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THE WORLDWIDE TECHNOLOGY WEEKLY

MARCH 31, 1986

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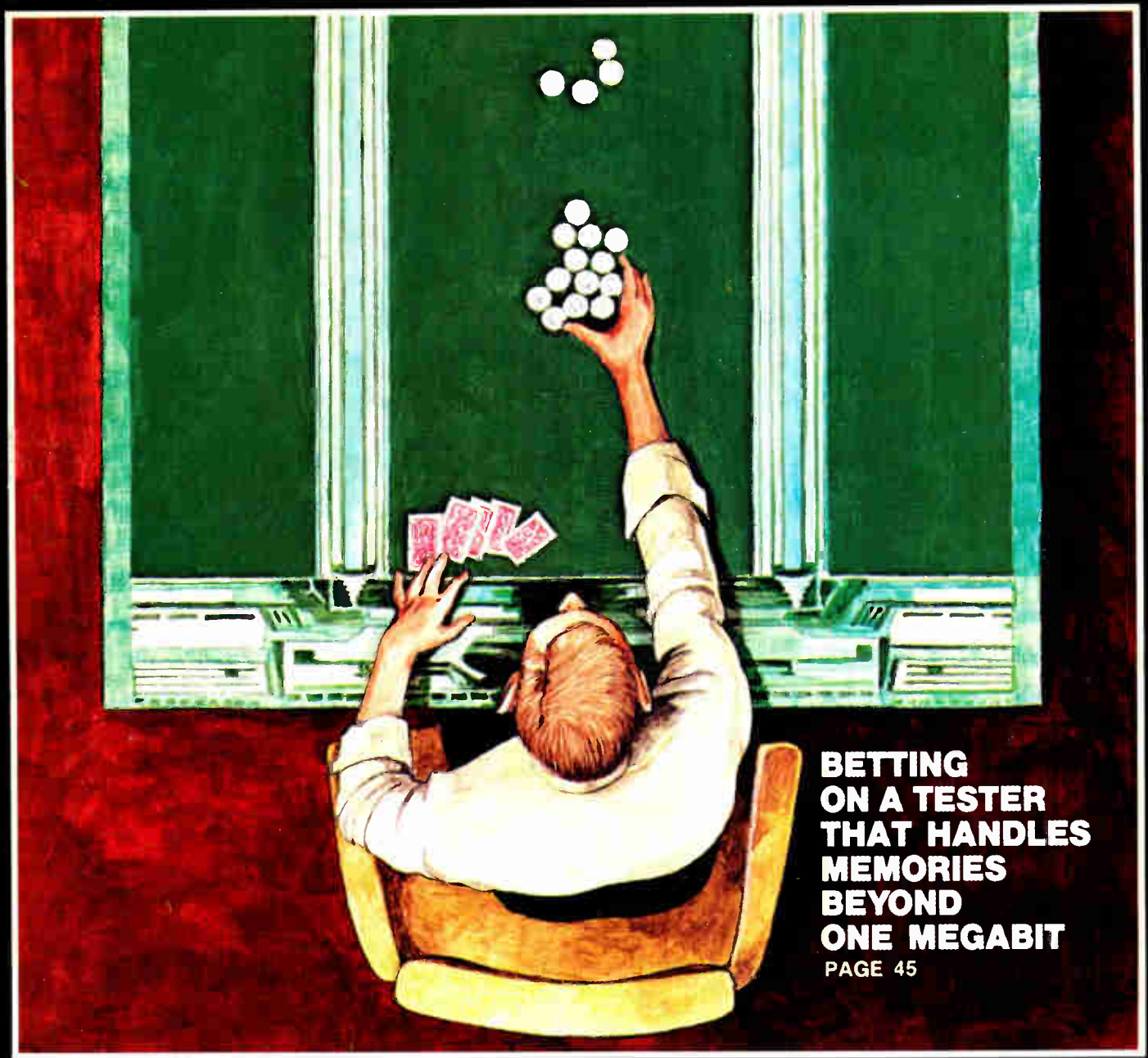

BETTING ON A TESTER THAT HANDLES MEMORIES BEYOND ONE MEGABIT

PAGE 45

SPECIAL REPORT: STRATEGIES SHIFT IN LOCAL-AREA NETS/33

A NEW WAY TO CUT THE COST OF A-TO-D CONVERTERS/42

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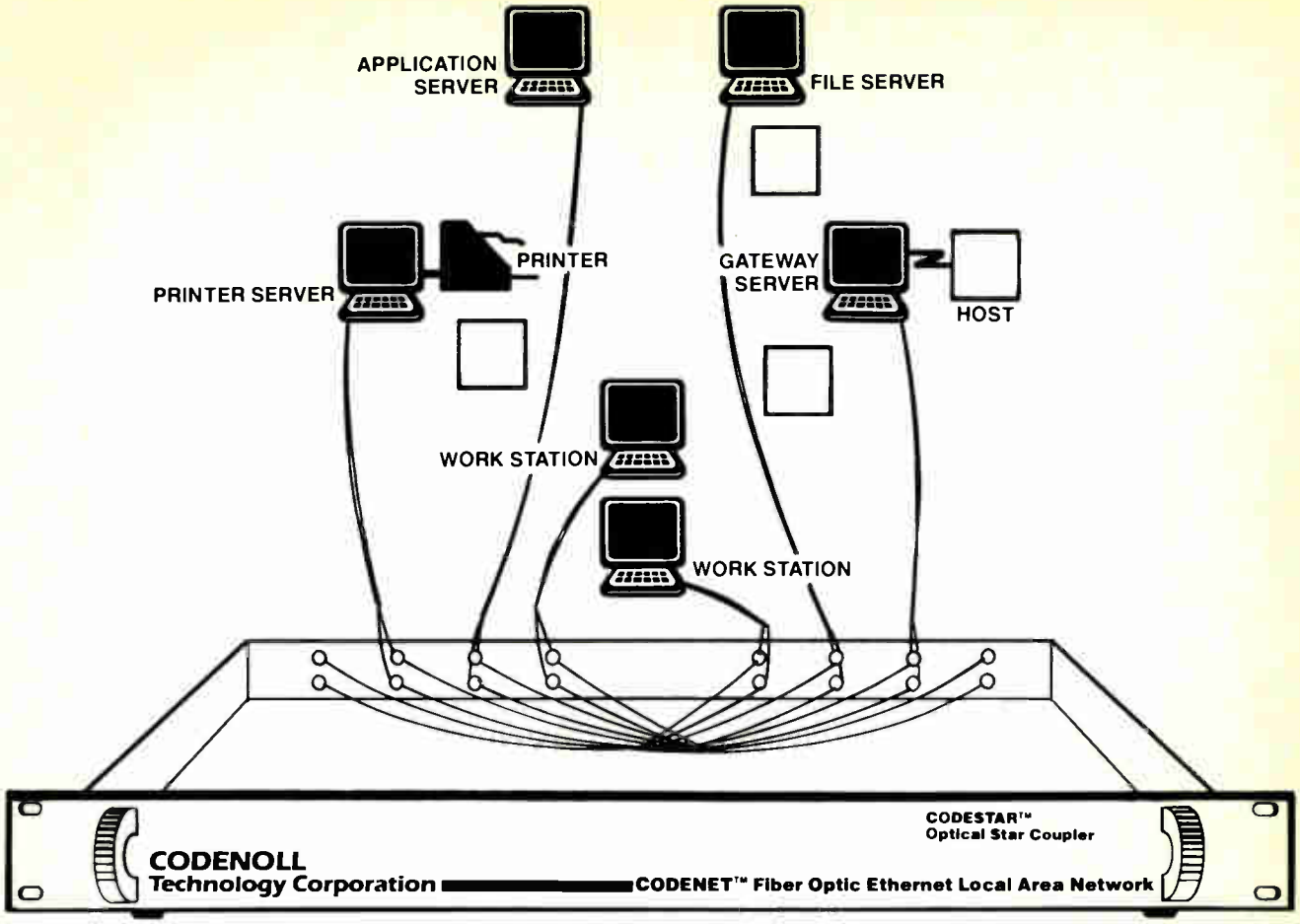

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MARCH 31, 1986 VOLUME 59, NO. 13

Electronics

NEWS

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COVER

Cover by art director Fred J. Sklenar

NEW PRODUCTS

DEPARTMENTS

Hit the High Notes of New Technology

May 19, 1-6 p.m.
May 20-21, 10 a.m.-6 p.m.
May 22, 10 a.m.- 5 p.m.
San Mateo County Fairgrounds and Bay Meadows Race Course
San Mateo, CA

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New York is a nice place to visit, and Tobias Naegele can be forgiven for sometimes thinking that his fate is to be the perennial visitor who's just passing through. The irony of it is that Tobias, who is the New York bureau manager for the magazine, not only has an office in the city but is a Manhattan native.

"Ever since I began covering the New York-New Jersey-Connecticut beat—and that includes Philadelphia—I have felt like a tourist. Not only do I spend very little time in the city, but I've even moved to Jersey City." Tobias is thinking of moving back, though, because "Jersey City is all the bad things people say about New York come true."

As little time as he does spend in New York, he spends even less at the magazine's headquarters. That's because his office is located six floors and two elevator rides from the rest of the New York staff, the better to insulate him from the hour-to-hour production routine so that he may devote all his time to covering the news.

Tobias is a hard-digging reporter who is represented in this issue by no fewer than three articles—a story about an all-digital radio-telephone system, on p. 21; and People stories on pages 64 and 65. Those articles illustrate his geographic range. He talked to Arthur Schimel in Stamford, Conn., and to William Hilsman in Philadelphia. "I drive as much as 1,000 miles a month," he says, "which is quite a bit in a compact area like the tristate region. And I do that mileage on some of the worst roads imaginable, all of them major thoroughfares."

Tobias has been on our staff since January 1985, coming to us from a stint as a freelance researcher. Before that he worked as a reporter for the Wilmington (Del.) News-Journal newspapers after graduating from the University of Delaware with a BA in liberal studies.

NAEGELE: Native New Yorker on the move.

Creativity, both visual and written, runs in Tobias's blood. Not only was his grandfather, Reinhold Nägele, a well-known German painter of the first half of the century, but his father is an advertising illustrator and teacher; his mother is a painter who has shows regularly in New York; one of his two brothers is Vienna bureau chief of Voice of America; and a first cousin is Milan bureau chief for Reuters, the British news agency.

Laurence Altman

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IMS1423 4K x 4	25,35,45	660	33 CMOS	CMOS
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IMS1620 16K x 4	45,55,70	440	77 CMOS	CMOS

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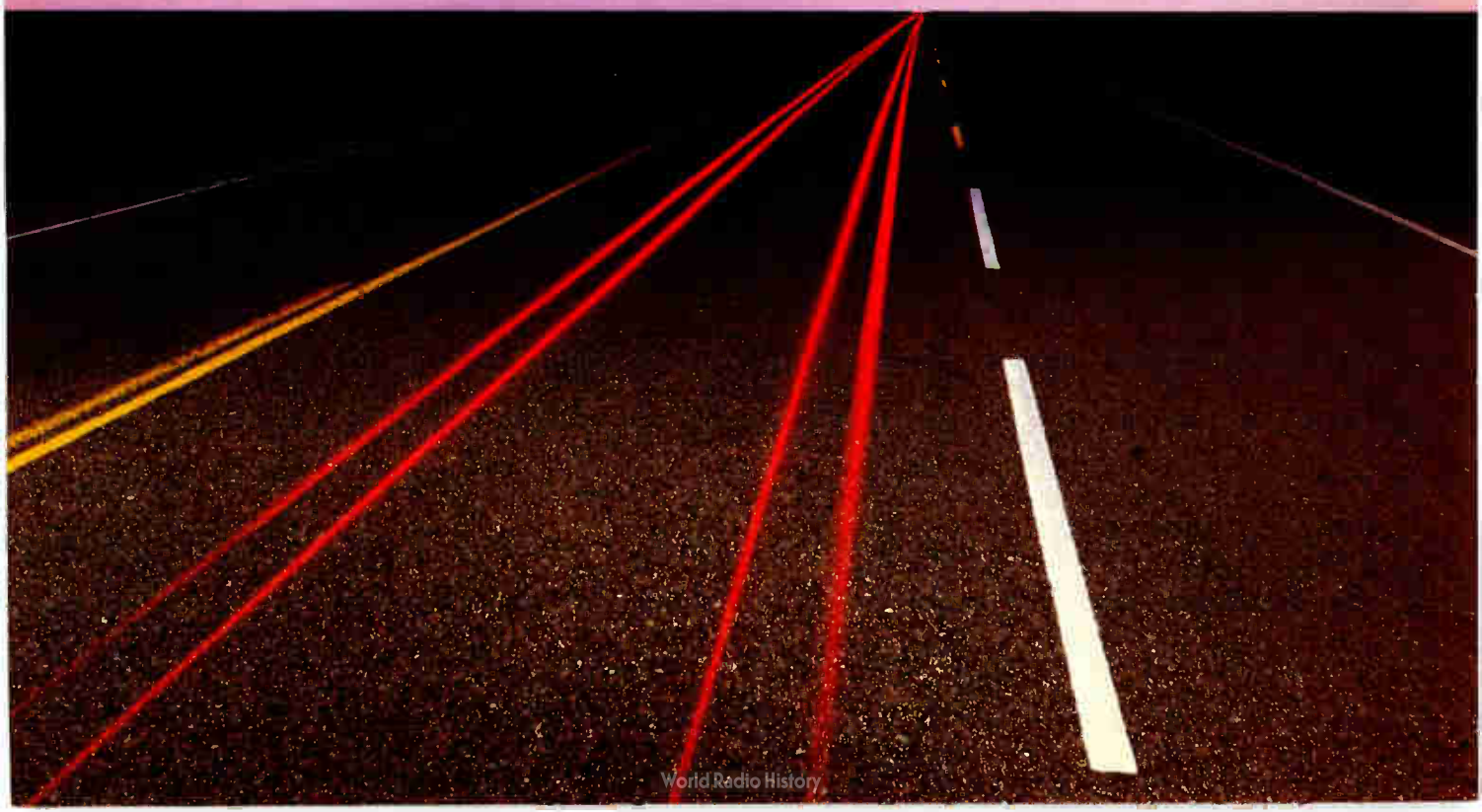

TECHNOLOGY NEWSLETTER

THE DOD PROBES TEST METHODS FOR TAPE AUTOMATED BONDING

The Defense Department has indicated that it will choose tape automated bonding for the assembly and packaging of the dense, high-pin-count chips coming out of its Very High Speed Integrated Circuits program. The DOD signaled its commitment this month when it awarded twin contracts for checking bond integrity of TAB ICs. One, for infrared inspections, went to Vanzetti Systems, Stoughton, Mass.; the other, for ultrasonic techniques, went to Sonoscan Inc., Bensonville, Ill. Eugene Blackburn, materials research engineer at the Rome Air Development Center's microelectronics reliability branch, says that the goal of the two-year contracts is "a complete report detailing the developed test method, the proposed test procedure and accept/reject criteria for military acceptance." RADC is administering the contract. Vanzetti will use a variation of its Laser Inspect system [*Electronics*, Oct. 28, 1985, p. 58]. Sonoscan will work with its scanning laser acoustic microscopy technique [*ElectronicsWeek*, Nov. 26, 1984, p. 63], which gives a video picture of a bond's mechanical condition. □

GRAPHICS INTERFACE STANDARD GAINS SUPPORT

Broad-based industry endorsement will boost the Direct Graphics Interface Specification standard proposed by four-year-old Graphics Software Systems Inc., Beaverton, Ore. Supporters include manufacturers of graphics controller chips (Intel, Texas Instruments, Chips & Technologies, and Paradise Systems), software designers (Lotus Development, Ashton-Tate, Software Publishing, Borland International), and graphics subsystem makers (Number Nine Computers and the personal computer division of NCR). The board-level DGIS provides performance comparable to that of direct-to-hardware applications but frees programmers from learning each graphics chip's instruction set. It's designed for MS-DOS and PC-DOS systems. But it can also be made compatible with applications based on various graphics standards, including IBM Corp.'s Enhanced Graphics Adapter, Color Graphics Adapter, and Monochrome Graphics Adapter designs and the American National Standards Institute's Computer Graphics Interface. □

MATRA AND SUN WILL TEAM UP TO MAKE AND SELL WORK STATIONS

The Matra Datasystème subsidiary of France's government-controlled Matra SA will team up with Sun Microsystems Inc. to manufacture and market work stations. The French company will develop original-equipment-manufacturer systems based on the Mountain View, Calif., company's Unix work stations and market them in Belgium, France, Greece, Italy, and Spain. The two companies also will jointly develop work station products that they will commercialize in Europe and the U. S. Matra expects that total revenue from the deal for both companies will reach some $20 million during the first two years. □

INFRARED SENSORS WILL SIGHT DRUG SMUGGLERS

Infrared sensors initially intended only for military use will soon be used to spot drug smugglers sneaking across U. S. borders under cover of darkness. The microprocessor-controlled Night Vision Systems from Hughes Aircraft Co., El Segundo, Calif., carry an AN/AAQ-16 military designation. The U. S. Customs Service is installing them on Piper Cheyenne 111A aircraft engaged in anti-drug-smuggling operations. The units, built by the General Motors Corp. subsidiary for the past year, detect minute variations in heat emitted by persons in the sensing field, then produce an image similar to a black and white TV picture for cockpit display. □

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ELECTRONICS NEWSLETTER

MERGER 'MADE IN HEAVEN' COLLAPSES AFTER REVENUES SHIFT

Even the two companies involved seemed stunned and unsure of their next step after they abruptly canceled their much-ballyhooed merger last week. Apparently, a fear of possible stockholder lawsuits led to the collapse of the merger of Convergent Technologies Inc., San Jose, Calif., and 3Com Corp., in nearby Mountain View. Both managements were vigorous supporters of the deal (see story, p. 35) and were clearly disappointed over its last-minute collapse, leading some observers to predict that the two would resume discussions once the situation cools down. 3Com's investment banker, Robertson, Colman & Stephens, reversed its opinion that the merger was financially fair after Convergent reported that its first-quarter 1986 sales might slip as low as $70 million, down $30 million from the year-ago quarter, while 3Com reported record quarterly sales of $16.8 million and profits of $1.8 million. 3Com reluctantly called off the merger last Wednesday, only one day before it was to have been formally approved by shareholders. □

LAWSUITS THREATEN U. S.-JAPAN SEMICONDUCTOR TALKS

Government-level talks on semiconductors between the U. S. and Japan will be influenced by lawsuits flying between American and Asian chip makers. The latest, filed by NEC Corp. in Tokyo District Court, seeks to prevent Texas Instruments Inc.'s Japanese subsidiary from making and selling 256-K and larger dynamic random-access memories in Japan because they purportedly infringe on NEC's patents. Industry sources view the Tokyo company's action as a countersuit to force TI to return to the bargaining table and rescind its actions before the Dallas District Court and the U. S. International Trade Commission against nine Asian manufacturers. □

SUPREME COURT SENDS ZENITH'S ANTITRUST SUIT BACK TO LOWER COURT

The 15-year-old antitrust case that pitted Matsushita Electric Industrial Co. against Zenith Radio Corp. will probably end in a decision against U. S. television makers. Last week, the U. S. Supreme Court overturned by a narrow 5-4 margin a lower-court ruling that favored U. S. TV manufacturers, who claimed that 21 Japanese firms conspired to drive them out of the U. S. market. The case was sent back to the U. S. Court of Appeals to determine whether additional "unambiguous" evidence of the alleged conspiracy exists. Zenith officials are convinced that the court will find that the Japanese had a motive to undercut U. S. producers, which would keep the case alive. If there is no new evidence, however, a 1981 U. S. District Court ruling to dismiss the antidumping case will be reinstated. Significantly, the high court did not rule on the key antitrust issue raised by the Japanese: that they were compelled by Japan's Ministry of International Trade and Industry to sell in the U. S. at prices well below those in Japan and that MITI's imposed pricing agreements could not serve as the basis for antitrust liability. □

FRENCH BANK AND IBM FRANCE MAY FORM TELECOM VENTURE

One of France's principal banks and IBM France are considering a joint venture to exploit the easing of telecommunications regulations that could result from the recent election of a right-wing coalition to the Assemblée Nationale. A key preelection promise of the Rassemblement Pour la République, the senior partner in the coalition, was that it would open the national market for such services. Should the right wing's slim parliamentary majority enact that plank of its platform, IBM France and Sema-Matra, a data-processing software and service company owned by Paribas, a nationalized bank, would team up to offer a national value-added network. □

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DT2758	A/D dual	4SE	Simultaneous inputs, 4 level interrupts	100	•	•
DT3362	A/D quad	64SE 32DI	Dual Port, channel/ gain list, PGH	50/250		•
DT3368	A/D quad	12SE	Dual Port, Simultaneous inputs	100		•
DT3382	A/D quad	64SE 32DI	Multi-channel, PGH	50/250	•	•
DT3388	A/D quad	12SE	Simultaneous inputs	100	•	•
DT2751	D/A dual	2	D/A, 4 level interrupts	200	•	•
DT3366	D/A quad	8	D/A, 4 channel list files	500		•

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PRODUCTS NEWSLETTER

SOLID-STATE FUSE IS A SEVENTH THE SIZE OF CONVENTIONAL UNITS

Bussman has applied solid-state technology to fuses and has come up with a product so small that seven of them can fit where a single conventional glass fuse and socket do now. The 0.35-by-0.35-by-0.18-in. PC-Tron from the St. Louis division of Cooper Industries cuts the board space required to mount the fuses by 88%. PC-Tron is a radial-lead surface-mountable subminiature fuse that offers short-circuit interrupting capacities of 35 A at 250 V ac and 10,000 A at 125 V ac, suiting it for protecting power supplies on the line side. The new fuse will sell for 45¢ each when available in May—but because it can be automatically inserted, overall installed cost will be less than other fuses. The fuse has an extremely low pass-through energy rating (I^2t). A 2-A PC-Tron has an I^2t rating of 0.1 A^2-s, versus 7 A^2-s for a glass fuse. □

HP DOUBLES CONTRAST RATIO OF ITS PORTABLE'S LCD SCREEN

Hewlett-Packard Co. has boosted the contrast ratio of its Portable Plus's LCD screen to 7 : 1, compared with 3 : 1 in the previous version. The Palo Alto company says the improvement comes from increased refraction and a better yellower source. The Portable Plus with 256-K bytes of memory will be available in April for $2,695, $200 less than the earlier Portable Plus. A 512-K-byte model will sell for $3,395, compared with $3,880 for the earlier version. □

SUN DROPS ENTRY PRICE OF ITS WORK STATION

Sun Microsystems Inc. is dropping the entry price for its line of work stations by going to a high-resolution monochrome display in the new Sun-3/160G. The $29,900 price puts the Sun-3/160G between personal computer-based systems and Sun's $35,000 color-display products. The Mountain View, Calif., company says the new machine is suitable for applications such as computer-aided publishing that require high resolution but not full color capability. The Sun-3/160G's display has eight bit planes, which can support up to 256 shades of gray. The system, which uses a 16.67-MHz 68020 microprocessor and a 12.5-MHz 68881 floating-point processor, comes with 4 megabytes of main memory. It is available now. □

TANDEM EASES INTERFACE WITH IBM HOSTS

Tandem Computers Inc. is making its NonStop on-line transaction processors easier to link with IBM Corp. hosts. Its new SNAX/APC software provides access to IBM's Logical Unit 6.2 protocols for program-to-program communications between devices on an SNA network. With SNAX/APC, programmers no longer need to write interface software. Available in the third quarter from the Cupertino, Calif., company, SNAX/APC has a $5,000 license fee and $600 monthly fee for NonStop II and NonStop TXP systems, and a $1,000 license fee with $240 monthly fee for the NonStop EXT model. □

DEVELOPMENT SYSTEM IS AVAILABLE FOR MIL-STD-1750A COMPUTERS

Developing application software using the military's MIL-STD-1750A instruction set will be easier now that Mikros Systems Corp. has introduced its MKS1750/AT development system. The Mercerville, N. J., company's system connects directly to an IBM Corp. Personal Computer to provide a real-time environment for developing and debugging 1750A application programs. Future options will include a MIL-STD-1553B interface, a tracer card for debugging 1750A hardware, and an Ada language environment. The $12,500 system is available in 60 days. □

Electronics

1.3-MICRON OPTOELECTRONIC ICs ARE ON THE WAY FROM NEC

LASERS AND PHOTODIODES FOR GIGABIT LINKS HAVE InP SUBSTRATES

KAWASAKI, JAPAN

The sentinels of high technology long ago spotted the advances that Japan was making in optoelectronics through a national program set up by the Ministry of International Trade and Industry. NEC Corp. participated in the project with a baker's dozen of other companies to develop lasers, photodiodes, and optical fibers with MITI's backing, but it lit out on its own for optoelectronic integrated circuits, quietly taking a risk with a new technology as it did so.

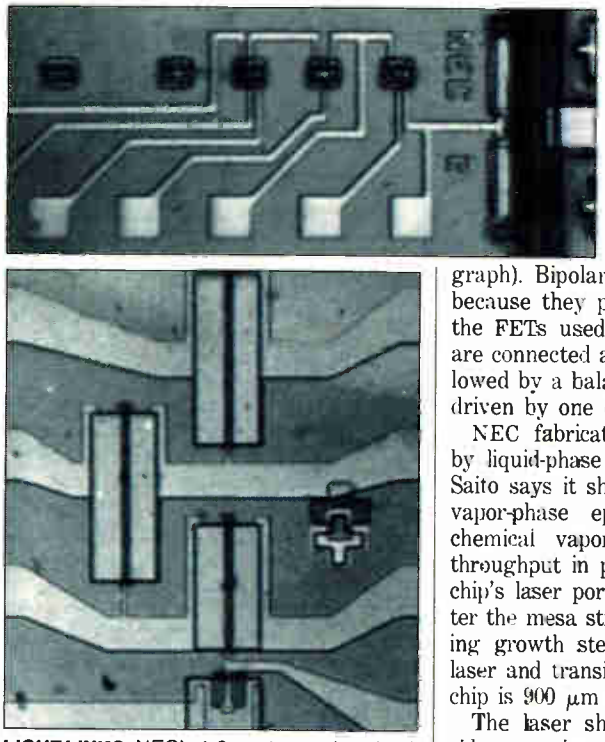
Now the Tokyo company has bounded to the forefront with ultrahigh-speed long-wavelength optoelectronic ICs operating at 1.2 Gb/s in the 1.3-μm band. Earlier optoelectronic ICs worked at shorter wavelengths and suffered higher attenuation losses as a result.

The lower attenuation and dispersion losses at 1.3 μm are well known, but NEC ventured into virgin territory when it opted for indium phosphide substrates for its optical chips rather than conventional gallium arsenide substrates. The InP substrate is necessary for a 1.3-μm laser, and NEC was able to develop a process to integrate heterojunction bipolar transistors on the same chip.

The venture brought a solid return. The light-emitting and optical-receiver chip pair developed at NEC's Opto-Electronics Research Laboratories in Kawasaki will one day catch on strong for short communications links, says Fujio Saito, general manager of the labs.

FARTHER AND FASTER. NEC's new ICs make possible a 12-km communications link at 1.2 Gb/s with a 7.7-dB margin. At 565 Mb/s, the length can stretch to 22 km while still maintaining a 9.9-dB margin. That's farther and faster than the hardware that has come out of the government's Optical Measurement and Control System Large Scale Project [*Electronics*, March 17, 1986, p. 50]. Fujitsu Ltd.'s optical IC pair, for example, operates in the 0.85-μm band at data rates of 400 Mb/s up to 4 km, and Hitachi Ltd.'s hardware is good for data rates of 1 Gb/s at distances up to 1 km.

Saito is convinced that the performance of NEC's new chips will do for almost any application except telephone-company long-distance trunk systems. For local-area networks, subscriber loops, interconnections among computers and peripherals, and the like, he maintains, the optoelectronic chips offer the promise of much lower cost and size than the prevalent current solution: discrete optical devices combined with hybrid driver and amplifier ICs.



LIGHT LINKS. NEC's 1.3-μm transmitter (top) integrates a stripe laser and bipolar drive transistors. The companion receiver (bottom) carries a p-i-n diode and three FETs.

Now that his group has built lab samples, Saito figures NEC can develop the additional technology needed for volume production within three years. For long-distance trunks, where maximum distance is imperative and the cost of parts is less important, the company will for the present stick with discrete devices that operate in the 1.55-μm-wavelength band, where transmission losses are even less than at 1.3 μm [*Electronics*, Feb. 24, 1986, p. 19].

The light-emitting chip includes a 1.3-μm, double-channel planar buried heterostructure laser, similar to the one used in the company's 1.55-μm discrete device, and three InGaAsP/InP heterojunction bipolar transistors on the same substrate (upper photograph). Bipolar transistors were chosen because they provide higher drive than the FETs used in earlier devices. They are connected as an emitter-follower followed by a balanced pair, with the laser driven by one collector of the pair.

NEC fabricates the experimental ICs by liquid-phase epitaxial growth, though Saito says it should be possible to use a vapor-phase epitaxy or metal-organic chemical vapor deposition for higher throughput in production. First, only the chip's laser portion is fabricated. But after the mesa stripe is etched, the remaining growth steps are used to fabricate laser and transistors simultaneously. The chip is 900 μm long and 350 μm wide.

The laser shows up as a monolithic ridge running across the width of the chip. Repeated mesa etching of transistors, which is possible because of the differential etching rates of InP and InGaAsP, gives them a layered look somewhat resembling a wedding cake. Despite this inhospitable terrain, NEC successfully makes reliable interconnections by selective gold plating.

SEMI-INSULATING. The laser's output power is 20 mW peak when modulated at rates between 500 Mb/s and 1 Gb/s. Isolation between elements and reduced capacitance afforded by the semi-insulating substrate enable operation up to 2 Gb/s in non-return-to-zero mode.

The receiver incorporates a p-i-n diode and three low-noise InGaAsP junction FETs on a chip measuring 600 by 600 μm (lower photograph). The p-i-n diode cannot match the gain inherent in the harder-to-fabricate avalanche photodiodes, but it still has good sensitivity. For an error rate of 10^{-9}, sensitivity at a data rate of 400 Mb/s is –27 dBm, and at a data rate of 1.2 Gb/s it is –14 dBm.

–Charles L. Cohen

SIMPLER SCREEN REDUCES MINITEL SIZE

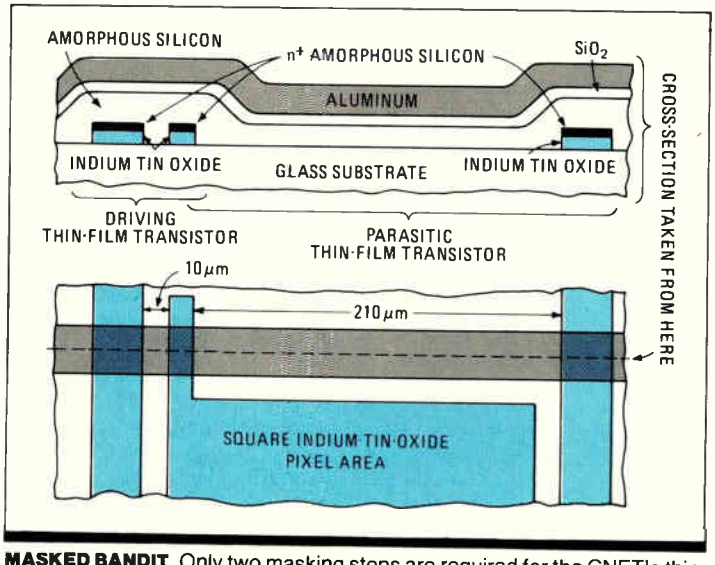
PARIS

France's ambitious and profitable videotex program is about to get a boost from a technological advance in liquid-crystal displays.

Engineers at the Centre National d'Etudes des Télécommunications (CNET) have developed a flat-screen prototype of the Minitel, the inexpensive terminal that is driving the country's explosion in videotex services [*Electronics*, Dec. 23, 1985, p. 23]. The screen, based on thin-film technology, uses a single transistor to address each pixel and reduces the size of a Minitel terminal to one third that of the present cathode-ray-tube models, which measure 20 cm high by 24 cm wide by 26 cm deep.

The highly original, though simple, technology reduces the five masking steps usually necessary to realize thin-film transistor arrays to two, so the outlook for its industrialization seems bright. The CNET's prototype screen measures 10 by 13 cm, or 6 in. diagonally, with a resolution of 250 lines by 320 columns. These figures correspond to the standard 25 lines of 40 characters each in French videotex transmission.

The technology is in essence that of a thin-film amorphous-silicon array deposited at low temperatures—less than 300°C. The process begins with a glass substrate covered with indium tin oxide on which is deposited a thin layer of n+ doped amorphous silicon. Columns and pixels are patterned in these two layers by photolithography, after which chemical-vapor deposition adds successive layers of undoped amorphous silicon and silicon dioxide. After aluminum gate deposition, a second photolithography step defines the rows as well as the thin-film transistors.



MASKED BANDIT. Only two masking steps are required for the CNET's thin-film transistor array for LCDs, which will reduce the size of Minitel terminals.

The drive transistor for each pixel is located under the row between the column and pixel. Because the amorphous silicon and silicon dioxide are present under the entire row, a parasitic transistor is automatically formed between the drive transistor and the next column, which can limit current flow. But by manipulating overlap areas between the gate and source and the gate and drain, the CNET can double or triple currents to reach an acceptable level of 0.4 μA.

ANOTHER PLATE. The screen is completed by mounting another glass plate bearing the transparent counter electrode, which forms the capacitor for each pixel some 8 to 10 μm from the array. This gap is then filled with a twisted-nematic liquid-crystal material. Pads at each side of the substrate are connected to external drivers.

The two masking steps instead of five point up the CNET technology's main advantage—simplicity. And because the thin-film transistor size is defined by the intersection of the two levels, the ratio of channel length to width is exactly the same for drive transistors throughout the matrix. Fabrication thus requires no critical alignment, either vertically or horizontally.

This simplicity is already paying dividends. Researchers at CNET's Lannion laboratory are realizing arrays with no more than one defective transistor in 10,000. They expect an improvement in those figures in an industrial environment.

CNET is negotiating technology transfer with France's three Minitel makers: Matra SA; RTC-La Radiotechnique-Compélec, a subsidiary of Dutch NV Philips; and the Télic-Alcatel subsidiary of the Compagnie Générale d'Electricité. *–Robert T. Gallagher*

MAP TESTS MOVE TO WORK STATIONS

ANN ARBOR, MICH.

Soon it could be simpler and more convenient to test products built to meet the Manufacturing Automation Protocol factory-communications standard. That's because officials at the Industrial Technology Institute in Ann Arbor are developing engineering work station-based software to help handle the procedure.

The package, complete with a set of tools to simplify the user interface, will be based on a suite of MAP tests that now run on ITI's in-house VAX equipment from Digital Equipment Corp. The work-station version will be aimed largely at vendors that are developing MAP products, but it could also be used by end users who are developing MAP-based factory networks, says Andrew H. McMillan, manager of ITI's Network Evaluation and Test Center.

Under McMillan's direction, ITI is the only organization that offers an independent testing service for gear that is designed for use with MAP, the emerging multivendor factory-communications standard championed by General Motors Corp. [*Electronics*, Nov. 4, 1985, p. 55]. The not-for-profit institute offers product-conformance testing for vendors to assure compliance with the MAP standard. It also offers application-specific

testing for users who are assembling MAP networks using equipment acquired from multiple vendors.

Many agree that the planned ITI work station package could be useful to the MAP community. "It's an admirable goal. The more readily it [test software] is available, the more useful it will be," says John F. Heafner, chief of the Systems and Network Architecture Division at the National Bureau of Standards, which is involved in MAP test development.

ON THEIR OWN. But others note that many MAP vendors have already developed their own conformance-testing techniques. The ITI work station package may be useful to "anybody new to the field who is now starting to implement MAP," says Darrell Furlong, manager of local-area network products at Concord Data Systems Inc., Waltham, Mass. But for vendors such as Concord that are already selling and developing MAP products, he says, "We can probably do much better on our own."

ITI, however, promotes testing at its site as a way for vendors to assuage customer concerns about the compliance of their equipment with the MAP standard. The MAP Users Group has recommended that its members require third-party testing as a prerequisite for purchasing MAP gear. And while MAP test tools are still under active evolutionary development, with involvement by such organizations as NBS, GM, ITI, and, more recently, the vendor-backed Corporation for Open Systems, the ultimate goal is the establishment of a single suite of tools for MAP testing, says Michael Kaminski, GM's MAP program manager. To date, ITI is the only third-party organization to offer tests based on tools approved by the Users' Group, according to Kaminski.

Vendors and end users must now bring their MAP gear to Ann Arbor for testing. But with the work station project, ITI is "focusing on how to bring the test technology closer to the implementer," McMillan explains.

LICENSE THE SOFTWARE. "Our current thinking is that you could just license the software from us and purchase the hardware outright from the vendor that you chose," McMillan says. Based on interest from vendors with MAP products in development, ITI is looking at Sun Microsystems' Sun-3 and DEC's MicroVAX as likely first platforms for the package. "I can guarantee that by the end of the year, we'll have it on at least one [machine], and probably several," McMillan says. Initial versions of the work station package will most likely be written for use under the Unix 4.2bsd operating system, with longer-term plans to go to AT&T Bell Laboratories' Unix System V, McMillan says.

MAP MAN. ITI's Andrew McMillan intends to put MAP testing facilities on work stations.

Today, ITI can test for compliance with six of the 10 software protocols currently used in the upper five and a half layers of MAP, says McMillan. (MAP is based upon the International Organization for Standardization's seven-layer open-systems interconnection model.) Tests for two additional software protocols will be ready by June, he adds, with the remainder to be done by year end, when the work station version is also planned for completion.

ITI also offers tests on MAP's lower physical layer, which requires some specialized laboratory equipment. But only the upper-layer software protocol tests will be provided in the work station package, McMillan says.

ITI's MAP compliance-test suite currently runs under Eunis, a sub-operating system supplied by the Wollongong Group, Palo Alto. Eunis in turn runs beneath VMS on ITI's in-house VAX 11/750. Though ITI has sold "bits and pieces" of its current test suite for use by outsiders, the VAX-based system is complex and requires a sophisticated software-engineering staff to support, McMillan says. By contrast, the work station package will include tools to make the user interface easy to use, taking advantage of the windowing and graphics capabilities available in today's advanced multiprocessor-based work stations. *–Wesley R. Iversen*

SEMICONDUCTORS

GaAs IC SENSORS HEAD FOR THE ROAD

COLORADO SPRINGS

Monolithic Hall-effect position sensors, aimed at a wide range of automotive applications, may finally put gallium-arsenide integrated circuits on the map in high-volume commercial markets. And one of the driving forces behind the move, appropriately, is Ford Microelectronics Inc. Another is Siemens AG of Munich.

Ford Microelectronics and Siemens are separately showing prototypes of GaAs ICs to automakers and brake-system suppliers. The high temperature GaAs chips combine magnetic-sensitive Hall-effect elements with signal amplifiers.

The new chips will replace less reliable inductors

The Hall ICs will be aimed at replacing less-reliable variable-reluctance inductors, the wire-wound magnetic devices commonly used in antiskid brake systems since the 1960s. The major drawback to wire-wound inductors is that they work in association with a rotating magnetic chopper, where the output voltage of the inductor is proportional to the speed at which the chopper turns. Control systems in slow-moving vehicles, then, suffer a drop in performance because of the lower voltage.

Hall devices, in contrast, have a constant output regardless of the number of revolutions per minute. When fabricated in silicon, however, Hall-effect ICs suffer a drop in electron mobility, hence lower output signals, in environments over 150°C.

Ford Microelectronics, which is entering the commercial GaAs markets later this year with a 1-ns 1-K static random-access memory and a 500-gate (four-input NOR) logic array, plans to have product information available on a Hall IC family in the fourth quarter. The Hall IC will be the Colorado Springs company's first application-specific GaAs chip with high-volume potential, says Lawrence E. Dickens, manager of technical marketing for GaAs products.

"Since we are part of Ford and Ford has said it has a specific need for such a part, we were asked to look at it. The more we looked at it, the more we realized a tremendous potential," says Dickens. Ford Motor Co. is considering GaAs Hall ICs for camshaft positioning, ignition timing, transmission control, and dynamic suspension systems, as well as for antiskid braking systems.

Product designers at the microelectronics subsidiary are working on a family of parts that will have operating temperatures of 200°C. In addition to the Hall generator element, the 32-by-26-mil chip contains Schmitt trigger-based hysteresis circuitry, a FET differential comparator, an amplifier, and TTL-compatible output buffers. It will trigger in a magnetic field of 250 gauss and will reset with a 250-G field of the opposite polarity (or 500 G of hysteresis). The current drain of the prototype is 13 mA at 5 V power supply.

Siemens has recently disclosed a working prototype of a monolithic GaAs Hall sensor-amplifier, also likely to be targeted at high-volume automotive applications. The three-stage Hall-effect IC has a differential amplifier that delivers a low-frequency gain of 100 to 150.

The Siemens chip works off a supply voltage of 8 to 15 V at temperatures up to 180°C. Siemens says its double-implantation, one-metalization process, called DIOM, has been critical to maintaining the reliability of the Hall sensor while providing a stable structure for the GaAs differential amplifier. Siemens uses a localized ion implantation and self-aligned gate in its DIOM GaAs process. *–J. Robert Lineback*

ARTIFICIAL INTELLIGENCE

LISP PROCESSOR CHIPS POINT TO DESKTOP AI

DALLAS

Lisp-language processor chips are moving from silicon-design centers toward fabrication lines as two rival symbolic-computing vendors, Texas Instruments Inc. and Symbolics Inc., continue pressing to get artificial intelligence into high-volume end-user products.

Integration of symbolic-processing architectures will allow AI manufacturers to shift the majority of their sales from large, high-priced development systems to smaller, cheaper AI-delivery machines and thereby tap new classes of customers. Systems based on Lisp chips, in fact, have the potential of doing for AI what personal computers have done for computer-aided design: putting new automation tools on the desktop and within reach of most engineers.

The chips will start showing up by midyear, when Dallas-based TI expects to have working silicon on a complex 32-bit Lisp microprocessor. Symbolics will introduce its work station next month. The Cambridge, Mass., company has built the machine around semicustom gate arrays, but it has custom chips on the way from its in-house chip-design group.

FROM CRUISE TO CRAY. "TI has an advantage in that their forte is in the chip area, but Symbolics has the edge in that they know what it takes to create a new implementation of Lisp and the total system," says analyst and newsletter editor Harvey Newquist of DM Data Inc., Scottsdale, Ariz. "These new integrated Lisp chips will allow a broad perspective of applications which would include almost every kind of machine—from a cruise missile to a Cray to a personal computer. Right now, there has been hesitation on the part of many potential users to invest in more than a handful of Lisp systems because of the high price tag."

Prices on Lisp symbolic-computing systems range from $30,000 to well over $100,000. The eventual hope is not only to lower costs but also to team symbolic processing with more conventional numeric-computing software—such as spreadsheets, computer-aided design, and office automation—for such AI applications as expert systems.

Today's $120 million Lisp-machine market has been growing 50% a year on the strength of development-system sales to research laboratories at companies wishing to join the AI revolution, says Newquist. He believes the growth rate will eventually settle down into a more realistic 25% to 35%. Participants in the Lisp machine market believe the second phase of AI growth will be fueled by smaller delivery machines.

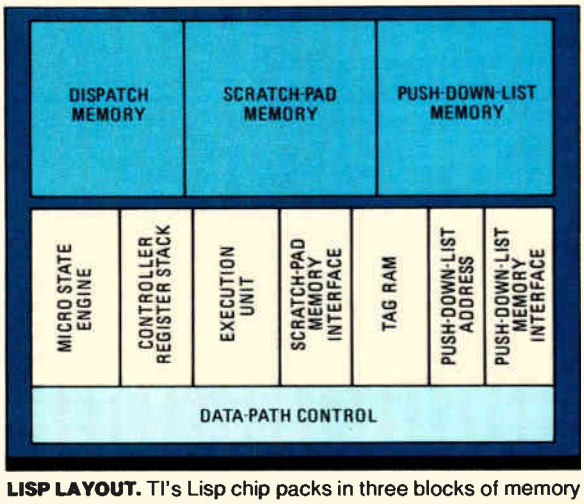
TI this month started its first pass at silicon for its chip, based on sub-2-μm technology—the fruit of one of its most extensive CAD and test efforts ever. The chip measures 1 cm on a side, has 224 active input/output pins, and contains more than a half-million transistors. In the third quarter, TI intends to demonstrate the Lisp chip in a ruggedized Compact Lisp machine as part of its development contract with the Defense Department, which contributed $6 million to the IC development. Commercial products based on the device are likely by next year.

The Lisp microprocessor will come housed inside a 264-pin grid array. On board it has an execution unit, a state microengine, 2.5-K words of 18-bit-wide dispatch memory, 1,000 32-bit words of scratch-pad storage, and another 1,000 words of push-down list memory, which acts as a top-of-cache stack frame (see figure). TI's efforts to ensure success on the first pass have resulted in a bundle of new Lisp-based CAD tools and debugging testing programs that the company is now using internally (see "TI harvests CAD software from AI effort," p. 21).

EMBEDDED. TI corporate leaders believe embedded AI will be one of the most promising new technological opportunities for the company's diverse business interests, which range from IC sales to industrial controls to searching for oil. The initial demonstration of TI's Compact Lisp machine will show the processor's potential for a wide range of embedded avionics and smart weapon systems.

The initial military-hardened setup will pack a Lisp machine onto four 6-by-6.5-in. double-card modules. The Compact Lisp machine will contain a NuBus-like backplane and will hold between 2 and 8 megabytes of random-access memory. Two of the modules form the processor: one holds the VLSI Lisp processor and support circuits, and the second has 64-K bytes of data cache made up of 8-K-by-9-bit static RAMs from TI's work for the Pentagon's Very High Speed Integrated Circuits program. The second module also has map-translation hardware to translate virtual to physical memory, giving cache-storage virtual-addressing capability. A third module has a Multibus I I/O interface coupler, and the fourth is main memory. The unit will use a newly developed high-density power supply, similar to a low-profile unit TI is readying for military systems markets [*Electronics*, March 17, 1986, p. 22].

TI has commercial plans for its new Lisp chip, as well. The CMOS device



LISP LAYOUT. TI's Lisp chip packs in three blocks of memory along with an execution unit and data-path controller.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SEIKO INSTRUMENTS

Circle 20 on reader service card

will replace bipolar bit-slice processors and about three quarters of the engine of TI's 18-month-old Explorer work station. The chip is compatible with software running on the Explorer. When applied without any additional VLSI circuits, the Lisp chip will boost the Explorer's performance about fivefold, says Gene Matthews, director of TI's Symbolic Computing Laboratory in Dallas. Under nondisclosure agreements, TI is telling potential customers and key users of its work stations just how much faster the system will run when other VLSI chips are applied to the Explorer architecture.

GATE ARRAYS FOR STARTERS. By contrast, Symbolics uses semicustom gate arrays to reduce the size, and potentially the cost, of a Lisp central processor compatible with its existing 3600 equipment. The new Symbolics hardware, internally dubbed the G machine, will be unveiled in mid-April along with a major new release of Lisp system software.

Symbolics, which has been producing custom test chips for the past year, continues its hushed development of a full-custom IC implementation of a third-generation Lisp-computing architecture. It will also use a new Lisp compiler. The new architecture, which Symbolics declines to discuss, will have a wider memory bandwidth than the current 36 bits on the 3600. *–J. Robert Lineback*

TI HARVESTS CAD SOFTWARE FROM AI EFFORT

Texas Instruments Inc. doesn't expect any immediate market return for its long-haul effort in Lisp integration, but the Dallas company has already garnered some internal benefits from its extensive Lisp-processor development efforts in recent years.

In the course of developing its 32-bit Lisp microprocessor and the Explorer work station, TI created 14 different software packages for its own design and test automation. The bundle of Lisp-based packages supplements TI's internal computer-aided-design systems.

The new programs were all spun out of three basic CAD packages that TI uses internally, and their creation underlines the potential of Lisp outside the traditional definitions of artificial intelligence, says Gene Matthews, director of TI's Symbolic Computing Laboratory in Dallas. "A lot of things are overlooked about symbolic computers. They are good for doing things besides just expert systems," says Matthews.

For example, TI uses Lisp to tailor its chip-designer interface, called Seymour, for a number of development applications using its Explorer work station. Lisp was also used in CAD software for what Matthews calls application-specific abstractions, which closely match a programmer's language and structure to a job. A variety of graphics programs and data types can be combined in these abstractions. Unlike numeric programming languages, Lisp allows programmers access to all levels of code, says Matthews.

Among the 14 new packages is a very large-scale integrated-circuit design and test tool set, a functional simulator that generates test vectors to verify designs. Designers are given general guidelines to tie logic blocks together, and test vectors are then generated. For 100% verification of a design, these test vectors and the functional simulation are compared with the hardware emulation and test vectors coming from the schematic capture and logic design of a circuit. "The uniqueness here is that the functional simulator has become an executable spec," says Matthews.

A new VLSI-chip testing program, called Megaspy, plays off a program called Casablanca, which provides windows to view and debug thousands of words of states in the Lisp processor microengine. Megaspy enables a design engineer to control a complex VLSI-chip tester without the extensive training normally required, says Matthews. In addition, TI is using a number of printed-circuit-board layout and schematic editor packages that incorporate engineering expert systems to help designers avoid a variety of potential trouble spots. *–J. R. L.*

TELECOMMUNICATIONS

A DIGITAL RADIO PHONE THAT'S PRICE COMPETITIVE

System provides low-cost links to remote phones

PHILADELPHIA

Engineers have known for years that a fully digital radio-telephone system would outperform conventional cellular radio in data-transmission speed, integrity, and security. But only now has an equipment maker come up with a prototype that seems to be economically feasible. A small Philadelphia telecommunications company, International Mobile Machines Corp., is completing development of an inexpensive all-digital radio telephone.

Its Ultraphone 100 addresses a small niche market—remote locations where either terrain or cost has kept local telephone companies from providing or upgrading service. But it also has much broader implications for the growing mobile-telephone market and for rural service in general, says Richard Saunders, senior vice president for engineering and manufacturing. Its all-digital architecture makes it harder for eavesdroppers to monitor conversations, and it makes possible mobile high-speed high-security data transmission at 9.6 kb/s.

Transmitting in the 454- to 460-MHz range, the system compresses data to optimize speed and secure privacy while conserving radio bandwidth. Four voice or data paths are multiplexed on a single 25-kHz channel, conserving valuable space on the ultrahigh-frequency radio band.

The cost saving can be staggering. Laying 20 miles of line is likely to cost well over $100,000, but a number of Ultraphones can be installed "for under $3,000 each—including the amortized cost of the base station and subscriber unit."

The heart of the Ultraphone 100 system, which Mountain Bell will try out this summer in Glendo, Wyo., [*Electronics*, March 24, 1986, p. 13], is its base station. Consisting of a central office terminal, a radio processor unit, and a remote radio terminal with a 40-mile transmitting/receiving range, the system connects to a mainframe telephone switch as if it were a local loop. The resemblance ends there, however. Although Ultraphone is completely transparent to the user, says Saunders, the system must do some extensive data manipulation to operate.

The central office terminal interfaces directly to the main distributing frame at the telephone office, converting analog signals into digital baseband 64-kb/s pulse-code-modulation signals. Signals are next concentrated with a time-slot interchanger for transmission over high-speed T1 lines to the remote radio terminal. Under control of a microcomputer based on a Motorola 68000 chip, the remote terminal accepts the twenty-four 64-kb/s incoming channels from the T1 line.

A channel controller compresses each channel into a 14.57-kb/s conversation and adds control bits to preserve data integrity. These conversations are multiplexed four to a channel onto six new 64-kb/s channels. The multiplexed signals are then broken into 4-bit chunks, called symbols, that take one bit from each conversation. That

reordering creates six 16-kilosymbol/s signals that are processed for transmission over radio links to subscribers' homes.

The subscriber units reverse the process to provide a steady, noise-free conversation. Each channel uses a 20-kHz bandwidth and includes an accompanying 5-kHz guardband. Base station transmitting frequencies are always 5 MHz under corresponding receiving signals.

"Our objective is to have the system transparent on the local loop," Saunders says. "And I can say we're there."

REMOTE MARKET. Hilsman (right) and Saunders take aim.

Getting there wasn't easy, though. The company has twice run out of money in the last three years, missing its payroll for up to four weeks, says company president William Hilsman, a retired Army lieutenant general (see p. 64). But he adds that the company is no longer short of cash after a public offering last summer. In addition, he says its working arrangement with M/A-Com Inc., a major stockholder in Burlington, Mass., that has done much of the development work on Ultraphone, remains strong. And the company has an agreement with United Technologies Corp., Hartford, Conn., another major stockholder, to develop a military version of Ultraphone in a 50-50 joint venture.

International Mobile Machines is beginning to target its commercial customers, and the regional Bell operating companies figure to be a major source of revenue—provided the Mountain Bell tests go well. According to James Mullen, vice president for marketing at the company, there is a large potential market for a system like Ultraphone in any of four categories: new installations for remote locations not served by local telephone companies; new installations for communities being developed more than 3.5 miles from a central telephone switch; upgrading of locations where many customers still use multiparty lines; and upgrades in communities where old or damaged wire is in need of replacement. "About 15% of these can be addressed by a system of this sort," Mullen says.

Saunders is even more emphatic about Ultraphone's potential: "By the year 2000, you're not going to see telephone poles in rural areas—you're going to see radio technology taking over." *-Tobias Naegele*

DATA PROCESSING

'MICROPROCESSOR FARM' HARVESTS REAL-TIME DATA

PROVIDENCE, R. I.

The need for massive real-time data acquisition in high-speed physics has traditionally been met by home-grown custom hardware and software. But researchers at Brown University have now linked a half-dozen computers to build the prototype of an off-the-shelf solution to many large data-acquisition tasks.

Called a microprocessor farm, the system consists of 49 Digital Equipment Corp. MicroVAX II computers linked in a configuration managed by a supervising computer. DEC, Brown, and Zeller Research Ltd., a local company that did the bulk of the system design, expect to soon sign an agreement calling for the construction of a showcase microprocessor farm at the Providence campus. The farm may also provide a secondary crop: off-line batch processing.

In addition to use in high-speed physics, microprocessors may find applications in such fields as medical imaging, says Raymond Zeller, a Brown research engineer and president of Zeller Research. "There is no standard commercial product that can do real-time image processing for the medical community." Another possible application would be to make use of interactive computers in off-hours for off-line batch processing.

The microprocessor-farm scheme was developed to collect data for a proton-antiproton beam-collision experiment to be conducted at Fermi National Accelerator Laboratory in Batavia, Ill. The Department of Energy project, which should be ready for testing by the end of 1987 and in full operation by 1989, is being carried out in a large collaborative effort that includes Brown. After data goes through hardware prefiltering, the data-acquisition system will use a software filter to reduce a 400-Hz event rate (250-K bytes/event) down to less than 2 Hz.

Zeller estimates that to collect the experiment's data, the system computers will have to execute about 40 million instructions per second and handle data-transfer rates averaging 100 megabytes/s. "That's a tall order even for a low-end Cray," says Zeller, adding that a number of high-end VAX machines would also choke on the input/output requirements demanded.

Another option was to design and build a custom system, which has been necessary in the past because of the limitations of commercially available computers. But that option has heavy costs of its own. "We don't have the people to maintain a custom system even if it was given to us," says David Cutts, a professor of physics and assistant department head at Brown who is also working on the collision experiment.

SOFTWARE FILTER. Instead, the Brown group chose to use 50 MicroVAX II computers, each with 4 megabytes of random-access memory but without disks and backplanes, packaged 24 to a rack with water cooling. One of the major design decisions was to build the system filter in software, rather than hardware, so that programmability would make it more flexible, says Zeller.

The foundation for the software filter, distributed among the system's nodes, is built on Digital Equipment's Vaxeln memory-resident operating system. It allows downline loading to dependent nodes without accessing storage peripherals.

One MicroVAX II serves as the system supervisor. In conventional operation, it steers events to available processors. For diagnostics, it can steer the same event to multiple computers. A notable feature of the supervisor lets it route special events to a node set up to calibrate only those events.

Moving through the microprocessor-farm system, data from particle collisions is digitized by front-end electronics and then routed along twisted-pair cable to a single processor, with that computer handling all analysis required for the event. This single-processor single-event

HIGH-TECH FARMERS. Raymond Zeller (right) designed the microcomputer farm that David Cutts and other physics professors will exploit at Brown University.

approach minimizes interprocessor communication and simplifies both software development and data flow.

To handle the huge data input, Zeller developed extremely high-speed dual-port memory boards. Each board has two input channels 32 bits wide and 250-K bytes in size. The input channels can transfer data at 40 megabytes/s through external ports, meaning that each node can handle 320-megabyte/s aggregate throughput.

The dual-port boards have an external bus port and a Q-bus port that makes the board look like Q-bus memory to the processor, eliminating the need for special drivers. Each memory board is also capable of being a block-mode master and can move data directly to private memory of a MicroVAX II at 3 megabytes/s. The bandwidth of the MicroVAX II local memory is sufficiently high that these transfers can be interleaved without degrading ongoing processor performance.

FUTUREBUS AND ETHERNET. The data cables—each 25 ft long—and external ports have open-collector Futurebus transceivers. "We wanted to stick with single-ended drivers [as opposed to differential] and TTL because of cost and simplicity," says Zeller. "To get that performance, Futurebus transceivers were the best choice."

The nodes have two back-end Ethernet connections. One can pass data using a custom protocol to mass storage in the host or server. The other uses Decnet protocols and is for down-line loading and communication. *–Craig D. Rose*

MICROWAVE ICs

AIR-BRIDGE CUTS GaAs FET GATE NOISE

VIEMERCATE, ITALY

Designers of gallium arsenide integrated circuits, always on the lookout for ways to better the high-frequency performance of their chips, often turn to air bridges to lower the capacitance of connections between on-chip wiring and the gates of field-effect transistors. Engineers at Telettra SpA, the telecommunications subsidiary of Fiat, the European automotive giant, have added an Italian touch to the technique. They connect the FET gate to its pad through an air bridge that runs above the source.

Telettra's twist makes possible a very short-length, low-noise gate without going to geometries so tight that the yields become uneconomical. explains Giorgio Guarini, manager for components and technologies at the company's Viemercate research facility. With the air-bridge layout (figure), only the 0.5-μm-wide point of contact with the transistor's active layer contributes to the gate's distributed resistance, the principal parameter determining noise.

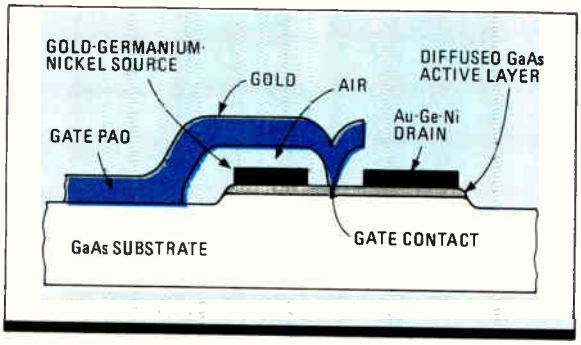
Guarini believes the technique is particularly promising for fabricating monolithic circuits aimed at high-volume applications, such as direct-broadcast-satellite receivers. It could well turn up in power ICs, too, because the bridges can replace the complicated interdigitated structures needed to handle high voltages and currents.

Interestingly, Telettra began work in GaAs technology less than three years ago. At that time, the Milan company decided that as a major European producer of radio links, it had become too dependent on outside suppliers for the microwave components that are essential to its systems.

"We felt that GaAs components were of high strategic importance because there were only one or two suppliers for what we needed, and they were Japanese," says Guarini. "We had good experience in reliability and packaging, so the microwave culture was here, but no experience in semiconductor production." Since that time, Telettra has filed for two GaAs process patents, one for its low-noise FET structure and one for a processing detail.

For Telettra's FETs, fabrication begins with a standard GaAs substrate, which is doped to create an active layer and then etched to form a mesa structure for each transistor. After deposition of gold-germanium-nickel source and drain contacts, a layer of photoresist is deposited, and the gate contacts with the active layer and gate pads on the substrate are defined using standard photolithography. Gate metalization is then deposited on the entire wafer and electrolytic gold grown in turn on top of it.

BUILDING BRIDGES. A second photoresist layer is then masked and deposited to define the air-bridge connection. After that, the gate metalization and the gold atop it are etched off through the photoresist mask. Removal of the two photoresist layers leaves the free space required for the air-bridge structure. The gap between the gate electrode and the source is a full 4 μm, and this is large enough to keep parasitic ca-



LOW-TOLL BRIDGE. By using an air-bridge structure, Telettra reduces distributed gate resistance, and therefore noise, for GaAs FETs.

pacitance to a negligible level.

To test the technology, Telettra has produced interdigitated GaAs FETs on the same substrate as its air-bridge devices. First results showed a drop in noise of 0.4 to 1.4 dB over the standard part—significant in a field where total noise figures are generally measured in 1 or 2 dB. Telettra has developed a prototype of what will probably be its first application, a two-stage monolithic DBS preamplifier. *–Robert T. Gallagher*

COMPONENTS

HOW TO MAKE DISK DRIVES START UP THE FIRST TIME

TUSTIN, CALIF.

If the best product-development strategy is to come up quickly with a salable solution to a thorny problem, then Smartflex probably hits the mark as squarely as anything. It sounds simple enough: a one-piece subsystem that carries the chips used to drive the head and disk assembly of a disk drive mounted directly onto the flexible interconnection that links the drive to its power source.

Smartflex replaces a hodgepodge of scattered head-drive integrated circuits whose failure from poor system design has been giving fits to drive makers. Silicon Systems chairman Carmelo J. Santoro, for one, claims that up to 80% of drives don't work when first powered up during production tests. This failure rate never drops below 20%, drive makers agree.

Early response to the product, which Silicon Systems Inc. announced late last year—just six months after beginning development—hints at rapid success. Smartflex already has found its way into 23 prototype drives. And that impending success figures to accelerate the trend of bundling drive electronics in custom chips.

Silicon Systems has permission to identify only one Smartflex customer so far—Quantum Corp., Milpitas, Calif., which uses Smartflex in its Q200 drive family. But "essentially, every major drive company in the top 20 worldwide is working on a prototype," claims Stephen E. Cooper, senior vice president and general manager of Silicon Systems' Microperipheral Products Division.

The Tustin company (see story, p. 60) produces the chips for the connectors, and Rogers Co., Rogers, Conn., supplies the cables. Until a joint venture by the two companies gets under way in several months, Silicon Systems is assembling Smartflex and shipping it in quantity to five drive makers, with evaluation units going to others.

The problem that Smartflex solves comes from the ticklish nature of designing and laying out the drive circuits, primarily the sensitive analog preamplifier and amplifier devices used by read/write heads. Silicon Systems is the major supplier of these chips. Placement of the ICs is especially critical: the farther the drive signals have to travel, the more likely it is that an error will occur, says Cooper. Complicating the task even more is a lack of space in the drive that he terms "terribly restrictive" for new 3½-in. half-height units.

TAKING OFF. Competitor VTC Inc., Bloomington, Minn., supplies many of the same drive chips as Silicon Systems. And it agrees wholeheartedly that demand for bundled interconnection and head-drive devices is taking off. In fact, VTC is offering a similar package, but through several flexible-cable suppliers instead of just one, says Donald Griffith, director of its Microcircuits Division. He argues, however, that the idea should be regarded as "more of a marketing technique than revolutionary technology."

ON THE RISE. Smartflex is catching on with disk-drive makers, says Silicon Systems' Cooper.

But along with Silicon Systems officials, Griffith predicts that bundling will accelerate to include all of the analog functions, in addition to the head-drive chips, and that the momentum is toward bundling all drive electronics into fewer integrated circuits.

This direction, even more than the takeoff of Smartflex-type products, impresses semiconductor marketing and process consultant William I. Strauss, of Forward Concepts Inc., Tempe, Ariz. "In essence, some chip houses are becoming subsystem houses," he observes. While it is too early to label that development a full-fledged trend, Strauss says it clearly is important for companies that can pull off the transition. "That's one way to fend off the Japanese chip maker competition," he says.

Silicon Systems at first tried its hand at the interconnects, along with the ICs, but soon discovered its limitations. "There's lots of technology there, more than we thought," admits Cooper. The cable not only is conductive material but also has to flex through millions of cycles.

No two Smartflex designs are alike, because customers' drive designs differ. So prices vary, too. The simplest Smartflex joins a single standard-amp chip and a flex interconnect, which sell separately for about $5 and $3, respectively; the Smartflex is priced at $15. Another design, employing custom ICs and created for a large computer company, goes for nearly $100.

One Smartflex customer that understands this advantage is Quantum, notes Rolf Brauchler, its director of marketing. Buying a complete, tested subsystem is a new approach for the drive maker, and means "a different level of integration for our chips, too." Brauchler points out another edge: the faster turnaround between design and production phases afforded by reliable subsystems. That, he says, helped Quantum quickly develop the Q200, whose main feature is a controller integrated into the drive.

GOING UP. Silicon Systems and Rogers know they're onto a good thing with Smartflex and are pushing production. The chip company has ramped up to about 3,750 units weekly and is still expanding. Rogers will take over Smartflex assembly soon at the Flexible Interconnect Division's Chandler, Ariz., plant.

And Silicon Systems has variations in the works. Cooper sees ways to apply Smartflex-type units to motor-speed control, printers, and other end-equipment applications. Besides locking customers in during the design stage and expanding chip sales, the beauty of having chips mounted on the cable, says Cooper, is "getting the value-added return up front." *–Larry Waller*

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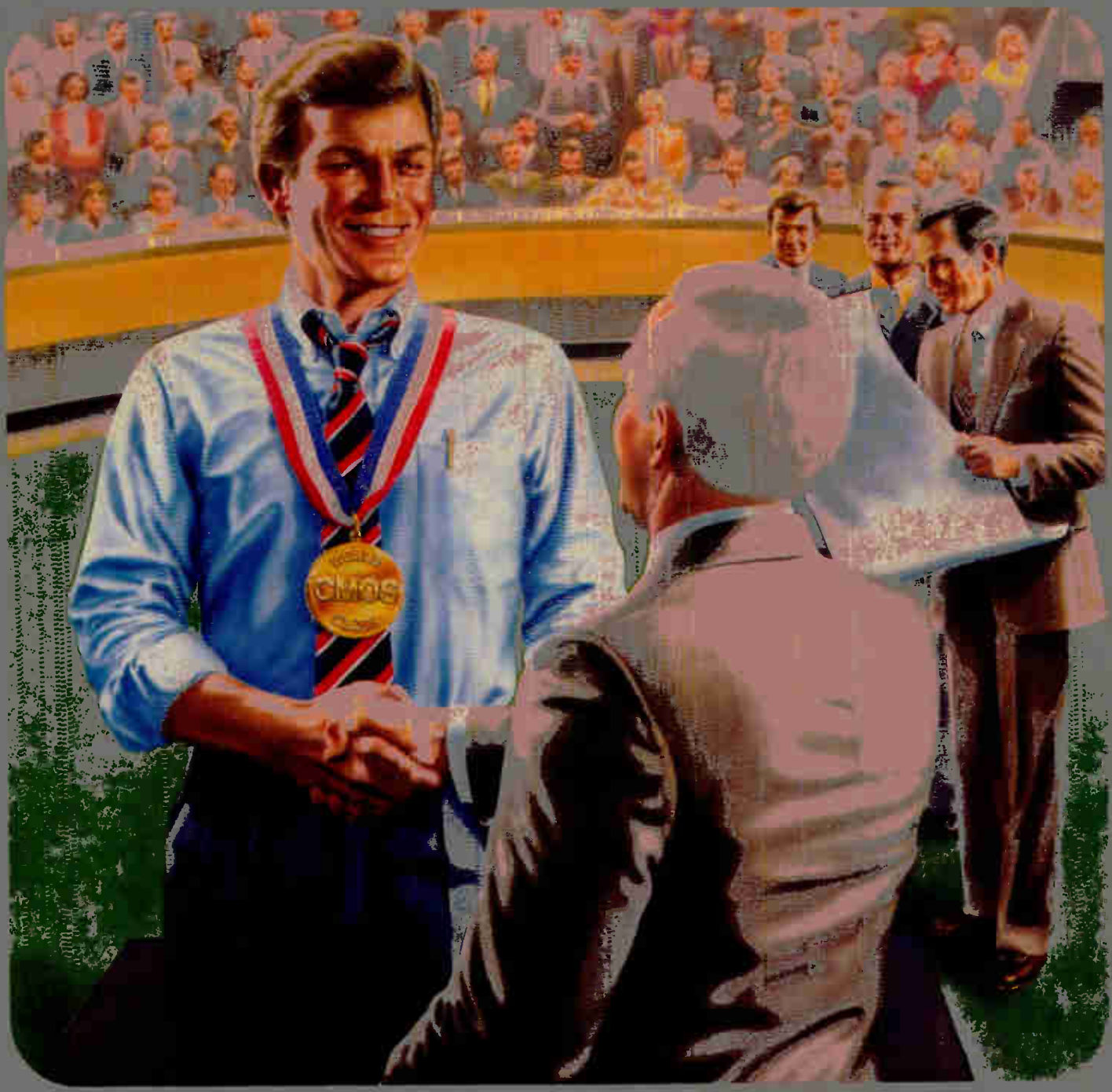

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INSIDE TECHNOLOGY

SPECIAL REPORT: STRATEGIES SHIFT IN LOCAL-AREA NETWORKS

NEW AT&T AND IBM PRODUCTS PUT PRESSURE ON SMALLER VENDORS

by Robert Rosenberg

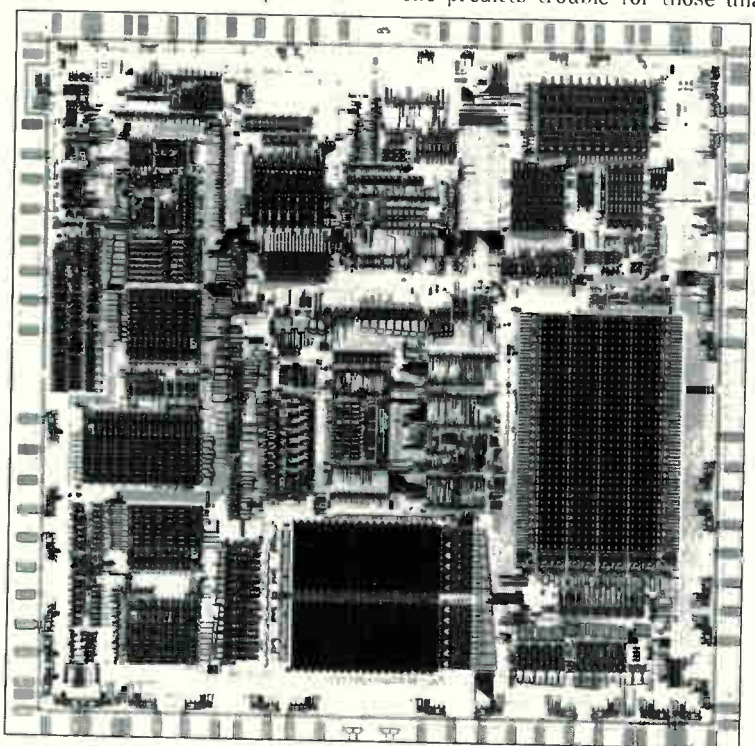
The coming months will be the best and worst of times for independent vendors of local-area networks. LAN markets are growing rapidly, but companies—especially those with personal computer networks—are jockeying for new positions in a market increasingly dominated by huge companies such as AT&T Co. and IBM Corp. For those offering high-end networks for a computer room crowded with mainframes or for the factory floor, the outlook is brighter. The need for networks able to connect complex automation equipment with corporate mainframes should make this market grow fast enough to accommodate many players.

Pressure on the independents in the general-purpose LAN market is coming from several directions. The emergence of new AT&T and IBM networking products has already forced a number of smaller companies into strategic alliances as a way to broaden and differentiate their product lines, or to concentrate on niches missed by the giants. And besides worrying about where the giants may tread next, the independents must also keep ahead of the new breed of private branch exchange manufacturers, who are introducing switches that tightly couple LAN functionality into the PBX architecture.

Competition among the independents selling high-performance LANs to work-station manufacturers has been less severe than at the low end, though market pressure brought about the marriage of two companies. Others are hanging tough, deepening their product lines. And even in the burgeoning factory-automation LAN market, strategic alliances are playing a big part in the plans of several companies.

For the independents that survive, the rewards will be substantial. The market for hardware, software, and services that make it possible to hitch heterogeneous processors together so they can communicate should leap from around $400 million last year to $1.2 billion this year. It will continue spiraling upward to become a $5 billion market by the end of the decade, says Mark D. Stahlman of Sanford C. Bernstein & Co., the New York investment banker. "My working assumption was that only 20% of the installed base of terminals would need LANs," Stahlman says. "In 1985, that number was 305,000. It will increase to 1.8 billion nodes by 1990."

But the variety of the AT&T and IBM product offerings has made it increasingly difficult for the independents to differentiate their products from those of the giants. "A couple of years ago, the low end of the LAN market was made up primarily of startups," says Kathryn Korostoff, telecommunications industry analyst for Northern Business Information, a New York consulting firm. "But the entry of AT&T and IBM means many of these companies won't be able to compete." She predicts trouble for those unable to offer the full range of networking products.



1. CORVUS'S BOOSTER. The CMOS version of the Omninet controller that was codeveloped by NEC and Corvus Systems will handle data at 4 Mb/s.

AT&T, for instance, is working on several fronts. Its heavy-duty data offering is the Information Services Network, a high-speed baseband packet switch from AT&T Information Systems, Morristown, N.J. With its interface to the IBM 3270 communications environment, it switches synchronous devices through an optical backbone to another node at 8.64 Mb/s. The packet switch also can be connected to Ethernet and StarLan, AT&T's 1-Mb/s version of Ethernet incorporating the IEEE-802.3 protocols for collision-sensing multiple access with collision detection (CSMA/CD) and operating over twisted-pair wires.

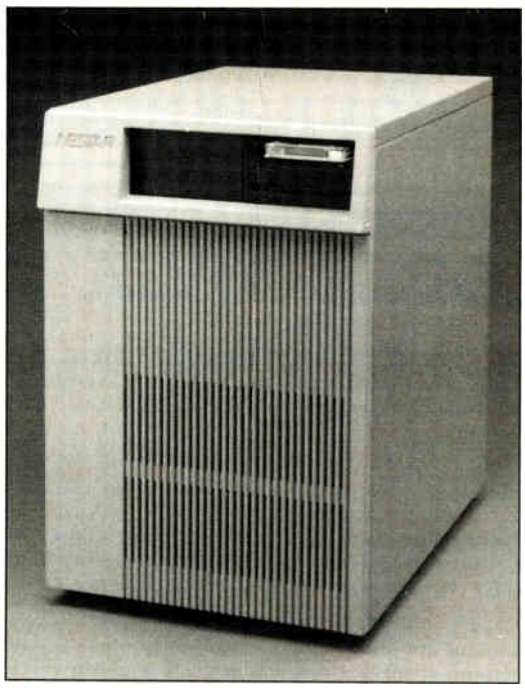
But the offerings look to be an adjunct to, not a competitor with, AT&T's System 75 and System 85 PBXs. These large circuit switches show why AT&T is preeminent in circuit-switching technology. They handle data traffic at 64 kb/s for synchronous transmission and 19.2 kb/s for asynchronous, in addition to voice-switching chores, and can be linked to the packet switch over AT&T's Digital Multiplexed Interface protocols.

IBM raised the stakes in the general-purpose LAN market last October with the introduction of its long-awaited Token-

Ring Network, making product differentiation even more difficult. Furthermore, it competes with the PC Network, the 2-Mb/s net that Sytek Inc., Mountain View, Calif., began offering two years ago as an original equipment manufacturer. IBM subsequently endorsed the Sytek product as a way to link its Personal Computers into clusters.

However, an eight-station PC Network costs $762 per connection, and a comparable 4-Mb/s Token-Ring Network sells for only a little more—$828 per connection. The broadband PC Network may offer lower cost, but the baseband Token-Ring Network promises greater speeds, potentially lower manufacturing costs, and a wider variety of system attachments. A more extensive library of network management services is also expected to become available for the Token-Ring Network.

The introduction of the Token-Ring Network raises questions about the depth of IBM's commitment to the PC Network. The investment that the computer giant is making in the Token Ring positions it as the centerpiece of IBM's long-term office-automation strategy. Its introduction set off an avalanche of announcements by the independents promising gateways, bridges, and boards supporting the net [*Electronics*, Oct. 21, 1985, p. 16].



2. NESTAR'S PLAN. More than a gigabyte of storage is available in Nestar's top-of-the-line PLAN 5000 server.

IBM's initial Token-Ring product offerings were skimpy—a PC adapter card, the passive wire center that protects the network from device failure, a Netbios interface between the PC Network and the Token-Ring Network, and some gateway software. And though the company announced no direct connections to the System/36 and System/38 departmental processors, the Series/1 minicomputer, or mainframes, such connections are inevitable. This too will leave less room for the independents to maneuver.

As an independent LAN vendor with plenty of experience living in the shadow of giant IBM, Sytek is deepening its broadband offerings as a way to differentiate its product line and provide a cushion to offset any decline in revenue should IBM forsake the PC Network. Thus in answer to the Token-Ring Network, it introduced the System 6000 product family for larger users. Sytek's 6050 Network Translator, for example, will link up to 1,000 nodes, whereas the PC Network handles a maximum of 72 nodes per IBM Network Translator. Sytek also recently added a file server to its line. The model 6010's 75 megabytes of file storage can serve up to 1,000 nodes with an average access time of 28 ms.

IBM's Token-Ring Net leaves the independents less room to maneuver

SHAKEOUT LOOMS

Now that AT&T and IBM have made their presences felt, the possibility of a shakeout in the low-end LAN market looms larger. "I think the shakeout has already begun in the U.S.," says Rick Rebo, executive vice president for research and development at Fox Research Inc., Dayton, Ohio, which makes 10-Net. Fox Research—whose profits have rocketed from $26,000 to $16 million in three years—decided to make its mark in Europe before trying to crack the crowded U.S. market.

Fox Research's 10-Net is a 1-Mb/s twisted-pair LAN that uses CSMA/CD protocols to link IBM PCs and their compatibles. It is similar architecturally to StarLan but, according to Rebo, it runs faster.

"We run 50% faster in the critical areas like Copy and Load commands," claims Rebo, adding that more tightly written code gave 10-Net the edge over StarLan in functional tests performed by Ing. C. Olivetti & Co. Last summer, Fox Research won a lucrative OEM deal with Olivetti—even though AT&T owns 25% of the Italian computer giant and buys its PC 6300 personal computer from the company. Fox Research also signed a $21 million deal to sell its network to the French Ministry of Posts and Telecommunications and has formed a strategic alliance with ITT Corp., which plans to use the 10-Net as the LAN for its model 5700 voice-data switch.

But strategic alliances have sometimes proved less than successful. Corvus Systems Inc. began selling the 1-Mb/s Omninet running on twisted-pair cabling back in 1981 and built up a huge installed base among Apple II and IBM PC users (table, p. 36). But last year, the San Jose, Calif., company stumbled when trying to broaden its product line with the 16-bit Unix-based microcomputer developed by Onyx + Imi Inc., a company it bought.

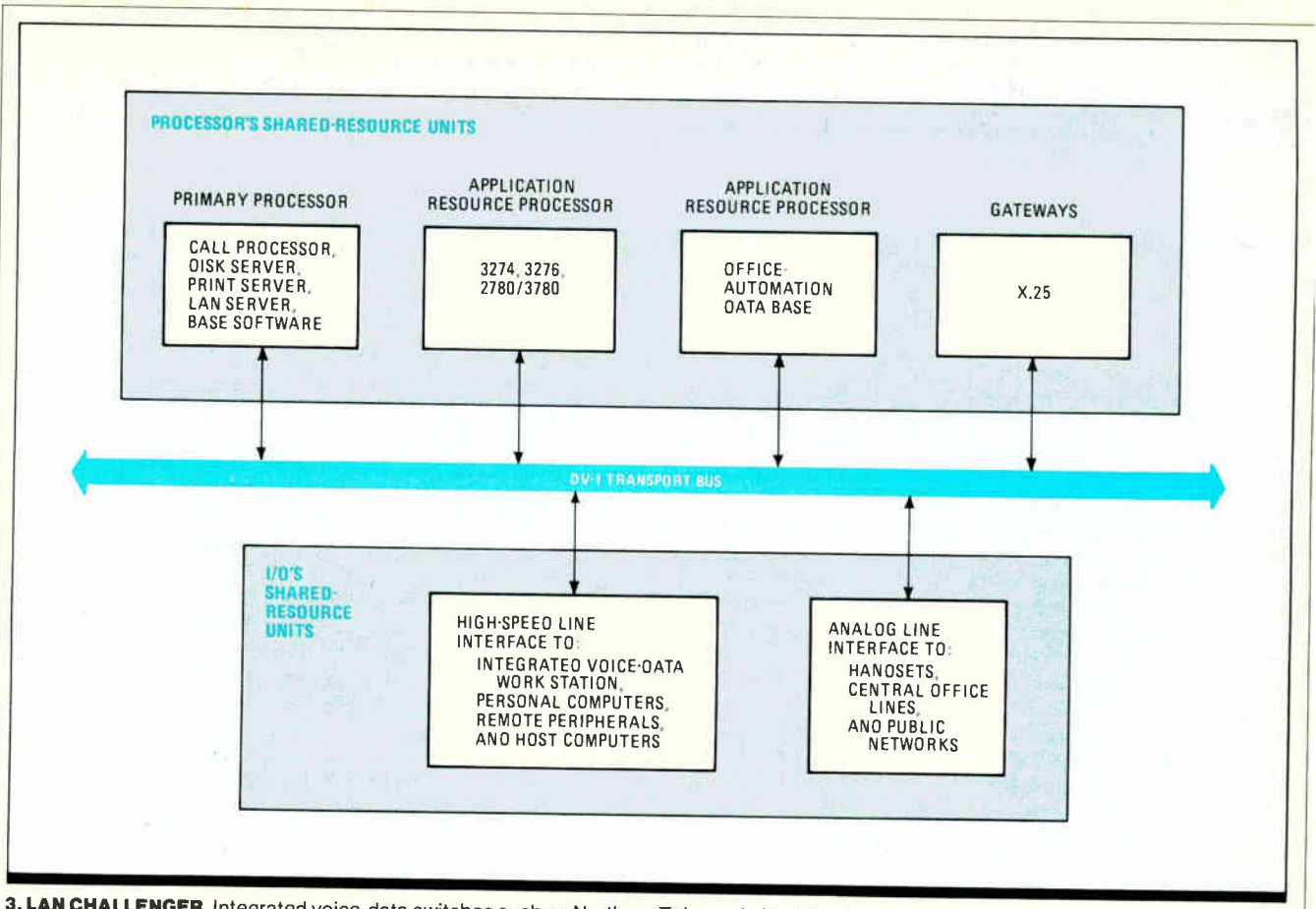
Corvus got caught behind the development curve trying to develop a multiuser machine while personal computer prices were dropping and new software was making file sharing on a LAN possible, according to its new chief executive officer, James L. Siehl. The result was a big drop in sales and profits.

Early this year, Siehl cut his losses, selling Onyx + Imi to Megalogic Inc., San Jose, the U.S. affiliate of Micrological Aplicada, Mexico City. At the same time, Siehl made two new acquisitions. Through stock swaps, he acquired Oemtek Inc., the San Jose manufacturer of PC- and PC AT-compatible personal computers, and Applied Intelligence Inc., the Mountain View developer of the PC/NOS network operating system.

The Oemtek acquisition gives Corvus an inexpensive source of PC-compatible computers and access to PC hardware-engineering expertise, which the company is already putting to work developing an interface between Omninet and the Token-Ring Network. But the Applied Intelligence acquisition could get the company on a steadier course.

The message-passing PC/NOS operating system allows true interprocess communication. In an MS-DOS environment, the operating system rides on top of the PC/NOS. All MS-DOS calls are translated to a PC/NOS message, then transmitted by the PC/NOS kernel to a PC/NOS kernel residing on every node. This means that all MS-DOS resources can be shared. PC/NOS does not need a dedicated file server; the network intelligence and files can reside anywhere on the net. Besides the usual file and record locking, PC/NOS provides a base for distributed multiprocessor applications. For example, all clocks can be synchronized, giving the uniform date and time stamp needed for such applications as transaction processing.

Corvus is also getting a boost from NEC Corp., Kawasaki, Japan, which entered into a deal with Corvus a year and a half ago to implement a single-chip version of the Omninet controller (Fig. 1). The CMOS part, implemented with 1.5-μm geometries, contains the equivalent of 125,000 transistors. It will push



3. LAN CHALLENGER. Integrated voice-data switches such as Northern Telecom's Meridian DV-1 are challenging personal computer LANs in the office. It provides two voice channels plus a data channel with a data rate greater than 2 Mb/s over a single twisted pair.

data down the twisted wire at a rate of 4 Mb/s using Omninet protocols but with a longer, 48-bit addressing space for destinations on the net. Samples of the chip are now being shipped. The further integration should eventually better Corvus's margins, but for now the company has slashed the unit price of a PC interface from $495 to $199 to gain market share.

MERGER FOR 3COM

Pioneering PC LAN vendor 3Com Corp. is also feeling pressure to expand its offerings to stay ahead of the giants. "We looked around and said it is getting dangerous out here," says Howard S. Charney, senior vice president and manager of the Network Systems Division. The Mountain View company that started out in 1982 marketing Ethernet controllers and transceivers just completed a merger with work-station maker Convergent Technologies Inc., Santa Clara, Calif.

3Com builds single-board PC interfaces with built-in transceivers that can run on either the standard Ethernet cable or the newer thin-cable Ethernet. It also offers 36- and 70-megabyte file servers and network gateways to IBM's 3270 communications environment and Apple Computer Inc.'s Appletalk net. The company also plans to support StarLan and the Token-Ring Network with gateways. At the end of February, 3Com started shipping its 3+ family of networking software, which is compatible with the de facto standards set by IBM for PC networking.

3Com does not plan to take the route that tripped up Corvus: trying to integrate its network with existing work stations from its new partner. Instead it plans to make sure that future work-station designs will work with its network products. "With the merger, we have a chance to influence the entire design of the work station that Convergent sells to OEMs," Charney says.

Where a company such as Corvus faltered trying to expand its base too quickly, rival Nestar Systems Inc. may have erred on the side of conservatism. The company has announced its intention to support IBM's Token-Ring Network, but the question is whether it has stayed too long with the ARCnet token-passing protocols developed by Datapoint Corp. as the rest of the world turns to IBM's token-passing net.

The Palo Alto microcomputer LAN vendor is betting everything on its server technology. The 1.1-gigabyte capacity of the top-of-the-line PLAN 5000 server is a far cry from the earlier Cluster/One—the 16-megabyte/s Apple II server launched in 1978—but founder and chief scientist Harry J. Saal is convinced that success comes by sticking to what you do best (Fig. 2).

"I don't want to be a Corvus and try to compete in personal computers with Apple or with AST Research in disk drives. There is a trade-off between increasing your product line and cutting yourself off from allies," says Saal. Nestar's strategy under Saal will be to buy everything except the server technology. It is scrapping the ARCnet physical and data-link layer protocols used in its network servers in favor of the protocols defined by the IEEE-802.5 standard. But moving the installed base could take time.

The ARCnet protocols were the only token-passing game in town in the late 1970s, according to Saal, but IBM's token-ring implementation sets the new standard for deterministic nets. However, Saal says Nestar plans to stay well away from the cutthroat competition that is sure to erupt when personal computer token-ring interface boards hit the streets.

"We have produced our personal computer ARCnet interface boards in-house since 1982," Saal says. "But in the case of the Token-Ring Network, we don't plan to build our own. If 3Com wants to compete against IBM, that's great—but it is

not our business." But even so, they will have to work harder to maintain their niche position, says David K. Moy, a telecommunications analyst for investment bankers Morgan Stanley & Co., New York. "A reinvigorated 3Com has some advantages, though Nestar tends to stay out of 3Com's way by selling larger configurations and selling direct," Moy says.

Pressure on the independents at the low end of the LAN market is also coming from integrated voice-data PBXs. These switches—which tightly couple LAN functionality with a digital matrix switching architecture—are aimed at providing a single solution to the problem confronting office automation: integrating data and voice communications using the same processors.

WORLDWIDE MARKET SHARE IN PC LANs

Company	Product	Year founded	%
Corvus	Omninet	1981	30.3
3-Com	Etherseries	1982	16.9
Orchid	PCNet	1982	9.7
Fox Research	10-Net	1984	7.3
Digital Microsystems	HiNet	1980	5.5
Gateway	G/Net	1984	5.5
AST	PCNet, PCNet II	1983	2.4
Compucorp	Omeganet	1981	2.4
Others			20.0

SOURCE NORTHERN BUSINESS INFORMATION INC.

Though large PBX switches are integrating voice and data, a bigger threat to LAN vendors is the smaller integrated voice-data switches, such as Northern Telecom Inc.'s Meridian DV-1. Introduced a little over a year ago to serve as a departmental voice and data switch in a 10- to 50-person office, it provides up to two voice channels plus a data channel with a data rate greater than 2 Mb/s over a single twisted pair.

The switch's high-speed bus, the DV-1 transport, dedicates 20 Mb/s to synchronous voice and data traffic, reserving another 20 Mb/s for asynchronous switching of data. Its Shared Resource Units, or processors, are linked to the bus and typically perform the logical, physical, and electrical functions of an application or an input/output subsystem. Thus, for example, one processor could act as an application processor handling call processing and the disk, print, and LAN servers while another could take over the chores as an I/O applications processor controlling up to 12 high-speed lines to integrate voice and data terminals, personal computers, or remote devices, such as printers (Fig. 3).

Northern Telecom expanded its Meridian offerings this month with an audio-conferencing bridge called Meeting Communications Services. It gives voice- and data-sharing capability to as many as 24 separate lines. Two speakers can occupy the virtual bridge in what is in effect a simultaneous conversation without the clipping that cuts off the ends of utterances that is common in other bridging technology.

Smaller companies are also betting that voice and data integration is the wave of the future. CXC Corp., Irvine, Calif., is delivering its dual-cabled Rose PBX, an integrated voice-data switch with a 50-Mb/s broadband ring and a tightly integrated 10-Mb/s Ethernet. Only 33 Mb/s are being used for circuit-switching both voice and data between nodes. The rest were originally specified for a token ring to handle network-control signaling and packet transmissions. But "it is extremely likely we will be implementing the ring using 100-Mb/s fiber technology. This will increase the capacity of the system two to three times," says Robert C. Hawk, vice president of strategic planning and product marketing.

While the token ring is under development, the Ethernet acts as the control and packet channel. Later it will be joined to the ring by a gateway. Up to eight rings can be linked by bridges, each supporting up to 64 nodes. Selected nodes can also be designated as gateways to other nets.

CUSTOM CIRCUITRY

The heart of the Rose is a per-line switch, which is custom line-card circuitry that allocates the bandwidth for voice or data applications. For example, a frame from a digital handset or a terminal consists of a packet channel with synchronization and control information and two 64-Kb/s channels for voice or data. The per-line switch juggles the switching requirements of the voice and data channels at the same time that it handles the control information from the packet bus.

Compared with the PC LAN vendors, competition among the LAN independents selling to work-station OEMs has been less severe, though Interlan Inc., the Westford, Mass., Ethernet house, was acquired last year by Micom Systems Inc., Chatsworth, Calif. Micom bought Interlan to complement its data PBX line, but integrating the two companies' sales forces proved difficult and sales suffered.

Also at the midrange of the LAN market is Excelan Inc., a San Jose company founded in 1982 to provide front-end Ethernet processors for Multibus work stations. Excelan claims it

U. S. GIANTS FINALLY GIVE MORE THAN LIP SERVICE TO OPEN SYSTEMS

For years, major computer vendors paid only lip service to the banner carried by the independent LAN vendors—that of interoperability among incompatible machines—while they continued to push proprietary communications architectures to keep their customer bases locked in. Only recently has the picture changed. The big vendors are flocking to get behind the Manufacturing Automation Protocol, sponsored by General Motors Corp., and to join a new consortium formed to foster open systems, the Corporation for Open Systems (COS).

If MAP efforts and COS ultimately speed the formation and adoption of official standards, they owe much to the early missionary work of the independent LAN vendors promoting interoperability among systems. Now LAN purchasers are demanding the interoperability that results from open systems.

Vendors worldwide have participated for years, through nationally sanctioned representation such as the American National Standards Institute, in the International Organization for Standardization's effort to develop the open-systems-interconnection reference model (OSI) and the protocols to facilitate interoperability. But results have been slow in coming because gaining consensus in an international arena is exceedingly cumbersome.

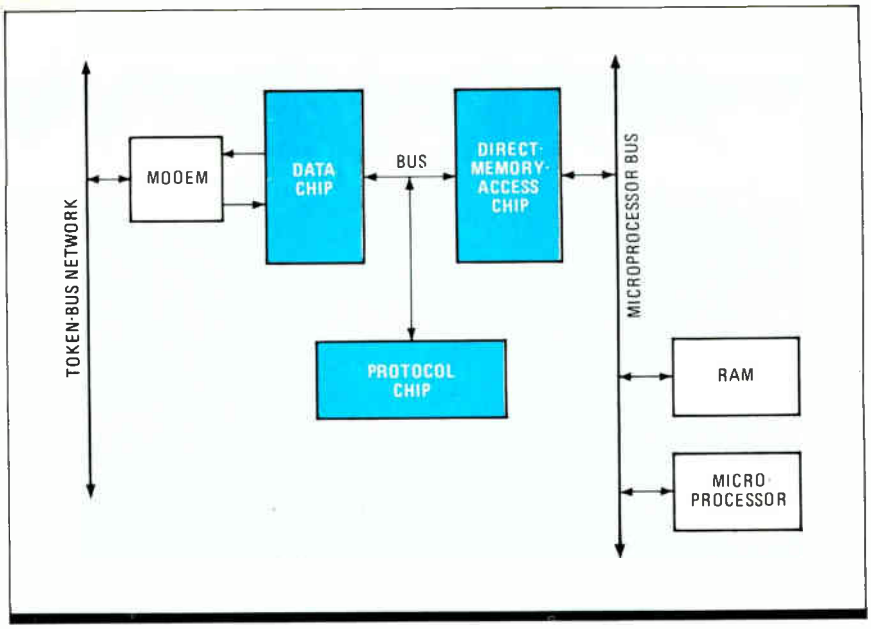
Even the speed of standards making at the national level is glacial and was particularly frustrating to GM, which invested heavily in hardware and software to automate its factories only to find that equipment stood like islands of automation without the ability to share data. It was against this background that GM launched MAP two years ago.

The most eloquent testimony to the success that GM and the independent LAN vendors have had in shaking up the status quo among the major computer vendors comes from the recent formation of COS. This consortium of 50 leading U. S. computer and communications companies will push OSI and other standards needed to create interoperable, multivendor products and services. In contrast to the unfulfilled commitments made by many big U. S. vendors in the past, the consortium's members will spend up to $2 million per test network to verify interoperability for such functions as extended name and address management and document printing.

had the first commercial implementation of the Transmission Control Protocol/Internet Protocol (TCP/IP) transport-level protocols developed originally for the Department of Defense's Arpanet. It has broadened its offering with front-end processors supporting VMEbus-, Q-bus-, Unibus-, and PC-bus-based systems running under the Unix, RSX, and VMS operating systems.

Last month, Excelan introduced an Ethernet network analyzer built around an IBM PC/XT, PC AT, or a compatible. "In a multivendor environment, a manager needs a tool that gives him the ability to end the finger pointing, especially with multiple protocols like TCP/IP and Decnet existing on the cable simultaneously," explains Jay Weil, manager of strategic and product marketing.

Excelan's LANalyzer can monitor or capture 1,000 packets per second independent of the protocols. Up to eight criteria can be selected concurrently with the appropriate filter—to capture errors in cyclic redundancy checking, alignment, and short-length packets, for example. Besides its utility as a troubleshooting device, it also serves as a statistics gatherer for measuring overall network performance. It can buffer up to 700-K bytes in burst mode or 1,000 packets/s in a sustained mode and display the results in real time as histograms or numeric values.



4. MAP MARCHES ON. Concord Data Systems and Gould/AMI Semiconductors are teaming up on three processors for linking either a carrier-band or a broadband modem to MAP.

Two areas that seem immune from downturns in the coming months are the mainframe LANs and factory-automation networks. Network Systems Corp. seized the high ground in large-system LANs shortly after it shipped its first 50-Mb/s Hyperchannel host-to-host communications product in 1977, and it hasn't let go. Besides the Hyperchannel A series, the company is also offering a 10-Mb/s Hyperbus bus-based LAN. Network Systems recently expanded its product offerings with a 10-Mb/s version of the Hyperchannel called the Hyperchannel B series and the PC Dataport. The Hyperchannel B Series is an intelligent interface with onboard buffering that links work stations together and to mainframes and complements the host-to-host speeds of the Hyperchannel A. The PC Dataport coprocessor boards give PCs 3270 file-transfer capability using the 10-Mb/s Hyperchannel.

The next hot market for local networks is factory automation

FACTORY NETWORKS

Networking for factory automation, with General Motors Corp.'s Manufacturing Automation Protocol (MAP) leading the way, also looks to be a secure niche. Stahlman's report for Bernstein & Co. says it will become a billion-dollar worldwide market by the end of the decade.

IBM has given unqualified support to MAP, underscoring its intention to support broadband IEEE-802.4 applications for factory automation. Though it aims to be a presence in this market, however, IBM is not driving the standard, as it is attempting to do with personal computers and general-purpose LANs. This should leave room for the independents in the factory arena.

The MAP protocols are centered on the IEEE-802.4 broadband network specifications. But tight tuning is required to seamlessly integrate the high-frequency filters, radio-frequency modulators, and mixers needed to implement a broadband modulation scheme. Using broadband technology to link the thousands of work cells in an automated factory would not be cost-effective. To drive the cost of connections down while punching up the speeds, MAP is specifying a new carrier-band subnetwork that uses a single channel with two shared frequencies carrying modulated phase-coherent frequency-shift-keyed signals [*Electronics*, Nov. 11, 1985, p. 16].

So far, Concord Data Systems Inc., Waltham, Mass., and Motorola Inc. have made commitments to carrier-band technology, and Honeywell Inc.'s Manufacturing Systems Division is rewriting code to integrate its products into Concord's Token/Net MAP product line.

At the heart of Concord's offering are three very large-scale integration processors fabricated in 2-μm double-metal, single-poly, p-well HCMOS. Developed jointly with Gould/AMI Semiconductors, Santa Clara, they are designed to link either a carrier-band or a broadband modem to MAP (Fig. 4). The data chip performs all modem-dependent operations, including serial input and output coding, broadband-modem processing, and management functions that require quick response. The protocol chip handles execution of the IEEE-802.4 token bus protocol, including error monitoring and recovery. A direct-memory-access chip provides connection over a byte-wide local-microprocessor bus and controls the transmitter and receiver queues and buffers.

But the big winner in the race to sign strategic partners is Industrial Networking Inc., Santa Clara, the joint venture of General Electric Co. and independent LAN vendor Ungermann-Bass Inc. Industrial Networking recently introduced six products, including two-board interfaces between MAP and Multibus or VMEbus, a general-purpose RS-422-to-MAP interface, and a MAP interface to the IBM PC bus, as well as a network control console and a head-end remodulator. The company recently signed joint-development agreements with Fanuc Ltd., Japan, a leading supplier of computer-controlled numerical-control machines, and with IBM's Manufacturing Systems Products group. Industrial Networking also has standing agreements with Cincinnati Milacron, GMF Robotics, Gould, Intel, and Motorola.

The teaming of industry heavyweights to exploit a networking niche in factory automation is a strong indication of the consolidation taking place in all segments of the LAN market. For less well-endowed companies, especially at the low end, the coming months may decide sucess or failure. □

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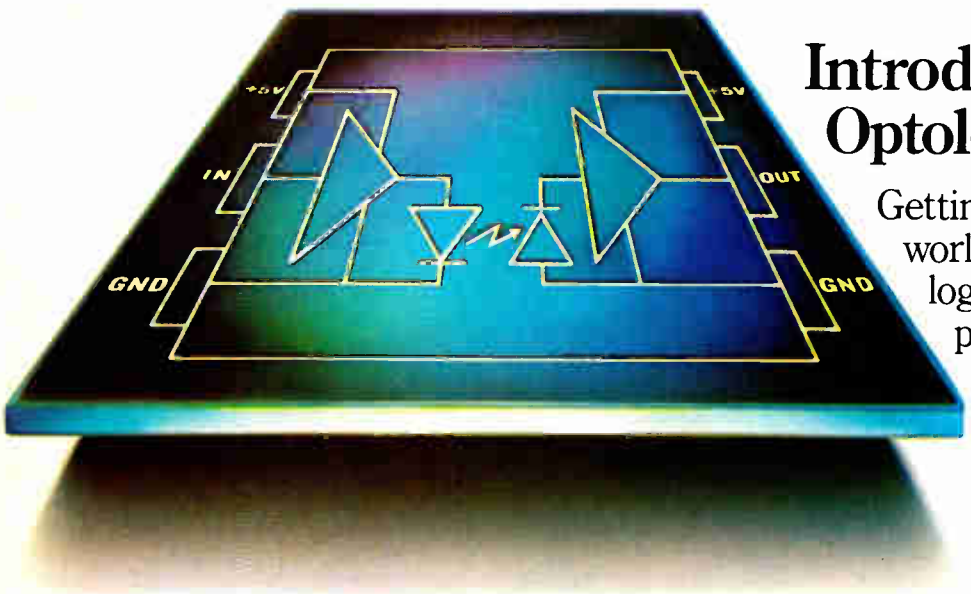

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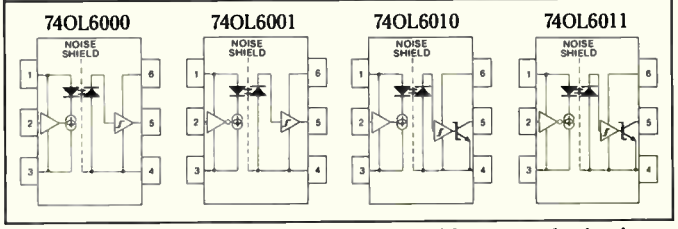
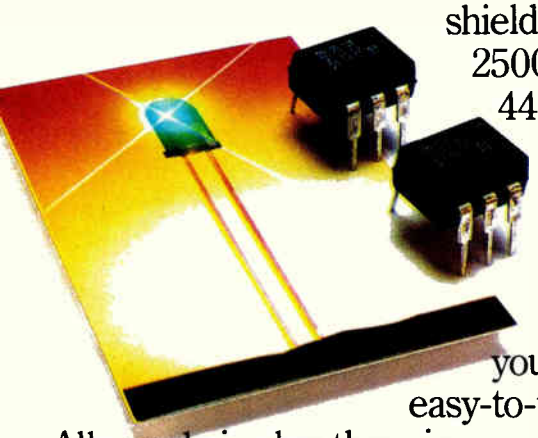
74OL6001	LSTTL	TTL	INVERTER	TOTEM POLE
74OL6010	LSTTL	CMOS	BUFFER	OPEN COLLECTOR
74OL6011	LSTTL	CMOS	INVERTER	OPEN COLLECTOR



There are two output versions available: one with totem pole circuit configuration for TTL compatibility, and another with open collector for interface to 4.5 V to 15 V CMOS or power transistors.



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A NEW WAY TO CUT THE COST OF A-TO-D CONVERTERS

DIGITAL SIGNAL PROCESSOR ADVANCES MAKE OVERSAMPLING PRACTICAL

by Craig D. Rose

A new class of analog-to-digital converters is coming. Based on oversampling, a conversion technique that has long languished in textbooks, it is emerging in several forms to challenge conventional ADCs in telecommunications applications. Driving the technology forward and making it practical to use in commercial products now are recent developments in digital signal processing, where speeds are soaring and costs are falling like a rock.

To some designers, the trend already is firmly taking hold. Jim Candy, a technical staff member at AT&T Bell Laboratories in Holmdel, N.J., who has worked in this field for 15 years, goes so far as to predict that "eventually all the ADCs and DACs will be oversampled; these things will be so cheap you'll put one in each source." He is an enthusiastic advocate: "Delta modulation is not a circuit technique—it's a religion."

The oversampling technique on which most researchers are focusing their efforts is sigma-delta modulation, which uses an integrator, a 1-bit comparator, and a 1-bit digital-to-analog converter. An alternative approach being developed is interpolative modulation, which uses an integrator in the feed-forward position, a companding ADC, and a digital accumulator.

Declining costs help to drive this technology

Oversampled sigma-delta modulation essentially permits sophisticated results to be derived from relatively crude data. This is accomplished by taking a far greater number of samples than usual—hence the name of the technique—with a crude comparator and then filtering the result into a digital word through averaging. Sigma-delta modulation can yield 2.5 bits of resolution for every factor of 2 that a signal is oversampled.

Also making oversampling more attractive is the growing difficulty—as circuit design rules get tighter—of scaling down some of the circuitry needed to accompany conventional ADCs. Conventional codecs require switched-capacitor analog filters, along with ADCs and DACs. The analog filters, which are needed to prevent aliasing, do not scale down easily and serious obstacles crop up when very large-scale-integration processes move from 2-μm design rules to 1 or 1.5 μm.

The great appeal of using oversampling in telecommunications is in its ability to provide analog circuitry in small areas while reducing these prefiltering requirements, which are much less demanding for sigma-delta configurations than for other approaches. By sampling at frequencies far above the Nyquist rate (which is about twice the highest signal frequency), sigma-delta modulators can use simple analog low-pass filters, which scale down nicely. The 1-bit comparators that this technique uses are also simple and small.

Oversampled delta modulation was developed in the 1940s but was not used for codecs until the 1960s. Only recently has it gained the critical momentum derived from cost efficiency. Oversampling techniques are now cost-competitive with conventional 1.5- or 2-μm technology for codec functions that require some programmability.

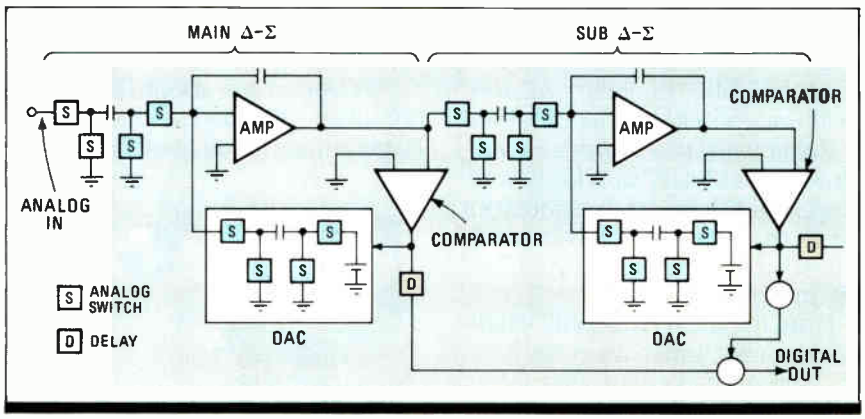
Though at least one company—Advanced Micro Devices Inc.—has been shipping a codec using oversampled interpolative modulation, the vast majority of codecs shipped are still conventional. That should start changing soon, though. "If you look forward to 1-μm-and-below technology at this time, sigma-delta oversampled codecs appear to have a compelling advantage for voice-band telecommunications applications," says Paul Gray, professor of electrical engineering at the University of California at Berkeley. The techniques are also being tried out in modems, and some designers are working on chips for the integrated services digital network (ISDN).

Doug Grant, new-product manager at Analog Devices Inc., Wilmington, Mass., agrees that oversampled ADC techniques are attractive for telecommunications. "With sigma-delta modulation and judicious use of digital signal processing, both [filtering and analog-to-digital conversion] can be done very efficiently," he says. The technology is particularly suited to telecommunications because filtering requirements are very precise and specifically defined, he adds. "For certain well-defined and high-volume applications, it's a workable technique."

SIMPLE CIRCUITRY

In Grant's view, sigma-delta oversampling is gaining popularity because of the decreasing cost of digital signal processing. "The advantage is that the ADC circuitry is relatively simple," he says. "But you still need a good linear amplifier, and that's hard to do in MOS. Things like reference sources are also difficult in MOS. Sigma-delta will not save the world, but it will be useful in certain applications."

In applications other than codecs and modems, oversam-



1. TWO PARTS. NTT's design has main and secondary delta-sigma modulators, each with an integrator, comparator, and converter.

pling is less appealing because sales volumes are smaller and application requirements vary widely, Grant says. "You'd have to make it user-configurable, and it becomes much harder" to use oversampling techniques. A better approach for these applications might be mixed bipolar and MOS, he says. It offers the advantages of MOS capability for high-performance digital requirements and bipolar-processed analog for components such as amplifiers and generators.

PENALTY IN FLEXIBILITY

But that kind of mixed technology greatly decreases system flexibility, according to Bell Labs' Candy. Moreover, he says, the day is near when ADCs will be required in hosts of new applications, thereby raising the volume to levels justifying the use of oversampling technology.

The bulk of current efforts is focused on the transition from research chips to products. In that work, the nitty-gritty problems frequently encountered are delays in operational amplifiers and errors caused by imperfections in the analog circuitry. At the same time, researchers seek to do the digital processing in ever-smaller areas.

The work in oversampling ADC, meanwhile, is still undeveloped enough to inspire near-religious and exclusionary zeal for each of its approaches. Candy, for example, comes down firmly on the side of second-order sigma-delta modulation. In this configuration, a single comparator is linked with two feedback loops. But the approach requires high speed and results in a narrower discrepancy tolerance, say its critics.

Candy replies that discrepancy tolerances for second-order sigma-delta modulators, ±3%, are sufficiently wide and that the higher speeds are no problem. It is possible to attain 16 bits of resolution for telephone communications at 1 MHz, for high-fidelity music at 5 MHz, and for video at 10 MHz, he says.

Meanwhile, researchers at Nippon Telegraph & Telephone Corp.'s Electrical Communications Laboratories in Atsugi, Japan, are trying to avoid the limitations of a second-order modulator by designing a first-order ADC using a two-stage modulator. The NTT work arose out of an earlier effort to build codecs. The oversampled design was realized using 1.5-μm silicon-gate CMOS and resulted in 14-bit precision for audio-range input.

The NTT design (Fig. 1) includes a main modulator and a submodulator, each of which includes a switched-capacitor integrator, a comparator with a single threshold, and a 1-bit local DAC. The primary modulator converts analog input into digital, and its integrator output is applied to the submodulator. There is no feedback loop except for each integrator. Bandwidth limiting as well as μ-law conversion can be performed by the output digital filter, which gets smaller as design rules shrink. The small, uncomplicated modulators are 1-bit models.

Atsushi Iwata, head of the Linear Integrated Circuit Section of the Integrated Electronics Department at the NTT Atsugi Electrical Communications Laboratories, says this scheme could be extended by adding a third modulator, but he adds that two modulators are sufficient for telephone applications. Experimental work is being done to develop three-stage devices of this type for audio applications, including compact disks and digital audio tape. In fact, a three-stage device has been fabricated, but practical versions are several years in the future, according to Iwata. With conventional sigma-delta methods, two stages would be the maximum: with more stages, the system tends to become unstable, and parasitic oscillations occur, says Iwata.

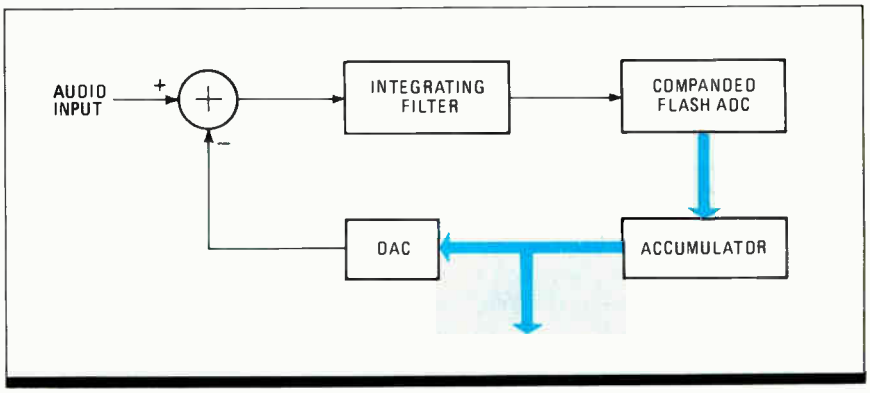
With the existing scheme, Iwata says he expects improved feed-forward using an improved chip with two stages. At present, telephone voice bandwidth is limited to 3.4 kHz and sound quality is poor. The objective at NTT is to improve telephone sound with the same 64 kb/s now used. Another application is the audio channel of television conferencing systems. Field tests can be expected in this area in about one year, and practical applications are possible within two years.

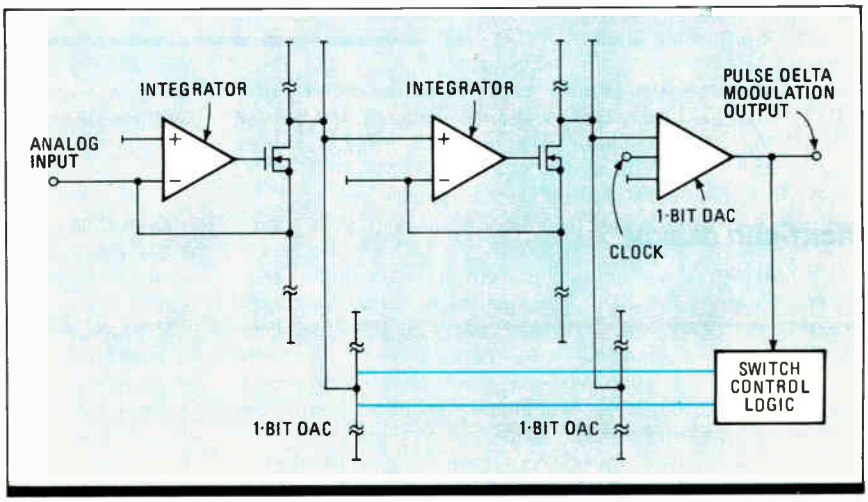
INTERPOLATIVE ANGLE

Researchers at the Massachusetts Institute of Technology have recently presented papers at the International Solid State Circuits Conference on work in interpolative modulation, as have groups at Hitachi Ltd. and elsewhere. The MIT approach achieves high-resolution CMOS analog-to-digital conversion by oversampling a feedback loop that attenuates quantization noise in a low-frequency baseband. The design (Fig. 2) employs a multibit ADC and puts the accumulator in the feedback loop, where it tracks the slope of the signal rather than the signal itself. This variant of interpolative modulation is called slope-adaptive delta modulation.

Charles Sodini, the professor of electrical engineering who

2. VARIANT. MIT designers put the accumulator in the feedback loop, where it tracks the slope of the signal, rather than the signal itself, to accomplish high-resolution conversion.





3. STRICT. An analog front end of an echo canceler for ISDN, the Siemens design requires strict linearity of the analog parts.

heads the MIT effort, says this slope-adaptive approach reduces the required dynamic range of the flash ADC below that of the DAC in the feedback loop. An additional advantage to tracking the slope, he adds, is that it results in more efficient encoding—that is, fewer bits per sample.

Finally, the MIT approach accepts greater hardware complexity for the sake of reducing the sampling rate. Though it is not as important as it once was, speed could again become an obstacle as applications demands grow, says Sodini. "They're going to have to sample a lot faster—10 to 12 MHz—and the question will be whether all the components in the loop operate ideally at those frequencies. If they do, they'll get the resolution. If the components don't operate ideally, second-order effects may cut the resolution."

The biggest challenge, Sodini says, is achieving 16-bit resolution "on silicon" in the audio band. "I haven't seen that," he adds.

SODINI: MIT's approach requires fewer bits per sample.

Overall, the MIT approach yields 1.5 bits of resolution per factor of 2 oversampling. At the high frequencies, Sodini reports measurements of 15.5 bits of resolution. The device achieved a measured dynamic range of 91 dB for a sampling frequency of 1 MHz, close to the theoretical value of 97 dB. Total harmonic distortion of the slope-adaptive converter is limited by the nonlinearity of the feedback DAC, the group reported.

However, the MIT converter is not a completed product. "Our design is a test chip," Sodini says. "We don't have the digital filtering on the same chip yet."

Candy of Bell Labs says interpolative modulation was invented at the labs a decade ago. "The ICs wouldn't go very fast, so we went to interpolation to get high speeds," he says. "But that is gone now—we have the high [IC] speeds." He argues that the use of interpolative techniques defeats the main purpose of oversampling ADC techniques, which is to "make the simplest tolerant circuits work fast." The use of multibit comparators brings with it level-spacing problems, which are avoided with 1-bit two-level comparators.

The best way to build modems may still be conventional converters

Another promising application for oversampling technology is the ISDN. Rudolf Koch and Bernd Heise of Siemens AG, Munich, reported at the ISSCC [*Electronics*, Feb. 17, 1986, p. 23] on the development of a second-order sigma-delta modulator. The device, which has a baseband width of 120 kHz and a clock frequency of 15 MHz, achieved 12-bit integral and differential linearity.

FRONT-END DESIGN

It was designed as the analog front end of a digital adaptive echo canceler for ISDN. The application imposed stringent demands on linearity of the analog parts, in this case corresponding to a signal-to-noise ratio of at least 72 dB. Going with a conventional approach—using a successive-approximation register, for example—would have required costly trimming or self-calibration mechanisms.

The Siemens team found resolution limited to slightly more than 80 dB; because they used a second-order approach, no other signal was needed. To convert the pulse-density-modulated signal from the sigma-delta coder into a 12-bit word, an additional filter was devised on a separate chip measuring roughly 1.35 mm^2.

Although sigma-delta modulation clearly will play a large role in codecs, the extent to which it will be used in modems is less certain. "In the modem area, it's still a muddy picture," says Gray of Berkeley. "A lot of people are working in analog, and they think that's the way to go. For low-speed modems in the 300- and 1,200-baud areas, the all-analog switched-capacitor approach still is being used by a number of manufacturers. At the 2- to 3-μm feature sizes used for low-speed modems and high-speed modem front ends, the oversampled architecture with digital bandsplit filters requires more silicon areas than an optimized analog switched-capacitor approach." Also, he adds, it is difficult to assess the relative merits of oversampling in ISDN until the type of digital coding and transceiver architecture are standardized.

At Advanced Micro Devices, development work focuses on building converters with higher performance and reducing both the silicon and the analog filtering requirements, says Russ Apfel, director of communication products. The Sunnyvale, Calif., company offered the first commercial part with an oversampled interpolative modulator in 1982. "As people want more features and functions, they'll find it more cost-efficient with a DSP approach," he says. Only in low-cost, simple applications such as private branch exchanges or in older products far down the price curve does Apfel expect standard ADC to remain dominant.

But while oversampled approaches move ahead, those researchers working in the analog area are also pushing that technology. "In analog, there's an awful lot of room left for clever circuit guys to scale those things down," says Gray. He adds that the feature sizes at which oversampling offers advantages have continually dropped because of progress in the conventional analog approach.

Indeed, Analog Devices recently announced a 16-bit-precision DAC with 16 bits of monotonicity. Using the company's BiMOS II polysilicon-gate process, the chip contains three high-accuracy operational amplifiers, two 256-switch segment-decode sections, and two high-precision resistor strings to ensure typical ±0.0004% differential nonlinearity and ±0.01% integral nonlinearity. Several other companies also offer monolithic 16-bit converters.

Even though DACs are somewhat easier to scale down than ADCs are, the relative advantage of oversampling techniques would be diminished if progress in DACs could be applied to ADCs. At any rate, says Gray, "It will be a slow transition."

Meanwhile, at least some segments of the industry are moving quickly to oversampled ADCs. "Here at Bell, there's a lot of effort to make [oversampled converters] and get them going in production," says Candy. □

Additional reporting was provided by Charles L. Cohen in Tokyo and Alexander Wolfe in New York.

TERADYNE'S BIG GAMBLE IN TEST EQUIPMENT

BETTING ON A NEXT-GENERATION SYSTEM THAT HANDLES 1-Mb DRAMs

Teradyne Inc. is counting heavily on its chip-maker customers to spend big money on a new generation of testers that they don't need—yet. The Boston-based company believes they will increasingly need the speed of its new J937 Memory Test System to develop the increasingly complex families of megabit static and dynamic random-access memories that will come over the next five years.

Its tester runs plenty fast; it is two to four times faster than the most advanced test equipment that's currently being announced in Japan. The J937 is capable of operating at 100 MHz, or 50 MHz unrestricted, on up to 16 chips in parallel (Fig. 1). The Japanese testers can handle up to thirty-two 1- and 4-Mb chips in parallel.

With the new tester, Teradyne is making another big gamble: it plans to reestablish itself in the Japanese market, where U.S. makers of test equipment have long since lost their dominant position. Company officials think a major presence in Japan is crucial for any test maker that aims to be a world-class producer (see p. 52).

The J937 has the speed needed to test devices beyond the 16-Mb generation, as well as the flexibility to handle memories other than 1-Mb DRAMs and SRAMs. Teradyne claims the J937 is the first system that can test the full range of memories, including 1-Mb and higher-capacity DRAMs, high-speed SRAMs, video RAMs, and dual-ported RAMs. With 210 signals plus power and ground available on the test station, the J937 can simultaneously test up to 16 memories organized as 16 Mb by 4 bits, and most read-only memories and programmable ROMs.

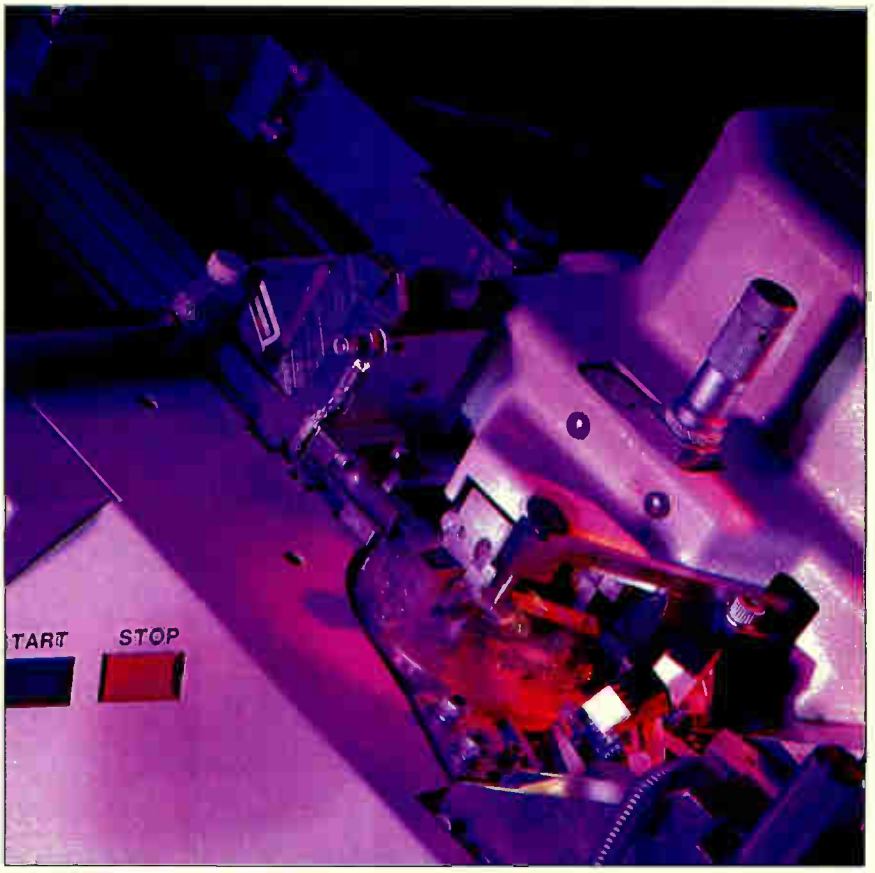
Test-equipment makers have been hard-pressed to come up with gear fast enough to wring the bugs from the denser chips. Though densities have more than quadrupled in the succeeding generations of memories from 4- to 256-K, testers have changed little, largely because the cycle times of the chips remained in a range that testers could handle.

But the design and the performance capabilities of the new generation of 1-Mb DRAMs are rendering older testers obsolete. Built to 1-μm design rules on dice as small as 1.4 by 0.6 cm, these chips can halve memory cycle times. Also, new application-specific integrated circuits are denser and use much higher data rates for graphics, networking, and multiprocessing applications. They too are outpacing existing testers.

The electronics industry is quickly adopting application-specific memories such as video RAMs, which replace 40 to 50 of their forebears in high-resolution graphics work stations, and dual-ported RAMs used in networking hardware, says Daniel Gentry, marketing manager for memory product testers at Teradyne's Semiconductor Test Division, Woodland Hills, Calif. "We knew we had to build a machine with considerable flexibility. For example, video RAMs have a lower pin count than dual-port RAMs, so we needed to build a machine that could test both with little setup time. We believe we have the first machine that can fully test video RAMs, yet still keep pace with the faster DRAMs."

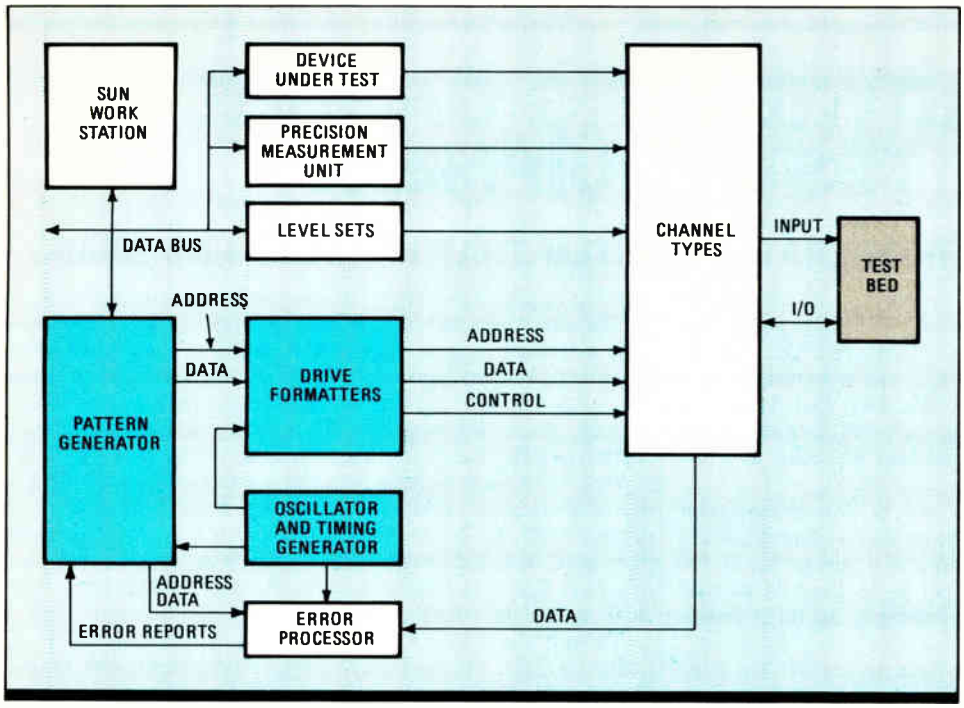
Though the J937's versatility will open doors to the U.S. ASIC markets, its speed may prove a more potent sales tool in Japan. "We think we surpassed the Japanese manufacturers of test gear," Gentry says. "Parallel testing is what the Japanese seem to be concerned about, and they are showing systems that can test up to 32 devices in parallel. But the Japanese testers run at slower speeds, typically at 25 to 30 MHz."

The J937's higher operating frequencies are made possible by emitter-coupled-logic arrays, used extensively in the system's pattern generator, formatter, and timing systems (Fig. 2). Discrete ECL was impractical for these applications, says



1. FAST DEALER. The high operating speeds of Teradyne's memory tester are complemented by its autohandler, which moves devices to eight parallel test sites.

TECHNOLOGY TO WATCH is a regular feature of Electronics *that provides readers with exclusive, in-depth reports on important technical innovations from companies around the world. It covers significant technology, processes, and developments incorporated in major new products.*



2. MEMORY TESTER. Higher test speeds in Teradyne's J937 are made possible by an investment in ECL arrays used in the system's pattern generator, formatter, and timing systems.

Gentry; the ECL gate array is three times faster than equivalent discrete components in terms of gate propagation delays.

"We selected Motorola's MCA2500 arrays, which are among the most full-featured arrays we could find," explains hardware development manager George Conner. "Each array replaced about 110 ECL discretes, making it possible for us to replace eight or nine boards used in older testers with a single board having just seven arrays." Teradyne looks to be firmly committed to gate-array technology, having brought all the Motorola libraries into its automated design system.

The J937 is built around a standard 68010-based work station from Sun Microsystems Inc. It performs such functions as real-time testing, data collection and reporting, test-program development, and debugging. It also handles communications with peripherals such as handlers and probers as well as communications with the outside world.

A typical J937 consists of two test stations that can handle up to eight DRAMs or four SRAMs per test head, with data and address multiplexing to support 9- and 18-bit-wide output signals. For DRAM testing, 12 address drivers, 8 clock drivers, and 4 data input/output pins are available per device. SRAM testing is handled by 24 address drivers, 14 clock drivers, and 9 data I/O pins. The test system is designed to be integrated into an automated factory using an Ethernet network (Fig. 3). As envisioned by Gentry, the tester will be linked along a production-line network with Sun work stations, a laser system for off-line repairs, a Teradyne 300 series handler for package testing, and an Electroglas EG-2001 or similar prober. On- and off-line repair, wafer probing, device characterization, and package testing would be controlled through the Ethernet link.

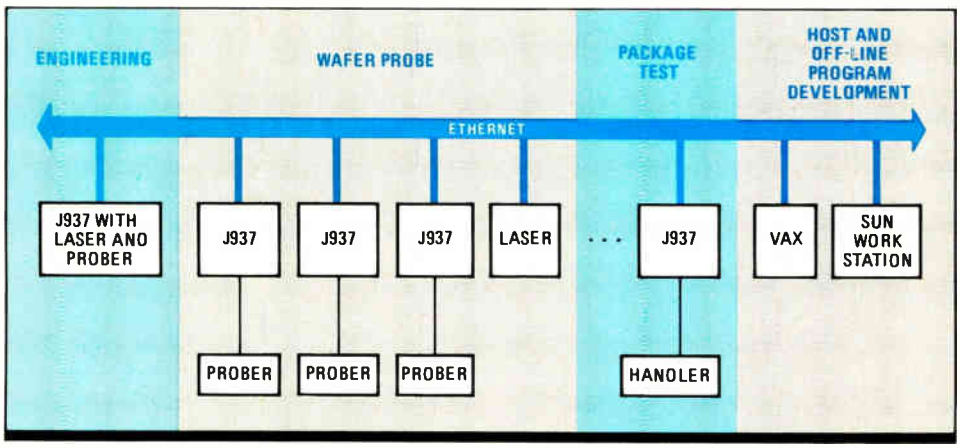
Teradyne decided to forego its proprietary computer design and turned instead to an industry-standard host. "In the past, our computer was more akin to a controller—acting to drive voltages high and low on the test bed—than a true number cruncher," explains Gentry. "But with the current generation of memory products, we need a computer able to wrestle a part 100 ways under test, then communicate the data to the outside world."

System software runs on Sun V2.0, Sun's version of AT&T Bell Laboratories' Unix operating system with 4.2bsd enhancements and extra utilities. Teradyne added numerous enhancements to Unix to optimize it for real-time testing, including functions for test-program debugging written in its version of C, a strict superset of the programming language. By selecting an industry-standard operating system and a programming language, Teradyne aims to make the tester accessible to the widest possible audience, Gentry says.

PET DEBUGGER

A powerful part of the system software is PET, for Product Engineering Tools. PET functions as a simple source-level debugger for test-program flow control, providing a means to stop a failing test, then view and manipulate the hardware while on-line. Perhaps PET's most outstanding feature is the ease with which a new device can be characterized. PET includes such engineering test modules as shmoo plots; bit maps, to check memory cells; wafer maps; waveform generators, to check the relationship of inputs; and a pattern generator debugger. By combining PET in a stand-alone mode with standard levels, times, pattern background, and patterns with test modules, users can characterize a device without writing a test program for it. Or PET can link in three different ways to an existing test program.

"PET gives a user the ability to change the test parameters of the device while still on-line," notes software coordinator Leslie Wachtel. "This required significant software effort. Another thing we are proud of is that PET provides a means of characterizing a brand-new piece of silicon without the need to go



3. FACTORY FAVORITE. The J937 can link to an Ethernet with Sun work stations, laser repair system, handler for package testing, and a prober to build a fully automated production line.

through an extensive software development effort."

The system's computer controls the pattern generator—the heart of the test system—as well as formatting and timing systems, the dc measurement systems, digital-to-analog converters, comparators, voltage sources, and data storage. When more computing power is needed, the J937 can be linked to a VAX minicomputer using an Ethernet link.

The timing system provides the address, data, and timing information to the device under test. The tester compares the part's output with the expected data. It also provides the timing necessary for generating the cycle widths, I/O testing, and multiplexing. The 2,500-gate arrays used in the oscillator and timing generator produce the 50-MHz timing using a dual-clock system. Dual clocks make it possible to generate waveform edges independent of the previous edges, maintaining timing accuracy to better than 1 ns.

"We can measure how fast our timing system works, but it's just within our limits to do so," says Conner. "We built our own ECL timing measurement system with 10-ps repeatability. It is programmable within increments of 100 ps and can be changed on the fly."

Teradyne says the pattern generator is the most sophisticated part of the system. In about 20 ns, the pattern generator, acting like a dedicated test controller, defines the setups, address, and data parameters for each device under test. The pattern generator consists of one dedicated arithmetic logic unit and three counters for each axis, which can be linked on the fly with their counterparts in X or Y. It can generate 256 pattern-control steps with 16 levels of nested subroutines with parameter-passing to simplify programming tests.

"The pattern generator is something like a 24-bit processor built of three 8-bit-slice gate arrays," Conner says. "It basically implements the instruction set of a microprocessor, though we eliminated instructions we felt we wouldn't ever need. It will do a 24-bit add or a jump-on condition on a 20-ns instruction cycle. Its cycle time is roughly about 0.5 to 1 ms."

The formatter combines pattern data and timing information to provide comparator data and digital signals to drive the device under test. Five drive formats are offered as well as several comparison formats. The channel circuitry transfers the test signals to the device. The new DRAMs and SRAMs require a capacitive load of less than 50 pF. By using surface-mounted drivers placed near the test station, Teradyne minimized channel length and loading on the circuit, keeping the loading on the device under test to only 30 pF.

"We also had to modify the design of our test heads in order to minimize the channel length, getting the channel lengths down to about 4 in.," says Conner. "We've worked hard to eliminate every little picofarad, and my personal opinion is that this was one of the most challenging aspects of the design. Getting a 30-pF channel is like doing the four-minute mile. It will be a record to break for some time to come." □

FOR TERADYNE'S DESIGNERS, IT WAS THE CHANCE OF A LIFETIME

To its designers, the J937 megabit memory tester posed a once-in-a-lifetime opportunity. For once, George Conner, 33, and Robin D. Dooling, 32, had the chance to break out of the conventional product-development mold formed by economic constraints that lead to measured, incremental improvements. In testers with high price tags, such an approach prevails because customers have hefty investments in both hardware and software.

But in deciding that the J937 demanded 50-MHz speed, Teradyne set its goals well beyond what has been done in the past. In September 1984, it tapped Conner to direct hardware design and Dooling to direct software development.

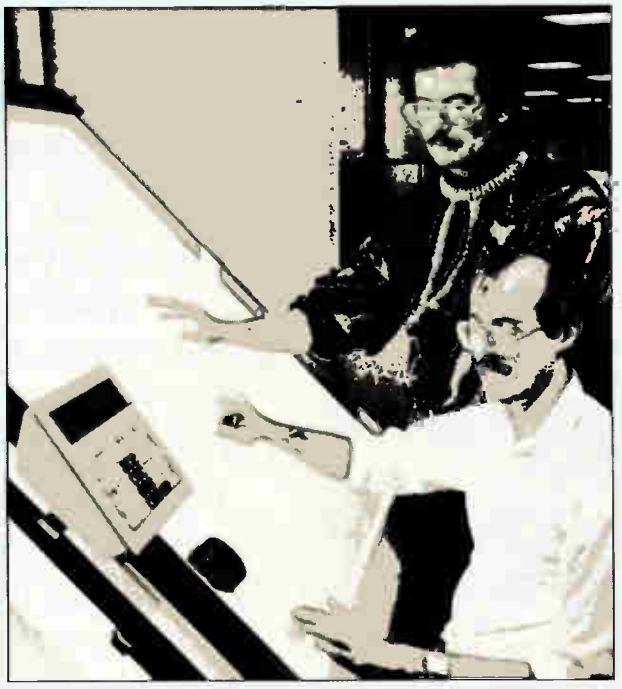
Both men are Teradyne veterans: Conner has seven years with the company; Dooling, eight. Conner holds a BS in physics from Harvey Mudd College, Pomona, Calif.; Dooling received a BSEE from DeVry Institute, Phoenix. Neither has a formal title denoting responsibility in the project, in keeping with Teradyne practice. Instead, they call themselves "drivers," which describes how they force their minions to the limits.

The key goal they were pursuing was to go above 40-MHz performance, which required a totally new approach, say the two designers. Recalls Dooling, "It was the chance to cut loose from 'backward compatibility' and advance the state of the art." Conner agrees wholeheartedly.

Designing a tester that can handle integrated circuits that have not yet reached the working silicon stage added an extra challenge to the task, explains Conner. "The trick is using today's technology for tomorrow's devices."

For a 50-MHz tester, the only logic in sight at the beginning that was speedy enough to do the job was the Motorola Semiconductor Products' macrocell gate-array line, MCA2500. Also illustrating the magnitude of the job facing Dooling's software team was the requirement to write programs before the hardware design was completed.

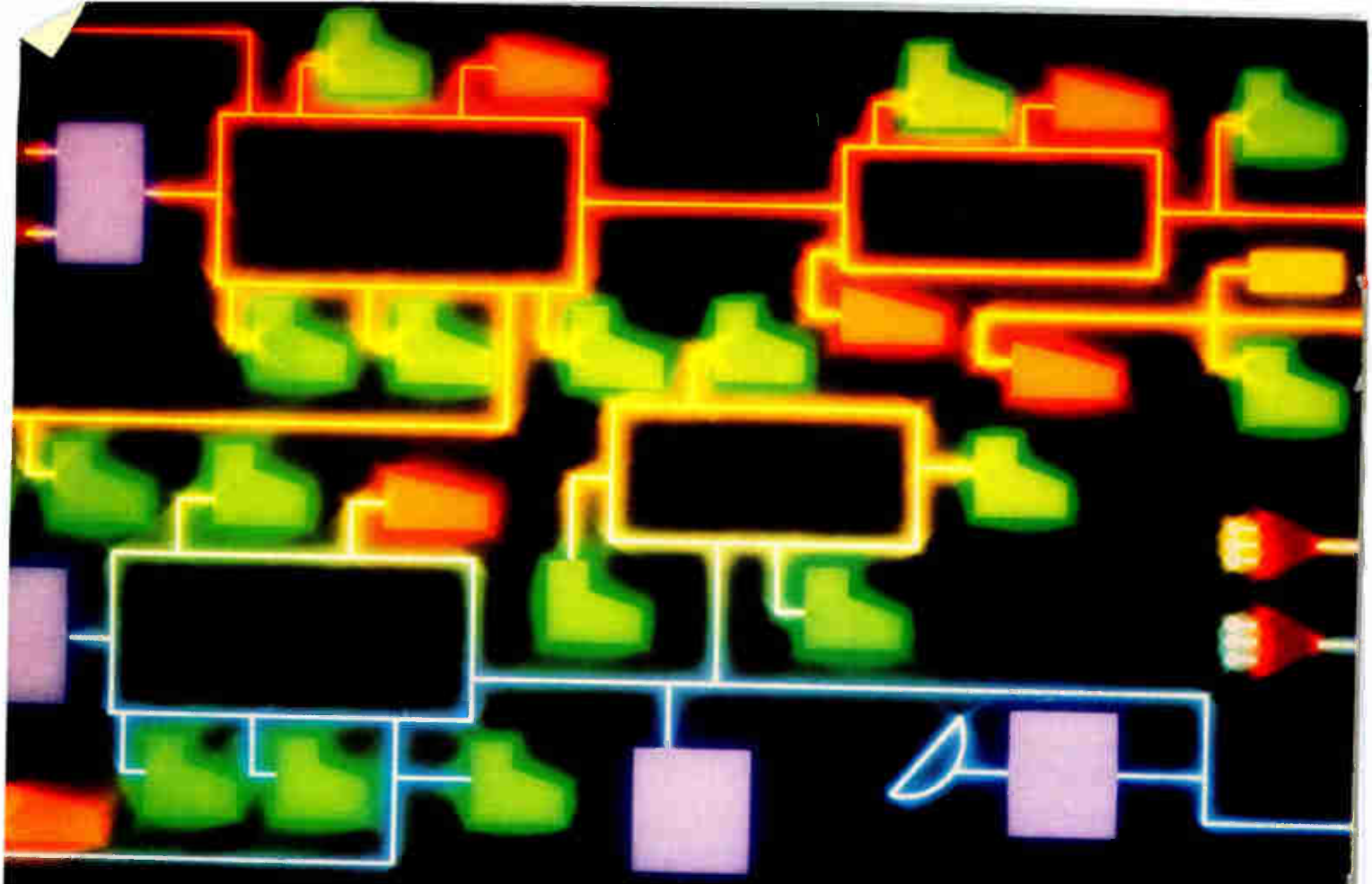
Making the J937 run faster than the devices it will test meant pushing for operating speeds so fast that only the designers of supercomputers are working at similar levels, the Teradyne managers point out. Thinking of the pattern generator in the tester as a 50-MHz special-purpose central processor illustrates this most clearly, they say. It performs addition and goes to subroutines in 20 ns, for example.



DRIVING FORCES. Dooling and Conner (foreground) led the development of Teradyne's J937 megabit-memory tester.

Software writing has an equal challenge, and Dooling's team will write nearly 1 million lines of code by the time the project is finished. Besides the scope of the job, the programming work pushes this art into new dimensions due to its speed and complexity, in Dooling's opinion. But this difficulty serves to spur his programmers on, because they thrive on doing something that no other team of programmers has done.

With the J937 heading for third-quarter initial shipping, both designers are confident it represents an outstanding job. "It feels good, so we know it's right," says Dooling. They agree the most satisfying part was pushing performance to new levels. "You can only redo the same thing so often," notes Dooling. "Sometimes you have to gamble."



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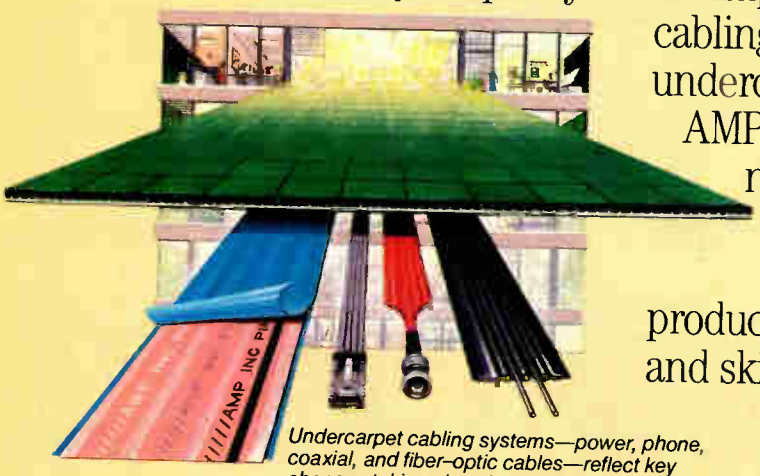

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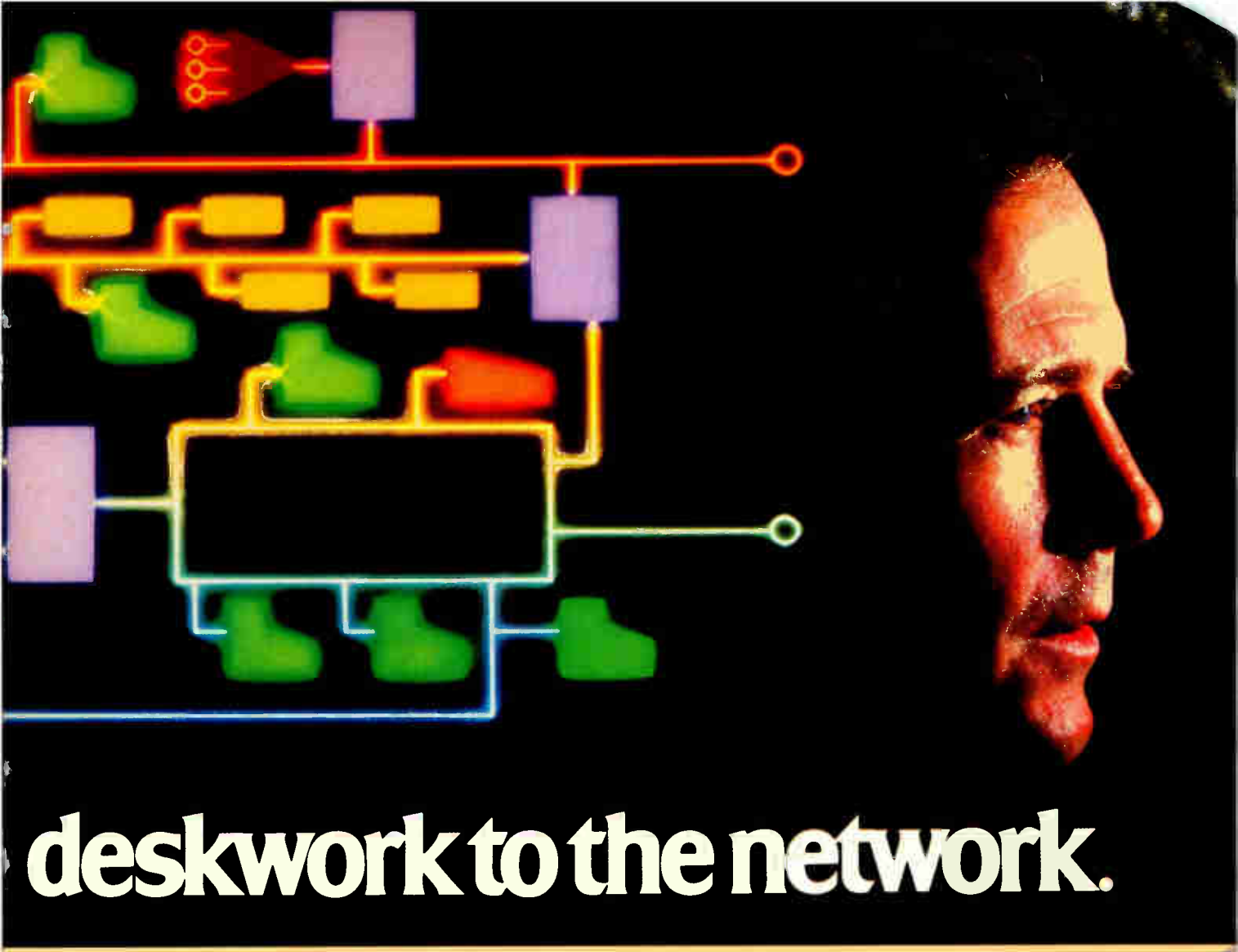

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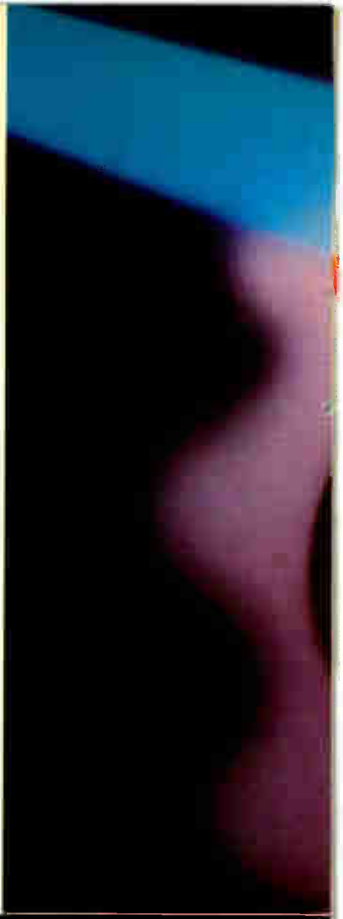
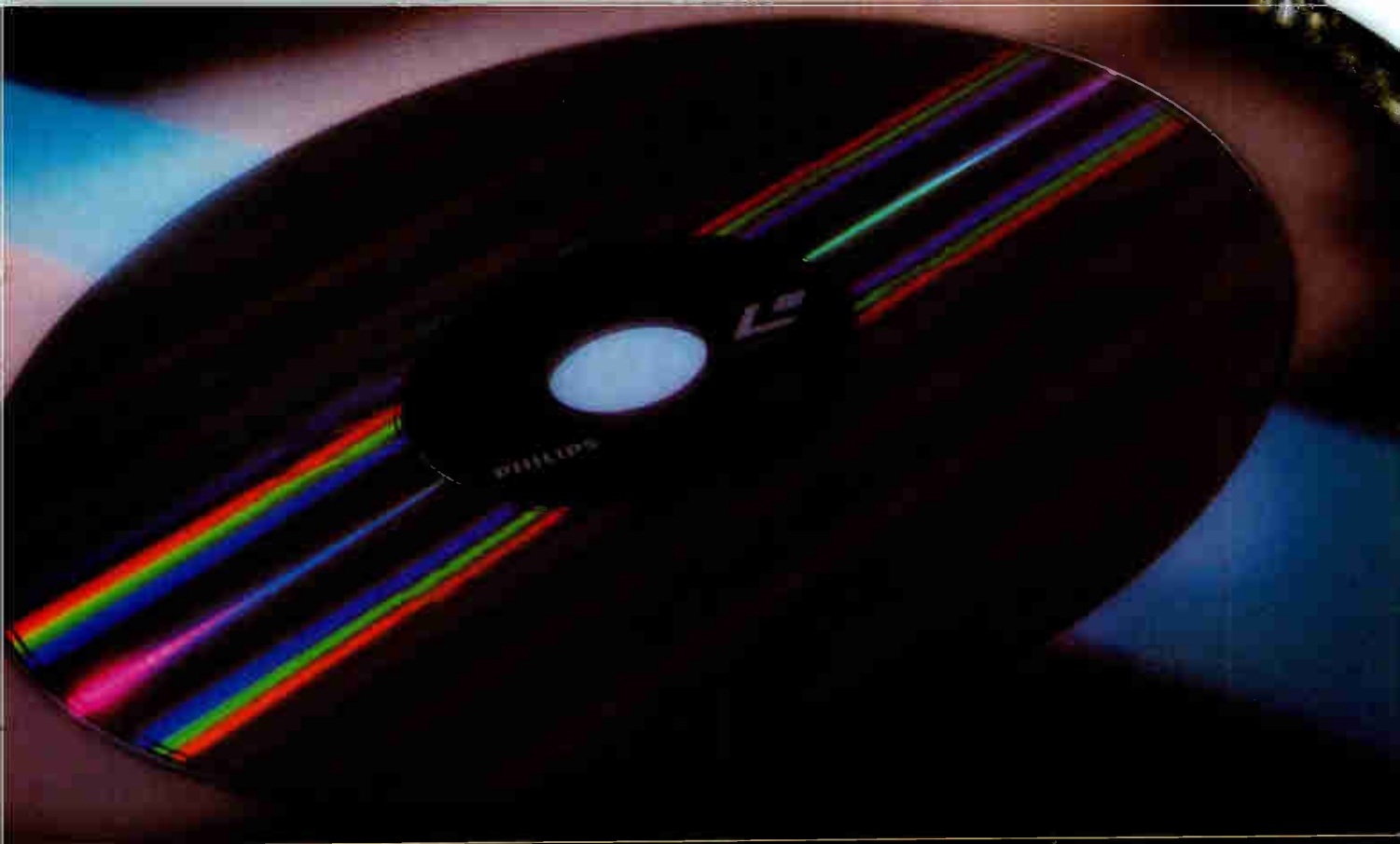


Philips-keeping the pa



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PROBING THE NEWS

WHY TERADYNE THINKS IT CAN RECAPTURE JAPAN

IC TESTER MAKER PINS HOPES ON ITS NEW MEGABIT-MEMORY SYSTEM

by Larry Waller

WOODLAND HILLS, CALIF.

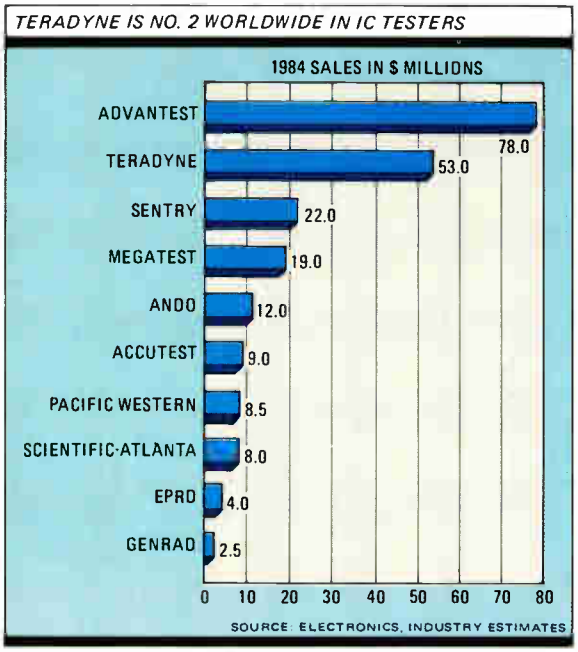
For sheer audacity, Teradyne Inc. probably ranks near the top of the list. This week it will unveil a major new product, a next-generation megabit memory tester. But to make it big, the Boston company will have to sell a bunch of the new machines to the Japanese, a market that it had previously lost to local equipment makers.

The decision to make a major try at reclaiming the Japanese market caused a great deal of soul-searching at Teradyne's Semiconductor Test Division in Woodland Hills before it forged full-speed ahead with the project in September 1984. "We really asked ourselves if we should do it, through a series of discussions that went on and on," recalls James A. Prestridge, vice president who heads up the Components Test Group. "But the answer was definitely yes; that market is a big, interesting, and good one. We have to be there."

If the new J937 tester "breaks out in the Japanese market, it will be a fabulous investment," Prestridge boldly proclaims. Good sales there would also induce Teradyne to manufacture its testers in Japan. Moreover, success in Japan could also open up sales in the U.S. NEC Corp. is already producing memory products in the U.S., and Hitachi and Mitsubishi are both moving in that direction. There is also a chance that Oki will build a U.S. factory.

Arguing most forcefully for the assault on Japan, according to Prestridge, is what Teradyne sees as "a technology lead over the Japanese." The J937 memory test system's technology (see p. 45) is eye-catching, boosting tester speed and accuracy to the hitherto-unreachable levels of 100 MHz and less than 1 ns, respectively. That kind of performance is considered necessary to put the new crop of very complex memory chips through their paces.

Teradyne has been able to hold the biggest share of the market in the U.S., but its products have not made much of an impression in the past few years in the Japanese market. Major Japanese semiconductor makers that dominate the world memory business had switched their preference to local makers. Teradyne's goal is nothing less than to become No. 1 in Japan. To do this, it must convince these tough customers that the J937 is far ahead of the tester pack, a product they simply cannot do without.



Teradyne's chutzpah lies more in marketing strategy than technology

By any standard, Teradyne's investment in the J937 is of significant size for a company whose total sales were $336 million in 1985. The company does not reveal its magnitude, but a rule-of-thumb for the test business is that developing a new tester costs from 30 to 50 times the unit's price, estimates G. Dan Hutcheson, executive vice president of VLSI Research Inc., San Jose, Calif., which closely tracks worldwide semiconductor production. This would mean that Teradyne's outlay for developing the J937, whose price starts at $350,000 and runs typically to $600,000 for a model with multiple test stations to handle multiple types of devices, would run upward of $20 million.

Results of Teradyne's J937 investment gamble should not be long in coming. Market watchers predict the returns will be in by no later than the end of this year. Even if Japanese sales don't come rolling in as expected, these industry experts don't expect the failure to hurt Teradyne badly. Its costs are managed too well, they quickly add. Whatever happens in Japan, Prestridge maintains, "the J937 will be a good investment payout."

Teradyne was once the biggest seller of memory testers in Japan, but Advantest Co. has been taking the business away since the early 1980s. The Tokyo company, which until last year was called Takeda Riken, came out with machines that were more technically advanced at the same time that Japanese memory makers were taking over that market. Advantest's sales worldwide amounted to $78 million in 1984, compared with Teradyne's $53 million, according to VLSI Research.

Teradyne also decided to take on the Japanese now because the timing was right in the evolution of integrated circuits to greater densities. "Devices are now going through the 1-μm transition," says Prestridge. That development presents a window of opportunity, he says, "for a new high-end test system."

Even more important, failing to seize the opportunity now might mean that Teradyne will miss out on the last chance to be a leading tester company in Japan. Its decision to try to break the tight buyer-seller union forged by Japa-

nese tester suppliers and memory manufacturers represents "a gutsy move," says Hutcheson of VLSI Research. "They're taking on the Japanese head-on, in their home market, attacking their stronghold."

MAJOR BLOW. Hutcheson strongly agrees with Prestridge that U. S. tester makers have to sell in Japan. "But many have rolled over" or opted out because of the tough competition, in the same manner American companies lost the memory business, he says. "This is a major blow to the U. S."

He exempts Teradyne from his indictment, however, noting the company has kept slugging it out with the Japanese in all types of tester equipment, and even managed to regain some overall market share. For example, its 16-bit microprocessor tester, the J941, quickly established itself as the major machine in that segment of the market, despite a late arrival in 1984.

If Teradyne makes hay with the J937 in Japan—"I think it can do something," says Hutcheson—the reason will be that it anticipated basic technology and equipment support needs of the semiconductor makers. As the company sees it, a "major market discontinuity" in testers now looms, brought about by the second round of megabit dynamic and static random-access memories now being designed.

Still years away from the commercial market, these chips use 1-μm design rules and smaller dice than the current first-generation 1-Mb DRAMs, which have only recently arrived in sample quantities. Access times less than 20 ns will make the second-generation chips many times faster than present RAMs, whose cycle times can still be handled by current testers.

This coming level of memory-chip performance calls for test system hardware not currently offered by any manufacturer, says Teradyne, and it sets the stage for the J937. The company thinks it has the numbers: its engineers, taking advantage of the speed of emitter-coupled-logic arrays, have souped up the J937 to the point where it is capable of 100 MHz with multiplexing, with 50 MHz the unrestricted system frequency. Timing accuracy is better than 1 ns.

The tester also has 30-pF capacitive loading, claimed to be the lowest in the industry. The significance of this feature is that many of the new RAMs are built in CMOS, which requires a capacitive load of less than 50 pF.

Also, the tester is designed for flexibility: with 210 signals plus power and ground on the test station, the J937 can handle up to 16 devices, each 16 Mb by 4 bits, at one time. Furthermore, it accommodates all kinds of organizations as well as application-specific memories, such as video and dual-ported RAMs.

Teradyne believes development of the J937 puts it six months to a year ahead of the Japanese competition, Advantest and Ando Electric Co. At Advantest—whose most recent memory tester, the T3331B, has been on the market since 1982—officials understandably won't yield an inch to the opposition's new system. But the company does not deny that development of more advanced testers than its present unit is well along. The T3331B has 40-MHz speed, 1.1-ns accuracy, and a capacitance load of 50 pF. It sells for about $457,000 to both Japanese and U. S. makers of big ICs.

For Ando's part, spokesmen say it has been selling since the summer of 1985 a new tester intended for megabit memories, the DIC-8042. Prices range from $429,000 up to $571,000, according to system configuration. But its specifications—40-MHz speed and 1.1-ns accuracy—limit usefulness in testing next-generation RAMs, industry sources say.

THINKING SMALL. Teradyne testers tend to occupy little space, and the J937 is no exception.

Both Advantest and Ando say they are putting a great deal of effort into the design of an advanced test system, but neither is willing to give details about performance or when to expect an announcement. However, Ando does say that its system will be able to handle 4- and 16-Mb test applications.

JAPAN'S LEAD. Between them, Advantest and Ando have locked up about 80% of the Japanese memory tester market, estimate observers in Japan. Advantest by itself has carved out over 50%, says an analyst from market consultant Dataquest Inc., San Jose. An official at another company, involved with industry exhibitions but who does not want to be identified, agrees with this market-share breakdown.

But they do not assess advanced tester performance alone as the No. 1 feature to wedge open the checkbooks of Japanese memory manufacturers. Rather, the two most important characteristics needed by a memory tester to sell in Japan are high reliability and high throughput, they say. As they see it, performance does not have to be greatly advanced beyond what already is available because the 1-Mb DRAMs will still resemble today's standard 256-K devices, except with four times the capacity. "They won't be especially faster," says the Dataquest analyst.

Although Teradyne obviously does not agree with this view, Advantest evidently is committed to it, as reflected by changes it has introduced into its basic memory-tester line. The company has concentrated on boosting throughput through multiplexing techniques that allow one tester to handle 2, 4, 8, and 16 RAMs simultaneously. It is now working on an improved version that will test 32 devices.

The timing of the Teradyne J937 campaign is good, however, since semiconductor manufacturers will be starting up 1-Mb production lines by the end of this year, according to the Japanese-based sources. These developments are already set, even though overall semiconductor capital investment itself will be down for the year.

But Teradyne must successfully hit the 1986 window or lose its foothold in the Japanese memory tester business, even though it is still strong in linear and logic testers. Another reason the memory tester business is so important: these machines are more profitable than

other tester types because the market's large size means that a single basic model can rack up more sales.

Finally, recent changes in the value of the yen make the Japanese emphasis on economic factors even more important, say the observers. "To sell, the testers must be effective in helping increase yield and decrease costs, because Japanese manufacturers must somehow cancel increased costs brought about by the increased value of the yen."

NEXT ROUND. From the U. S. side, other tester companies are also gearing up for the next round. For example, Sentry/Schlumberger Division of San Jose, Calif., says it is developing a new machine, and work has gotten to the point where it is discussing details with potential customers, merchant-market memory producers in the U. S.

"We believe this tester represents the utmost state-of-the-art memory-tester technology," says Fred Laccubue, vice president for sales at the Schlumberger Ltd. subsidiary, recently spun off from fellow subsidiary Fairchild Semiconductor Corp. "We certainly can compete for some of the new-generation memories, especially in the higher-density higher-performance devices."

Because part of the formula for successfully penetrating the Japanese market—besides the right product—is strong engineering and service support to back it, Teradyne has beefed up its once-minimal operation there. "We've actually formed a J937 task force that includes sales, engineering, and applications people," says Prestridge. It is headed by Phil E. Phillips, who is "orchestrating and organizing," in Prestridge's words, with some 15 engineers working primarily on tester tasks, along with other Teradyne business.

Teradyne has yet to receive a firm order for the new tester in Japan, says Prestridge, but presentations already made to key potential customers have been well received. "From their perspective, the J937 does interesting things technically," he adds. But the key to selling the new tester, he says, is convincing Japanese producers of commodity DRAMs that it is a necessity—"that's the real issue."

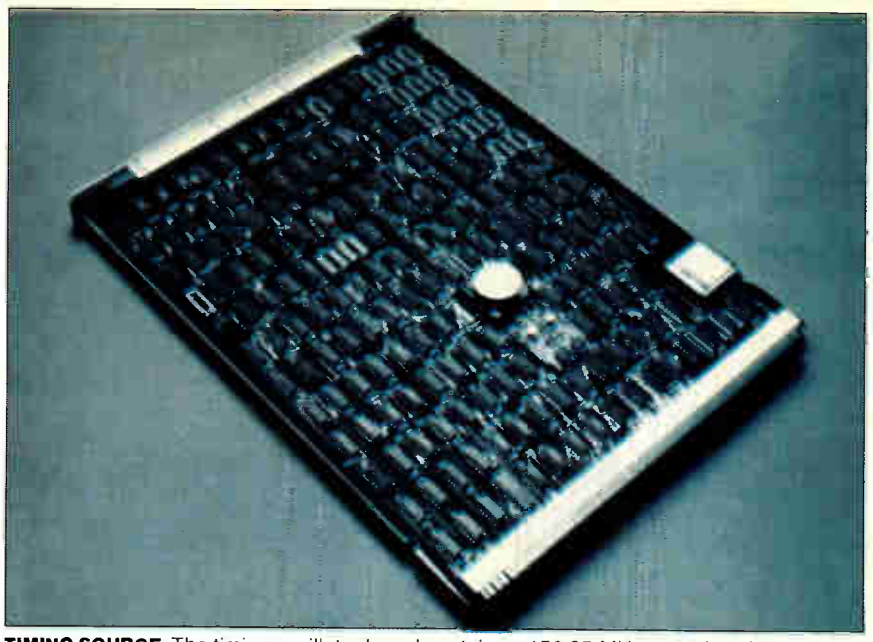
While Teradyne is sparing little effort in going after the plum accounts in Japan, it also cannot neglect potential U. S. customers for the new gear. Prestridge identifies these as not only the large semiconductor merchant market houses, but also major captive operations and, of growing importance, the specialty memory houses that have sprung up in this decade.

He has high hopes that the big captive lines, in particular, will prefer to buy American rather than go for Japanese equipment "that would put them at the mercy of their competitors." In addition, the top semiconductor companies are not entirely out of the commodity DRAM market and will need advanced testers to continue development. Prestridge, in a late 1985 speech to financial analysts, noted that "confidential discussions with major manufacturers have led to several preliminary commitments to this new system."

Teradyne's J937 introduction and its ambitious Japanese plans constitute a "meaningful announcement" on several levels, observes financial analyst Peter D. Schleider of New York's L. F. Rothschild Unterberg Towbin Inc. To improve its market position, Teradyne "must be in this business [advanced memory testing] and has to have a presence in Japan to be a long-term survivor."

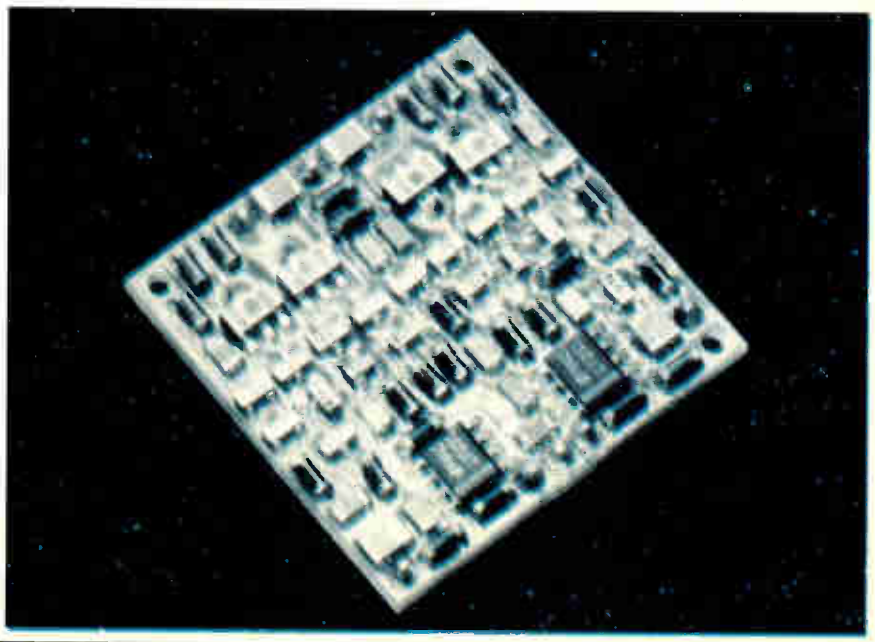
Furthermore, bringing developments of this magnitude to market on a regular basis is especially critical for U. S. testing-equipment companies. Only those with the resources to pull off the feat will make it against the stiff Japanese competition, in Schleider's view. He says that Teradyne, with the J937, is demonstrating that its management is doing a good job, adding that he is impressed that it kept its research and development team together during a recession to work on a long-term project. □

Reporting was also provided by Charles L. Cohen in Tokyo.



TIMING SOURCE. The timing oscillator board contains a 156.25-MHz crystal oscillator.

SMALL BOARD. The level-buffer circuit board, less than 2 in.², achieves 50-MHz performance.



WHAT'S THE BEST WAY TO FUND SEMICONDUCTOR R&D?

REPORT CITES PROBLEMS IN BOTH CORPORATE AND FEDERAL SUPPORT

by George Leopold

WASHINGTON

The long-running debate on how best to maintain funding of semiconductor research and development at a time when profit margins are under growing pressure has a new voice and a new controversy. It comes from a recent report from the U. S. Office of Technology Assessment.

The OTA report is causing controversy because it says that although R&D is the lifeblood of the industry, reduced profits of U. S. companies, caused by the business downturn and by heightened Japanese competition, "may be leading to decreased efforts by industry." And it gives mounting evidence that Japanese basic research is outpacing U. S. efforts in such areas as optoelectronics. At the same time, money from the prime alternate source, the Defense Department, is becoming tainted by an inclination to narrowly direct research toward the Strategic Defense Initiative. This tilt also raises the possibility that commercial application will be hindered by strict secrecy rules.

In discussing current R&D activity, including the most promising technologies, the report, written by OTA analyst Arati Prabhaker, raises specific concerns about the impact of centralizing Pentagon R&D support for microelectronics—by far the largest segment of direct federal funding—in agencies such as the Strategic Defense Initiative Organization. As the administrative office for the Reagan administration's "Star Wars" program, it hands out the SDI funds. The report supports current multisource funding through various agencies and the National Science Foundation, among others.

CO-OP OR NOT. The issue is boiling over at a time when the industry itself is trying to decide whether it would be helped more if the government would simply create the business conditions that would let companies work on their own R&D, or, as growing numbers believe, it should follow a trend that is inevitably leading toward cooperative R&D including the government. Such R&D cooperatives as the Semiconductor Research Corp., with government agencies as members [*Electronics*, March 17, 1986, p. 52], are becoming more attractive. Thus the debate is over direct government aid or cooperative research on one hand, versus private funding on the other.

The increasingly restricted Pentagon-sponsored R&D mentioned by the report is a primary reason for the industry's reluctance to support further direct federal involvement. Government is geared overwhelmingly toward defense, with little consideration given to commercial needs, says Geoffrey A. Feiss, manager of government affairs for the American Electronics Association.

Shifting R&D programs to SDI, the report warns, could result in a "major restructuring" of funding for microelectronics R&D from various Pentagon agencies. "Given the wide perception that the current arrangement for DOD-sponsored research—with several different agencies operating independently but communicating with each other—works well, centralized funding of microelectronics R&D through the Strategic Defense Initiative Organization could decrease the DOD's effectiveness in the field." The transfer of gallium arsenide pilot lines from the Defense Advanced Research Projects Agency to the SDI operation is early evidence of this shift, the OTA says.

Amplifying on that theme, Arvid G. Larson, chairman of the Institute of Electrical and Electronics Engineers' Defense R&D Committee, warns, "I'm afraid we are destroying our seed corn" with SDI. SDI research will be geared toward developing advanced technology for a specific program, Larson explains, rather than on the basic research that must be nurtured so that technology spreads throughout the society.

Moreover, commercial applications of research may be hindered by strict classification requirements. Although the current system of multiple funding sources may be awkward, Larson says it may be better suited to an era of constrained federal funding.

AUTHOR. Analyst Arati Prabhaker wrote the OTA report.

What's really raising the hackles of industry, however, is a basic question raised by the OTA report on whether private industry has the continuing ability to fund chip R&D. The document, which was reviewed by 34 top industry, academic, and government officials involved in electronics R&D, says that the industry's current problems with Japanese competition poses a paradox. "Without continued strength in R&D, solutions to the near-term problems will only delay the decline of the U. S. companies," the OTA states. "Yet microelectronics firms that are struggling to survive are likely to neglect R&D activity in the face of more immediate and pressing problems."

That is what's causing the fuss. Although most observers agree with one official's assessment that semiconductor R&D remains the "lifeblood of the industry," they differ on whether the government should increase direct R&D funding or instead ease the financial burden and lower the risks of private research and development.

And several industry trade groups even dispute the notion that private

R&D funding is on the decline. For example, the AEA's Feiss maintains that the electronics industry remains extremely research-oriented, generally spending twice as much on R&D as other U.S. industries. "What we need is a lower cost of capital," along with an extension of the R&D tax credit, according to Feiss.

Supporting that view, Daryl G. Hatano, government affairs manager for the Semiconductor Industry Association, estimates that the semiconductor industry currently spends about 10% of annual sales on R&D. In 1984, the last full year for which figures are available, that came to $1.4 billion. Hatano adds that if U.S. trade officials could pave the way so that domestic chip makers could win a 30% share of the Japanese chip market, it would add $2 billion to their sales and mean that the industry could spend as much as $200 million more a year on R&D.

CALLED INEVITABLE. But other industry officials say that the trend toward cooperative R&D—which will likely include federal support—is inevitable. "More and more, the industry is coming to that conclusion," says Bill Reed, executive director of the Semiconductor Equipment and Materials Institute (SEMI). Reed says that although he is wary of direct government participation in cooperative research efforts, such cooperation is "a path to survival."

SEMI represents about 1,100 electronics companies, 92% of which have annual sales of less than $10 million. Reed says the institute has attempted to pool the R&D resources of these smaller companies by joining the Semiconductor Research Corp., an industry R&D consortium based in Research Triangle Park, N.C. SRC funds university research and is currently seeking government members.

Robert M. Burger, SRC's vice president for research, maintains that the current problems of the U.S. chip industry are far too big for individual companies to solve on their own. "We must merge these individual contributions," he asserts.

Burger doesn't agree with the argument made by critics of further federal involvement that R&D results will meet commercial needs and be made available to industry only if the commercial sector carries out the work itself. He stresses that "the research that we support eventually becomes available to everyone," while product technologies that drive the industry would remain proprietary.

Cooperative R&D is a growing trend, agrees Donald J. Silversmith, director of the National Science Foundation's Solid-State and Microstructures Engineering program. The NSF is the pivotal group in SRC's plan to admit federal agencies to its fold, and Silversmith, who reviewed the early stages of the OTA report, represents several government agencies in discussions aimed at bringing them into SRC for the first time.

In assessing the report, Silversmith and others note that Japan, through its Ministry of International Trade and Industry, has been better able to coordinate Japanese R&D in such areas as optoelectronics. Coordinated R&D efforts, he says, "can produce more bang for the buck."

Coordinated R&D 'can produce more bang for the buck'

Meanwhile, at least one member of Congress, Rep. George E. Brown (D., Calif.), a member of the Technology Assessment Board that oversees the OTA, echoes the report's worries about Pentagon R&D centralization, adding that he is "very much concerned" about the growing role of the Pentagon in areas such as R&D and the space program. Although Brown favors consolidating many government R&D activities into one agency (see "Wanted: a single agency to fix R&D policy," below), he says SDI work won't have much commercial benefit. "That's a flaw in the centralization scheme," he says.

Nevertheless, he thinks government and industry are beginning to lay the groundwork for a consensus on issues such as cooperative R&D. "We're creeping up on it very slowly," he says.

The OTA report also identifies technological trends in R&D and notes that efforts to push chip densities with improved fabrication technology, for instance, will require more basic R&D activities. "This technological factor may drive expanded federal participation in R&D for potential alternative microelectronics technologies," the report says.

Although gallium arsenide and other compound semiconductors are identified as possible alternatives, the OTA report says that virtually no experts believe they will overtake silicon technology for most applications. One area of GaAs research singled out as particularly promising, however, is the growth of superlattices, alternating layers of two different compound materials [*Electronics*, March 3, 1986, p. 20].

Current research is focusing on designing better systems for growing these layers, such as molecular-beam epitaxy and metal-organic chemical-vapor deposition. Devices based on superlattice and other quantum-effect structures include III-V and II-VI photodetectors, lasers, and transistors. The superlattice work is "one of the most exciting areas of research today," the OTA states.

The NSF's Silversmith says the lack of a coordinated U.S. effort stems from the absence of an overall industrial policy. Referring to the OTA report, he adds, "We've had enough studies about what the problem is." What is needed now is "a manifesto for action." □

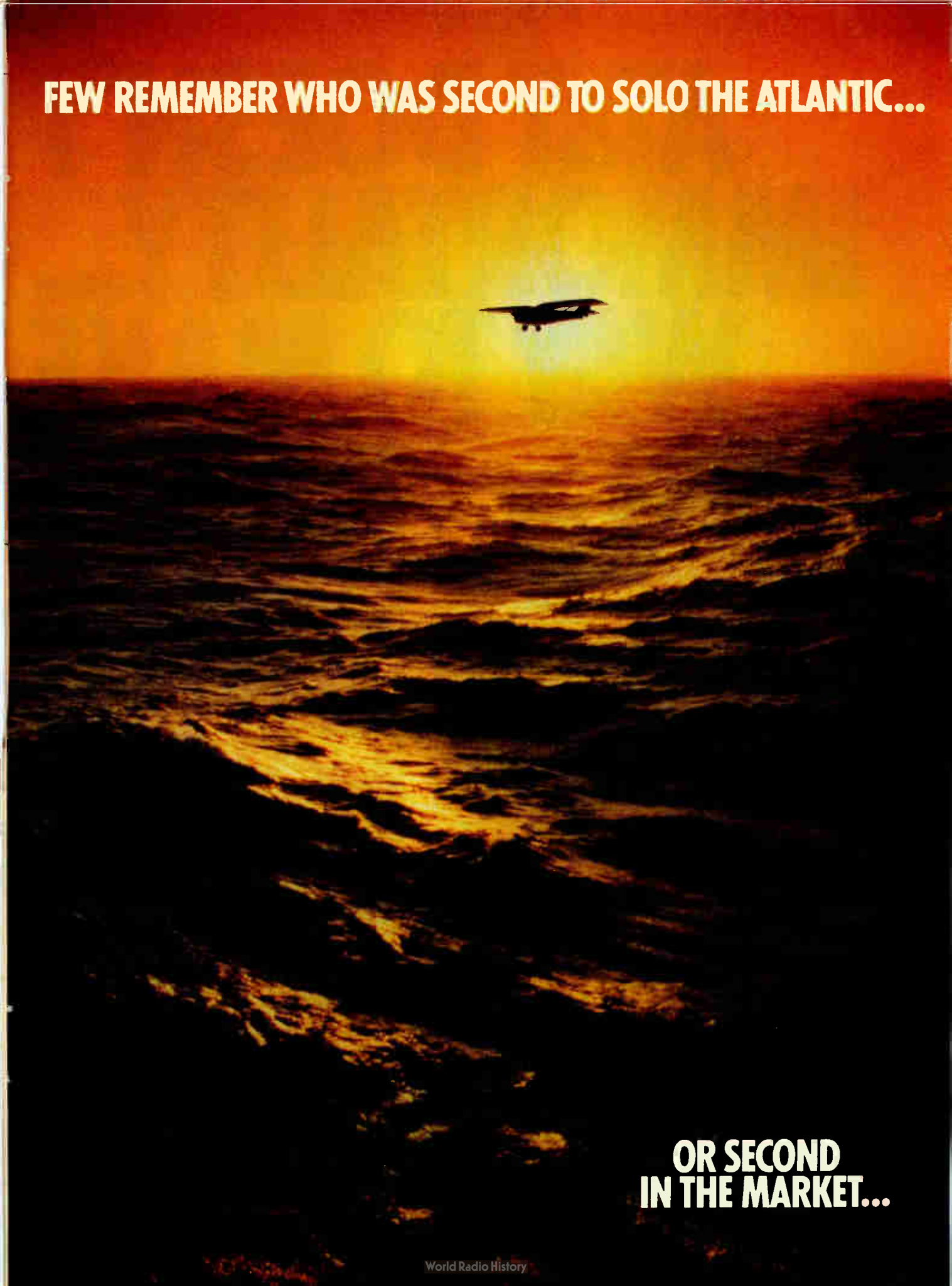
WANTED: A SINGLE AGENCY TO FIX R&D POLICY

One legislative effort to coordinate government support for research and development is the National Technology Foundation Act of 1985, sponsored by Rep. George E. Brown (D., Calif.). The bill, first proposed in 1980 and reintroduced in January 1985 as H.R. 745, seeks to consolidate in one independent federal agency responsibility for a number of programs scattered throughout the government. Among the agencies that would be transferred to the foundation are the National Bureau of Standards from the Commerce Department and the engineering directorate and Office of Small Business Research and Development from the National Science Foundation.

"The foundation would help tie progress in basic scientific research to useful applications," says Brown, a ranking member of the House Science and Technology Committee and the congressional Technology Assessment Board. Although he readily acknowledges that the bill's prognosis during this session is "not good," Brown adds that "we're establishing a background" for future administrations.

Under former presidential Science Adviser George Keyworth, the Reagan administration proposed the creation of two cabinet-level agencies to coordinate science policy and federal R&D activities: a Department of International Trade and Industry and a Department of Science and Technology. "Those seem to have died," says Brown.

His proposal also calls for the "development of the generic research base important for technological advance and innovative activity in which individual firms have little incentive to invest, but which may have significant economic importance, such as manufacturing technology." Moreover, Brown says his centralization plan is compatible with the OTA's call for retaining flexible multisource federal funding of R&D because a National Technology Foundation would help pull together a scattered federal policy covering high technology. —*G. L.*



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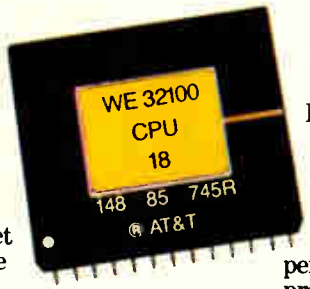

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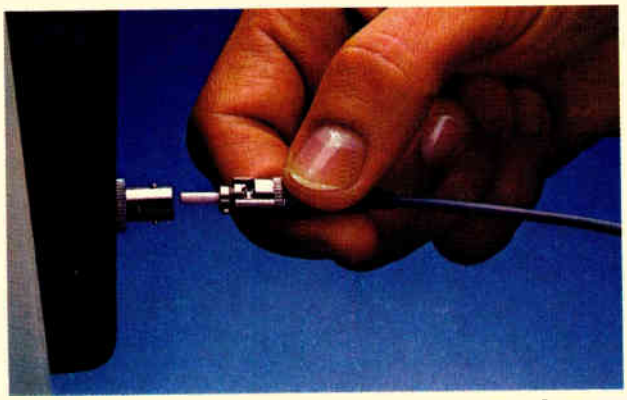

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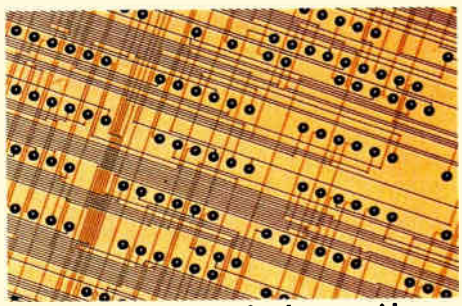

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SILICON SYSTEMS IS SITTING PRETTY

AFTER EASILY WEATHERING THE RECESSION, THE ASIC MAKER GAINS STRENGTH AS IT HEADS INTO A STRONG UPTURN

TUSTIN, CALIF.

Silicon Systems Inc. is looking good. Bookings at the maker of application-specific integrated circuits for Winchester disk drives and telecommunications equipment took a solid turn up late last year and are still gaining momentum. This is at a time when most other companies—even fellow niche suppliers—are sweating out the industry's shaky return to economic stability.

"I feel pretty good about things," says chairman and chief executive officer Carmelo J. Santoro. And well he might—under Santoro, Silicon Systems has used its mixed-process expertise to pull off a feat often attempted but seldom achieved by most semiconductor companies. The company develops custom ICs for a paying customer, then turns them into a family of standard ASIC products that can be tailored to the needs of a wider circle of users.

That strategy not only helped Silicon Systems weather the recession, it also sowed the seeds for growth in single-chip modems. The company remained profitable through fiscal 1985, ended Sept. 28, with sales dropping only about 4%. When weakness in the personal computer market finally caught up with the company in its first 1986 quarter, sales dropped by nearly a third, to $11.3 million from $16.4 million, and caused a $2.4 million loss.

FAST RECOVERY. But even as the company was going through what Santoro labels "our only red quarter," recovery already was under way. Sizable orders for its read/write amplifier components and other drive functions appeared so quickly that they surprised even the Silicon Systems officials who closely track disk drives. The impetus comes from demand for large drives, 20 megabytes and up, needed for data storage in engineering work stations and networked microcomputers as well as in minicomputers. "Those large-disk-drive guys are on a roll," remarks Santoro.

At least one financial analyst says the same thing about Silicon Systems. "I look for good things from it," says Andrew J. Kessler of PaineWebber Inc., New York. The company won't forecast revenues or earnings, but Kessler predicts revenues could reach $70 million this year, up from $54.6 million in 1985.

Turning ICs designed for one customer into standard products

He likes the company's drive chips and its market share, along with the fast start its new small-scale-integration K212 single-chip modem has made. But what really impresses him is the supporting strategy and the way it is implemented.

To get the cooperation of its initial customers, Silicon Systems foots part of the development cost in exchange for marketing rights. The most important factor is the design expertise gained in custom development, and how it relates to market needs. "That's how we learn those businesses," notes Santoro. The most recent example is the K212 chip modem, compatible with the Bell 212A 1,200/300-baud modem standard. "We probably know how to apply the Bell 212 specs better than anybody now."

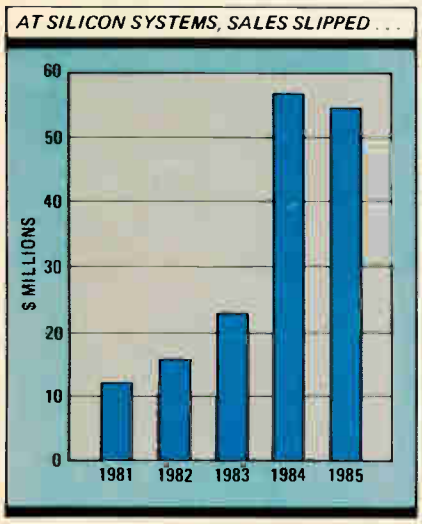
"That level of quality design expertise is Silicon Systems' future," says PaineWebber's Kessler. "It is really an innovative proprietary-product development company, which sets it apart from the commodity manufacturers. It also does not push the state of the art in manufacturing, which is an advantage." Silicon Systems specializes in implementing analog functions in CMOS with switched-capacitor filter designs and bipolar processes. It also is one of the leading companies able to consistently turn out chips containing both digital and analog devices, says Kessler.

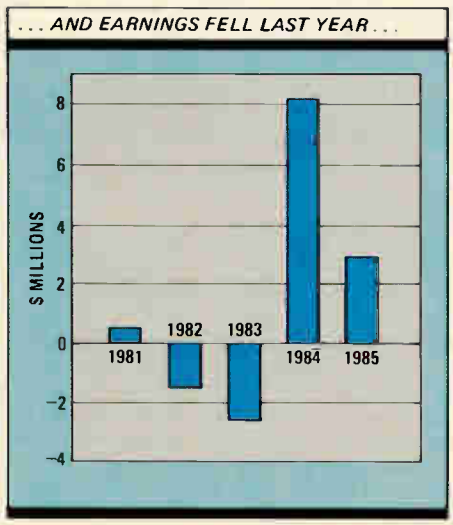
Though the design and manufacturing elements for applying custom-chip know-how to standard-type parts were on hand before Santoro took over in 1983, he soon refocused them into the present structure. That's how the company got its start in the drive business.

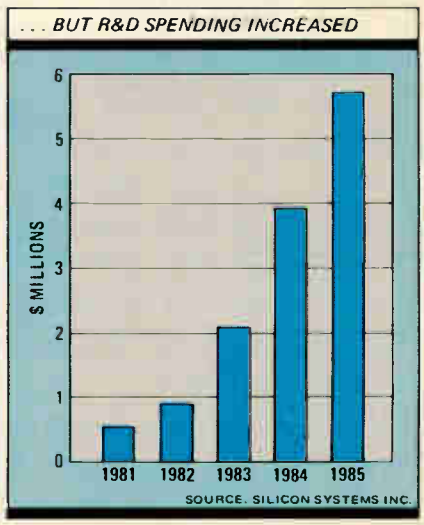
Silicon Systems designed and built chips for the drive-head assemblies used in the IBM plug-compatible computers and made a family of them. It expanded drive lines to chip sets that now include ICs for controllers, servos, and the Small Computer System Interface. Acceptance has soared, too; Silicon Systems says it has at least one chip on 90% of the drives built worldwide.

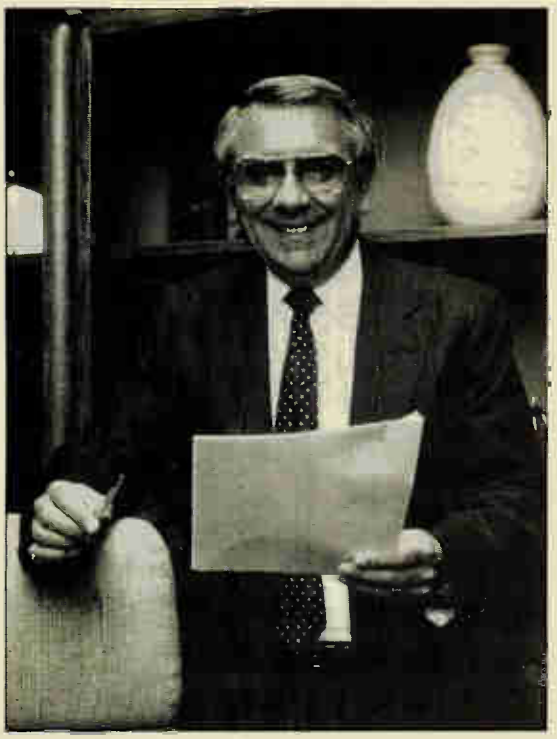
Because the company is closely involved with customer needs, its drive experts pick up quickly on any problem that can be solved with a new product. One is Smartflex, introduced last year as a joint venture with interconnector manufacturer Rogers Corp., Rogers, Conn., that bundles drive electronics with the internal drive cabling and interconnections. A part that has a different configuration for each manufacturer, it already has been designed into more than 20 drives and looks to be a big winner.

But Santoro emphasizes that his com-









DOING WELL. Carmelo Santoro has Silicon Systems on a roll.

pany's standard parts are not really off-the-shelf items sold to all comers. Rather, because each customer has a different set of performance requirements, no two drives are exactly alike. "We never know what combination to expect when a customer walks in," he says.

The product lines therefore are families of ASICs, for both drive electronics and the new modem lines, that can be visualized as what Santoro terms a "30-sided box of parameters." Silicon Systems applications engineers are in the position of greeting customers with "Just what flavor do you want, sir?" he quips.

The Tustin company, with its drive and telecom products, has the reputation of addressing only the niche markets, which are largely regarded as having limited growth opportunities, in contrast to high-volume markets for microprocessors and memories. For Silicon Systems, both its drive electronics and telecom segments have expanded so fast that it is not concerned about outgrowing its markets.

Far more important, says Santoro, is "understanding everything about a market segment. In our case, we want to be the dominant force in each segment." Selling to 90% of drive companies easily qualifies him in that business, and the company expects to sell 1 million single-chip modems, with the total 1986 market estimated at about 4 million. At an average price of more than $20 each, the K212 should rack up a respectable score in its first year.

One improvement already helping Silicon Systems meet the surge in orders is an assembly and test plant in Singapore, which came onstream in the first quarter. Volumes are increasing steadily and now stand at about 220,000 units a month, including all the company's quad and plastic dual in-line packages.

The Silicon Systems chairman thinks the Far East is more than a place to cut production costs. Rather, "it is a market in its own right, to generate products." Foreign sales in 1985 grew to 28% of the total, from 11% a year earlier, much of the increase coming from design-ins at nearly all the Japanese Winchester disk drive makers. Now the company is considering wafer fabrication in the Far East.

During the slowdown in 1985, the company sped product development, bringing out 11 new disk-drive offerings, and it plans to introduce 15 to 20 this year. This activity blunts one criticism from some industry observers that Silicon Systems was milking products and not investing for the future.

Besides improving its wares in existing lines, the company is looking at related fields where its technology would be effective. One is power ICs, which combine logic and power switching elements on the same chip, says Alan H. Portnoy, senior vice president for business development. Another is military and industrial parts, where it expects a profit of 20% of total revenue within four years. To get into the U. S. military market, it has signed a second-sourcing deal with Britain's Ferranti plc.

With bookings and sales on the rise, Silicon Systems seems poised to start its climb into the ranks of the majors. But that will mean meeting heavyweight competition in modems from the likes of AMD, Rockwell, and Texas Instruments, among others. Santoro, however, regards his company's modem family as superior products and believes the advantages of a smaller, faster-moving company neutralize the size disparity.

Consultant Jack Beedle of In-Stat Inc. in Scottsdale, Ariz., also singles out modems, "or the collapse of telecommunications," as the only risk. "But we don't see this happening," he adds. He gives highest marks to the company, especially for its product strategy. "Carm identifies the market first, and then designs a product to fit it. The other guys do it opposite, and that's why they so often fail." *–Larry Waller*

BOTTOM LINES

MERGER ACTIVITY HITS NEW RECORD IN 1985

Despite a brief slowdown in the fourth quarter, mergers and acquisitions in the electronics industry hit a record last year, according to the Cerberus Group, a Frenchtown, N.J., company that tracks these deals. Takeovers and mergers of companies in the computer, software, services, communications, and information industries totaled 290 last year, up 13% from 1984's then-record 256 deals. The Cerberus Group says that, because of the large number of mega-deals, the total dollar value paid for all transactions in 1985 reached a record $5 billion, beating 1984's then-record $4.5 billion by 10%. The two biggest deals were Dow Jones & Co.'s purchase of Telerate Inc. and MCI Communications Corp.'s takeover of Satellite Business Systems, each for $460 million.

ZENITH TO SELL DEBT, SEES LOSS IN QUARTER

Consumer electronics maker Zenith Electronics Corp. says it plans to offer $100 million of convertible subordinated debentures. The Glenview, Ill., company also expects to post a loss in the first quarter of 1986, caused by lower selling prices that have carried over from 1985 and by a shortage of consumer electronics and microcomputer products. Zenith says it is working to increase inventories, depleted by record shipments of color TVs and microcomputers in last year's fourth quarter. The company says it will use proceeds for general corporate purposes.

ORACLE COMPLETES PUBLIC STOCK OFFER

Oracle Systems Corp. has completed its initial public offering of stock. The Belmont, Calif., company, which developed the Oracle relational data-base management system, says it sold 1 million shares of stock, while shareholders sold 1.1 million shares, all at $15 a share. Its proceeds will be used to repay a revolving line of credit and for general corporate purposes.

ISSCO BUYS 60% OF SWEDISH COMPANY

Integrated Software Systems Corp., San Diego, Calif., has agreed in principle to acquire 60% of Mimer Information Systems AB, Uppsala, Sweden, for an undisclosed amount. It also has the right to acquire an additional 31% of the Swedish company, which develops integrated relational data-base software.

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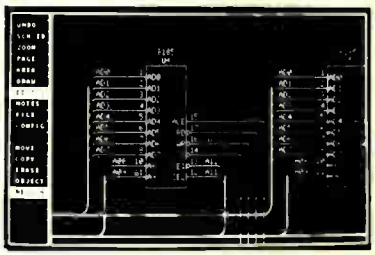

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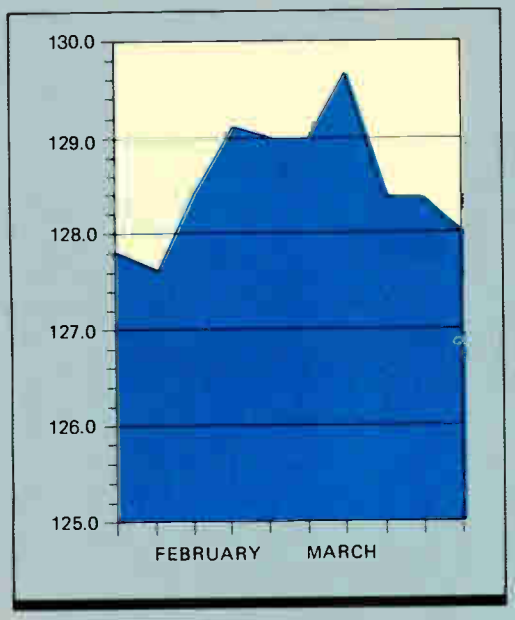
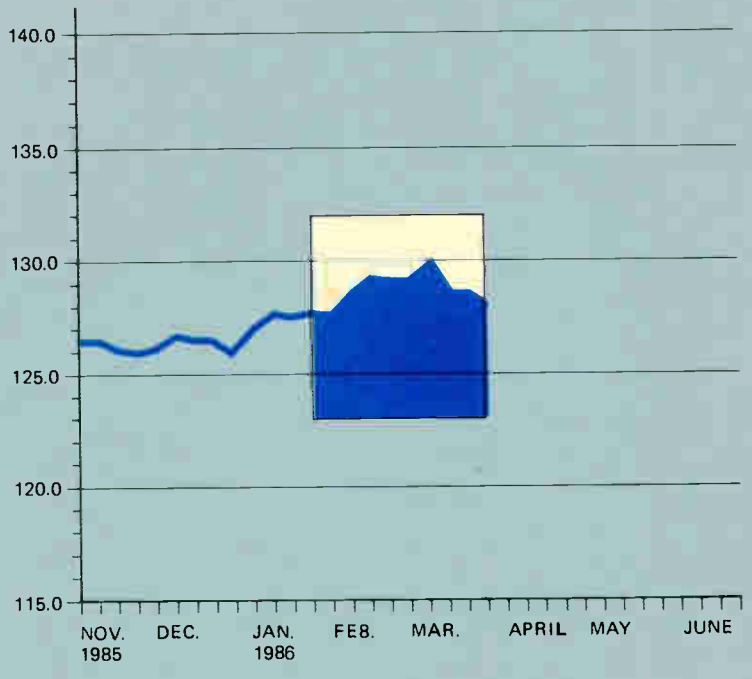
ELECTRONICS INDEX





THIS WEEK	= 128.0
LAST WEEK	= 128.4
YEAR AGO	= 128.3
1982	= 100.0

The *Electronics* Index, a seasonally adjusted measure of the U.S. electronics industry's health, is a weighted average of various indicators. Different indicators will appear from week to week.

U. S. GENERAL ECONOMIC INDICATORS

	February 1986	January 1986	February 1985
Average prime rate (%)	9.50	9.50	10.50
Retail sales ($ billions)	117.274	117.364	112.096
Unemployment rate (%)	7.2	6.6	7.2

U. S. ELECTRONICS PRODUCTION INDEX

	January 1986	December 1985	January 1985
Office and data-processing equipment	260.9	261.6	262.1
Communications equipment	220.5	222.7	213.6
Radio and TV equipment	159.4	175.3	145.0
Electronic and electrical instruments	141.5	140.6	138.6
Components	241.2	245.9	301.9

Production of electronics goods in the U. S. slipped 1.6% in January, pushing the *Electronics* Index to its lowest level in two months. The drop in output by manufacturers ended the industry's two-month run of growth and soured hopes for an immediate—and significant—improvement in the industry's fortunes.

All sectors suffered declines in production, with the exception of instruments, which managed a meager 0.6% increase. Production of TV and radio equipment in January plunged 9.1% from its level at the end of 1985, making it by far the biggest loser. Nevertheless, following output gains that totaled 29% in November and December, domestic production of consumer electronics goods still remains at healthy levels.

The slightest decline for the period was in production of office and data-processing equipment, which slid a mere 0.26%. Communications equipment slipped by 1%, and components dropped 2%.

In spite of the rising level in the semiconductor industry's book-to-bill ratio, U. S. production of all electronics components dropped 1.9% in January. This latest decline brings domestic component output to its lowest level in over two years.

Meanwhile, production of communications equipment fell 1% in January. Despite the drop, output of communications gear in January was still ahead of January 1985's level. Production of office and data-processing equipment slipped 0.3% from December's levels.

HILSMAN IS READY TO SEE HIS DREAM COME TRUE

PHILADELPHIA

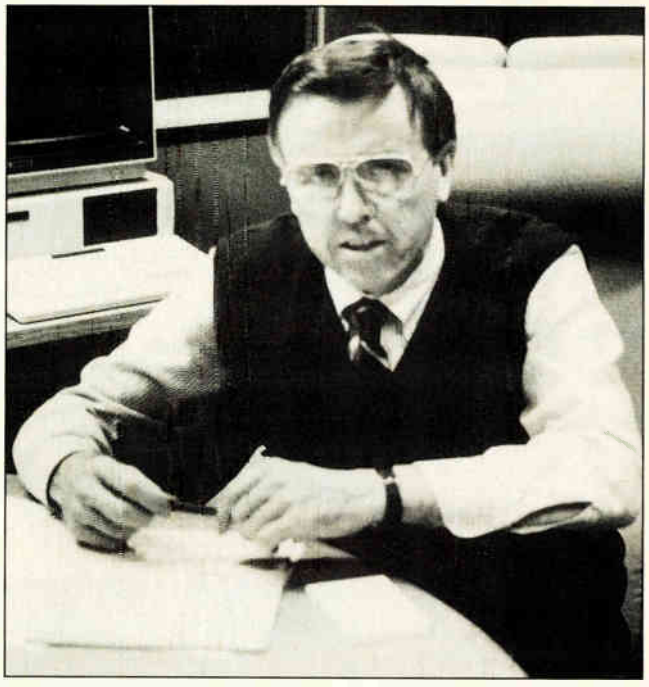
William Hilsman has been chasing a technological dream for more than a decade, and now his dream appears to be coming true. The president and chief executive officer of International Mobile Machines Corp. is convinced that an all-digital radio-based mobile telecommunications system for voice and data is on the verge of becoming practical.

A stationary version of the system, called Ultraphone, will undergo a trial study in Glendo, Wyo., this summer, and Hilsman believes that the company will begin marketing the system this year. The digital mobile system has a number of advantages over cellular telephone systems, he says, such as high-speed, high-security voice and data transmission, spectrum conservation, and potentially lower cost (see p. 21).

Hilsman, a retired Army lieutenant general, outlined a plan to develop a similar system when he was director of the Defense Communications Agency from 1980 to 1983. He appointed a task force to study the idea, but little progress had been made by the time he retired from the armed services in 1983 after 30 years of service.

Hilsman, who holds an MSEE from Northeastern University in Boston, says he had been "the Army's high-tech communications and computers general," and over the years dealt with the nation's top defense contractors. When his retirement was announced, he recalls, there were rumors about which company would hire him, and he entertained more than a half dozen offers.

GUT FEELING. But on the advice of a friend, he stopped to consider what sort of work he really wanted to do and decided that digital mobile telephony was what interested him most. He was prepared to leave the Army behind but not his plans for a digital mobile phone. Just about that time, he learned about International Mobile Machines, an 11-year old company with a new approach to mobile digital telecommunications.



WILLIAM HILSMAN: For more than a decade, he has been looking for an all-digital radio-based mobile telecom system for voice and data.

Chairman Sherwin Seligsohn, a financial expert, had founded the company in 1972 to develop a secure, high-speed digital communications system that would let him keep tabs on the stock market from, say, a lounge chair on the beach. But he needed someone to direct the company's technological advancement. Seligsohn and Hilsman had seen the future from different vantage points—Seligsohn from the time-is-money business world and Hilsman from the security-conscious military—but their visions were the same. Hilsman seemed a natural choice.

Although he got more lucra-

PEOPLE ON THE MOVE

LEROY D. YOUNG

☐ Racal-Milgo has promoted Leroy D. Young to director of modem development. Young, who joined the company in 1974 as a design engineer specializing in large-scale-integration applications, has also been involved in the evolution of the modem product line. He earlier spent five years as a design engineer with Western Electric/Bell Laboratories and holds three patents in electronic musical synthesis. He has a BSEE from Purdue University.

PETER G. PARASKOS

☐ The new president and chief executive officer at Systron Donner Corp. is Peter G. Paraskos. He succeeds Christopher M. Power, who is returning to London and Thorn EMI Electronics, Systron Donner's parent company. For the past three years, Paraskos has been general manager of Systron's Inertial Division in Concord, Calif., which designs and manufactures inertial sensors and subsystems for a wide variety of guidance and control functions. Before that, he worked for Vought Corp. and for Rockwell International Corp. He holds two engineering degrees from Columbia University and served in the Marine Corps.

DAVID L. CHAPMAN

☐ Cullinet Software Inc. has named David L. Chapman vice chairman, president, and chief executive officer. He comes to the Westwood, Mass., company after five years with Data General Corp., where he had been senior vice president of manufacturing. Before that, Chapman spent 23 years at IBM Corp., serving in a variety of senior management positions. As president of Cullinet, he replaces Robert N. Goldman, who has resigned but continues with the company on a consulting basis.

NOBURU TAKAHASHI

☐ New York's Mitsubishi International Corp. has named Noburu Takahashi president and chief executive officer. He replaces Takeo Kondo, who is returning to Japan to become executive vice president of Mitsubishi Corp., the parent company. A 38-year company veteran, Takahashi, 63, has been general manager of the Osaka branch and served in New York as executive vice president from 1980 to 1984. Prior to that, he spent 11 years at Mitsubishi International GmbH in Düsseldorf and Hamburg, eventually becoming president and managing director in 1974.

PETER J. SHAW

☐ Saying he has completed the job he was hired to do, Peter J. Shaw has resigned as president of Genisco Computers Corp., Costa Mesa, Calif., to start a business-development service company for high-technology companies. Genisco will be a customer in the areas of product development, planning, marketing, and sales. Before joining the company in 1984, he was president of Syte Information Technology and president and chief executive officer of Megatek Inc., now a subsidiary of United Telecommunications Inc.

tive offers, Hilsman says, he elected to join the small Philadelphia company because it offered him the challenge to complete in the business sector what he had not had time to finish for the Army.

"I've been chasing this dream for 10 or 15 years," he says. "I probably could have made three or four times more from some of the other offers, but this was a decision of the heart."

Hilsman helped recruit a number of his former Pentagon colleagues for the company. But he no longer had the benefit of the enormous, sophisticated support services he had grown accustomed to. In the Army he could put 50 people on a project, he says, but International Mobile Machines has a total of just 20 employees. His staff and Seligsohn stuck with him, though, and now he says it was all worthwhile.

"It's been a tough, uphill road," he says. "But now there is not a single doubt that we have the technology, and that we will go into the market this year. We are there." *–Tobias Naegele*

A CONFIDENT SCHIMEL BUILDS HIS OWN EMPIRE

STAMFORD, CONN.

Ever since he ran away from home at the age of 14, Art Schimel has done things his own way. Confident to the point of being cocky, the 46-year-old Schimel spent the last several years parlaying 20 years of sales experience into a controlling interest in National Computer Communication Corp., a distribution company worth $20 million in annual sales.

The story behind Schimel's journey from marketing executive to president of National Computer is the dream of every employee who ever yearned to go one better than his boss.

In 1981, Schimel was lured from a comfortable job as national sales manager for Page Printing Systems at Honeywell Information Systems to be vice president for sales at Digital Associates Corp., a Stamford, Conn., distributor of impact printers, which sweetened its offer with the promise of an equity interest. Two years later, with the promise unfulfilled, Schimel left Digital Associates to start a competing business, Printer Warehouse Inc.

ART SCHIMEL: Holding all the cards at National Computer Communication Corp.

Employing just one person—his wife, Deborah—and working less than 30 hours a week, Schimel, who has a degree in sociology from Brown University, saw the company take off: by the end of its first 18 months, it was boasting $3 million in annual sales. In September 1984, it was snapped up by Robert Loonin, president and cofounder of National Computer, for an undisclosed sum. "The guy made me an offer I couldn't refuse," says Schimel, who stayed on as executive vice president.

By the following March, Schimel was National Computer's biggest creditor, lending the money he had earned on the Printer Warehouse sale so the company could buy out his former employer and competitor, Digital Associates.

IN CONTROL. Schimel didn't stop there. He next acquired a controlling interest in National Computer—he now holds 70% of the company's stock—and in January he took over as president. "To me," Schimel explains, "the word 'opportunist' was never a dirty word."

But Schimel is more than a wheeler-dealer; he's also a shrewd businessman with a nose for ferreting out waste. Since taking over Digital Associates, he says he has increased sales by 26% while more than halving staff and costs. He has consolidated the operations of three separate businesses into a single location—a windowless converted garage in Stamford—and plans to move to a less expensive location, probably in nearby Bridgeport, Conn., within a year to further trim costs.

To keep up morale in such uncomfortable surroundings, Schimel offers a profit-sharing plan and has created an energetic workplace for his 90 employees, each of whom he knows by name. "I believe in the law of enlightened self-interest," he says. By that, he means "if they can get a bigger piece of the pie by making it grow, I'll get a bigger piece, too."

By 1990, Schimel expects to double earnings and boost employment by at least 50%. That done, he plans to sell National Computer lock, stock, and barrel. "And then," he says, leaning back in his chair, "I expect to be at the beach." *–Tobias Naegele*

NEW PRODUCTS

FLAT-SCREEN PORTABLE BOASTS FULL IBM COMPATIBILITY

OLIVETTI'S M-22 USES 5¼-IN. DISKS, YET WEIGHS ONLY 16 LB

The emerging market for portable personal computers is fluid, to say the least. If a product is truly as functional as a desktop model, it is too heavy for most people to carry. And if a machine is the small laptop version, it falls short on features. These trade-offs have stunted the market's development.

Now Olivetti, Italy's foremost producer of data-processing and office-automation systems, is jumping in with a flat-screen computer that it thinks will be the first high-volume seller because it weighs little more than a laptop but still has the functionality of a model with a CRT display. Weighing 16 lb, the M-22 is a flat-screen model that is compatible with IBM Corp.'s Personal Computer.

The new Italian computer will end up competing against a handful of products that are already trying to sell into the same market niche. They include the Data General One, the Datavue 25, Sharp's PC7000, and the Zenith Z-171, which was selected by the Internal Revenue Service for its field agents.

Olivetti has already begun marketing the machine in Europe. Massimo Ziliani, general manager of the company's Personal Computer division, stops short of saying that AT&T Co., which holds a 25% stake in Olivetti, will market the portable in the U.S. But indications are strong that the telecommunications giant will add the machine to its U.S. product line. So far, AT&T has offered all the Italian company's work stations in the U.S. "AT&T is very interested in the M-22," Ziliani says, adding that the computer was developed in cooperation with the U.S. company.

BACKLIT DISPLAY. The M-22 uses a backlit liquid-crystal display with six brightness levels to create a clear image that can be read easily in conditions ranging from bright light to total darkness. In alphanumeric mode, the screen displays 25 lines of 80 characters each; in graphics mode, it offers a resolution of 640 by 200 pixels, satisfying the resolution needs of such graphics-based programs as Lotus's 1-2-3.

Built around an Intel 80C88 4.77-MHz microprocessor, the M-22 uses Microsoft's MS-DOS operating system, which Olivetti claims is 100% compatible with the IBM PC. Olivetti also claims the M-22 offers all the functionality of a standard PC-compatible, with an added bonus that most flat-screen units don't have: an integrated 5¼-in. floppy-disk drive. Ziliani points out that the Data General One, the portable that he considers the most advanced up to now, is equipped with a 3½-in. drive. That means that in most cases the user must transfer software to the smaller disks.

BACKLIT. Olivetti's 16-lb IBM PC-compatible computer has a backlit liquid-crystal display screen with six brightness levels.

Another key part of the standard M-22 is 256-K bytes of RAM, expandable to 1 megabyte. When memory is expanded, up to 360-K bytes—the standard capacity of a floppy-disk drive—can be configured as a nonvolatile RAM disk, with data safeguarded by the machine's alkaline or rechargeable nickel-cadmium battery pack.

Users who need even more power can substitute a half-height Winchester hard disk for the battery pack and operate from a standard ac power supply. Increased functionality can be gained by adding one or two mini expansion cards supplied by Olivetti, in addition to a full-size industry-standard expansion card. The standard unit includes RS-232-C serial and Centronics parallel interfaces.

One example of the functionality bonus that Olivetti is offering comes from a second 80C88 processor identical to the CPU's. In addition to controlling the RAM-disk function, the processor drives an integrated personal-windows software package that provides simple word-processing, calendar, and calculator functions. A password facility protects all data in the personal-windows environment against unauthorized use.

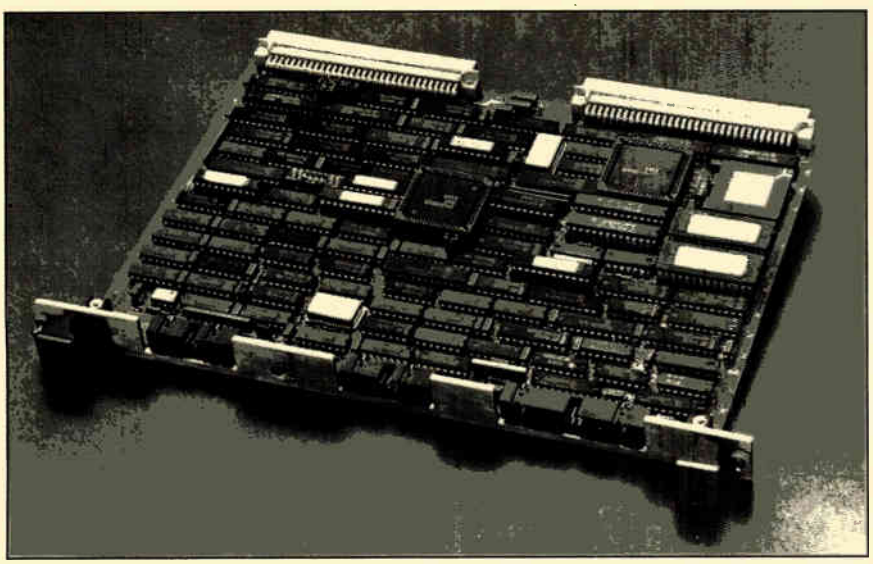
The price of the M-22 is around $3,000, a figure that will vary from market to market. The rule of thumb with other Olivetti products has been that their prices stabilize at about 85% of the IBM PC's. *–Robert T. Gallagher*

Ing. C. Olivetti & Co., via Jervis 77, 10015 Ivrea, Italy. Phone (39-125) 522747 [Circle reader service number 338]

ESDI CONTROLLER ADDS BIG-DISK FEATURES

Interphase Corp. is applying some of its performance-boosting technology and multitasking-controller architecture to speed up a new VMEbus-based Enhanced Small Disk Interface board for 5¼-in. hard-disk drives. The V/ESDI 3201 hinges on a number of innovations developed earlier by Interphase for Storage Module Drive interfaces used with larger 8-, 10-, and 14-in. hard disks.

These big-disk features will make it possible for Storage Module Drive controller customers to plug an ESDI controller into their systems that does not require significant redevelopment work, says Tom Kent, director of marketing.



SMART. Interphase's controller predicts the data the CPU will want next and puts it in a buffer.

Interphase claims to have done just that. The Dallas company believes the emerging ESDI de facto standard is attractive to integrators of engineering work stations and minicomputers as they broaden their hard-disk offerings from Storage Module Drive interfaces to smaller lower-cost but still high-performance 5¼-in. drives.

COMPATIBLE. The V/ESDI 3201 incorporates all the features of Interphase's 18-month-old V/SMD 3200 controller. The new intelligent controller is based on the same Motorola 68000 microprocessor as the Storage Module Drive board, and it is software-compatible with the V/SMD 3200. As a result, unmodified software drivers for the Storage Module Drive card can be used for the ESDI controller, Kent says.

Like Interphase's Storage Module Drive controller, the V/3201 employs a forward-looking cache-memory algorithm to predict which data will be used next from mass storage under disk-intensive operating systems such as AT&T Bell Laboratories' Unix [*Electronics*, Aug. 25, 1983, p. 51]. Interphase calls the feature Virtual Buffer Architecture.

The controller architecture enables the board to use multiport memory to simultaneously take data off a disk and shift it to the VMEbus. The 68000-based controller uses the multiport memory as a cache buffer. Once data is sent to the system processor, the intelligent controller continues to access sequential sectors of data from the disk and loads them into cache to make them quickly available to the host.

The aim of the virtual buffer feature is to eliminate the latency associated with the time it takes to position the read/write head on a whirling disk. It ensures that accessing a single track of data will never take more than one complete disk revolution, reducing disk-transfer time by about a third.

Unlike some recently announced competitive ESDI controllers, such as the one from Adaptec Inc. [*Electronics*, March 3, 1986, p. 13], Interphase says its 3201 board works directly with the system bus, avoiding the need for an intermediate interface, such as a Small Computer System Interface.

"The intermediate interfaces, such as SCSI, can slow down the transfer rate," says Kent, noting that the VMEbus is 32 bits wide and handles more than 20 megabytes/s. SCSI is an 8-bit-wide interface, operating in the range of 800 kilobytes/s. Synchronous SCSI interfaces raise throughput to as much as 4 megabytes/s but are still slower than an ESDI board directly attached to the 32-bit VMEbus, he adds. Many of Interphase's identified applications, such as engineering work stations, will require high-performance ESDI 5¼-in. hard disks.

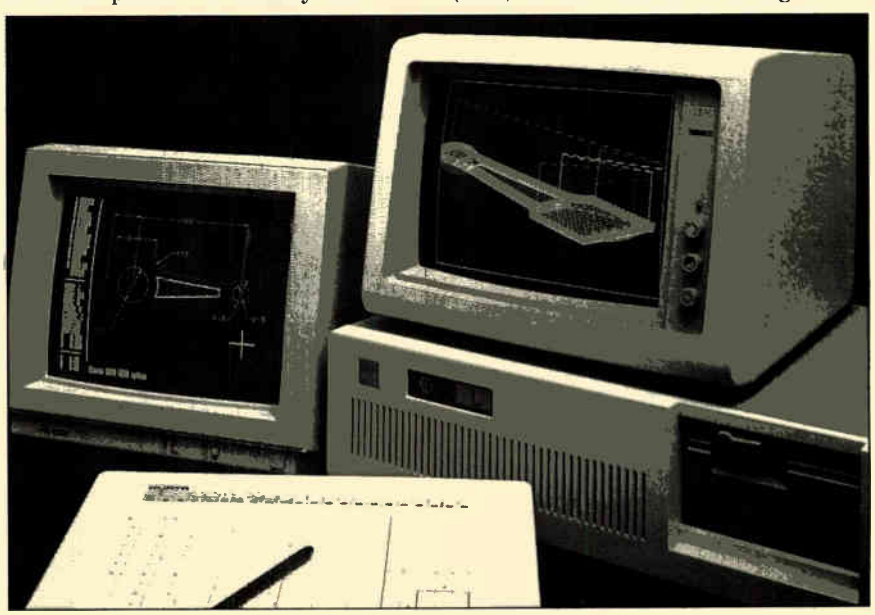
In single quantities, the V/ESDI 3201 will cost $1,995. The board will be available in May. *–J. Robert Lineback*

Interphase Corp., 2925 Merrell Rd., Dallas, Texas 75229.
Phone (214) 350-9000 [Circle 339]

AI EASES CONVERSION FROM CAD TO NC FORMAT

PMX has added rudimentary artificial intelligence to make it easier to use its parts software for the IBM Corp. Personal Computer/XT and AT. The package greatly simplifies the task of converting geometric data from a computer-aided-design drawing into a program that can be used by a machine to make the part on the factory floor.

The latest version of the three-year-old XL/NC program is so new that it has not yet been named, but it is available for shipment now, says Jerry Peterson, PMX marketing director. The new version accepts CAD data in standard Initial Graphics Exchange Specification (IGES) or Data Exchange File (DXF) format. But after asking a few



DIRECT. PMX's software takes CAD files and converts them for numerical-control machines.

simple questions of the user, the XL/NC software will also automatically translate the data into a format that can be used by a numerical-control machine tool.

Other systems can work with utility communications packages to take IGES or DXF data from a CAD system. But part geometries such as circles, lines, and points in IGES or DXF are supplied in random form without information about their relationships with one another, says James Clack, head of technical development for the company.

Competitive programs, he says, require the user to reformat the geometry to direct how the part is to be machined. "Our system not only has the communications utility built in, but it goes a step farther by automatically handling the reformatting job." Once the IGES or DFX file is obtained, Clack explains, XL/NC asks the user five questions: where the cutting should start, which entity should be cut first, the cutting direction, the last entity to be cut, and where the tool should be placed after the task is complete.

AI ASSIST. When the user supplies answers to these questions, XL/NC takes over to write most of the machining program, using what Peterson says is a rudimentary form of AI. With the user-supplied information, XL/NC analyzes the parameters of the part's geometries and reformats the random IGES or DXF file to create the proper sequence for machining.

When XL/NC completes this task, all that remains for the user is to specify the tool and cutting speed to be used by the factory machine. The XL/NC output then is put through a postprocessor for conversion into machine language that can be read by the particular factory machine to be used.

XL/NC is available for IBM PC/XT, AT, and compatible computers. A version equipped to work with two-dimensional parts files costs $8,500 per copy. A version with 3-d capabilities sells for $11,500. *–Wesley R. Iversen*

PMX Inc., 33129 Schoolcraft Rd., Livonia, Mich. 48150.
Phone (313) 422-3740 [Circle 340]

GaAs IC CONVERTS RF SIGNALS TO I-F

Three monolithic microwave ICs each include radio-frequency and intermediate-frequency amplifiers, a mixer, and a local-oscillator buffer to serve as single-chip TV receive-only converters. The gallium arsenide chips, which are less than 1 mm², are only 5% to 10% the size of converter subsystems based on discrete-level technology, the manufacturer says.

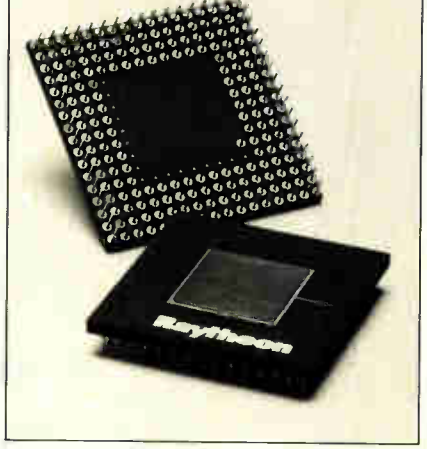
The chips convert an rf signal to an i-f signal at a 20- to 40-dB conversion gain, covering the frequency range of 0.8 to 8.0 GHz. They are offered primarily to the satellite TV receive-only (TVRO) industry, but also have a number of applications in the military—radar, electronic countermeasures, and communications—and in the automotive industry—in automatic braking and collision-avoidance systems.

The ICs offer reliability and system-sensitivity advantages as well as superior phase and gain tracking and matching, according to the manufacturer. The radiation-hardened parts come in various housings, including an eight-lead, 0.062-in.-thick surface-mountable package. In small quantities, the converters cost $500 each; in production quantities (10,000 or more pieces annually), they are as low as $50 each.

Pacific Monolithics Inc., 245 Santa Ana Ct., Sunnyvale, Calif. 94086.
Phone (408) 732-8000 [Circle 363]

CMOS ARRAY HITS UP TO 10,013 GATES

A family of CMOS logic gate arrays ranging from 880 to 10,013 equivalent gates is now available for designers. Raytheon's 2-μm RL7000 series, based on LSI Design System software from LSI Logic Corp., offers several options. Users can supply pattern-generation tapes already developed on LSI systems, schematics, or netlists, or they can remotely access Raytheon's computers.



The high-speed series operates at 1.4 ns/gate with high noise margins and a low power consumption of 18 μW/gate/MHz. Extensive macrocell and macrofunction libraries are available. The largest members of the family can be used for complete subsystems, including special-purpose processors and multifunction controllers; small arrays can replace high-speed Schottky TTL and 10K ECL logic devices.

A broad selection of standard package types is available, as is screening to MIL-STD-883, class B, and MIL-M-38510. Evaluation-sample turnaround time is 6 to 10 weeks, and the nonrecurring engineering cost to the customer runs from $25,000 to $75,000. The company will quote unit prices, with no minimum quantity stipulated.

Raytheon Co., Semiconductor Division, 350 Ellis St., Mountain View, Calif. 94039.
Phone (415) 968-9211 [Circle 355]

CMOS DEVICE TOPS BIPOLAR CORRELATOR

A new CMOS 64-bit digital correlator boasts higher frequency and lower power dissipation than the comparable bipolar device, says its manufacturer, Logic Devices. The L10C23-1 is said to be functionally identical and pin-compatible to TRW Inc.'s TDC1023 bipolar correlator, but it performs parallel correlation at a 35-MHz clock frequency while dissipating 250 mW. The bipolar circuit operates at 20 MHz and dissipates 900 mW.

The circuit consists of three independently clocked 64-bit shift registers, one 64-bit reference-holding latch, an independently clocked 64-bit pipelined digital summer, and a 7-bit parallel compare register with flag. The L10C23-1 is designed to detect signals in environments with low signal-to-noise ratios and can synchronize received signals at the frame, word, or bit level. Its applications lie in video-frame synchronization, high-density recording, and time-delay measurement of radar and sonar signals.

The price is $41.25 per circuit, in quantities of 100.

Logic Devices Inc., 628 E. Evelyn Ave., Sunnyvale, Calif. 94086.
Phone (408) 720-8630 [Circle 357]

GaAs DIVIDER RUNS FROM dc TO 2 GHz

A gallium arsenide digital IC for frequency-synthesizer and prescaler applications can divide an input signal by 10 or 11 according to the mode selected, from dc to 2-GHz clock speed. The HMD-11011-2 is designed for use in microwave communications systems, satel-

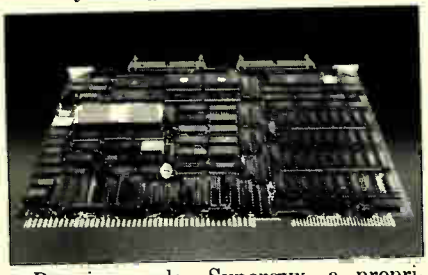
lite receivers, instrumentation, and high-speed video processing.

A single input controls the division ratio of the divide by 10 or 11. The device divides by 10 when the mode-select input is high, or by 11 when the input is low. It features 950-ps typical propagation delay and count-enable control for gated clocking. Available in a 16-pin hermetic metal flatpack, the device is priced at $241 per chip, in quantities of 100. Shipping time is four weeks.

Harris Corp., Microwave Semiconductor Division, 1530 McCarthy Blvd., Milpitas, Calif. 95035. Phone (408) 262-2222 [Circle 356]

COMPUTER HAS 16 MEMORY MANAGERS

The SM68E, a Multibus single-board computer, has a two-level memory-management unit that is divided into 16 contexts. Each functions as a separate management unit, performing independent address mapping into user-accessible memory. Thus the board allows the CPU to switch between as many as 16 different processes without reinitializing the memory-management unit's registers.



Running under Synergyx, a proprietary version of AT&T's Unix 5.2, the SM68E can address up to 8 megabytes of no-wait-state memory. Pricing depends on configurations, which include 10- or 12-MHz versions of the 68000 or 68010 with 256-K bytes or 1 megabyte of onboard RAM, and optional daughterboards and serial ports.

A Small Computer System Interface peripheral controller that transfers data at 1.5 megabytes/s is standard. Units are available from stock.

Synergy Microsystems Inc., 1820 Cambridge Ave., Cardiff, Calif. 92007. Phone (619) 753-2191 [Circle 360]

AMD'S 1-Mb EPROM IS NOW AVAILABLE

Advanced Micro Devices' 1-Mb EPROM has finally arrived. In lots of 100, the Am27C1024 sells for $199 in 40-pin side-brazed packages. Its 64-K-by-16-bit architecture allows direct interfacing with 16- and 32-bit systems.

The EPROM's nonmultiplexed interface simplifies system timing and design, offering flexibility when used with 16- and 32-bit microprocessors. In standby mode, the 1.5-μm CMOS memory uses 5 mW, which is just 2% of the 250 mW used in the active mode.

Because 16 bits are programmed simultaneously, the chip can be programmed in less than 2 minutes. Production quantities are available now.

Advanced Micro Devices Inc., 901 Thompson Pl., P. O. Box 3453, Sunnyvale, Calif. 94088. Phone (408) 732-2400 [Circle 371]

WORK STATION BOASTS VAX PERFORMANCE

The Edgel work-station family delivers the performance of a Digital Equipment Corp. VAX 8600 minicomputer—about 3.5 million instructions/s—for as little as $45,000 compared with the over $100,000 for the VAX. Unlike other computer-aided design and engineering work stations, which are microproces-

sor-based, the Edge1 series uses 21 CMOS very large-scale gate arrays.

The family consists of the 500M monochrome station, the 500C color version, the 500S network server, and the multiuser 5000, which runs on AT&T's Unix operating system. For graphics, Edge1 uses a 16-bit Z-buffer, Gouraud shading, and a window manager. It generates 28,000 three-dimensional polygons per second with a resolution of 1,280 by 1,024 pixels, thanks to a floating-point accelerator and a four-stage pipelined CPU.

For networking, the family supports the Ethernet Transmission Control Protocol/Internet Protocol, the Sun XNS network file system, and the Manufacturing Automation Protocol. Software includes the company's Guaranteed Share Unix, based on Unix System V, and optimized C, Pascal, and Fortran compilers. Memory can be expanded to 64 megabytes, and up to 3.5 gigabytes of disk storage is available.

Prices begin at $45,000, in quantities of 100. An average configuration with color capability runs $63,000, including a seven-slot Multibus card cage, Ethernet and Unix, 8 megabytes of main memory, and a 165-megabyte hard disk, streaming tape cartridge, and floppy disk.

Edge Computer Corp., 7273 E. Butherus, Scottsdale, Ariz. 85260.
Phone (602) 951-2020 [Circle 371]

COPIER PRINTS ON VELLUM OR FILM

Xerox's $3,695 engineering copier prints on 36-in.-wide vellum or polyester film as well as on paper, in virtually any length. The model 2510 operates at a constant speed of 10 ft/min. This thermographic machine, which resembles a standard office copier and measures 55 by 20 by 16 in., will reproduce engineering drawings, diazo prints, blueprints, sepias, and two-sided and mounted originals up to ⅛ in. thick.

The printer's programmable functions include image adjustment on the copy medium for a binding edge. In addition, the user can choose to reproduce only a portion of a given document. A roll cutter and paper storage bin are available as options.

The company will begin taking orders in the northeastern U. S. this month and will be taking nationwide orders by the third quarter of this year.

Xerox Corp., Xerox Sq., Rochester, N. Y. 14644. Phone (716) 423-3535 [Circle 364]

INTEGRATED NETWORK USES EXISTING WIRING

The Information Exchange, an office communications system, creates an integrated voice and data network over in-place telephone wiring, including PBXs and office-automation equipment.

Major functions of the Information Exchange are voice and text messaging, file display and printing, and file transfer among compatible personal computers. The system includes the central server, desktop terminal, voice-synthesis converter, message-center console, shared printers, modem and personal-computer ports, and up to 220 message lights for office phones.

Smart phone functions, such as automatic speed dialing and callback, can also be integrated into existing PBX installations.

The price of the Information Exchange is under $70,000 for a 115-user system; systems for up to 220 users are possible. A smaller configuration, for up to 30 users, costs under $30,000, and leasing is available.

Systems are being installed now, and they will be marketed through value-added resellers and original-equipment manufacturers later this year.

Zymacom Inc., 2 Lyberty Way, Westford, Mass. 01886.
Phone (617) 692-4500 [Circle 368]

MULTIPLYING DAC IS PRECISE TO 16 BITS

Hybrid Systems' multiplying digital-to-analog converter guarantees monotonicity to 16 bits at military and commercial temperature ranges. The HS9371 consumes just 45 mW, maximum, when driven with CMOS input levels. It also offers dual 8-bit input registers for linking directly with 8- or 16-bit buses, with easy pinout connections for 8-bit users located underneath the double-buffered DAC's 28-pin double DIP.

The HS9371 uses a digital decoding technique to achieve high accuracy by dividing the four most significant bits into 15 equal switches instead of the usual four binary weighted switches. This reduces offset errors as well as linearity errors due to resistor drifts by a factor of 8, with the remaining 12 bits routed through the normal R-2R network.

Pricing for military-grade parts starts at $125 in lots of 100; commercial pricing starts at $48 each in like quantities. Both are available now.

Hybrid Systems Corp., 22 Linnell Circle, Suburban Industrial Park, Billerica, Mass. 01821. Phone (617) 667-8700 [Circle 369]

MODULE LIBRARY AIDS C PROGRAMMERS

A comprehensive library of object-oriented functions and subroutines promises to halve C programming time and costs. Called PforCe, the software gives programmers a tool for handling a range of complex tasks.

High-level functions enable users to manipulate windows, menus, and data bases; low-level functions offer hardware control and defaults that can be changed at will. Subsystems handle such complex jobs as interrupt-driven communications and a data-base system with demand paging and B-trees to store access and index data.

PforCe is available now for Microsoft, Lattice, Computer Innovations, and Wizard compilers. It sells for $395.

Phoenix Computer Products Corp., 320 Norwood Park S., Norwood, Mass. 02062.
Phone (617) 762-5030 [Circle 353]

PROGRAMS EMULATE HP HAND-HELD COMPUTER

Programs for Hewlett-Packard's HP41CV hand-held computer can run on any MS-DOS- or PC-DOS-based personal computer, thanks to a software package called The FortyOne. Or the computer can be used to write programs for the calculator. No conversion or reprogramming is necessary, and the user does not have to learn a high-level language.

The FortyOne uses 320 registers and more than 16,000 program steps, its developer says. Priced at $115, the software runs most of the 5,000 programs in the HP41 Users Library without alteration. Over 240 programs are already available for use on the IBM Corp. Personal Computer. It is available now.

Straightforward, 15000 Halldale Ave., Suite 115, Gardena, Calif. 90249.
Phone (213) 324-8827 [Circle 354]

Electronics

THE ADVERTISERS AUDIT STUDY CONTEST

Enter a drawing for $1,000 cash by selecting your favorite ads in the March issue of *Electronics*.

Reader Contest Rules

1. After you have examined this issue of *Electronics*, pick your three favorite ads and enter your selections on the entry blank bound in this issue or on a 3" x 5" index card. Your entry should include: 1) the name of the advertiser; 2) the advertiser's Reader Service Number; 3) the page number the advertisement appears on; and, 4) if you would like, your comments explaining what you like most about the ads you selected. Ads placed by McGraw-Hill, Inc. should not be considered in this contest.

2. Check the box on the entry blank marked "Reader Contest." No more than one entry *per issue* may be submitted by any one individual. All entries must be postmarked no later than midnight, April 18, 1986. The winner will be notified in May, 1986.

3. The winner of the $1,000 cash prize will be selected in a random drawing from among all eligible entries. Winner will be notified by mail. Odds of winning depend on the number of entries received.

4. No purchase necessary. Contest void where prohibited or restricted by law. Liability for any taxes on the $1,000 cash prize is the sole responsibility of the winner. Employees of McGraw-Hill, Inc., its advertising agencies, and their families are not eligible to participate.

Advertiser Contest Rules

1. All advertising and marketing personnel in companies and agencies (other than McGraw-Hill, Inc. and its advertising agencies) are invited to participate in a separate contest for advertisers. All rules for the Reader Contest will similarly apply for this contest, with two exceptions: 1) the winner of the Advertiser Contest will *not* be selected in a random drawing from among all eligible entries; and 2) the box on the entry blank marked "Advertiser Contest" must be checked.

2. Examine the March issues of *Electronics* with extra care. Choose the three ads in each issue that you think readers of *Electronics* will pick as their favorites and enter your selections on the entry blanks bound in each issue or on a 3" x 5" index card. No more than one entry *per issue* may be submitted by any one individual.

3. All entries must be postmarked no later than midnight, April 18, 1986. Each individual's qualifying entries will be matched against the winning ads as determined in the Reader Contest. Whichever individual in this Special Advertiser Contest comes closest to picking the 15 winning ads for the month of March, 1986 will receive: 1) $1,000 cash; 2) one free full-page ad in *Electronics* for their company or client; and 3) a plaque acknowledging their skill in evaluating advertising. McGraw-Hill, Inc. reserves the right to schedule the free ad at its discretion.

4. This special Advertisers Contest is open to all advertising and marketing personnel in companies and agencies (other than McGraw-Hill, Inc. and its advertising agencies), whether or not their companies or agencies have an advertisement in the March, 1986 contest issues.

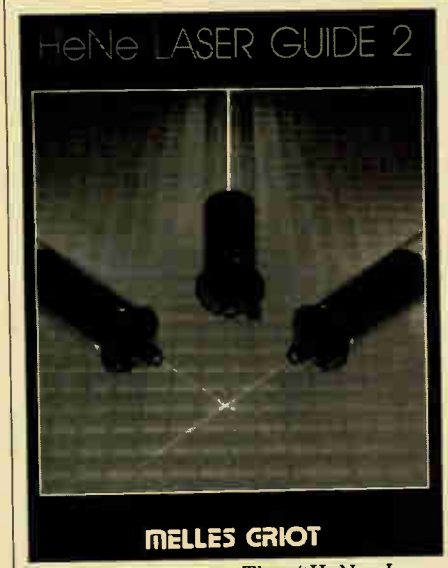
5. No purchase necessary. Contest void where prohibited or restricted by law. Liability for any taxes on the $1,000 cash prize is the sole responsibility of the winner. Employees of McGraw-Hill, Inc., its advertising agencies, and their families are not eligible to participate.

Winning Advertisers Earn Free Ad Reruns

The three advertisers receiving the most votes in each March 1986 issue of *Electronics* will receive a free rerun of their winning ads and a plaque commemorating their achievement. Since there are five issues of *Electronics* in March, there will be a total of 15 winning ads.

After all the March Reader Contest ballots are received, the three ads that scored the highest over the course of the entire contest will be determined and announced in May, 1986. These three Grand Prize Winners will receive a special plaque, plus a free rerun in *Electronics* of *all* the ads they ran in *Electronics* during the entire month of March.

All reruns will be made from existing plates or negatives. If the advertisement qualifying for a free rerun is an insert, the winner may run up to a four-color, two-page spread on R.O.P. stock from existing plates or negatives. McGraw-Hill, Inc. reserves the right to schedule reruns at its discretion.



LASERS AT WORK. The "HeNe Laser Guide 2" advises technical users and original-equipment manufacturers on the operation, design, and production of lasers. The 40-page brochure has sections on Gaussian-beam optics, helium-neon laser applications, and safety. Free copies are available from Melles Griot Laser Products, 435 S. Pacific St., San Marcos, Calif. 92069. Phone (619) 744-7060 [Circle reader service number 421]

HCMOS DESIGNERS' GUIDE. A 280-page guide to creating HCMOS circuits gives examples of Schmitt triggers, crystal oscillators, and automotive applications. It also shows how to replace large-scale TTL circuits with HCMOS. To receive a free copy, write to Philips Elcoma Press Office, P. O. Box 523, 5600 AM Eindhoven, the Netherlands. [Circle 422]

INFORMATION TECHNOLOGY. An executive handbook titled *Trends in Information Technology: 1986* offers an overview of this field and advice on how to use the technology to competitive advantage. Published by Arthur Andersen & Co., one of the Big Eight accountants, the 82-page book covers integrated-systems architecture, telecommunications, computer-integrated manufacturing, and end-user computing. It sells for $10 and can be ordered through the company's Division Services, Room 962, 33 W. Monroe St., Chicago, Ill. 60603. [Circle 423]

DATA-BASE MANAGEMENT. The National Bureau of Standards has developed a guide to help managers, systems analysts, and applications programmers plan a data base. Called the *Guide to Logical Database Design*, the 115-page publication focuses on very large, complex information systems. NBS Special Publication 500-122, stock number 003-003-02631-0, priced at $4.50, can be ordered from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

MOS FET SELECTION GUIDE. The six-page "MOSFET Selection Guide and Cross Reference List" offers design data on complementary n- and p-channel transistors in chart form. Key parameters are given for more than 170 MOS FET types in standard packages, including surface-mountable SOT-23 packages. The guide also includes a cross-reference to equivalent devices. For a free copy, call Ferranti Semiconductors at (516) 543-0200; the address is 87 Modular Ave., Commack, N. Y. 11725. [Circle 425]

UNINTERRUPTIBLE SUPPLIES. Ten models of Ferrups and Micro-Ferrups uninterruptible power supplies are described in a four-color 12-page brochure from their manufacturer. The devices, for both mainframes and microcomputers, shut down the system and sound an alarm in case of emergency, then reboot when it's over. Microprocessors control their self-diagnostic and monitoring capabilities. For a free copy, call Best Power Technology Inc. at (800) 356-5794—in Wisconsin, (608) 565-7200—or write the company at P. O. Box 280, Necedah, Wis. 54646. [Circle 426]

COILED FIBERS. Optical fibers that remain stable when coiled are the subject of this technical report from Corning Glass Works. These polarization-retaining single-mode fibers are intended for compact, lightweight sensor designs where coiling is needed to reduce overall volume—for example, in interferometers. The authors discuss design, fabrication, and physical and optical properties and give results of coiling experiments on five fiber types. Free copies are available from Corning's Telecommunications Products Division, MP-BH-5-1, Corning, N. Y. 14831. [Circle 427]

METALWORKING FACILITIES. A custom fabricator of metal products, parts, and components offers electronic consoles and cabinetry as part of its line. This eight-page brochure illustrates the company's capabilities, which include design and engineering as well as custom fabrication to user specifications. General shop equipment is specified. Request the free brochure from Metalfab Inc., P. O. Box 9, Vernon, N. J. 07462. Phone (201) 764-2000. [Circle 428]

MICROELECTRONICS CAPABILITIES. A 12-page color brochure describes Raytheon Co.'s microelectronics design, production, and quality control in its Quincy, Mass., facility, which specializes in high-reliability hybrid circuits. The brochure also describes typical circuits used in military and medical applications. Copies are available at no charge from Raytheon, 465 Centre St., Quincy, Mass. 02269, phone (617) 475-5300, or from a Microwave and Power Tube Division sales office. [Circle 429]

IMPEDANCE MATCHING. Specifications and applications for a line of impedance-matching adapters are featured in this brochure from Opt Industries Inc. The adapters bring 50- and 75-Ω data-processing equipment up to the 93-Ω rated input impedance of the IBM Corp. cabling system. For a copy of the two-page brochure, form number IM301, call the company at (800) 453-2580—in New Jersey, (201) 454-2600—or write to 300 Red School Lane, Phillipsburg, N. J. 08865. [Circle 430]

WIRE PREPARATION. Make or buy analysis is the subject of a free pamphlet that discusses whether certain wire operations are better done in-house or by subcontractors. These include cut and strip; cut, strip, and terminate; and harness making. The booklet also has checklists to help the original-equipment manufacturer pinpoint quality and service issues. To order a copy, write to Wiretronics Inc., 1648 Locust Ave., Bohemia, N. Y. 11716. Phone (516) 567-6500. [Circle 431]

DIP RELAYS. A free data sheet describes a line of 200-mW DIP relays, including a sealed version that can withstand immersion cleaning. The series 51 data sheet presents full electrical and mechanical specifications for the components, whose coil voltages range from 5 to 48 V. Copies are available from Stantel Components Inc., 636 Remington Rd., Schaumburg, Ill. 60195. Phone (312) 490-7150. [Circle 432]

MEETINGS

ECC COVERS CHIP COOLING TO CERAMICS

The 17 sessions of this year's Electronics Components Conference will take some surprising side trips. Besides such strictly components-related issues as packaging and chip cooling, the May 5-7 meeting will delve into everything from new ceramic materials to Star Wars.

Jack Balde, who chairs a session on new technologies in packaging, claims "the most significant paper of the whole ECC" is the last one to be presented at his session. The paper, from Nippon Telegraph & Telephone Corp., presents a chip-cooling scheme that is "an interesting alternative to IBM Corp.'s thermal-conduction modules," says Balde, owner of Interconnection Decision Consulting in Flemington, N. J. NTT's liquid-cooled ceramic substrate permits taking heat down from the substrate instead of up through the module. Other papers cover pin grid arrays and tape automated bonding, and Balde says Hitachi Ltd., which is "doing some of the most innovative things in packaging today" will update its efforts.

The ceramics session will cover thick and thin films plus bulk form, says chairman Chee G. Chen, principal scientist for electrical materials at Eaton Corp., Milwaukee. Chen says the session will feature "new developments in aluminum nitride substrates, metalization for ceramics, and metal-ceramic interface analysis."

A special evening session on the Strategic Defense Initiative will describe the technologies used, its four development phases, and how the initiative fits into the overall defense policy.

Flat-Plate Solar Array Project Meeting, Jet Propulsion Laboratory of the California Institute of Technology (William T. Callaghan, CIT, 4800 Oak Grove Dr., Pasadena, Calif. 91109), Pasadena Center, Pasadena, April 29-30.

BIO EXPO '86: American Commercial & Industrial Conference & Exposition in Biotechnology, Cahners Exposition Group (999 Summer St., Stamford, Conn. 06905), World Congress Center, Boston, April 29-May 1.

Semiconductor-Based Heterostructures, Metallurgical Society and Materials Research Society (Martin L. Green, AT&T Bell Laboratories, Room 1A-124, 600 Mountain Ave., Murray Hill, N. J. 07974), AT&T Bell Laboratories, Murray Hill, May 1-2.

5th International Symposium on Silicon Materials Science and Technology, Electrochemical Society (Howard R. Huff, Monsanto Electronic Materials Co., 755 Page Mill Rd., Palo Alto, Calif. 94303), Sheraton Boston Hotel & Towers, Boston, May 4-9.

ECC: Electronics Components Conference, IEEE and Electronic Industries Association (Leo G. Feinstein, Sprague Electric Co., 115 Northeast Cutoff, Worcester, Mass. 01606), Westin Hotel, Seattle, May 5-7.

Industrial & Commercial Power Systems Conference, IEEE (C. E. Becker, Cleveland Electric Illuminating Co., P. O. Box 5000, Cleveland, Ohio 44101), Bond Court, Cleveland, May 5-8.

International Conference & Exhibition on Computer Graphics, World Computer Graphics Association Inc. *et al.* (ICO Graphics, via Mecenate 87/6, 20138 Milano, Italy), Milan Fairgrounds, Milan, May 5-9.

E'ssembly '86: The Assembly Conference and Exposition for Electronics, Society of Manufacturing Engineers (1 SME Dr., Dearborn, Mich. 48121), Anaheim Hilton & Towers, Anaheim, Calif. May 6-8.

1986 SID International Symposium, Society for Information Display (Mark Goldfarb, Palisades Institute for Research Services Inc., 201 Varick St., New York, N. Y. 10014), Town & Country Hotel, San Diego, May 6-8.

Control Expo 86: Control Engineering Conference & Exposition, *Control Engineering* (Tower Conference Management Co., 331 W. Wesley St., Wheaton, Ill. 60187), O'Hare Exposition Center, Rosemont, Ill., May 6-8.

NTT International Symposium, Nippon Telegraph & Telephone Corp. (Ruder Finn & Rotman Inc., 110 E. 59th St., New York, N. Y., 10022), Keidanren Kaikan, Tokyo, May 7-8.

Computer Graphics '86, National Computer Graphics Association (2722 Merrilee Dr., Suite 200, Fairfax, Va. 22031), Anaheim Convention Center, Anaheim, Calif., May 11-15.

Comdex/Europe '86, The Interface Group Inc. (300 First Ave., Needham, Mass. 02194), RAI Congress & Exhibition Centre, Amsterdam, the Netherlands, May 12-14.

1986 Microwave Power Tube Conference, IEEE *et al.* (David Zavadil, Northrop Corp., 600 Hicks Rd., Rolling Meadows, Ill. 60008), Naval Postgraduate School, Monterey, Calif., May 12-14.

CICC: Custom Integrated Circuits Conference, IEEE (Tom Foxall, Pacific Microcircuits Ltd., 240 H St., Blaine, Wash. 98230), Riverside Convention Center, Rochester, N. Y., May 12-15.

LETTERS

Rogers supplies TAB tapes

To the editor: I was extremely surprised to read that Rogers Corp. had gotten out of the tape-automated-bonding business [*Electronics*, Feb. 17, 1986, p. 38]!

Rogers has been supplying high-quality three-layer (polyimide-adhesive-copper) material to TAB etchers for nearly a decade, and we remain actively committed to the market and to improving the materials available to users. We are preeminent in the three-layer field, our material having been used in tens of millions of TAB sites. We have recently developed and patented Fatab, a floating-annulus TAB material that includes a precise, mechanically generated, unsupported stabilizing ring at each TAB site, allowing positive support for cantilevered leads on three-layer material.

Steven T. Holzinger
Product Manager,
Semiconductor Materials
Rogers Corp.
Chandler, Ariz.

☐ Electronics *regrets the error and any problems it may have caused Rogers Corp. The point that should have been made is that Rogers left the TAB etching business—that is, the firm still supplies tapes, but does not etch them.*

PLDs are totally tested

To the editor: I appreciate your efforts in responding to the letter from Mr. Smith [*Electronics*, Feb. 24, 1986, p. 93] regarding ultraviolet-based programmable logic devices. As you properly indicated, E^2 (electrically erasable) PLDs can be erased and reprogrammed more quickly than UV devices. However, this is only the tip of the iceberg.

The true comparison of the testability of any device is shown by the bottom line. Only E^2-based PLDs are 100% testable and 100% tested. The Lattice GAL16V8 and GAL20V8 devices are the first and only E^2-based PLDs. These devices offer programming and postprogramming yields guaranteed to be 100%. Over four dozen array patterns are used to guarantee, through actual test, our unmatched yields. In contrast, the UV devices are patterned twice to compromised patterns, use phantom arrays [Cypress, PAL Application Brief, 1985] and offer no yield guarantees.

I refer you to our applications brief #104, which I would be very happy to send to any of your readers.

Dean Suhr
Product Marketing Manager
Programmable Logic Products
Lattice Semiconductor Corp.
Portland, Ore.

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ELECTRONICS WEEK

INDUSTRY SALES UP A BIT IN 1985

U.S. electronics companies sold some $229 billion of domestically produced goods and services in 1985, up 1.4% from 1984, says the American Electronics Association. But the year ended on a downswing as fourth-quarter sales dipped to $60.3 billion from the $61.1 billion reported for the comparable 1984 quarter. December sales of $21.6 billion were 2.7% below the same month in 1984. The December bright spot was in new orders, which at $21.1 billion were 6% ahead of December 1984 and 13% better than November 1985.

ELECTRONICS JOBS DOWN BY 50,000

The American Electronics Association, using data from the U.S. Bureau of Labor Statistics, has determined that U.S. electronics companies cut a net 50,000 jobs in 1985, down 2.3% from 1984's record employment of 2.59 million. Though the software and programming sector added 31,000 jobs, up 17.5%, and the communications sector came in with 27,000 new jobs, up 4.3%, heavy losses hit components manufacturers, down 9.1% with 63,000 jobs lost, and the computer and office-machinery makers, whose employment was down 8.4% with 45,000 jobs lost.

JAPAN'S U.S. SALES ROSE 15% IN 1985

Japan maintained its huge lead in electronic product exports to the U.S. during 1985, the Electronic Industries Association reported last week. Japan increased sales to the U.S. by 15% over 1984, to $20 billion. Taiwan was a distant second, selling products worth more than $3.2 billion. Canada sent more than $2.5 billion worth of goods across the border, but also topped the U.S. customer list, importing more than $4 billion worth of goods. The UK followed with more than $3.2 billion and Japan was third with a mere $2.6 billion in U.S. imports. The EIA, which used Commerce Department "raw data" to compile the trade figures, says U.S. electronics exports during 1985 totaled $31 billion.

ARMY WILL TRAIN ON VIDEO GAMES

U.S. military planners have committed at least one service to using video-game-like technology on a wide scale to train its personnel. A $57.8 million contract awarded last week to Perceptronics Inc., Woodland Hills, Calif., provides funds to take the Army's simulation network (Simnet) into a development stage in which it would approach the objective of a computer-controlled mock battlefield.

ELECTRONICS R&D REQUESTS RISE

While budget tightening is obvious in many of the U.S. government's spending plans for fiscal 1987, amounts requested for research and development and related programs in electronics are generally higher than those budgeted in fiscal 1986, according to an analysis by the U.S. Activities Board of the Institute of Electrical and Electronics Engineers. The Defense Department's funding request for electronics R&D, testing, and evaluation is up about 18.2% to $42 billion; the National Aeronautics and Space Administration's R&D request has risen 8.9% to $3 billion; and the National Science Foundation has requested $1.4 billion, up $126.7 million.

SIEMENS OFFERS ISDN SPECS...

Siemens Components Inc. is offering detailed information about its integrated services digital network-oriented modular interface to "any integrated-circuits manufacturer" wishing to produce chips for central-office and private-branch-exchange systems. Siemens, which is sampling a number of the ISDN-oriented modular, or IOM, devices, says the chips are fully compatible with CCITT standards. Because many countries, including the U.S., have not yet chosen an ISDN standard, the Iselin, N.J., subsidiary of Munich's Siemens AG hopes its modular, flexible approach will assure it a strong position when the market develops.

...AND JOINS WITH TANDBERG

The Westlake, Calif., Memory Products Division of another Siemens AG subsidiary, Siemens Information Systems Inc. of Boca Raton, Fla., has agreed with Tandberg Data Inc., Oslo, Norway, to coordinate marketing, sales, and technical support of data storage devices in the U.S. The effort will concentrate on Siemens's 5¼-in. Winchester disk drives and Tandberg's recently announced QIC 120-compatible 120-Mb streaming tape drive. It's intended to facilitate better penetration by both companies into the market for supermicrocomputers, professional work stations, and network file servers.

TWO DATA BASES WILL SHARE DATA

A complementary development agreement is bringing together two of the leading names in data-base management software: Applied Data Research Inc., Princeton, N.J., and Ashton-Tate Co., Culver City, Calif. The deal will provide for direct information exchange between ADR's mainframe program, Datacom/DB, and Ashton-Tate's microcomputer program families, dBase and Framework, through ADR's PC Datacom, a microcomputer-based query and report facility.

SANYO TO USE CHEAPER CRTs

The rise of the yen, which has put a squeeze on the price competitiveness of Japanese exports, has prompted Sanyo Electric Co. to begin importing less expensive cathode-ray tubes from two South Korean makers. The CRTs made by Lucky Gold Star Electronics and Samsung Electron Devices Co. are headed for Sanyo's color television factory in Forrest City, Ark., where close to 1 million sets a year are produced.

SWITCH MAKER IN NEW JAPAN DEAL

Digital Switch Corp., the Richardson, Texas, company that last fall became the first U.S. manufacturer to close a major switching contract with a Japanese carrier, Daini-Denden Inc., has formed a joint venture subsidiary in Tokyo with Mitsubishi Corp. The new company will promote further sales of Digital Switch's switching systems in Japan, as well as offering installation, maintenance, and training support to customers.

PCs TO BEAT OUT MINIS, MAINFRAMES

Personal computers, not systems based on minicomputers or mainframes, will win the race to automate corporate America, predicts Rod Canion, president of Compaq Computer Corp. In his keynote address to the 7th Annual Afips Office Automation Conference in Houston last week, Canion said IBM Corp. PC-compatible computers have emerged as the de facto office work station, and future PC work stations will continue to be based on Intel Corp.'s microprocessors, including the 80286 and 80386.

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