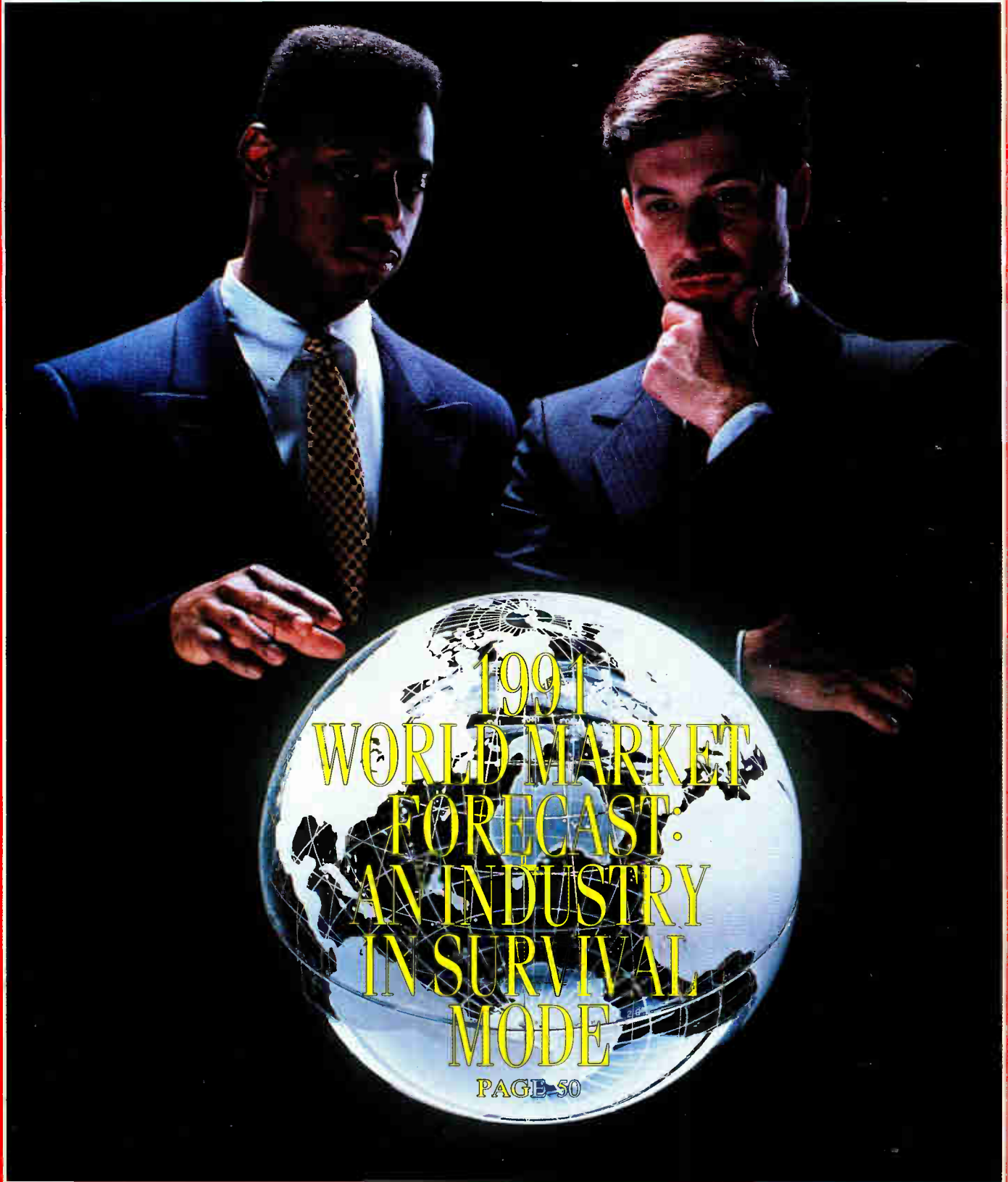


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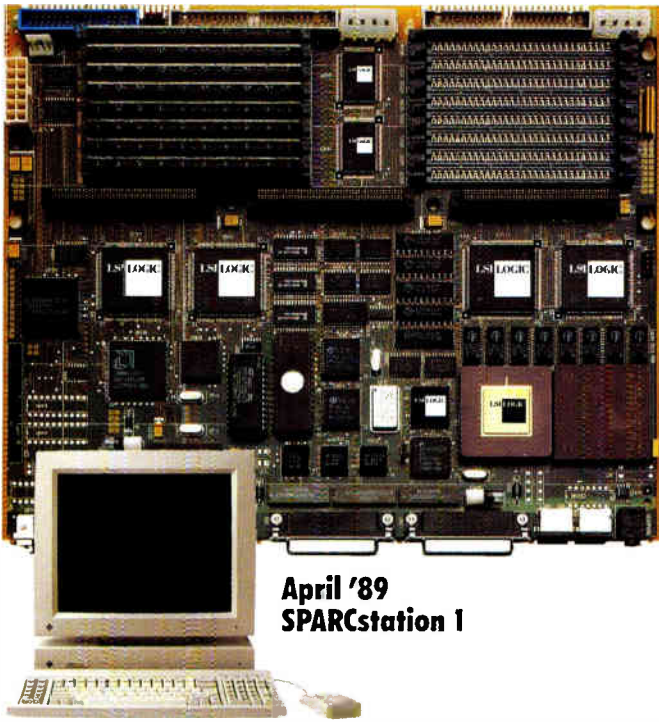
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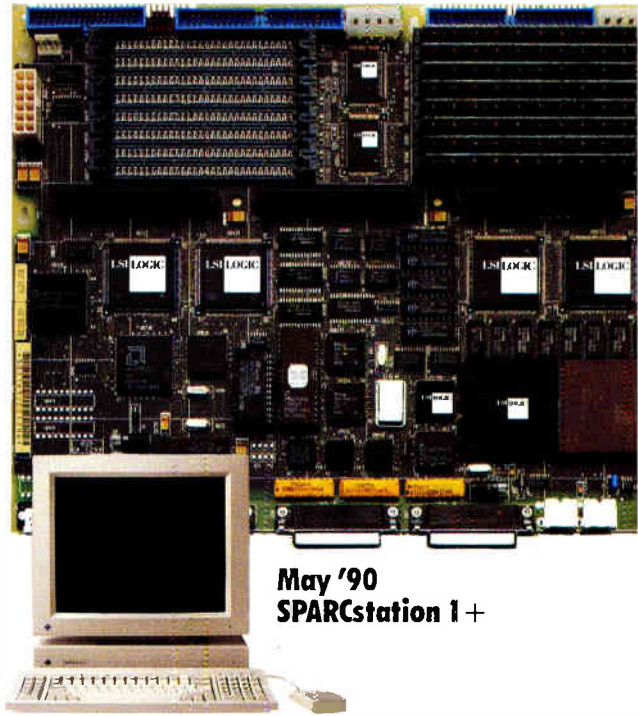


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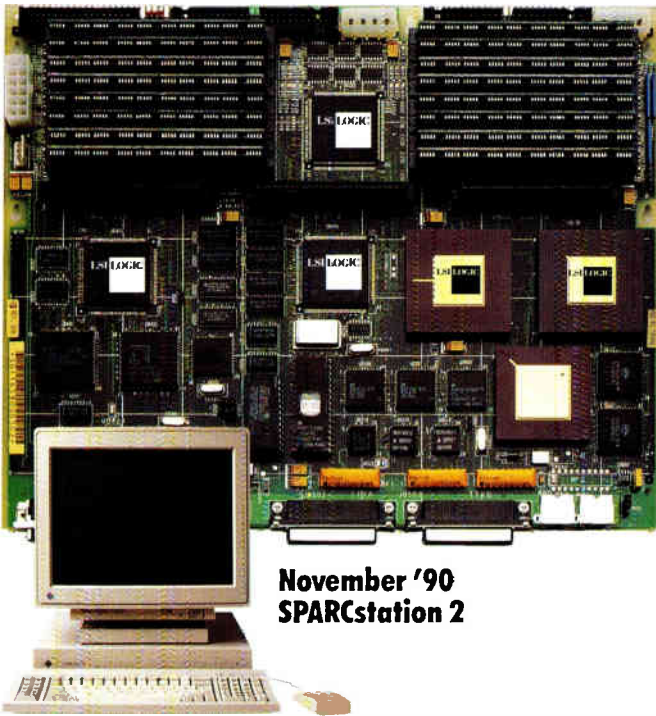
PAGE 50



**April '89
SPARCstation 1**



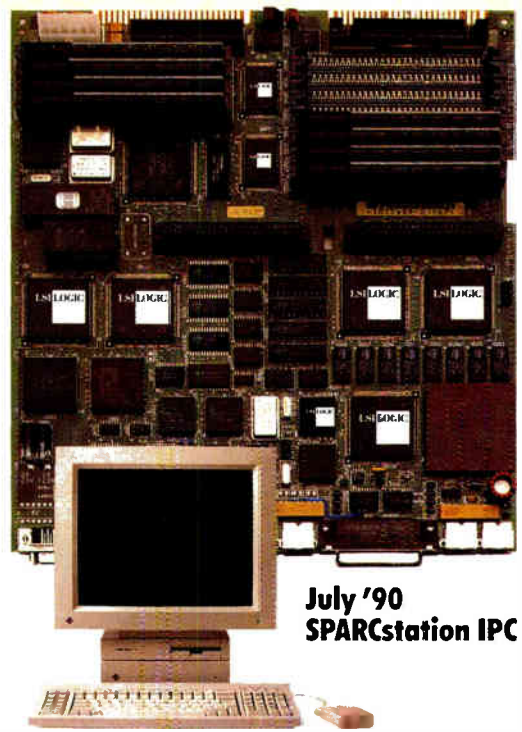
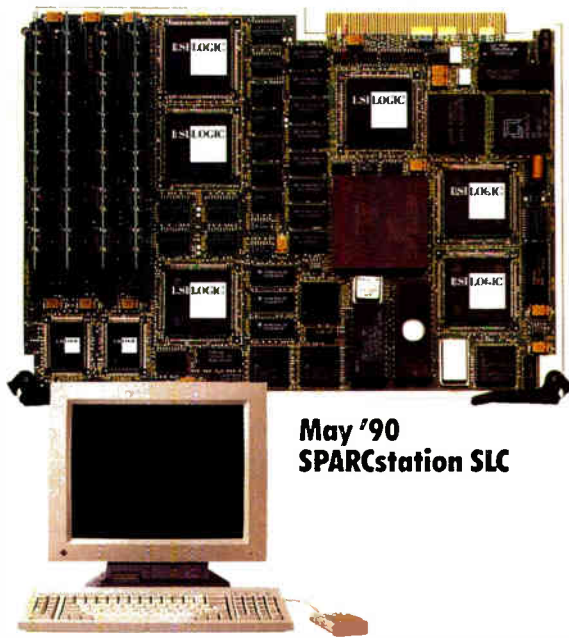
**May '90
SPARCstation 1+**



**November '90
SPARCstation 2**

LSI HAS ANOTHER

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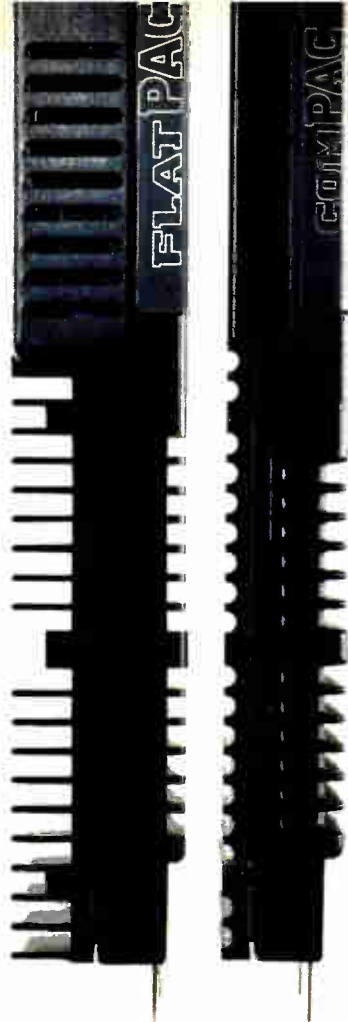
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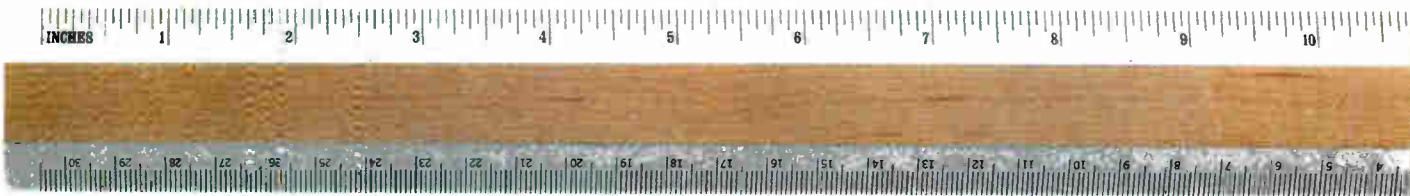
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CIRCLE 204

WHITHER THE ECONOMY?

The threat of recession hangs around the neck of the electronics industry like an albatross, as this year's annual *Electronics Market Forecast* shows (see p. 50). The industry seems stuck in a limbo state between economic growth and recession. But is it?

Richard O'Brien, corporate economist at Hewlett-Packard Co. in Palo Alto, Calif., says the symptoms the U.S. exhibits do not indicate recession. "A recession is characterized as an economy with a 5% drop in manufacturing output, a 1% drop in real GNP [gross national product], and a 2% rise in unemployment," he says. By contrast, U.S. manufacturing output is still positive, GNP continues to grow, albeit slowly, and unemployment has risen less than 1%.

O'Brien believes that the electronics industry is on the verge of an upturn in the first quarter of 1991. Inflation is falling in the face of increased competition, depressing prices across the board. Inventories are tight, so any uptick in demand will drive production up quickly.

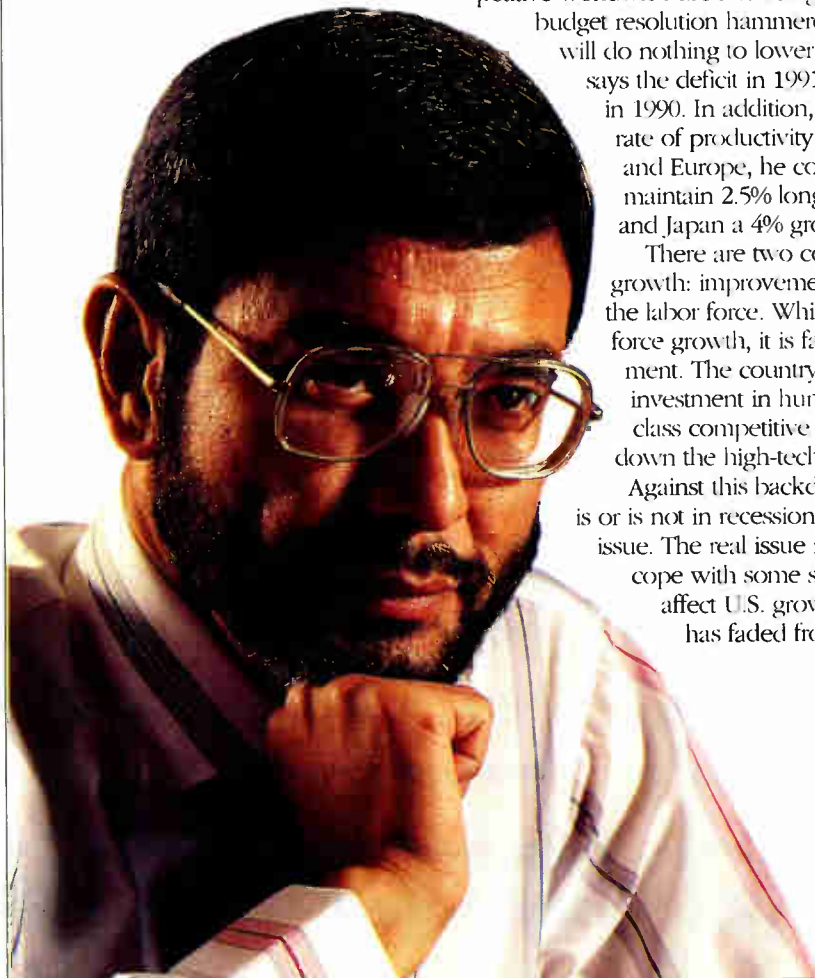
Finally, the declining value of the dollar, which O'Brien believes will continue, is making U.S. goods extremely attractive to foreign buyers. He believes demand from overseas is offsetting the downward slide in the U.S. economy. "Our primary export market is Europe, with a smaller amount to the Far East," he says. "This should continue as Germany remains an engine of growth in Europe."

But there's an underside to this relatively heartening picture. First, it's the weak dollar that's driving the export demand for U.S. goods, not real cost-performance advantages. Up until the precipitous drop in the value of the dollar, the trade balance in the U.S. high-tech sector has been unfavorable to the U.S. industry. The momentary respite we are now experiencing is the result of currency devaluations, not a major improvement in U.S. electronics-industry competitiveness.

Second, in the long term, economic factors that will make the U.S. electronics industry more competitive worldwide are not being addressed on the national level. The budget resolution hammered out by Congress and the president will do nothing to lower the staggering deficit. In fact, O'Brien says the deficit in 1991 is expected to be higher than it was in 1990. In addition, the U.S. is not keeping pace with the rate of productivity improvements occurring in Japan and Europe, he contends. The U.S. is struggling to maintain 2.5% long-term growth. Europe enjoys a 3% and Japan a 4% growth rate.

There are two components of long-term economic growth: improvements in productivity and an increase in the labor force. While the U.S. is maintaining its labor-force growth, it is falling behind in productivity improvement. The country has failed to maintain the level of investment in human capital needed to remain a world-class competitive nation. All these factors now weigh down the high-tech economic engine.

Against this backdrop, the question of whether the U.S. is or is not in recession becomes something of an academic issue. The real issue is, can the industry—and the nation—cope with some serious underlying problems that will affect U.S. growth long after the downturn of 1991 has faded from memory. **E**



Jonah McLeod

JONAH McLEOD
EDITOR

CAE Technology Report

January 1991
Vol. 2, No. 8

Is U.S. Technological Leadership Threatened?

While some chief executives are concerned over the U.S. losing its technological leadership, others like Stanley Hyduke, President of ALDEC Co., Inc., claim "we are losing only in our erroneous perceptions because we still keep the same scoring system despite that the technology game has changed."

As the competition in the 90's moves from physical manufacturing to information processing, the U.S. software industry will play a major role in increasing the competitiveness of U.S. industry. Software companies such as Microsoft,™ Novell,™ etc., are becoming the core of new U.S. industrial strength. This information processing orientation of U.S. industry will allow it to be very responsive to the fast changing environments of the 90's.

The U.S. is also leading in development of new information processing related technologies that will create new industries within the coming decade.

The technology game has changed and the U.S. is still the world's technological avant garde.



Redefined EDA Ready For The 90's

A major change is taking place in the EDA field as vendors try to get their bearings for the 90's. The 90's will be the years of disposable products, niche markets and tight world-wide competition. This requires broad design automation to assure product quality, low design cost and minimum design time. While the 80's were years of EDA gurus, the 90's are the years of EDA for the engineering masses. Easy to use, fully automated and low-cost EDA tools that operate in real-time are the way of the 90's. Such products are already appearing and they sell fast. **Circle 101**

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FPGA-Based Designs Take Only Hours

Designs with multiple Xilinx™, Actel™ and other FPGA and PLD parts can now be instantly simulated with the new SUSIE™ 6.0 logic simulator from ALDEC that simulates these designs with picosecond accuracy. SUSIE allows you to verify FPGA designs, together with other system components, in minimum time because all problems such as timing violations, bus conflicts, etc., are automatically captured and displayed by SUSIE. Since SUSIE compiles all user entries within microseconds, working with SUSIE is like working with real hardware. SUSIE pricing starts at \$1995; options and some libraries are extra. (FAX: 805-498-7945) **Circle 102**

New Hot Schematic

One of today's hottest schematic capture products is FutureNet-5™. At \$895 (\$499-10 pcs), it provides workstation performance on the PC. New features include pop-up menus and dialog boxes, undo/redo, continuous zoom and symbol browsing. It also supports concurrent work by several designers on the same hierarchical schematic. Excellent for FPGA and system-level design, FutureNet-5 works closely with the hot new SUSIE 6.0 logic simulator. Contact Bruce Rodgers, Data I/O, (206) 881-6444. **Circle 106**

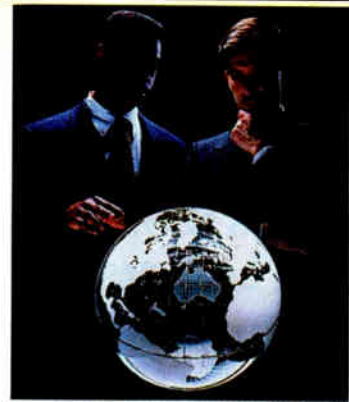
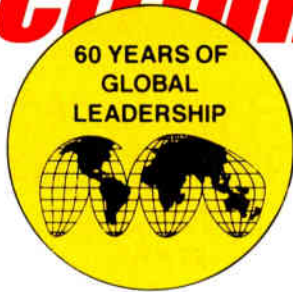


Simulators Gain Major Momentum

New logic simulators are closely imitating hardware breadboarding and lab instrumentation. Based on incremental compilation, the simulators respond instantly to the designer's inputs. For example, the designer can replace ICs, change the design of Xilinx parts, load new JEDEC and hex files, etc., all with microsecond speed.

Moreover, the designer can instantly return to previous locations in the simulation process and resimulate the design with new test vectors, different switch positions or with an entire new set of ICs, etc. Some CAE vendors, like ALDEC, report big increases in simulator sales. **Circle 103**

Electronics



COVER STORY PAGE 50

FEATURES

50

COVER: 1991 WORLD MARKET FORECAST
The Year of Living Dangerously
 Modest growth of 9.5% is expected for electronics markets worldwide, but the crystal ball has never been cloudier

66

A So-So Year Ahead for Consumer Electronics
 A few hot products will spark overall U. S. growth of 4%; mature sectors will stall

67

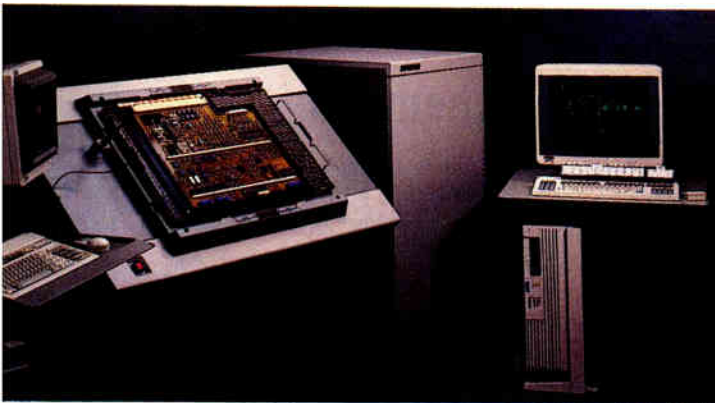
International: Eastern Buying Spree Buoy German Consumer Sector

70

The Chip Business Has a Worried Look
 Recovering from a flat 1990, the industry expects new growth; the question for uncertain times is, how much?

72

International: Slow Growth Seen as the 4-Mbit DRAM Takes Hold



PAGE 32

52

In Data Processing, the Greatest Growth is on the Desktop
 Workstations, high-end PCs, and nonstop systems propel 12.4% overall growth in the worldwide computer sector

54

International: A Strong Year for Computers in Germany, Lower Growth in Japan

58

For Communications, it's Another Year of Double-Digit Growth
 In a recessionary economy, products that deliver productivity gains will shine

60

International: The Heaviest Communications Action is in Europe



PAGE 37

77

Production and Test Gear Falter, but CAD is Strong
 Manufacturers look for growth in 1992, when next-generation ICs will come on line

78

International: Prospects for Capital Equipment are Brighter in Europe and Asia

DEPARTMENTS

4 Up Front

13 Letter from London

15 Readers' Report

20 Face-Off

64 Information Center

82 Electronics Index

84 Advertisers' Index

NEWS ROUNDUP**24****News Front**

- IBM takes silicon on insulator to a new level
- Why they decided that Apples and Acorns can mix
- De Castro exits, Skates solidifies control at Data General . . .
- . . . and the company dumps its ECL 88000 project

28**Products to Watch**

- FDDI: Getting more for less with AMD's SuperNet 2
- GenRad's HILO 4 tools shorten ASIC time to market
- Board tester from Teradyne has vector option
- HP's pulse analyzer handles rf range
- National's new logic can keep up with 50-MHz microprocessors

37**European Observer**

- European Community slaps stiff tariffs on Asian cassettes
- Philips sets up a Semiconductor Division
- Eastern Europe has big demand for chips, with USSR leading
- Thanks to unification, the Germans inherit Intersputnik facility

WORLDWIDE NEWS**31****Video**

Super TV may precede HDTV, thanks to Faroudja's affordable and compatible SuperNTSC scheme

32**Test**

A duet of products from Hewlett-Packard and Schlumberger makes it possible to develop test programs concurrently with pc-board design

33**Multimedia**

Chip, board, and software debuts—including Intel's new DVI chip set—make 1991 the coming-out year for multimedia

EXECUTIVE BRIEFING**41****Manufacturing**

Replacing CFCs with a no-clean solution could save money along with the ozone layer

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

Acorn Computers Ltd.	24	ITT Semiconductors Group	70
Actel Corp.	70	John Fluke Mfg. Co.	77
Advanced Micro Devices Inc.	28	JVC Co. of America	66
Alcatel NV	58	L. M. Ericsson	58
Alderbrook Consultants	31	Lam Research Inc.	77
Allied Chemical Corp.	41	LSI Logic Corp.	31, 70
Alpha Metals Corp.	41	McDonald Securities Inc.	66
American Electronics Association	50	MEL Ltd.	13
Apple Computer Inc.	24	Mentor Graphics Corp.	32, 77
ARM Ltd.	24	Mercury Communications Ltd.	13, 58
AT&T Bell Laboratories	41	Microsoft Corp.	58
AT&T Co.	58	Motorola Inc.	24, 37, 58, 66
AT&T Computer Systems	33	National Semiconductor Corp.	28
BASF AG	37	NEC Corp.	52, 58
British Satellite Broad- casting Ltd.	13	Needham & Co.	70
British Sky Satellite Broad- casting Ltd.	13	New Media Graphics Corp.	33
British Telecom	13, 58	New Video Corp.	33
BT Tynnet	58	Nintendo Co.	66
Bull HN	32F*	Nokia GmbH	66
Bull SA	52	Northern Telecom Ltd.	13
Cadence Design Systems Inc.	77	Novell Inc.	58
Canopus Research	20	Opti Inc.	70
Chips & Technologies Inc.	33, 70	Outlook Technology Inc.	15
Compaq Computer Corp.	20, 33, 52	Petroferm Inc.	41
Daewoo Electronics Corp.	66	Philips Components	66, 70
Data General Corp.	24, 52	Philips GmbH	77
Dataquest Inc.	52, 58, 70, 77	Philips International NV	13, 37, 52
Dataquest UK	70	Polaroid Corp.	15
Deutsche Aerospace	32F*	Racal Electronics plc	13
Dialog Semiconductors Ltd.	32F*	Racal Telecom plc	13
Digital Equipment Corp.	15	Reseau SpA	58
DuPont Co.	41	Retix Inc.	58
Electronic Industries Association	50	Schlumberger ATE Division	32
Elsevier Advanced Technology Ltd.	52, 58, 66, 70	Seiko Epson	52
Ericsson Radio AB	32F*	Semiconductor Industry Association	70
Faroudja Research Enter- prises Inc.	31	SGS-Thomson Micro- electronics	70
Fiat SpA	52, 70	Sharp Electronics	66
Fluent Machines Inc.	33	Siemens AG	37, 52, 66, 70
France Telecom	58	Siemens Nixdorf AG	32F*
Fujitsu Ltd.	13	Silicon Valley Group Inc.	77
Gartner Group Inc.	20, 52, 58	Sky TV Ltd.	13
GEC Plessey Telecommunica- tions Ltd.	32D*	Sony Corp.	66
General Electric Co.	13	STC plc	13
GenRad Inc.	28	Sun Microsystems Inc.	33, 52, 70
Genus Inc.	15, 77	Synopsys Inc.	77
Hambrecht & Quist Inc.	52, 58, 77	Technology Research Group Inc.	77
Hewlett-Packard Co.	4, 28, 32, 77	Teknibank SpA	58
Hexacon Electric Co.	41	Telefunken Electronic GmbH	70
Hitachi Ltd.	70	Telettra SpA	58
Honeywell Inc.	32F*	Teradyne Inc.	28, 50, 77
IBM Corp.	24, 52	Texas Instruments Inc.	70
ICL Ltd.	13	Thomson Consumer Electronics	41
IMP Inc.	32F*	Thorn EMI plc	13
In-Stat Inc.	70	3Com Corp.	58
Ing. C. Olivetti & Co. SpA	24, 52, 70	Timeplex Inc.	58
Intel Corp.	33	Toshiba Corp.	52, 70
International Data Corp.	52, 58	Unisys GmbH	52
International Mobile Machines Corp.	32B*	Unitel Ltd.	13
Italtel SpA	70	Valid Logic Systems Inc.	28
		Via Technology Inc.	70
		VLSI Research Inc.	24, 77
		Wessels, Arnold & Henderson	77
		Zenith Electronics Corp.	32F*

*International only



When Smith Corona's
production line went
down, HP support
was up and running.



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**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.

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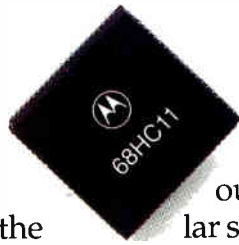
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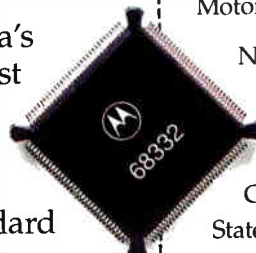
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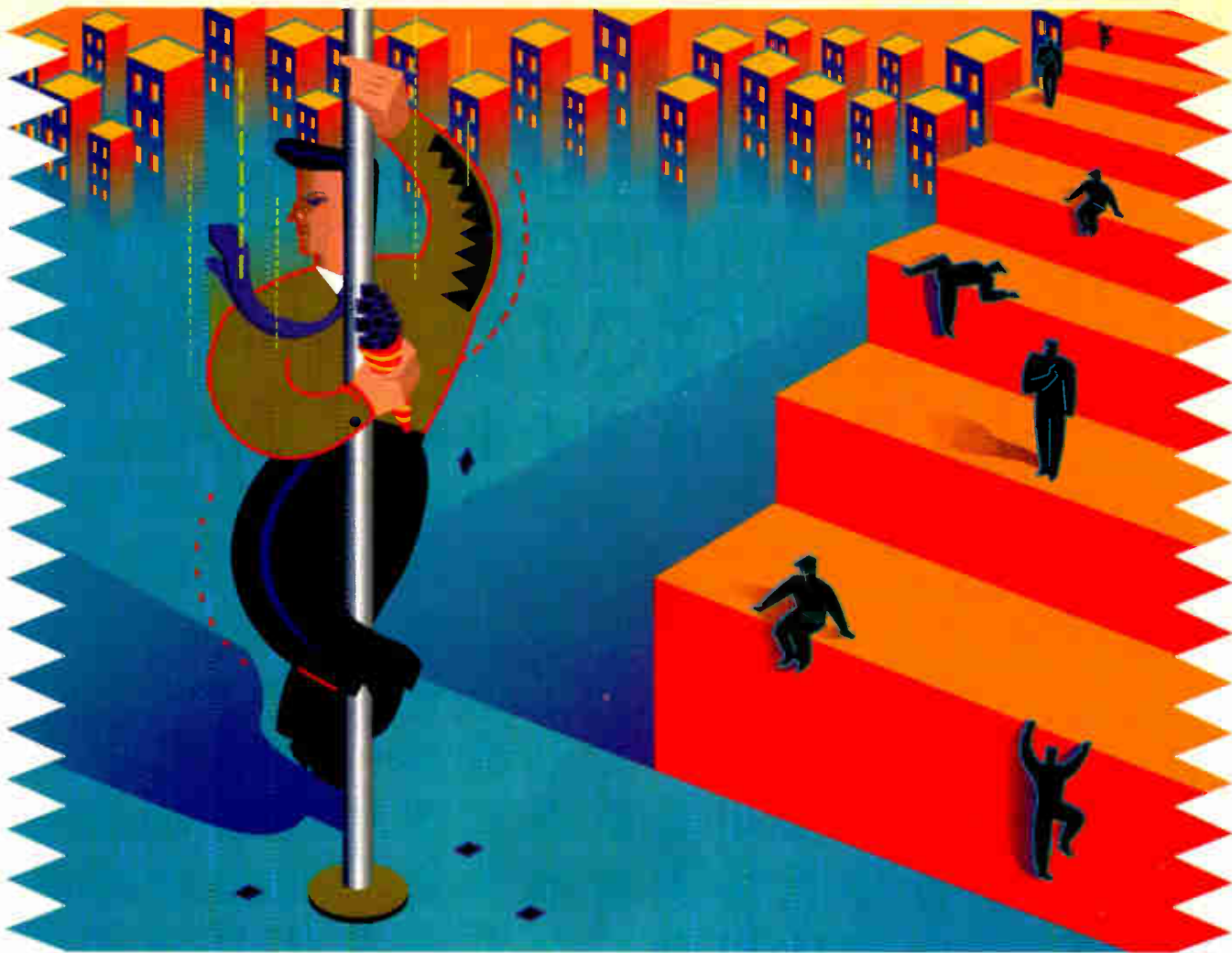
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World Radio History

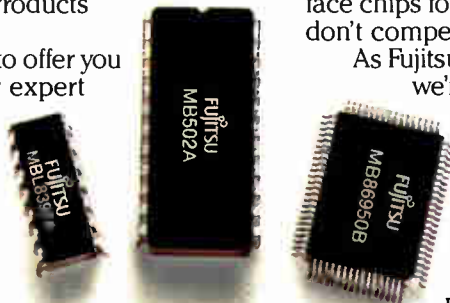


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CIRCLE 210

World Radio History

LONDON

A FLURRY OF RADICAL SURGERY FOR BRITISH ELECTRONICS
IT'S MERGER MANIA IN THE UK

BY PETER FLETCHER

THE YEAR JUST ENDED was anything but dull in Britain for the politicians as well as the industrialists and their moneyed allies. Politically, the sudden decline and fall of Prime Minister Margaret Thatcher spelled the end of an era. On the industrial front, the changes in the electronics industry were in their own way equally dramatic, generating a feeling that another new era was dawning as 1990 wound down with a flurry of mergers, takeovers, and corporate restructuring.

November was the big month. In quick order:

- The country's two satellite broadcasting companies, British Satellite Broadcasting Ltd. and Sky TV Ltd., erstwhile deadly rivals, decided to merge.
- Thorn EMI plc—the entertainment, lighting, and defense electronics conglomerate—bought Philips International NV's UK defense electronics arm, MEL Ltd., and sold its lighting business to General Electric Co. of the U. S.
- STC plc accepted a \$3.61 billion takeover offer from Canada's Northern Telecom Ltd.
- Racal Electronics plc, the \$3 billion electronics, security, and telecommunications group, announced that it intended to restructure itself into three separate corporations.

Why now? For British Satellite and Sky TV, it was money—or the lack of it—that finally buried the hatchets. Despite almost a one-year head start on its rival, and claiming a million viewers, Sky TV was drowning in red ink. The subsidiary of Australian entrepreneur Rupert Murdoch's News International empire was reportedly losing money at the rate of millions of pounds sterling a week. But Sky emerged victorious after British Satellite's backers pulled the rug from under it.

The major backer, Reed International plc—another newspaper publishing group—finally lost its nerve first in the poker game for viewers and ratings

and insisted on the deal, say financial analysts, giving Sky control.

Technologically, British Satellite is the more advanced of the two. Its broadcasts use the D2-MAC transmission standard adopted as a pan-European standard for high-definition TV; Sky

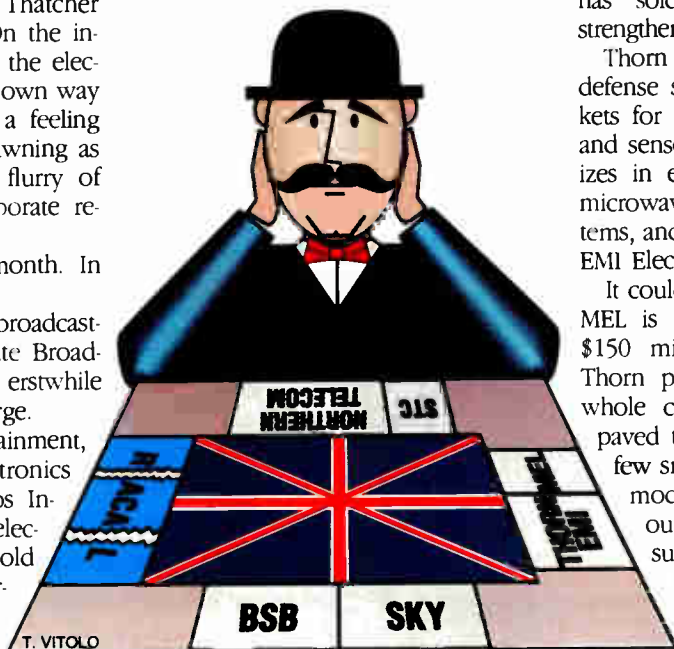
Thorn EMI's moves also represent something of an about-face. Little more than a year and a half earlier, the company had stated categorically that it intended to sell its defense electronics interests "in order to pursue core businesses of lighting, music, and retailing." Now it has sold its lighting division and strengthened its defense sector.

Thorn says that despite reductions in defense spending, it expects the markets for surveillance, communications, and sensors to hold firm. MEL specializes in electronic warfare, radar, and microwave data communications systems, and will be integrated into Thorn EMI Electronics' Sensors Division.

It could be that Thorn got a bargain. MEL is reported to have more than \$150 million worth of orders, but Thorn paid just \$19 million for the whole company. The deal has also paved the way for Thorn to make a few smart real estate deals. MEL has modern offices, labs, and plant outside London; Thorn's sensor subsidiary occupies a 60-year-old building in the western suburbs, so, with land prices high, selling the old site for development could recoup more than the cost of buying MEL.

The STC deal came as no surprise. Speculation centered not on whether STC would merge with Northern Telecom, but when. This followed the news that STC, Britain's third-largest information-technology group, intended to sell 80% of its ICL Ltd. computer subsidiary to Fujitsu Ltd. of Japan. After that, it was just a matter of time, the analysts concluded, before the remainder of STC was sold too.

Unlike Britain's bloody 1989 takeover battle, fought tooth and nail between Plessey Co. and a consortium formed by GEC plc and Siemens AG, this deal will be a tranquil affair. The only condition set was that the sale of ICL to Fujitsu be completed as scheduled on Nov. 30. That brought \$1.5 billion cash to add to STC's fiscal 1989 earnings of \$550 million and 1990 first-half profits of \$155 million. Both figures include contribu-



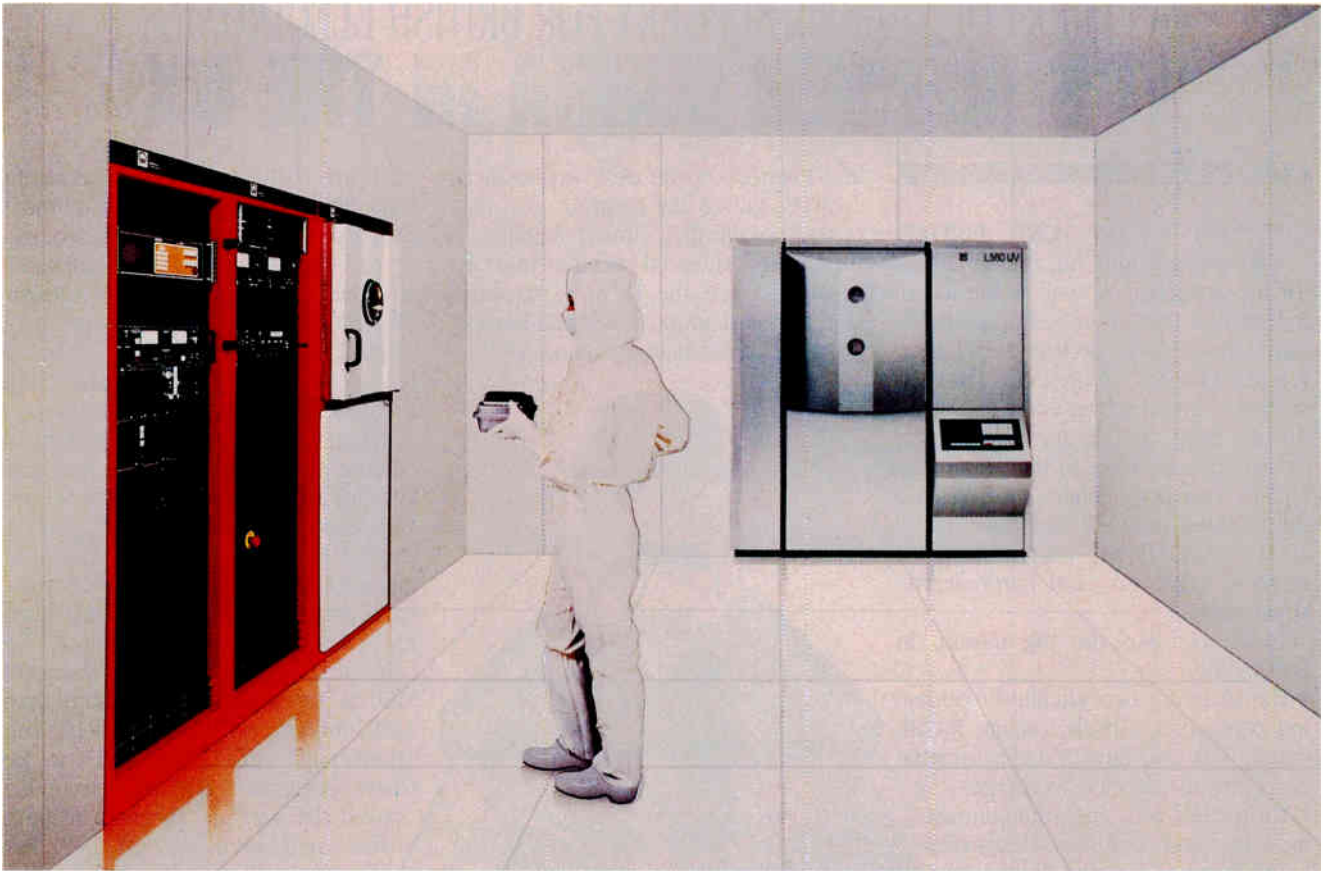
uses plain-vanilla PAL transmissions. However, the new company, British Sky Satellite Broadcasting Ltd., has insisted that dealers immediately cease selling the advanced D2-MAC decoders and the novel "squarial," a 30-cm² active antenna.

Just where that leaves British HDTV hopes is unclear. British Satellite was scheduled to start wide-screen broadcasts this month as a precursor to 1,250-line HDTV trials later in the year. The company had also started renting digital channels, which form part of the D2-MAC standard, to businesses such as banks and stockbrokers for high-speed data-burst broadcasting—a facility it was able to offer under the terms of a British government Special Satellite Services Broadcasting license it won two years ago. Ironically, Murdoch's Sky Channel had sought a similar license but was turned down.

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tions from ICL's activities. Sales revenues were \$5 billion in 1989, and \$3.5 million for the first six months of 1990.

Divested of ICL, STC's main businesses fit well with Northern's. Most of the \$1.9 billion 1989 revenues brought in from noncomputer business derived from sales of telecommunications transmission systems, ranging from long-distance undersea cables to metropolitan-area networks and digital microwave link systems. The company also has interests in semiconductors and components distribution and operates a research laboratory, STC Technology Ltd. A defense electronics division operates in the military radio, microwave, and optoelectronics sectors.

In the past three years, STC has also met with success as a distributor, selling Northern Telecom DMS-100 digital telephone exchange equipment to Britain's two national telephone companies, British Telecom and Mercury Communications Ltd. And STC is heavily involved in mobile communications in the UK, both as a potential hardware vendor and as a network operator. STC Technologies Ltd. and STC Semiconductors together are developing pocket-size digital radio-telephones based on its Zero Intermediate Frequency (ZIF) technology under an \$11.4 million contract awarded by British Telecom in 1987.

At the same time, STC is a major partner in Unitel Ltd.—one of the three companies awarded licenses to build personal communications networks in the UK—and Phonetel, which operates a public "Telepoint" service.

In a move that has bemused analysts and its competitors, Racal Electronics plc revealed that it is to undergo major corporate restructuring. In effect, the group is to be "demerged" and split into three separate entities—Racal Telecom plc, Racal Chubb Security plc, and Racal Electronics' core businesses. These range from computer-aided design through navigation systems, radio communica-

tions, instrumentation, military radar, and avionics. It also has contracts to build and operate data communications networks for the British government.

Already, in 1988, the group's highly profitable mobile communications Vodafone operations had been spun off to form the nucleus of Racal Telecom plc, a company whose shares were listed separately from those of Racal Electronics. Now its security division, formed in 1984 with the acquisition of the famous safe maker and locksmith Chubb Ltd., is also to become a separately listed corporation.

The remaining core electronics businesses will become a privately owned company following a management buyout led by current chairman and chief executive Sir Ernest Harrison. Harrison says the plan is to distribute the 80% of Racal Telecom shares that are owned by Racal Electronics Group to its shareholders. Similarly, stock in the new company to be formed from the former Chubb division will also be issued free of charge to current Racal Electronics shareholders.

Officially, the rationale for the scheme is the "disappointment" felt by the board of Racal Electronics that its share price "has consistently failed to reflect the full value of its 80% shareholding in Racal Telecom." At the time of the announcement, the relative share prices meant that the 80% of Racal Telecom was actually valued at \$5.1 billion. By comparison, despite its \$1.7-billion-a-year revenues, analysts put the worth of Racal Electronics at about \$3.9 billion—or, as one puts it, "a valuation of minus \$200 million, a liability rather than an asset." And that, they say, could make the group a prime target for a hostile takeover.

Judgment on whether the move is sensible or hasty is reserved. "It depends on whether they are responding to a shadow on the wall or something more material," says one electronics industry analyst. **E**

Battle winner

To the editor: The extent of Genus Inc.'s dominance of the total tungsten CVD equipment market was understated in "The Tungsten Battle" (November 1990, p. 29). Actually, Genus holds approximately 60% of the tungsten market and over 80% of the tungsten silicide market.

Marilyn Lund
Genus Inc.

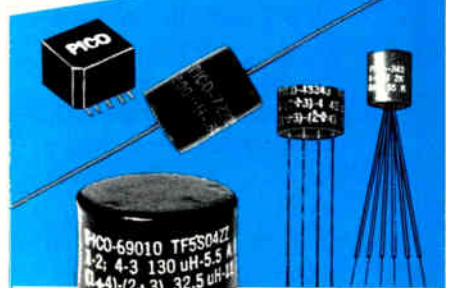
Corrections

Digital Equipment Corp.'s Engineers into Education program (November 1990, p. 37) was inspired by a similar program at Polaroid Corp. The attribution was incorrectly reported.

The caption on p. 31 in the December 1990 issue incorrectly identified the digital oscilloscope shown. It is actually the Logic Oscilloscope from Outlook Technology Inc. of Campbell, Calif.

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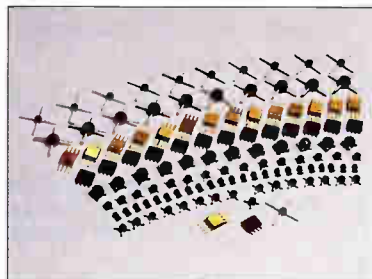
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CIRCLE 206

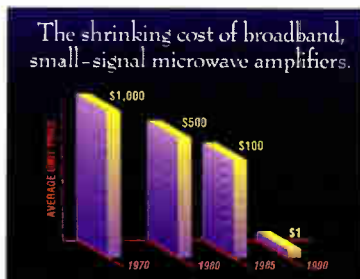
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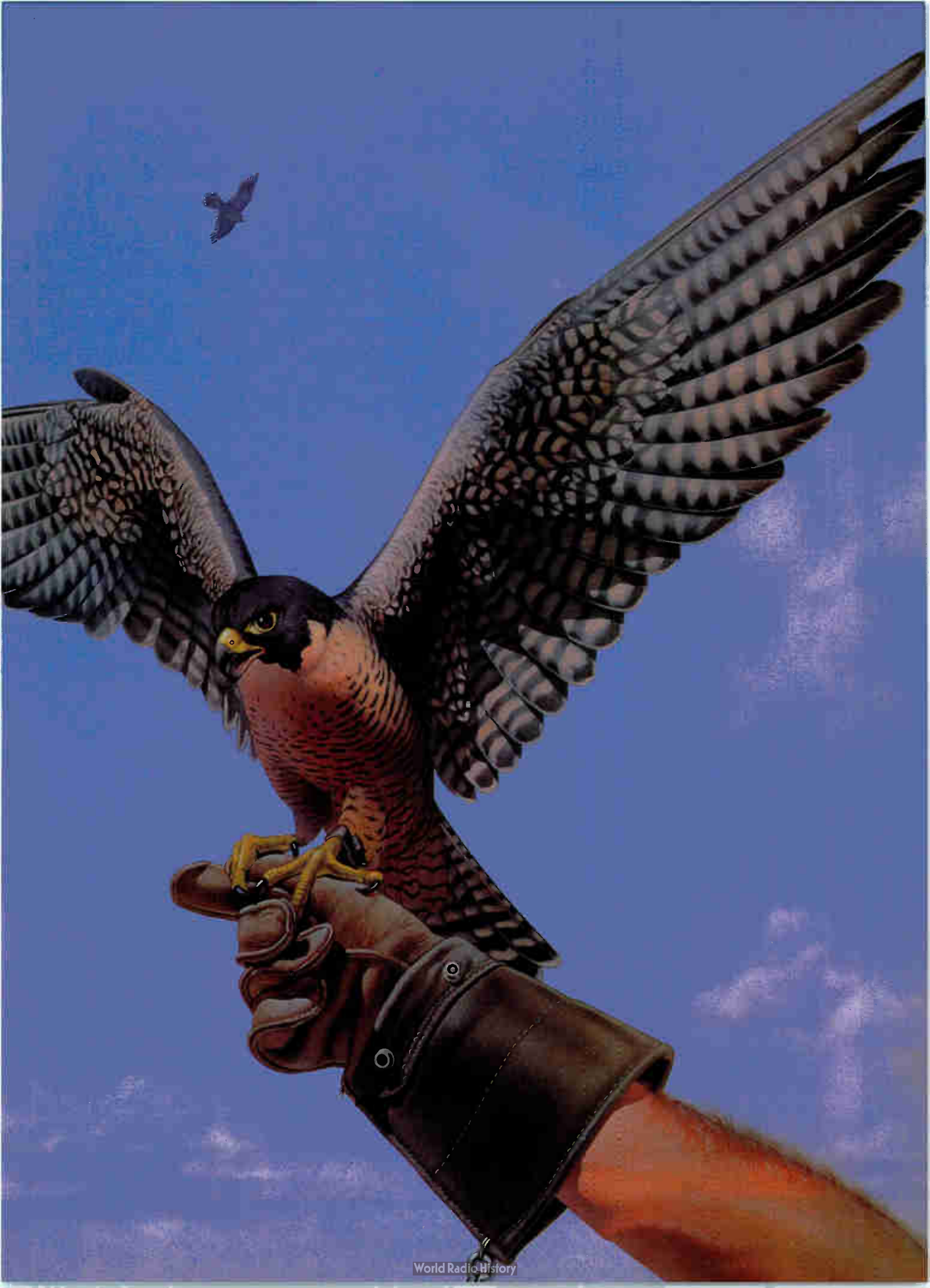
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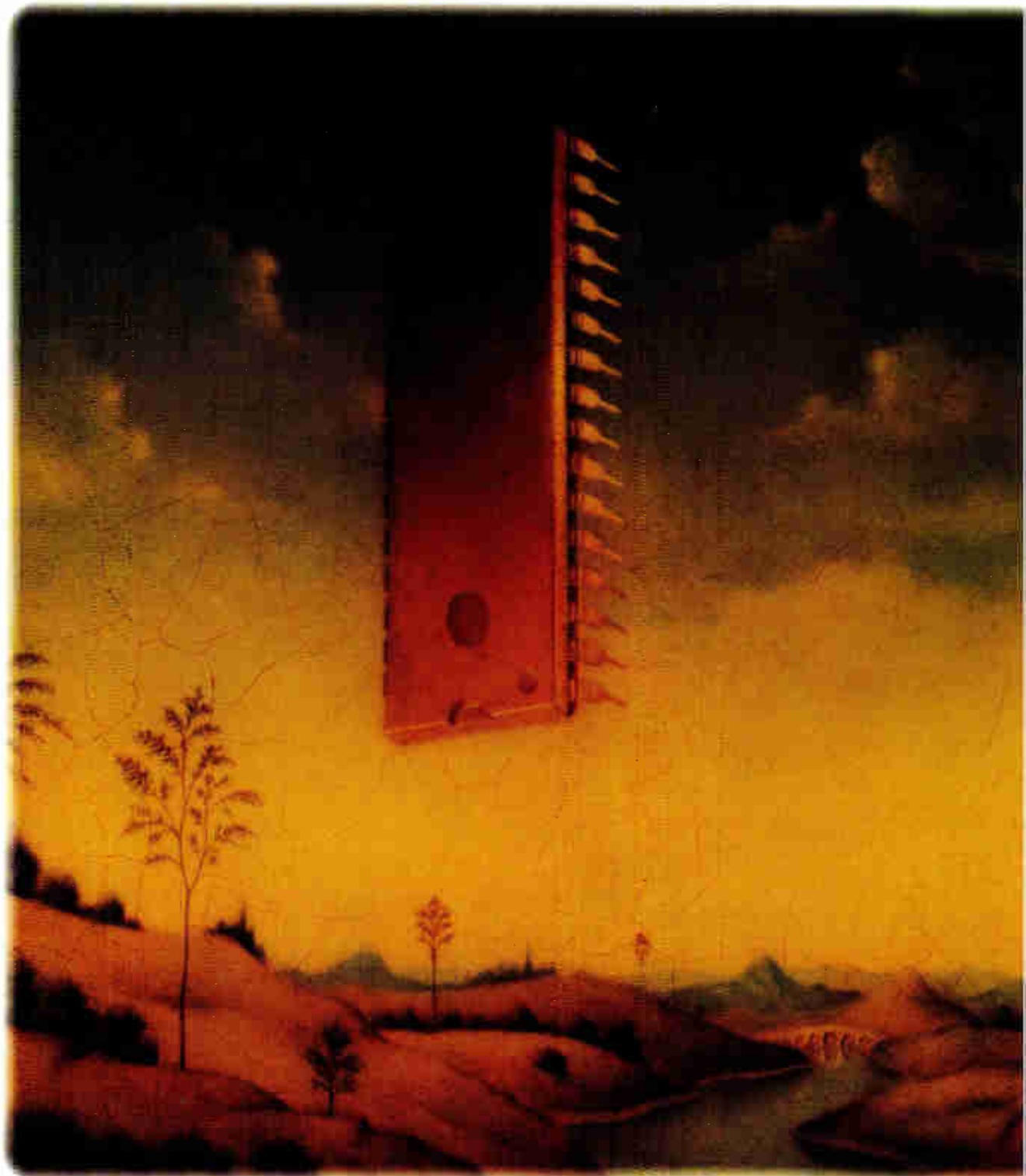
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After all, the best way to contemplate the 6.6 million transistors on the part, is to get your hands on one.



° Available 1991. © Samsung Semiconductor, Inc., 1990.

CIRCLE 214

OFF

IS THE PARTY OVER?

FOR AS LONG AS MANY OF US can remember, the information-technology industry has been a growth industry. But for the past three years, the haunting question has become, "Is the party over" for this industry?

Some analysts question the ability of computer vendors to return in the 1990s to the double-digit growth they once enjoyed. For users, this translates into whether information technology will remain a strategic component of doing business or become a cost-sensitive support function, such as transportation or facilities.

I see three possible scenarios unfolding in the years ahead, each of which carries a different degree of probability. The first is the conventional notion that the recession in the information-technology industry is a cyclical indigestion phenomenon. Once vendors solve the connectivity problem—getting multivendor systems to talk with one another—then growth will be restored.

However, solving the connectivity problem alone through open systems will only compound the profitability and growth problems facing many vendors. Open systems tend to be synonymous with commodity markets. Low profit margins will make the industry shrink and eventually implode. This scenario has a 20% probability.

The second and third scenarios share the assumption that the industry's recession is not cyclical. Rather, it is the result of three developments in the industry: indigestion—too much technology to assimilate too quickly; a lack of connectivity; and a lack of new demand in the computer marketplace.

Scenario 2, which has a 50% probability, assumes that vendors will successfully address all three issues by marketing new "master platforms"—long-lived major revenue-producing systems to take the place of the IBM Corp. System 370 architecture, for example. Under this scenario, growth

will return to the 10%-to-15% range by the middle of the decade.

Scenario 3, on the other hand, is based on the assumption that vendors fail to solve the three major problems they now face. Growth settles in at 5% to 8% as a result, and the industry implodes. The probability for this scenario coming to pass is 30%.

The demand drivers are the key to which scenario unfolds. What will they be? Candidates include cooperative processing, operation automation, networked architectures, and multimedia, including imaging.

These technologies are obviously not mutually exclusive. They are all the result of an evolution in corporate structure away from the complex hierarchies of computing resources that once held sway and toward simple, networked operations. In the new corporation, small groups work with more autonomy and have more responsibility than in the past. They deliver innovation, quality, and responsiveness.

If vendors cannot re-architect their master platforms to encompass the new demand drivers, the industry will grow at only 5% to 8%. Senior information-systems managers must realize the stakes. Unless they have the courage to push and partner with vendors, the U.S. information-technology industry will begin to resemble the telephone industry as it was between 1925 and 1975. In short, information technology will become a dormant industry.

The new-age platform will make technical uncertainty, risk, exposure, and opportunity major issues again. Many new information-systems managers were not around for the last migration to a new master platform and may be caught with their guard down this time around. For them we can only hope.—*BRUCE ROGOW, executive vice president, worldwide analytic resources, The Gartner Group Inc., Stamford, Conn.*



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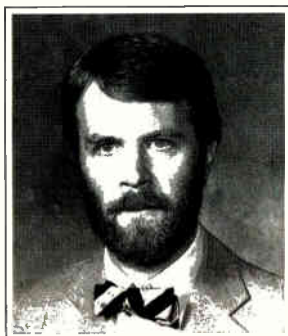
A public service of this publication.

OR IS IT JUST BEGINNING?

TO ANALYZE SLOW GROWTH in the information-technology industry in terms of problems with "connectivity" or the need for new "demand drivers," whether cyclical or fundamental—and regardless of the probabilities assigned—is to miss, completely, the essential dynamics of the industry as it operates today.

"Downsizing," the replacement of expensive, proprietary, traditional mainframe and minicomputer systems with inexpensive, standardized, emerging microprocessor-based alternatives, is the specific cause for vanishing growth in demand.

Downsizing is the word I first used in 1985 in an International Data Corp. research memorandum to refer to the replacement of traditional mainframe and minicomputer systems by microprocessor-based alternatives. The microprocessor-based systems offer much lower price per unit of performance.



WILLIAM F. ZACHMANN

Downsizing does not mean running everything on personal computers, or even on networked personal computers. The microprocessor-based alternatives include larger, more powerful systems as well, from basic servers, such as the Compaq Computer Corp. SystemPro, to large and powerful systems like Sequent Computer's or the AT&T StarServer.

Even bigger and more powerful systems built from standard microprocessors are on the way that will run standard operating systems and use standard networking protocols. Over the next few years, these systems will not only match but exceed the processing, storage, and communications capabilities of the largest traditional mainframe systems.

A million instructions per second still costs \$60,000 to \$80,000 on a traditional mainframe system, but as little as \$500 on personal computers. That is economically rational as long as the latter are used only a few hours a day while

the mainframe runs at, say, 90% utilization or more for three full shifts, six days a week.

However, once the cheap chips that microprocessor-based systems deliver are put to work in production systems (as is increasingly being done via downsizing), continuing to pay mainframe prices per unit of performance becomes economic idiocy.

Traditional mainframe and minicomputer systems cost as much as they do because their proprietary architectures, operating systems, and networking created semimonopoly franchises for their vendors. Conversion costs kept users

locked in, making it possible for vendors to charge what amounts to semimonopoly prices.

Intense competition among vendors within standards, however, has led to the very low (and falling) costs of microprocessor-based systems. As they grow more capable of replacing minicomputer and even mainframe

systems, these open systems will eat into the revenues of traditional systems; growth in demand for traditional systems will slow.

That is only the beginning. Demand for traditional mainframe and minicomputer systems will begin to fall over the next year. That will be the beginning of the end for them. These traditional systems are as surely doomed as the dinosaurs were 65 million years ago. They will be replaced by much less expensive systems, including big ones, built around standard microprocessors by the end of the 1990s.

However, as the traditional information-technology industry built around proprietary mainframe and minicomputer dinosaurs dies out, a new industry is evolving from the proto-mammals of the microprocessor revolution. It is to these that one must look to see where the sources of new growth in the 1990s will lie.—**WILLIAM F. ZACHMANN**, president, *Canopus Research*, Duxbury, Mass.



School of American Ballet student performance: Merrill Ashley. Copyright: Martha Swope, 1967

Thanks to the Library, American dance has taken great leaps forward.

American dance is more popular than ever, and one of the reasons is The New York Public Library's Dance Collection.

Choreographer Eliot Feld says the Library at Lincoln Center is "as vital a workroom as my studio." Agnes de Mille says, "the revival of any work is dependent on access to the Library's Dance Collection."

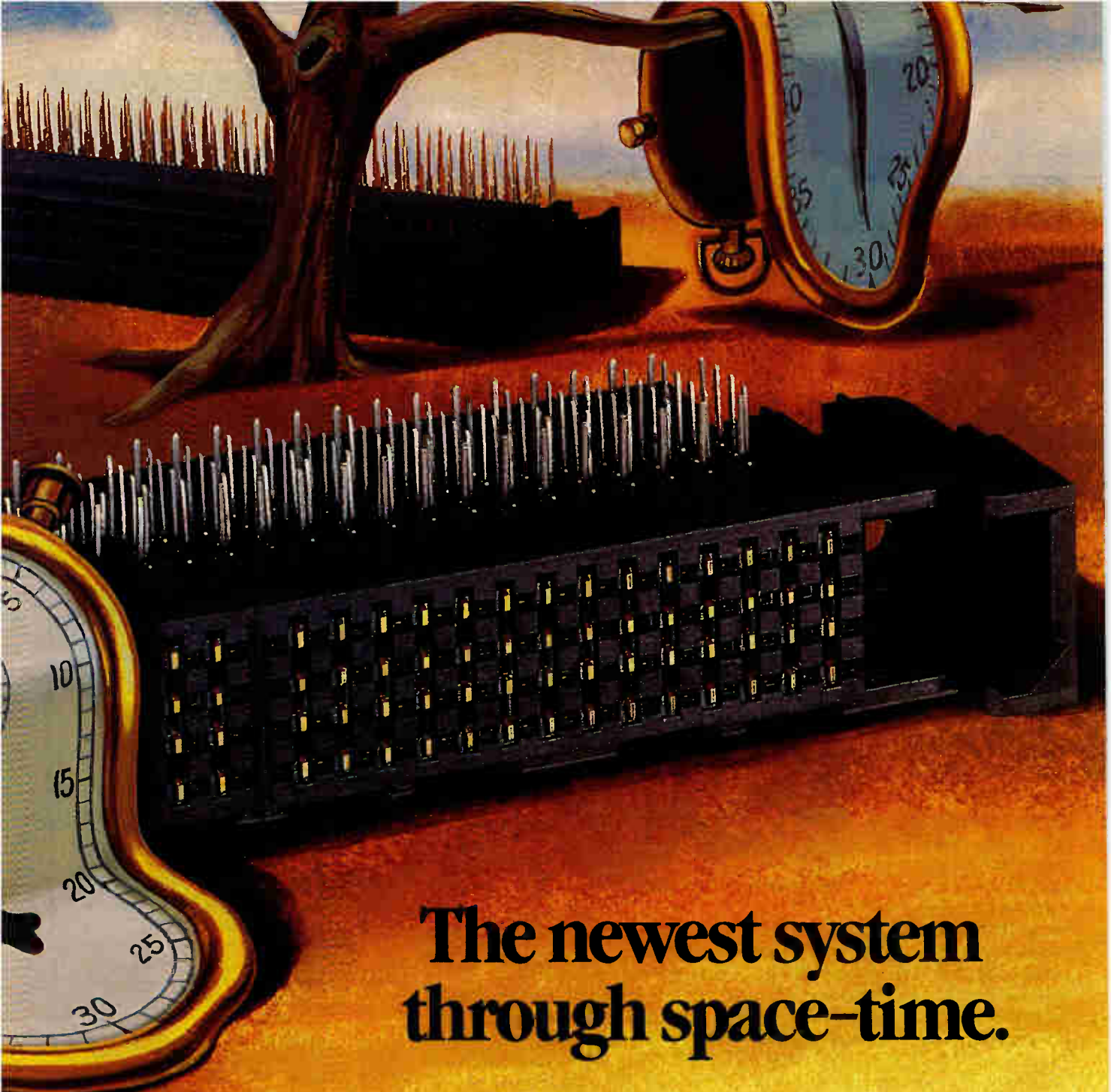
And they're not the only ones. For dancers and choreographers everywhere, over 37,000 volumes, 250,000 photographs, and an enormous film archive have been essential elements in the renaissance of American dance.

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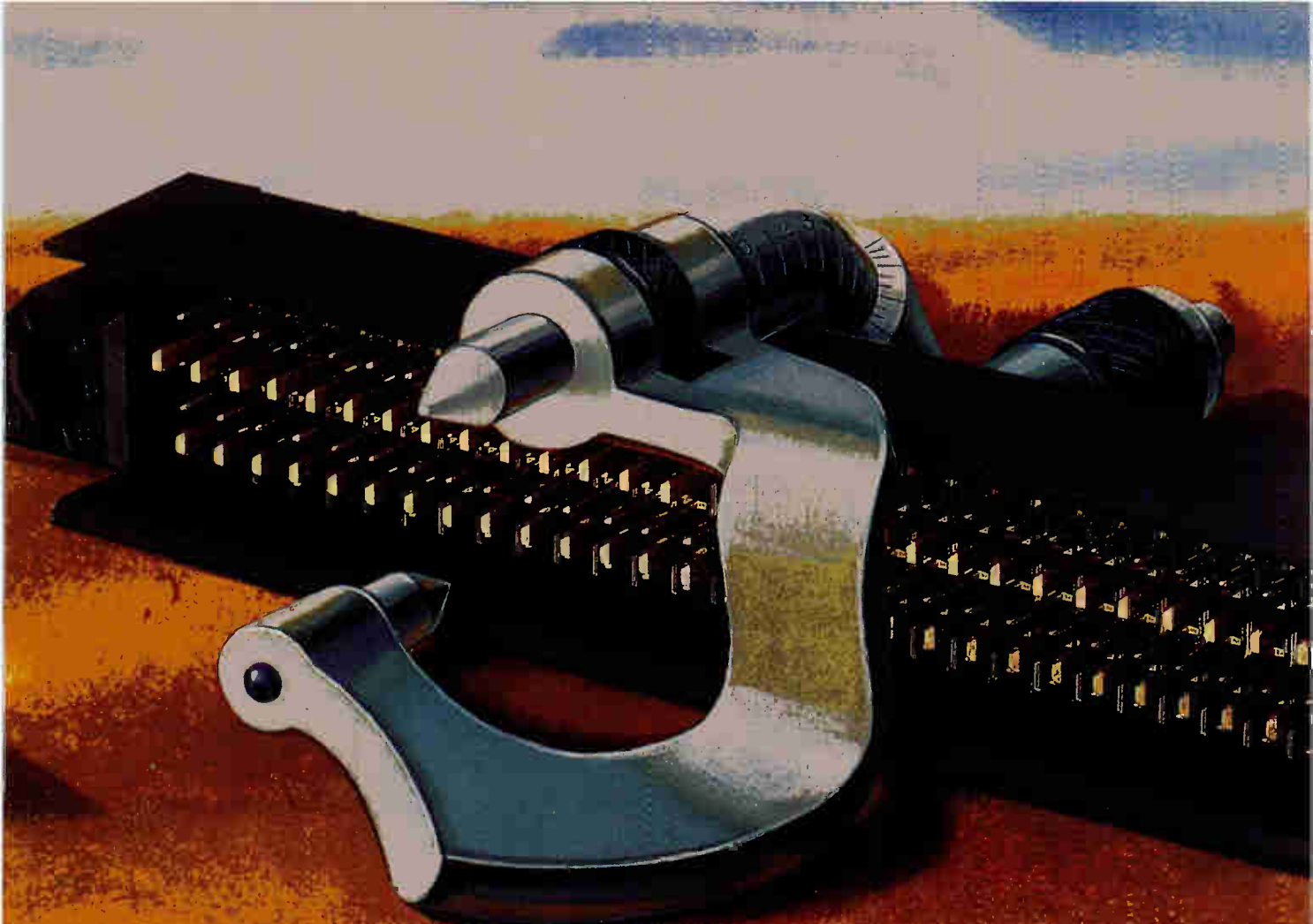
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CIRCLE 203
World Radio History

FRONT

IBM TAKES SOI TO NEW LEVEL

Say this for silicon, if it's on the way out it certainly isn't going peacefully. Even as semiconductor makers fret that their basic material is reaching the limits of its speed and density, they keep wringing more performance out of it.

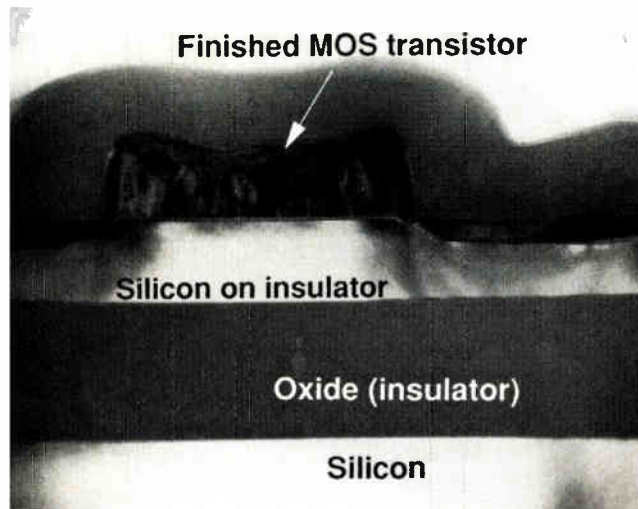
The latest to do so is IBM Corp., with its silicon-on-insulator CMOS transistors with half-micron features, which it says switches at 33 ps. That is three times faster than comparable CMOS devices with 0.5- μm features built on pure silicon, say the IBM researchers.

IBM's feat, described last month at the International Electron Devices Meeting in San Francisco, was to find a way to grow virtually defect-free silicon that compares in quality to the pure material. After growing a layer of silicon oxide—the insulator—

the IBM researchers opened lines in the oxide to expose the silicon beneath. To deposit silicon along the lines, they passed a chlorine gas containing silicon over the wafer (a process called

selective silicon epitaxy). Along and atop the lines, the silicon grows in blobs, which are thinned to 0.1 μm .

IBM won't say when the process can be expected to yield commercial parts. **E**



Using IBM's new process, this 0.5- μm MOS transistor was built on silicon-on-insulator material.

WHY THEY DECIDED THAT APPLES AND ACORNS CAN MIX

Why did Apple Computer Inc. decide to sink \$3.2 million into 30% of a new company formed with VLSI Technology Inc. and England's Acorn Computers Ltd.? The answer: to avoid paying royalties to a potential rival.

It all started when Cupertino, Calif.-based Apple decided it liked Acorn's reduced-instruction-set processor. The company won't say where the device would be used, but it would be well-suited for "mobile products such as laptop computers, cellular telephones, and electronic organizers," hints Larry Tesler, Apple's vice president for advanced projects. However, Acorn, though tiny by comparison with Apple, dominates the UK educational computer market. What's more, along with Ing. C. Olivetti & Co. SpA of Milan—which owns 80% of Acorn—it is attempting to penetrate both North American and additional European education markets.

That's getting uncomfortably close to Apple's turf, so the American company decided it would be better to invest in a new partnership that might earn it some cash rather than write checks to a company battling to topple it from its position atop the U.S. schools market. The result is ARM Ltd.—ARM stands for Acorn RISC Machine, also the name of the four-chip Acorn processor. Like Apple, Acorn has 30%. VLSI Technology, the San Jose, Calif., chip maker that has been building ARM parts under license, has 5%, and investors are being sought for the remainder. **E**

De CASTRO EXITS, SKATES SOLIDIFIES CONTROL AT DATA GENERAL...

The anticipated changing of the guard at Data General Corp. has come somewhat sooner than most industry watchers figured it would happen. Ronald L. Skates, president and chief executive officer at Data General, is solidifying his control of the

troubled Westboro, Mass., computer firm after its board of directors pushed founder and chairman Edson de Castro, 52, into early retirement last month.

Skates was de Castro's choice to take over day-to-day operations in November

1989 [*Electronics*, May 1989, p. 129] as de Castro surrendered those duties to become chairman and chief scientist. But few insiders expected de Castro to depart this soon, even though Data General hasn't been profitable for five years.

The company's fiscal 1990 loss was \$140 million on revenues of \$1.2 billion—down from \$1.3 billion in 1989. A spokesman said the board "decided it was time for Ed to leave the company."

De Castro was one of five Data General founders in 1968, and had been president from the start until Skates's appointment. The company pioneered 16-bit minicomputers with its original Nova design. **E**

...AS THE FIRM DUMPS ECL 88000 PROJECT

Don't hold your breath waiting for an emitter-coupled-logic version of the Motorola 88000 RISC microprocessor. The ECL 88000 project at Data General Corp. has been "scaled back," says an executive at the Westboro, Mass., computer manufacturer, which was work-

ing with Motorola Inc. on a design for Motorola to fabricate. In fact, the program to produce this year a five-chip set that could reach 100 million instructions/s is probably dead. That's because Motorola's own 88110 will offer performance close to that of ECL. **E**

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M5M5180A	8K x 8 (Latched)	20, 25	SOJ, Flat Pack, DIP

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CIRCLE 196

TO WATCH

FDDI: GETTING MORE FOR LESS

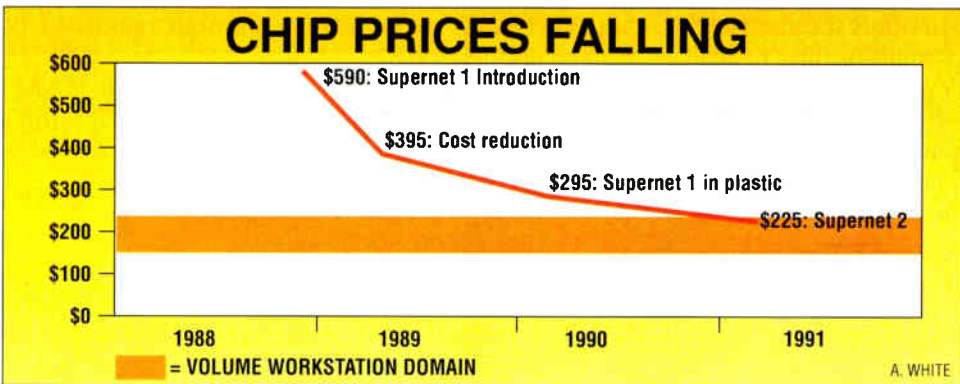
A higher level of integration in Advanced Micro Devices Inc.'s second-generation chip set lowers the cost of implementing a Fiber Distributed Data Interface on the desktop.

Priced at \$225, the SuperNet 2 chip set makes 100-Mbit/s networking with FDDI viable in a workstation. The chips also cut board space in half. A single-attachment station can now

be handled by an AT half-card, says Basil Alwan, marketing manager for the Sunnyvale, Calif., firm.

Power consumption has dropped from more than 4 W in the first-generation chips to 2 W, and internal chip performance is greatly enhanced by a 400-Mbit/s memory bandwidth. The physical-layer chip implements key parts of FDDI's station management specifi-

cations, and can drive and receive signals over either copper wire or fiber-optic cable. AMD has created a common interface between the Media-Access Controller and Physical Layer chips so that existing SuperNet 1 users can tailor products to take advantage of SuperNet 2 with only minor design changes. Samples are available now; volume production starts this quarter. **E**



GENRAD'S HILO 4 DESIGN TOOLS SHORTEN ASIC TIME TO MARKET

A new version of the System HILO suite of design analysis, verification, and test-generation tools from GenRad Inc. is said to provide up to 10 times the performance of its predecessor while cutting memory consumption by a factor of 10.

System HILO 4, available this quarter for \$18,000 per seat from the Concord, Mass., developer, provides faster simulation of application-specific integrated circuits, printed-circuit boards, and systems.

All the simulation tools have been enhanced over HILO 3, including simulation for design verification, timing analysis through dual-delay simulation, and fault simulation.

HILO 4's ASIC cell libraries are said to run simulations as much as eight times faster than gate-level modeling, topping the best foundry simulators in some benchmarks.

HILO 4 can operate with the industry-standard VHDL (VHSIC Hardware Descrip-

tion Language) or GenRad's own GHDL.

It is integrated into the Valid Logic Systems Inc. Valid Logic User Environment (Value), operating through Valid's CAE Views, which provides a direct link from the Valid GED schematic to HILO 4. **E**

NATIONAL'S NEW LOGIC CAN KEEP UP WITH 50-MHz MICROPROCESSORS

To keep pace with high-speed microprocessors and memories, National Semiconductor Corp. has extended its FAST line of bipolar logic devices.

Maximum propagation-delay time for the FASTr 8-bit octal buffer/line driver

devices is just 3.9 ns.

The Santa Clara, Calif.-based chip maker says that makes them suitable for the highest-speed signal-busing and clock-distribution applications in 33 to 50-MHz microprocessor-based systems.

BOARD TESTER HAS VECTOR OPTION

Users of the Teradyne Inc. Z1800 board tester can add a vector processor to boost fault detection on complex boards containing ASICs, PALs, and other VLSI devices.

The \$30,000 VP upgrade for the Z1800 series, made by the Zehntel Systems Division, Walnut Creek, Calif., tests devices with up to 2,048 pins.

The VP offers a vector function flexible enough to guarantee high coverage of manufacturing defects, such as stuck-at faults, open, and shorted pins. **E**

HP'S PULSE ANALYZER HANDLES RF RANGE

Developers of systems based on pulsed radio-frequency signals, such as radar, sonar, and electronic intelligence units, no longer need homemade setups to test their equipment. They can use the HP 5373A from Hewlett-Packard Co., Palo Alto, Calif.

The \$30,000 modulation-domain pulse analyzer can study agile-carrier, chirp, phase, and similar modulations on pulsed or nonrepetitive signals. The unit sells for about \$30,000; delivery is four weeks after ordering. **E**

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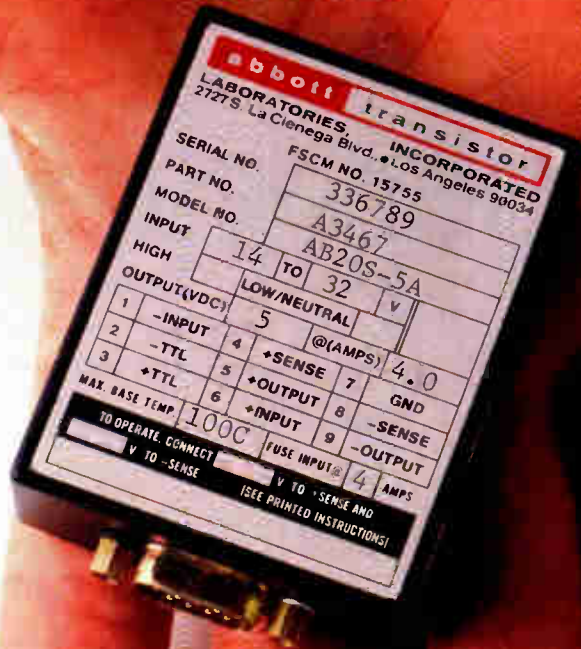
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HDTV? NO, SUPER TV

BY JACK SHANDLE

WHAT DO YOU DO UNTIL high-definition TV comes to the U. S.? If you're a chip maker, TV-set manufacturer, broadcaster, or cable TV operator, you watch with keen interest the five-month test beginning this month of SuperNTSC—an affordable and compatible enhanced-definition TV technology that might well benefit you long before HDTV becomes a reality.

Developed by Faroudja Research Enterprises Inc., SuperNTSC dramatically enhances the picture quality of TV signals—and does it within the waveform and channel-allocation specification set 40 years ago by the National Television Standards Committee. That makes it an NTSC picture that does not require approval of the Federal Communications Commission, says Bruce Jones, managing director of Alderbrook Consultants, the Topsfield, Mass., firm overseeing the tests. FCC chief engineer Thomas Stanley has indicated that—as described in technical documentation—the SuperNTSC is NTSC-compatible: it does not alter the waveform or infringe on existing channel allocations.

"Every one of the broadcasters involved is theoretically in danger of losing his broadcasting license if this does not conform to NTSC specifications,"

says Jones. "So you can bet that we are bloody confident that it does conform." The project is being backed financially by a roster of heavyweights: Capital Cities/ABC Television, Comcast, Continental Cablevision, General Instrument, Newhouse, Scientific Atlanta, Tele-communications, Viacom, and Westinghouse Broadcasting.

The tests, to be phased in over a five-month period, will have three goals: to prove NTSC compatibility over all media—broadcast, cable, satellite, VCR, and videodisc; to measure consumer response to the enhancements; and to introduce SuperNTSC-encoded productions to the broadcasters' and cablecasters' product mix. Programs produced using conventional NTSC technology cannot be postprocessed into SuperNTSC.

Yves Faroudja, president of the Sunnyvale, Calif., company that bears his name, predicts that the signal-processing chips that implement SuperNTSC will add just \$300 to the cost of a TV set. At the encoding end, studio cameras will be retrofitted for \$5,000 apiece. That's much less than the studio investment of millions estimated for HDTV [*Electronics*, June 1990, p. 66]. However, SuperNTSC prototype equipment to be used in the trials is rack mounted and costs many thou-

sands of dollars—a line doubler alone costs more than \$30,000.

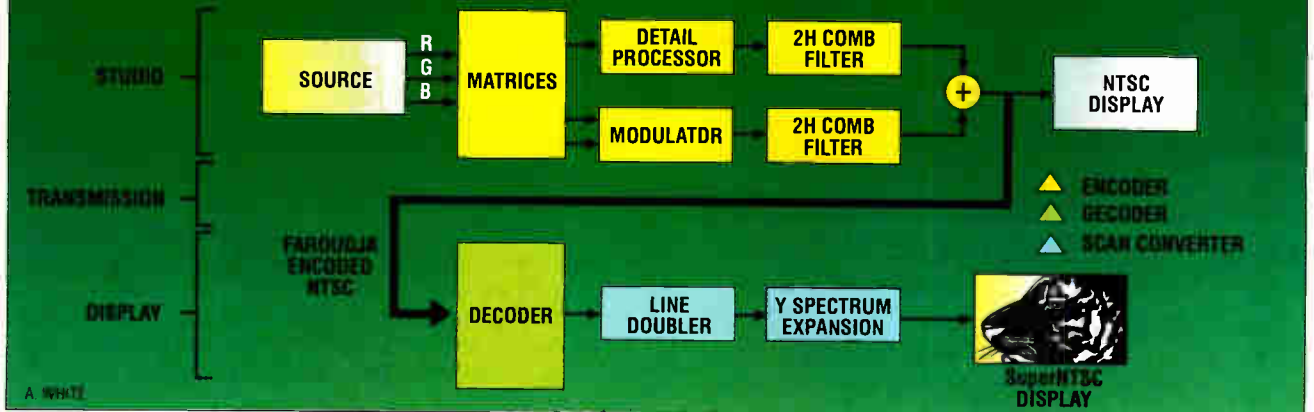
The market impact of SuperNTSC could be enormous and near-term. Approximately 20 million TV sets are sold each year in the U. S. as replacements, but only a quarter of them have screens measuring 25 in. or more. That's because over-25-in. sets do not get better picture quality for the additional cost, says Julius Barnathan, senior vice president of technology and strategic planning for Cap Cities/ABC. In fact, since the picture is larger, the shortcomings of NTSC are magnified: low resolution, cross-color distortion, and smearing of saturated colors.

SuperNTSC goes a long way toward eliminating those problems. Best of all, Faroudja says he could shrink the system to a handful of chips and have a marketable product within two years. In fact, he is working with LSI Logic Corp. of Milpitas, Calif., on semicustom designs to do just that.

For its part, the FCC clearly perceives HDTV as its top priority. Only after an HDTV system is chosen will it decide whether it wants to implement an enhanced-NTSC standard such as Faroudja's, because the FCC wants to ensure compatibility. So Faroudja withdrew his technology from the competitive tests being conducted by the Advanced Television Test Committee in Alexandria, Va., because, he says, the FCC would not come up with a winner for two years. This leaves Samoff Laboratories' enhanced-TV system and five HDTV systems in the test program.

Functionally, SuperNTSC's enhancements fall into three categories: moder-

GETTING THE PICTURE



ating radio-frequency distortions introduced during transmission; addressing color problems by converting NTSC's color scheme to red-green-blue; and increasing apparent resolution by line doubling. The scheme will be implemented modularly as well, and Faroudja says that at least seven chips will be needed. Existing TVs cannot be retrofitted, he says, and the picture-enhancement techniques are not appropriate for Europe's PAL or Secam TV standards.

SuperNTSC uses the NTSC standard 4:3 screen aspect ratio. Faroudja achieves HDTV's 16:9 aspect ratio by introducing black bars at the top and bottom of the screen. SuperNTSC has digital sound for which Faroudja would like to use Dolby Laboratories Inc.'s digital subcarrier scheme, but for the time being at least has not figured out how this can be accomplished within NTSC specs.

The interest of TV set manufacturers such as Sony Corp. is obvious: for a mere \$300 more for large-screen sets, SuperNTSC delivers real picture enhancements. Broadcasters and cablecasters have poured money into Faroudja's work partly because of the improved picture quality and partly because it would save them hundreds of thousands of dollars in retrofitting their cameras and studio video postprocessing equipment. "The majority of broadcast-TV viewing comes into the home over cable," says John Sie, vice president of Tele-Communications Inc.

Testing begins this month in San Francisco at Westinghouse's KGO, ABC's KPIX, and Viacom Cable Corp. In February, it's on to Boston; in March, to Washington; in April, to Philadelphia; and in May, to New York. **E**

TEST

THE GOAL IS TO DEVELOP TEST SCHEMES AND BOARDS TOGETHER

DESIGN DUET

BY JONAH McLEOD

CREATING A PROGRAM TO COMPLETELY test all the functions of a printed-circuit board is a fussy, time-consuming process. Worse, such programs are typically developed after the board has been designed, thus cutting into time to market. With the advent of concurrent engineering—performing more design tasks in parallel instead of serially—manufacturers of board testers are looking to do test development in parallel with board design.

Two automatic test equipment manufacturers now say they have solved the problem. Hewlett-Packard Co. in Loveland, Colo., offers its new HP3078 system, while the Schlumberger ATE Division, San Jose, Calif., weighs in with its S780 combinational tester.

HP's new HP3078 system is a joint development with computer-aided-design heavyweight Mentor Graphics Corp. of Beaverton, Ore. Priced starting at \$460,000, this functional board tester allows test-program development concurrent with board design. The S780 from Schlumberger, priced from \$250,000, likewise uses software to move large amounts of design data into the test-development workstation, thus shortening test-development time.

These testers come into a market that is at best sluggish and at worst going negative. HP estimates that the total ATE market in 1989 was \$640 million, says V. V. Ramanan, HP's market research manager in Loveland. In 1990, the figure declined 8% to \$589 million, and in 1991 it will be flat.

It's a business undergoing transformation, says Carolyn Rogers, technology analyst at Hambrecht & Quist Inc. in San Francisco. "Customers are developing test programs as the board is being designed and performing checks earlier in the manufacturing process," she says.

This is exactly what these two new systems do. Jim Hutchinson, product-line manager at HP, says Mentor Graphics modified its Quickgrade and Quickfault software to create two new tools that accommodate concurrent development of test programs as the designer creates his board design. As the design engineer generates simulator vectors to evaluate his design, Hutchinson says, the test engineer can evaluate the faults detectable by the vector and determine the fault coverage of the vector set as a whole.

Preview, one of two new tools in the HP3078, simulates testers in the HP3070 family, to show the test engineer how the vector will operate in a final board tester. The other piece of software, Fixturing, actually creates the engineering drawings to build a test fixture for the board to be tested.

In the HP system, the test engineer works with the designer. If there are nodes within the heart of the board that a vector cannot access, the test engineer can ask the designer for a test point at the edge connector to access the hidden node or to change the design to make the hidden point

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CIRCLE 202



Schlumberger's S780 board-test system comes with a computer-aided test-engineering workstation to run its software.

accessible from the edge connector.

The Schlumberger S780 likewise comes with a complement of software that runs on a computer-aided test-engineering workstation supplied with the system. Linked to a designer's system via a local-area network, the CATE workstation can import schematic and physical board layout, along with test

vectors and other simulator data.

The CATE software generates test programs automatically for each standard part and application-specific integrated circuit on a board. Because the system is an in-circuit tester, the test programs are typically created quickly from those originally developed for the ASIC or standard VLSI part. **E**

MULTIMEDIA

CHIP, BOARD, AND SOFTWARE DEBUTS MAKE 1991 THE COMING-OUT YEAR FOR MULTIMEDIA

A NOVELTY NO MORE

BY LAWRENCE CURRAN

THIS YEAR MAY WELL BE remembered as the one when multimedia technology graduated from an expensive novelty to a widespread application on personal computers. A flurry of activity as 1990 came to a close presages significant strides for multimedia companies, making the technology much more affordable.

Recent developments involving the implementation of real-time full-motion video and sound on a PC include new chips, boards, and software. Among them are:

- Intel Corp.'s new Digital Video Interactive chip set, which greatly cuts costs for board developers;
- Chips & Technologies Inc.'s PC Video chip, which performs scan-rate conversion and windowing control to display

full-motion live video images;

- New Media Graphics Corp.'s Super VideoWindows, a full function digital video/audio board, which uses the PC Video chip and sells for 30% of the price of existing boards;
- New Video Corp.'s Macintosh-housed board, to be introduced this spring, based on Intel's DVI standard.

In addition to these announcements, some of which came at the Fall Comdex show, other multimedia developments encompass support for the technology from industry heavyweights AT&T Computer Systems, Compaq Computer, and Sun Microsystems, as well as an intriguing hint by Intel of coming software that will ease the assimilation of multimedia technology.

David House, president of Intel's Microcomputer Components Group in Santa Clara, Calif., has indicated that

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the company this year will release an audio video kernel that will make DVI independent of computer operating systems. Intel stole a march on the Comdex announcements by coming out a week before the show with a second-generation two-chip set that sells for about \$85. It consists of the 82750PB (i750) pixel processor and 82750DB display processor [*Electronics*, December 1990, p. 51]. Their availability means that all the components needed for a DVI board that handles motion video, still images, audio, and special effects will cost a system developer about \$280—half the cost of existing approaches.

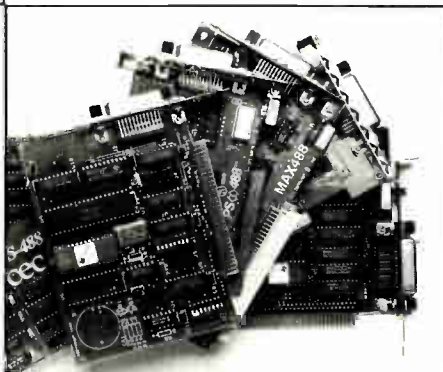
Still waiting in the wings is an imminent announcement from startup Fluent Machines Inc., Framingham, Mass., which has undertaken an ambitious approach to full-motion digital video and sound. The company is expected to unveil soon a hardware-software combination that will run on OS/2 machines. Details are scarce, but the Fluent system will probably allow networked PC users to accommodate several standards, such as JPEG, MPEG, and DVI, to capture and simultaneously display in multiple windows several streams of full-motion video and sound [*Electronics*, March 1990, p. 80].

Various analysts estimate that the market for desktop video-conferencing alone—a primary application for multimedia technology—will grow from \$330 million last year to about \$1 billion in 1995. And computer-based training, now done mostly with analog

video-disk PC stations, could climb from \$300 million in 1990 to \$700 million three years from now.

The Super VideoWindows board from New Media Graphics significantly slashes the price of a board for capturing and displaying full-motion video and stereo audio in a window of any size. Where an earlier board from the Billerica, Mass., company that performs similar functions is priced at \$2,195, the new board sells for just \$695. Other solutions include the IBM Corp. M-Motion Adapter (\$2,250) and Videologic's DVA-4000 (\$2,494).

The Super version runs under Microsoft Windows 3.0 or Hewlett-Packard Co.'s NewWave 3.0. Martin Duhms, president of New Media, says the huge cost reduction stems primarily from the



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use of Chips & Technologies' PC Video device. The chip incorporates "all the logic of a two-board set into a single device housed in a 160-pin package," according to Johanna Ohlsson, product marketing manager at Chips & Technologies' Multimedia Operation in San Jose, Calif.

The chip sells for about \$40; another \$90 worth of components (digitizer chips, memory, and miscellaneous logic), plus a \$20 board cost adds up to \$150 in material cost for a board that performs all the windowing, scaling control, and scan-rate conversion required for video digitizing and display.

PC Video enables programmable windowing control functions to scale and position the video window at any

pixel location on the screen. The window can be made to assume any shape, and can include text and graphics overlays. The chip results in part from Chips & Technologies' licensing the windowing approach embodied on New Media Graphics' original VideoWindows board.

Super VideoWindows is one of a New Media Graphics multimedia family that will include a Super VGA daughterboard, a TV tuner for live television on a PC, and a JPEG compression board for video networking and storing full-motion clips on disk.

Back in the DVI camp, New Video was quick to jump on the second-generation Intel chip set. The Venice, Calif., firm provides interactive video hardware and software for the Apple Computer Inc. Macintosh. Peter Forman, New Video president, says his company expects to announce a family of products based on the Intel i750 video processor this quarter "that are binary-media-file-compatible with the IBM PC."

New Video has access to all the DVI technology under the terms of a strategic alliance. "With New Video's implementation [of DVI], customers will be able to capture video and author productions on the Macintosh and play them back on an IBM PC under DOS and Windows," says Tom Trainor, general manager of Intel's Princeton, N. J., DVI operation. He says this will permit the exchange of binary-compatible video files between those platforms for the first time. ■

Additional reporting by Jack Shandle



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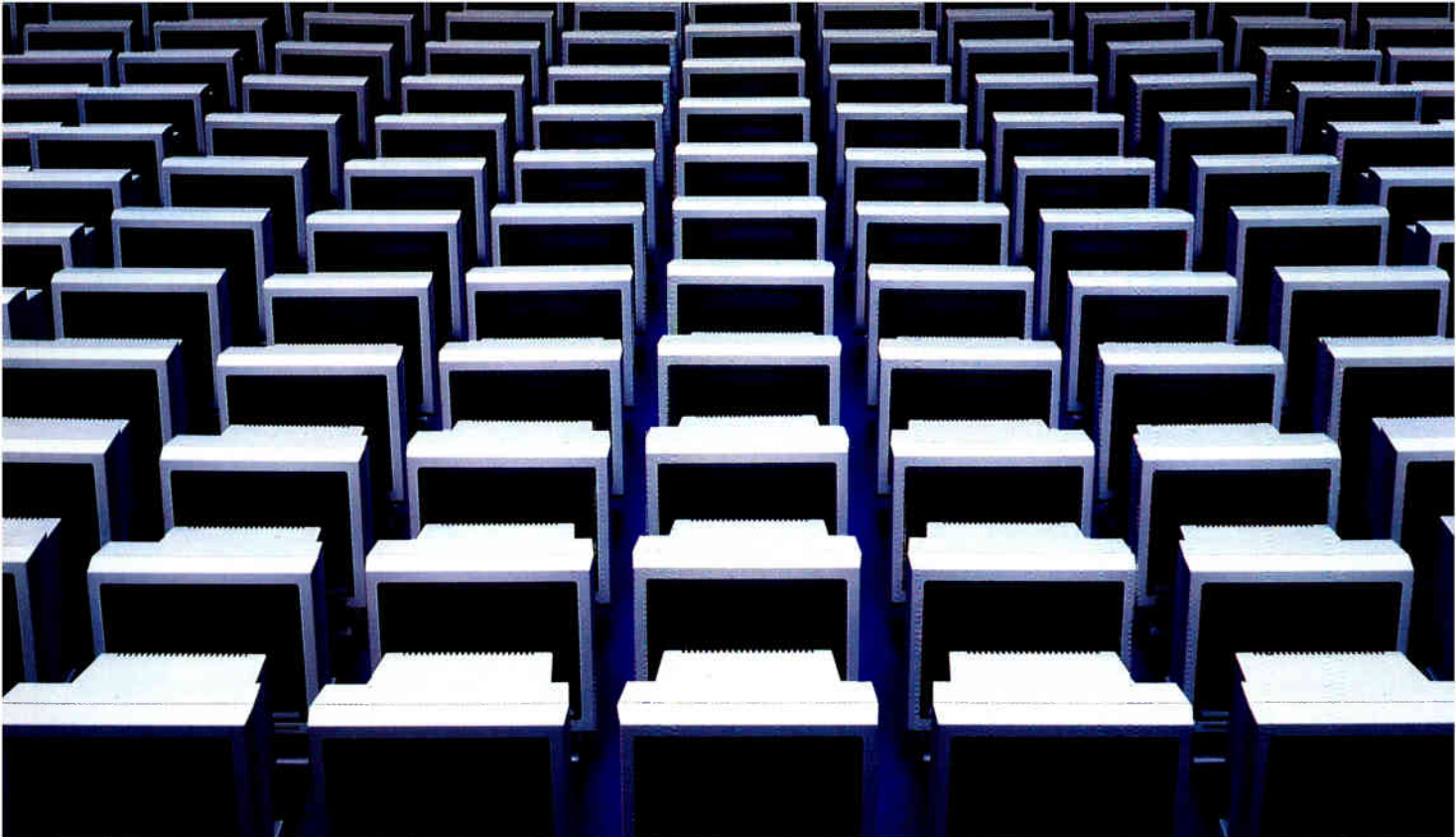
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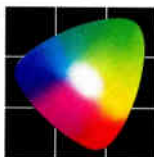


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STIFF TARIFFS PUT ON CASSETTES

Reacting to the complaints of European suppliers, the Brussels-based European Commission has slapped stiff antidumping tariffs on compact cassette imports from Japan, South Korea, and Taiwan. For Japan, the tariffs amount to 22.4%; for South Korea, the figure is 19.4%; and for Taiwan, the impost has been set at 2.4%.

But European manufacturers are only partly mollified. Although they say that they are pleased with the EC's reaction to their complaints and to the problem of what they term "unfair imports,"

European compact cassette makers say the tariffs are not high enough.

For its part, Germany's BASF AG says that because the dumping margins are as high as 80%, the punitive tariffs are too low. What's more, during the long period—about two years—that it took the EC to process the complaints, European manufacturers were forced to suffer severely.

Meanwhile, the EC has not yet decided on tariffs on imported tape material needed for compact cassette production. For some time,



easy for Japanese competitors to get around the tariffs on complete imported cassettes.

For that reason, European producers have included the tape material in their dumping charges

several Japanese firms have been producing cassettes for European markets in EC countries using tape material from Japan. That, says BASF, makes it

filed with the EC. Understandably, they are hoping for a decision in their favor "so that fairness again reigns in the marketplace." ■

PHILIPS SETS UP SEMICONDUCTOR DIVISION

Philips International NV has established a new product division for its semiconductor activities. The troubled Dutch company believes that the realignment will enable it to better react to the rapid changes in this competitive market.

Formerly part of the Components product division, these activities are now combined in the Semiconductor product division, which was established up Jan. 1.

The new division encompasses the Integrated Circuits and the Discrete Semiconductors business units. Heading the new division is Heinz W. Hagmeister, who was formerly responsible for Philips's global IC activities. The division employs about 25,000 people worldwide. ■

EAST HAS BIG DEMAND FOR SEMICONDUCTORS, WITH USSR LEADING

If you want to sell semiconductor components to East Europe, you're in the right place at the right time. The experts have been saying that demand is strong there, and now Axel Hartstang, sales and marketing director for Central Europe at Motorola Inc.'s European Semiconductor Group in

Munich, has the 1989 figures to back them up.

As expected, the strongest demand—for some \$900 million worth of semiconductor parts—was in the Soviet Union. Ranking a rather distant second and third were East Germany and Yugoslavia with \$200 million and \$103 million, respective-

ly. Next came Poland and Hungary, with about \$41 million each. Finally, there were Czechoslovakia, \$20 million; Bulgaria, \$11 million; and Romania, \$4 million.

That's a lot of potential, but tapping it will not be all that easy, Hartstang cautions. There are at present essentially three barriers to doing business in East Europe: the recession resulting from converting from a command economy to one that's market-driven, financial problems, and the Cocom rules that restrict sales of many strategic components to East Europe.

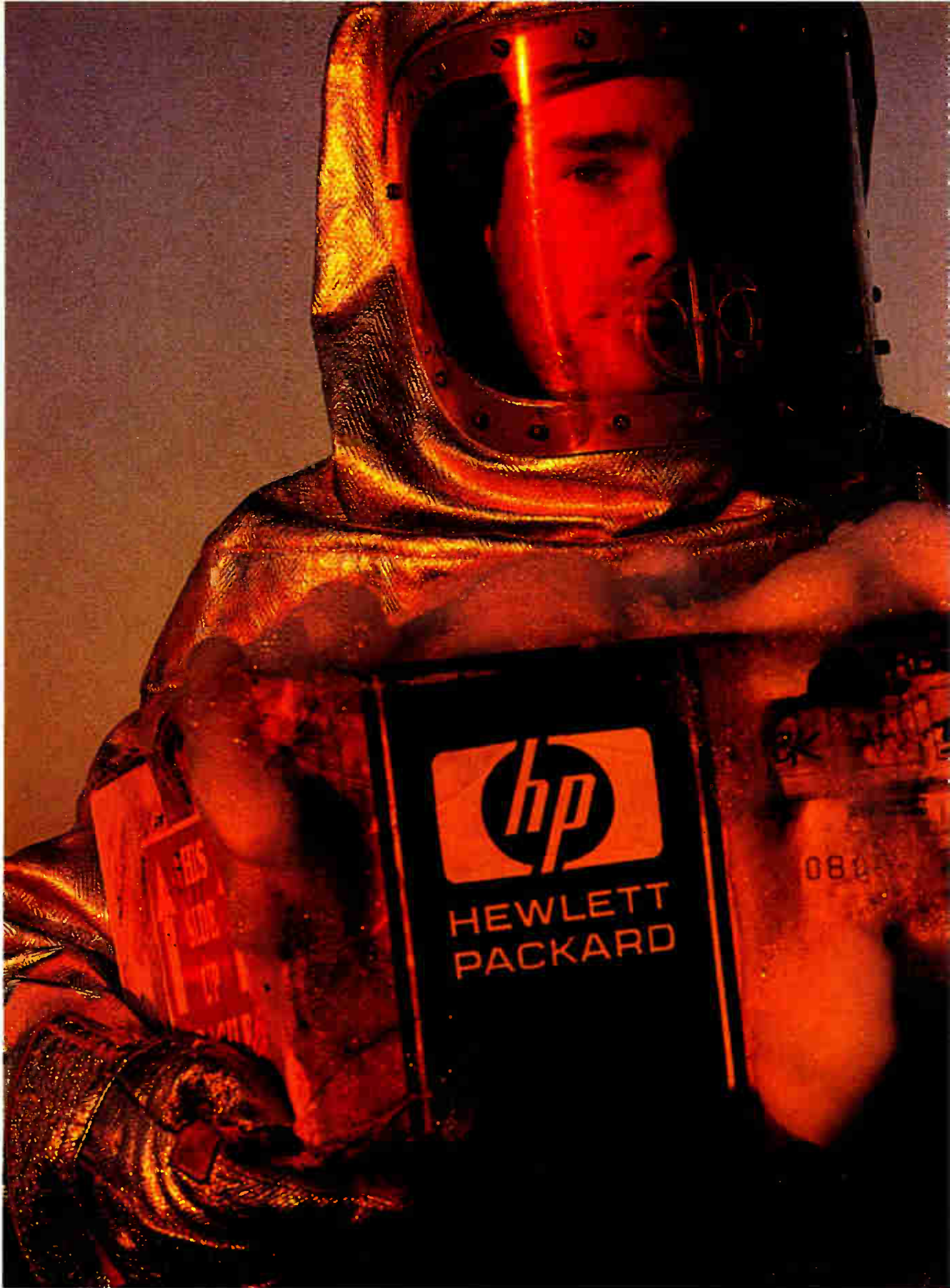
But in the longer term, Hartstang adds, suppliers in the West may do well if they invest in resources to develop East European markets, look at cooperation and joint ventures, augment distributor networks, and support expansion of customers in the West. ■

GERMANS INHERIT INTERSPUTNIK FACILITY

The unification of West Germany and the former East Germany has made the "new" Germany not only the possessor of Soviet-built weapons systems such as MIG aircraft but also, by virtue of East Germany's membership in the Warsaw Pact, a participant in the East's international satellite organization Intersputnik.

Germany's access to this satcom network is at present

via a satellite ground station in Neu-Golm, near Berlin. Through this facility, satellite communications can be established with all East European countries as well as Algeria, Syria, Yemen, Iraq, the U.S., Canada, Cuba, and Nicaragua. The service connects Germany also to such places as Afghanistan, Vietnam, Cambodia, North Korea, Laos, Mongolia, and China. ■



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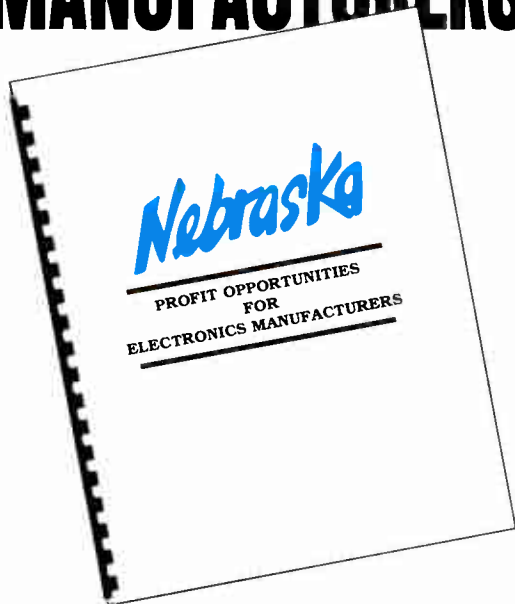
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CIRCLE 228

vapor-phase soldering—will also be evaluated, says Kathy Johnson, director of research and development at Hexacon Electric Co., Roselle Park, N.J. Both Johnson and AT&T's Guth have been involved with the IPC's CFC initiative.

The result of the testing, however, is unlikely to be a single CFC replacement. CFCs have become popular partially because they are relatively inexpensive, but also because they are very mild chemicals that can be used with a wide range of electronic components without damaging the polymer, plastic, or elastomer packaging. But their cost advantage is quickly slipping away, if not already gone. Taxes on CFCs in the U.S. have made them less attractive than they once were. "Their cost has doubled, tripled, and quadrupled in a few years," says Laura Turbini, associate director of the Georgia Institute of Technology's Manufacturing Research Center. "So the financial deadline might be the overriding one."

Nevertheless, on the horizon looms a worldwide ban of CFCs adopted by 23 nations and referred to as the Montreal Protocol. Based on 1986 usage, CFCs must be reduced 20% by 1993, 50% by 1995, 85% by 1997, and 100% by 2000.

The IPC's three-phase approach to the problem began by benchmarking the performance characteristics of conventional solder fluxes and pastes that were cleaned with CFC 113, which is a specified military cleaning product. This paved the way for meaningful comparisons of alternative technologies. Phase 2 started in the summer of 1989 and evaluated seven cleaning alternatives—such as semiaqueous and aqueous cleaning—using the same boards, fluxes, pastes, and test protocols as in Phase 1. Six of the seven products submitted for testing demonstrated that they are at least as good as CFC 113, says AT&T's Guth.

THE NO-CLEAN FLUXES TO BE TESTED IN PHASE 3 are a line of products with much lower solids content. The idea is that if less flux residue is left behind there is no need to remove it. Noting that fluxes remain chemically active after the soldering process, Hexacon's Johnson does not totally subscribe to this theory. Some fluxes can be left in specific applications and under specific circumstances, she says, but "we ought to look at them as low-solid fluxes that may not have to be cleaned."

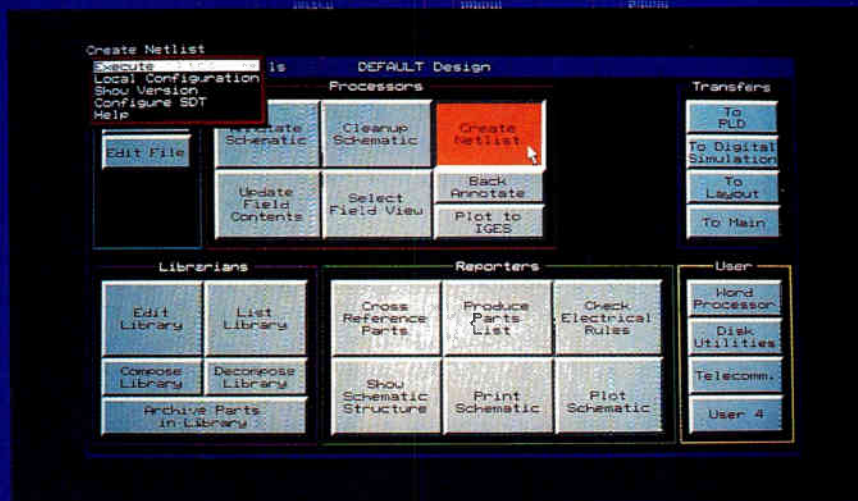
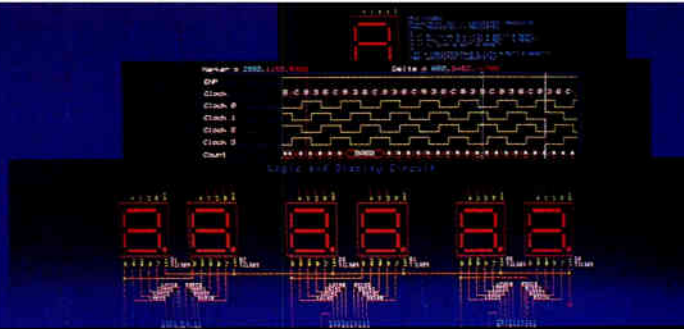
The testing and evaluation—not to mention the Pentagon's review process prior to altering the specification—will not happen overnight, however, and in the meantime other alternatives are being used. Within the realm of vapor-cleaning technologies, there are two CFC alternatives, says Alvin Schneider, director of assembly-chemical research and development at Alpha Metals Corp., Jersey City, N.J. One approach is based on hydrochlorofluorocarbons (HCFCs) and the other on chlorinated ethane. HCFCs have been developed by both DuPont Co. and Allied Chemical Corp. Neither has marketed a product, but Allied has announced it will build an HCFC production plant.

HCFCs create fewer ozone problems than CFCs, but they do contribute to ozone depletion. As a result, the environmental community has reservations about them. The 23 nations supporting the Montreal Protocol announced last spring in London that HCFC use should be discontinued by 2040 at the latest and by 2020 if at all possible.

The other vapor-cleaning alternative—1,1,1 trichloroethane—is in much the same position as HCFCs. It, too, is easier on the ozone layer than CFCs, but it has been targeted

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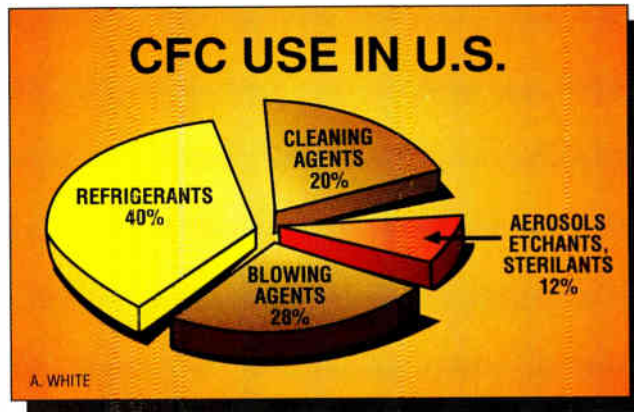
CIRCLE 187

for 100% phase-out by 2005.

The most promising CFC alternatives come from outside the realm of vapor cleaning. These include semiaqueous cleaning, in which the residues are dissolved with a solvent and then rinsed once or more with water; aqueous cleaning, in which the flux is either water soluble or can be cleaned with a detergent; and no-clean techniques, in which specially formulated fluxes are used.

Semiaqueous cleaning can be used on rosin-based fluxes, says Alpha Metals' Schneider. They are based on terpenes—a readily biodegradable chemical derived from the skin of oranges. Alpha and Petroferm Inc., Fernandina Beach, Fla., both market terpene-based cleaning agents. The terpene is combined with a surfactant, in which the residues are emulsified so they can be washed away with water. After rinsing, the water can be recycled for several months, while the terpene can be skimmed off the top layer of the emulsified mixture.

Aqueous cleaning technologies split into two classes: water-soluble fluxes and rosin-based fluxes that can be cleaned with detergents called saponifiers. These concentrated alkalines are added to water, says Schneider. "Since rosins



are mildly acidic, the result is a water-soluble, soaplike product that can be washed away." Saponifiers have one big drawback: they have to be discarded after every 8 to 16 hours of production, which means high cost and more water-treatment equipment to purify the water. The cleaning equipment is similar to that used in semiaqueous cleaning.

Water-soluble fluxes are less expensive than those used with saponifiers, says Schneider. But they exhibit more corrosive properties and require extremely effective cleaning equipment in order to minimize component failure due to corrosion in the field.

The last—and by most accounts most promising—alternative is not to clean at all. "Cleaning alternatives are going to drop by the wayside," says Hexacon's Johnson. "Why spend thousands of dollars on capital equipment if there is an alternative of a no-clean operation?" Companies attending the Carnegie Mellon Research Institute's Solder Paste Symposium last November showed "a great deal of interest in no-clean fluxes, since they use much less hazardous materials and are less expensive. That is, they eliminate the entire cleaning process," says Margaret Nasta, a Carnegie Mellon Research Institute scientist.

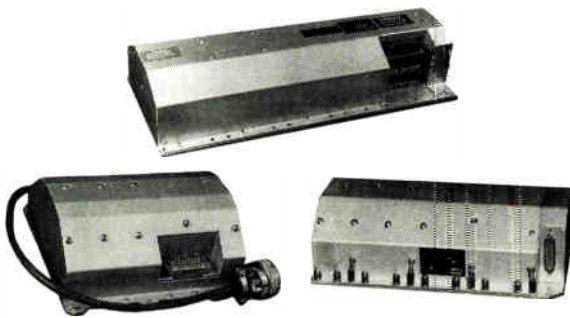
At the same time, most electronics producers are not ready to change technologies without evidence that what is left on the pc board has no long-term negative effects on product reliability. No-clean techniques are already being used by such consumer-electronics manufacturers as Thomson Consumer Electronics in Indianapolis, says Nasta. However, "people in the military and industry seem to be suspicious of consumer-electronics results because the products have limited life spans and do not need to meet strict specifications," she says.

What's more, no-clean technologies have limitations of their own, says Hexacon's Johnson. "They don't work like high-solid rosin fluxes, and you have to know how they differ and when they are appropriate."

One area where no suitable solution has been found is multichip-module connections, says Nasta. The reason is that the solders and temperatures used in multichip modules are much different from those used in pc boards. Alternative terpene- and water-soluble fluxes either decompose or evaporate at the high temperatures that are used with this technology. "If there is something commercial out there, no one has sent me any," Nasta says.

Using no-clean fluxes also calls for much better equipment to apply the flux. On the one hand, enough flux must be applied to assure a good solder bond, but not so much as might leave excessive residues that could cause failures later. AT&T has developed a low-solids fluxer that accurately controls the amount of flux deposited and is marketing it to other companies, says Guth. In fact, AT&T has implemented a number of the alternative solutions—some for more than a decade. "We started using water-soluble fluxes in the early 1980s," says Guth, "and we helped develop the terpene-cleaning process with Petroferm." ■

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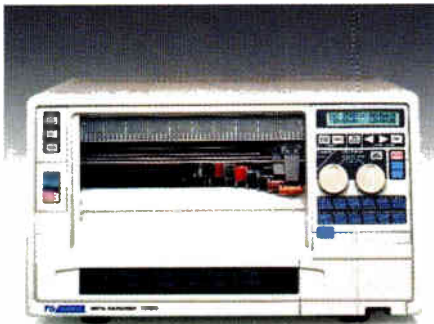
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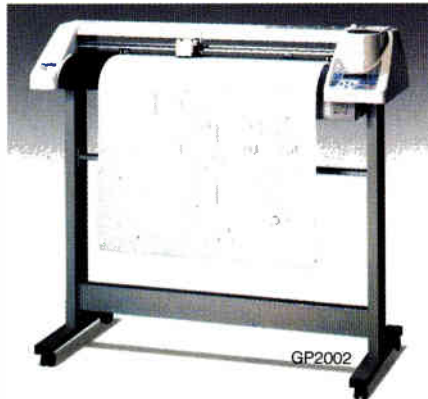
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Hipparchus

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CIRCLE 176

1991: The Year of Living Dangerously

MODEST GROWTH OF 9.5% IS EXPECTED WORLDWIDE, BUT THE CRYSTAL BALL HAS NEVER BEEN CLOUDIER

BY JACQUELINE DAMIAN

It's a bad year for forecasters. "We tried [to project growth figures for 1991] and couldn't come up with any consensus," says Mark Rosenker, vice president of public affairs at the Electronic Industries Association in Washington. And that pretty much sums up the uncertainty surrounding the annual *Electronics* market forecast. In almost every market category, in almost every country surveyed, analysts and executives alike are hedging their bets. Everyone is anticipating growth in worldwide consumption of electronic equipment and components in 1991. But no one is confident predicting just how much.

Recession has struck parts of the world, including the UK, Canada, and Australia, and first-quarter results on top of a down final quarter of 1990 will undoubtedly

edly show the U.S. is technically in recession, too. The Japanese juggernaut is slowing, and a Europe poised on the brink of economic unification also has the recessionary jitters. Add to this the Persian Gulf crisis and the forecast becomes cloudier still.

"I think we're waiting to see what this recession is all about, whether it's going to be short and shallow or long and deep," says John Hatch, vice president of the American Electronics Association in Washington. "Some of our member-company executives are saying things are pretty good; some are saying the opposite."

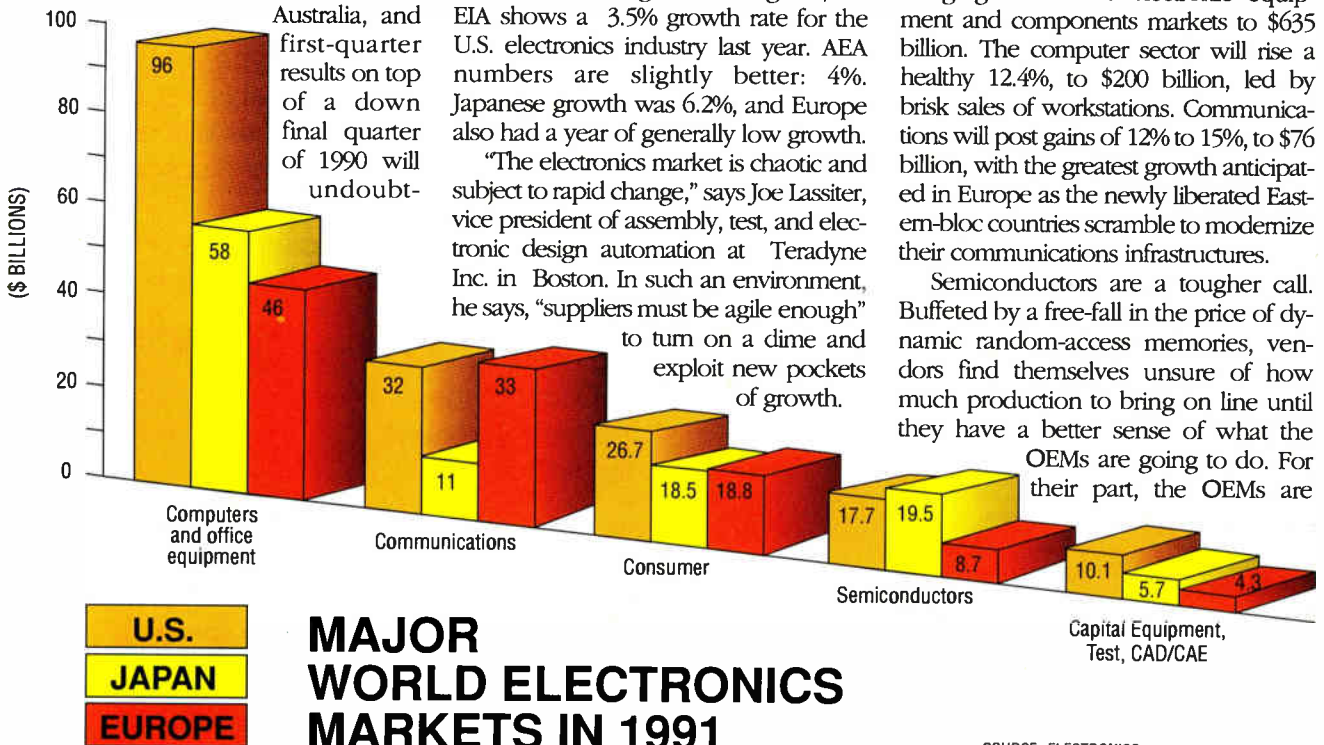
The wobbly forecasts for 1991 come on the heels of very modest growth in 1990. Based on eight-month figures, the EIA shows a 3.5% growth rate for the U.S. electronics industry last year. AEA numbers are slightly better: 4%. Japanese growth was 6.2%, and Europe also had a year of generally low growth.

"The electronics market is chaotic and subject to rapid change," says Joe Lassiter, vice president of assembly, test, and electronic design automation at Teradyne Inc. in Boston. In such an environment, he says, "suppliers must be agile enough" to turn on a dime and exploit new pockets of growth.

And indeed, some vendors are doing exactly that. Each of the five broad categories *Electronics* surveyed this year—computers, communications, consumer electronics, semiconductors, and capital equipment—shows fast-growing segments that will help boost overall 1991 sales figures. But in many other segments, especially the traditional market drivers, most bets are off. The uncertainty is such that in one critical business—semiconductors—analysts' growth projections ping-pong from 15% to 3% for 1991.

Taking all these considerations into account, and assuming no war in the Middle East, the *Electronics* forecast projects growth of 9.5% overall in 1991, bringing worldwide electronic equipment and components markets to \$635 billion. The computer sector will rise a healthy 12.4%, to \$200 billion, led by brisk sales of workstations. Communications will post gains of 12% to 15%, to \$76 billion, with the greatest growth anticipated in Europe as the newly liberated East-em-bloc countries scramble to modernize their communications infrastructures.

Semiconductors are a tougher call. Buffeted by a free-fall in the price of dynamic random-access memories, vendors find themselves unsure of how much production to bring on line until they have a better sense of what the OEMs are going to do. For their part, the OEMs are



SOURCE: ELECTRONICS

dithering between two choices: ganging up several cheap 1-Mbit DRAMs or holding out for a single 4-Mbit part, in the hope that prices for the larger devices will likewise plummet once they move into volume production.

The best guess is a growth rate of about 6%, bringing the semiconductor industry to \$46 billion worldwide.

Consumer electronics will toddle along at low-single-digit growth worldwide, to \$64 billion. In the U.S., sales of a few hot items, such as camcorders, will fuel an overall 4% market rise. The outlook is better in Europe, where Eastern consumers hungry for electronic playthings will help propel 6% to 8% growth. Japan should see just 3% growth as the next generation of products, such as digital-audio-tape players, reach for a toehold in the market.

Finally, the weakest performer is capital equipment, a category that embraces the engineering tools and high-priced machines needed to build integrated circuits and other electronic products. This sector—which includes semiconductor production equipment, test gear, and design-automation tools—always suffers in recessionary times, as the industry postpones big-ticket purchases. It will remain essentially flat at \$20 billion. The remaining \$229 billion is in such areas as industrial and military electronics and components.

All the clouds in this year's crystal ball underscore the fact that the globalization of the electronics industry is more than just a buzzword. Softness in any one geographic market sends shivers down the spines of producers halfway around the world.

For U.S. manufacturers, "the major trend [of 1990] has been an increase in exports," says Pete McCloskey, president of the EIA. "Sales to domestic users were almost flat. Three quarters of the 3.5% uptick we recorded was in exports." McCloskey, who was basing his estimates

on eight-month figures for 1990, notes that this kind of situation "needs a strong international market to continue. If the international economy stays strong, it will continue to pull exports out of us."

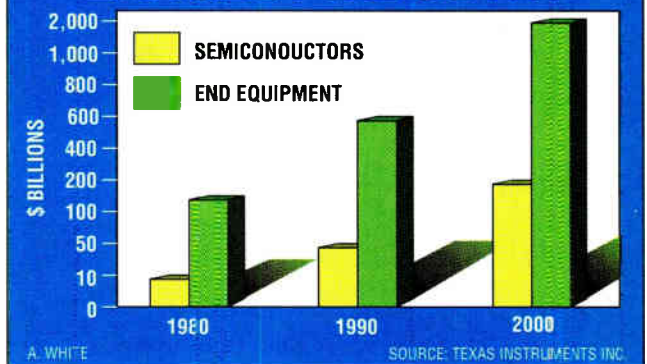
But can the international economy stay strong if the U.S. falters? Statistics from America's main trading partners—including Japan, the UK, Germany, and France—show that the percentage of exports to North America has grown significantly since 1980. As a result, Asian and European economies are more sensitive to a U.S. recession than they once were.

Japan is already feeling a pinch. Inflation and unemployment are up, corporate profits are down 5%, and the Ministry of International Trade and Industry expects capital spending to rise just 2.5% this year. That's a big drop from the 16% to 20% upticks of the past.

In electronics markets, Japan had a lackluster 1990. The overall 6.2% growth rate suffered from the trouncing of MOS memory prices and the resulting flat performance of the components sector. In 1991, analysts expect a modest rebound: 8% growth in equipment, to \$155.52 billion, and 9% in semiconductors, to \$19.5 billion.

In Europe, the picture is mixed. Germany, of course, is buoyed by the October unification of East and West, and electronics executives in that nation anticipate a blossoming of demand in virtually all sectors as the five new eastern states clamor for much-needed electronic equipment. The gains are especially notable in data processing, set to

BY 2000, THE WORLD'S LARGEST INDUSTRY



rise almost 12% in 1991, and in telecommunications, due for increases up to 20% in some sectors.

The Gulf crisis, with its inflationary push on oil prices, should not have an important effect on the French economy, thanks to France's 50% reliance on nuclear energy. Analysts expect French consumers to continue buying computers and other electronic gear. But OEMs expect some hesitation on the part of large corporate accounts until the Gulf crisis is over. As a result, the electronics sector will see a rise of about 5% this year, down from more than 8% last year.

The picture is shakier in Italy, which is 80% dependent on imported oil. Therefore, analysts expect a mere 4% rise for Italian electronics producers, with the best performance in the consumer and telecom sectors.

In the UK, electronic markets were depressed in 1990, except for telecom, where a boom helped offset the poor performance in other sectors. But 10% inflation combined with new personal taxes held consumer spending way down, and the recession led businesses to postpone buying decisions. Better growth is anticipated in 1991, though it will still be small: from \$44.3 billion to \$45.3 billion overall. **E**

This Electronics forecast is substantially different from those we have traditionally published each January. Those reports included extensive tables showing breakdowns of electronic products in minute detail. We have dispensed with those tables this year. When Electronics began publishing this forecast nearly 30 years ago, it provided a rare service, because there were few market research organizations doing similar work. With the growth and sophistication of such organizations, whose primary business is reporting and forecasting unit shipments and revenues, we understand that most of our readers rely on them to provide such detailed data. Accordingly, our focus this year is to report on major trends. We drew upon the considerable resources of several organizations to augment the reporting with their estimates of unit shipments and revenues, and we wish to thank those firms for their assistance.

They include: American Electronics Association, Associazione Nazionale Industrie Elettrotecniche ed Elettroniche, BIS Mackintosh Ltd., Computer and Business Equipment Manufacturers Association, Dataquest Inc., Dataquest UK, Electronic Industries Association, Elsevier Advanced Technology Ltd., Gartner Group Inc., Groupement des Industries Electroniques, Hambrecht & Quist Inc., In-Stat Inc., International Data Corp., Malcolm McIntyre Consultancy, Nomura Research Institute Ltd., Semiconductor Industry Association, Technology Research Group Inc., VLSI Research Inc.

The Greatest Growth Is on the Desktop

WORKSTATIONS, HIGH-END PCs, AND NONSTOP SYSTEMS PROPEL 12.4% OVERALL GROWTH IN THE COMPUTER SECTOR **BY LAWRENCE CURRAN**

Maybe it's time to rethink growth rates in the computer industry. A decade ago, it would have required a major stretch for anyone to find comfort in 12.4% year-to-year growth. That's where it looks like 1991 will come in after all the spreadsheets have been massaged, and it doesn't seem too bad.

What many economists expect to be a short recession in the U.S., with its related downturn in purchases of capital equipment, accounts for sluggishness in some segments. And certainly the explosive growth of the 1960s and 70s is gone forever. That's when it was normal, first for the mini-computer sector and then for personal computers, to roar along like bullet trains, registering growth rates of 40% plus per year. Perhaps new norms should be adopted that consider an increase in the value of worldwide shipments of the major hardware sectors from \$142.2 billion to \$159.9 billion a pretty fair year. If you consider that sluggish, so be it, but the computer industry is maturing, and 12%-to-15% growth is more typical than 30% to 40% in mature industries.

As has been true for several years, engineering workstations will easily top the industry average, producing 30% or more in revenue this year than they did in 1990. PCs also will do better than the average, registering growth of more than 15%. So will software. The Computer and Business Equipment Manufacturers Association in Washington projects revenue from software prod-

ucts this year to reach \$48.9 billion—an increase of 15% over 1990's \$42.5 billion.

One niche that remains well ahead of that pace, however, is computer-aided software engineering, which is bounding ahead at a rate of more than 50% in seats installed and 62% plus in revenues. That's the view of Tony Picardi, director of the application development tools service at International Data

briskly to meet the special needs of on-line transaction-processing applications. OLTP systems are expected to grow 20% this year, from about \$36 billion worldwide to \$43.2 billion, according to Hambrecht & Quist Inc., the New York and San Francisco securities firm.

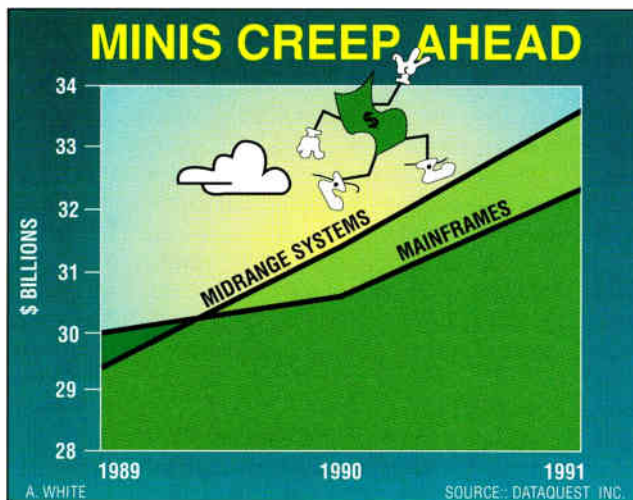
Mainframes will grow faster than they did last year, too, although an improvement from 2% to 5.5% is hardly meteoric.

And there won't be much to cheer about in supercomputers or minicomputers/midrange systems. Supercomputers should inch up almost 15%, but from a very small base—\$1.7 billion to \$1.9 billion—while midrange systems creep 7% to \$33.6 billion. So says Douglas Crook, senior analyst at Dataquest Inc., a San Jose, Calif., market research firm. That scenario extends internationally, with few exceptions.

The big battleground for hardware suppliers is on the desktop, as the focus of corporate computing continues the inexorable shift from data center and departmental computing to widely distributed net-

worked end users. But mainframes will make a comeback this year. The introduction last year of the IBM System/390, along with new mainframes from Amdahl, Hitachi, and Fujitsu [*Electronics*, November 1990, p. 54], will spur a market segment that either has declined or barely grown in recent years.

Jim Cassell, vice president of the large computer market service at the Gartner Group in Stamford, Conn., says flatly that the IBM announcement of the System 390, its related ES/9000 processors, and a slew of software last Septem-



Although mainframes will rebound in 1991, minicomputers will overtake them in revenues for the first time.

Corp., the Framingham, Mass., market research firm. Picardi estimates that CASE installations have zoomed from an installed base of about 20,000 in 1984 to more than 380,000 worldwide last year. "The reason for the fast growth of CASE is that you can finally do something with it," Picardi says. "It's not just a diagramming tool anymore. CASE algorithms are efficiently written and the code that's generated is good."

Continuously running computers, which can be mainframes or mini/midrange systems, are also selling

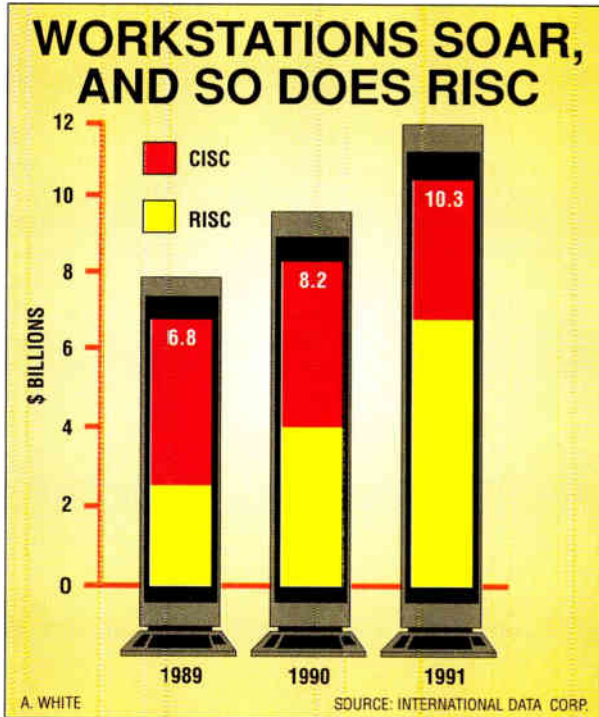
ber is the most important introduction in the computer industry since Big Blue rolled out the 360 in 1964. Cassell expects IBM to ship more than 400 serial numbers by year's end, with each serial number encompassing one to six processors. "Demand outstrips supply now, and the only way IBM can screw up the second half will be if they can't deliver the 9000 processors," Cassell maintains.

A broader perspective comes from Crook of Dataquest, who estimates mainframe sector growth from \$30.6 billion in 1990 to \$32.3 billion this year, or 5.5%. He characterizes the year as one of modest growth in unit sales but flat in real dollar growth. Crook says the lagging mainframe market of recent years is attributable to users waiting for IBM's System/390. With that done, "things can resume at a normal clip," in Crook's view.

The midrange/minicomputer market is searching for a new identity. Crook believes it's "in complete turmoil because so many distinctly different technologies are rushing into the segment." Those include PC-based local-area networks, multiuser Unix machines, 386/486-based computers, as well as traditional minis. He estimates the 1990 midrange market at \$31.4 billion, which will grow by some 7% to \$33.6 billion this year, including servers.

Companies that relied primarily on a proprietary minicomputer product line for their sustenance are struggling through a period during which they've had to augment those lines with open systems—usually multiuser Unix machines—that have far lower profit margins than their proprietary families.

Data General Corp. in Westboro, Mass., reflects the adjustments facing these companies. DG hasn't been profitable for five years, and revenues have bounced back and forth between \$1.2 billion and \$1.3 billion during that time. But Stephen Baxter, vice president for corporate marketing, is encouraged by how well the firm's reduced-instruction-set-computing Avion workstation family has taken off. Avion, which uses the Motorola 88000 RISC microprocessor, doesn't come close to matching the



company's proprietary Eclipse MV line in revenue production, but Baxter says it zoomed from zero to \$100 million in fiscal 1990—its first full year of shipments.

A strong niche in the midrange segment is in OLTP, or continuously running computers, used in applications where no downtime can be tolerated, as in processing stock purchases, bank automatic teller machine transactions, and airline reservations. The OLTP market is growing at some 20% per year, or twice the rate of the overall computer industry, says Hambrecht & Quist's J. Neil Weintraut, an analyst in the San Francisco office. He says OLTP is "becoming the computer industry's leading market opportunity in the 1990s."

The brightest star in the computer galaxy for the last few years and a few more to come is engineering workstations, with analyst estimates of 1991 growth rates ranging from 26% to 40%. These powerful desktop-computers-in-a-network are taking market share from PCs, midrange systems, and perhaps even mainframes. When 1990 numbers are finally tabulated, they should also show that more RISC-based than CISC workstations were shipped for the first time.

The move to RISC technology "is an overwhelming trend" in workstations, says Vicki Brown, vice president for systems research at IDC. Brown says RISC

workstations amounted to 56.5% of unit shipments in 1990. And the beat goes on: RISC processors will account for 78% of the workstations installed this year. That share will add up to \$6.8 billion in a total workstation market worth \$10.3 billion worldwide. By 1994, Brown projects that few CISC units will be manufactured: 96.5% of the units shipped will use RISC processors. As for RISC processor types, Brown looks for the Sun Microsystems Inc. Sparc and MIPS Computer Systems Inc. architectures to continue to dominate in workstations.

Not surprisingly, Andy Nilssen, product line manager for entry Sparc systems at Sun in Mountain View, Calif., doesn't quarrel with that assessment. But he isn't as quick to agree that RISC workstation shipments overtook CISC last year because of the blurring of distinctions between workstations

and PCs equipped with 32-bit processors.

"I guess RISC did overtake CISC, but PCs and workstations have collided and worked into each other's turf, although I question the definition of a workstation," Nilssen says. It usually connotes a networked desktop computer powered by a 32-bit processor. But the PC-workstation competition "gets a heck of a lot more interesting when you consider 32-bit 386- and 486-based PCs."

Nilssen acknowledges that Sun and other workstation vendors face keener competition from PC manufacturers. "But guess what," he adds, "they're getting more competition from us, too." He points out that because of the 386/386SX/486-based PCs, users with 32-bit applications "will look at the desktop hardware they have and ask which architecture has the most entrenched software base to meet those applications." Nilssen believes the answer will come up Sparc most of the time.

Despite all the talk about PCs built around the Intel 80386, 80386SX, and 80486—and certainly that's where the PC growth is—there's surprising life left in the 80286. Bruce Stephen, director of PC hardware research at IDC, estimates that although shipments of 286-based machines peaked last year, they will account for more unit shipments this year than any other microprocessor outside

the Apple Computer Inc. world. That number will top 8 million, down from 9.1 million machines last year but still ahead of the 386 or 386SX.

Taken together, however, the 386SX (about 5.4 million) and 386 (4.9 million) will eclipse the 286 in a 1991 worldwide PC market that Stephen projects at \$80.9 billion—up 15.5% from last year. As for the 486, “it’s just coming out of its first year of shipments,” which reached about 133,000 machines, Stephen says. But that number should really take off this year to more than 630,000 machines, IDC projects.

For his part, Michael Swavely, president, North America, at Compaq Computer Corp. in Houston, says the U.S. market for PCs used in businesses (not including home computers) began to slow in mid-1989, and remained slower than expected all year. “Going into 1990, our expectations were for growth in unit shipments between 5% and 10%,” Swavely says, “but it looks like the

rate will be more like 5% to 6%.” He adds that entering this year, Compaq’s expectations for the U.S. are again 5% to 10%.

The international picture is brighter. Swavely, who also acts as corporate director of sales and marketing, looks for unit shipments to grow 15% to 20% this year in Western Europe, and to top 20% for the Pacific Rim, including Japan. It all averages out to a growth in worldwide unit shipments of PCs for this year of about 15%, he says. The laptop category is “one of huge growth,” although portable PCs of all kinds add up to just 12% to 15% of the worldwide market, Swavely estimates.

As for operating systems, DOS still dominates in shipments of Compaq PCs, which are based on the 286, 386, and 486 processors. “DOS still is the vast majority of what we ship,” he notes, accounting for 90% of unit shipments. OS/2 is a minuscule 1% to 2%, with Unix or Novell’s Netware making up the remaining 8%. ■

For all the good prospects for PCs and small systems, the mainframe sector isn’t hurting, either. But its increase is smaller—less than 10% a year. Contrary to the trend in most other countries, however, mainframes are getting a powerful boost from the rising application of networking, says Siemens AG computer analyst Harald Wunderlich. “Networking will keep giving mainframes a push in the years ahead,” he says.

The rest of Europe reports mixed expectations. The French computer market should not be especially affected by the current general economic slowdown and the Gulf crisis because France depends less on foreign oil than its neighbors do. “French business has a healthy reserve of cash and a solid economy to count on,” says Thierry Dumont, an analyst with International Data Corp in Paris. The market for data-processing and office equipment is expected to rise about 10%, to \$17.5 billion.

The PC segment should see healthy growth, probably at the expense of minis and mainframes, as networking mushrooms. Dataquest Inc. predicted last summer that growth would be about 15% for PCs, says PC analyst Mary Tonnaire in Paris, but she is prepared to revise that down to 13% or so under the current circumstances. PCs probably represented about \$2.6 billion in 1990.

The trend for connectable PCs fuels demand for laptops, most analysts agree. Notebook PCs will be one of the high-growth products, although most observers feel it is too early to provide revenue forecasts. Philips International NV of the Netherlands and Bull SA, France’s national-champion computer manufacturer, are both preparing to market new notebook products.

As elsewhere, minis and mainframes have been hurt by PCs. IDC analyst Jonathan Portch predicts just 5% growth in these segments. “We lopped 24,000 units off our 1990 estimate for France,” says Portch, “largely because of inroads made by networked PCs.” Portch thinks there will be some resistance to the networking trend because of the large installed bases of Bull and IBM computers, both of which had only proprietary systems until recently. “Big companies like banks, with mission-critical systems that can never go down, aren’t eager to retrain staff to use new systems,” he says.

Because Italy will be relatively more

A Strong Year in Germany, Lower Growth in Japan

Internationally, 1991 will see solid growth in most nations in the computer sector, with stellar performance especially in Germany. Annual growth rates of around 10% have been common for West Germany’s computer and office equipment market, but now analysts expect a sudden jump. The October 1990 unification of West and East portends a 1991 rise of 11.5% for the united country.

After West Germany’s computer market rose about 10.7% in 1989, consumption dipped a bit in 1990 to just above 10%. That brought the 1990 market to roughly \$16.6 billion, including software and services. Two reasons account for the slight decline, says Jochen Rössner, senior marketing analyst at Unisys GmbH in Sulzbach, Germany: customers held back orders waiting for new systems from market leader IBM Corp., and users kept tighter reins on investments in view of uncertainties surrounding the date of German unification.

INTERNATIONAL

“With this wait-and-see policy a thing of the past, customers are again making clear decisions regarding computer purchases,” Rössner says. New ordering plus equipment needs for a technology-hungry eastern sector will push the market back up again in the second half of 1991. The 11.5% spurt predicted should bring Germany’s computer market, including software and services, to \$18.5 billion.

Services and software now account for 40% of Germany’s computer market, with services claiming the major portion. This trend will accelerate in the future. The fastest-growing hardware sectors are professional PCs with price tags over \$2,500 and midrange systems selling for up to \$65,000. These sectors will see growth of more than 20% in 1991. Fueling it are the rising computing power that “small” midrange systems offer and their growing acceptance as an indispensable tool for handling jobs in offices and factories.

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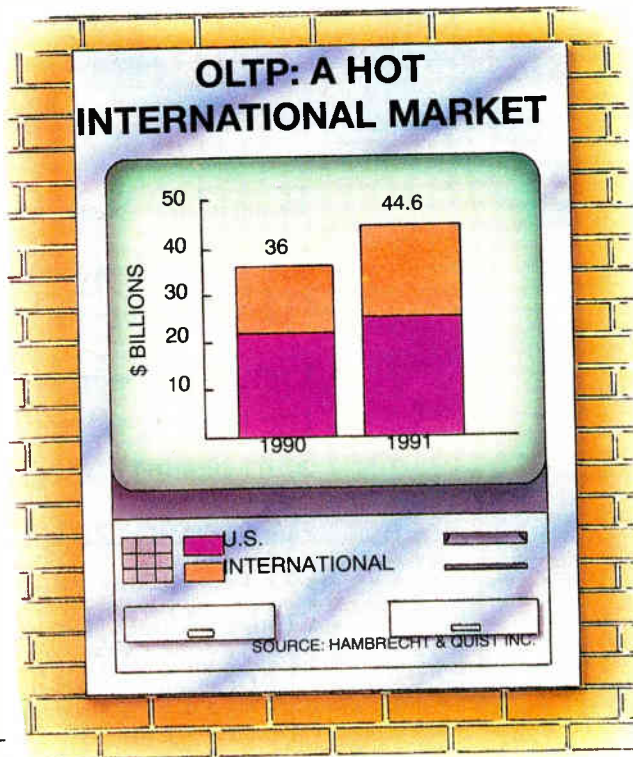
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banks, with mission-critical systems that can never go down, aren't eager to retrain staff to use new systems," he says.

Because Italy will be relatively more affected than France by the business slowdown and the Persian Gulf crisis, investments in information technology are expected to slow. "There is considerable preoccupation" with those situations, says Roberto Taranto, director of the Teknibank research firm in Milan.



The Italian data-processing and office equipment market will probably reach about \$2.2 billion this year.

Financial results at the 150 largest companies in Italy—by far the biggest investors in information technology—are all down this year, creating a holding pattern in equipment purchases. Carmaker Fiat SpA is cutting production. But none is feeling the effects of the slowdown more than Ing. C. Olivetti & Co. SpA. Its profits fell 40% in the first semester of 1990, and analysts are waiting to see new products that will help stop that slide.

Olivetti is weak in the laptop segment, perhaps because Italians have not yet begun to use computers at home. Massimo Moggi, a computer industry analyst with the research firm Nomos Srl in Milan, points out that the fall of the dollar

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It Looks Like Another Year Of Double-Digit Growth

IN A RECESSIONARY ECONOMY, PRODUCTS THAT DELIVER PRODUCTIVITY GAINS WILL SHINE **BY JACK SHANDLE**

It looks like another good year for the vendors of communications equipment and services, regardless of whether there is a U.S. recession. Worldwide growth in revenues will vary from region to region, but should be in the range of 15% for telecommunications and 20% for data communications. Total revenues will hit at least \$76 billion and may go much higher.

In the U.S., the growth rates of some highfliers, such as local-area-network adapter cards, will moderate, in part because growth is calculated on an increasingly larger installed base each year. Other star performers, such as internetworking equipment (including bridges and routers), will enjoy robust growth: around 25% in the U.S., 40% in Europe, and 50% in Japan and the Far East, where the existing base is very small. Sales of equipment implementing the 100-Mbit/s Fiber Distributed Data Interface will be growing like gangbusters in the U.S. especially, but it is starting from a base of near zero.

Communications has become the lifeblood of corporations around the world, so the argument goes, and recession-era buzzwords such as "downsizing" and "productivity gains" play well with decisions to install communications gear that delivers more productivity bang for the buck. This is not to say that macroeconomics will not have an effect. For example, the networking market is now so large that it cannot help but be affected by any slow-

down in capital spending, says consultant Les Denend, formerly an executive vice president at 3Com Corp., Santa Clara, Calif.

"Purchasing managers will hold off and we will be affected," he says. "There will be a qualitative shift toward completing those investments that will add productivity to the existing base as opposed to installing new networks."

Regional variations will play a big role—and not just because of the variations in growth potential due to existing infrastructures, says James Fiedler, executive vice president of Timeplex Inc., Woodcliff Lake, N.J. In telecommunications, the tariffs imposed by national telecom authorities will be a key determinant to growth in 1991. For example, in the 2.048-Mbit/s T1 market in Europe, "privatization in the European Community countries will change tariffs and accelerate growth even above its 25% levels of last year," he says.

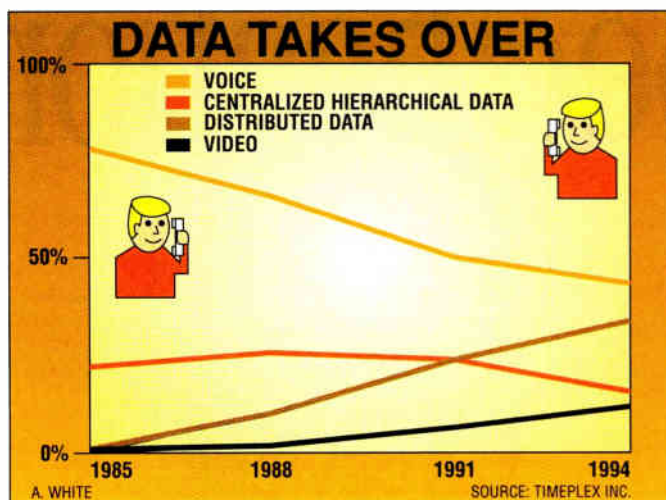
But a long-term trend that transcends

global and local economic variables in communications is the sea change in what constitutes telecommunications traffic. Fiedler believes that 1991 might be the year in which data traffic in the U.S. exceeds voice traffic for the first time for high-bandwidth business users. Increased use of voice-compression technology will partially account for the transition from 80% voice—that is, private-branch-exchange traffic—in 1984-86 to just 40% in 1993-95.

More importantly, data traffic will become increasingly segmented and that segmentation will reflect the way corporate America computes. The number of front-end processors and cluster controllers used in mainframe-based hierarchical architectures will drop steadily while direct connections to LANs via wide-area networking services and tariffed metropolitan-area networks will grow 23% by 1993-95, says Fiedler. Two relatively new data types—compressed and full-motion video—will also make their presence known this year. By 1993-95, video will constitute 10% of all traffic, he says.

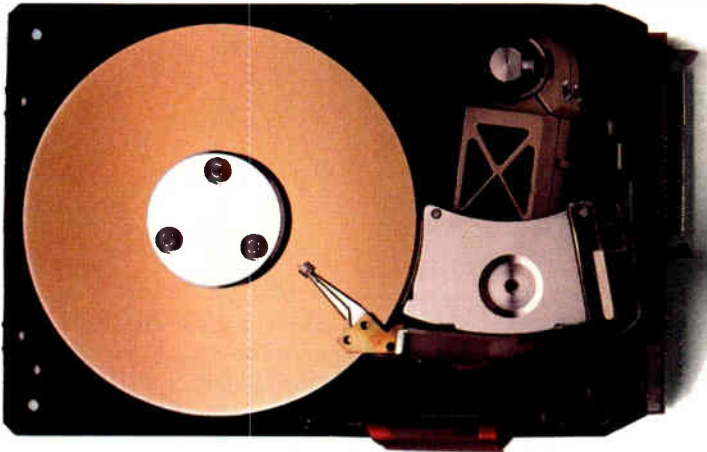
The trend toward proportionately more data in corporate communications is also a trend toward more bandwidth, says Steven Levy, senior technology analyst at Hambrecht & Quist Inc., New York. "We are in the fax period now and we are headed toward video," he says, "and all these new data types are bandwidth hogs."

The movement is clearly from T1 to Sonet (for Synchronous Optical Network) and from copper wire to fiber. "Voice processing will

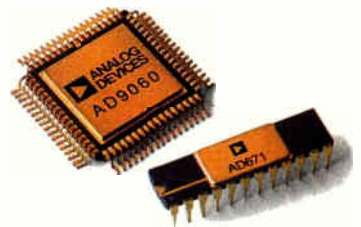


For high-bandwidth business users, 1991 will be the year when data traffic for the first time exceeds voice.

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be increasingly used as a front end to access computer data systems," says Levy. "But I am not forecasting the end of voice. It will continue to grow, but not as fast as data."

Ultimately, says Levy, the communications market will see continuous-speech, voice-recognition technology that is speaker-independent serve as front-end data systems, but that is not in the near future. In the meantime, Levy says he expects voice processing—which includes voice-messaging and voice-response technologies—to continue to grow by leaps and bounds. Worldwide, the increase will be from \$1.1 billion in 1990 to \$1.4 billion in 1991 and then 20% to 25% a year.

A more traditional indicator of overall growth in telecommunications is the T1 market. Viewed regionally, it will grow fastest outside the U.S., says Timeplex's Fiedler. "Growth in the Far East will be in excess of 30%," he says, "but frankly, that is because it is working on a small base. In Europe, we see growth well over 20%, with both infrastructure and tariff issues involved. My forecast assumes tariffs will converge as Europe approaches [economic unification in] 1992. The worry point is the UK—inflation and the value of the pound sterling. Germany will be super because of East-West unification." Fiedler pegs T1 in the U.S. in the "high single digits or low teens."

Revenues from shared-network services should grow 12% to 15% worldwide because of the increasingly global nature of corporate business, says Ronald Bamberg, vice president for business development and planning at BT Tymnet, San Jose, Calif. BT Tymnet operates in 20 countries, he says, and finds that most firms do not have the resources to set up what amounts to numerous private networks with leased lines. Instead, they are using hybrids: leased-line private networks where traffic is heaviest, and shared networks such as those offered by Tymnet in other places. "People have found that they had made a large investment just to become network operators," says Bamberg, "and they are turning away from private networks."

The LAN market is starting to cool off, but only from an incremental perspective: no more 40%-plus growth rates for this maturing industry. William Redman, a vice

president of the Stamford, Conn.-based Gartner Group's Networking Research Division, expects LAN-node equipment revenues in the U.S. to grow 27% in 1991. Revenue sources include the interface card, server, software, and bridge/router hardware. Some \$5.1 billion in LAN-node revenues are forecast for 1991—up from \$4 billion in 1990.

The march toward a connected desktop will continue, Redman says, with 54% of the 31.2 million business personal computers networked in 1991, compared with 45% of 26.5 million PCs in 1990. The percentage of networked PCs will grow to 73% by 1995.

A radical reapportionment of market share of operating-system software will begin in 1991 spurred by Microsoft Corp.'s new LAN Manager strategy, contends Redman. The software giant's August 1990 decision to aggressively enter the LAN market rather than depend on business partners will eventually end Novell Inc.'s dominance. Redman expects Novell's 60% share in 1990 to drop off linearly to 30% by 1994 as LAN Manager's share grows to 22%.

Connectivity equipment—namely, local bridges, remote bridges, and routers—will outstrip the overall LAN

U.S. LANs Keep Growing

	1987	1990	1991	1995
Business PCs (Millions)	13.9	26.5	31.2	52.2
Percent connected	14	45	54	73
Installed nodes (Millions)	1.9	11.9	16.9	38.1
U.S. LAN revenues (Billions)	\$1.6	\$4.0	\$5.1	\$11.1

SOURCE: GARTNER GROUP INC.

market significantly in all three global regions, says Randy Ferdal, marketing director for Retix Inc. in Santa Monica, Calif. Only 15% to 20% of LANs are now interconnected, he says, while up to 50% need to be.

In the U.S., local-bridge sales revenues will grow at a 40% rate through 1991 and then moderate to the 10%-to-20% level. Remote-bridge sales will grow at 25% and then drop off because of bridge/router products that have more functionality. Routers will grow at 45% in 1991, then moderate.

European LAN markets lag behind those of the U.S. by about three years, so Ferdal expects "explosive" growth in sales of bridges and routers there in 1991: up to 50%. In the Far East, he notes, Japanese companies installed lots of LANs in 1989 and the interconnection market—although small in absolute terms—could grow 40% to 50%. The worldwide market for internetworking products is \$400 million, he says. ■

Europe Looks Forward To Robust Growth

Clearly, the heaviest action in communications in 1991 will **INTERNATIONAL** be outside the U.S. The opportunities are particularly good in a newly united Germany. On the other hand, the British are nervous over an upcoming round of deregulation, while the outlook is mixed in France and Italy. And in Japan—where cordless phone shipments should double—analysts anticipate 10% growth in the market. In Germany, the potential in what used to be East Germany is impressive, with the capital available from the former West Germany. October's unification is the impetus pushing the 1991 market for some equipment—like public telephone and data-switching systems—a whopping 20%. Consumption of other gear, such as private switches and fax terminals, is expected to go up a

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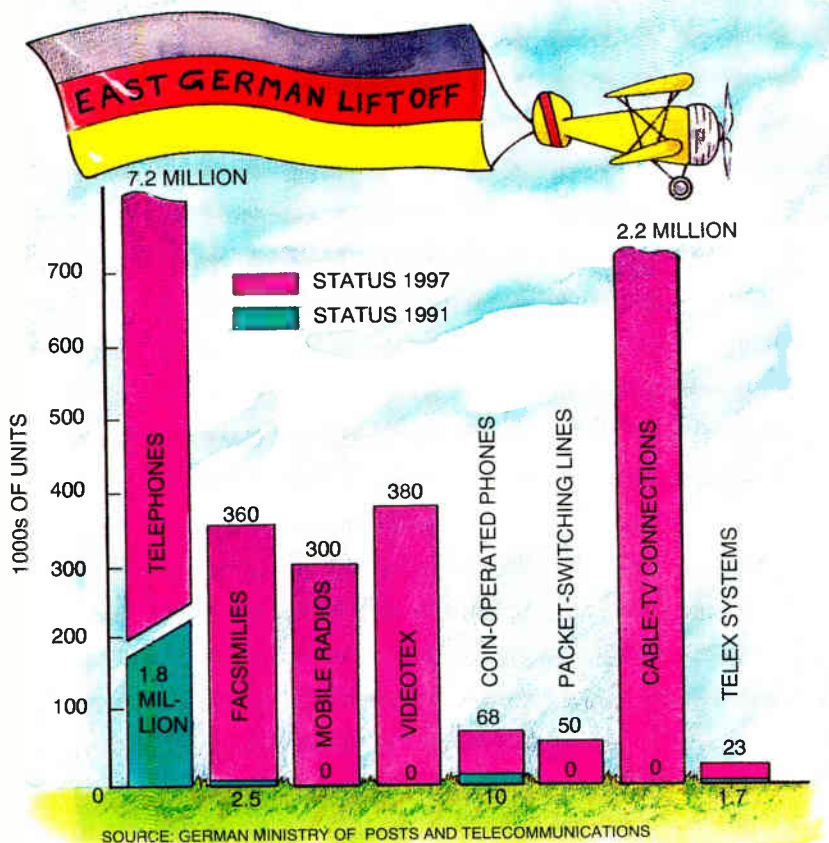
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CIRCLE 198
World Radio History



tors—the Department of Trade and Industry and the Office of Telecommunications—plan to throw the nation's communications services wide open. The nation will gain at least a third, and possibly a fourth, national telephone network operator. It will also add as many as 150 local telephone service operators, because cable TV franchise holders will have to provide fiber to the home as a condition of their licenses. At the same time, operators of "telepoint," cellular, and personal communications networks are expected to be actively encouraged to provide competing "wireless telephony" radio tails to domestic and business telephone users, as well as pursuing their business of attracting mobile customers.

To compete, the existing carriers—British Telecom and Mercury Communications Ltd.—will rush their plans to introduce high-speed communications, including ISDN, and continue to press for the right to carry broadband signals over switched fiber networks and to complete international ISDN connections. Corporate telecom users will also be allowed to resell spare capacity on their digital switched networks, while at the same time being offered wireless private branch exchanges and local-area networks to reduce the running costs of their internal phone systems.

Despite all this activity, the UK telecommunications markets should pick up a mere 2% growth over the \$9.85 billion attained in 1990, says Ken Wilson of Elsevier Advanced Technology Ltd. of Oxford. After that, all is a mystery. For 1992 the UK telecommunications industry could be rolling in sales—if the latest round of deregulation takes the predicted form.

Elsewhere in Europe, France's market for public telecommunications remains Europe's largest and the most advanced after Britain's. Worth about \$1 billion out of a total 1990 communications market of \$7.9 billion, it is expected to grow about 5% in the coming year. According to Dataquest Inc., France has 27 million phone lines, with 70% of them already served by digital exchanges. Now, public network provider France Telecom proclaims that it will reach 100% ISDN installation by the end of 1992.

"The French economy may slow down a bit, but there is no reason to

respectable 10% to 15%, also partly a result of unification. With 16.5 million people, the former East Germany has just 1.8 million phone subscriber lines; by comparison, there are 27.6 million for West Germany, with a population only four times greater.

The phone density on the basis of households is 16%, versus 97% in West Germany. What's more, in East Germany there are 1.2 million households waiting for a phone versus none in West Germany. There are just 2,500 fax systems, 6,000 data-terminal connections, and 17,000 telex machines operating in the former East Germany.

Now that the two Germanys are one, all this is going to change. German telecom authorities have earmarked some \$36 billion to expand and modernize the communications system between now and 1997.

The upshot is big business. The industry will leapfrog right into the latest technologies available, installing fiber-optic communication lines, high-speed telefax systems, and digital switches.

Besides a technology-hungry eastern

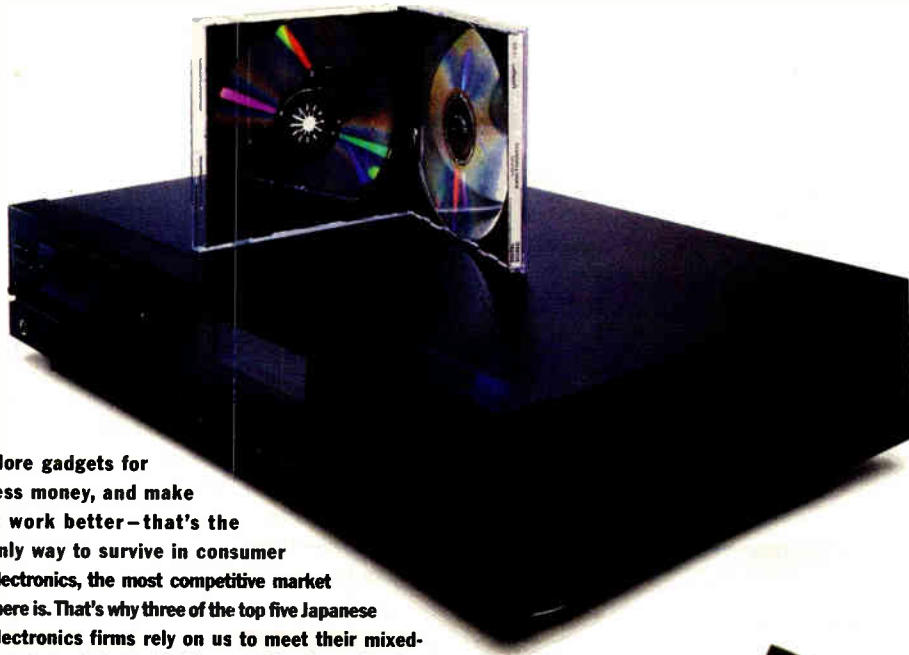
sector, another major contributor to above-average growth for Germany in 1991 is the opening of East Europe. That means a bigger market for transmission systems, microwave networks, and telephone and data-switch gear.

All told, these growth stimulants plus Germany's continuing efforts to digitize its nation-spanning array of switches should propel the country's 1991 market for communications equipment 8% to 10% over the previous year's level. That would push the market to about \$7.35 billion in 1991. So even as competition stiffens and profit margins shrink, the mood of German communications executives is one of optimism.

In Britain, on the other hand, communications executives are a bit nervous. Seven years after the nation's public telephone services ceased to be the monopoly of British Telecom, a new round of liberalization and deregulation is about to take place. It could mean a gold rush, but all the uncertainty connected with it is keeping growth estimates bearish—like 2%.

Britain's telecommunications regula-

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believe that public telecom sales will follow the trend," says Dataquest telecommunications analyst John Dinsdale. In fact, most analysts expect France Telecom to continue to upgrade next year. "But government support may dwindle, because of the slowing economy," Dinsdale adds.

Alcatel NV, with 80% to 85%, still dominates every area of the public telecommunications market in France. And despite the EC's moves toward liberalizing the market across the Continent, it will take years for other companies—foreign or otherwise—to gain significant market share. "There is no chance whatsoever for liberalization to affect technical and commercial barriers," says Dinsdale.

Transmission is growing faster than switching, and some areas of transmission are growing very fast indeed. "France Telecom is starting to buy digital cross-connect systems, which have long been used in the States, but not in the EC," Dinsdale observes. "It's only \$5 million to \$6 million worth so far, but the investment will continue." The low price and efficiency of digital cross-connect systems appeal to Europeans no less than to Americans. France will also invest about \$350 million in fiber-optic cable in 1991. "Everybody is putting it in," says Dinsdale. "The price is coming down for equipment like line systems driven by fiber-optic-related equipment, and the market is growing fast."

Sales of private telecommunications equipment in France are growing a lot faster than gear destined for the public sector. On the private front, which should account for sales of \$1 billion this year, the list is led by explosive growth in data transmission and LANs.

Because France has been a better PC market and has a better software base than almost all the rest of Europe, analysts say that PC networking is a natural step for French business.

"And the good telecommunications system makes running PC nets easier," says Thierry Dumont, an analyst with International Data Corp. in Paris. All of which leads to predictions of more than 10% growth in this key area. "What is typical of France," adds Dumont, "is the demand for information services, not just equipment."

Growth in electronic data interchange should also fuel the trend for data transmission and related services. The number of French companies using EDI is expected to rise 50% in 1991.

The market for private switching will slow in the coming year, analysts say. "Sales kicked from 1988 to 1990, bringing the market to \$1.5 million," says Dataquest analyst Terry Wright, who thinks it will grow a mere 2% to 3% in 1991. "There is a replacement market for midrange PBXs in France, most of which do not use the CCITT standard," he adds.

All private telecommunications producers in France are looking to a large jump in radio-telephone sales, as Europe creates its Continental network. In 1991, analysts say that sales are expected to rise 60% on the prospects.

And the Minitel, France's videotex network, surprised analysts by continuing its growth last year. There are now 5 million Minitel subscribers in France, and, thanks to the wide variety of services it offers, the network should continue to develop at the rate of about 5%.

Italy presents the opposite picture from that of France. Driven by the \$1 billion annual investment of SIP, the public network provider, the market for public switching and transmission is growing faster than that of equipment for private. SIP's so-called "Piano Europa" is a four-year project intended to make up the disastrous lag in Italy's public network. SIP has pumped in \$2 billion over the last two years, and apparently will be able to continue, although few analysts think it will reach the goal of 100% digital exchanges by 1992.

The plan spurred a 15% rise in digital switching last year, according to Roberto Taranto, director of the Milan research firm Teknibank SpA, and is expected to account for another year of 13% to 14% growth in 1991.

Italtel SpA, the Italian national switching leader, has more than 50% of that market; AT&T Co. shares in it thanks to its joint venture with Italtel. The rest is still divided between L.M. Ericsson and Alcatel subsidiaries. Telettra SpA sells a few switches in Italy, but it is not expected to substantially increase its market share.

While the private sector is growing more slowly—at the rate of 7% to 9%—operators are hoping that the improved

outlook for the public network will help invigorate private sales. Private switching is expected to stay at about the 1990 level of \$550 million, says Giorgio Centuori, chief telecommunications analyst with the Milan research firm Reseau SpA. Office investment is expected to be slowed because of the economic effects of the Gulf crisis.

One thing that is stimulating demand is the new 900-MHz public network for radio-telephones, built for the World Cup soccer games last year. That is helping to make mobile radio the fastest-growing sector. "Italy is moving to liberalize the market for these radios," says Centuori, "and their popularity has been limited only by SIP's ability to provide them." Centuori predicts 21% growth in this area in the coming year.

In Japan, growth in the market for communications equipment is expected to exceed 10% in 1991, driven by 100% growth rates for cordless telephones. Cordless phones are of great interest technically due to ISDN support and the merging with portable telephones. Shipments are estimated to reach \$2 billion this year, meaning the average annual growth rate will continue at 100% for the second successive year.

The reasons for this growth lie in the lower prices of the product itself and the evolution in understanding the consumer's living environment. In the future, the market for business phones will also be affected. In the portable telephone segment, products from Motorola, NEC, and NTT are finding ready buyers, leading to a 20% growth rate in 1991.

ISDN, the infrastructure of wide-area networks, is also spreading rapidly. The digitalization of NTT's public telephone switches should also be a major contribution to demand in the future. The PBX market, where NEC, Fujitsu, Hitachi, and Oki Electric possess a combined market share of 90%, will enjoy increased demand. But these companies have new competitors in Toshiba and Mitsubishi, both of which are entering the market. This will create more severe competition but will also depress pricing, holding growth in 1991 to around 5%.—Peter Fletcher, John Gosch, Shin Kusunoki, and Andrew Rosenbaum

A So-So Year Ahead for Consumer Electronics

A FEW HOT PRODUCTS WILL SPARK OVERALL U.S. GROWTH OF 4%, BUT MATURE SECTORS WILL STALL **BY LEE TESCHLER**

The 1991 consumer electronics market is shaping up to be one of down or flat sales. Overall, factory shipments are expected to grow at a rate of slightly less than 4% in the U.S., coming on top of modest growth in 1990. But even this figure is misleading. Most of the growth will be concentrated in a few hot product areas such as cellular telephones, home office equipment, vehicular audio and security, and small-format camcorders. The forecast for other parts of the market is overwhelmingly mediocre.

Suppliers of automotive electronics, for example, may have a tough year. "Growth in 1991 will depend on consumer confidence, whether or not auto companies provide cheap financing to stimulate demand and potential changes in federal tax policies," says Mark Parr, a senior analyst with McDonald Securities Inc. in Cleveland. Though automotive functions such as antilock brakes, air bags, and engine controls are loaded with electronic components, only up-market autos tend to carry these advanced features. Analysts expect automakers to shift their emphasis from expensive to utilitarian models.

That change in product mix spells slowing growth for automotive electronics makers. All told, shipments grew at about a 10% pace in 1990. Shipments in 1991 may grow at half that rate.

The picture is even worse for TVs. TV manufacturers are expecting a flat to down year overall. "Consumers are just not up for buying TVs right now," laments Al Levene, general manager of JVC Co. of America's TV Division in

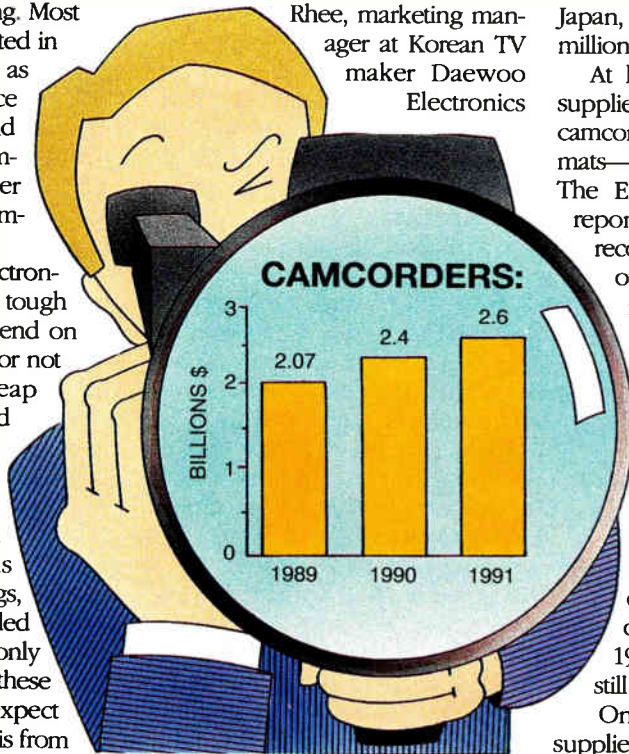
Elmwood Park, N.J. In what is largely a replacement market, suppliers see sales growth primarily in large-screen TVs, those with 27-, 29-, and 31-in. diagonal measurements. These sets will carry price tags comparable to those in the 19- and 20-in. category, says Jason Rhee, marketing manager at Korean TV maker Daewoo Electronics

Despite the grim prospects for TV sales, there are a few bright spots in other kinds of video equipment. One is video games, which were flat last year but may get a boost from the introduction of 16-bit games. Chief beneficiary of this trend is Nintendo Co. of Kyoto, Japan, which estimates that it sold 70 million units last year.

At least for the foreseeable future, suppliers think that sales of compact camcorders—in 8-mm and VHS-C formats—will continue to grow quickly. The Electronic Industries Association reports that last September was a record month for camcorder sales overall; sales of compact versions more than doubled from the levels of a year earlier. And if trends continue, sales of small-format camcorders could be up about 30% in 1991.

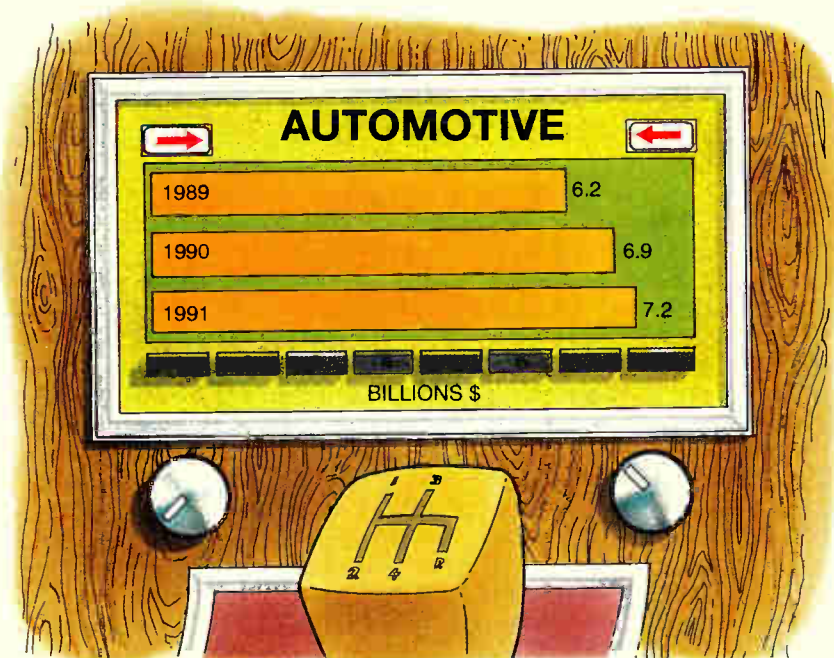
Analysts also anticipate strong growth in sales of video-disc players in 1991. The EIA estimates that sales rose about 35% last year, and some suppliers say that growth on the order of 40% wouldn't be out of line for 1991, because the installed base is still relatively small.

On the audio side of the business, suppliers expect a lackluster year for personal audio products, coming off a generally flat 1990. But there were pockets of growth last year that are expected to carry over to 1991. Portable compact-disk players and three-piece CD "boom boxes" were in short supply because "the market took off a lot faster than we had anticipated," says Dan Murphy, Sony Corp.'s director of business products, Park Ridge, N.J. Sony sees CD audio as a promising area for 1991 as well, in some cases stealing



Corp., Carlstadt, N.J. Thus large-screen TV sales will probably come at the expense of these smaller models.

Some TV suppliers anticipated shortages of the picture tubes in these larger sizes, but the drought generally didn't materialize. One reason is that sales predictions were overly optimistic. In 1991, there may even be an oversupply of these picture tubes, because new plants have come on line in the U.S.



sales from tape-only audio products. The average price of entry-level CD boom boxes dropped \$50 in 1990, to \$149.

New products may stimulate the audio market. Long-awaited digital-audio-tape (DAT) players finally made their commercial debut in the U.S. last September. DAT entered the market with high-end prices, as most observers expected. Sony's DAT Walkman carries a suggested retail price of \$850, while its DAT player for the auto aftermarket lists for \$1,100.

The relatively steep prices will probably diminish DAT's near-term impact on the market. But Sony expects that DAT will begin to gather steam once a critical mass of prerecorded tapes becomes commercially available, probably near the end of this year.

There is at least one segment of consumer electronics that is still expanding at a fast pace: cellular telephone shipments grew rapidly last year and will probably continue to rise at about a 25% rate in 1991. One reason is that phone service suppliers are aggressively pushing down prices. In some cases, carriers are giving dealers phones at artificially low, loss-leader prices in order to sign up subscribers, says Rhonda Wickham, editor of *Cellular Business Magazine*. Wickham estimates that the average price of a mobile cellular phone today (one permanently installed in a vehicle) is about \$199 to \$399; transportables, which come with a large battery pack,

are averaging \$599 to \$699; true portables small enough to be carried in a briefcase are running \$899 and up. These prices are down \$100 to \$200 from 1989 levels.

Analysts expect more stimulus in the first quarter of 1991 with the introduction of a new wave of pocket-size portable phones that will compete with Motorola Inc.'s MicroTAC. There is also a possibility that completely digital cellular phones will debut late this year. This could impact sales and pricing of analog phones. "Common sense would dictate that analog phones would hold their price, because to do otherwise might imply to customers that they were

obsolete," says editor Wickham. "Digital phones, by rights, would have to come into the market at an elevated price, though stranger things have happened."

A mushrooming cellular phone business is an indication of a larger trend: an expanding need for personal office products that are used at home or on the road. In 1990, home office products provided one of the hottest markets for electronics, growing at a 13% clip overall. The pace is expected to slow in 1991 to about 6%. But some kinds of equipment normally used in traditional offices will begin making the transition to consumer products. The 6% figure doesn't reflect this migration, and thus may be low.

"We may see more desktop-publishing systems geared toward home offices," says Nancy Colon, marketing manager at Sharp Electronics' Home Office Division, Mahwah, N.J. "This may bring larger numbers of laser and ink-jet printers into home offices." Sharp also expects PC-based word processors to begin cannibalizing sales of electronic typewriters to the home. Expectations are that "the doubling and tripling in home fax sales is over," says Colon, since the installed base is now so much larger.

The growing importance of home offices also helps move PCs. Estimates are that about 22% of all desktop PCs (and 9% of all laptops) are used in home-office businesses, and that desktop PCs used in home offices will grow at about a 6% rate in 1991. Shipments of laptops for home offices will increase by only about 2%, in part because prices will remain rigidly high. ■

Eastern Buying Spree Buoys Germany

Throughout most of **INTERNATIONAL** wild shopping spree for video cassette recorders, compact-disk players, and feature-laden TV sets ever since. This shopping spree was largely responsible for a 10% jump in sales within the two Germanys this year, pushing the total German entertainment electronics market to \$13.9 billion, says Johanna von Ronai-Horvath, manager of market research at Nokia GmbH, the Finnish Nokia group's German sub-

East Germans were able to buy Western-made goods with deutsche marks as of July 1. They have been on a

man subsidiary. Von Ronai sees healthy growth in 1991 as well—7%, which will lift the market to \$14.8 billion.

Although the East Germans earn less than half the wages of their cousins in the West, they have more money in the bank—an average of \$8,387 per capita versus \$5,161. Moreover, the pent-up demand is probably just a hint of things to come. The real boom, says von Ronai, will come in a few years when Easterners' wage levels are on a par with those in West Germany.

German companies and foreign firms with operations in West Germany are reaping the most benefits from the thriving market in the East. But Far Eastern suppliers are already making sales as well. For example, Korean TV maker Daewoo Electronics Corp. says that Eastern Europe is sucking up the output from 60% of its manufacturing capacity, and that other Korean suppliers are having similar experiences.

Most TV sales in Western Europe are to replace existing units, and suppliers say that VCRs are increasingly a replacement market as well. Estimates are that VCRs can be found in 48% of all West German households. In camcorders, however, there's much room for expansion—only 6% of Germans have one.

In France, consumer spending should not drop markedly in 1991, analysts say. French producers are slashing margins to both boost exports and compete with the Far East for the French market, which should rise about 6% this year to \$4.5 billion. "Our manufacturers have cut prices 20% in the last two years," says a spokesman for the Groupement des Industries Electroniques, France's trade association. The GIE has been one of the foremost sponsors of lobbying the EC Commission to keep limits on goods from the Far East.

French manufacturers export a healthy chunk of their products—especially TVs—to Germany. Exports went up 35% between 1989 and 1990, and are expected to increase at a similar rate in 1991. At home, French consumers have a taste for VCRs, whose sales, at close to \$1 billion, have been rising 10% a year.

Increasing oil prices may put a crimp in Italian growth. "It's too soon to say how much spending will slow," says Dario Zappini of the Associazione

Nazionale Industrie Elettrotecniche ed Elettroniche industry trade association. "Through the summer, the consumer sector was still going well." Zappini expects the Italian consumer electronics market—worth \$3.3 billion in 1990—to increase about 6% to 8% in 1991.

Though color TV is largely a replacement market in Italy, the VCR is just beginning to achieve serious market penetration. "The Italian consumer discovered camcorders after 1986," says Zappini, "and there has been steady growth"—perhaps 15% next year.

Consumer electronics manufacturers have hit an all-time low in the UK. "A 6% downturn in consumer electronic markets in 1990 is the dominant cause of the UK electronics market as a whole not showing more than a modest 1% increase," says Ken Wilson of market research firm Elsevier Advanced Technology Ltd., Oxford. He adds that he expects no more than a 0.33% increase in 1991, to \$3.04 billion.

Andrew Dascalopoulos of the Malcolm McIntyre Consultancy in London puts the blame squarely on Britain's tight economic climate. "Hardest hit are medium- and small-screen TV sets—popular with young British homemakers," says Dascalopoulos.

With the disposable incomes of 18- to 45-year-olds under severe pressure, vendors are looking to a section of the community dubbed GLAMS—graying, leisured, and monied. This new group of people in their 50s, defined by Manfred Perlitz of Luneberg University in Germany, is the least affected by high interest rates. They have finished borrowing and are more likely to have savings—and grandchildren they want to record on videotape.

As a result, the UK camcorder and VCR market has remained relatively buoyant. Dascalopoulos predicts \$1.6 billion in VCR sales this year. Camcorders rose 50% in 1990, to \$756 million, and similar growth is expected this year.

One of the fastest-rising markets in Europe is the automotive sector, says Manfred Schmidt, managing director of Philips Components Hamburg. In Germany, production of systems and equipment will go from \$3.35 billion in 1990 to \$5.3 billion in 1994, a 12.4% increase per year.

Reasons for growth aren't hard to find. For one thing, Germany's auto

industry is doing well and should continue to do so in 1991. For another, more and more electronic systems are finding their way into cars and trucks. Even if vehicle production levels off, use of automotive electronics will keep rising, Schmidt declares.

Christoph Horstmann, executive director in the Semiconductor Division of Siemens AG, is also optimistic. One reason is that electronically controlled equipment such as antiskid, fuel injection, and seat adjustment systems are beginning to migrate into lower-priced cars. Previously, such equipment has been confined to cars of the Mercedes and BMW class. "We are seeing the market going from the top downwards," Horstmann says.

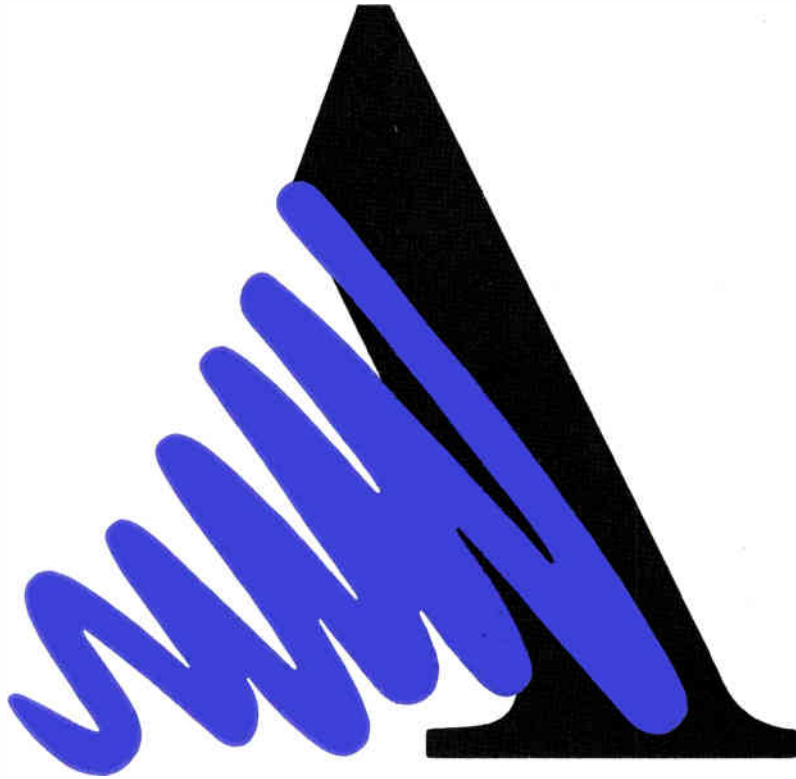
Asian producers will reap some of the benefits of a healthy European market, but deteriorating economic conditions in many parts of the world are expected to result in a flat to down year overall. Suppliers in Japan foresee about 3% growth in 1991, to \$18.5 billion, while the Pacific Rim should see better growth: 7%, to \$11.6 billion. Sales in several mature sectors, including microwave ovens and some kinds of TVs, are expected to drop.

A few hot areas are expected to see double-digit growth, however. For example, camcorders should remain strong. One reason is that prices are dropping. In addition, new hand-held camcorders make these devices more appealing for ordinary man-in-the-street users.

Other rising stars are video-disc and digital-audio-tape players. Video-disc players are expected to see strong consumer acceptance in 1991, with factory shipments growing perhaps as much as 90% over 1990. Similarly, DAT players will begin to have an impact in 1991. All of these devices are manufactured in Japan. An increase in satellite broadcast channels will probably also stimulate the demand for satellite receivers. The move is from stand-alone tuners to devices that are integrated into TV sets.

Though the TV market overall is mature, there are niches within it that will thrive. Compact TVs with liquid-crystal displays, though barely a footnote in the huge worldwide market, are expected to grow steadily.—*Peter Fletcher, John Gosch, Shin Kusumoki, and Andrew Rosenbaum*

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The Chip Business Has a Worried Look

RECOVERING FROM A FLAT 1990, THE INDUSTRY EXPECTS NEW GROWTH; THE QUESTION FOR UNCERTAIN TIMES IS, HOW MUCH? **BY SAMUEL WEBER**

These are troublesome times for the \$50 billion worldwide semiconductor industry. Slowdown and softness are evident everywhere, and uncertainty about the future, engendered by the Middle East crisis and the general economic slowdown in the U.S. and Japan, is exacerbating the general air of pessimism that currently pervades the industry. Led by a precipitous drop in the prices of MOS memory and compounded by softness in the computer sector, 1990 worldwide semiconductor revenue growth was flat at best, and may even have gone negative by some industry estimates.

As for 1991, the outlook is ambiguous. Most forecasters predict growth, but the dimensions of that growth are uncertain. For example, Dataquest Inc., the San Jose, Calif., market research firm, predicts that 1991 will show a rise of 15%, but that forecast is accompanied by a lot of caution. "This is one of the toughest forecasts we've ever pre-

pared," says David Angel, group vice president and director of worldwide research. "There are an awful lot of things that can go wrong."

The Semiconductor Industry Association forecasts 12.5% growth, but allows that a dislocation such as a Persian Gulf war could halve that figure. And perennially conservative In-Stat Inc. predicts that worldwide sales will be up only 3.3% next year, with the U.S. making only a 1.1% gain.

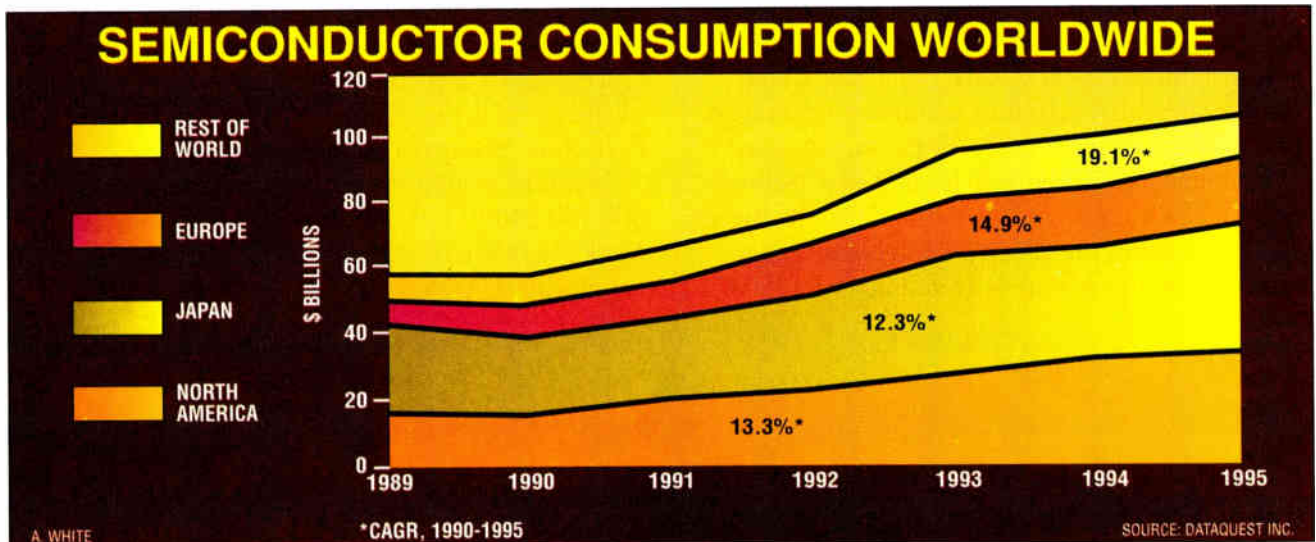
According to Jim Feldham, senior vice president of the Scottsdale, Ariz., firm, the reasons for the low growth are all too familiar: softness in the computer market persists, inflation is rising, the auto industry is flagging, and the housing market is not doing well. "We've tried to include the Middle East in our assumptions, but it has to raise the uncertainty level, causing people to postpone decisions," Feldham says. "And that's showing in our projections for low growth."

By far the biggest disaster area in 1990 was MOS memory, with dynamic

random-access memory consumption declining by about 19%. That amounted to a loss of about \$3 billion compared with 1989, according to Dataquest. In Japan, the memory drop was a head-spinning 25%, as prices for 1-Mbit DRAMs plummeted. With the low 1-Mbit prices luring OEMs, the demand for 4-Mbit devices, anticipated to be strong, is sluggish instead.

The debacle was not restricted to DRAMs. Static RAMs were also hard hit, resulting in suppliers such as Advanced Micro Devices, National Semiconductor, Philips, and VLSI Technology abandoning the SRAM market.

The bipolar device market was essentially flat in 1990, at about \$4 billion, except for application-specific integrated circuits: programmable logic devices, gate arrays, and standard cells were all marginally up. Discrete devices, worth \$9 billion in 1990, were flat. The SIA predicts growth of about 7.5% this year. A continuing bright spot is MOS microlog-ic—a category that includes micropro-



GROWTH SEGMENTS FOR CHIP MAKERS

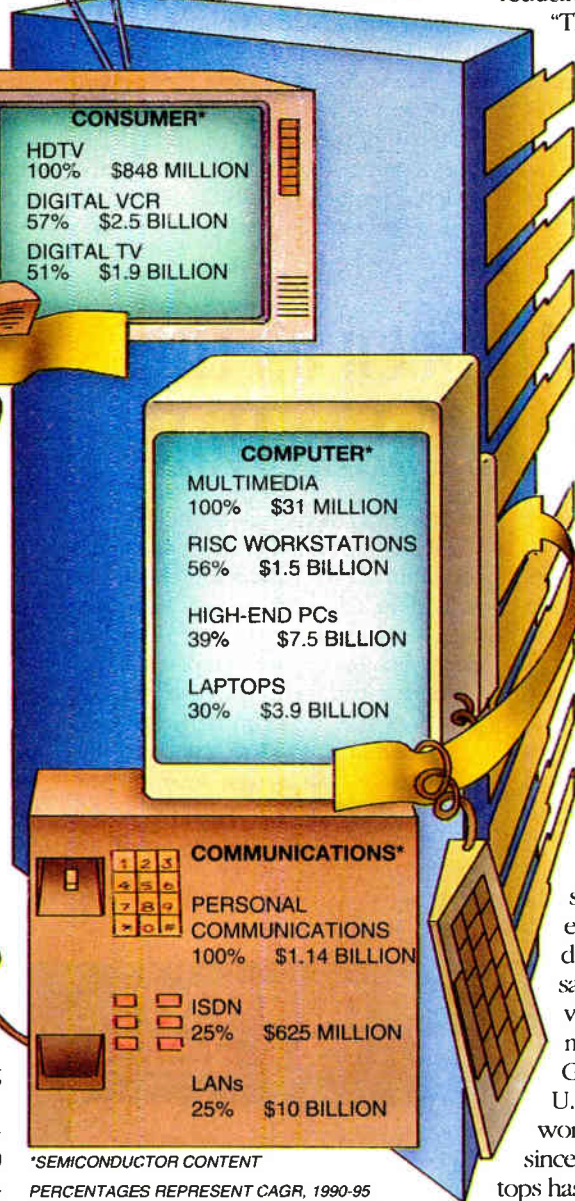
processors, microcontrollers, and peripheral chips. Their sales were up 21%, In-Stat says, fueled by price rises. Dataquest pegs this market at around \$9 billion, going to almost \$11 billion in 1991. Another bright spot is the 11% growth in MOS ASIC devices, which include gate arrays, standard cells, and field-programmable gate arrays. Andy Haines, director of marketing at Actel Corp., a major supplier of FPGAs, says sales tripled last year over 1989, with a strong military component of orders. World sales in FPGAs stand at around \$100 million now and should hit \$500 million by 1994.

Continued growth in the workstation market offers some relief to semiconductor suppliers by absorbing high-performance logic and graphics chips and by pulling increasing amounts of memory. "The strongest end-user segment happens to be workstations right now," says Bruce Entin, vice president of investor relations at LSI Logic Corp. in Milpitas, Calif.

"We're seeing the last wave of midrange proprietary computers that are shifting to RISC Unix-based systems—the open-systems approach." While these shipment numbers don't compare to PC shipments, Entin says, "they are growing and the numbers are getting pretty substantial."

Entin points out that higher-performance machines—at 15 million to 30 million instructions/s—command higher average selling prices, and the semiconductor content is increasing. "In the old VAX machines, there wasn't a lot of ASIC content and no microprocessor content," he says. "Now the percentage of our chips in these boxes is increasing and more boxes are being shipped. So for the semiconductor companies that have products in this area, it's going to be a good year."

Tom Miller, president of Via Technology Inc. in Sunnyvale, Calif., also sees reduced-instruction-set computing as sparking prime growth, especially the Sparc chip-set business. "Sun [Microsystems Inc.] is shipping around 150,000



*SEMICONDUCTOR CONTENT
 PERCENTAGES REPRESENT CAGR, 1990-95
 \$ FIGURES REPRESENT TOTAL AVAILABLE MARKET
 SOURCE: TEXAS INSTRUMENTS INC.

units a year currently," he says. "In 1991 that number will double, and it will double again in 1992." Miller predicts that by 1993, more than 1 million Sparc-based systems will ship, and Entin points out that "the emergence of Sun clones" further enlarges the market. As a result, the segment will begin to gather the momentum of the early PC market.

Reflecting the decline in personal computer sales this year, chip sets for this market registered dead flat in 1990, says Feldham of In-Stat. Prices on 286-

type chip sets are now \$25 or \$30, he reports, while integration has increased, reducing the chip count in a set.

"That's a double-edged sword for suppliers," says Feldham. "The volume has gone up, but prices have fallen. It's a really tough business, highly competitive."

But chip sets for 386-based systems operating at 25 MHz or higher are doing fine, says Ron Jaswa, vice president of marketing at Opti Inc. in Santa Clara, Calif. He says Opti is shipping everything it can make and is growing faster in its first years of operation than Chips & Technologies Inc., the San Jose high-flyer whence Opti sprang.

"We are operating at a \$2 million per month run rate," Jaswa says, "and we are the largest supplier of DX and 486 chip sets."

Entin of LSI Logic points to the recent Comdex show as a watershed event where a plethora of laptops and notebook computers, as well as products based on single-chip 286 and 386 products, were shown. This heralds a rapidly expanding market for semiconductor components in 1991, he says. But Wally Rhines, executive vice president of Texas Instruments Inc.'s Semiconductor Group in Dallas, points out that U.S. semiconductor suppliers won't enjoy much of this growth, since the current generation of laptops has a high percentage of Japanese components.

The slowing of the PC market may not be the disaster some believe it is. "What's happening is the computer market is undergoing some major changes, the kind that only take place every decade or so," says James Magid, senior adviser at Needham & Co. Inc. in New York. Pointing to Comdex as a barometer he says: "You will be seeing a whole new class of product, a transportable or laptop that you can take with you all day long, with all the function of a desktop. It's a new category, and it will have spectacular growth."

What's more, Magid says there's a

growing recognition among business people that the half life of an office computer is about two and a half years, considering the performance advances that keep coming along. Accordingly, he foresees a huge PC replacement market shaping up. All this, he says, means that "the components industry is in much better shape than one would expect with the current state of the general economy."

Telecommunications is one area that is strong and getting stronger, particularly in Europe. Dataquest's Angel says demand for cellular telephones in Germany, France, and the UK is explosive, and the book-to-bill ratio for telecom chips at two major European companies is running between 1.5 and 2.0. TI's Rhines agrees that cellular phones and switches pull a lot of ASICs, DSPs, and analog and mixed-signal products. ■

Contributing to the components growth will be almost all electronic sectors, but the automotive is by far the liveliest performer, although from a small base. Production will mushroom 12.4% a year in the near future, hitting \$5.3 billion in 1994, according to Philips Components in Germany. Sales of microelectronic parts to the auto sector should go up an average 10% a year at least through 1994, says Manfred Schmidt, managing director of the Hamburg-based company.

Another big components user in Germany is the consumer electronics sector. Its market is predicted to climb 7% in 1991. The push here is coming from several directions: booming sales of video systems, the addition of 16.5 million consumers resulting from the October 1990 unification of the two Germanys, brisk replacement and multiple-set-per-household sales of TV receivers, and the presence of Japanese equipment makers in Germany.

Somewhat surprisingly, Far Eastern equipment producers in Europe are sizable customers of European-made components, especially of parts that must conform to, say, TV standards specific for the continent. All told, say market researchers at Philips Components, sales to the consumer sector will reach \$1.9 billion in 1994, up from \$1.6 billion in 1990. That translates into a 3% annual rise.

A steeper climb is in the cards for components for the office and data-processing equipment sector—7% a year is the word from Philips. That should lift parts sales to the industry to \$1.48 billion by 1994. The sector will benefit from above-average growth of small computer systems selling for up to \$80,000, a solid mainframe business, and rising system sales to technology-starved ex-East Germany.

A spurt of about 7% a year from 1990 to 1994 is predicted also for components for communications. The need for communications gear in the five new eastern states will create a big demand for components in telecom equipment. German postal authorities have

Slow Growth Seen as the 4-Mbit DRAM Takes Hold

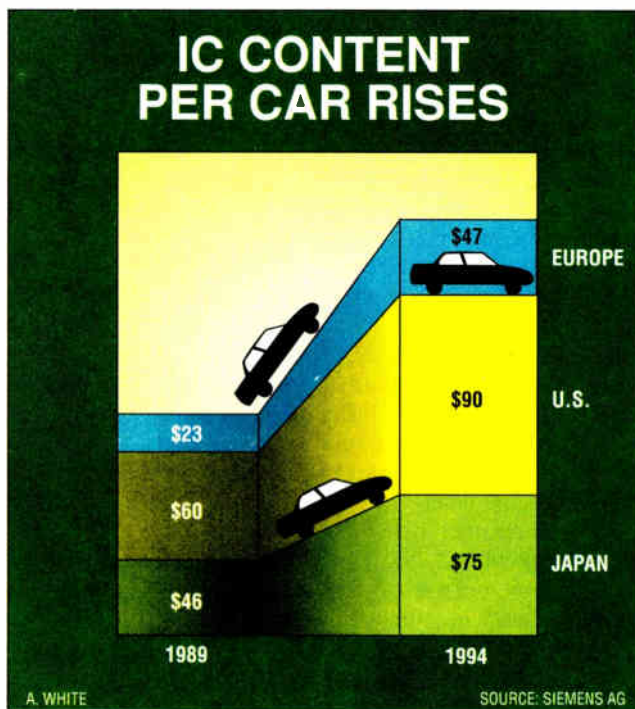
Big increases in device production and sharp price declines, especially for standard parts, were typical for Europe's 1990 semiconductor market. As in the U.S. and Japan, the drop was particularly severe for memories. In Germany, for example, prices for 1-Mbit dynamic random-access memories tumbled 65% from the January level to \$5 apiece by year's end. Sharp increases in memory production at Munich-based Siemens AG, Europe's only volume producer of high-density DRAMs, could not compensate for the steep price decline.

"In all probability, the price erosion for memories will continue in 1991," says Christoph Horstmann, executive director for sales and marketing in Siemens's Semiconductor Division in Munich. "The problem is that an oversupply of 1-Mbit DRAMs coincides with a weak personal computer sector, the main customer." Prices will firm up only if problems are encountered in the transition from 1- to 4-Mbit DRAM production. If this transition goes smoothly—and Horstmann thinks it will—then the price erosion will continue, this time for 4-Mbit parts.

But despite the fact that these devices account for 20% to 25% of global semiconductor sales, the impact

INTERNATIONAL of memories should not be overrated. For many other parts prices are stable or dropping only slightly. Against this background, and given the good sales performance of virtually all electronics sectors, the European semiconductor market should register modest growth of 10% to 11% in 1991.

In Germany, the predictions for the 1991 market value from several firms, among them Telefunken Electronic GmbH in Heilbronn and the ITT Semiconductors Group in Freiburg, are in close agreement—\$3 billion. That represents an 11% rise.





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carmarked some \$36 billion between now and 1997 to expand and modernize the communications infrastructure in the new provinces.

In France, analysts caution that the 10% overall growth figure may not be as solid as it looks. "Semiconductor sales are counted in dollars," explains Jean Philippe Dauvin, research chief at SGS-Thomson Microelectronics. "The decrease in the dollar's value over the last year pushes up the sales figures. In reality, [1991 growth] should be valued from 7% to 10%." Total market value is expected to rise to \$1.48 billion, from \$1.35 billion in 1990, the company says.

Despite the fall in prices for DRAMs, the OEMs are being cautious, Dauvin says. "The European computer market is so slow at the moment that many OEMs have decided to wait for the 4-Mbit DRAM to become generally available." The gradual introduction of the 486-based machines at the big European companies should begin to pull demand up again in 1992, he says. All together, computer IC sales should increase to \$398 million next year, from \$342 million.

The consumer and telecom sectors are doing better. France will be relatively unaffected by the Gulf crisis and its inflationary push, thanks to its reliance on nuclear energy. Thus, consumers will keep spending money on TVs and radios. Altogether the consumer sector will account for \$170 million in ICs in 1991, a jump from \$160 million in 1990.

France Telecom is working to make its network digital, and chip makers can count on continued investment in that area. Mobile radio is the hot product in telecom; as Europe moves to create a pan-European cellular network in July 1991, demand should jump. According to Dataquest Inc., the semiconductor cost per first-generation GSM hand set will exceed three times that used in current analog cellular hand sets. All of which means good news for chip makers in France, where telecom sales should hit \$300 million in 1991, says SGS-Thomson, from \$280 million in 1990. Dauvin predicts a rebound for the French IC market in 1992, when an improved economy will boost sales 18%.

Demand for semiconductors in Italy is also to grow at about the 10% level,

with a similar adjustment for the weak dollar, Dauvin says. The market will rise to \$1.21 billion in 1991, he estimates.

Ing. C. Olivetti & Co. SpA is the biggest semiconductor purchaser in the country, and it is in difficult straits, with profits falling by more than 40% and new products delayed. The resulting slowdown in investment from one of Europe's largest computer makers is one reason why Dauvin predicts Italy's \$427 million computer memory market to rise to a mere \$492 million in 1991.

Fiat's auto sales are also way down this year, as the company cuts production and lays off 35,000 workers. That means Fiat subsidiary Magnetti Marelli, Europe's largest producer of electronic auto components, will also see a decline in sales. Hence the \$75 million IC market for cars will rise only to \$85 million in 1991. Although demand for telecom equipment is way up in Italy, the market is divided between Italtel SpA, the national champion, and foreign firms like Ericsson and Nokia that produce elsewhere. Hence, despite rising demand, the market will go only from \$140 million in 1990 to \$150 million in 1991.

In the UK, analysts expect a basically flat year with growth of 5% to 7%, on the heels of virtually zero growth in 1990. "After 1990, some of our competitors are forecasting huge growth rates," says analyst Ken Wilson of Elsevier Advanced Technology. "We say 5% growth for 1991 and an average of about 10% CAGR till 1994."

Wilson adds that growth will return to the UK market in 1991 for two basic reasons: average selling prices will stabilize after a significant decline; and new generations of products such as mobile communications equipment and advanced PCs, which have a higher semiconductor content will enter production. Indeed, Wilson puts most of the 5% growth he forecasts firmly down to mobile communications.

Sales of ASICs and linear devices are set to grow strongly compared with other sectors, ASICs by as much as 10% and linears by around 7%. The market for memories will be soft, perhaps showing a 3% decline by value.

DRAMs makes up the bulk of this market, and ASPs have reached bottom, says Mike Lennan of Dataquest UK. The reason for the forecast decline is more a result of users switching from 1- to 4-

Mbit devices, he claims. "The price ratio between the two parts is now at around 3.8 to 1 in the UK," he says, with prices for 4-Mbit DRAMs ranging between \$17 and \$22 depending on volume. That means that it is cheaper to use one 4-Mbit part than four 1-Mbit chips.

All in all, most analysts see the European market starting 1991 slow and improving in the last two quarters, then surging ahead in 1992.

The Japanese semiconductor industry started to face tough times in the third quarter of 1989, the trough of the silicon cycle. The effect of declines in MOS memory prices drove final overall semiconductor growth to \$18.6 billion, a decline of 2.6%. "They don't have a strong microprocessor industry—an Intel or a Motorola—to counteract the loss in memories," says Jim Feldham, senior vice president of In-Stat Inc. in Scottsdale, Ariz. "Their MOS logic was up 10% and ASICs up 9%, but not enough to bring them into the positive range."

But in 1991, based on long-term demand trends, growth centering around MOS memories will drive a rebound in semiconductors as a whole, with a 13% rise foreseen. In an attempt to avoid precipitous price cuts, the manufacturers imposed a 10% reduction in 1-Mbit DRAM production starting in the latter half of 1989. It was prompted by the bitter experience with overproduction of 256-Kbit DRAMs during the semiconductor slump of 1985. Even so, 1-Mbit DRAMs are currently priced at around \$6 on a spot basis, but many analysts feel the bottom has been reached.

Hitachi Ltd. and Toshiba Corp., the two largest semiconductor manufacturers, say they are planning to shift emphasis to the 4-Mbit DRAM over time. But Feldham thinks the 4-Mbit device will come in more slowly than people expect because the low prices of 1-Mbit parts make these DRAMs so attractive to system builders. He forecasts 200 million 4-Mbit units to be sold in 1991, up from 40 million in 1990. That's a substantial gain, but overall, a drop in the memory bucket, according to Feldham.

The Japanese also plan to increase the production ratio of the more profitable ASICs. Analysts see growth of 22% in 1991.—Peter Fletcher, John Gosch, Andrew Rosenbaum, and Sam Weber

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Production and Test Gear Falter, but CAD Is Strong

MANUFACTURERS LOOK FOR GROWTH NEXT YEAR, WHEN NEXT-GENERATION ICs WILL COME ON LINE **BY JONAH McLEOD**

What does 1991 hold for the engineering tools and production equipment used to design and build electronic components and systems? Says Gil Reeser, group marketing manager at Hewlett-Packard Co. in Santa Clara, Calif., "Of all the years I've predicted demand for test and measurement, I am least sure of 1991."

Despite the uncertainty, industry players in semiconductor production equipment and T&M expect a flat or down year in 1991, although electronic design automation should chalk up some growth. But in the category overall, the good growth rates of a few star performers aren't enough to balance the bad news in other segments.

For example, sales of systems to build submicron process technology should soar, but the future is bleak for older systems used to increase production capacity. This year will be good for mixed analog and digital automatic test equipment, but dismal for commodity logic and memory testers. Design-automation systems will continue growing, especially tools that speed time to market.

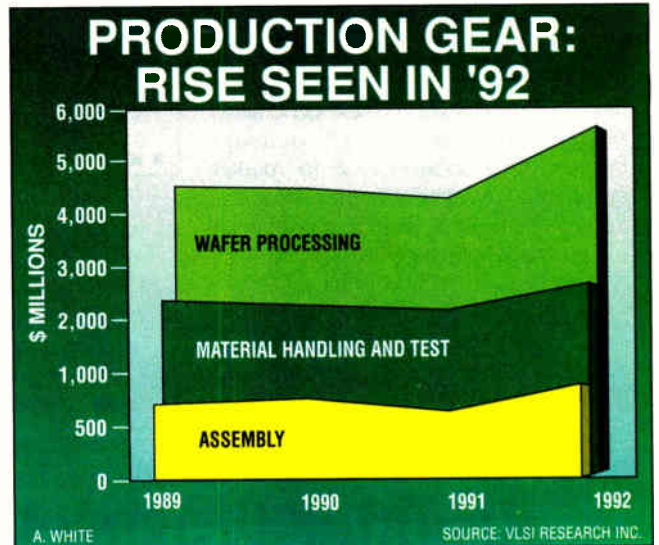
In semiconductor production gear, "Business was down a couple of percentage points in 1990 and will be down about 4% worldwide in 1991," says G. Dan Hutcheson, president of VLSI Research Inc. in San Jose, Calif. "Semiconductor manufacturers' capital expenditures, in general, have not been large and Japanese IC makers have not invested heavily, because 4-Mbit dynamic random-access memories have been slow coming on line."

However, "The downturn of 1991 will not be as devastating as in past years," says Carolyn Rogers, technology analyst with Hambrecht & Quist Inc. in

San Francisco. "There is not as much surplus inventory at the semiconductor houses or at production equipment vendors. While semiconductor equipment manufacturers are not buying to build extra capacity, they are buying next-generation equipment."

That next-generation gear includes machines to handle the larger, 8-in. wafers and to cope with submicron geometries, says Krishna Shankar, industry analyst at Dataquest Inc. in San Jose. "Less than 10% of the installed equipment can process 8-in. wafers, but this will double next year," concurs John Osborne, vice president of Lam Research Inc. in Fremont, Calif. "In addition, semiconductor manufacturers are moving from 1.0- μ m to 0.7- μ m process equipment," he says.

Growth in deposition and etch equipment will come from the shift to 8-in. wafer-handling equipment, says Shankar, while lithography growth will come from the move to submicron processing. "From 3.0- to 0.8- μ m lithography, conventional refractive optic steppers are sufficient," says Hutcheson. "But below 0.8 μ m, a reflective optic stepper is better, because ultraviolet light that exposes film used to build a device does not go through glass as a refractive stepper does. Glass distorts the light and leads to less precise details on the film." Only one company has so far patented a reflective stepper: the Silicon Valley Group Inc. in Santa Clara.



"Lithography and etch equipment used to be bottlenecks in wafer processing," says Rogers of Hambrecht & Quist. "Now it's deposition." However, the bottleneck is being broken with the advent of systems able to perform tungsten deposition [*Electronics*, November 1990, p. 29]. Ken Schroeder, president of tungsten leader Genus Inc. of Mountain View, Calif., expects widespread adoption of the technology next year. VLSI Research predicts a 32% rise for deposition gear in 1992, to \$5.8 billion.

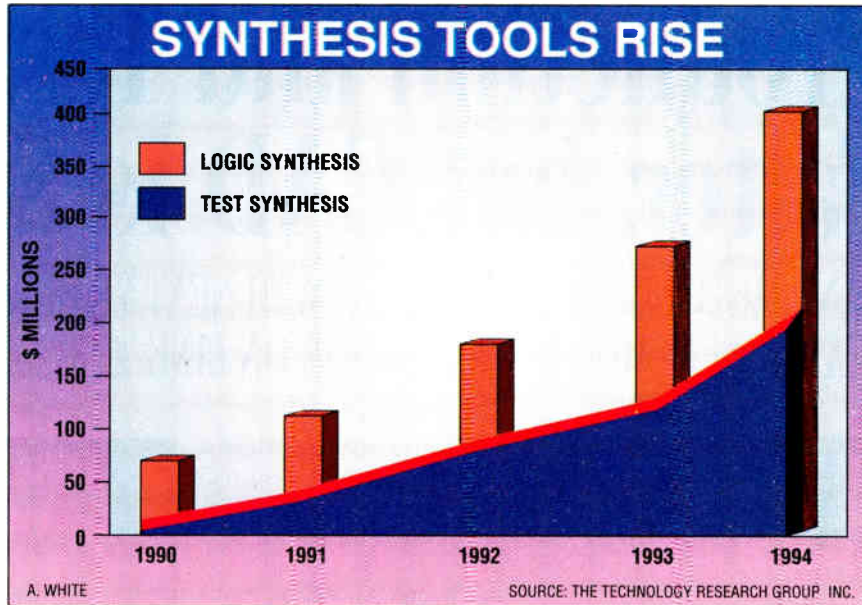
ATE is a production equipment segment that has suffered more than most in recent years. "ATE has been down since 1988," says Hutcheson, "and the outlook for 1991 does not hold out much hope for a significant upturn." Joe Lassiter, vice president of the assembly, test, and EDA group at Teradyne Inc. in Boston, concurs: "Mainframe suppliers, certain PC vendors, and some consumer products manufacturers are buying ATE, but generally the market is slow." Las-

siter cites one bright spot: the government. A bubble of federal spending in the fourth quarter of 1990 will extend into the first quarter of this year.

"The demand comes from several military weapons programs that finally received Congressional approval and procurement finally got under way," he says. Despite the general sluggishness in ATE, individual companies are managing to weather the storm. "Mixed-signal testers are bucking the downward trend," says Hutcheson.

One bright spot for 1991 is computer-aided design and engineering. According to the Technology Research Group in Boston, the total CAD/CAE market should grow 27% in 1991, hitting almost \$2 billion. Next-generation design tools are in high demand because they shorten time to market and handle designs of higher complexity, says Peter D. Schleider, a partner in the investment firm of Wessels, Arnold, & Henderson in Minneapolis.

He cites companies such as Synopsys Inc. of Mountain View, with its VHDL synthesis tool, as addressing these market requirements. The compa-



ny grew 300% in 1990, says Bob Smith, Synopsys' director of marketing, and it's looking for more growth—although probably not as heated—this year.

"Besides synthesis, designers want to simulate designs described at different levels of abstraction—behavioral, gate,

etc.—as well as simulate digital and analog circuits," says Tony Zingale, vice president of corporate marketing at Cadence Design Systems Inc. in San Jose. The company's Amadeus product meets this need, as does Mentor Graphics Corp.'s L-Sim simulator. ■

Brighter Prospects in Europe and Asia

More dependent on **INTERNATIONAL** equipment, says Dataquest exports to the U.S. than they were even a decade ago, European and Asian electronics manufacturers will be as depressed as their American counterparts. They will be hurt by a weak dollar that makes foreign goods more expensive in the U.S.—even as it makes U.S.-made goods more attractive to overseas customers—and by diminished U.S. demand.

The result is that makers of production equipment are exploiting Asian and European markets in an effort to replace diminished U.S. demand, and manufacturers of test and measurement systems are following suit. For their part, computer-aided design and engineering companies view European and Asian demand as equal to, if not greater than, the strong demand in the U.S.

In Europe, last year's European Community decision requiring local content in semiconductors sold in Europe boosted sales of production

business has grown as semiconductor makers worldwide rush to meet the deadline," says John Osborne, vice president of Lam Research Inc. in Fremont, Calif.

After moderate growth in 1989, the German T&M market leveled off in 1990. "Overall, it will stay flat in the year ahead or climb slightly," says Karl Brand, responsible for marketing support at Philips GmbH in Kassel, Germany. A no-growth year will see 1991 T&M sales in Germany remain at around \$580 million.

In France and Italy, because of cuts in defense spending, T&M sales have slowed a bit. "The budget reductions in Europe mean reduced sales for test and measurement equipment," says Hewlett Packard Co.'s Jean-Pierre Humbert. He predicts a 6% rise in sales for France's \$300 million T&M market. The T&M sector in Italy, which will cut even

more than France from defense spending, should see sales rise less than 5%.

For CAD/CAE, spending in France remains on the rise, with the Airbus program fueling growth. The consortium that builds the new planes is to invest \$2 billion in technology over the next two years, and much of that will call for electronic design.

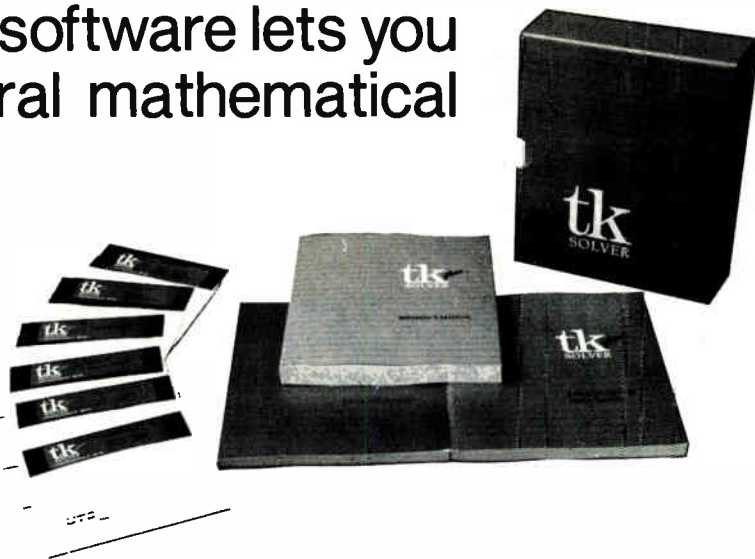
In Italy, CAD/CAE producers are still enjoying a boom. The market increased 30% last year, says Massimo Moggi, an analyst with Nomos Ricerca in Milan, and is expected to jump another 21% in the coming year, despite the economic slowdown.

The Far East is the fastest-growing component of T&M business for John Fluke Mfg. Co. in Everett, Wash. "The falling dollar halved our products' cost in Japan," says Ron Wambolt, senior vice president and director of worldwide sales. And that goes for Taiwan and Korea as well as China, where sales are strong, adds Wambolt. ■

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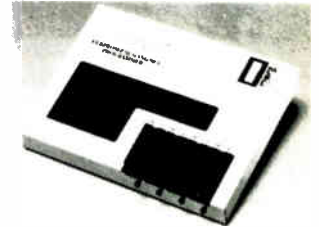
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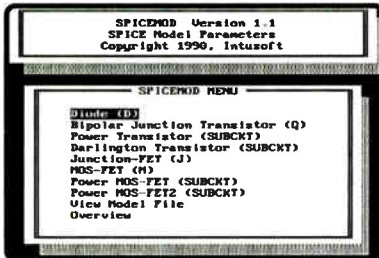
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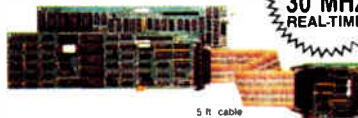
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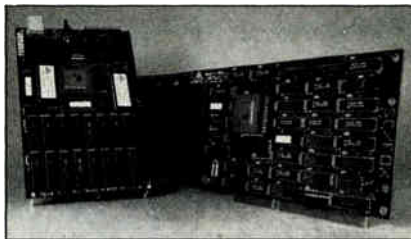
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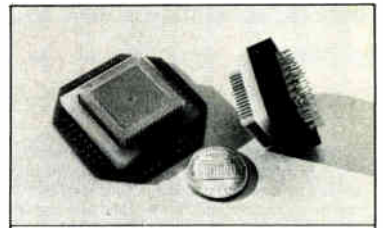
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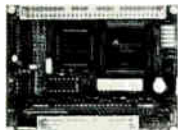
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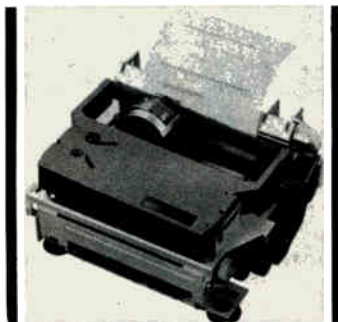
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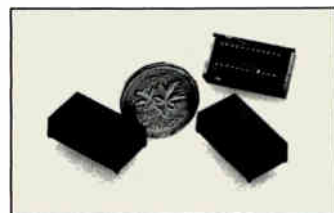
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ORDER PATTERNS ARE IN A SEESAW MODE

OVERALL ORDER PATTERNS HAVE been on a seesaw for the past four or five months. However, the net effect is a general weakening of activity due to increasing economic uncertainty and a modest shift in demand from proprietary to commodity products.

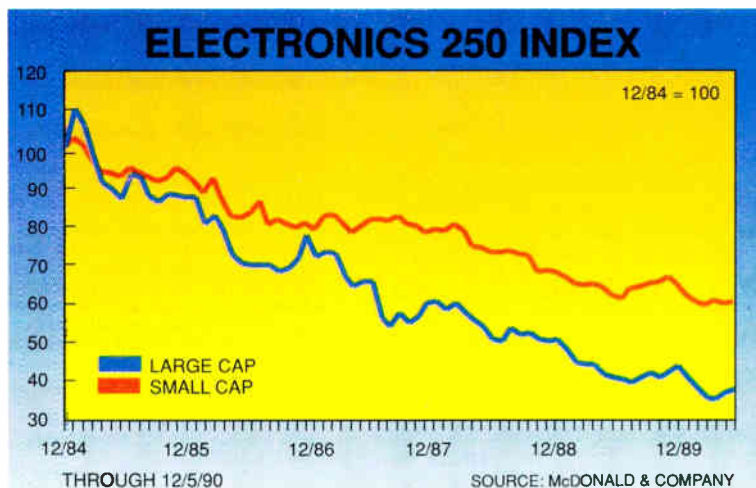
Demand for personal computers has accelerated, driven by the increasing acceptance of Microsoft Corp.'s Windows 3.0, price reductions on 80386-based machines, and the advent of new and improved graphical user interfaces. But the transition period to next-generation mainframe products will hinder computer-industry shipment patterns until April or May.

Offsetting the growth in PCs has been a decline in automotive production in both the U.S. and Europe, combined with some weakening of communications order patterns as well. Among European carmakers, recent demand suggests a broadening of existing weakness in the UK into France, Italy, and Spain as well.

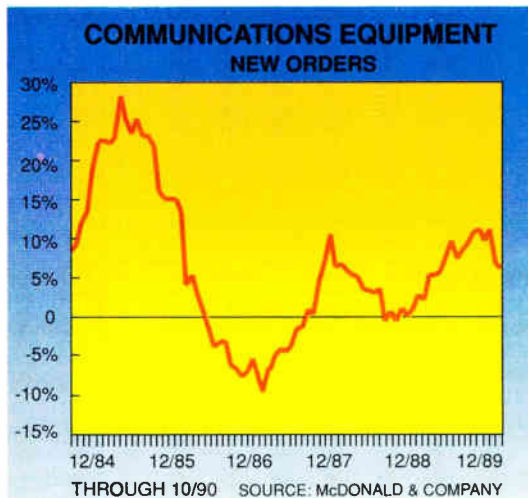
Domestic order patterns for components showed some modest seasonal improvement in October, with the best performances coming from niche players. However, November patterns showed more weakness.

Internationally, economic patterns in Brazil appear to be deteriorating once again after recovering nicely in the September quarter. Translation effects for companies with operations in Taiwan, Singapore, Malaysia, and Hong Kong have turned negative, limiting profit translation into dollars and weakening the outlook for new orders from domestic customers. In the U.S., tighter lending practices and a dearth of new equity financing are hurting new business formations and overall capital investments except for cash-rich, investment-minded firms. **E**

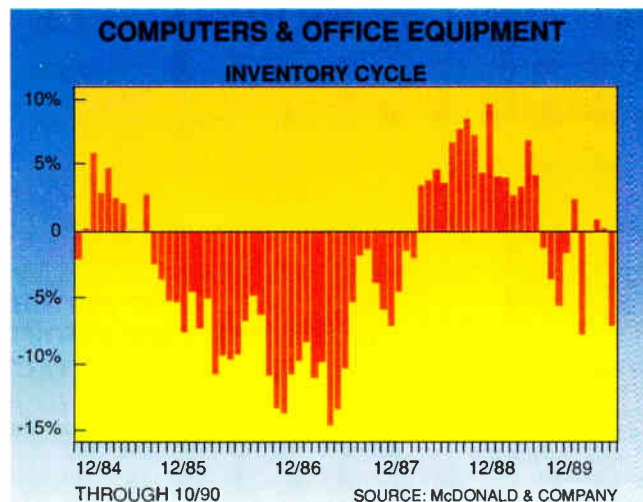
By Mark Parr, McDonald Securities Inc., Cleveland (216-443-2379)



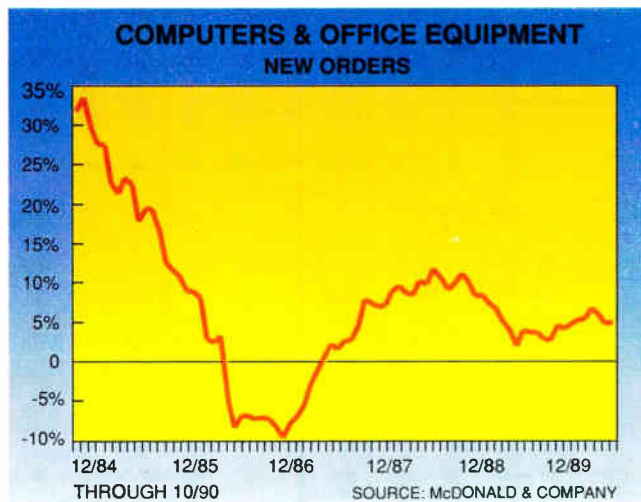
Large-cap companies—those capitalized at \$500 million or more—are maintaining their advantage over the small-cap crowd.



Reflecting the economy, communications equipment orders turned down at the end of the year.



After a short level period, inventories dipped sharply in the fourth quarter of last year.



In the light of fluctuating order activity, economic uncertainty has caused diminished activity.

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Alban Inc. 80	Graphtec Corp. 45	OrCAD 43
Aldec 5	Hewlett Packard 8-9,38-39	Philips Test & Measurement 14**,19**
Amp Corp. 22-23	Huber & Suhner 41	Photo Research 36
Analog Devices 57,59,61,63	Integrated Device Technology Cover III	Pico Electronics..... 15,33
Anritsu 48-49	Intusoft..... 80	Preci-Dip AG. Beil..... 32C**
Annulus Technical Industries, Inc. 81	Kemet Electronic Corp. 73	Pulizzi Engineering 81
Appian Technology Inc. 69	Karl Liester 32*	Rolyn Optics 81
ASIC Technology & News..... 76	Leybold AG 14*	Samsung Semiconductor 18-19*
Avantek 16-17	Logical Devices 80	Siemens 32H**,40
Best Western 2	LSI Logic..... Cover II,1	Silicon Composers, Inc. 80
Capital Equipment 34	Melfess Five, Inc. 81	Vicor 3
Commerce Tours International, Inc.75	Mitsubishi Electronics..... 25,26-27*	Wandel & Goltermann 32E**
Cypress Semiconductor Cover IV	Mosaic Industries 81	Western Design Center, Inc. 29
Deutsche Messe AG..... 32A**	Motorola Semiconductor 10-11	
EDI Corporation 80	Murata Mfg..... 32F**	
Emulation Technology 81	NEC Corporation..... 35	
Ferranti Venus 44	Needham's Electronics 80	
Fujitsu Ltd. 26-27**	Nohau Corp..... 80	
Fujitsu Microelectronics 12	NPPD Area Development..... 42	

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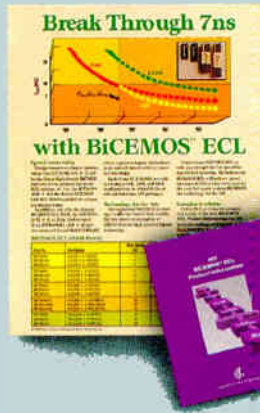
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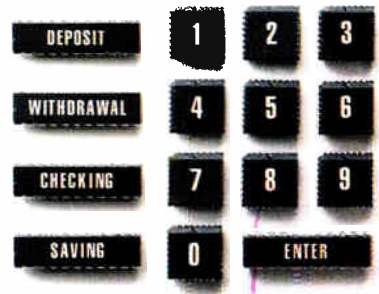
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