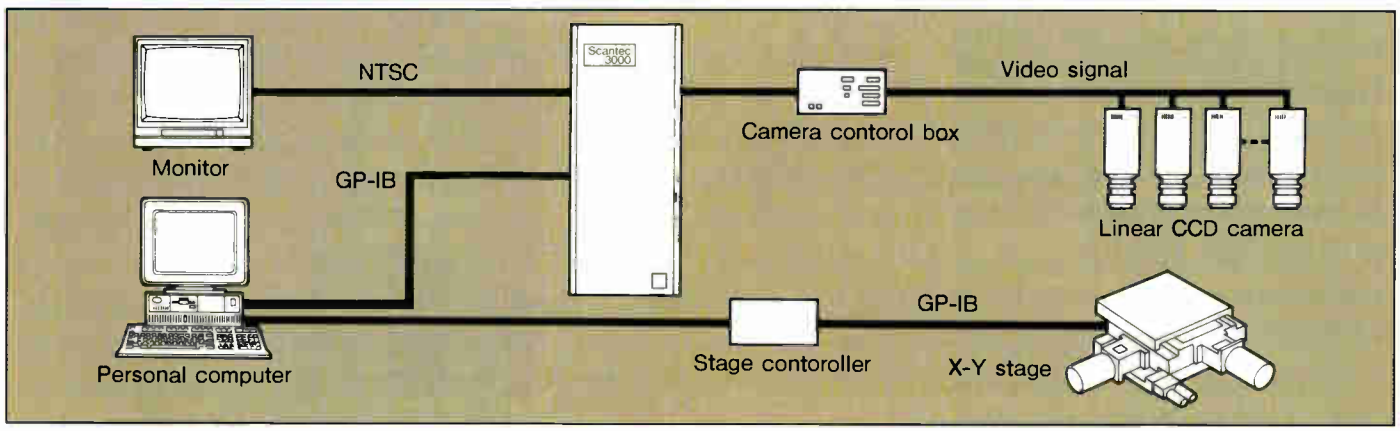

Displaying the inspection map

FEATURES

- Simultaneous parallel processing using up to 12 linear CCD cameras
- Maximum resolution of 8000 pixels per camera
- Real-time image processing speed of 120 million pixels per second for all processes (as shown to the above)
- Maximum resolution of 96,000 pixels per line for 12-camera system configuration
- Image processing commands applicable to all types of personal computers and engineering workstations

SYSTEM CONFIGURATION

CIRCLE 248



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to Mexican peasants who would bring their corn to the wealthy mill owners to be ground. But the high-technology companies in Mexico bristle at any such suggestions.

"None of our workers gets 55 cents an hour [an amount *The New York Times Magazine* reported was the going wage at some maquiladoras] or anything close to that," says Mac Jeffrey, an IBM Corp. World Trade spokesperson. Big Blue's facilities in Guadalajara, which produce the Personal System/2, "are routinely cited as a shining example," Jeffrey says. "Mexico and other international branches of IBM all follow the same personnel codes" as the U. S. operations. (IBM does not have a border-zone factory.)

THE MAIN LURE IS LOW-COST LABOR: ONE SOURCE ESTIMATES U. S. BUSINESSES SAVE $16,000 PER WORKER PER YEAR IN MEXICO

"For us, a Mexican, European, or American employee is the same. We treat them equally," echoes Jaime Conesa, general manager for the Latin American Division of Honeywell Inc., which has several factories in Mexico—one in Juarez, and two each in Chihuahua and Tijuana. "We look at Mexican employees like any any other employees." Most of Honeywell's south-of-the-border work involves the assembly of components and keyboards.

Conesa says that Honeywell has not had any problems with its maquiladora operation: "It has only brought positive things for us." But other companies have encountered difficulties, notably in keeping help. "There's not necessarily a problem with staffing, but a problem in retaining," says David Shiffman, director of administration at Canon Business Machines, which has a maquiladora in Tijuana employing 375 people, who assemble ribbon cassettes and circuit boards for typewriters.

Shiffman says that last year's average turnover rate was a whopping 20%. "The reasons why they leave are not so much performance-related as personal," he says. That's because many Mexicans come looking for work at the border plants from their homes in the interior—in effect, they're migrant workers in their own land. Like many immigrants, they make do with make-shift living conditions—the booming border region is dotted with shantytowns—the better to save their money. Once they do, they go home to their families. "They may show up one day and not show up another without any reason at all," Shiffman says. "And that's a difficult problem to cope with."

Management teams from a number of maquiladoras often meet to discuss the turnover situation and other shared problems, he says. Some maquiladoras offer their workers attendance-related and punctuality bonuses, which are given on a weekly basis. Others offer free lunches or food coupons (similar to food stamps). Shiffman says these have become common practices among the border factories. A few companies have experimented with transportation bonuses to help employees get to and from work.

Another problem facing foreign factories in Mexico is that the work force is largely unskilled. "They don't have experienced labor and management there," Shiffman says. Almost all of the maquiladoras are assembly-oriented; there's little if any design work going on. By definition, maquiladoras are factories whose sole purpose is adding value to materials. On the whole, they are not in the business of creating and developing products.

Some companies have set up educational and technical centers to help train employees. IBM, for example, built a center in Mexico as part of its network of employee-training facilities worldwide, and Ford Motor Co. has a training school in Mexico as well.

Whatever the problems, the move into Mexico shows no signs of abating—and the labor pool keeps growing. In the next 20 years, Mexico's population is expected to explode by 20 million and jobs are expected to increase by 500,000 a year. In short, the situation is this: one of the world's largest pools of available labor lives right next door to the biggest consumer market in the world. For electronics producers, that may be an irresistible combination.

CAUGHT IN MIDSTREAM WITHOUT A SOLUTION? OUR HIGH PERFORMANCE FAMILY SHOWS YOU THE WAY.

How do you move up in power and performance without wading through unnecessary changes in software and architectures?

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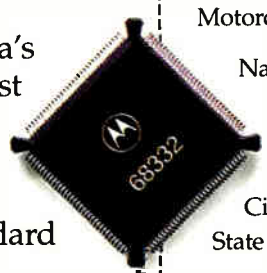

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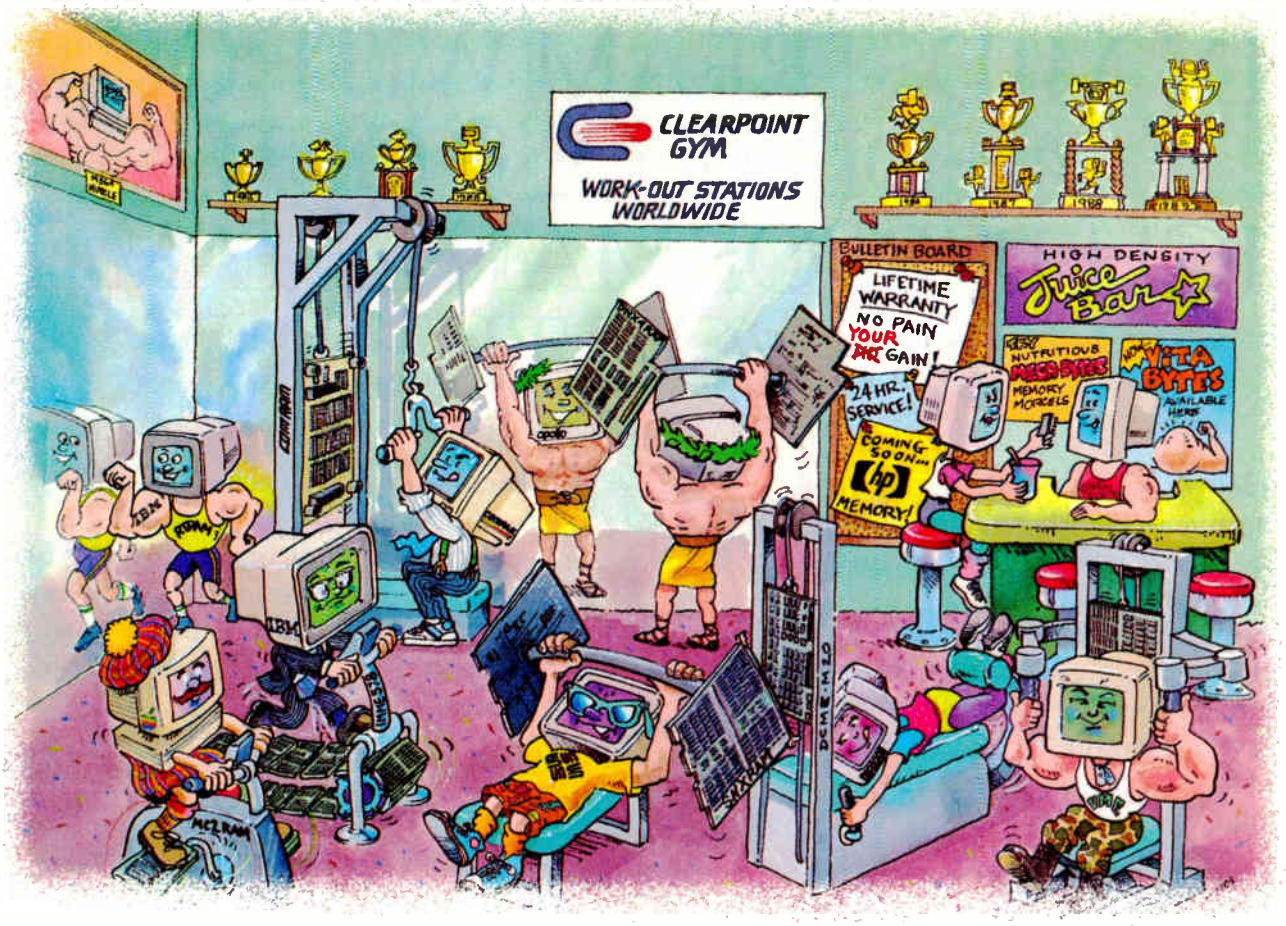

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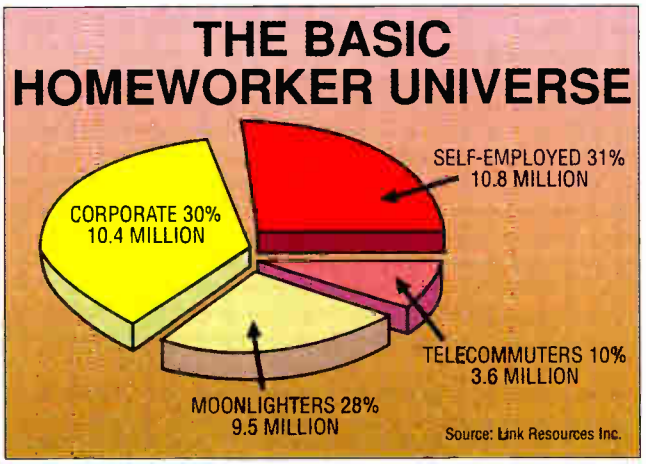
CIRCLE 252

HOME: WHERE THE WORK IS

Two new surveys document the resurgence of the home computer market. They deal specifically with the home-office segment, and predict that sales of machines to people who work at home will be a powerful market driver.

These are the forgotten people, maintains BIS CAP International of Norwell, Mass.: users in companies with fewer than 100 employees and those who work at home during the day or after regular working hours. For Link Resources Inc. of New York, which surveyed 2,500 homes, they are the 70% who say that some work is performed there.

Although total PC shipments are growing only 7% a year, says BIS CAP, sales to small business and home users will grow 16%. And when the count is limited to machines going into homes, the jump from 1989 to 1990 is 23%. "Home computers in the old days meant games and learning to type," says Raymond Boggs, a BIS CAP research manager. "Now they mean spread sheets, document creation, and data-base access." E



A DOUBLE COUP IN SUPERCOMUTING

In a major triumph for parallel-processing technology—as well as for Intel Corp.—a new 14-member supercomputing consortium has decided to buy Intel's Delta System. The machine, an advancement of Intel's iPSC/860, gets a peak speed of 32 gigaflops—32 billion floating-point operations/s—from its 528 numeric processors.

With an estimated commercial value of $15 million to $20 million, the Delta System is scheduled to be installed at the California Institute of Technology next March. The group, known as the Concurrent Supercomputing Consortium, will work on advanced computational and scientific problems. E

DIGITAL PLANNING A RISC CPU FOR THE VAX

Almost buried in a recent Digital Equipment Corp. multiproduct broadside was the company's acknowledgment that its mainstay VAX computer line will incorporate a reduced-instruction-set-computing central processor "in two to three years." That was mentioned when the Maynard, Mass., company introduced the latest models of the VAX 6000 family, and also announced the opening of its proprietary VMS operating system for the first time by adding X/Open, Open Software Foundation, and IEEE Posix standards to VMS. Peter Schay, a computer-industry analyst at the Gartner Group Inc., a Stamford, Conn., market research firm, believes a VAX RISC CPU will be running VMS in 1993. E

A LONE WOLF SAYS HE HAS COME UP WITH A QUANTUM FET

Can an individual working alone harness an exotic technology to which huge companies like IBM, Texas Instruments, and AT&T Bell Laboratories have committed substantial R&D resources without hitting pay dirt? Gene Cavanaugh, an engineer employed by Valid Logic Systems Inc. of San Jose, Calif., says he has.

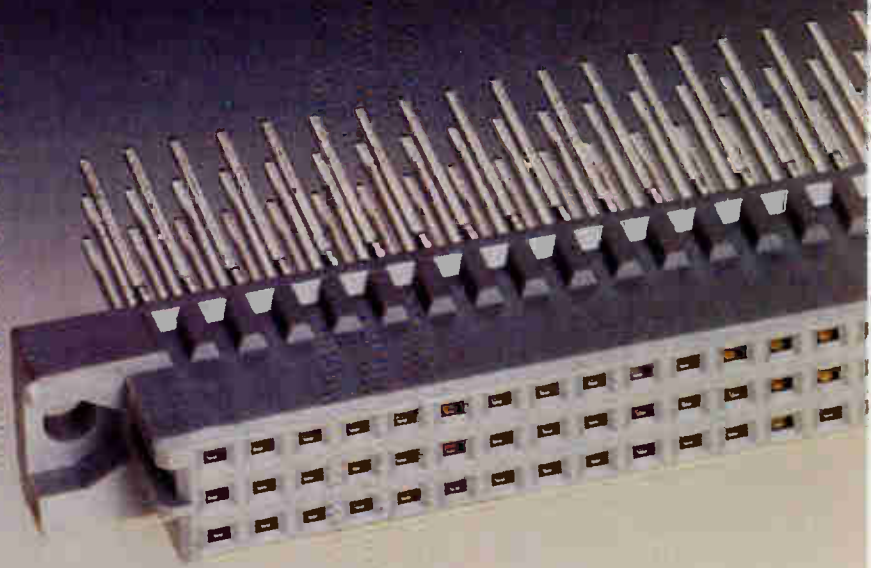
Cavanaugh, working privately on his own, thinks his QFET, a field-effect transistor that utilizes a quantum tunneling phenomenon, will lead to devices that are one tenth the size of traditional MOS devices, require one tenth the power, and operate 10 times faster. Such quantum-effect devices have been the object of much research, in the belief that conventional IC technology will reach its limits somewhere below 0.25 μm geometries.

Cavanaugh's device, which he says he has discussed with Intel, TI, and IBM, is similar in structure to a MOS transistor, except the source and drain are heavily doped with opposite polarities—in MOS, they're the same. In effect, this forms a diode. As the gate voltage is raised to a threshold of about 0.3 V, an enrichment of carriers takes place at the interface and tunneling occurs, accompanied by high conduction current. Cavanaugh says the QFET is not subject to latchup, transit-time delay, and other factors that limit conventional MOS devices. E

AFFORDABLE SILICON BOOSTS MULTIMEDIA

Multimedia technology has become affordable in personal computers with the advent of low-priced chip sets. First came Intel Corp.'s two-chip entry—a pixel processor/video processor pair (see p. 51). A week later at the Comdex show, Chips & Technologies Inc., San Jose, Calif., unveiled PC Video, which puts all the control logic for real-time video windowing on a single chip.

PC Video sells for $40 each in volume quantities, a price whose impact was seen immediately when New Media Graphics Corp. introduced the first board using PC Video, also at Comdex. The Billerica, Mass., firm sells its Super VideoWindows board for $695—a whopping reduction compared to its earlier $2,195 board. E



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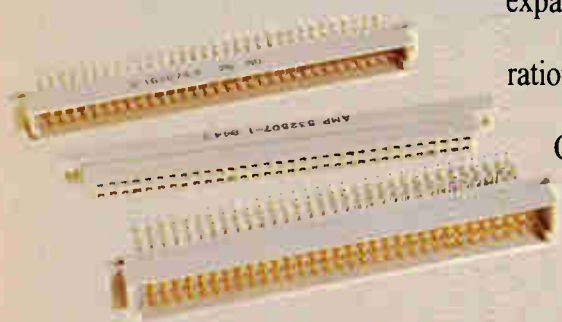

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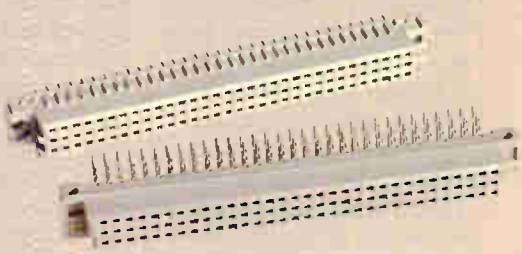

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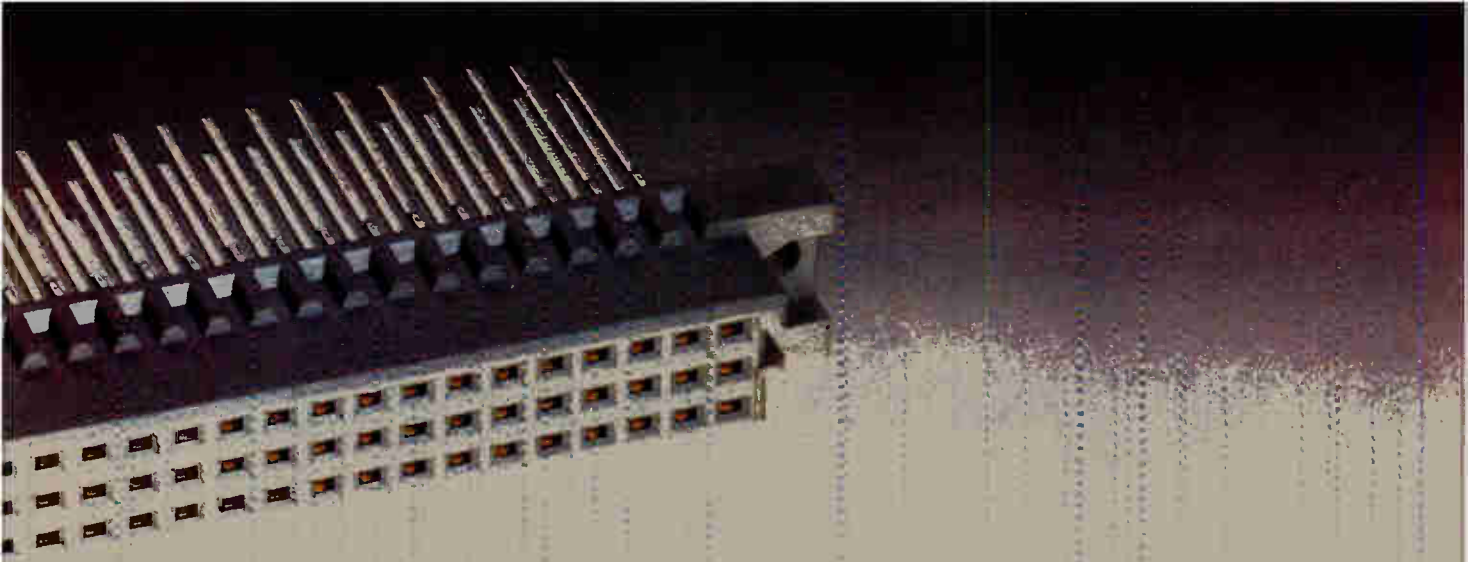

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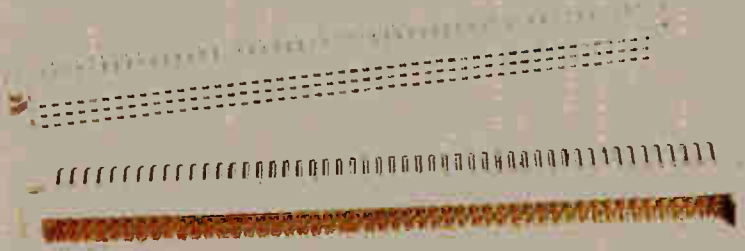

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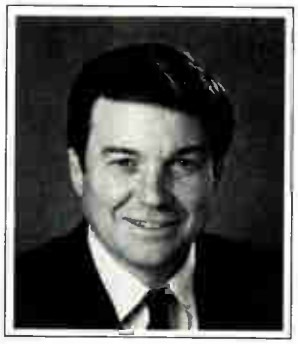
CIRCLE 211

FACE OFF

THE FINE ART OF LOBBYING:

SINCE THE UNITED STATES' first days, our government has been lobbied by individuals representing almost every imaginable interest. From the Northeast, lobbyists represent industrial interests; from the Midwest, lobbyists represent agricultural interests; and so on. We expect and even encourage this form of political participation because politics is the arena of competing interests. Over the past two decades, however, Japanese and other foreign interests have played an increasing role in how Americans run their country. We no longer have Americans lobbying only for American interests but for foreign interests as well.

We are all aware of the victories scored by Japan in the fields of consumer electronics, satellites, telecommunications, and semiconductors, among many others. Between 1980 and 1988, Japanese direct investment in the U.S. increased by more than 1,000%. Japan controls more than $329 billion of U.S. banking assets and possesses more real estate holdings in the U.S. than the members of the European Community combined. It is becoming increasingly clear that the manipulation of America's political and economic system by Japan and other foreign interests has reached the point where it threatens our national security and our future.



REP. DUNCAN HUNTER

It would be easy to blame the Japanese for abusing the system. The fact, however, is that Japan has scored big in America legally, and we have no one but ourselves to blame. One way Japan has developed this influence has been by hiring legions of American lobbyists, who have gained great influence on Capitol Hill.

A major source of this problem is that we have many people who come to Washington and spend a short time in the bureaucracy. They punch their time cards and make connections. Many see their time in public service as only a stepping stone to what they consider to be their ultimate careers: lobbying for big money. An obvious advantage is given to foreign interests in affairs of state when they are represented by lobbyists who know the people they are dealing with in our government.

Let me give you a recent example that occurred at the budget summit. Thirty-six hours before this secret conference was to close, Japanese electronics firms knew that they were being targeted for new taxes. They mobilized their American lobbyists and, as a result, the final budget plan has senior citizens paying more for Medicare but has the Japanese electronics industry excluded from any tax increases.

A change in Washington's ethics is needed. As a person who has a position of trust with the American people, the President should impose a 10- or 20-year ban on lobbying for foreign interests as a condition for working at the White House. This would send a signal to other government workers and former public servants. Also, legislation is needed to expand the "cooling-off" period for lower-level federal office holders. Beginning next year, former government officials will have to wait a year before they can lobby on trade matters. This period needs to be expanded to five or 10 years.

Congress must also strengthen the Foreign Agents Registration Act of 1938, which requires those who represent foreign interests to register with the Justice Department. The act has many loopholes. Lobbyists who work for an American affiliate of a foreign company, for example, are not required to register. They must be so registered.

As the world's political environment changes, economic strength will play a major role in determining who the future major powers will be. We must act now to protect America's future and to secure our place in this emerging world. America is not selling the farm; we're giving it away.—*REP. DUNCAN HUNTER (R., Calif.)*

CHECKS AND IMBALANCES

IN 1989, RONALD REAGAN ACcepted $2 million for a couple of speeches in Japan. The same year, a former U.S. Trade Representative received $16,500 per month to represent a Japanese auto company, commenting that everyone is "entitled to representation." Would an ex-MITI minister lobby for GM?

Foreign lobbying has many Americans irate. Perhaps we should adopt tougher lobbying restrictions. But we also need to examine the political implications of foreign lobbying and why there is so much of it in the nation's capital today. The concern is that our system of checks and balances—meant to reconcile the competing interests of U.S. citizens and companies—is now being used to give equal standing to the industries and governments of other nations. We owe it to our democracy to be clear about the implications. It is no accident that just as the importance of our government's commercial policies is increasing, they are being influenced from abroad on an unprecedented scale.

MICHAEL C. MAIBACH

But the real problem is not foreign lobbying alone. The real problem is the lack of clarity about America's national commercial interests—the lack of a U.S. trade and competitiveness policy that enhances growth and deals effectively with our trade partners when their behavior puts U.S. interests at an unfair disadvantage. When U.S. policy fails Americans, business leaders file trade complaints, demand tough trade legislation, and otherwise "lobby Washington." This engenders a predictable response from Japan and others that have learned how to neutralize governmental action through the American system of checks and balances.

So what is to be done? Allow me to suggest the following reforms.

First and foremost, the nation must make a commitment to commercial success. Our political leaders must sound the call to excellence in enterprise. "Hands off" must be replaced by "Let's win!" Presidents have challenged us to go to the moon and to topple the Berlin Wall. Yet not one has challenged America to be No. 1 in the Information Age.

Second, we need an effective trade and investment policy. "Reciprocity" will become the watchword in the '90s. If we cannot sell in another country or buy their companies, it is fair to start asking why access to America is not leveraged.

Third, we must also require full disclosure on who is lobbying for whom. Former presidents should never receive foreign compensation—something that should go without saying. Former Cabinet members and Congressmen should not serve foreign clients. Junior trade officials should have a "cooling off" period of three to five years before selling what they learned at the taxpayers' expense to foreign interests.

Finally, the participation of foreign companies in U.S. elections must be reviewed and sound policy adopted. Elections are the sacrament of democracies.

Alexander Hamilton wrote these words as America confronted European mercantilism: "Let Americans disdain to be the instruments of European greatness! Let the 13 states ... concur in erecting one great American system superior to the control of all transatlantic force or influence." In fairness, the world is more complex than it was in 1787. The rise of the multinational corporation, the advent of jet travel, telecommunications, and much more have blurred the lines called "domestic" and "foreign."

Nevertheless, there *are* important American commercial interests, and we must begin to clearly define them. Like it or not, the "nation state" remains the world's fundamental organizing principle. Men and women still give their lives for their countries; none yet, for their companies.—*MICHAEL C. MAIBACH, director of government affairs, Intel Corp.*

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CIRCLE 185

TO WATCH

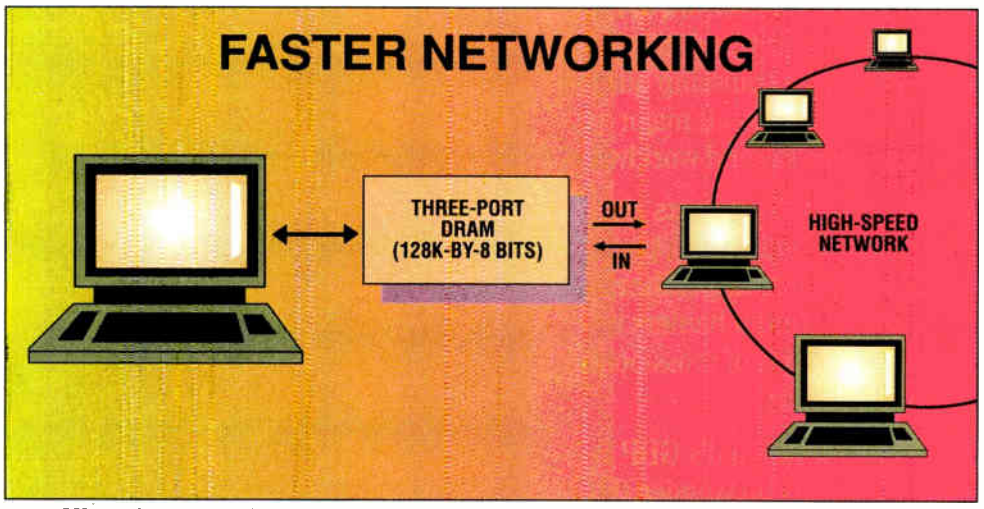
MICRON'S THREE-PORT DRAMs SPEED I/O

Micron Technology Inc. is turning up the performance of dynamic random-access memory chips to get them ready for real-time applications. Micron does it by integrating three input/output ports on its most recent 1-Mbit offering.

The 128-K-by-8-bit organization of the MT43C8128/9 means 8-bit words can be transferred in a single clock cycle—a first for three-port DRAMs—according to the Boise, Idaho, company. The chip boosts throughput in high-speed networks by implementing two serial-access memory ports—one for incoming data and the other for outgoing data.

The serial ports are backed up by SRAM-like 256-by-8-bit buffers. The MT43C8128/9 is a follow-on product to the MT43C4256, a 1-Mbit, triple-port DRAM organized as 256-K-by-4 bits. Both chips offer a 2,048 bit-mask register that is useful in video applications to "blank out" part of the screen to make space for graphic overlays.

Both chips also share speed characteristics. Three versions are available: 80 ns/25 ns; 100 ns/30 ns; and 120 ns/35 ns. E



Micron's newest three-port DRAM transfers 8-bit words in a single clock cycle.

PLESSEY CHIP AIMS AT FFTs

A quad-port random-access memory chip from GEC Plessey Semiconductors Corp. delivers four memory operations per 20-MHz clock cycle and is ideally suited for high-performance data-flow systems such as fast Fourier transforms.

The PDSP16520 has 16 Kbits of RAM arranged in four 256-by-16-bit segments. All address, data, and control inputs are fully registered. Available now, the part is priced at $295 in 1,000-unit quantities. E

IN FOCUS SYSTEMS' LCD MONITOR FOR PCs USES PASSIVE MATRIX

A color monitor based on In Focus Systems Inc.'s passive-matrix, liquid-crystal-display technology looks as if it can compete with active-matrix offerings based on thin-film technology.

The Tualatin, Ore., company's TSTN monitor displays up to 4,913 colors at 640-by-480-pixel resolutions. Its light source is a 50-W incandescent lamp. It uses a subtractive color process similar to color printing to achieve full color saturation. Competing technologies use an additive process, which delivers partial color saturation.

Other key specifications include a 10:1 contrast ratio, 100-fL brightness, a 45° viewing angle, and a 0.33-by-0.33-mm pixel pitch. The 6-lb unit is 3-in. deep and has a 10.5-in. diagonal screen.

Although new to the laptop market, the technology has been used since 1987 and does not have the manufacturing yield problems of active-matrix displays.

Two versions—one capable of displaying 64 colors, the other, 4,913—will be available in 1991 priced at $1,400 to $2,500. E

MATROX EXTENDS IMAGING FAMILY FOR EISA

Users of Enhanced Industry Standard Architecture computers can now tap into the real-time image processing and high-resolution graphics delivered by the Image series of boards from Matrox Electronic Systems Ltd., Dorval, Canada [*Electronics*, October 1989, p. 102].

The new board offers a 32-bit host interface—twice as wide as the company's original PC/AT board. Display resolution is 1,280 by 1,024 by 32 bits. The Image series/EISA board sells for $9,995 and is available now. E

SUN'S SPARCSTATION 2 DELIVERS 28.5 MIPS AND 16 MBYTES

Sun Microsystems Inc., Mountain View, Calif., is delivering its fastest workstation ever. At 21 SPECmarks (28.5 million instructions/s) and 4.2 million floating-point operations/s, the Sparcstation 2 is almost twice as fast as the Sparcstation 1+.

Several versions are available, ranging from a $14,995 entry-level monochrome model to a $49,995 high-end 3-d color graphics unit—the Sparcstation 2GT. With 16 Mbytes of memory standard, all models are available immediately. E

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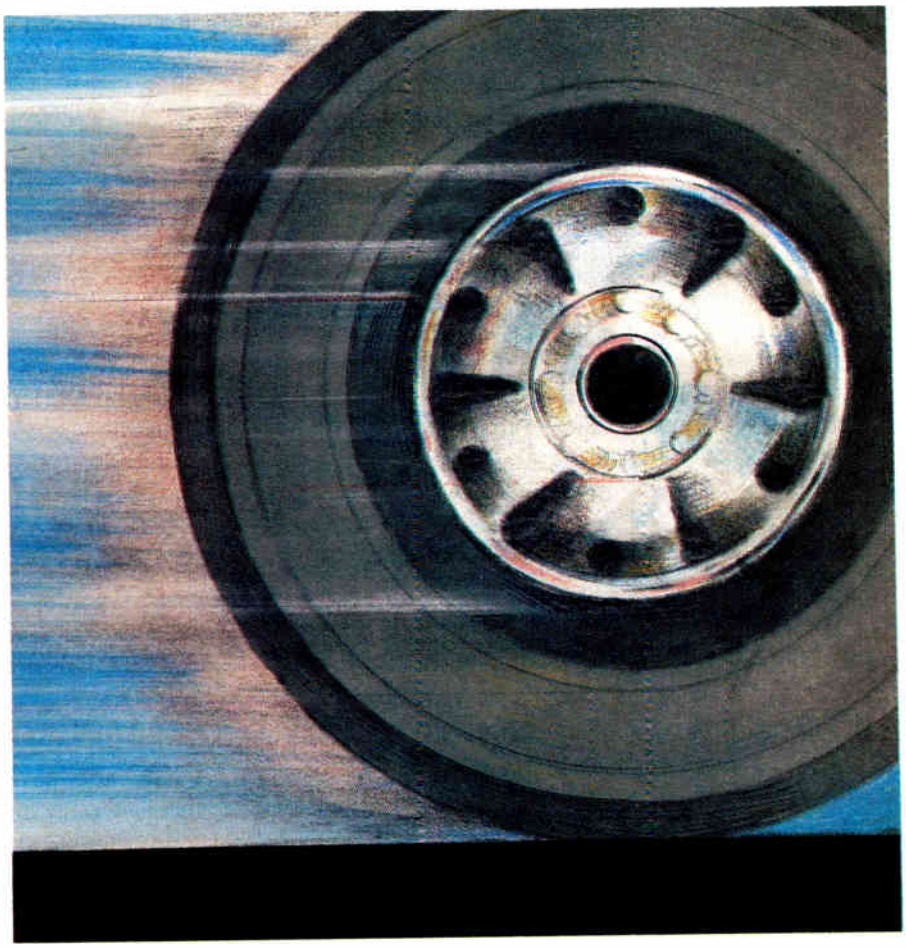

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HIT THE GROUND RUNNING

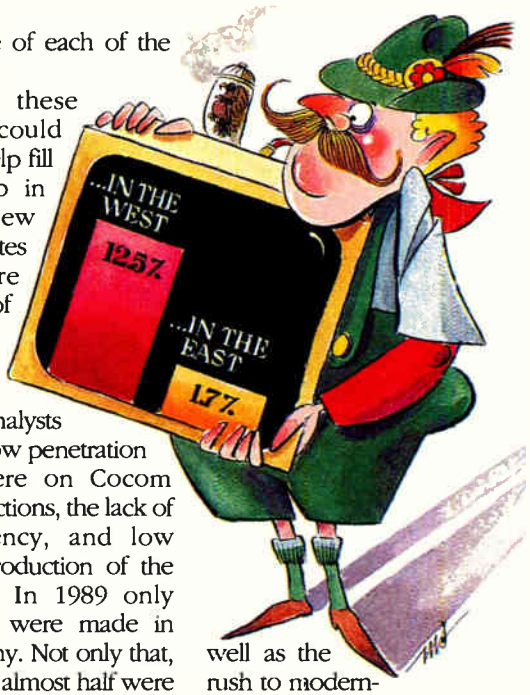
CIRCLE 194

COMPUTERS FOR THE EAST

In the western part of Germany, one out of every eight workers has a personal computer on his or her desk. In what used to be East Germany, the figure is only one in 60. Germany's new PC powerhouse, Siemens Nixdorf Information Systems AG, wants to fill that void, and it's getting Japanese help to do it.

Siemens Nixdorf—which opened for business Oct.1—last month signed an agreement with Matsushita Electric Industrial Co. giving it access to Matsushita's laptop and notebook PCs for distribution on European markets. In turn, the Paderborn-based PC maker will supply its Desktop Computer and Tower models to Matsushita, also to be sold in Europe. The different models from the two firms supplement the product line of each of the companies.

Each of these machines could very well help fill the PC gap in the five new German states that were carved out of what used to be the Communist East. Analysts blame the low penetration of PCs there on Cocom export restrictions, the lack of hard currency, and low domestic production of the computers. In 1989 only 61,000 PCs were made in East Germany. Not only that, but of those almost half were sold abroad, mainly to the Soviet Union. But in the wake of the dramatic change in the political landscape as well as the rush to modernize their industrial base, analysts say, the eastern states will have about 350,000 PCs in use by 1994. E



IRAN AND INDONESIA BUY SWITCHES FROM SEL AND SIEMENS

Two German companies—Standard Elektrik Lorenz AG and Siemens AG—have bagged big orders for their digital telephone exchange systems from phone companies in Iran and Indonesia.

SEL, the subsidiary of France's Alcatel NV communications group, has won a $390 million contract to deliver and locally manufacture its System 12 switch in Iran. The deal provides for the installation of 34 local and long-distance exchanges for a total of 450,000 subscriber lines. With local postal authorities and the Iranian Telecommunication Manufacturing Company, SEL will put up a System 12 manufacturing plant in Shiraz, south of Teheran.

The Siemens order, worth $150 million, is for the delivery to Indonesia of EWSD digital exchange systems, which are built specifically for thinly populated areas. The latest deliveries will increase the number of EWSD subscriber lines in that country to 1.5 million. Indonesia first picked the Siemens system as a standard in 1982 and has been building it under license since 1984. E

EUROPE'S LARGEST VSAT NETWORK

Germany's Dornier GmbH, under a contract from the Bundespost's Telekom Division, will supply 500 VSAT (very small aperture terminal) satellite ground stations that will form Europe's largest operational business-communications network to date. The system is a satellite-supported network linking a central station and a large number of small ground stations equipped with dish antennas measuring 1.8 meters (71 in.) in diameter. The 500 stations are intended to be in place at users' facilities by mid-1991. The VSAT system provides for data channels operating at 300 bits/s to 64 Kbits/s and exploits the advantages of satellite technology to distribute messages at low cost throughout Europe. E

PHILIPS CUTS WORK FORCE, RESHAPES INFO SYSTEMS

In an effort to raise productivity in its far-flung operations and put the company back on the road to profitability, hard-pressed Philips International NV, Europe's largest electronics firm, will lay off 35,000 to 45,000 employees worldwide by the end of 1991. These layoffs, plus those announced earlier this year, would reduce the Dutch company's global work force by 20%, to 228,000. Further, after losses of more than $1 billion during the first three quarters of this year, the Eindhoven-based firm will propose suspension of 1990 stock dividend.

Meanwhile, on the heels of cutbacks in its semiconductor operations last summer, Philips is trimming activities in its loss-ridden Information Systems Division as well. This means a reduction of about 4,900 of a total of 15,000 jobs.

Particularly hard hit is the subsidiary Philips Kommunikations Industrie AG in Nuremberg, Germany, where 900 of a 2,250-person work force are to lose their jobs.

The division will work on sectors where it has a strong and sustainable position. The emphasis will be on providing products and services to industry segments such as banking, government, insurance, and travel.

The focus will also be on image-based office automation systems using optical data storage, and service and maintenance of hardware and software.

Also, the division will stress the production of PC-based systems and network components. E

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CIRCLE 222

ECHELON MAY START A WHOLE NEW INDUSTRY WITH ITS LOCAL OPERATING NETWORKS

LOW-COST LINKS

BY JACK SHANDLE

ANY STARTUP THAT SIGNS partnerships with giants like Motorola and Toshiba to make its chips on a royalty basis warrants a closer look. Especially when that startup has the heady dream of creating a new industry that encompasses the consumer, industrial, and commercial markets.

Echelon Corp. is its name, and the low end of the computing market is its game. Low end means under $10—that's right, $10.

Founded in 1988 by Apple Computer Inc. cofounder Mike Markkula, the Palo Alto, Calif., company has combined a low-cost processor IC with an ultrarobust communications protocol to create a technology it calls a Local Operating Network. Because of their low implementation costs, LONs are expected to be useful for communicating and controlling all sorts of equipment and appliances in office buildings, factories, warehouses, homes, and even the family car. The cost of a typical node will be less than $10.

In an office building, a LON can link the security system with the lighting and ventilation systems by using the power lines as a communications medium, says Beatrice Yormark, vice president of marketing. In factories—the first market on Echelon's list—LONs can connect process controls using spread-spectrum radio, power lines, or infrared communication—all transparent to the network user. In cars, LONs can radically reduce the size of wiring harnesses by endowing the lights, suspension, and heater with the intelligence of a $5 chip called a Neuron Distributed Processing Unit running 3 million instructions/s.

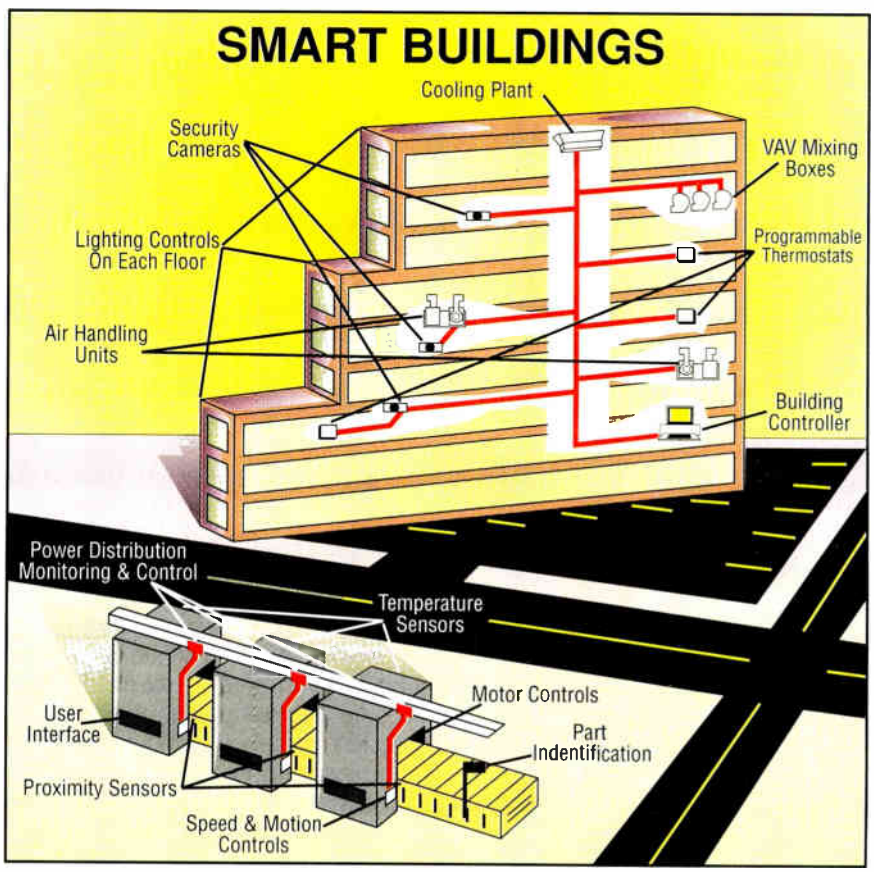
One way to view the Neuron chips that create control points in the LON is as a universal programmable logic controller, but that is not all they are, says Will Strauss, president of Forward Concepts Inc., a Phoenix market analysis firm. "Once you see one thing it can be used for," he says, "you tend to forget the other 30."

Indeed, the potential market is both vast and largely untapped, says Echelon president Kenneth Oshman. In 1991, there will be approximately 4.5 billion nodes worldwide where cheap intelligence could be useful. Less than 5 million nodes have been connected using traditional communications and control technologies, he says. Strauss says that in U.S. industry alone, 47.5 million nodes are being monitored and controlled at an average cost per point of $14.70. LONs can make deep inroads into that market as less expensive, value-added replacements, he says.

Such broad market reach requires a simple, robust architecture. Design specifications for the technology include media independence, scalable transmission rates, a universal addressing scheme for a very large number of nodes, and a self-contained protocol.

To satisfy these criteria, Echelon built a soup-to-nuts system on a chip, including a processor and a network protocol based on collision sensing and multiple access to the network by nodes. The LON protocol covers the complete International Standards Organization's seven-layer stack. Bit rates scale from 10 Kbits/s for applications using power lines as a medium up to 1.2 Mbits/s for twisted-pair wiring. The LON operating system supports up to 32,000 nodes per domain; domains can be linked by routers and bridges.

Each node is controlled by a Neuron chip that integrates three 8-bit, on-chip processors, each capable of handling 1 mips. The three processors share 2 Kbytes of RAM and 512 bytes of EEPROM and are dedicated to one of three functions: protocol conversion, communication, or computation. Fabricated in



Echelon's LON offers media independence and scalable transmission rates—the key to the logic-controller market.

1.2 μm CMOS, the initial semicustom chips are expected to cost about $5 each in 1991 with the price dipping to about $1 when an 0.8 μm full-custom version reaches volume sales.

Since a broad lineup of applications software is key to Echelon's success, the company is making it easy—and relatively inexpensive—for third-party developers and original equipment manufacturers. "OEMs can now concentrate on what they do best—producing, selling, servicing, and installing the products customers want—rather than wasting valuable R&D resources inventing new distributed sense-and-control technologies," says Oshman.

Echelon will also license its technology to OEMs for $2,500 and sell the $15,000 LON Builder development system and connectivity products such as transceivers, bridges, and routers. Echelon expects volume to ramp up to levels typical of consumer chips. Motorola Inc. in Phoenix and Toshiba Corp. in Tokyo will fab the chips. Echelon's royalty agreement calls for "three cents per chip or 3% of the chip price, whichever is greater," says Oshman. E

TEST & MEASUREMENT

DIGITAL SCOPE MARKET SHOWS SIGNS OF WEAR AS COMPETITION CUTS INTO FAST GROWTH

RUNNING OUT OF GAS?

BY JONAH McLEOD

JUST LIKE THE SINUSOIDAL waveforms that an oscilloscope measures, the market for the instruments has had its ups and downs. The last few years, since the advent of digital storage oscilloscopes, have been prosperous ones. But the exuberant growth has slowed as the market has become increasingly competitive and suppliers have been fielding products with more and more features.

Today's instrument offers higher resolution to serve in calibration and test equipment labs. It can locate randomly occurring glitches troublesome to digital systems, and has enough compute power for automated test applications and enough memory to locate problems in long bit streams of data.

In 1989, the industry shipped $600 million worth of scopes, says Galen Wampeter, president of market-watcher Prime Data Corp. in San Jose, Calif. In 1990, the market grew 10%; in the 1989-94 period, he expects a compound average growth rate of 11%. Not bad on the face of it, but the years of greater than 20% growth are gone.

"The market is very competitive," Wampeter says. For example, the model 9430 from LeCroy Corp. of Chestnut Ridge, N. Y., comes with a 10-bit analog-to-digital converter, says product manager Mark Zirngast. Com-

bine the ADC with a series of amplifiers and attenuators in the front end of the instrument and the user can detect a 1% noise perturbation in a staircase ramp signal with a 1-V peak-to-peak amplitude. The 300-MHz model 3323 digital scope from John Fluke Mfg. Co. is also equipped with a 10-bit ADC. "It can perform dc offset without having to use ac coupling," says Hans Toorens, product marketing manager at the Everett, Wash., company. "But its real strength is what it does with the information it has acquired"—fast Fourier transforms and spectrum analysis on signals of 100 MHz or less. The scope can analyze mechanical noise on data from the read head.

Better capability to locate spurious glitches in digital designs is another feature becoming common on 200-MHz-class products. For example, the 2400 Series from Tektronix Inc. of Beaverton, Ore., has an analog peak-detection circuit in the front end.

On its new HP54510A, Hewlett-Packard Co.'s Colorado Springs Division has added expanded triggering capability to locate spurious pulses. With it, the designer can qualify a trigger relative to a logic state or on the amount of time relative to an event. The unit also comes with an infinite-persistence mode for glitch capture: the scope memory acts as a first-in-first-out memory, with the occurrence of a glitch freezing the memory contents.

HP's HP54510A has expanded triggering capability and infinite-persistence memory.

Up to now, digital scopes have been general-purpose instruments that measure analog waveforms as well as digital events. Outlook Technology Inc. of Campbell, Calif., has developed a product that challenges this approach.

Called the Logic Oscilloscope, the instrument is optimized for logic design. It can have up to 160 channels, each with a 4-bit ADC that digitizes the waveform and provides information on the waveshape as well as its digital state, 1 or 0. Also unique are the probes, which provide 350 MHz of bandwidth at the probe tip and operate with all IC technologies—CMOS, n-MOS, GaAs, TTL, and ECL. The company could create a new class of instrument with this product—and yet another upswing for the oscilloscope market.

OPERATING SYSTEMS

SHOWING ITS STUFF IN NEW YORK

UNIX KEEPS ROLLING

BY HOWARD WOLFF

BACK IN 1982, THE ANNUAL *Electronics* Achievement Award (see p. 49) honored for the first time work in software. The winners were a pair of computer scientists from Bell Laboratories in Murray Hill, N.J., Ken Thompson and Dennis M. Ritchie; they were selected "for their efforts in developing . . . Unix."

During the intervening eight years, Unix gathered speed and converts, shedding its label as software for technical and scientific computing. Today, it is king of the operating systems for open multitasking systems in a networked environment [*Electronics*, September 1990, p. 54]. And the celebration was held last month in New York at Unix Expo.

It wasn't so much what was shown. Rather, it was a sense of optimism and excitement; a feeling that the Unix movement has finally reached critical mass. As Jim Manzi, president and chief executive officer of Lotus Development Corp. in Cambridge, Mass., flatly declared in his keynote speech, "Unix is the quintessential network OS."

Among the introductions was IBM Corp.'s new RS/6000, called PowerStation/PowerServer 550. It claims a CMOS clock rate of 41.6 MHz and performance of 56 million instructions/s. The PowerServer 550 starts at $135,322; the PowerStation configuration, $136,967.

In software, Hunter Systems Inc. of Palo Alto, Calif., which produces automated DOS-to-Unix porting technologies, took the wraps off its XDOS Transformer.

Finally, Unix International Inc. countered the Open Software Foundation's announcement of its OSF/1 operating system with a roster of enlistees for UI's year-old System V Release 4.

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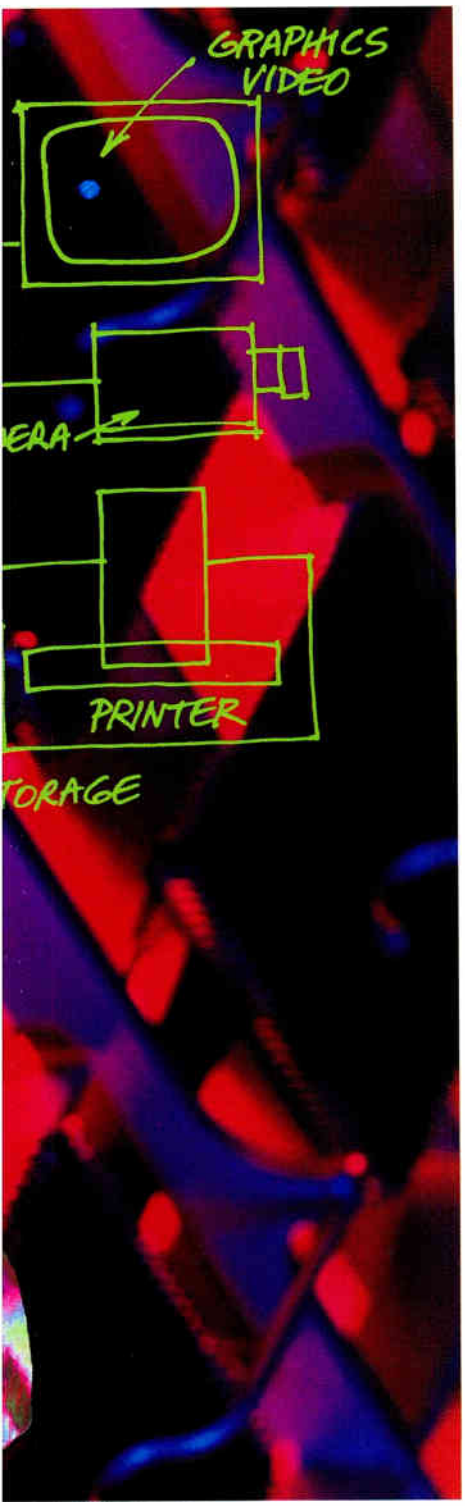

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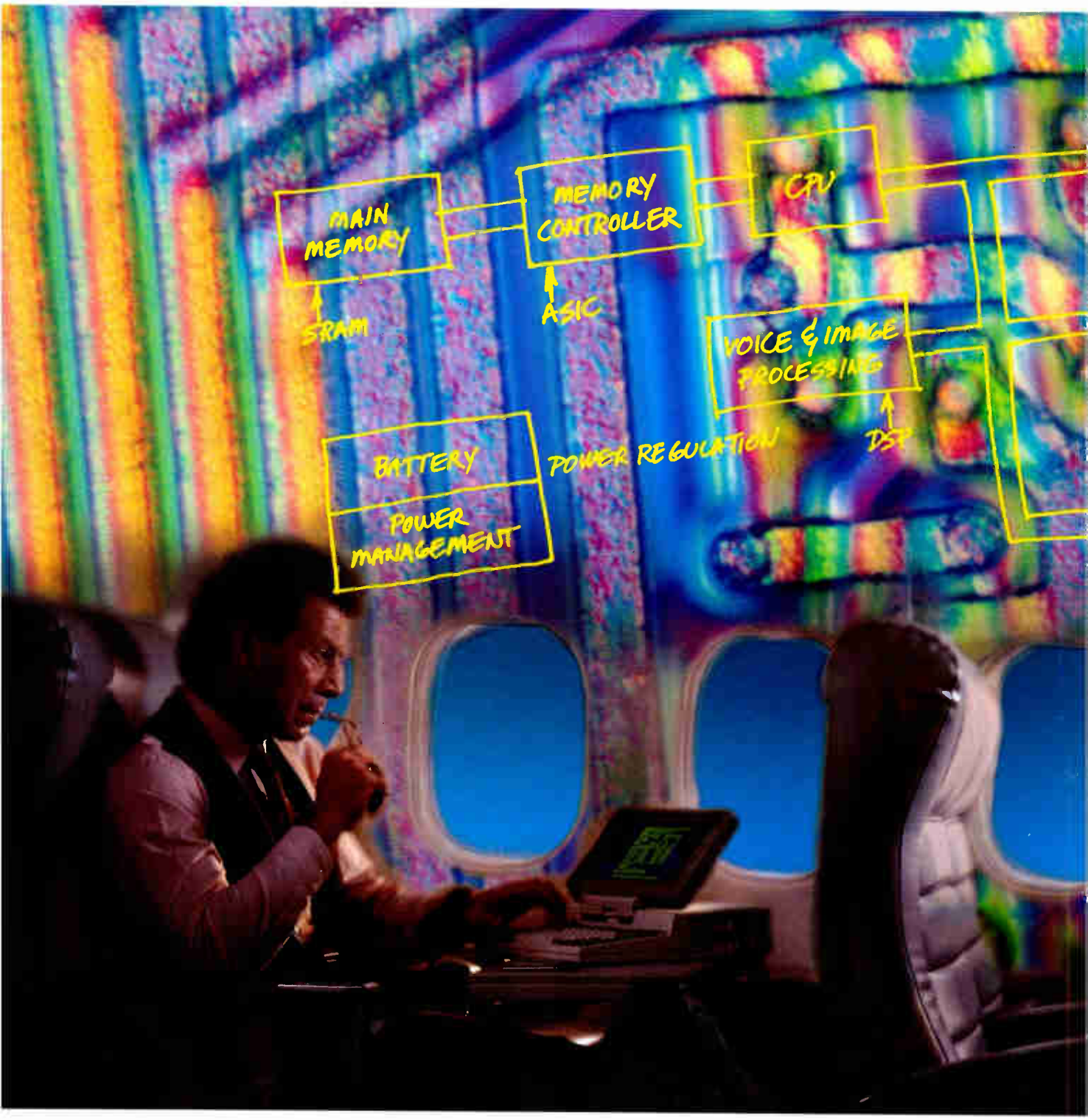

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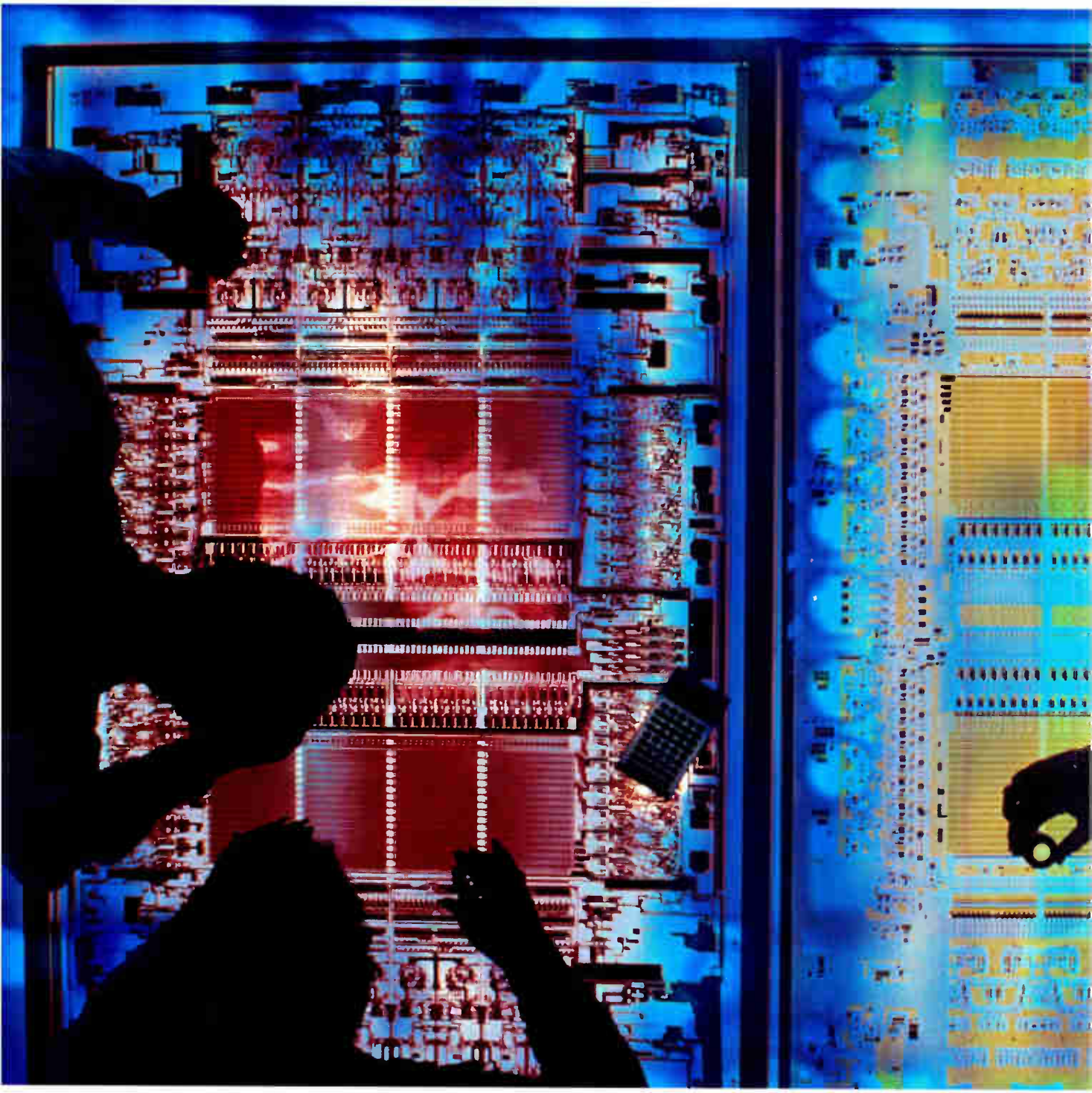

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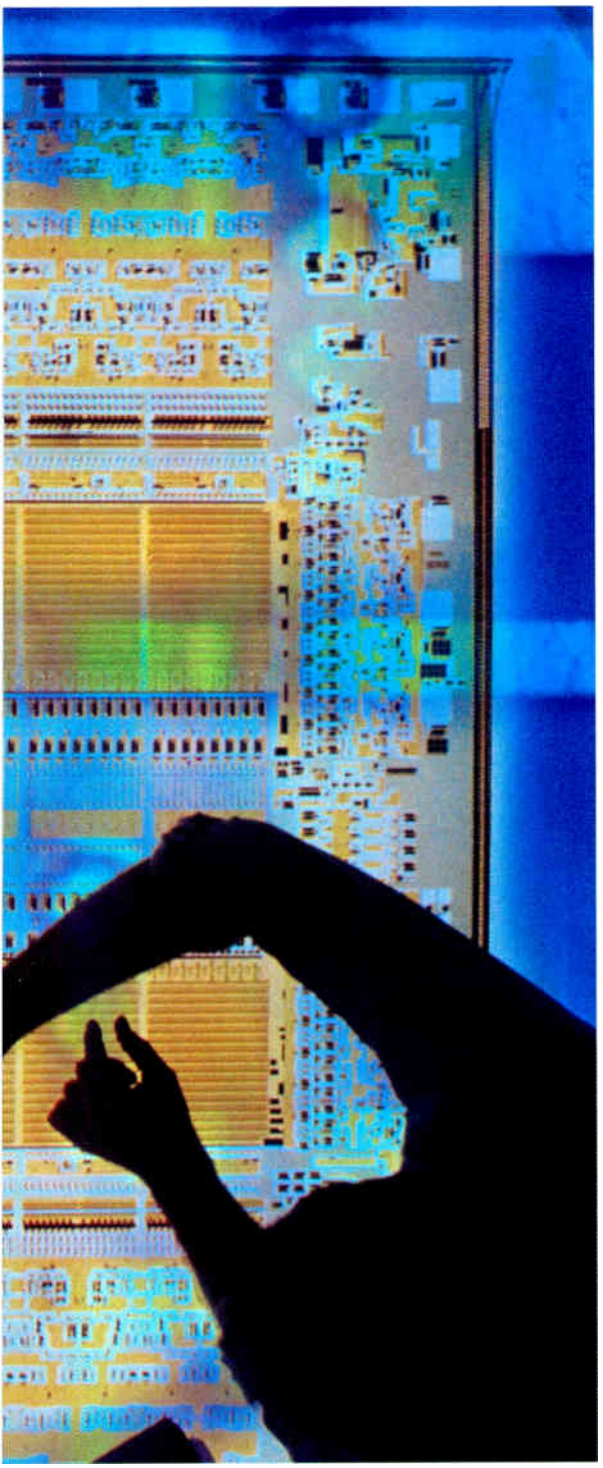

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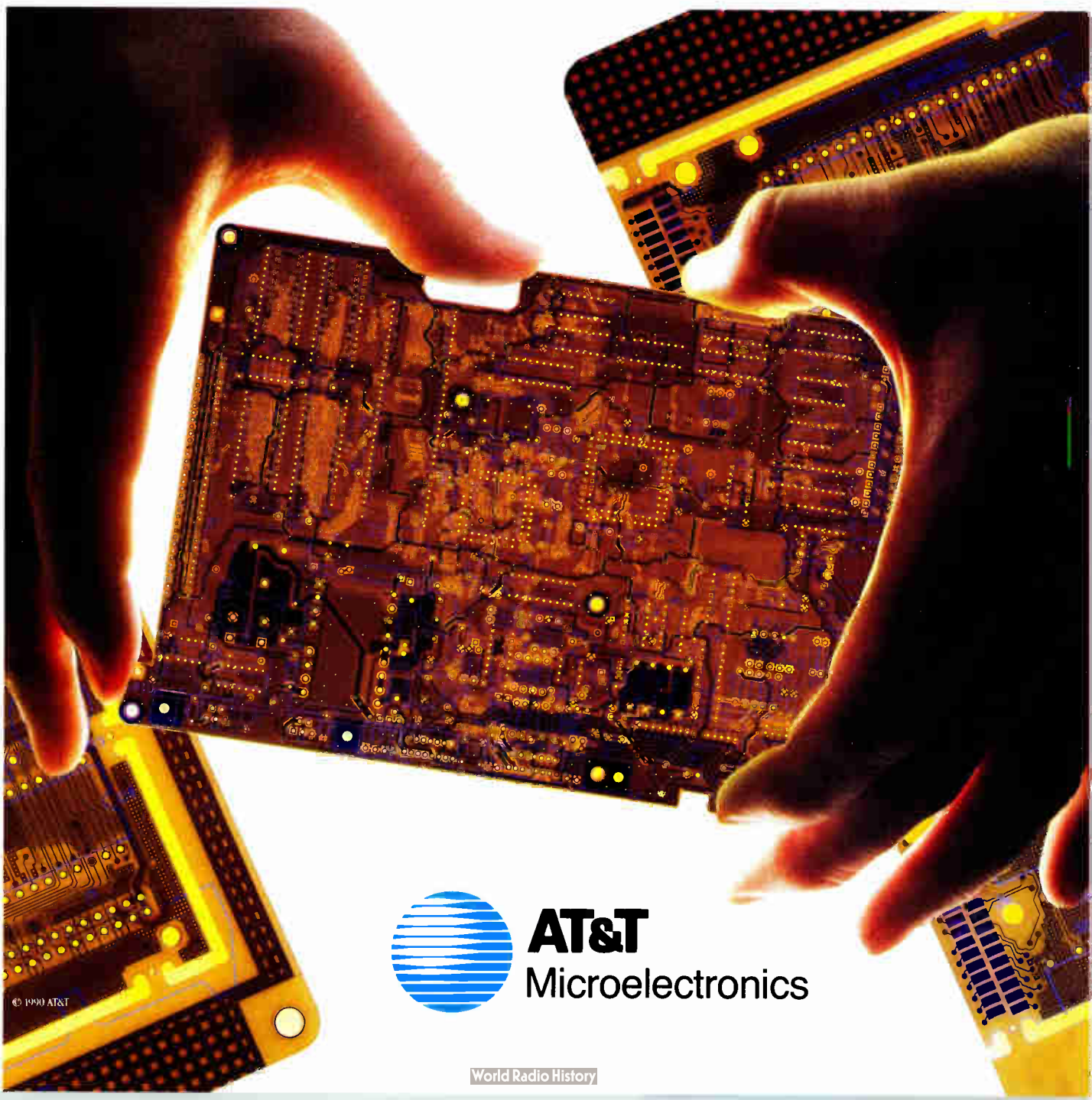

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OUTLOOK

IN THE FACE OF A SLUGGISH 1991, TOP EXECUTIVES VOW NOT TO CUT RESEARCH

RECESSION VS. R&D

BY LAWRENCE CURRAN

LIKE IT OR NOT, THE U. S. economy is undoubtedly in a recession as 1990 comes to an end. Few senior executives care to utter the "R" word, but many believe it's already happening. "We are in a recession—the question is, how deep and how long," says Scott Mercer, chief financial officer at LSI Logic Corp., the Milpitas, Calif., leader in application-specific integrated circuits.

But if business conditions constitute a recession, it probably won't last long, says Robert Ripp, treasurer of IBM Corp. in Armonk, N. Y. He expects that when the U. S. gross national product numbers for the period are added, they will show negative growth in this year's fourth quarter and next year's first, but that neither 1990 nor 1991 will be labeled as recession years. For all of 1991, Ripp says, IBM's economists expect growth of only 1% to 1.5% in global economies, with Asia the healthiest region at about 3%. He adds that those expectations assume no war in the Middle East. IBM expects a modest rebound in the U. S. GNP to a growth rate of 2% to 2.5% in 1992.

But whether the "R" word is used or not, most electronics executives view 1991 as another difficult year at best. And they're looking for ways to cut costs without hurting their companies' ability to compete. That probably means more layoffs, but no one wants to cut research and development muscle.

Typical of the executives polled is John F. (Jack) Smith, senior vice president for operations at Digital Equipment Corp. He says planning at the Maynard, Mass., computer giant "doesn't anticipate any dramatic improvement over current economic conditions or the present state of business in the computer industry." But R&D will remain solid, he says.

Reluctant to acknowledge a U. S. recession, Ray Stata nevertheless expects 1991 to be "another sluggish year," with spending for military and capital equipment curtailed. Stata is chairman and president of Analog Devices Inc., the Norwood, Mass., manufacturer of analog, digital-signal processing, and mixed-signal semiconductor devices. "We're planning for single-digit growth while hoping for a miracle in the latter part of the year," he says.

At Fujitsu Microelectronics Inc., Santa Clara, Calif., "we've seen soft business all this year," says Rich Christopher, vice president and general manager. He adds that dropping prices for dynamic random-access memories have hurt the company's bottom line. Fortunately, an unexpected strong demand for high-speed static RAMs has helped offset the DRAM doldrums. Christopher looks for history to repeat itself in at least a short-term rebound next year. "Except for two years," he says, "the second quarter of every year since 1980 has shown an upturn," which he foresees again in 1991.

Rick Hill, vice president and general manager of the oscilloscope group at Tektronix Inc., Beaverton, Ore., shares Christopher's hopes about the short-term prospects. He says that as Eastern Europe builds its telecommunications and computer infrastructure, test and measurement equipment will be needed.

In France and Italy, the 1991 outlook at SGS-Thomson Microelectronics is for single-digit growth in the global semiconductor industry. Vice president Philip Gere calls that a crisis, whether or not it's part of a recession. "Indeed, with market growth below 10%, a big crisis is on, but our company has proven that it can sail through the winds of recession with less pain than many competitors," Gere says. He cites "a high percentage of our sales taken by dedicated products and ASICs" as among the reasons the company expects to fare better than the market it serves.

Importantly, SGS-Thomson can count on support from the French and Italian governments, its two major shareholders, to see it through tough times. The firm expects a profit of only $3 million this year—a level that few large companies could absorb without state help.

A counterpoint to the glum 1991 outlook emerges from Germany, where Siemens AG in Munich expects neither a recession nor a decline in business. "Unless something drastic or unexpected happens, such as a drastic deviation in currency-exchange rates, we do not expect our business to decline," says Eberhard Posner, a Siemens executive director. "Neither do we expect lower profits

which privileges the bottom line and cuts expenses, including R&D and marketing," says Gere of SGS-Thomson. The company invests 20% of its sales in R&D. "The bottom line is our top priority," he says, "but we do not sacrifice the future of our company to it."

But whatever the foreign view of American R&D practices, most U. S. electronics executives vow they will not slash research despite the hard times. "That would be suicide in our business," says Aristacom's Kissner. Some companies—such as Teradyne Inc. and Analog Devices—are looking at new ways of financing research, such as partnerships.

Like many others, Teradyne, the Boston manufacturer of automatic test equipment, has trimmed the work force by about 2% this year, including some from R&D, despite its expectation of reasonably good growth in 1991. But Alex d'Arbeloff, president and chairman, stresses that he won't jeopardize a reputation for technical leadership built over 30 years. "We won't sacrifice that reputation to increase profits, because in a business as fast-changing as ours, any such gain would disappear as soon as customers sensed that we were backing off from our technical commitments."

He wants the company to ratchet back "a few percentage points as sales rise" from the current level of 15% of sales spent on engineering. One way that dip can be offset is by joining with partners to share R&D expenses. Among the first such venture is one announced in September with Samsung Electronics Co. Ltd., the Korean semiconductor memory device manufacturer in Seoul. The agreement has the firms jointly developing a system to test Samsung's next-generation memories. It involves the two sharing information about memory-device and memory-test systems in development so that each can influence the other's designs.

Analog Devices is doing something similar in semiconductor process development. The $485 million company now finds it needs strategic alliances with noncompeting companies to absorb some of the R&D burden. ADI expects to announce such a partnership soon. The goal is to invest 15% of revenues in R&D, says company president Stata. The current level at ADI is 16.5%.

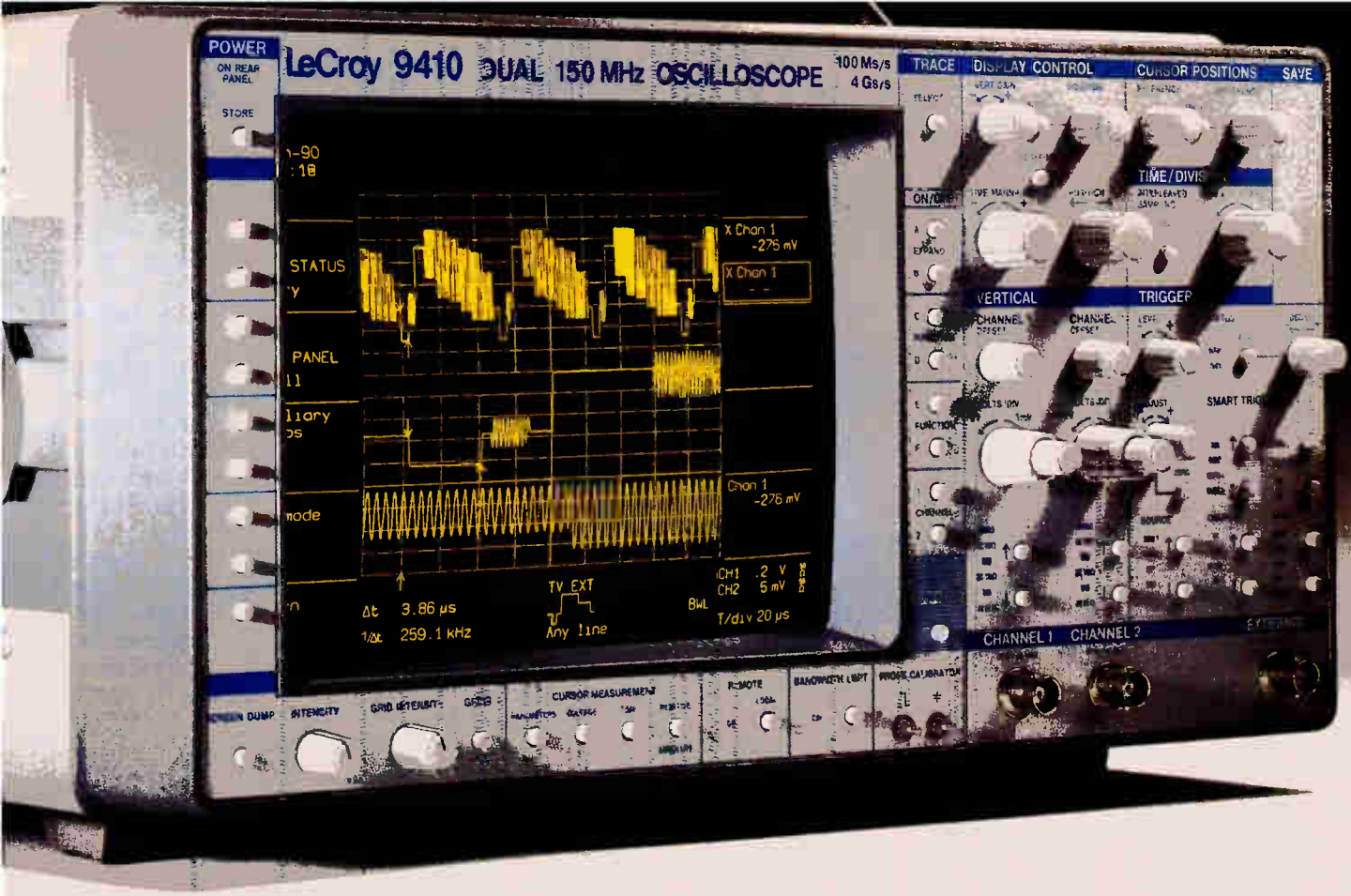
"We've kept the pump primed in R&D," he says, "but operating profits aren't acceptable. We'll make a major effort to improve profits next year by limiting expenses. We want to leave as much head room as possible in R&D, which translates into not cutting R&D, but limiting its growth."

For Texas Instruments Inc. in Dallas, cutting expenses is one thing, but R&D is sealed in a kind of tamper-proof package. "It is broken out separately—and monitored separately—for every organization. When we squeeze expenses, we do it independent of R&D," says Wally Rhines, executive vice president of the Semiconductor Group. "If someone is cutting the future to take care of the present it is evident in his quarterly reports." As for 1991, says Rhines, "We are looking to cut costs, but we're not going to cut R&D to accommodate the current market." What's more, adds Rhines, alluding to TI's vigorous pursuit of royalties on its patents, "for the first time there are two dimensions to the revenue generated by R&D: from products and from intellectual property."

At LSI Logic, the $650 million ASIC manufacturer, Mercer looks for the company to grow at 10% to 15% in the second half, after a flat first half of 1991, which he terms "pretty modest" in relation to the firm's historical compound annual growth rate of 40% through 1989. Nevertheless, R&D funding will remain steady. "We try to spend in the neighborhood of 9% to 9.5% of total revenues on R&D," Mercer says.

Digital's Smith says the company's consistently large investment in R&D won't change, despite pressure on profits. "We've had for some time an aggressive program of expense control, including the elimination of unneeded jobs," he says. That's certainly reflected in a midyear $400 million set aside for voluntary terminations. But "those investments related to continued product R&D will not be jeopardized by any short-term cost-control programs," Smith maintains. "Over time, our research and engineering investments have typically been 10% to 12% of revenues, and we plan that this will continue."

IBM's Ripp says that while R&D plans for 1991 include an increase over this year, the company stresses the long haul. For example, "If we need to invest in semiconductor technology to-



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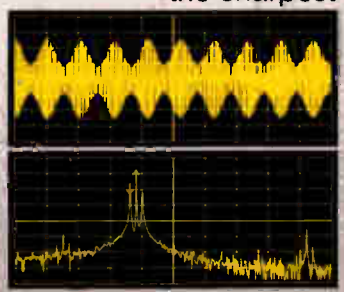
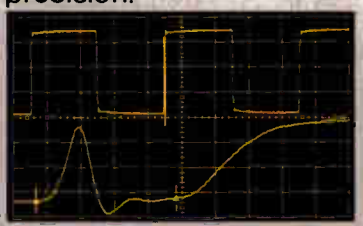


Spectrum Analysis Option

The Model 9410 doesn't stop there. It also includes LeCroy's SMART trigger that detects buried glitches, timing violations, and logic states (you'll be prepared for the most elusive signals). Internal signal processing calculates time, voltage and frequency parameters in fractions of a second.



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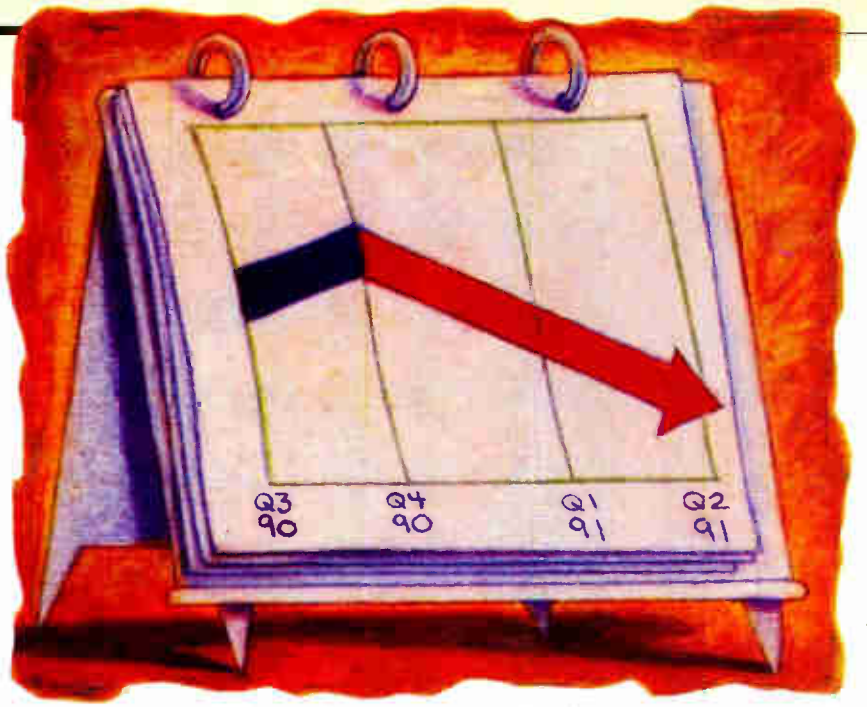

day even though revenues won't derive from it until 1995, we'll do it." Similarly, "We're doing a lot of work to transform the company more into a software and services organization, and we're pushing into open systems. It's difficult to say 'whack a chunk of that off' because of an economic downturn. But we get beat up in the financial community sometimes when we don't always hit our targets."

Fujitsu also continues to invest for the long term. Fujitsu's Christopher cites the example of its funding of gallium arsenide semiconductor technology, which the company doesn't expect to be a billion-dollar market for five years.

For his part, Sir Ernest Harrison, chairman and chief executive of both Racal Electronics plc and Racal Telecommunications plc in London, says that "our R&D expenditure has been maintained at a more or less constant level for some time, and in absolute terms, has grown in line with turnover [revenues]." The company's total revenues for its latest full year were $3.75 billion. Harrison adds that to ensure continued growth, he intends that "the relationship between R&D and sales revenue be maintained." Recently that relationship has been about 4%.

In Germany, the optimistic attitude at Siemens means that the company sees no reason to cut expenses, especially R&D. "Our R&D expenses are expected to be close to the figures of fiscal 1989," says Posner. The year's R&D investment was $4.5 billion, which represents more than 10% of total sales. E

Additional reporting by Jacqueline Damian, Peter Fletcher, John Gosch, Jonah McLeod, Andrew Rosenbaum, Jack Shandle, and Howard Wolff

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CIRCLE 232

BICMOS: THE NEXT GREAT WAVE IN SILICON?

SOME INDUSTRY PLAYERS ARE BETTING THIS TECHNOLOGY WILL DISPLACE CMOS, JUST AS CMOS NUDGED n-MOS ASIDE

BY SAMUEL WEBER

SEMICONDUCTORS

THERE IS A TIDAL WAVE racing toward CMOS processing technology and it has biCMOS written all over it. Those astute enough to see its impending arrival will ride it like skilled surfers into the next decade. Those that ignore its rapidly building mass and accelerating momentum could be swept away like the semiconductor companies that ignored the overwhelming force of CMOS in the early 1980s.

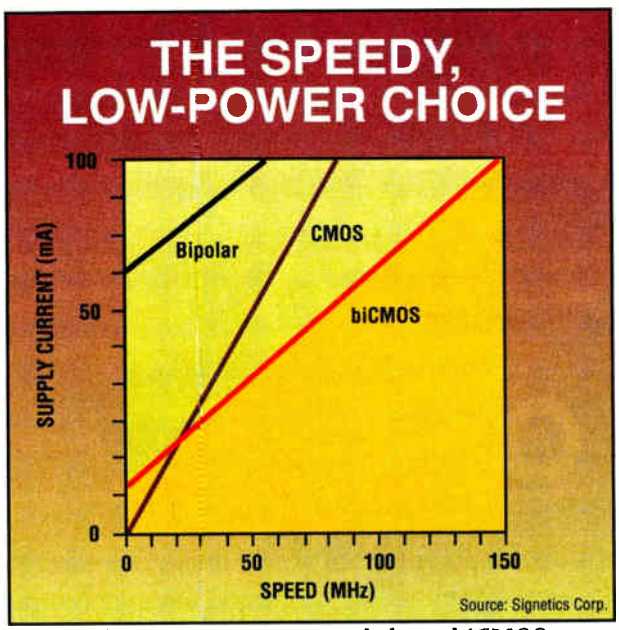
Although some in the chip industry avow that CMOS will remain the technology of choice for a good long while, others are pointing to any number of technological indicators showing biCMOS edging out in front. BiCMOS has speed and power advantages over CMOS. It tends to be more reliable than CMOS. It has superior drive current and can operate at either emitter-coupled-logic or TTL input/output levels. And it's fast moving into systems.

A plethora of semiconductor devices have begun to exploit these superior capabilities, belying biCMOS's status as a "niche" technology. With few exceptions, companies ranging from the big guns to smaller specialty houses are gearing up with biCMOS products, processes, and designs. And all of this activity is aimed at the entire spectrum of integrated circuits. Led by fast static RAMs, which are turning out to be the technology driver, biCMOS is being applied to standard logic and to central processing units, where it will help meet the drive for ever more mips.

As CPU and memory speeds rise, gate arrays and standard cells need to track these performance gains; hence the growing need for semicustom circuits implemented in biCMOS. Finally, mixed-signal devices merging analog and digital on the same chip can only be implemented in biCMOS (see p. 41).

All this interest has evoked some hefty growth numbers from market watchers like Integrated Circuit Engineering Corp. of Scottsdale, Ariz. ICE forecasts that biCMOS ICs will account for about 5% of the total chip market in 1994—growing to $3.8 billion that year from about $275 million this year. That adds up to a compound annual growth rate of 69%, starting from 1989.

But some observers go further, predicting that biCMOS will eclipse CMOS in the 1990s just as CMOS edged out n-MOS in the 1980s. "The economics of biCMOS are complex: 16 masks for CMOS versus 20 for biCMOS means that biCMOS cost 143% more than CMOS," says G. Dan Hutcheson, president of VLSI Research Inc. in San Jose, Calif. "When packaged, a biCMOS 256-Kbit SRAM costs $13.20, compared with $8.98 for a CMOS device. However, the biCMOS device provides a 3.5-times speed increase. We have seen over and over that the market is willing to pay the price for higher performance, and this is one reason biCMOS will boom this decade."



Plotting current vs. speed shows biCMOS outdistancing CMOS as the low-power process.

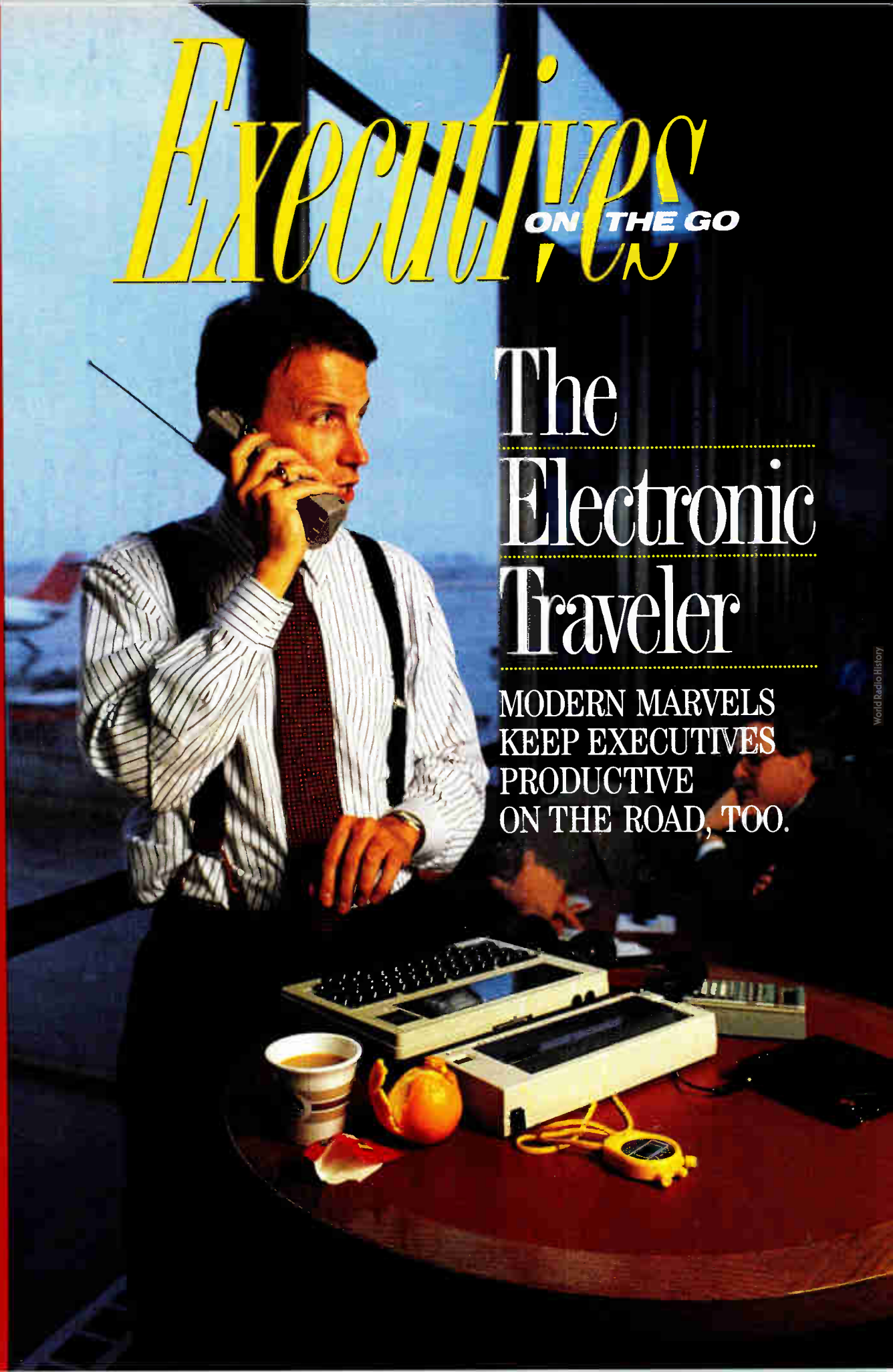
In fact, biCMOS can double the performance level of pure CMOS at a given density with the same lithography, says Pallab K. Chatterjee, vice president of Texas Instruments Inc.'s corporate staff and director of the company's semiconductor process and design center in Dallas. "The primary motivation for using biCMOS to begin with was to utilize the capacity and capabilities that were already in place, and increase the performance of chips that you had," Chatterjee says. Indeed, its compatibility with CMOS fabrication techniques is another reason biCMOS will rise fast, says Larry Jordan, vice president of marketing at Integrated Device Technology Inc. in Santa Clara, Calif.

"IDT has been working on biCMOS for four years with the idea of translating CMOS experience into biCMOS," says Jordan, who predicts that biCMOS's coming dominance will make the rise of CMOS look like a snail's crawl. "You add two to four masks to a CMOS process to get biCMOS. This was not true of CMOS versus n-MOS, which required changes in capital equipment."

Recently, James E. Dykes, president of Philips Components-Signetics Corp.,

A Lifestyle Supplement to Penton Publications/Travel/Lodging/Resorts/Recreation/Leisure

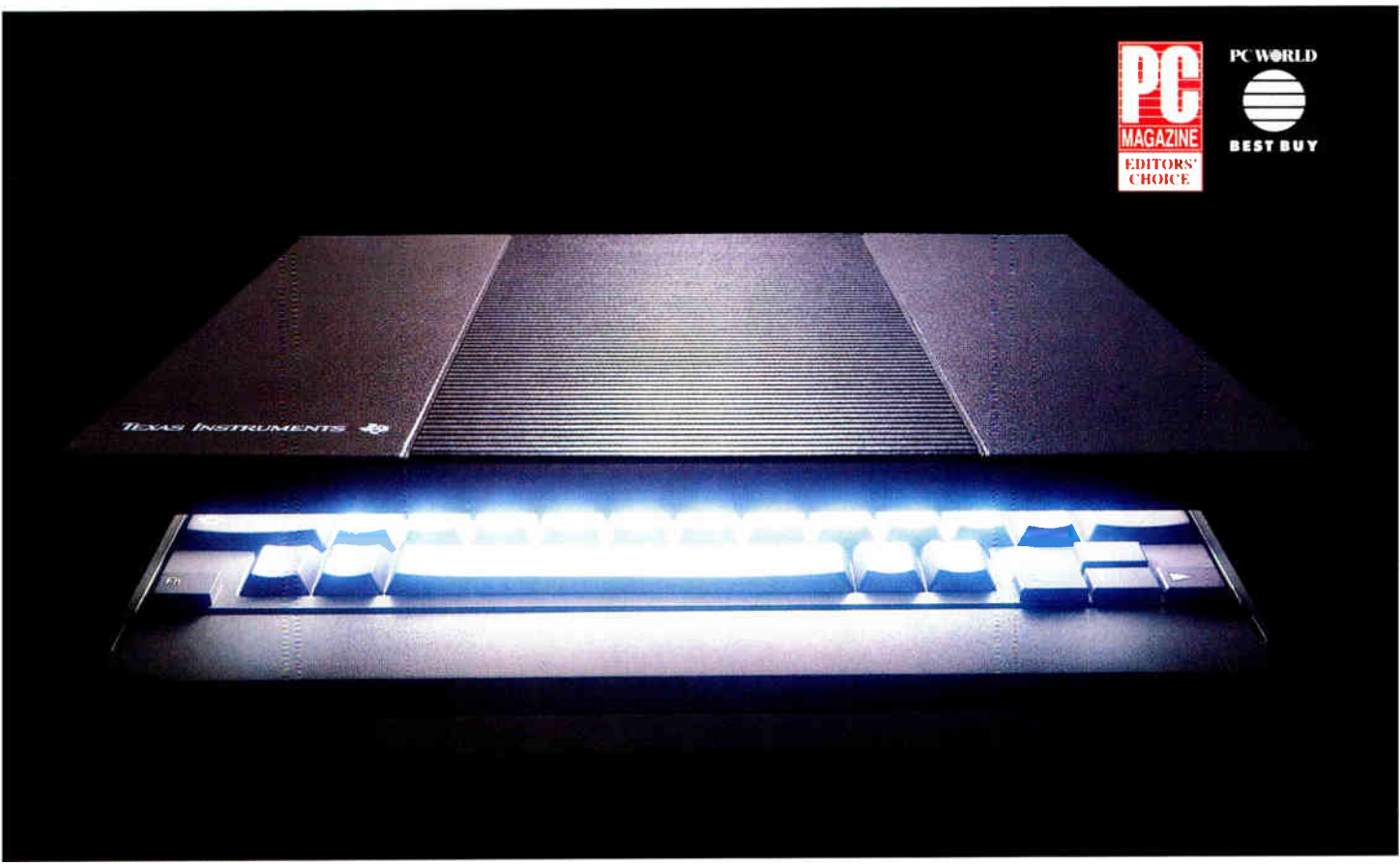
Executives ON THE GO



The Electronic Traveler

MODERN MARVELS KEEP EXECUTIVES PRODUCTIVE ON THE ROAD, TOO.

The new look of power.



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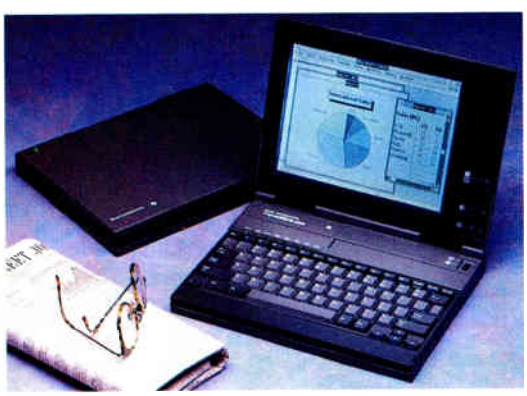

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TEXAS INSTRUMENTS

FOR INFORMATION, CIRCLE NO. 11

THE ELECTRONIC TRAVELER

BY TERRY BREEN

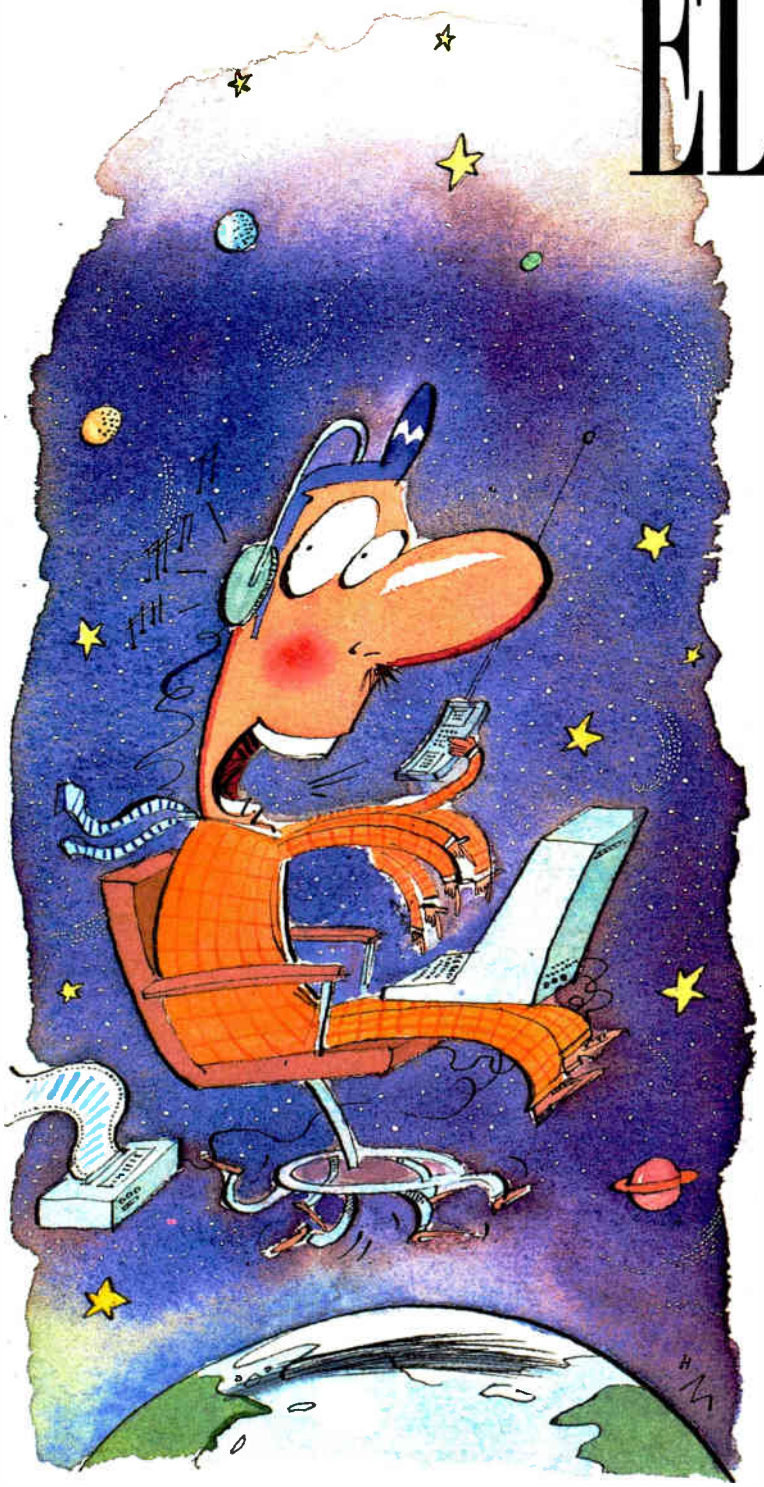


ILLUSTRATION: HAL MAYFORTH; COVER PHOTO: HOME OFFICE COMPUTING MAGAZINE

PORTABLE PHONES, LAPTOP COMPUTERS, AND OTHER MODERN MARVELS KEEP EXECUTIVES PRODUCTIVE ON THE ROAD, TOO.

▶A screenwriter portraying a state-of-the-art business executive might click with a script about a 41-year-old Minneapolis computer-industry analyst named Gary Smaby.

In an action-packed tale of endless planes to catch and details to juggle, Smaby (cover) would be an electronic marvel, thanks to the mobile office he carries in a canvas bag over his shoulder.

As the movie opens, Smaby would be videotaping a business presentation with a Sony camcorder not much bigger than his hand...

Cut to Smaby plugging his camcorder into his hotel-room TV, then dictating reactions to the tape into a tiny Olympus Pearlcorder microcassette recorder...

Then to him making a crucial call on his hand-held NEC cellular phone as he taxies to the airport...

Next, to a close-up of that same phone, with the camera pulling back to reveal Smaby bicycling down the beach near his winter home in San Diego...

Then to an airplane where he records his expenses for the day, then writes a report on a Tandy laptop computer...

Then to his next hotel room, where Smaby uses the laptop's built-in modem, linked to the phone, to send that report to a client's electronic mailbox

The Seiko Receptor ($225) is a digital watch plus pager.

and, moments later, receives a document on his portable Panasonic fax/answering machine...

Finally, to yet another phone, where Smaby dons featherweight Sony headphones and clicks on his portable Sony compact-disc (CD) player to unwind with some soothing jazz on his way home to Minneapolis...

Where he notes: "With the gear I carry in my bag, it doesn't make any difference where I am as long as there's a phone line."

Certainly, not all business travelers employ electronics with the passion of Gary Smaby, but millions of mobile executives now rely on an ever-growing selection of electronic wonders to keep them as productive on the road as they are in the office.

Says Michael Ribero, senior vice president of marketing for Hilton Hotels Corp.: "The ideal travel scenario is one that permits an *uninterrupted* work schedule—and recent technological advancements allow me to work in a hotel room, on the road, or in the air."

Ribero works during flights on a 7-lb. Compaq LTE computer that's the size of a notebook, stays in touch from his car with a Panasonic cellular phone, and relaxes by watching movies on his Sony Video Walkman, one of an increasing number of tiny VCRs that play tiny 8mm tapes.

Greyhound Corp. Chairman John Teets relies not only on portable phones, but on portable fax machines. On the road, he plugs his portable Savin fax machine into hotel room data ports to send and receive sensitive documents in privacy as well as comfort.

Likewise, David Masten, chairman/CEO of Cheskin-Masten, a Palo Alto, Calif., marketing research firm, appreciates his Tandy 1100 FD laptop computer as much for security as productivity. "Even in the close quarters of an airplane, my laptop's flat screen makes it difficult for people next to me to read what I'm writing," he says. "Using the laptop is more secure than writing on a pad."

One of the smallest hand-held cellular phones is the Motorola MicroTAC.

A hand-held cellular phone can even be a lifesaver, John Vitta Jr. discovered. The Detroit-area salesman for Ecolab Inc. recently was accidentally locked into a storage compound surrounded by a high fence and barbed wire. As barking guard dogs began circling his car, Vitta pulled his NovAtel phone from his briefcase and called for help.

Clearly, portable—often battery-powered—electronic devices have set road warriors free. The ripple that began 30 years ago with the first portable pagers, and intensified eight years ago with cellular phones and portable computers, is today a tidal wave of increasingly useful—and affordable—compact devices.

Consider electronic pagers. Originally used only by emergency personnel, battery-powered pagers are now worn or carried by nine million Americans in all walks of life. A proliferation of networks transmitting via satellite and/or radio, including national services SkyTel, Metrocast, and Cue Paging, allow subscribers to be beeped in and around most American cities—and, soon, internationally.

Sony's Video Walkman ($1,200 and up) color TV/VCR fits in the hand.

Using a pager generally is much cheaper than a cellular phone. Most pagers sell for $150-$400, and basic subscriptions run about $50 a month for national service.

Besides beeping, flashing, or vibrating, the typical pager (weighing only several ounces) displays callback numbers and short messages. For those desiring access to long messages, Cue Paging and SkyTel provide a voice-mail system.

Recently, Motorola combined the pager with a digital watch. Its Wrist Watch Pager ($300) is the size of a sports watch, weighing just 2oz.

Like pagers, cellular phones—some small enough to fit pocket or purse—can be used just about anywhere. That's because cellular telephone service—named for the "cells" or radio coverage areas which serve callers as they move

Sony's 8mm camcorder ($1,100) weighs only 2 lb.

The Sharp Wizard is an expandable organizer.

about—is now available in 300 U.S. cities. More than two million Americans use cellular phones.

Until the last few years, business travelers were limited to car-mounted "mobile," or heavy shoe box-sized "transportable" cellular phones. While less powerful, the new "portable" or "handheld" phones are more than adequate in metropolitan areas. Typically the size of cordless phone handsets, they're priced from $300 to $2,000.

One of the smallest hand-helds, Motorola's MicroTAC, is the size of a checkbook and weighs 11 oz. The $2,000 unit features speed dialing and call screening, and can store 120 numbers. Among distinctive services, Cincinnati Microwave's portable phone (a special Motorola Ultra Classic, $795) features a "Plus" button, connected to company headquarters, offering free roaming or service assistance.

Car phones also are becoming more innovative. In its upscale 1991 Plymouth, Dodge, and Chrysler models, Chrysler Corp. features Visorphone—a hands-free, speakerphone-style cellular phone mounted on the driver's sun visor ($869 plus installation). After punching in a number, the driver can talk while keeping both hands on the wheel. The unit automatically mutes the car radio during a call.

Cellular phone users pay handsomely for the convenience. Besides regular long-distance phone rates, they are charged a monthly service fee of approximately $30-$60, which includes some airtime, plus 35¢-65¢ for additional minutes, whether receiving or calling.

Through a small interface, today's cellular phones also can send and receive data from portable fax machines and computers. Among the portable fax machines are the Medbar Portafax 2001 ($700), a paperless unit that displays data on any computer or TV screen; Panasonic KX-F80 ($850), which doubles as an answering machine; Mitsubishi Acces, with built-in speakerphone ($1,299); and Ricoh PF-1 ($1,695), the smallest portable fax machine capable of sending and receiving letter-size documents. The size of a business letter, the PF-1 is 2 in. thick and weighs 5.5 lb. Most fax machines, by the way, double as copiers.

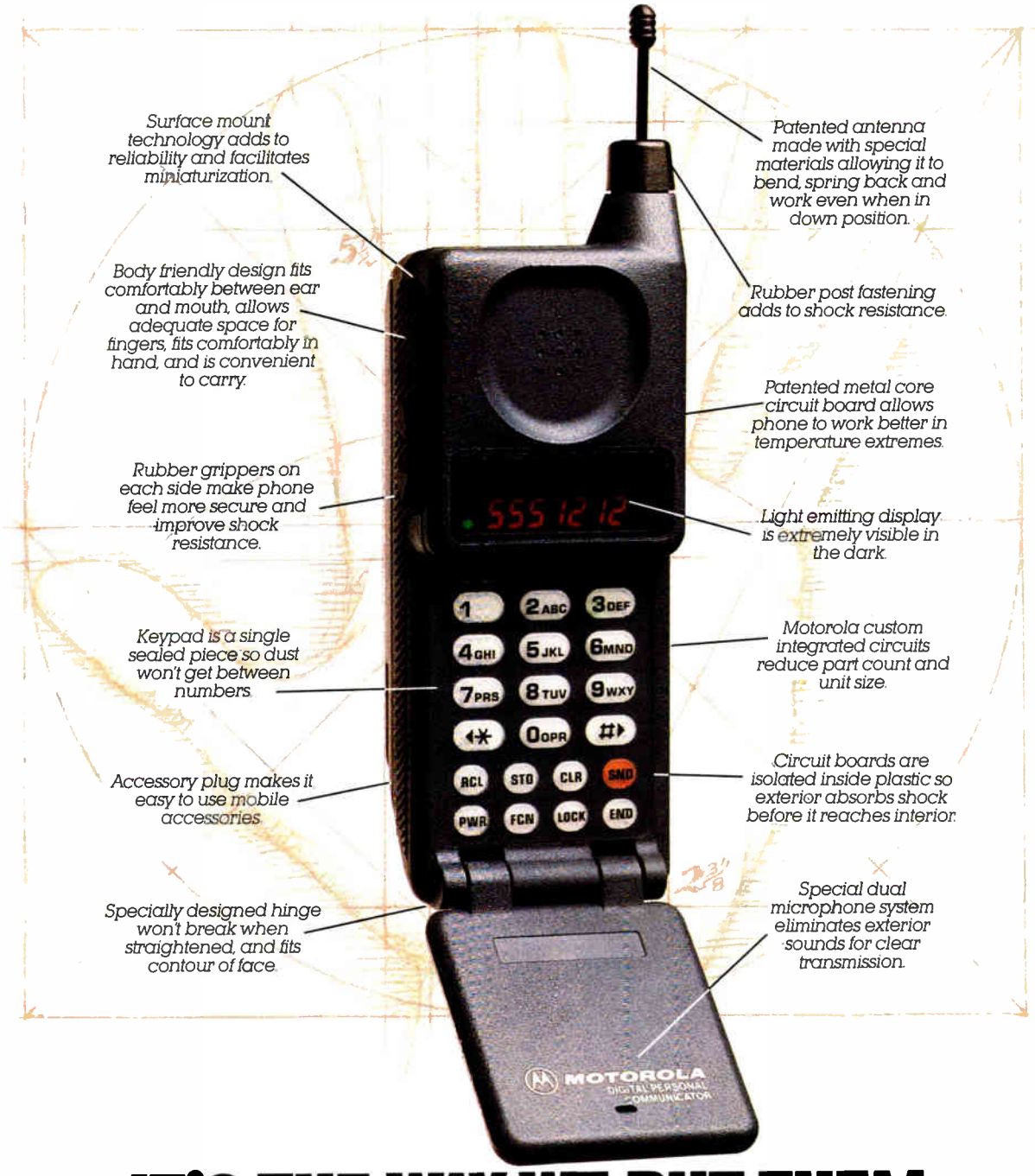
While portable computers can telecommunicate via cellular phones, Intelligence Technology Corp. recently launched what it calls the world's first *cellular* laptop computer—a portable computer and cellular phone combined (ITC 386 CEL; $8,700).

Benefits of exchanging computerized data over the phone while on the road—whether using cellular or standard land lines—include tapping into distant mainframes and electronic mail systems. But whether a portable computer is linked to a phone line or not, it's a grand traveling companion. Today, practically any computing that can be done in the office can be done on the road, thanks to small but powerful portables.

Among the most innovative laptop computers (these generally weigh 10-15 lb) is GRiD Systems' new GRiDCASE 1550sx. It's the first laptop PC with a "mouse" electronic pointing device built into the keyboard. Price: $6,295.

Notebook computers resemble thick hardcover books, easily fit into a briefcase and generally weigh less than 7 lb. State-of-the-art models include the Texas Instruments Travelmate 2000 ($3,999) and Compaq LTE/286 Model 20 ($4,600), both of which feature a 20MB hard-disk drive; 4.4-lb. NEC UltraLite ($2,500); Zenith MinisPort ($1,999); Tandy 1500 HD ($1,999), the only notebook computer weighing less than 6 lb with floppy and hard-disk drives; Toshiba T1000 ($999).

Even smaller than a notebook computer is the "palmtop" Atari Portfolio



IT'S THE WAY WE PUT THEM TOGETHER THAT SETS US APART.

At Motorola, we believe a cellular phone not only should work the first time out of the box, but we feel it should also be working years down the road.

And after we build them, we make it our business to ensure they're built right.

We put our phones through one of the most rigorous testing programs in the industry, exposing them to everything from temperature extremes to assorted shock and drop tests.

And this painstaking attention to quality pays off. Over the years the quality built into our phones has won over more than customers. It's also won some very prestigious awards. In 1988, Motorola received the first Malcolm Baldrige award, given by the President of the U.S. to recognize the quality of Motorola's equipment and services. And this year, Motorola received Japan's 1989 Nikkei award for creative excellence in products and services.

The fact is, when it comes to quality and durability, our phones don't just stand out.

They stand alone.

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($400), the size of a VHS videocassette and weighing less than a pound. Yet, it can perform a wealth of spreadsheet and word-processing functions, besides serving as an appointment calendar and calculator.

Smaller still is a device that's not quite a personal computer, but much more than a pocket calculator. The "electronic personal organizer," small enough to fit pocket or purse, serves as a sophisticated electronic notepad for appointments and phone numbers. Some organizers also can store a sizeable number of notes, which later can be downloaded into a computer system at the office.

Most popular organizer is the Sharp Wizard, available in eight models ranging from $100 to $400. The more advanced can store up to 35 pages of memos and several thousand phone-directory and calendar entries. Optional integrated circuit cards can expand the Wizard into a travel guide, language translator, spreadsheet, and more.

More specialized and less expensive (below $200) than electronic organizers are a bevy of pocket-sized electronic

Seiko's Multilingual Translator translates instantly.

novelty items, including pocket language translators, money exchange calculators, business-card files, and automatic phone dialers.

On the horizon are portable computers that recognize handwriting and/or the human voice. PCs that replace the keyboard with either a pen and electronic pad or a microphone soon will be common.

Les Spielman, president of Hospitality Automation Consultants, a hotel-technology consulting firm in North Hollywood, Calif., foresees the not-too-distant day when he'll have a laptop computer that will act like a real live traveling secretary.

"I'll be able to tell it to get me certain flight information, it will dial up the Official Airline Guide and get the information downloaded, and read it back to me in a synthesized voice," he says. "And this is the kind of traveling secretary that won't get me in trouble with my wife."

Terry Breen is a Chicago-based freelance writer and former senior editor of LODGING HOSPITALITY magazine.

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FOR INFORMATION, CIRCLE NO. 15

pointed out that a plot of supply current vs. speed shows that biCMOS is already beginning to outdistance CMOS as the low-power technology. More surprising, says Dykes, is the fact that the power-dissipation cross-over point between CMOS and biCMOS tends to occur well below the typical operating frequency of today's systems. In addition, biCMOS has much lower deviation in temperature than either CMOS or bipolar alone, says Michael Polacek, Signetics' marketing manager for biCMOS logic in Sunnyvale, Calif. And this helps solve a serious system problem in connection with critical clock distribution.

Yet another consideration is parameter distribution, which tends to be tighter in biCMOS than in CMOS, says Tom North, president and chief executive officer of Aspen Semiconductor, a subsidiary of Cypress Semiconductor Corp. established to exploit biCMOS technology. "In CMOS," North says, "you can see the same parts performing over a 25-to-45-ns spread. In biCMOS, the spread will typically be more like 5 ns. That's a distinct advantage from a manufacturing point of view." Also, he says, "from a reliability point of view, biCMOS tends to be more robust with respect to latchup."

The list of benefits goes on: "We're finding that with biCMOS you can get a couple of other things that people weren't thinking about," says TI's Chatterjee. "For example, in switched CMOS, you get a lot of noise; usually biCMOS gives better noise performance. What's more, biCMOS is a lot more efficient in being able to drive long lines across large chips. And it can operate at very low [ECL] logic levels."

As system speed rises to 50 MHz and above, predicts analyst Hutcheson, designs will shift from TTL logic levels to ECL's 3 V—and biCMOS will no longer be an option but a requirement. "There's a prospect of desktop ECL systems that cool with fans just like a normal personal computer," says Aspen's North. "BiCMOS pretty much opens a market for ECL systems."

Still, every stick has two ends, and biCMOS is no exception. On the down side, according to some, is its complexity in terms of masks and process steps—and the resulting higher cost. Also, for the same function and lithography, biCMOS often uses more chip real estate, adding to cost and cutting yield. "We see biCMOS as a niche technology—an enabling technology—and in no way challenging CMOS for the mainstream," says Robert Blair, senior vice president, ASIC group, at LSI Logic Corp. in Milpitas, Calif. "The reason is very simple: it's a more complex process, and its cost structure in manufacturing is going to be substantially higher than CMOS for many years to come."

But Jordan of IDT points out that as device speed rises, the number of masks to implement logic in CMOS increases. "As CMOS adds more mask steps to get higher performance it approaches parity with biCMOS, and the cost of the two converges," he says.

BiCMOS proponents also counter that the cost/performance trade-offs are favorable when considering cost-effectiveness at the system level, given the high degree of integration possible on a board and the savings from reduced cooling requirements.

Still, in Blair's opinion, "BiCMOS will have to earn its position on cost performance. Nobody can stand up and announce the arrival of biCMOS

MIXED-SIGNAL ICs MEAN GREATER SYSTEM INTEGRATION

AMONG THE ATTRACTIONS of biCMOS is the capability it offers of putting high-performance digital and analog functions on the same chip, permitting high degrees of system integration. That's the road that veteran manufacturers like Analog Devices, Harris Semiconductor, and SGS-Thomson are taking, along with biCMOS startups like Vanguard Semiconductor.

Vanguard, of Milpitas, Calif., was spun off in 1989 as a division of California Micro Devices expressly to exploit biCMOS. With a 1.2-μm process soon to be scaled to 0.8 μm, the company has already announced a half dozen products, including high-speed track-and-hold, differential, and video-buffer amplifiers.

Future products may embody what Mehrdad Nayebi, director of engineering, intriguingly describes as a new form of logic "that is faster than ECL but uses the same power." It uses a bootstrapping technique with n-MOS capacitors and differential bipolar amps. He cites a design for a sampling system that required a slew rate beyond the 10-V/ns capability of ECL. "With this [logic] technique we were able to get 18-to-19-V/ns," he says.

Three trends are fueling the growth of mixed-signal ICs, says Dennis Buss, vice president for technology development at Analog Devices Inc. in Norwood, Mass. These are a move toward adding analog input/output sections to digital microprocessors, the replacement of some traditional analog functions by digitally intensive architectures, and the advent of mixed-signal application-specific ICs.

The company has at least six biCMOS processes in production; its most potent, ABCMOS-1, imparts unique properties to high-speed ADCs, audio DACs, and disk-drive read-electronics circuits, Buss says. ABCMOS is based on a 10-V, 1.6-μm n-well CMOS process to which the company has added poly-diffused 3.5-GHz transistors. The first ABCMOS-1 product is the AD671, a 12-bit, 700-ns ADC introduced in May. Beyond ABCMOS-1, Analog Devices is developing three other process families that will be phased in over the next three to six years: analog CMOS with double-poly capacitors, digital biCMOS, and mixed-signal biCMOS.

Although Harris Corp.'s Semiconductor Sector produces a line of biCMOS standard logic and bus-interface products, the company's biCMOS strategy is heavily oriented toward mixed-signal applications. To the Palm Bay, Fla., firm, mixed signal comes in two flavors: optimized for analog and optimized for power. Harris recently introduced a cell library for mixed signal optimized for analog called HBC2500. The library is supported by a double-metal, double-poly biCMOS process with 3.0-μm CMOS and 300-MHz bipolar.

SGS-Thomson Microelectronics' biCMOS process, designated HF2CMOS, has been optimized for mixed-signal applications in telecom, video-processing, and analog semicustom. The Phoenix company's STKM2000 library is a merge between two libraries of digital macrocells and an extensive library of programmable analog macrocells. It is capable of implementing a wide range of system requirements from low to video frequencies at 2.7 to 11 V.—*Lawrence Curran and Samuel Weber*

and take over the world. It's not going to happen. It does have a role, a place it will earn, but I think that it will be a niche process over the next few years."

Because the need is there and a healthy market already exists, static random-access memories are by far the dominant area to which biCMOS technology is being applied today. BiCMOS ASICs comprising gate arrays and standard-cell arrays account for the largest segment of the biCMOS market, but SRAMs represent higher unit-volume production. Hence their role as technology driver.

According to In-Stat Inc., the Phoenix-based semiconductor industry watchers, biCMOS SRAMs will chalk up $809 million in sales in 1994. Not surprisingly, the Japanese—including Hitachi, Fujitsu, Mitsubishi, NEC, and Toshiba—are all participants in the high-speed SRAM market; leading U. S. contenders include Aspen/Cypress, IDT, Motorola, and Texas Instruments. National Semiconductor Corp. recently dropped its SRAM development, as did Philips International NV of the Netherlands. National is concentrating its biCMOS efforts on ASICs and bus-interface chips.

As reduced- and complex-instruction-set microprocessors push the speed envelope past 30, 40, and 50 MHz, faster and larger main- and cache-memory capacity has become mandatory. Pure bipolar ECL consumes prohibitive amounts of power as you get to densities in the 256-Kbit region. Pure CMOS gets the densities all right but bumps up against speed limits and other problems, like bounce when switching. Enter biCMOS.

"At any point in time, processor performance in workstations and PCs dictates the benchmark for memory," says IDT's Jordan. "To take advantage of the speed of the 80486 and RISC requires 256-Kbit SRAM and 1-Mbit DRAM. Four 64-Kbit SRAMs produce more capacitance—and thus reduce speed—on a board than a single 256-Kbit SRAM." Moreover, at 30-MHz and higher clock speeds, the SRAM must operate at 15 ns or lower, and only biCMOS parts can run this fast. IDT has just begun shipping samples of a 12-ns, 256-Kbit SRAM.

BiCMOS SRAMs come in two flavors: with ECL or TTL I/O, each with different speed/power trade-offs. Typically, they are designed with a CMOS core of storage cells surrounded by bipolar drive circuits at the periphery.

Fujitsu Microelectronics has been strong in the bipolar SRAM business for some time, especially the ECL variety. "But we realized when we were at the 64-Kbit level that to achieve power, speed, and density considerations at 256 Kbits, we'd have to go to an alternative technology," says Ray Creech, product marketing manager for SRAMs at Fujitsu in San Jose.

Last year, the company introduced two ECL biCMOS SRAMs organized as 256K by 1 and 64K by 4 and implemented with a 1.2-μm process. By the end of the year, Fujitsu will have introduced 1-Mbit devices in both ECL and TTL, both organized as 256K by 4 and 1 Mbit by 1. Speeds will be 15 ns for the ECL device and 25 ns for the TTL.

Creech casts his vote for biCMOS as a dominant technology in the 1990s. "By 1992," he says, "virtually all the products I'm producing will be biCMOS."

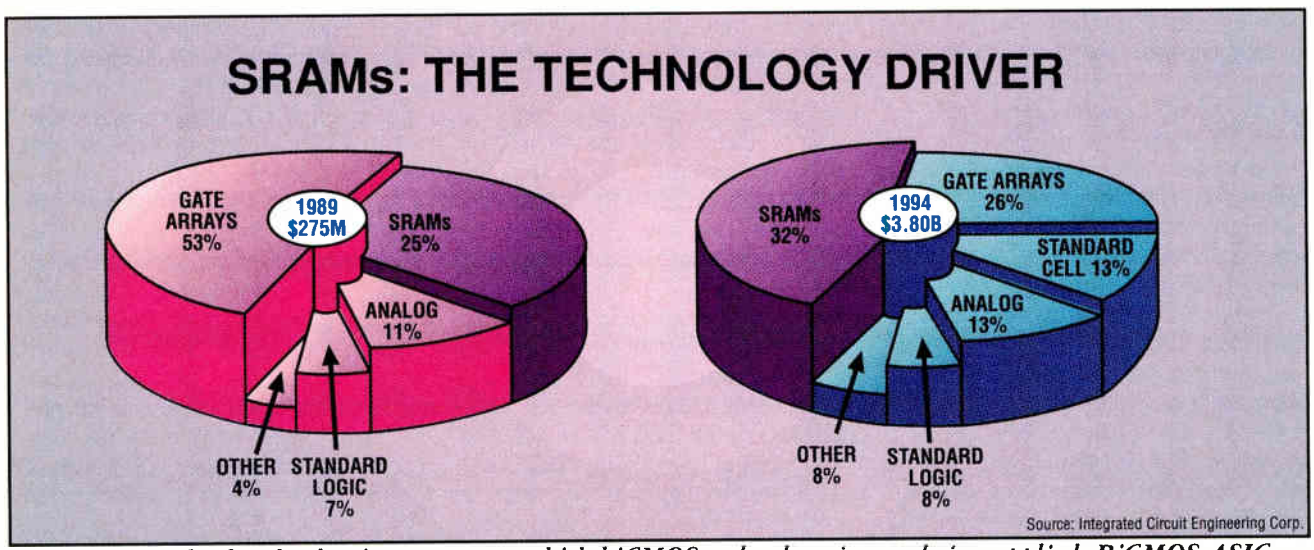
Hitachi Ltd. is another major player, utilizing its Hi-BiCMOS technology in both ECL and TTL product groups. The company can implement 2.0-, 1.3-, 1.0-, and 0.8-μm products now, says Robert Tabone, SRAM product marketing manager in Brisbane, Calif. In 1992, Tabone says, the process will be extended to 0.5-μm technology at the 1- and 4-Mbit level. Hitachi's 1-Mbit-by-1 ECL SRAM runs at 15 and 18 ns.

"As the 1.0- and 0.8-μm CMOS technology came on line," Tabone recalls, "CMOS devices could rival the performance of biCMOS up through the density level of 256 Kbits at speeds of 15 ns. The performance demarcation became very fuzzy. But we saw the increasing prevalence of 32-bit machines that perform at 33 MHz and higher, so we see a substantial market for TTL I/O at 256 Kbits and higher, in the speed range of 10 to 15 ns. We expect to play heavily in that market."

Next year, he says, Hitachi will offer a 256K-by-4 TTL device in that range. "We're talking here about 1-Mbit devices that will go faster than ECL devices go today. It will be a function of 0.8-μm technology and advanced design techniques," says Tabone.

Also zeroing in on SRAMs is Aspen Semiconductor, which Cypress established in Aspen, Colo., to produce small, very fast biCMOS SRAMs for cache. It has about 10 devices in production: the fastest is a 64-Kbit TTL part at 8 ns—a performance level that will be required as RISC processors get to the 40-MHz level and beyond.

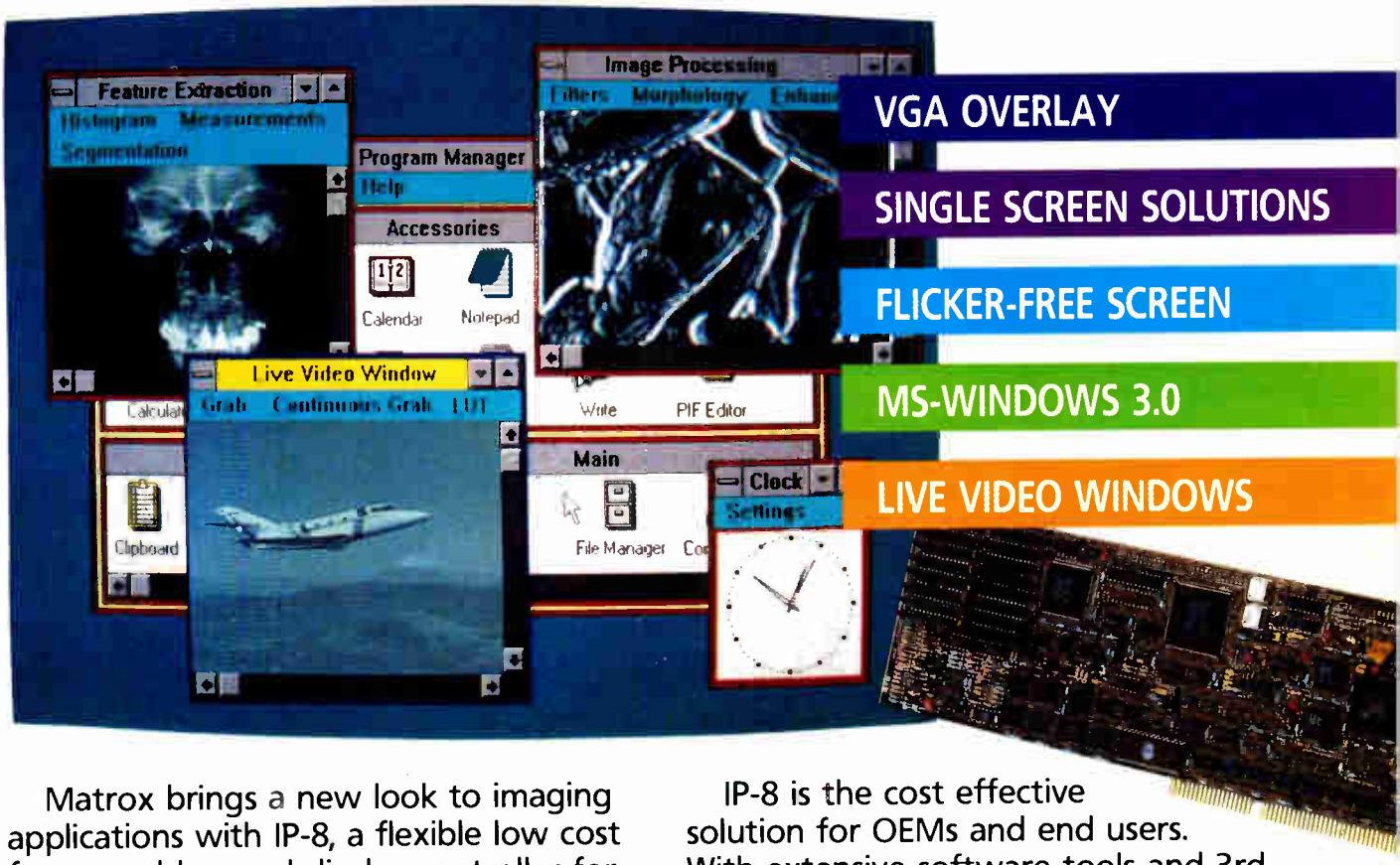
Aspen's North denies that there is a



SRAMs are by far the dominant area to which biCMOS technology is now being applied. BiCMOS ASICs account for the largest market segment, but SRAMs represent higher unit-volume production.

IP-8

THE NEW LOOK IN IMAGING



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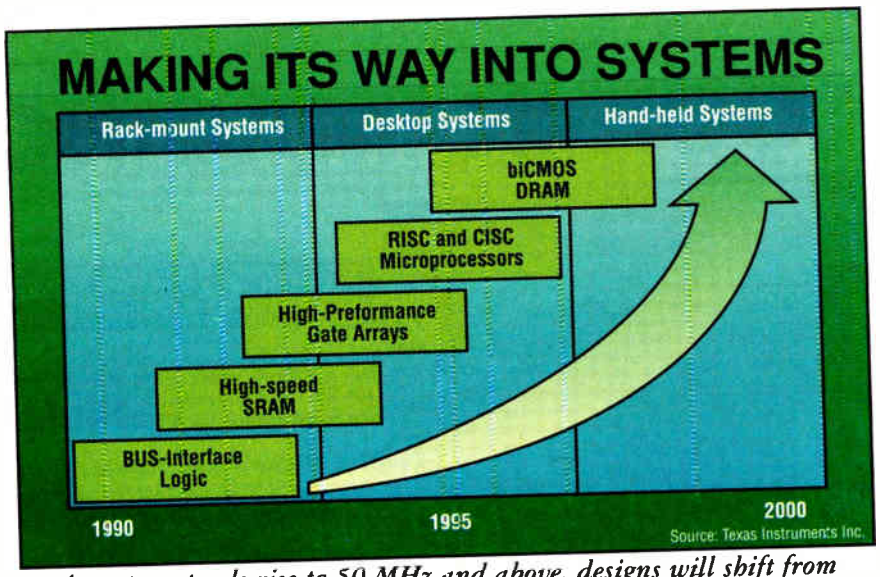


As system speeds rise to 50 MHz and above, designs will shift from TTL to ECL's 3 V—and biCMOS will be a requirement.

significant difference in density between biCMOS and CMOS SRAMs. "Our 64-Kbit biCMOS RAM is actually smaller than the CMOS RAM with the same 0.8-μm geometry. If you make the same comparison among competitive products, they are within 5% or 10%—there's no significant difference unless more features are added." North says that biCMOS SRAM density should track that of dynamic RAMs and will ultimately reach the 64-Mbit level.

Motorola Inc.'s MOS Memory Products Division in Austin, Texas, is gearing up to introduce biCMOS fast SRAM products with a 1.0-μm process. The company will have three 12-ns parts in early 1991, says Curt Wyman, product marketing manager for fast SRAMs: a 32K-by-8 device and two versions at 64K by 4, all with TTL I/O and aimed at high-performance cache applications. They will be configured with "evolutionary" pinouts, he says—that is, with corner power and ground pins. "The next parts we'll introduce in the second quarter will be ECL I/O versions of 32K by 9, and that will begin 'revolutionary' pinouts," Wyman discloses. "They will have center power and ground pins, and they'll be 10-ns parts."

Wyman says the company has a major program to develop 0.8-μm biCMOS with a full slate of products scheduled for 1992. "All the Motorola products faster than 20 ns will be biCMOS," he predicts. Late in 1992, 0.5-μm products will debut, according to the current road map.

For its part, TI is bringing biCMOS up on a number of different fronts, including a biCMOS version of the Sparc RISC microprocessor and, for the military, a biCMOS-based parallel processor called Aladdin. TI has also announced what is probably the largest gate array yet developed—a unit with 150,000 available gates (see p. 48).

Dubbed Viking, the biCMOS Sparc project is targeted at "state-of-the-art performance in a workstation-server processor," says Leon Adams, open systems marketing manager for the microprocessor and microcontroller products and logic group in Houston. "We see that biCMOS will get us up to 2.5 to 3 times CMOS performance with the same technology, but at only 30% more cost." Specifics are lacking, but Adams says the Viking will comprise "many millions of transistors with lots of on-board stuff. It will be competitive with anything else out there at the time"—late 1991.

The Aladdin computer is being developed by TI's Defense Systems and Electronics Group for the Defense Advanced Research Projects Agency. It is an Ada-programmable, modular 32-bit parallel processor comprised of five basic multichip biCMOS modules (BPMs). The entire computer is about the size of a soup can—4 in. in diameter—but it packs supercomputer performance. Each BPM has a maximum throughput of 100 million instructions/s of general-purpose scalar processing, simultaneous with 400 million floating-point operations/s plus 200 MHz of I/O—a total of 500 mips, 2,000 megaflops, and 1 GHz of I/O. TI designed four biCMOS ICs to complement the main RISC processor for each module. These include a vector coprocessor, a crossbar switch, a processor-interface chip, and a 10-ns, 16K-by-9 SRAM. The computer is intended for an advanced class of "smart weapons."

Signetics is one semiconductor house that enthusiastically embraces biCMOS as a mainstream technology. "We've made a very strong commitment to biCMOS," says Darrell Mayeux, strategic marketing manager for standard products. "We're looking at biCMOS to be the technology banner that we hold up." The company's main target is not memory, but bus-interface functions. As part of an aggressive strategy, Signetics forged an alternate-source agreement with TI last June to produce advanced biCMOS (ABT) bus-interface families.

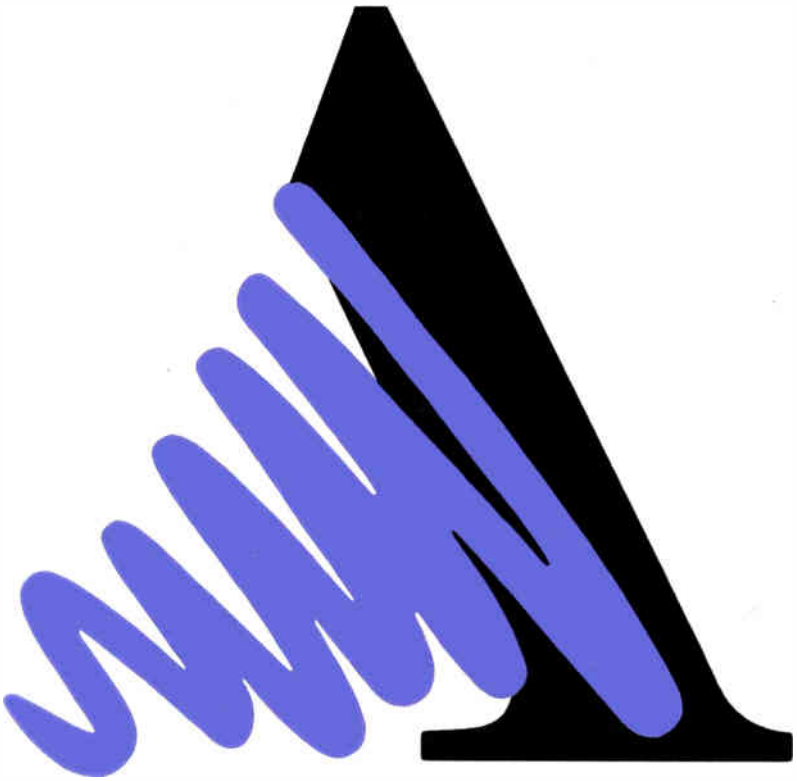
Initially comprising 39 TTL logic functions such as buffers, transceivers, latches, and flip-flops, the devices are being fabricated by each company with its own process technology: Signetics with its 1.0-μm bipolar, 0.8-μm QUBiC process and TI with its EPIC-2B. In October, the two announced another agreement to jointly develop a chip family that implements the Futurebus+ standard. Called FB2000 by Signetics and TFB2000 by TI, the first sample parts will begin to go out early next year.

In yet another strong move in November, Signetics unveiled the first family of advanced biCMOS bus-interface logic devices featuring 16-bit word widths. Dubbed the Multibyte family, its expanded functionality can halve system board space while offering 64 mA of output drive. Existing CMOS wide-word devices can't match that drive capability, says Michael Polacek, marketing manager for biCMOS logic.

"This is a perfect example of how you can take the biCMOS process and open the door to areas that are completely logical and that the world has been waiting for a long time," he says. "Today's buses aren't 8 bits wide anymore, they are 32 and 64 bits wide. And there's no reason why interface devices have to be 8 or 10 bits wide. The reason they are is that in the past, speed took priority over integration." But with biCMOS, Polacek says, "we can double the width of existing products with no compromise in performance."

Applied MicroCircuits Corp. of San Diego was one of the earliest suppliers of biCMOS ASICs, having introduced its Q14000 array line in 1987. Recently, another line, the high-speed Q24000

What Happens When ZyMOS and Renaissance GRX Take the Same Name...



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series, fabricated with mixed 1.0-μm CMOS/1.5-μm bipolar technology, was added to the product mix. Applied Microcircuits claims that at 210-MHz internal and interface frequency, it is the fastest family of biCMOS logic arrays commercially available.

The devices are made with a so-called "sea-of-cells" architecture, says Marc Friedman, director of strategic marketing. "With our smallest cell, you can implement a flip-flop—rather than a gate being four devices, our unit has at least twice that. We use three-layer metal and we upgraded our routing tools to enable us to get up to 95% utilization. There are no channels; all the cells abut one another. First-level interconnects define the function, second- and third-layer metal interconnect between cells."

Recently, AMCC began sampling a pair of chips implementing the Hippi (High-Performance Parallel Interface) ANSI data communication standard. Developed in conjunction with Network Systems Corp. of Minneapolis, the application is ideal for biCMOS, Friedman says. "It requires both ECL and TTL, runs at about 25 MHz, uses a wide word so the effective data rate is 800 Mbits/s, and runs over a cable up to 25 meters that requires differential ECL."

In late September, Micro Linear Corp. of San Jose obtained a license to AMCC's 1.5- and 1.0-μm biCMOS technology in exchange for cash and foundry support. Micro Linear specializes in high-performance linear standard and semistandard products, heretofore in bipolar and CMOS. AMCC's technology will enable the company to optimize mixed-signal products that have a significant amount of analog circuitry, says Charles Gopen, Micro Linear's vice president of marketing. The company will initally apply the technology to its line of local-area network products, hard-disk drives, and other power- and motion-control products.

This month, National Semiconductor announced three families of high-speed, low-power biCMOS gate arrays based on an 0.8-μm process called ABIC IV. The NGB family has only biCMOS gates—4,000 to 75,000 of them—while the NGM and NGR families mix biCMOS and bipolar ECL in 5,000 to 94,000 gates. The NGR array includes eight blocks of 512-by-10 SRAM. Early next year, the Santa Clara company will also expand its line of high-performance logic with a biCMOS family called BCT. These high-speed (30-to-66-MHz), low-power devices will be aimed at bus driving and interfacing in high-performance systems.

For its part, LSI Logic is testing the biCMOS waters with the LDD10000 array series, using a 0.9-μm CMOS and 1.5-μm bipolar two-layer-metal process. With TTL/CMOS input/output compatibility, the device comes in six sizes ranging from 7,198 to 116,778 available gates. The firm is also using biCMOS for high-frequency front ends in parts for cellular phones and for satellite communications.

Fujitsu currently offers two product lines in biCMOS gate arrays; the B-H series is an older line for small-gate-count bus-driving applications. It's envisioned as a TTL replacement and is available in 400 to 3,000 gates. A more recent entry is the BC-H line with gate counts from 4,312 to 16,720. One product in the series offers 8,000 gates and 40 Kbits of embedded RAM. ECL, TTL, or combined I/Os are available on the same array. Fujitsu will be moving toward 100,000- and 200,000-gate devices with a sea-of-gates approach in the future, says Joe Schwartz, product manager for biCMOS and GaAs ASICs.

'YOU CAN TAKE THE BICMOS PROCESS AND OPEN THE DOOR TO AREAS THAT THE WORLD HAS BEEN WAITING FOR'

Motorola is also applying biCMOS to its custom business, particularly in mixed-mode applications. BiCMOS is ideal for mixed mode, says Tom Lantszch, marketing director for bipolar. Product strategy is to focus on the video marketplace, mass storage, and disk drivers and controllers—markets characterized by a continuing need to drive up performance while shrinking the size of the application, Lantszch says. For these applications Motorola uses a 1.2-μm triple-level-metal process. Much of this biCMOS production will take place at a new $325 million advanced technology and manufacturing facility the company is building in Chandler, Ariz.

BiCMOS has become the strategic linchpin of several small companies, including Cherry Semiconductor Corp. (see p. 47). Another is Micro Power Systems Inc. of Santa Clara, until last year primarily a supplier of custom and semi-custom products built with CMOS and a low-performance biCMOS process.

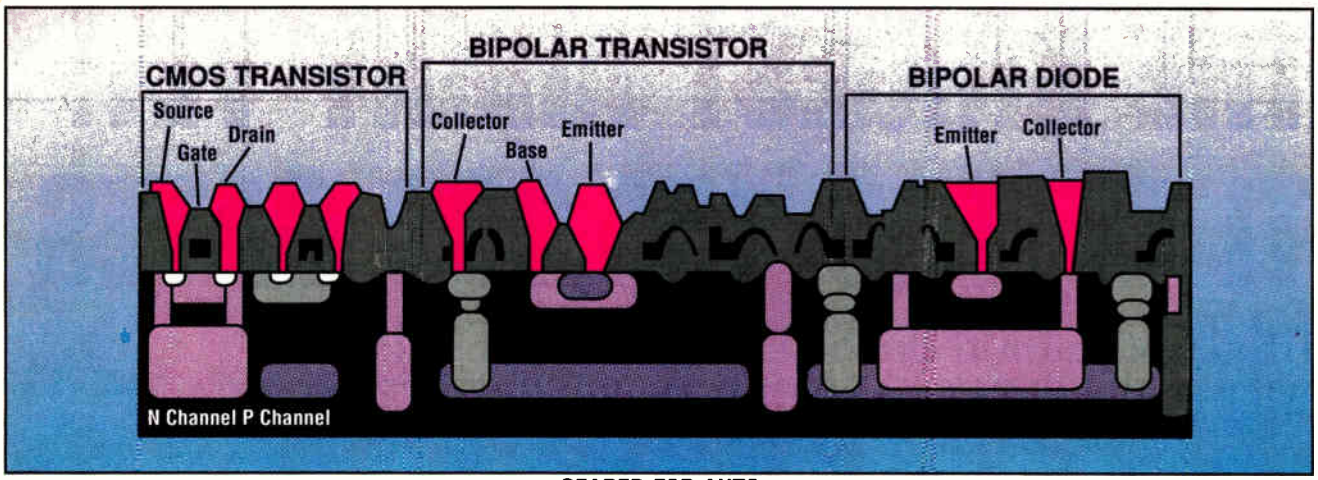
Plagued by the need to retain multiple technologies and dependence on nonrecurring engineering charges as a major revenue source, the company changed direction last year. It's now putting major emphasis on standard converters built with an advanced biCMOS process called BiCMOS IV, coupled with thin-film technology.

The company retired 62 older, low-technology devices and is designing high-speed products for the imaging and video market, says Tom Hardy, vice president of sales and marketing. Micro Power plans to extend its digital-to-analog converter products into the 16-bit arena, and is aiming at 12-bit and higher monolithic analog-to-digital converters. The company will continue to serve the custom market as well. In September, Micro Power announced the availability of an alternate source for Analog Devices Inc.'s 574A 12-bit ADC, long the industry standard. Fabricated in biCMOS, the MP574A is a monolithic upgrade of a two-chip version the company had marketed earlier. While the chip exactly duplicates the functionality of the Analog Devices' converter, Micro Power has halved the power requirements and reduced the noise.

At startup Silicon Connections Corp. of San Diego, "Our aim is to provide systems-level solutions with innovative and quality biCMOS products," says Jonathan Yu, president and cofounder. "We don't do everything—we try to solve the bottleneck areas in a system."

The company's first product is the SC2001, a 4-by-4-by-20 crossbar switch fabricated in a 1.2-μm process, jointly developed with Seiko Epson. Aimed at multiprocessor systems, the switch can handle multisource-to-multidestination synchronous switching of data paths at up to 100-MHz cycles. In the works are SRAMs, clock drivers, and bidirectional 40-bit-wide transceivers. The company has a 1.0-μm process as well and is developing 0.8 μm. ■

Additional reporting by Jonah McLeod



GEARED FOR AUTO

A cross-section of devices that will be available on the same chip in Cherry's biCMOS process shows, from left, a CMOS transistor, a standard bipolar transistor, and a bipolar low-leakage diode.

BICMOS HITS THE ROAD

CHERRY TWEAKS A RECIPE AIMED AT AUTOMOTIVE SOCKETS

BY LAWRENCE CURRAN

SEMICONDUCTORS

BICMOS ISN'T THE SOLE province of semiconductor giants. It's a tool that Barry Wiley says his company had to have in order to continue serving customers in the 1990s, especially those with automotive applications. Wiley is vice president of marketing and sales at Cherry Semiconductor Corp., which will have invested more than $1 million by the end of 1991 to develop an 80-V biCMOS process. The East Greenwich, R. I., company has seen first-silicon wafers fabricated with the new process, and expects to offer samples of initial application-specific development devices within six months.

Until now, the wholly owned subsidiary of Cherry Corp., Waukegan, Ill., has made a living providing integrated circuits and discrete devices made with a linear bipolar process to users in both the auto and computer-peripheral businesses [*Electronics*, February 1990, p. 87]. The $37 million company holds the conviction that biCMOS offers attractive mixed-signal performance stemming from the combination of bipolar's high drive capability and the low standby power that's characteristic of CMOS—a tandem especially well suited for auto electrical systems.

In addition, Cherry has enhanced device isolation to provide smaller transistors and low parasitic leakage currents, says Peter Rathfelder, Cherry's supervising engineer for process development. "The strategy for our biCMOS process was to add CMOS, DMOS, and dual-junction isolation to a breakdown-enhanced bipolar process," he says.

The 15-mask, single-layer poly, single-layer metal process will yield devices with minimum breakdown voltages of 80 V and 10-MHz logic, with TTL-compatible (20-MHz) CMOS speed. The 80-V biCMOS transistors will include standard vertical npn, enhanced lateral pnp, and isolated vertical pnp types. Low-leakage diodes at 60 V will also be available, as will Schottky diodes, implanted resistors, 120-V DMOS output devices, MOS stacked capacitors, polysilicon resistors, and, later, I^2L bipolar devices. Automotive applications for these circuits are in switches, regulators, and display drivers as well as solenoid and motor drivers.

"We operate from a five-year strategic plan that looks at what we need to remain relevant to our customers," Wiley says. "One of the needs was for a biCMOS process that allows us to further integrate, because straight bipolar wouldn't cut it." The decision was made two years ago to proceed with a new process, with one of the main considerations that it be compatible with Cherry's existing fab facility. "We considered purchasing a process or signing a joint technology agreement with someone else," Rathfelder says. "But each time we did that, it looked like it would have been too expensive to manufacture."

Rathfelder says that the Cherry biCMOS process is evolving well. To date, all device types except the I^2L bipolar units have been fabricated. "The bipolar devices are all very near the model parameters and are at higher-than-planned breakdown voltages. The CMOS devices also have higher-than-modeled output currents, and their speeds exceed the minimums required," he says.

There are 317 transistors in the mask set of the first wafers. Once first-silicon parameters have been fine-tuned, "We will develop a semicustom array that will incorporate all of the devices we have in the process," Wiley says. Plans then call for samples to be available for customers to evaluate as an ASIC vehicle either late in the first or early in the second quarter of 1991.

THE BIGGEST ARRAY YET: TI OFFERS 150,000 GATES

ITS 180-MHz, HIGH-DENSITY BICMOS ASIC FAMILY WILL UNDERCUT ECL AND GaAs IN PRICE

BY LAWRENCE CURRAN

BICMOS ARRAYS IN THE 100,000-gate ballpark are in development at a few major semiconductor manufacturers (see p. 40), but Texas Instruments Inc. is nearing introduction of an application-specific integrated circuit family that includes a sea-of-gates design offering up to 150,000 available (112,000 usable) gates. The device is believed to be the highest-density biCMOS gate array to date. It offers clock speeds greater than 180 MHz plus the ability to drive long, heavily loaded internal networks. The high drive ability stems from a novel core-logic cell design that incorporates an internal bipolar drive capability instead of limiting that ability to the chip's periphery, as most CMOS gate arrays do.

Developers at TI's ASIC Division in Dallas say members of the 0.8-μm family could show up in 1991 as central processors, glue logic, or as companion devices to reduced-instruction-set-computing CPUs in supercomputers or engineering workstations. Another application might be in telecommunications systems, where speeds greater than 180 MHz are required.

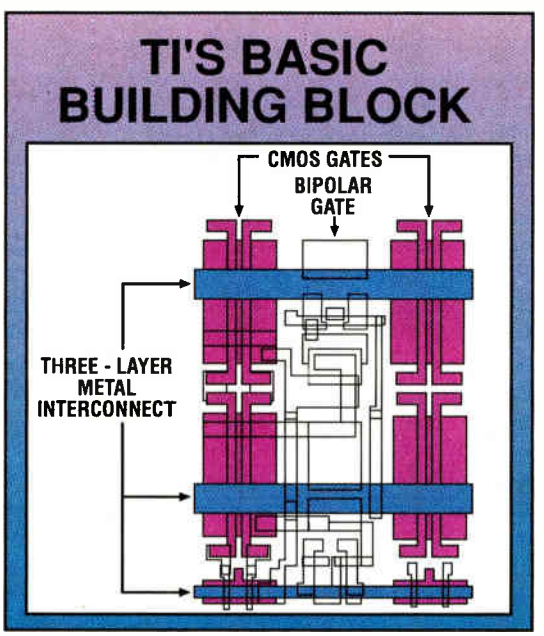
TI has seen "fully functioning silicon on more than one design" in the family, which will span a range from 13,000 (10,000 usable) to 150,000 available gates, says Tom Sprunger, manager of high-performance ASICs. He adds that advanced computer-aided design tools to support the family are now in beta tests with customers.

Sprunger says pricing for the biCMOS gate array family is still to be determined, and while it will be higher than for CMOS arrays, "it will be vastly lower—probably by an order of magnitude—than for [similar] emitter-coupled logic or gallium arsenide" arrays.

The new family is cast in TI's EPIC-IIB process—an 0.8-μm, technology based on triple-level metal. Sprunger says one of the devices made to date using this array has 750,000 transistors that are partitioned into 50,000 usable logic gates and 75,000 bits of static random-access memory on the same chip, which is housed in a 309-pin package.

ASICs

In addition to the core cell design, another contributor to the array's density and performance is a four-level interconnect scheme that permits the use of more than 80% of the array's gates, which TI says is double the usual gate usage in CMOS sea-of-gates arrays. Each cell consists of 18 transistors that are partitioned into three elements: a high-drive bipolar push-pull element nestled between two CMOS elements. Each cell incorporates enough components to implement two CMOS two-input NAND gates, or one biCMOS plus one CMOS NAND gate.



Each cell comprises a high-drive bipolar push-pull element and two CMOS gates.

The cell's bipolar element offers greater drive capacity than does pure CMOS. The large capacitive loading presented by external loads, such as those encountered in bus-interface applications, is difficult to accommodate with a CMOS driver. The same is true of the internal core circuitry used in large memory structures and in long, high-fanout interconnect paths. TI developers say that bipolar transistors are less sensitive to capacitive loading than is CMOS and, when coupled with CMOS transistors, provide a solution that's especially well suited to these complex circuits. In this array, intrinsic gate delay is a low 220 ps, which increases to just 360 ps when loaded with a fanout of four and 1 mm of metal interconnect.

Sprunger says that translates into biCMOS having five to 10 times the drive capability of CMOS in terms of the number of internal networks the logic can drive. "You'd need five times as many gates in CMOS to drive the same number of networks," he adds.

As for the interconnect approach, TI uses three levels of metalization and a fourth, local-interconnect scheme that boosts gate usage to about 80%. That contrasts with the two levels typical in CMOS sea-of-gates arrays, in which as much as 60% of the available gates are sacrificed to metal runs. TI has patented the local-interconnect concept, which uses straps of highly conductive titanium nitride to connect the polysilicon gates and the sources and drains of the transistors in the basic cell, implementing various macro functions. E

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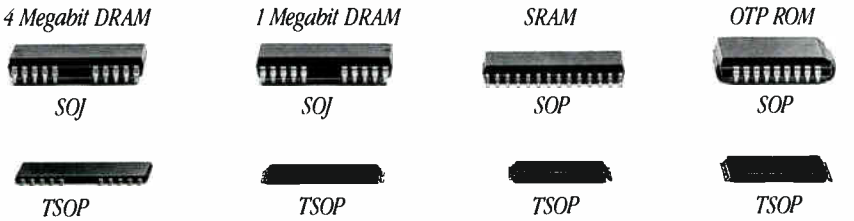

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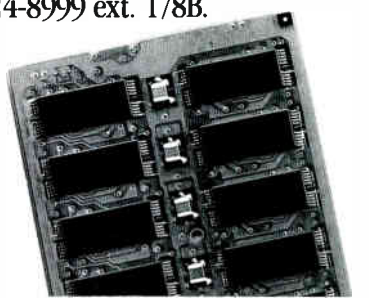

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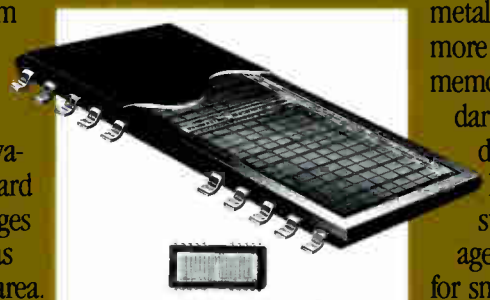

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1990 Award for Achievement

Co-inventor of the integrated circuit and cofounder of two of the most powerful semiconductor firms in the industry—Fairchild and Intel—Bob Noyce spent his last years pushing for U.S. chip-making competitiveness as head of Sematech

ROBERT N. NOYCE

His Cessna Citation jet streaked low and fast overhead, not quite as fast as he might have flown it himself, perhaps, but nonetheless in fitting tribute to the memory of Robert N. Noyce, whose adventures in life ranged from exploring the physics of semiconductors to piloting his own plane. The flyover was the poignant finale of a memorial gathering in San Jose, Calif., last summer to honor the man some called the father of Silicon Valley.

Robert Noyce died unexpectedly in June at the age of 62 [*Electronics*, July 1990, p. 4]. As the co-inventor of the integrated circuit and cofounder of two of the most influential semiconductor companies in the U.S.—Fairchild Semiconductor Corp. and Intel Corp.—Noyce was a near-legendary figure in the industry. As president and chief executive of Sematech, the U.S. semiconductor industry consortium, he dedicated himself, over the course of two years, to ensuring that U.S. companies would remain in the forefront of semiconductor manufacturing technology.

These are the reasons that Noyce has been chosen to posthumously receive the 1990 *Electronics* Award for Achievement.

"He always believed he could invent the future, and he made a serious commitment of resources and time to do so," says his widow, Ann Bowers. Noyce himself eloquently expressed his outlook in a 1989 speech. "Necessity, they say, is the mother of invention," he said. "We have a lot of necessity in our society today, and I think the time is here for inventing new approaches, new solutions to those various problems, so that we can indeed maintain America—and, indeed, the rest of the world as well—as the land of opportunity for all of those that will be the achievers of the future."

Noyce's can-do attitude owed much to his upbringing. The third of four sons of a Congregational preacher, Noyce grew up in the small Midwestern town of Grinnell, Iowa, during the Depression. The values instilled in his youth proved to be "the foundation for work hard, save your money, get an education, try to get ahead," Noyce once

recalled. Working hard came naturally to Robert Noyce. "When there was a job to be done, he did it happily," says Gordon E. Moore, chairman of Intel and Noyce's colleague for more than 30 years. Those jobs ranged from mopping up a flood in Intel's factory on the company's first Christmas Eve to taking a leading role in the newly formed Semiconductor Industry Association when U.S. chip makers first began to see a need for collective action.

As for saving money, it was "a virtue" during the Depression, Noyce once said. But "today, America's emphasis is on consuming, not saving. As a result, our national savings rate is the worst in the industrial world, our corporations are starved for capital, our trade deficit is enormous, and our trading partners are buying our national assets." Foreign acquisitions of U.S. high-tech companies became a major concern. Always a doer as well as a thinker, Noyce played a major role in finding U.S. buyers for Perkin-Elmer Corp.'s semiconductor production equipment operations and was lobbying, at the time of his death, to prevent the proposed Japanese acquisition of Semi-Gas, a Silicon Valley materials supplier.

Noyce came to California in 1956, when he was offered a job at Shockley Labs working under William Shockley, one of the Bell Labs inventors of the transistor. He did not hesitate a moment to quit his post at Philco in Philadelphia and make the 3,000-mile move. "I wanted to join the big leagues," he later explained. At the time, said Noyce, Shockley was "the guru, after whom the disciples [among them Moore] followed."

THE FOLLOWING YEAR, Noyce and seven other young engineers, including Moore, left to found Fairchild in a move that would later be recorded as the birth of the "Silicon Valley." It was as a young man in his 30s, working at Fairchild, that Noyce first conceived of the idea of building multiple transistors on a single silicon chip and created the prototype IC. (At about the same time, Jack Kilby of Texas Instruments Inc. came up with a similar, though less elegant, IC model. Following a 10-year patent-rights battle between Fairchild and TI, both companies' patents were upheld, and Noyce and Kilby duly became known as the co-inventors of the IC.)

"The integrated circuit came out of my own laziness," Noyce once said, in his typical self-deprecating style. "We took those transistors that were all nicely arranged on a piece of silicon, cut them up into little pieces, and then shipped them to the customers. Then they would put them all right back together again. So I thought, why not cut out all that middle ground and just put them together while they were still on the silicon. So that is what we did."

Though Noyce made it sound easy, Gordon Moore provides another view of this seminal invention. "Fairchild was working on the planar transistor—the basic technology underlying the IC," he recalls, "and we were looking at how we might build more complex structures. There were two things that were needed: a way of electrically isolating one transistor from the next and a way of making the interconnections between one part of the circuit and another. Bob invented solutions to both of these problems—junction isolation and the use of metalization adherent to the oxide over the film. These were the key inventions to take planar-transistor technology to the IC."

Noyce, Moore, and several colleagues founded Intel in 1968, establishing the first spinoff company in a process that eventually populated the Silicon Valley with hundreds of high-technology firms fathered by Fairchild. In recent years, he withdrew from the day-to-day management of Intel, although he remained vice chairman of the company at the time of his death.

Noyce was planning for an active early retirement, but in 1988 he felt compelled to take on a new task. At Sematech, Noyce for the first time "flew solo" in business. He quickly put his mark on the fledgling organization, drawing together the engineers and other employees on assignment from the consortium's 14 member companies into a cohesive group with a single-minded mission.

"Bob believed that Sematech represented an important new model for rebuilding the international competitiveness of U.S. industry," says Ann Bowers. "He had come to the conclusion that the old methods just were not working any more, that the U.S. had to try something new." Noyce recently described Sematech's goals in similar terms: "We are fostering cooperation to try to raise the capability of American industry. And we are doing so by adopting some of the elements of the Japanese model, a model that seems to be working better than our own."

Noyce also believed that Sematech was influencing U.S. industry and academia to "make manufacturing a respectable discipline." Persuading the Bush Administration to continue its support of Sematech became a major element of Noyce's job. He made frequent trips to Washington to lobby on behalf of the consortium and to counter the arguments of those in government who opposed federal funding.

SEMATECH IS UNIQUE, BUT the idea of getting government, industry, and academia together for a national purpose is not at all new," Noyce argued. "Years ago, the U.S. named agriculture as a critical industry and began a national effort to make sure our nation's farmers had what they needed to survive and compete. When Sputnik was launched in 1957, America decided aerospace was a critical national industry, and put its will and resources into making sure it succeeded, too."

Semiconductor manufacturing is the critical base upon which the entire U.S. electronics industry depends, Noyce argued. "Few people realize that electronics is the largest manufacturing industry in the U.S., bigger than automobiles and steel and aerospace put together. If we don't succeed in maintaining a healthy semiconductor industry the chances are we are going to lose a lot of the other electronics jobs."

To those in government who begrudged Sematech the $100 million per year funding that it receives from the Defense Department, Noyce responded: "If we succeed in our goals then this will be one of the best investments the government has ever made. And we expect to succeed."

At the Silicon Valley memorial celebration of his life, Noyce was remembered as much for the intensity with which he enjoyed life and for his wealth of talents as for his enormous contributions to the semiconductor industry. A true Renaissance man, Noyce's interests ranged from directing a madrigal singing group to underwater photography and skiing. "It seemed that Bob could do absolutely everything well," said his widow. "Yet he never made anybody else feel incompetent. He encouraged us to be more than we thought we could be."—*Louise Kehoe*

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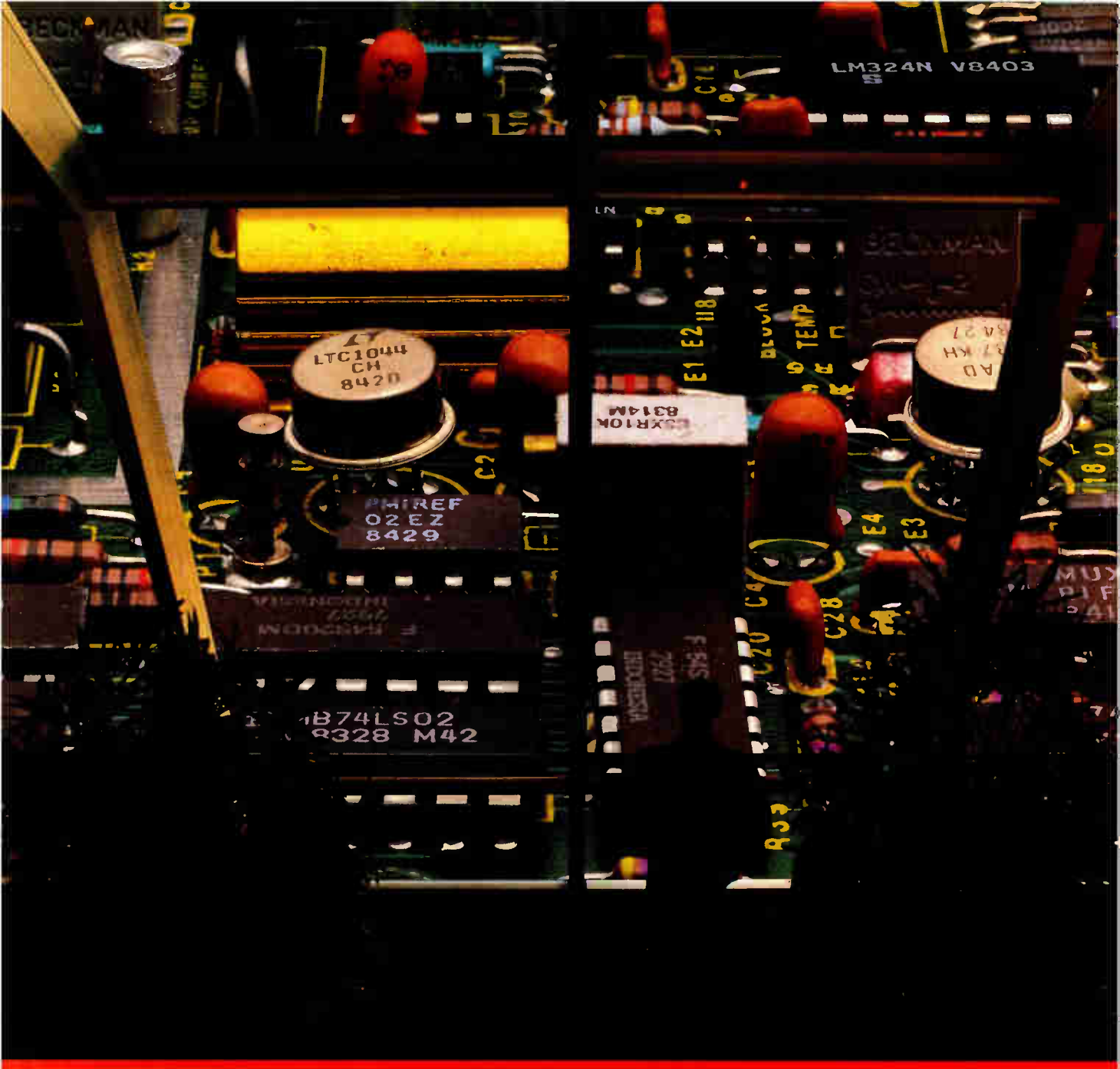

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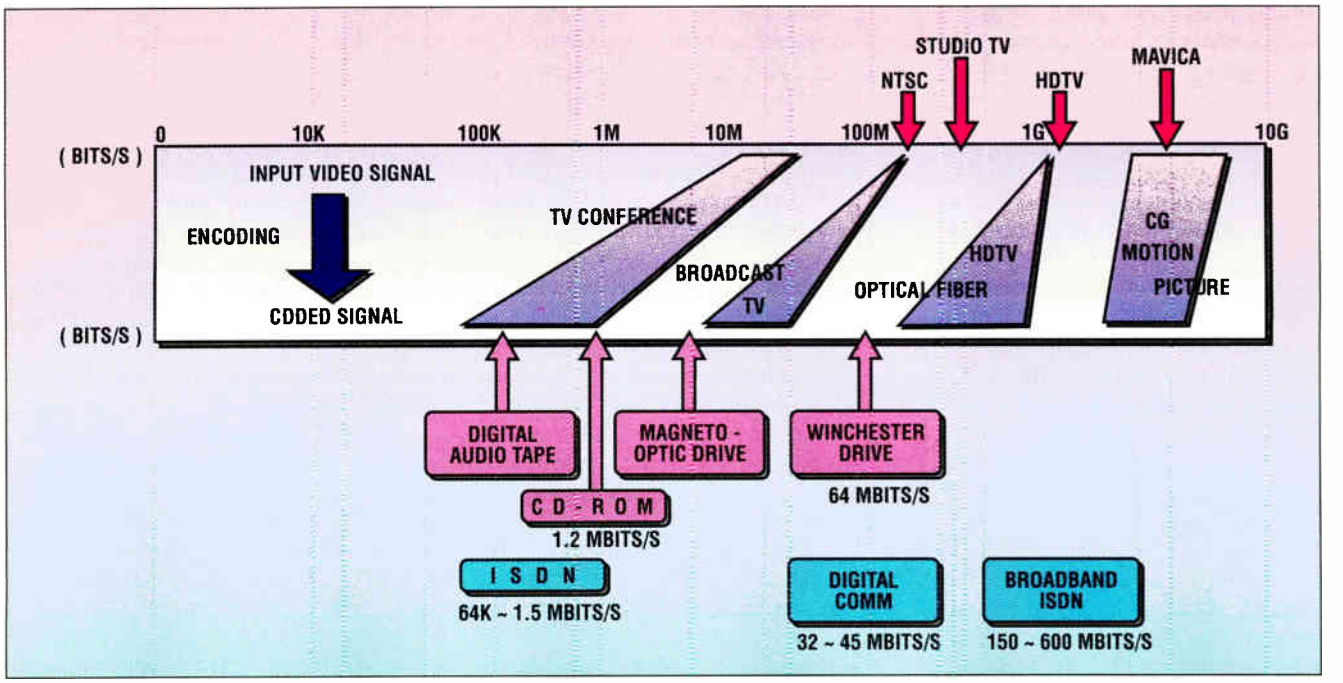


BROAD SPECTRUM

Since image compression spans many technologies, no single algorithm will cover them all.

MULTIMEDIA HEADACHE: WHO'S ON FIRST?

INTEL'S LATEST DVI CHIPS PUSH HARDWARE COSTS DOWN WHILE ISO COMPRESSION STANDARDS WAIT IN THE WINGS

BY JACK SHANDLE

MUCH LIKE ALICE'S ADVENtures in wonderland, the multimedia scene continues its technology free-fall, all the time getting "curiouser and curiouser." The good news is that some major players are embracing standards for still-picture compression, color-image interchange, audio, and motion-video compression. The curious news—for the smaller players—is that the big boys will mix and match standards with proprietary technology. Multimedia hardware will not be a commodity market.

Even curiouser, nobody has a VLSI solution that can execute the most ambitious video-compression standard. And even in its most robust implementation, the International Standards Organization's MPEG (Motion Picture Experts Group) standard will still deliver less than VCR-quality video.

In the meantime, component pricing for multimedia is coming down. For example, Intel Corp.'s recently introduced Digital Video Interactive chip set's $85 price tag means that a systems house can spend $280 for the components for a board that handles DVI motion video, still images, audio, and special-effect graphics. That's less than half the cost of competing solutions, according to Intel's Princeton, N.J.-based DVI Operation. Although Intel has been selling board-level systems to applications developers for more than a year, the second-generation chips—the 82750PB pixel processor and the 82750DB display processor—are the first to be sold on the open market.

The second-generation chips continue to offer one of DVI's trump cards: programmability. Compression and pixel-manipulation algorithms used in the chips are evolving at least as fast as chip makers deliver more performance. So keeping current means being programmable, says Larry Ryan, manager of DVI's VLSI design team.

"If you increase silicon performance by 10%," he says, "you can tweak your algorithms. But if you double performance, you can go to completely differ-

ent algorithms," Ryan adds.

So small-to-midsize companies that hoped standards would simplify their lives had better think again. While the draft MPEG proposal released in September is a big step in the right direction, it leaves plenty of room for partial implementations—and incompatibility among MPEG products when they become available. When finally approved in late 1991 or early 1992, the MPEG standard will include an audio-compression scheme and a standard for multiplexing the compressed audio and video into a single bit stream. It will not have much in common with the previously announced Joint Photographic Experts Group (JPEG) draft standard for still-image compression.

Moreover, the computational horsepower to handle the multiplexed MPEG bit stream will be daunting. "It will take several years—certainly after 1992—before the hardware will be ready that can execute MPEG effectively. By that I mean a cost-effective solution," says Karl Guttag, a TI Fellow specializing in graphics at Texas Instruments Inc.'s Houston Research Labs. Nevertheless, several chip makers—including Intel, LSI Logic, SGS-Thomson Microelectronics, and TI—are hard at work solving the so-called bops (for billions-of-operations-per-second) problem.

To add to the challenge, MPEG addresses a relatively narrow band of applications from 1.2 to 1.8 Mbits/s in the image-coding spectrum. No single algorithm can solve them all. "There are a number of algorithms tailored to different image applications such as teleconferencing, and still-image and motion video," says Rich Baker, director of research for PictureTel Inc., a Peabody, Mass., teleconferencing company. Video conferencing has a compression scheme in the standards process. It will be implemented in multiples of 64 Kbits/s and is being developed by the CCITT's H.261 committee.

Besides the standards being hammered out for these applications, systems houses will often want to include one or more proprietary compression schemes, says Baker. If its proprietary algorithm adds significant value, a systems house might want to use the formal standard just to ensure interoperability with other systems. PictureTel has, in fact, teamed up with Intel to develop algorithms that extend PictureTel's Hierarchical Vector Quantization (HVQ) and offer better performance than the standards. At the initiation of a communication, the systems decide which set of algorithms will be used. Standards become a fall-back solution.

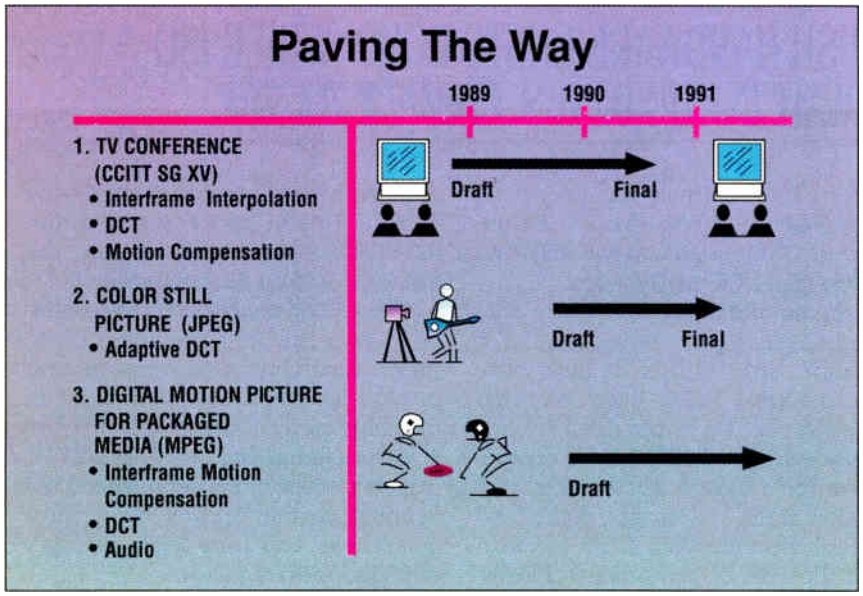
So the multimedia workstation of the future, for example, may have to execute many algorithms to attain true interoperability. These include MPEG, JPEG, H.261, DVI, HVQ, and PhotoY-CC, Eastman Kodak Co.'s proposed color interchange standard, which includes still-image compression and is complementary to JPEG. In the audio arena, CD-ROM-XA should be included, too. Sony Corp. will encode the audio bit stream in its systems with the CD-ROM-XA specification, says Takashi Sugiyama, manager of Sony Corp. of America's Multimedia Project in San Jose, Calif. Sony created CD-ROM-XA along with Microsoft Corp. and Philips International NV of the Netherlands, and it is already marketing CD-ROM-XA encoding/decoding boards. The MPEG working group for audio, on the other hand, is still deliberating on a compromise encoding scheme that will include parts of two proposals.

"As far as we know, no one is developing an audio decoder for MPEG," says Sugiyama. "So rather than wait, we have decided to use CD-ROM-XA." Besides being readily available, CD-ROM-XA also has the advantage of being compatible with the Compact Disc-Interactive multimedia specification from Philips. "CD-I is very important to us," says Sugiyama.

Al Simon, the system architect of Intel's DVI and chairman of the MPEG systems subcommittee responsible for combining the audio and video bit streams, acknowledges Sony's market clout, but disagrees with Sugiyama on the sound-quality issue. "XA requires twice as many bits to attain the same sound-quality level as MPEG," he says, "and this has some impact on the video quality, because any bits that are used for audio cannot be used for video."

MPEG's video-compression scheme has four primary components. First, the input video is transformed from the spatial to the frequency domain using the discrete cosine transform (DCT), a fast-Fourier transform. Then, frequency terms too high for the eye to perceive are deleted. Second, the remaining frequency terms are quantized. For example, instead of 256 terms being associated with a frequency, the number might be dropped to 16. Third, run-length coding is applied—that is, identical bits that are repeated are described as one bit plus the number of repetitions. The fourth step is variable-length coding. Also known as Huffman coding, this technique reassigns the coding used for each symbol so that the most frequently used symbols get the shortest codes. It is a bit like Morse code, which assigns short combinations of dots and dashes to the most frequently used letters.

The result of all this compression is a gray-scale image. Color is added by



COUNTDOWN TO STANDARDS

Progress is being made on three image standards—H.261 (or CCITT SG XV), MPEG, and JPEG. All are interrelated.

another set of algorithms. MPEG uses a YUV (chrominance, luminance, saturation) color scheme rather than RGB (red, green, blue). The resolution and frame rate for the video are also important factors. Input video is either 30 frames/s at 352 by 240 pixels or 25 frames/s at 352 by 288 pixels.

One of the most controversial issues about MPEG is its supposed symmetry. If coding and decoding can be done at the desktop, the algorithm is said to be symmetrical. If lots of computational horsepower is thrown into the encoding so that decoding is easy and the resulting image high in quality, then the algorithm is asymmetrical.

"Symmetry is basically a cost issue," says Intel's Simon. In MPEG's four-stage compression, DCT is a reversible transform that can use the same hardware for compression and decompression. The other three stages require separate and distinct hardware sets for coding and decoding.

"All MPEG will specify is the bit stream," says Simon. "So you will know how to build a decoder. But the standard says very little about how to encode those bits. It is implicit, but different manufacturers will have their own ideas on how to do it and they will be very closed-mouthed about compression." The end result is that one company's MPEG encoding could easily provide better pictures than another's. Since the MPEG algorithm is so computationally intensive, "this raises a question of whether the decoder of one manufacturer has enough mops [millions of operations/s] to decode all of the syntactically correct MPEG-coded images," says Simon. One option being considered by Simon's subcommittee is to include a minimum bit-rate decoder requirement in the MPEG bit stream generated by the encoder.

How compute-intensive is MPEG? First, compression requirements are not the only factor involved. The highly diverse types of video that must be treated are also a factor. In teleconferencing, every frame looks pretty much like the previous one. It is a safe bet to code one frame in its entirety and then just to encode the differences between frames, says PictureTel's Baker. "But broadcast video has lots of scene cuts. One frame might not look at all like the previous frame." To get around this, MPEG codes every 15th frame from scratch. The bottom line is that it will take about 1,000 mops to encode a signal in real time. Decoding might take 500 mops, says Baker, "but then you have to add mops for the audio bit stream and the multiplexing."

Managing to do this on a board-level product requires a parallel architecture, fast buses, and fast access to the memory storing the frames. Nobody has a solution, but Intel's second-generation DVI chips set a new benchmark. The chips run twice as fast as the previous generation and are fabricated in the same Intel CHMOS process as the 80486. The new chips execute 100 mops internally by doing four instructions per cycle at 25 MHz, says Intel's Ryan. Like its predecessor, the pixel processor mixes motion and still video, graphics, and text on a single screen. It just does it faster.

The display processor supports resolutions up to 1,024 by 768 pixels and most popular graphic and video formats including VGA, NTSC, PAL, and Secam. A future version with a faster clock speed will go beyond VGA resolutions. In the future, says Simon, Intel will have an MPEG-based algorithm. The next generation of DVI chips will offer more speed, handle more operations/s, incorporate more parallel processing, and perhaps reach 1,000 mops.

TI has also staked a claim in parallel-processing digital-signal processors with its TMS320C40, a general-purpose DSP that uses a six-channel direct-memory-access module and a six-port communications module to boost chip-to-chip throughput [*Electronics*, October 1990, p. 28]. The C40 delivers 50 million floating-point operations/s but can handle 275 mops inside the chip compared with 140 for its predecessor, the C30.

NOT A COMMODITY MARKET

Despite the move toward standards for video compression, color-image interchange, and audio, multimedia hardware will retain proprietary solutions. Vendors are likely to use standards for interoperability, nonstandard algorithms to add value.

Meanwhile, component pricing is dropping. A case in point: Intel's second-generation DVI chip set, at $85.

SGS-Thomson Microelectronics in Phoenix is also in the race. At the Electronica show in Munich last month, the company launched its STi3220 Motion Estimation Processor, which integrates 256 dedicated processors into a single VLSI device with a combined throughput of 14 billion operations/s. SGS-Thomson joined C-Cube Microsystems Inc., San Jose, in the single-chip JPEG market by announcing an encoder/decoder for still-image compression that uses the standard algorithm.

LSI Logic Corp. espouses still another silicon strategy, says Simon Dolan, DSP Division marketing manager. In late September, the Milpitas, Calif., design house unveiled seven products that can be mixed and matched to create image encoders and decoders. These include a DCT processor, a DCT quantization processor, a CCITT variable-length coder/decoder, and an intra/interframe decision processor, as well as an image-compression processor aimed directly at JPEG. Two other fabless chip-design houses—Chips & Technologies Inc. and Oak Technology Inc.—are also taking this approach.

Although some of LSI Logic's chips bear clear resemblance to the stages of MPEG compression, they are direct descendants of the CCITT's H.261 teleconferencing standard, says Dolan. It is important to note that MPEG is not backward-compatible with JPEG, he says. For example, JPEG has quite different quantization and variable-length coding strategies, he says.

LSI Logic thinks its chip sets will bring down the cost of video conferencing fivefold. "The 11 chips needed to implement a coder/decoder will cost about $700," Dolan says. "Adding memory and glue logic will bring the cost of silicon to about $1,000." At the system level, H.261 codecs sell in the $30,000-to-$50,000 range, so there is a lot of room for price competition. "Video conferencing is definitely headed onto the desktop," says Dolan. "By mid-to-late 1991, we will see a $10,000 codec, and by 1992, $5,000 add-in cards for PCs, Macintoshes, and Sun workstations."

Just as important to the market as lower-cost chips is the demystification of video compression. The chips make it relatively easy to build a codec, he says. Companies can get in the business without investing years to understand video compression and they avoid the stiff NRE costs of custom chips.

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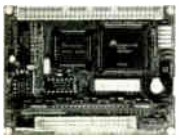

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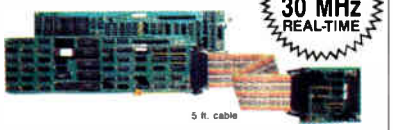

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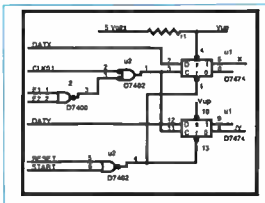

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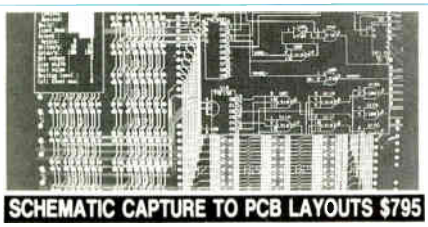

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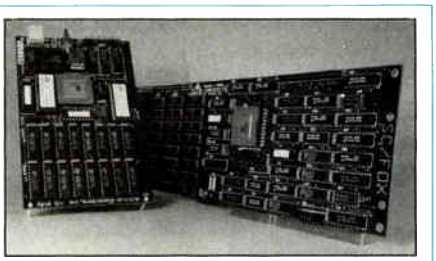

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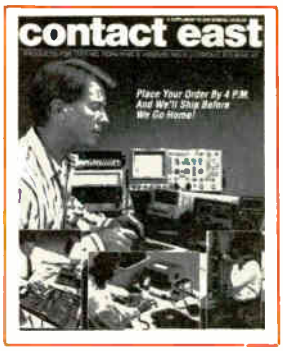

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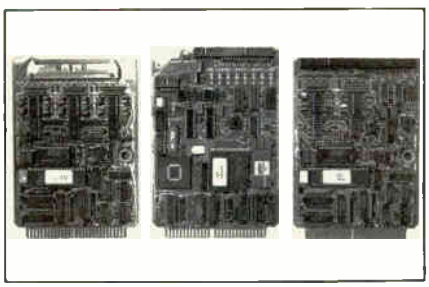

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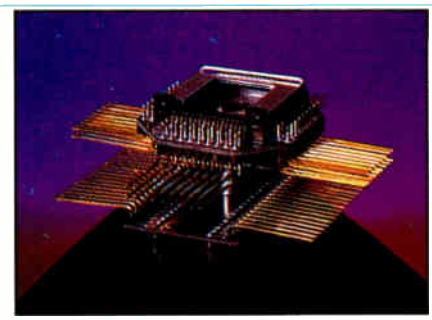

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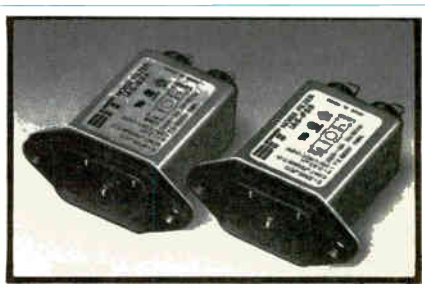

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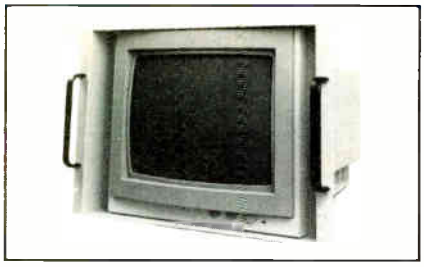

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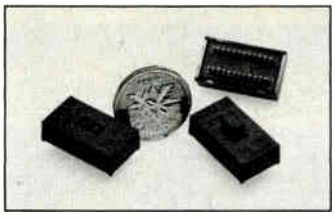

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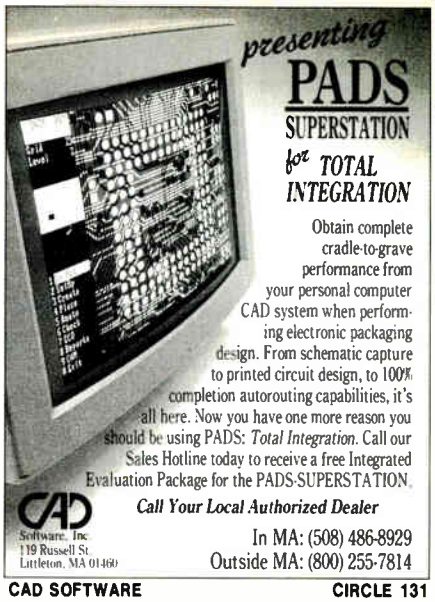

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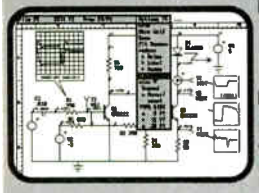

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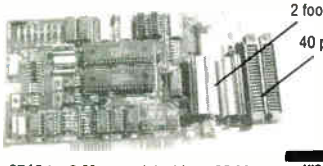

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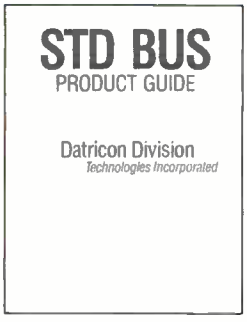

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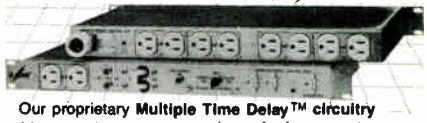

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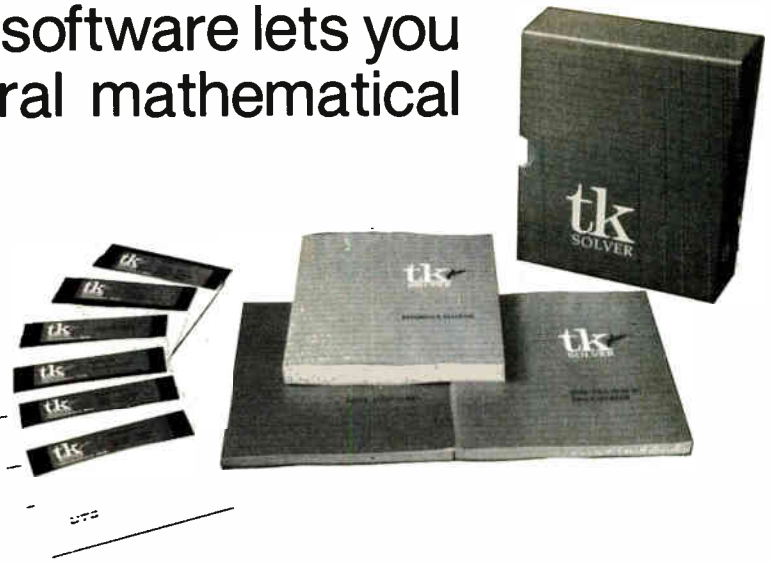

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ECONOMIC UNCERTAINTY, LACK OF support from the credit markets, and the growth transition of the electronics industry have dramatically worsened the chance for robust growth next year. The most likely scenario: continuation of modest growth despite generally weaker macroeconomic patterns.

Commerce Department data for September confirms the weakness reported last month, as order activity for computers, components, and communications equipment slowed markedly. At the same time, the automotive market is weakening and industrial production is limping along.

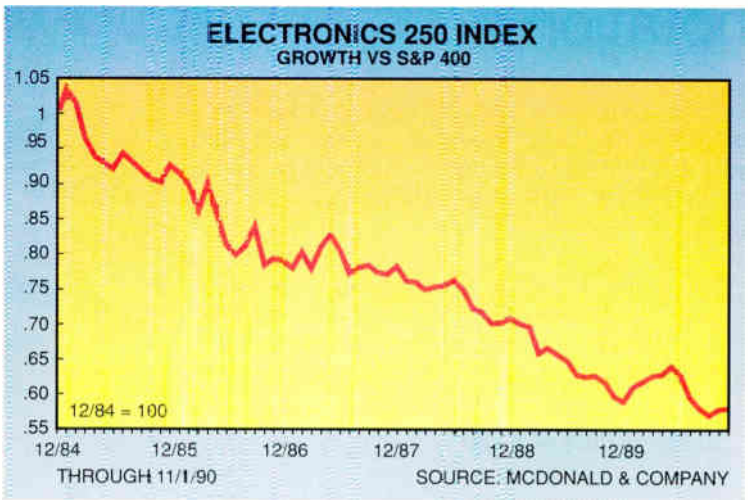
In computers, the transition to next-generation mainframe products will slow shipments until next April or May. A new mainframe cycle from IBM Corp. will also help offset the effects of weaker underlying demand.

Domestic orders for components showed some modest seasonal improvement in October, with the best performances coming from niche players. For connector manufacturers, the computer market in particular is no longer a growth market as connector content declines because of dramatic increases in wafer-scale integration.

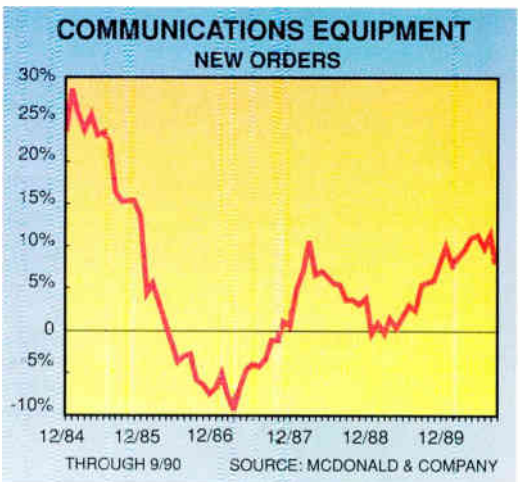
For communications equipment, the order rate also slowed in September, indicating some sensitivity to general economic patterns. Nevertheless, continuing growth should be expected due to productivity issues.

Automotive electronics applications will continue to multiply even as demand in Europe continues to slow and North American production schedules begin to slip badly. Industrial production began a slowing trend in early 1988 and has been shuffling along a trough through most of this year. The weakening value of the dollar is helping to stabilize the level of industrial activity. E

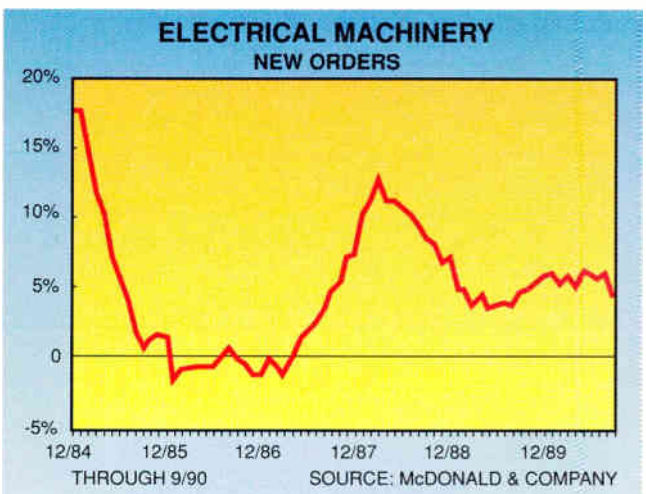
By Mark Parr, McDonald Securities Inc., Cleveland (216-443-2379)



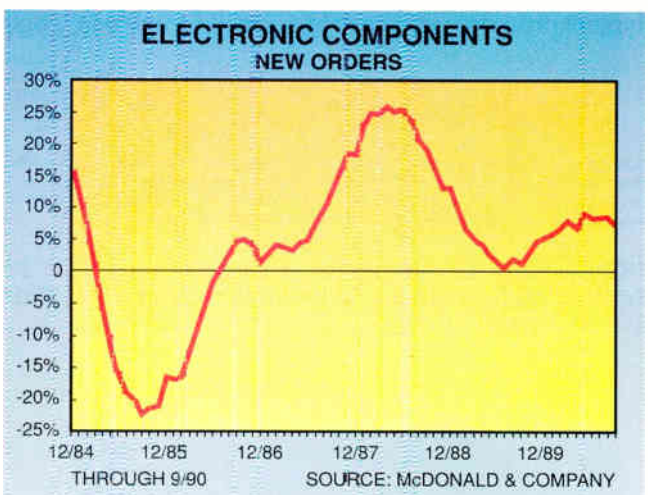
Growth in 250 electronics industry stocks has been modest, and the trend is expected to continue into the new year.



Though economic patterns caused slower growth, the uptrend should continue.



Orders for electrical machinery reflect the overall slump in purchasing, continuing to slide from an earlier uptick.



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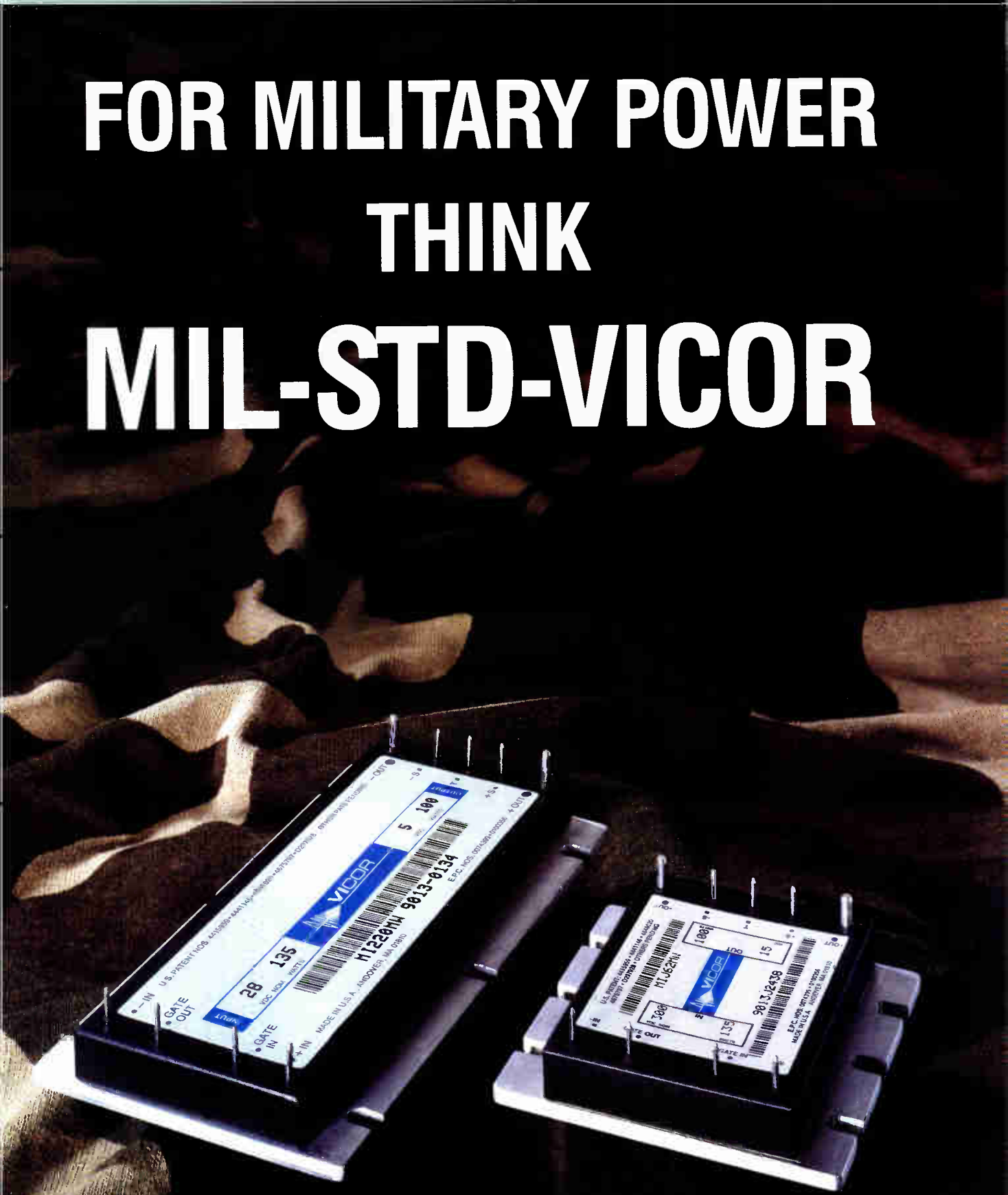

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