A McGRAW-HILL PUBLICATION

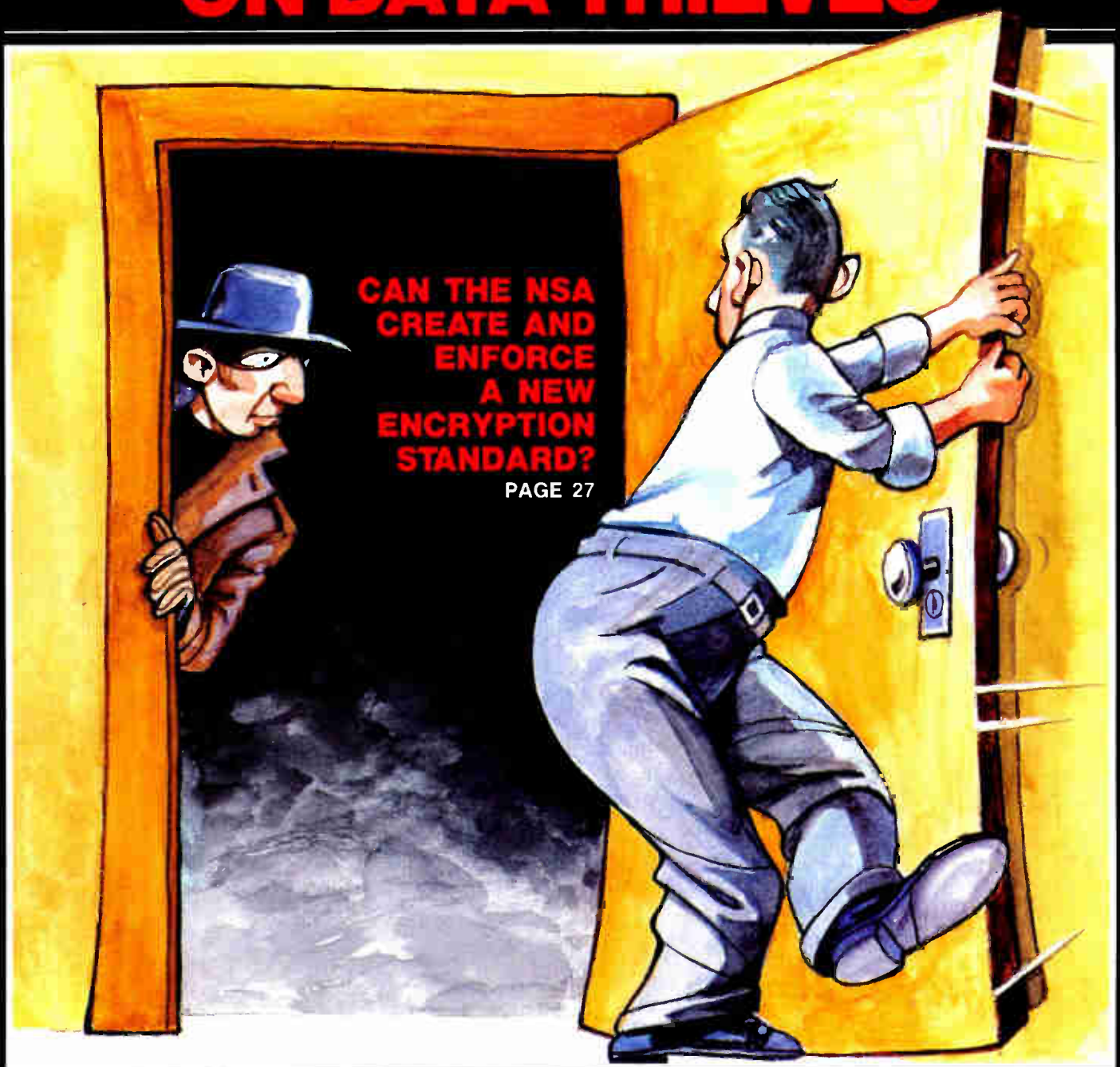
THREE DOLLARS

Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

FEBRUARY 3, 1986

SLAMMING THE DOOR ON DATA THIEVES



CAN THE NSA CREATE AND ENFORCE A NEW ENCRYPTION STANDARD?

PAGE 27

JUNKINS' 1986 STRATEGY TO GET TI BACK ON TRACK/18

IT'S ALL-OUT WAR IN JAPAN AS IBM COMES OUT FIGHTING/44

INTRODUCING OUR 1986 COMPACTS.

A McGRAW-HILL PUBLICATION

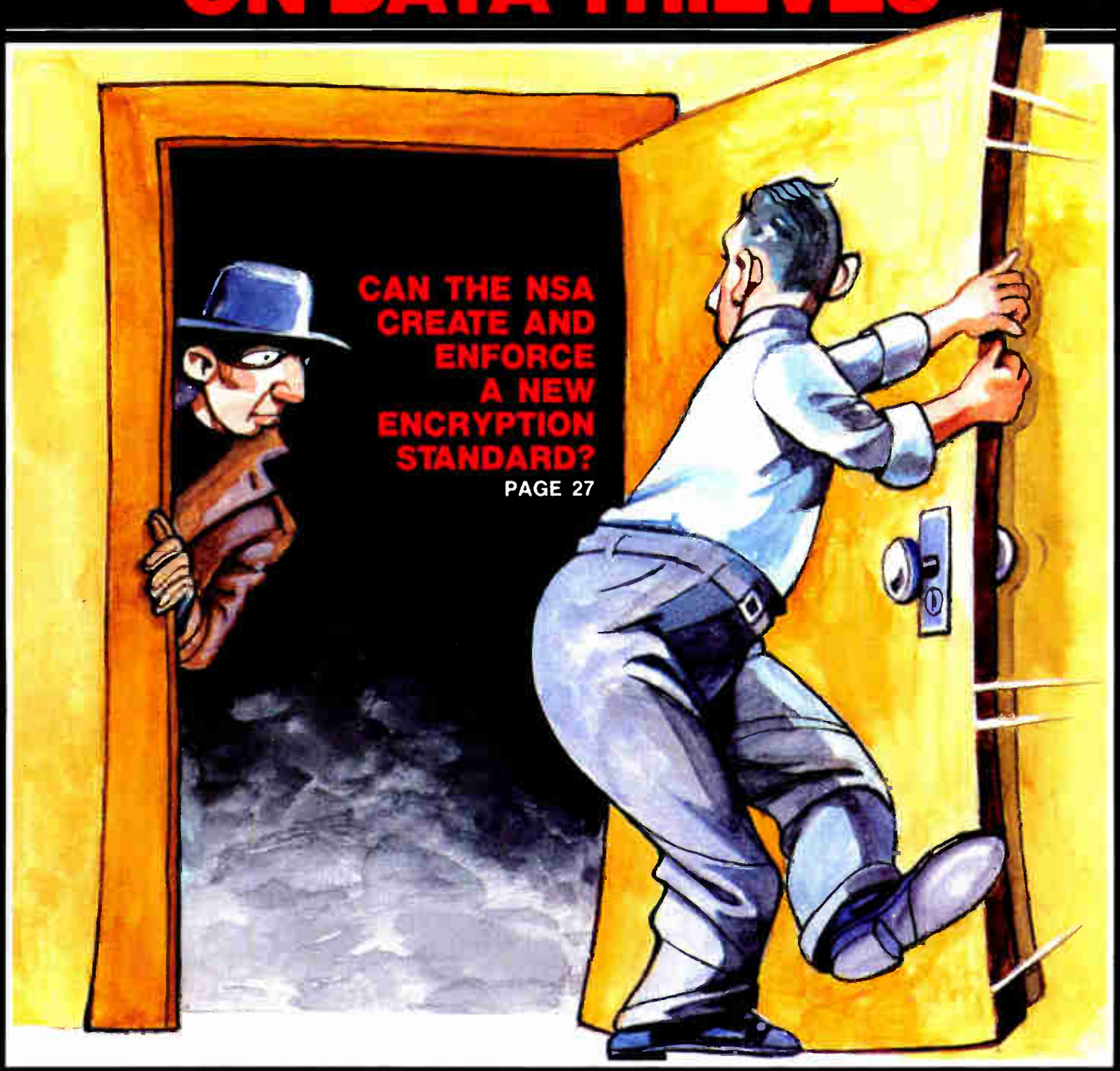
THREE DOLLARS

Electronics

THE WORLDWIDE TECHNOLOGY WEEKLY

FEBRUARY 3, 1986

SLAMMING THE DOOR ON DATA THIEVES



CAN THE NSA CREATE AND ENFORCE A NEW ENCRYPTION STANDARD?

PAGE 27

JUNKINS' 1986 STRATEGY TO GET TI BACK ON TRACK/18

IT'S ALL-OUT WAR IN JAPAN AS IBM COMES OUT FIGHTING/44

Open one up.

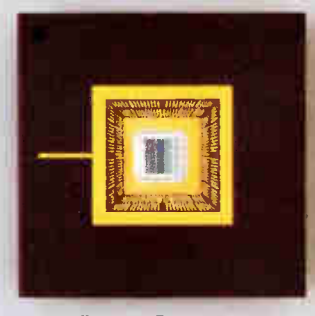
And feel your pulse accelerate. 50,000 logic gates on a single chip. Room enough to implement large macro-functions and build an entire digital system.

All with our new LCA 10000 Compacted Array™ Series.

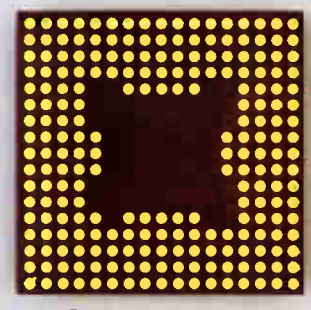
In theory, somewhere between a gate array and a cell-based custom IC.

In practice, it's a flat-out acceleration of our ASIC technology. With advanced 1.5 micron, dual-layer HCMOS technology. And our innovative variable routing tracks.

For performance no mere gate array can touch. 0.7 nanosecond propagation delay for a 2-input NAND gate. ECL-like speeds. Random Routing. VHSIC performance compatibility. And more.



Our new 50,000-gate LCA 10000 Compacted Array Series makes "System Scale Integration" a reality. Now, you can fit an entire system on a chip.



Even the packaging is advanced, with up to 256 I/O signal pins.

You'll get there fast, too, using our proprietary LDS™ Design System. Working at any of our 12 worldwide design centers.

And you'll get there safely. Thanks to our proven 97% first-time hit rate.

With manufacturing in our facilities. The best equipped in the country. Geared to pump out all you need. From hundreds. To hundreds of thousands. All thoroughly tested on our 256-pin system.

Start yours today. Call one of our sales offices listed below.

Because with our new Compacted Array Series driving your next design there's no telling how far you'll go.

Or how fast.

LSI LOGIC CORPORATION

San Jose, CA 408/248-5100, Irvine, CA 714/261-0124, Sherman Oaks, CA 818/906-0333, Denver, CO 303/756-8800, Westport, CT 203/222-9336, Altamonte Springs, FL 305/339-2242, Boca Raton, FL 305/395-6200, Schaumburg, IL 312/397-0155, Waltham, MA 617/890-0161, Ann Arbor, MI 313/769-0175, Minneapolis, MN 612/835-6161, Raleigh, NC 919/872-8400, Trevose, PA 215/638-3010, Austin, TX 512/343-4513, Dallas, TX 214/788-2966, Bellevue, WA 206/455-5055, Nepean, Ontario 613/726-1585, England 44-344-426544, Israel 972-3-421146/7, Japan 81-3-589-2711, West Germany 49-89-926903-0 LCA 10000 Compacted Array Series is a registered trademark of LSI Logic Corporation.

Circle 900 on reader service card

INTRODUCING OUR 1986 COMPACTS.

0-50,000 IN 0.7 NSEC.

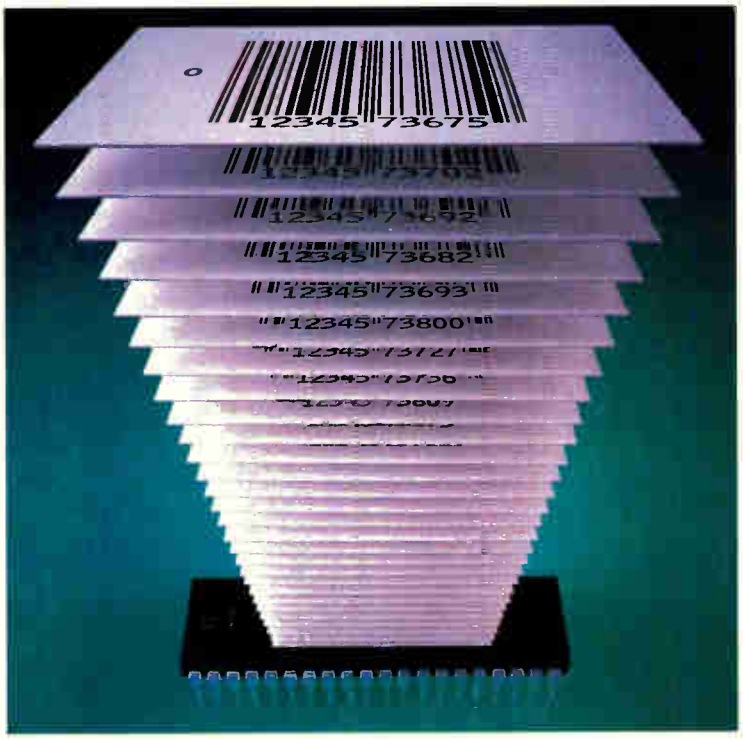
SURPRISE!

Introducing the world's most powerful bar-code decoder IC.

Compatible with most types of scanners.

Now, you can meet most of your customers' scanning requirements with a single decoder IC.

The new HP HBCR-2000 is compatible with most types of scanners — hand-held laser scanners, wands, or slot readers — used in all types of applications — industrial, retail or medical.



And a wide variety of symbologies.

You can address virtually any market because the HP IC supports a wide range of bar-code symbologies. Combine it with the appropriate scanner and your equipment will be compatible with industry standards that specify Code 39, Interleaved 2 of 5, UPC/EAN, Codabar, or Code 128.

Design simplification.

By eliminating the need for bar-code software development, the HP IC can save you both time and money. Its flexible, bidirectional serial ASCII interface can be used independently or easily connected to another microprocessor for data processing or data reformatting.

Broad range of scanners, too.

HP manufactures a broad line of scanners, including state-of-the-art digital wands and slot readers, so we can also provide you with complete solutions to your bar code reading needs.

For pricing and delivery information, contact the Hewlett-Packard sales office listed in your telephone directory white pages and ask for the Components Department.

HP: The right choices for bar code solutions.

HEWLETT PACKARD

CG08505

Circle 1 on reader service card 1

MAINFRAME PCB LAYOUT POWER ON YOUR DESK-TOP IBM PC.

FutureNet's new DASH-PCB™ is an innovative pc-based layout "expert." Now, features of a proven PCB layout system are yours to complement our famous DASH Schematic Designer. Exclusive features, previously available only on an expensive mainframe, are combined in a package that is cost-effective, easy to learn, easy to use, and highly productive.

Here's an "Expert Multi-Strategy"™ router without equal. Your choice of routing strategies, plus trace hugging, rubber-banding, fine line rules, 45 degree routing, large board capacity, 18 trace layers, and easy to use command menus. It's truly auto-routing with the mind of an expert.

FREE BROCHURE!

Call today for your copy of the complete description of FutureNet's exciting new DASH-PCB — the "expert" system that puts mainframe power on your IBM PC.

FutureNet®

A DATA I/O Company

FutureNet Corporation • 9310 Topanga Canyon Boulevard
Chatsworth, California 91311-5728 USA • TWX: 910-494-2681
(818) 700-0691

Authorized IBM® Value-Added Dealer

Rent or Lease from:
- **Electro Rent Corporation**
- **United States Instrument Rentals, Inc.**

Circle 2 on reader service card

FEBRUARY 3, 1986 VOLUME 59, NO. 5

Electronics

NEWS

INSIDE TECHNOLOGY

PROBING THE NEWS

COVER

Cover illustration by Art Director Fred J. Sklenar

NEW PRODUCTS

DEPARTMENTS

SOMETIMES, THE FIRST STEPS ARE THE HARDEST.

So it seems with GaAs ICs.

As with anything new, you've got to walk before you can run.

A little help along the way always speeds things up, making the learning process a whole lot easier.

As the first full line supplier of GaAs integrated circuits, we know. We've taken GaAs from its infancy to a practical IC solution for ultra-high speed memory and logic applications. In doing so, we've set the learning curve.

Our GaAs IC Foundry Service gets you up and running.

It lets you design and layout your own GaAs IC's under our guidance. Then, we fabricate these circuits using our 1 micron D-MESFET process. So you can run with 100 picosecond gate delays.

From this experience, you'll learn that designing GaAs ICs isn't harder — it's just a little different.

You'll also understand why you should run your design on the line that runs more GaAs wafers than anyone in the world.

For immediate information on our GaAs IC Foundry Service, call (800) GaAs ICS (422-7427). In CA (805) 499-0610. Or write: GigaBit Logic, 1908 Oak Terrace Lane, Newbury Park, CA 91320. Telex 6711358.

And become a part of the GaAs generation.

GBL GigaBit Logic

THE NEXT GENERATION

Every journalist can remember a story that virtually dropped into his or her lap, complete with good, readily available sources who have plenty to say. But more often, putting together a news story involves weeks of hard digging because those in the know won't—or can't—talk.

A case in point is the Probing the News on p. 44 of this issue, which outlines the redoubled efforts of IBM Corp. to regain its position as the leader in computer sales in Japan. IBM refused to talk. For the average American reporter, that refusal might have killed the story. But Mike Berger of our Tokyo bureau was able to bridge the cultural gap between himself and the Japanese computer industry officials who had the needed information. He used all the skills and tricks of the trade to wedge the story out of Japanese sources over a six-week period.

EXPERT. Lyman knows VHSIC.

Giving Mike an edge was his background in Japan's culture and language. He has spent a good part of his adult life in Japan. Before working for us, he lived there as the recipient of a Fulbright-Hayes research award, which gave him the opportunity to study the language and the society as well as to do freelance writing for the *Washington Post*, the *New York Times*, and the *New Leader* magazine as well as the *San Francisco Chronicle*, a newspaper for which he also worked full-time.

Not only that, but Mike, who is a graduate of the University of California at Berkeley, has used his knowledge of Japan and the Japanese on a number of films, including an award-winning documentary. He even wrote the script for a 16-part film series called "Japan: the Changing Tradition."

So if there is such a thing as the ideal background for dealing with stubborn news sources in Japan, Mike Berger would seem to have it.

For anyone making a short list of ideal backgrounds, our Packaging & Production editor, Jerry Lyman, would have to be on it. Jerry, whose expertise extends to testing, displays his talents on p. 42 in the article on the problems that the Pentagon's Very High Speed Integrated Circuits program is having in its hunt for automatic test equipment to handle the complex VHSIC chips.

Jerry, who started in engineering as a technician in the Navy, has been on the staff of *Electronics* for 11 years. Before that, he worked as a design and test engineer: as many people in the industry maintain, he hasn't forgotten a thing.

February 3, 1986 Volume 59, Number 5
90,707 copies of this issue printed

Electronics (ISSN 0883-4989). Published weekly by McGraw-Hill Inc. Founder: James H. McGraw 1860-1948. Publication office: 1221 Avenue of the Americas, N.Y., N.Y. 10020; second class postage paid at New York, New York and additional mailing offices. Postage paid at Montreal, P.Q. Registration Number 9034.

Executive, editorial, circulation, and advertising addresses: Electronics, McGraw-Hill Building, 1221 Avenue of the Americas, New York, N.Y. 10020. Telephone (212) 512-2000. Teletype 12-7960 TWX 710-581-4879. Cable address: M C G R A W H I L L N E W Y O R K.

Subscriptions limited to professional persons with active responsibility in electronics technology. No subscriptions accepted without complete identification of subscriber name, title or job function, company or organization, and product manufactured or services performed. Based on information supplied, the publisher reserves the right to reject nonqualified requests. Subscription rates: the United States and possessions $32 one year, $55 two years, $76 three years; company addresses and company libraries $40 one year, $67 two years, $93 three years; Canada and Mexico $34 one year, $57 two years, $78 three years; Europe $50 one year, $85 two years, $125 three years; Japan, Israel, and Brazil $85 one year, $140 two years, $200 three years; Australia and New Zealand $95 one year, $170 two years, $240 three years, including air freight; all other countries $50 one year, $85 two years, $125 three years. Limited quota of subscriptions available at higher-than-basic rate for persons allied to field served. Check with publisher for these rates. Single copies: $3.00. Please allow four to eight weeks for shipment.

Officers of McGraw-Hill Information Systems Company: President: Richard B. Miller; Executive Vice Presidents: Frederick P. Jannot, Construction Information Group; Russell C. White, Computers and Communications Information Group; J. Thomas Ryan, Marketing and International. Senior Vice Presidents: Francis A. Shinal, Controller; Robert C. Violette, Manufacturing and Technology. Senior Vice Presidents and Publishers: Harry L. Brown, Computers and Communications; David J. McGrath, Construction. Group Vice President: Peter B. McCuen, Communications. Vice Presidents: Fred O. Jensen, Planning and Development; Margaret L. Dagner, Human Resources.

Officers of McGraw-Hill Inc.: Harold W. McGraw Jr., Chairman; Joseph L. Dionne, President and Chief Executive Officer; Robert N. Landes, Executive Vice President and Secretary; Walter D. Serwatka, Executive Vice President, Publishing Services; Shel F. Asen, Senior Vice President, Manufacturing; Ralph R. Schulz, Senior Vice President, Editorial; George R. Elsinger, Vice President, Circulation; Ralph J. Webb, Vice President and Treasurer.

Subscribers: The publisher, upon written request to our New York office from any subscriber, agrees to refund that part of the subscription price applying to copies not yet mailed. Please send change-of-address notices or complaints to Fulfillment Manager, subscription orders to Circulation Manager, Electronics, at address below. Change-of-address notices should provide old as well as new address, including zip codes. Attach address label from recent issue. Allow one month for change to become effective. Subscriber Service: call (201) 356-7980, 9 a.m. to 4 p.m. EST. Postmaster: Please send address changes to Electronics, att: Fulfillment Manager, CN 808, Martinsville, N.J. 08836.

Editorial department phones: Administration (212) 512-2645, News and New Products (212) 512-2685, Technology (212) 512-2666. Bureaus: Boston (617) 262-1160, Chicago (312) 751-3811, Dallas (214) 458-2400, Los Angeles (213) 480-5234, New York (212) 512-6985, San Francisco/Palo Alto (415) 968-2712, Washington (202) 463-1650, Frankfurt 72-5566. London 493-1451, Paris 720-2070, Tokyo 581-9816. **Business departments:** (212) 512-3469 (Business departments follow the Advertisers' Index).

"We did it!"

"It's our competitors' faces I want to see. We've really cracked this market now."

"Like National's 32-bit microprocessor family?"

"I knew we'd close that sale. Did you see their faces?"

"Looks like we made all the right decisions at the right times."

"You can't build a system out of data sheets and promises. National had it, they delivered it, and they got us here first."

While you're still dreaming about success, Sequent is delivering it. With National's Series 32000 family.

On January 17, 1983, eighteen people started a new company called Sequent Computer Systems. They had no product, no plan, no backing. Only a dream.

Two years later, that dream came true. They delivered their first system—a sophisticated parallel processing computer. A full year ahead of their competitors.

How'd they do it? Hard work. Calculated risks. Belief. And a critical decision. They chose the Series 32000™ microprocessor family.

It offered them a *complete* 32-bit microprocessor family, including demand paged virtual Memory Management, Floating Point, and other peripherals with full UNIX™ support.

But the Series 32000 wasn't just the right engineering decision, it was the right *business* decision. It helped Sequent get their system to market fast. First.

Sequent hit their window of opportunity. And that window is still open—for now. So find out how the Series 32000 can help you build your own success story. Contact National Semiconductor today.

National's Series 32000, MS 23-200
P.O. Box 58090
Santa Clara, CA 95052-8090

National Semiconductor
We're doing it.

Circle 7 on reader service card

MEETINGS

CDROM GETS ITS OWN CONFERENCE

Growing interest in the compact-disk read-only memory as a storage medium for personal computers has inspired Microsoft Corp., developer of MS-DOS, to sponsor the 1st International Conference on CDROM technology.

Steve Lambert, editor of *CDROM: The New Papyrus* and speaker coordinator for the meeting, says Microsoft has a natural interest in CDROM because the Bellevue, Wash., company's operating system is pervasive in the personal computer market. William Gates, company chairman, will speak at the conference, along with Gary Kildall, chairman of Digital Research Inc. and founder of Activenture Corp.

A key topic will be standards, for which an unusually high level of cooperation exists, Lambert says. "Everybody's willing to work together to produce a product that will meet a standard, play on all machines, work with all software. In the computer industry in the past, people haven't been that cooperative." He says they may have learned from the successful cooperation in the CD audio market.

The 20 sessions will split almost evenly into two tracks: marketing and technical. Lambert says the technical sessions are "medium-level technology, not down to the bits and bytes." The marketing track "is aimed at existing database publishers who are aware it will have an effect on their business but are not sure what to do."

Conference speakers come from both the computing and publishing industries. Big names in computing—Apple Computer, Ashton-Tate, Digital Equipment, North American Philips, and 3M—will be represented. The publishing industry will be represented by such houses as Houghton Mifflin, McGraw-Hill, and Grolier Electronic Publishing, producer of the first consumer CDROM encyclopedia.

Nepcon West 86, Cahners Exposition Group (Show manager, Nepcon West 86, Cahners Exposition Group, 1350 E. Touhy Ave., Des Plaines, Ill. 60017-5060), Convention Center, Anaheim, Calif., Feb. 25-27.

IGWO '86: Topical Meeting on Integrated and Guided-Wave Optics, IEEE and Optical Society of America (Optical Society of America Meetings Department, 1816 Jefferson Pl. N. W., Washington, D. C. 20036), Marriott Marquis Hotel, Atlanta, Feb. 26-28.

Sensors: Devices, Materials & Processing, The Metallurgical Society (420 Commonwealth Dr., Warrendale, Pa. 15086), Marriott Hotel and Sheraton Hotel, New Orleans, March 2-6.

Comdex in Japan '86, Interface Group Inc., (300 First Ave., Needham, Mass. 02194), Harumi Exhibition Center, Tokyo, March 3-6.

Power UK '86, Power Supply Manufacturers Association (TCM Expositions Ltd., Exchange House, 33 Station Rd., Liphook, Hampshire GU30 7DN, England), The Kensington Exhibition Centre, London, March 4-6.

1st International Conference on CDROM, Microsoft Corp. (Travel Incentives, 650 Hampshire Rd., Suite 216, Westlake Village, Calif. 91361), Sheraton, Seattle, Wash., March 4-7.

Conference on Computer Graphics, Frost & Sullivan Inc. (106 Fulton St., New York, N. Y. 10038-2786), Diplomat Hotel, Hollywood, Fla., March 5-7.

Automation '86, American Automation Association (Edmond Macaluso, Tektronix Inc., 12303-A Technology Blvd., Austin, Texas 78727), Hyatt Regency, Houston, March 9-12.

Micro '86: Symposium on Microlithography, Society of Photo-Optical Instrumentation Engineers (SPIE, P. O. Box 10, Bellingham, Wash. 98227-0010), Santa Clara Marriott Hotel, Santa Clara, Calif., March 9-14.

ESC '86: Eastern Simulation Conference, Society for Computer Simulation (P. O. Box 17900, San Diego, Calif. 92117), Omni International Hotel, Norfolk, Va., March 10-12.

ADEE West: Automated Design & Engineering for Electronics West, Cahners Exposition Group (Show manager, ADEE West, 1350 E. Touhy Ave., Des Plaines, Ill. 60017-5060), Moscone Convention Center, San Francisco, March 11-13.

IZS '86: International Zurich Seminar on Digital Communications, IEEE *et al.* (R. Hartmann, Zellweger Uster AG, 8634 Hombrechtikon, Switzerland), Swiss Federal Institute of Technology, Zurich, March 11-13.

PD '86: Physical Design '86 Conference, IEEE (Nelson Brady, Tektronix Inc., 12303-A Technology Blvd., Austin, Texas, 78727), Hyatt Regency, Houston, March 12-14.

Work Station Technology & Systems Conference, IEEE (Helen Yonan, Moore School of Electrical Engineering, University of Pennsylvania, Philadelphia, Pa., 19104) Bally's Park Place Casino Hotel, Atlantic City, N. J., March 18-20.

Keep Up with Changing Technologies and Changing Markets Every Week with Electronics. The Voice of the Industry.

Electronics — A McGraw-Hill Electronics Publication

Today's decision makers, engineers and managers, are faced with a complex worldwide industry where technologies and markets change rapidly. Success or failure is directly related to information. Timely and accurate information that analyzes technology and its impact.

Only Electronics has the necessary editorial resources with 11 full time news bureaus around the world. (The largest in the electronics industry press) to bring you the latest technological developments. Timely, accurate and analytical information with top quality writing, reporting in an easy to read format.

Subscribe today by completing and mailing the attached card or just pick up the phone and call toll-free 800-257-9402, ext. 14 (in New Jersey call collect 609-426-5330, ext. 14).

McGraw-Hill

Electronics
CN 807
Martinsville, N.J. 08836

YES, please enter my subscription to Electronics for one year. (52 issues)

Name _____
Title _____
Company _____
Div. or Dept. _____
Co. address _____
City _____ State _____ Zip _____

☐ **Check here if you wish publication to be sent to home address:**

Street _____
City _____ State _____ Zip _____
Signature _____

Those not qualifying may pay higher than basic price.

	US	CANADA	MEXICO
☐ One Year:	$32	$ 51 CDN	12,580 Pesos
☐ Two Years:	$55	$ 86 CDN	21,090 Pesos
☐ Three Years:	$76	$117 CDN	28,860 Pesos

☐ **Payment enclosed** ☐ **Bill me**

Charge my subscription to: ☐ AMEX ☐ DC ☐ VISA
☐ MC-Bank# _____
Acct# _____ Exp. _____
Signature _____

Subscriptions are normally entered within 2 weeks, but please allow 4 weeks for shipment.

Please check which best describes your company's business at your location:
☐ Manufacturing ☐ Distribution ☐ Retailing ☐ Other _____

☐ **Indicate the primary product manufactured or services performed at your plant. (place applicable letter in box)**
A. Computers, data processing and peripheral equipment, office and business machines
B. Communications, data communications, telecommunications systems and equipment
C. Navigation and guidance, aircraft and missile systems or equipment (oceanography)
D. Test and measurement equipment
E. Consumer products (TV, radio, hi-fi, recorders, home computers, appliances)
F. Medical, industrial controls, systems or equipment
G. Semiconductor production equipment (component insertion, coil winding, etc.)
H. Electronic sub-assemblies, components and materials (passive, active components, IC's, discretes, hybrids, power supplies)
I. Other manufacturers using electronics equipment as part of their product (machine tools, chemicals, metals, plastics, pharmaceuticals, etc.)
J. Government and military
K. Independent research and development laboratory or consultant
L. Research and development organizations which are part of an educational institution
M. Independent software developers
N. Operators of communications equipment (utilities, railroads, police and airlines, broadcasting, etc.)
O. Educational: 2-4 year college, university
P. Other _____

☐ **Indicate your principal job function, occupation and/or title (place applicable letter in box. If letters O, P, or Q are used, fill in name of college or university).**
A. Corporate Management (Owners, Partners, Presidents, V.P.'s, etc.)
B. Operating Management (General Managers, Group Managers, Division Heads, etc.)
C. Engineering Management (Project Manager, Chief Engineer, Section Heads, V.P. Engineering, V.P. Research and Development, V.P. Quality Control, etc.)
D. Software Engineering
E. Systems Engineering/Integration
F. Quality Control Engineering (Reliability and Standards)
G. Design Engineering
H. Engineering Support (Lab Assistants, etc.)
I. Test Engineering (Materials, Test, Evaluation)
J. Field Service Engineering
K. Research and Development (Scientists, Chemists, Physicists)
L. Manufacturing and Production
M. Purchasing and Procurement
N. Marketing and Sales
O. Professor/Instructor at _____
P. Senior Student at _____
Q. Graduate Student at _____

☐ **Indicate your principal job responsibility. (place the appropriate number in box)**
1. Management 2. Engineering Management 3. Engineering

Estimated number of employees at this location. (check one)
☐ 1 to 49 ☐ 50 to 249 ☐ 250 to 999 ☐ over 1,000

Date _____ Signature _____

All information is required for reentry of subscription

5521

YES, please enter my subscription to Electronics for one year. (52 issues)

Name _____
Title _____
Company _____
Div. or Dept. _____
Co. address _____
City _____ State _____ Zip _____

☐ **Check here if you wish publication to be sent to home address:**

Street _____
City _____ State _____ Zip _____
Signature _____

Those not qualifying may pay higher than basic price.

	US	CANADA	MEXICO
☐ One Year:	$32	$ 51 CDN	12,580 Pesos
☐ Two Years:	$55	$ 86 CDN	21,090 Pesos
☐ Three Years:	$76	$117 CDN	28,860 Pesos

☐ **Payment enclosed** ☐ **Bill me**

Charge my subscription to: ☐ AMEX ☐ DC ☐ VISA
☐ MC-Bank# _____
Acct# _____ Exp. _____
Signature _____

Subscriptions are normally entered within 2 weeks, but please allow 4 weeks for shipment.

Please check which best describes your company's business at your location:
☐ Manufacturing ☐ Distribution ☐ Retailing ☐ Other _____

☐ **Indicate the primary product manufactured or services performed at your plant. (place applicable letter in box)**
A. Computers, data processing and peripheral equipment, office and business machines
B. Communications, data communications, telecommunications systems and equipment
C. Navigation and guidance, aircraft and missile systems or equipment (oceanography)
D. Test and measurement equipment
E. Consumer products (TV, radio, hi-fi, recorders, home computers, appliances)
F. Medical, industrial controls, systems or equipment
G. Semiconductor production equipment (component insertion, coil winding, etc.)
H. Electronic sub-assemblies, components and materials (passive, active components, IC's, discretes, hybrids, power supplies)
I. Other manufacturers using electronics equipment as part of their product (machine tools, chemicals, metals, plastics, pharmaceuticals, etc.)
J. Government and military
K. Independent research and development laboratory or consultant
L. Research and development organizations which are part of an educational institution
M. Independent software developers
N. Operators of communications equipment (utilities, railroads, police and airlines, broadcasting, etc.)
O. Educational: 2-4 year college, university
P. Other _____

☐ **Indicate your principal job function, occupation and/or title (place applicable letter in box. If letters O, P, or Q are used, fill in name of college or university).**
A. Corporate Management (Owners, Partners, Presidents, V.P.'s, etc.)
B. Operating Management (General Managers, Group Managers, Division Heads, etc.)
C. Engineering Management (Project Manager, Chief Engineer, Section Heads, V.P. Engineering, V.P. Research and Development, V.P. Quality Control, etc.)
D. Software Engineering
E. Systems Engineering/Integration
F. Quality Control Engineering (Reliability and Standards)
G. Design Engineering
H. Engineering Support (Lab Assistants, etc.)
I. Test Engineering (Materials, Test, Evaluation)
J. Field Service Engineering
K. Research and Development (Scientists, Chemists, Physicists)
L. Manufacturing and Production
M. Purchasing and Procurement
N. Marketing and Sales
O. Professor/Instructor at _____
P. Senior Student at _____
Q. Graduate Student at _____

☐ **Indicate your principal job responsibility. (place the appropriate number in box)**
1. Management 2. Engineering Management 3. Engineering

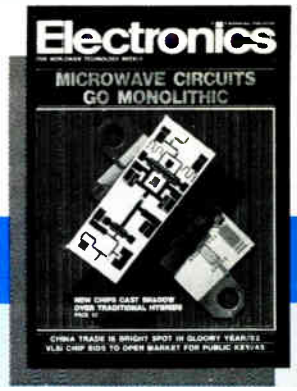
Estimated number of employees at this location. (check one)
☐ 1 to 49 ☐ 50 to 249 ☐ 250 to 999 ☐ over 1,000

Date _____ Signature _____

All information is required for reentry of subscription

5521

Keep Up with Changing Technologies and Changing Markets Every Week with Electronics. The Voice of the Industry.



Electronics A McGraw-Hill Electronics Publication

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 55 MARTINSVILLE, NJ

Postage will be paid by Addressee

Electronics

CN 807
MARTINSVILLE, NJ 08836

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 55 MARTINSVILLE, NJ

Postage will be paid by Addressee

Electronics

CN 807
MARTINSVILLE, NJ 08836

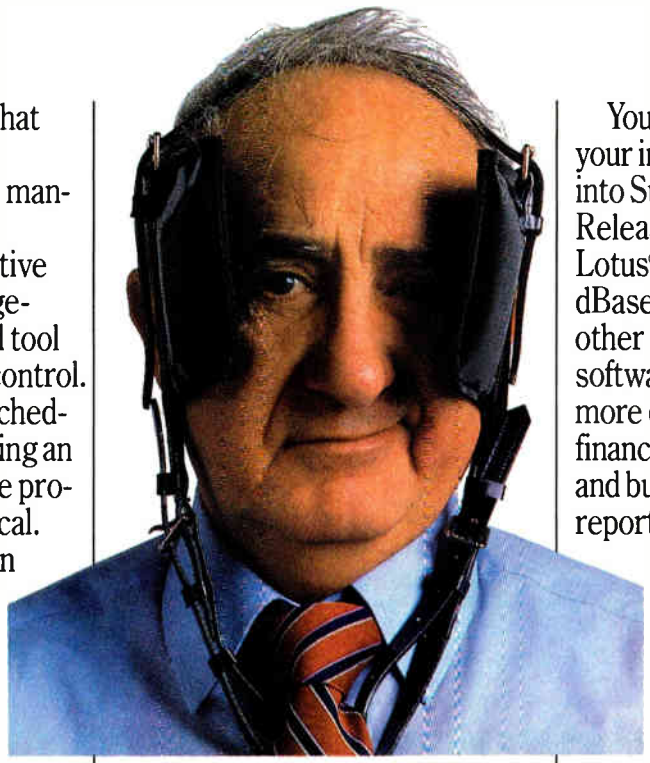
Today's decision makers, engineers and managers, are faced with a complex worldwide industry where technologies and markets change rapidly. Success or failure is directly related to information. Timely and accurate information that analyzes technology and its impact.

Only Electronics has the necessary editorial resources with 11 full time news bureaus around the world. (The largest in the electronics industry press) to bring you the latest technological developments. Timely, accurate and analytical information with top quality writing, reporting in an easy to read format.

Subscribe today by completing and mailing the attached card or just pick up the phone and call toll-free 800-257-9402, ext. 14 (in New Jersey call collect 609-426-5330, ext. 14).

Electronics
CN 807
Martinsville, N.J. 08836

Why look like the average manager?



At last there is software that puts you ahead of the pack.

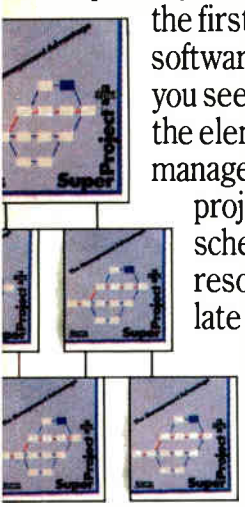
SuperProject Plus.™ The management advantage.

We have refined the effective techniques of project management into an unprecedented tool for complete management control.

From planning an audit, scheduling a new product, budgeting an ad campaign to managing the production of a Broadway musical.

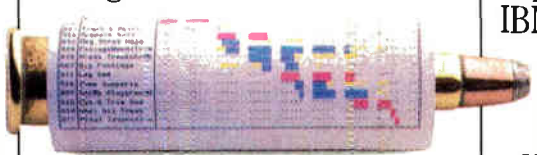
At a level any manager can understand. From beginner to expert.

SuperProject Plus is the first micro software that lets you see how *all* the elements you manage – your people, projects, budgets, schedules and resources – relate to and affect each other.



SuperProject Plus can improve performance on any level.

So you can plan ahead with confidence. Identify potential problem areas and take corrective action *before* it's too late. Compare your actual performance against your plans. And never be surprised by a deadline again.

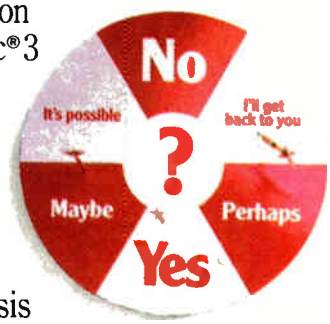


Now you'll have the ammunition you need to make better decisions.

SuperProject Plus will help you optimize resources. Take on greater challenges. Manage more intelligently.

In short, be a better manager.

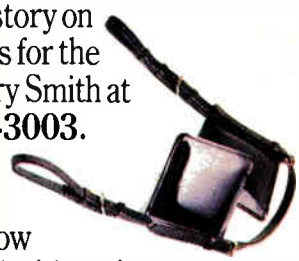
You can even directly transfer your information into SuperCalc® 3 Release 2, Lotus® 1-2-3,® dBase™ and other leading software for more detailed financial analysis and business reports.



Why rely on hit-or-miss management?

SuperProject Plus. From Computer Associates, the world's most experienced business software maker. With a list of satisfied customers that includes over 80% of the Fortune 1000.

For the whole story on SuperProject Plus for the IBM PC, call Terry Smith at **1-800-645-3003.** Or see your dealer.



You'll wonder how you ever managed without it.

COMPUTER ASSOCIATES
Software superior by design.

The way is CA.

Circle 11 on reader service card

The INMOS 25ns Static RAM Family. Because some designers prefer life in the fast lane.

INMOS just gave you a passing lane for high-speed Static RAMs. You're no longer stuck in low gear with slow-speed memories. Simply shift into over-drive with our advanced high-performance CMOS products.

You can accelerate to access times of 25, 35 and 45ns with our IMS1423 (4kx4) and 35, 45 and 55ns with our IMS1600 (64kx1). Our IMS1620 (16k x 4) offers 45, 55 and 70ns access times.

Our fast memories are fuel efficient: perfect for your power requirements. With E high, they can be placed in a low standby condition. And for even higher efficiency, you can reduce the standby power by using CMOS input levels.

Soup-up your system design with our IMS1423, IMS1620 and IMS1600. And let the competition eat dust.

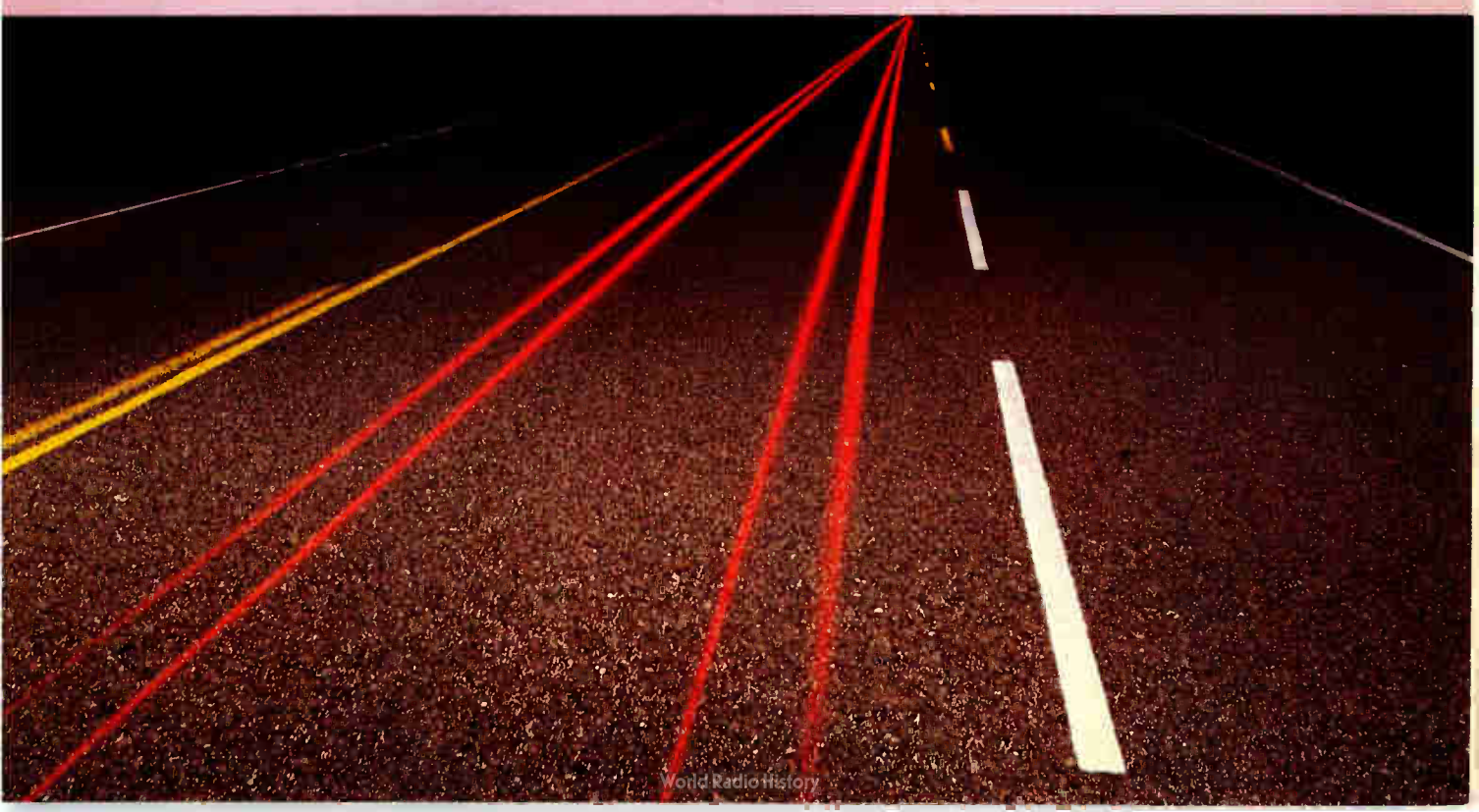
INMOS Corporation, Colorado Springs, Colorado. Tel. (303) 630-4000 Bristol, England. Tel. 0272-290-861 Paris, France. Tel. (1) 687-2201 Munich, Germany. Tel. (089) 319-1028

Device	Access Times	Max Power (mW) act	stby	Process
IMS1400 16K x 1	35,45,55	660	110	NMOS
IMS1420 4K x 4	45,55	605	165	NMOS
IMS1423 4K x 4	25,35,45	660	33 CMOS	CMOS
IMS1600 64K x 1	45,55,70	440	77 CMOS	CMOS
IMS1620 16K x 4	45,55,70	440	77 CMOS	CMOS

inmos

When you're ready to make tracks, not follow them, call INMOS.

Circle 12 on reader service card



TECHNOLOGY NEWSLETTER

SMALLER CCD ARRAY COULD SLASH PRICES OF VIDEO IMAGERS

A 1.5-μm charge-coupled-device array developed by Texas Instruments Inc. could cut the costs of a CCD imager kit for video cameras by almost two thirds, to around $100, when it hits volume production in 1987. Known at TI as the VID270, the chip is designed for use in 8-mm diagonal-format applications, and includes color filters. It is about half the size of TI's current TC240C array, which also uses the company's virtual-phase technology but with 2.5-μm minimum channel lengths. The 270's pixel size is 8.5 by 19.75 μm, compared with 11.5 by 27 μm on the 240C. Each chip has 754 horizontal pixels and 488 vertical pixels. Critical to the reduced size is an improved on-chip charge-detector amplifier, providing a stronger imaging signal from the shrunken CCD cells. Initial samples will go to potential customers in Japan during the spring. TI is banking on the new chip to make it a major contender in CCD imagers. The Dallas company says $100 for a CCD array kit, which includes the array and essential components, could open up widespread use in consumer and industrial video cameras—in robots, for example. □

WATCH OUT FOR 'SNAPBACK' IN ULTRADENSE ICs, WARNS SANDIA

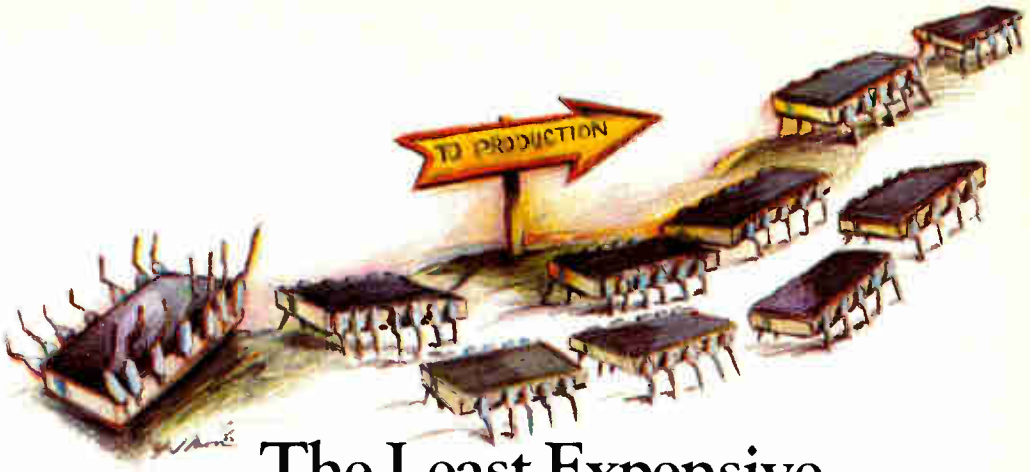
Researchers at Sandia National Laboratories are encouraging chip designers to pay more attention to a problem they call "snapback" that becomes more serious as the sizes of integrated-circuit features drop below 1.5 μm. Now under study at the Albuquerque, N. M., labs, this phenomenon can destroy an IC by forcing too much current through its circuitry. A combination of two conditions causes snapback: a transistor must be operating slightly above its operating voltage (12 V, ±½ V for a 3-μm chip on a 10-V supply), and it must be struck with an initiating event, such as radiation or electrostatic discharge. Chip designers can avoid the problem by including a mechanism to reduce the voltage when an initiating event strikes. □

UNIX SYSTEM V WILL BE PORTED TO INTEL'S 80386

Interactive Systems Corp. will port AT&T Co.'s Unix System V operating system to the Intel Corp. 80386, the 32-bit microprocessor that supports both Unix and MS-DOS. Intel says Unix System V is rapidly becoming the industry-standard version of the operating system. The Santa Clara, Calif., company will continue to use Microsoft Corp.'s Xenix version of Unix on its system-level products, but it will make the Interactive adaptation standard for its chips. It plans to have Unix System V and several high-level languages, including C, Fortran, Pascal, and Lisp, in beta-test sites by midsummer. Interactive Systems, which claims to be the largest Unix port specialist, has been working on the 386 since last August. The Santa Monica, Calif., company will help Intel customers tailor System V to 80386-based systems. □

NEWEST VAX OUTRACES THE 11/780 BY A FACTOR OF 12

A tightly coupled dual processor, 27 new custom chips, and 186 ECL gate arrays give Digital Equipment Corp.'s new VAX 8800 superminicomputer 12 times the throughput of a VAX-11/780. The $650,000 machine has 64-K bytes of cache memory and is completely compatible with DEC's VMS operating system. It uses a 60-megabyte/s main-memory bus and up to four new VaxBI buses for I/O transfers as fast as 30 megabytes/s. To accommodate the two processors and four I/O buses in one backplane, DEC has developed a 22-layer printed-wiring board. The Maynard, Mass., company also introduced the $127,000 VAX 8200, which offers 11/780 performance at half the cost, a new price-performance point for the VAX. A dual-processor version, the $160,000 VAX 8300, has nearly twice the performance of the 8200. □



The Least Expensive Way To Get The Bugs Out Of Your Department.

If you need a workhorse memory tester, you could spend up to three times more money than you really have to.

Up to 1 megabyte, GenRad's 1734M benchtop system does virtually everything those big testers do. At about one third the cost.

The 1734M handles a broad range of memories: RAMs, ROMs, EPROMs. It has auto calibration and pin deskew, for a high level of test repeatability and National Bureau of Standards traceability. It comes with a huge test program library, for extensive fault coverage. And it can network with our SCAN™ software to help you evaluate vendors and formulate test strategies.

So, for primary test or large system off-load, a 1734M is all you need to get the bugs out.

Anything else is simply overkill.

Call 1-800-4-GENRAD, or write GenRad, 170 Tracer Lane, MS66, Waltham, MA 02254.

GenRad®

ELECTRONICS NEWSLETTER

IS INTEL TOO INDEPENDENT FOR IBM?

Inability to call the tune at Intel Corp. may be the reason IBM Corp. has decided to reduce its investment in the Santa Clara, Calif., chip maker. Last week the computer giant, citing a desire to raise some $300 million, said it will sell as much as a third of its 22.5 million shares, which represent slightly under 20% of Intel's stock. Industry analysts say the move may have been triggered by Intel's abandoning of the random-access-memory market, which IBM considers to be the main chip-technology driver, and by its decision to divert resources from microprocessor development in favor of gaining a foothold in application-specific integrated circuits. Currently sitting on more than $350 million in cash and short-term investments, Intel has been immune to IBM pressure, analysts say. Both companies emphasized that IBM—now Intel's largest customer—will remain a major account. □

TWO JAPANESE COMPANIES THREATEN MOTOROLA'S LEAD IN DISCRETES

The continuing strength of Japanese consumer-electronics products, especially video cassette recorders, is reflected in a new estimate that two Japanese producers have passed the long-time leader in discrete components, Motorola Inc. Dean A. Winkelmann of industry consultant Integrated Circuit Engineering Corp., Scottsdale, Ariz., says his initial compilation shows Toshiba Corp. the 1985 leader with $580 million in discrete sales, NEC Corp. second at $570 million, and Motorola third at $550 million—a $100 million drop from its 1984 lead figure. Motorola refutes this ranking, saying that parts it classifies as ICs may be included in the Japanese discrete numbers. □

FCC'S FOWLER WANTS STATES TO COOPERATE ON OPEN ACCESS

The Federal Communications Commission is urging state public utilities commissions to quicken the pace of deregulation of the national telephone network. Chairman Mark S. Fowler wants the states to work with the FCC to ensure enhanced-service providers the same ease of entry into the local loop now enjoyed by the local phone companies themselves. Creating an open-network architecture and providing ready access to the functional elements of the networks on an unbundled basis would drive local phone rates down, Fowler said in launching the idea at Communications Networks '86 in Washington last week. Several states are already considering the plan. □

BULL CHARGES BACK, SPURRED BY PERSONAL COMPUTER SALES

Bull, France's flagship data-processing equipment manufacturer, expects to have another big year in microcomputers. The firm says it may sell as many as 50,000 of its Micral machines, up about 50% over the 1985 figure of 33,000. Bull boosted its 1985 microcomputer market share to 13%; in 1984, it was only 5%. That jump underpinned the company's steep rise in total sales: $2.2 billion for 1985, an increase of 18.5% on its 1984 revenue. □

HP's SPECTRUM, WITH A 3000 LABEL, WILL BOW NEXT MONTH

The long-awaited Spectrum reduced-instruction-set computer from Hewlett-Packard Co. will bear the HP 3000 label to emphasize continuity. President John Young told securities analysts last week that the first commercial model of the Spectrum series will be introduced next month and will be marketed as an enhanced version of last year's 3000 model 68. He predicted modest sales improvements for 1986 and said the Palo Alto company had seen a 6% increase in orders in the first two months of fiscal 1986 over the corresponding months of 1985, which were part of a record-setting quarter. □

"Who else could squeeze 512 analog input channels on 2 MULTIBUS™ boards? Or even 128 channels on one? We've done both."

Try this on for size.

Data Translation's new DT712 has 128 analog input channels. More than any other A/D board on the market. Add the DT713 to get 512 inputs.

Engineers faced with a lot of analog sensor inputs no longer have to add on a ton of extra boards for industrial process control applications.

Now all they need is one. Ours.

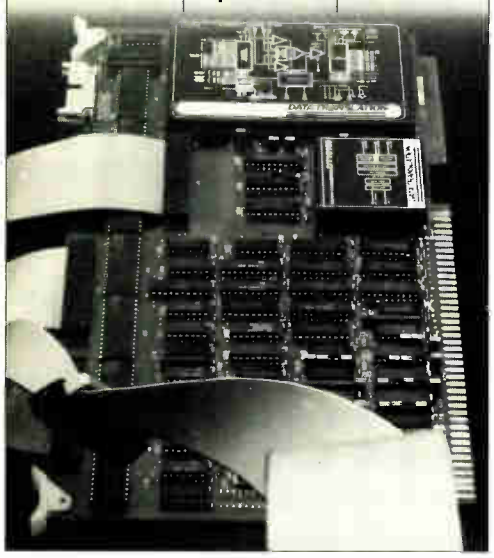
The DT712 is also extremely economical. With more channels, the cost per channel is at least a third less than anything the competition can offer.

Besides greater cost efficiency, the DT712 also includes multiple triggering and scanning schemes, and an on-board programmable clock. Plus, a unique screw terminal panel lets you enjoy easy installation of analog signals, and a very clean, noise-free cabling connection.

Fred Molinari, President

DT712 SERIES A/D BOARD DESCRIPTION

MODEL	TYPE	MAX NUMBER OF CHANNELS
DT712	High Level A/D	128SE/64DI
DT712 + DT713	High Level A/D Expanded	512SE/256DI
DT714	Low Level A/D	64DI
DT714 + DT715	Low Level A/D Expanded	256DI



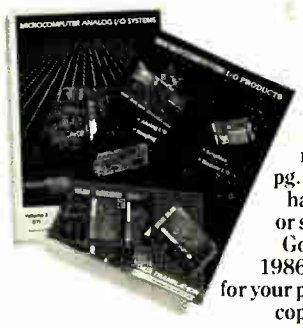
The DT712 provides for up to 128 A/D channels on a single MULTIBUS board.

And the DT712 is compatible with the latest MULTIBUS interface... including 24-bit addressing and 16-bit data transfers.

So before you get into a tight spot, call Data Translation.

We've loosened up the problem 512 ways.

Call (617) 481-3700.



See our new 646 pg. catalog/ handbook or see us in Gold Book 1986. Or call for your personal copy today.

DATA TRANSLATION

World Headquarters: Data Translation, Inc., 100 Locke Dr., Marlboro, MA 01752 (617) 481-3700 Tlx 951-646.
European Headquarters: Data Translation, Ltd., 13 The Business Centre, Molly Millars Lane, Wokingham Berks, RG112QZ. England Tlx: 851849862 (#D)

PRODUCTS NEWSLETTER

TI AND PHILIPS-SIGNETICS TEAM FOR 1-MICRON CMOS LOGIC

Texas Instruments Inc. has joined forces with Signetics Corp. and its Dutch parent Philips to develop and manufacture a 1-μm advanced CMOS logic (ACL) chip family. The initial three members of the family will be available in the second quarter of this year. TI, of Dallas, will make its ACL parts with its 1-μm Enhanced Performance Implanted CMOS process [*Electronics*, Jan. 27, 1986, p. 16]. Signetics, of Sunnyvale, Calif., and Philips will use a logic version of their 1-μm CMOS, known as MicroMOS. The family of chips represents the fastest CMOS line to date, with average propagation delays of 3 ns—about three times faster than standard silicon-gate HCMOS logic. By early next year, the companies expect to have 111 parts on the market; prices for the family will be announced later this spring. □

TRIPLE VMEBUS CARD PACKS A 32-BIT COMPUTER

Goodspeed Systems Inc. has announced the Uni-System, a 68020-based computer on a single triple-high VMEbus card. The East Haddam, Conn., manufacturer's first single-board system, which sells for $6,000, will do the work of five to seven cards. Intended for original-equipment manufacturers, Uni-System aims to fill the gap between end-user 32-bit systems and computers built by combining multiple boards from various manufacturers. Optional color graphics and an Ethernet link tailor the computer to automatic-test-equipment and graphics markets. □

WEITEK SLASHES PRICES ON FLOATING-POINT CHIPS

Weitek Corp. has added incentive for original-equipment manufacturers and system integrators who want to use more floating-point technology in the superminicomputer and work-station markets. In late January, the Sunnyvale, Calif., chip maker slashed the price on its WTL 1064/5 and WTL 1264/5 64-bit vector floating-point chip sets to $795, down from $2,200. At the same time, Weitek cut the cost of its WTL 1164/5 floating-point coprocessor chip set to $580, down from $700. The new prices are effective immediately. □

PHILIPS TO GUARANTEE ZERO DEFECTS ON ALL SEMICONDUCTORS

Look for Philips of the Netherlands to announce in the next week or so a zero-defect warranty on all the semiconductors it produces at its affiliates around the world. The Eindhoven company thus follows a policy started last summer by its subsidiary, Signetics Corp., in Sunnyvale, Calif. The Philips warranty, which becomes effective March 1, allows users who spot defects in a production lot of standard parts to return the whole lot to the factory for rescreening. Eventually, the warranty will be extended to include application-specific ICs. □

60-CHANNEL NETWORK HANDLES THOUSANDS OF NODES

As many as 10,000 nodes spread throughout a large campus can be tied together through Sytek Inc.'s 60-channel System 2000 family. Each port in the network has an individualized directory, and the network loader features "broadcast download" for updating software at all nodes at once. The family consists of the 2500 network loader, which sells for $1,395; the 2502 packet-communication unit, priced at $1,195; the 2522 asynchronous interface card, $600; the 2532 modular packet-communication unit, $4,400; and the 2550 network translator, $3,000. In addition, the Mountain View, Calif., company charges an annual license fee of $1,000. □

Electronics

JUNKINS' 1986 STRATEGY TO GET TI BACK ON TRACK

HE IS PUTTING MORE MUSCLE INTO FEWER PRODUCT LINES

DALLAS

Jerry R. Junkins is reducing the number of product lines at Texas Instruments Inc. to get the electronics giant back on track. "I'm convinced we've been trying to do too many things. That's the conclusion that [a new corporate management team] has come to in the past six months," says Junkins, who took over the job of running TI just eight months ago.

The Dallas company will "concentrate on doing a few things well; we'll put our muscle on them." And when a marketplace changes, or if TI doesn't have a good market share, the company will consider pulling out, he says.

Junkins will also focus research and development efforts primarily in three or four major areas. Microprocessors and microcontrollers will be one big target. And a major investment in artificial intelligence will be spread across the entire company, both in military and industrial product areas, he says. "We'll also put more muscle in industrial automation; it's a good little business."

TI wants to make its industrial unit a full systems business and is considering strategic alliances as well as acquisitions to build the operation. "We've already looked at some small companies," Junkins adds. And TI now intends to focus more of its troubled Data Systems Group on industrial automation markets after making little headway in the crowded office-automation markets.

MORE SERVICE. At the same time, the 48-year-old TI president is concentrating the company more than ever on marketing and on customer service, which he calls the "ultimate differential." In a wide-ranging interview with *Electronics*' editors, Junkins says he's asking TI divisions to develop "much closer customer relationships." Service "dominates our thinking now," he says. "It is no longer sufficient for a company to have a corner on the technology and the cost."

Adding impetus to his job of reshaping TI was the $118.7 million net loss for 1985 that the company reported last week—its second deficit in the past three years. Clobbered primarily by the steep semiconductor slump, TI's 1985 sales dipped 14% to $4.92 billion. Last year's loss was in sharp contrast to the record net profits of $316 million in 1984.

TI entered the 1980s as a semiconductor-based manufacturer with heavy involvement in consumer markets—including digital watches and home computers. Junkins now intends to depart the troubled decade as a force in industrial automation, leveraging its extensive IC know-how, its emerging expertise in AI, and volume-manufacturing disciplines.

CONCENTRATING. Junkins intends to have TI doing a better job in fewer areas.

Junkins, whose ascent to TI president and chief executive officer came suddenly last May after the early retirement of J. Fred Bucy, launched an extensive effort last summer to assess the firm's widely varying businesses, which range from ICs to oil-search and consumer electronics. His review had Junkins globetrotting to TI plants worldwide [*Electronics*, Aug. 12, 1985, p. 22].

Last fall, remedies were taken to stem what the 27-year TI veteran says were short-term problems. After posting an $82.8 million net loss in the third quarter, the company began closing an aging U.S. IC front end, an offshore assembly facility in El Salvador, and two computer plants in Texas. Worldwide employment totaled 77,872 at the end of 1985, down nearly 10% from 86,563 a year earlier. Many industry analysts believe these critical cuts in overhead were initiated much more quickly by Junkins than they would have been under Bucy.

TI lagged other U.S. semiconductor houses in showing a turnaround in chip sales late in 1985. "That principally reflects their exposure to the dynamic RAM business," says James L. Barlage, industry analyst with Smith Barney, Harris Upham & Co., New York. TI showed a drop in chip sales, while fourth-quarter gains were reported over third-quarter shipments by AMD, Intel, and Motorola. Still, Barlage is predicting a recovery for the chip industry, making the business profitable in 1986. He predicts that TI will record net income of $155 million in 1986, "assuming no unusual or extraordinary changes."

For 1986, Junkins will concentrate on reshaping the company's business directions as well as blending marketing and customer-service skills with the manufacturing and technology base. Part of that effort is a campaign to win market share in commodity chips by outperforming the competition in quality and on-time deliveries. Initial efforts are under way at TI's standard-logic operations and an automated IC-assembly line in Sherman, Texas. The line, called FAM, for flexible assembly module, will guarantee short lead times whenever demand rockets and chip shortages plague the commodity markets. TI is also inking partnership pacts with major computer houses in hopes of eventually becoming a sole source to them of commodity bipolar and CMOS logic chips.

Junkins says he wants another $50 million trimmed from the company's oil-search subsidiary, Geophysical Service Inc. GSI cut expenditures by $50 million in 1985, and it managed a modest profit in the fourth quarter despite continuing cutbacks in oil-well drilling.

The usually profitable Defense Electronics and Systems Group had flat revenue last year compared with 1984. But this business will return to growth rates comparable to the past 10 years, Junkins says. "Profits have been pretty stable, and barring major disaster, we'll have no major swings in profits this year."

The Data Systems Group in Austin, Texas, could tighten its belt further. "Our intention is not to let this group be a drag in 1986," Junkins says. The group will introduce a 32-bit minicomputer this year and is putting more R&D into terminals and peripherals. "We don't want to let that business dwindle," he says. This year, TI's consumer business will be "relatively flat and maybe down." This operation still needs to get costs down, he says.

In 1986, TI's Industrial Systems Division "can spend as much as they make [developing] new products and grow as fast as it can," Junkins says. The small division, which started out in the mid-1970s as an industrial-controller maker, was added officially to TI's business objectives in 1983. It has completed a number of turnkey factory-automation projects for food companies, pipeline plants, and internal company operations. TI material-moving robots, sensors, and controls are used in the Sherman FAM assembly line as well as TI's 6-in.-wafer plants in Dallas and Miho, Japan.

But how TI will do this year hinges on how quickly the semiconductor business turns around. "The road to recovery will be a bit more gradual [than in previous recessions]," Junkins says. But there are stirrings, he adds. The company has "already seen some lead times stretch out in bipolar." *–J. Robert Lineback*

MEMORIES

TI'S GET-TOUGH POLICY IN MEMORY CHIP PATENTS

DALLAS

Hold onto your legal briefs. A series of patent-infringement lawsuits filed recently by Texas Instruments Inc. against nine memory-chip producers in the Far East is just the start of a get-tough protection policy over TI's semiconductor inventions. The Dallas chip maker is stepping up the use of its huge catalog of patents to block competitors around the world and make dynamic random-access memories a more lucrative business for itself.

TI has quietly filed over the past year a barrage of patent applications in the U. S. and overseas intended to cover the most feasible approaches to three-dimensional structures for storage cells. A 3-d storage cell is considered essential to reducing the array areas of DRAMs reaching densities of 4 Mb and beyond.

"We are excited about the 4-Mb DRAM because it does represent a patentable position in the memory business for a U. S. company," says George Heilmeier, TI senior vice president and chief technical officer in charge of corporate research programs. The promising 4-Mb cell structure places the storage capacitor in a trench about 7 to 8 μm deep, topped off with a pass transistor. TI calls it a trench-transistor cell and has used it to fabricate an experimental 4-Mb CMOS DRAM [*Electronics*, Dec. 2, 1985, p. 50]. TI has filed trench-transistor patents in every country "where DRAM technology might migrate in the next decade," including India, adds Heilmeier.

SLEW OF SUITS. At the end of January, TI started the action by announcing it was suing nine DRAM makers—eight in Japan and one in Korea. The federal lawsuits claim existing DRAM products violate TI patent rights. Named in suits filed in Dallas federal court are Samsung Semiconductor of Seoul, and Japan's Fujitsu, Hitachi, Matsushita, Mitsubishi, NEC, Oki Electric, Sharp, and Toshiba. TI also plans to file for action before the International Trade Commission.

The suits are intended to protect "intellectual property and to increase the return on the investments in research and development that led to the technology embodied in TI's patents," according to William P. (Pat) Weber, executive vice president and corporate development officer. No suits are planned against U. S. companies.

TI claims to have 150 U. S. patents applicable to DRAM production. It cited eight registered U. S. patents, dating from 1970 to 1985, in the suit against the Korean and Japanese companies. The patents cover a binary decoder; a high-density, high-speed, random-access read-write memory; high-speed sense amplifiers for MOS RAMs; a RAM cell with different capacitor and transistor oxide thicknesses; an integrated-circuit

SHUTTLE DISASTER MAY MEAN MORE EMPHASIS ON ELECTRONICS IN SPACE

Electronic systems were not directly blamed in the aftermath of last week's space shuttle disaster, but questions were asked about why telemetry from on-board processors did not sense any problem. One possible effect of the tragedy on the electronics industry could be a long-range trend toward shuttle automation and more electronics-intensive unmanned launches.

National Aeronautics and Space Administration officials reportedly were baffled last week following initial evaluation of flight data. Unlike data in previous shuttle failures, data from the *Challenger* contained no evidence of a warning from its network of sensors. Jesse W. Moore, NASA's associate administrator for space flight, noted during a press conference that neither launch controllers at Cape Canaveral nor mission controllers at the Johnson Space Center in Houston detected anything unusual in the telemetry.

The shuttle processors, a fault-tolerant network built by IBM Corp., include five AP-101 navigation computers. A rash of hardware problems on previous flights led to a recent NASA decision to order 26 new code-compatible processors with three times the processing speed of the AP-101 [*Electronics*, Oct. 28, 1985, p. 24].

Based on initial telemetry evaluations, however, "there is no indication of a computer malfunction," stated James F. Harroun of IBM's Federal Systems Division in Bethesda, Md., in a heated denial. IBM still expects to deliver the enhanced-performance 101-S processors in 1987.

Shirley Henry of fault-tolerant-computer manufacturer Tolerant Systems, San Jose, Calif., said the real-time fault-tolerant technology used on the shuttle is mature. She suggested, however, that telemetry-analysis software used in early evaluations may not have found all possible correlations. In later evaluations, she added, "I would expect NASA would be ripping the data apart to get an answer."

Even though the Air Force says it is too early to assess the impact of the mishap on its space activities, a representative did say it may focus interest on two Air Force programs already under way. The first will modify 13 Titan II boosters to launch military payloads. A second program, to produce complementary expendable launch vehicles, as they are called, would be ready to launch two payloads per year by 1988.

The accident "will probably put more emphasis on the sophistication of automation on the shuttle," said David R. Criswell, an official of the California Space Institute who recently helped compile a report on automation and robotics for the space program. Criswell said the center, with headquarters at the University of California at San Diego, had been conducting "wide-ranging studies" on unmanned vehicles. A consortium of aerospace companies may eventually seek a more cost-effective means of getting payloads into orbit, he said. That would probably mean a more even mix of manned and automated vehicles. *–George Leopold*

MOS capacitor using implanted regions to change thresholds; carrier packaging for ICs; and two high-performance dynamic sense amplifiers with voltage boost for row-address lines.

"It is impossible to make a DRAM today without drawing on the technology described or covered in our patents in some way," says Norman H. Neureiter, TI vice president, corporate staff. Neureiter adds that TI has had patent cross-licensing pacts with many Japanese companies, but all expired without being renewed. The status of such agreements with U.S. companies was unclear last week, but TI officials indicate the suits are being brought against its Asian competitors because they are TI's major rivals in DRAMs.

In Japan and Korea last week, most of the defendant companies declined to comment on the suit. Toshiba acknowledges that its last pact with TI expired and says it is talking with TI to renew the agreements, but last week it had not been formally notified of the suit.

During the research phase of the 4-Mb trench-transistor cell, TI's semiconductor laboratory explored 15 to 20 possible approaches. "There was a patent a week coming out of there," recalls Greg Armstrong, manager of CMOS technology in the Advanced Development Division of the Semiconductor Group. "I would suspect we have covered just about every possible alternative of putting a transistor in a trench for a single cell. There will be a lot of people frustrated—every way they turn, there will be a TI patent."

PRICE PROTECTION. Heilmeier suggests patent enforcements may provide a new vehicle for protection against hostile price competition as well. In recent months, U.S. chip makers and trade organizations have asked the federal government to take action against Japanese companies accused of predatory pricing and of dumping memories onto the market at below their manufacturing cost.

"It is interesting with all this gloom and doom in the semiconductor industry about our ability as a nation to compete in the memory business," says Heilmeier. "Maybe this is one way that we will be able to compete. I think the trench-transistor cell shows there is plenty of innovation left in something a lot of people have written off as a commodity." *–J. Robert Lineback*

MILITARY

PENTAGON COMPROMISES ON PUBLISHING RESEARCH

WASHINGTON

Long-awaited guidelines designed to clarify U.S. policy on the publication of Pentagon-sponsored unclassified research could be implemented as early as this spring, technical society officials predicted last week. The draft policy, to be published in the Federal Register early this month, could reduce the incidence of last-minute censorship of technical papers by stipulating speedy Defense Department reviews of their contents.

HEARTENED. DOD move "shows the system works," says the IEEE's Eldon.

The proposed policy stems from an often rancorous dispute between Pentagon officials and the nation's leading professional societies. The dispute can be traced to a DOD announcement in February 1984 that it would seek to control attendance at unclassified technical meetings. Last September, 12 societies threatened to end sponsorship of classified sessions at their meetings to protest the plan [*Electronics*, Sept. 30, 1985, p. 12].

Technical society officials were upbeat last week about the DOD guidelines, saying they represent a compromise and a consensus of most society members. "I think release of that document shows that the system works," says Charles A. Eldon, who is a former president of the Institute of Electrical and Electronics Engineers and a key negotiator on behalf of societies representing 2 million engineers and scientists.

The guidelines would set up a "policy for the consideration of national security in the dissemination of scientific and technical information in the possession or under the control of the Department of Defense at conferences and meetings." The policy covers contracted fundamental research performed by universities or industry but excludes "rare and exceptional circumstances" where performance characteristics of military systems or critical manufacturing technologies would be disclosed.

At the suggestion of society officials, a mechanism for speedy review of papers was added to the draft policy. Reviews would be done in 10 working days for abstracts, in 20 days for papers intended for unclassified sessions with unlimited access, and in 30 days for papers to be presented at limited-access unclassified sessions and those for classified sessions. Explanations would be provided if a review could not be completed on time.

Another major issue addressed in the proposal is export-controlled technical data. Release of information would be dictated under appropriate exemptions to the International Traffic in Arms Regulations, the guidelines state. Although the application of export-control laws to the dissemination of technical data remains a basic problem, Eldon says he is satisfied with the DOD proposal. Pentagon officials "are doing the best they can under the wording of the law," he figures. *–George Leopold*

PHOTONICS

NEW CRYSTAL ADDS PUNCH TO LASERS

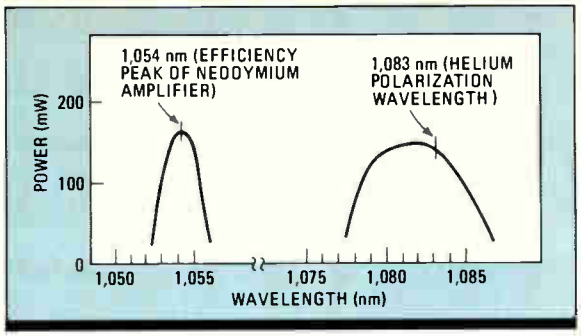
GRENOBLE, FRANCE

French chemists and optoelectronic materials engineers may have found the way to open up the use of power lasers in more automated industrial applications. With the development of a new material called lanthanum-neodymium hexaluminate, referred to as LNA, the production of small solid-state lasers with output power ranging from hundreds of watts to several kilowatts becomes a real possibility.

Such a laser would occupy a volume about the size of a shoe box, which would allow for relatively easy manipulation by robots and other automated production equipment. By comparison, many high-power carbon dioxide lasers take up entire rooms. In most industrial applications, the use of CO_2 lasers requires the redirection and focusing of their light output by cumbersome, costly, and unreliable arrangements of mirrors and lenses.

LNA was discovered at the Ecole Nationale Supérieure de Chimie in Paris and is being developed for laser applications at the Laboratoire d'Electronique et de Technologie de l'Informatique (LETI) in Grenoble. Philippe Coeuré, director of the LETI's Crystal Growth and Materials Research Laboratory, points out that the only other material currently available for solid-state power laser sources is Nd:YAG—neodymium-doped yttrium aluminum garnet. Lasers with up to 500 W of output power have been produced using Nd:YAG, and the LETI will continue its research using that material, principally because more is known about how to produce it and work with it.

Nonetheless, Coeuré feels that LNA could well be the solution to the two inherent difficulties presented by YAG lasers. One is that the amount of neodymium that can be present in the YAG material is very limited, which limits the output power. Second, the material lases at 1,060 nm. At that wavelength, the efficiency of a neodymium amplifier, which could be used to boost the output level, is very low.



TWO RANGES. LNA crystals lase in two known wavelength ranges. (Power figures shown are for small samples.)

LNA overcomes both these difficulties. The material's formula is given as $La_{1-x}Nd_xMgAl_{11}O_{19}$, which expresses the fact that Nd atoms can be substituted for lanthanum in the crystal. Most, if not all, of the lanthanum can be replaced, which substantially raises the potential output power. In addition, its lasing wavelength of 1,054 nm coincides with the efficiency peak of neodymium amplifiers, thus significantly improving its power potential.

Interest in LNA is not limited to power-laser applications. There are two known wavelength ranges at which the material lases (figure). At a wavelength of 1,083 nm, it operates with a peak tuning range of 80 Å. The 1,083-nm point in the spectrum is important because it is located at a resonance transition point in the triplet (He_3) spectrum of helium.

IN FUSION RESEARCH. A practical, efficient laser emitting at 1,083 nm would permit improved spectrographic studies of He resonance levels. Further, it would provide a useful source for optical pumping of He_3 and He_4. Optical pumping creates polarizations of the electronic and nuclear spins in these atoms. This pumping has potential uses in research into controlled nuclear fusion reactions and for generating jets of ions, electrons, and metastable atoms. Coeuré says details of these and other applications must be held back until patents are filed.

For the moment, the researchers at LETI have produced LNA lasers that, unaided by neodymium amplifiers, achieve output power comparable to the 500 W available from YAG devices. Coeuré sets the laboratory's middle-term objective, about five years from now, at boosting the figure to around 3 kW, rising to 5 kW in the longer term. The LETI is trying to establish with a number of partners a project in the European Eureka program to meet these objectives.

But for all its potential, LNA is not without drawbacks. The principal one is that its crystals are hexagonal, which makes them more difficult to work with than the cube-shaped YAG structures. When it is ready for market, material produced by the laboratory will be commercialized by Crismatec. This company is a joint venture formed by French chemical giant Rhone-Poulenc and the French Atomic Energy Commission, under whose jurisdiction the LETI operates. *–Robert T. Gallagher*

SENDING DATA OPTICALLY AT GIGABITS PER SECOND

BERKELEY, CALIF.

Gordon Rogers, a 25-year-old Berkeley inventor and horticulturist, has exploited a geometric fact about ellipses to design a startlingly simple method for transmitting optically encoded data.

Rogers's patented device uses a light source or sources at one focus of an internally mirrored ellipsoid. Light signals reflect to the other focus, where they can be transmitted to other destinations within a system. It is based on the fact that the sum of the distances between any point on an ellipse and its two foci is a constant, equal to the length of the major axis of the ellipse.

No manufacturers have committed themselves as yet to developing products based on the concept, but potential applications exist—for example, in connecting the processors of a multiprocessor supercomputer. The device could also be applied to the less complex but still vexing problem of connecting many high-speed electrical signals to a large bundle of optical fibers in a cable.

The system can be of almost any kind. Rogers calls his device the gross optical bus because he sees it as a way to link many processors in a high-speed supercomputer—where, he says, it would have a data-transmission rate in the gigabits-per-second range.

But backer and fellow Berkeleyite Lee Felsenstein, the designer of the Osborne I computer, says the device is not a bus at all. Rather, it is a kind of basic interface that could play a central role in applications as diverse as coupling signals to fiber-optic cable and connecting optical integrated circuits.

In any of these applications, the signals would reflect from an array of optical emitters at one focus to some form of receptor at the other. Because all paths between the foci are of equal length, signals sent at the same frequency over different routes are assured of arriving at the same time.

SYNCHRONICITY. The Japanese Ministry of International Trade and Industry has also patented an optical information-exchange system in which signals reflect from one processor to another—in this case, through a cylindrical mirror. In MITI's system, however, the processors are outside the mirrored surface, so the reflector itself blocks communication between some of the processors, and there is no built-in synchronicity. In Rogers's device, optical signals stay inside the cavity unless they exit through a fiber-optic cable.

Mirrored ellipsoid optically links processors in a system

A MITI group is working on a five-processor prototype for a high-speed system with up to 1,000 nodes. The ministry has not built the optical bus, only emulated it electronically.

Rogers, who dropped out of the University of California at Berkeley to work on his device, is not trained as an engineer and supports himself by raising orchids and house plants. He has designed a 64-processor system in which an array of optical transceivers routes signals between individual processor boards.

In this system, the processor boards must be located within the optical cavity. But Felsenstein has designed an application for the Rogers device in which the ellipsoidal cavity is used to couple many electronic signals to a fiber-optic cable in a single operation. This would eliminate the technical difficulties of cutting, polishing, and attaching an array of many transducers to optical fibers (figure, p. 22).

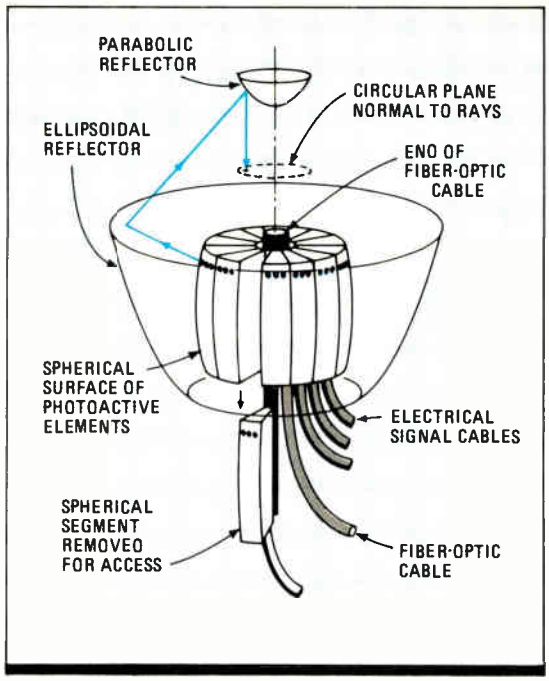
In Felsenstein's design, the electronics are connected to an array of light emitters and receptors on the surface of a sphere whose center is at one focus of the ellipsoidal cavity. Light radiating

out from the sphere is reflected toward a parabolic reflector whose focus is coincident with the second focus of the ellipsoid. The optical signals are thus reflected back in parallel along the major axis of the ellipsoid into the cross-section of the fiber-optic cable. Each emitter's beam goes to a single fiber.

Because the Rogers device maps the surface of a sphere to a planar surface, Felsenstein continues, it also offers promise as an interconnection scheme for future gallium arsenide-based supercomputer wafers carrying integrated optical emitters and detectors. Such devices already are being designed and fabricated [*Electronics*, Nov. 18, 1985, p. 39].

"Pins are the scarce resource in very large-scale integration," Felsenstein says. "This device offers a way to replace a mechanical link with optics." An array of switches on a wafer, he suggests, could be coupled to a fiber-optic cable by the Rogers cavity.

"Supercomputers are often conceptualized as spherical structures of circuit elements linked by radial conductors to an outer sphere to which connections from the outside are brought," says Felsenstein. "Since semiconductor development is using circular wafers . . . the mapping effect of the Rogers reflective cavity shows some promise for realizing these difficult geometries well before such physical geometries can be achieved." *–Clifford Barney*



CURVES. Light from emitters on a sphere reflects to a cable's fibers in one variation of Rogers's invention.

COMPUTERS

CHIP MAY HOLD KEY TO CONCURRENT COMPUTING

PASADENA, CALIF.

An experimental chip that incorporates a novel message-routing scheme may hold the key to the second generation of concurrent computers, according to Charles L. Seitz, a pioneer in this form of computing. A professor of computer science at the California Institute of Technology and developer of the Cosmic Cube architecture for linking multiple processors, Seitz worked with doctoral candidate William J. Dally, who designed and fabricated the Torus Routing Chip—named for its doughnut-shaped topology.

Using a scheme similar to virtual computer memory, the chip seeks to overcome a hang-up caused by the very feature that gives concurrent computing schemes their boosted horsepower: large numbers of microprocessor nodes working simultaneously on the same task. Messages running between nodes can get logjammed in single-dimension communication channels, thus deadlocking operation.

The self-timed chip has demonstrated at the Caltech laboratory that it can perform deadlock-free message routing. It differs from circuits used in store-and-forward packet-switching communication networks in several important respects. These conventional networks are used by present concurrent computers—such as Intel Corp.'s commercial version of the Cosmic Cube, the iPSC—in which interconnection deadlocks can occur as node queues fill with messages destined for the next node. When no message can advance, the cycle is deadlocked.

VIRTUAL METHODS. "That's one of the things we learned from the Cosmic Cube," says Dally. "We need the flexibility of more dimensions." Therefore, instead of a single communication channel, the chip "makes it look like two channels can be shared, rather than one," he explains. The effect compares with that of virtual memory in computer systems, where the software makes the computer work as though it had more main memory than it actually has.

An even more marked departure from store-and-forward message passing is the way the chip routes data. In place of the customary self-contained packets carrying routing and sequencing information, the chip breaks the messages down into much smaller segments that can be more easily multiplexed through virtual channels. A new term—"flit," for flow-control digit—has been coined to define their lengths.

The Caltech scientists also had to find suitable words to describe the process itself. After initially calling movement of the segmented flits "wormholing," they changed the term to "cut-through routing."

"We want it to tell people the difference between store-and-forward messages, which advance as a whole, and cut-through, which travels like separate little trains," says Seitz. He and Dally note that with their technique, messages do not interact with a node's processor or its memory along the route. They

HOW EXPERTS VIEW CALTECH CHIP'S POTENTIAL

Because Caltech's message-routing chip has not yet been discussed publicly, consultants and hardware specialists do not yet have details on the device. But they are quick to spot its potential.

"If it's truly like circuit switching, then it could be very powerful in the concurrent architecture," notes William I. Strauss of Forward Concepts Inc., Tempe, Ariz. Strauss, a semiconductor and computer consultant, confirms that data-flow problems increase with the number of processors in concurrent machines, such as Intel Corp.'s iPSC. "Its significance is it can force skeptics [about the Cosmic Cube] to rethink their position."

Philip M. Neches, chief scientist at Teradata Corp., Los Angeles, believes the Caltech development, if it holds up, could be important for several reasons. "It could close some of the gap between shared memory and message passing by making message passing more efficient," he notes. In addition, the development will help in writing more-complex software for a wider range of applications, a capability that Neches says is lacking in present concurrent computers.

In contrast to the Cosmic Cube, Teradata's DBC/1012 uses dedicated communication channels, connecting each of the processors in its parallel architecture to every other one. *–L. W.*

stay strictly within the chip's network all the way to their destination.

The Caltech chip more closely resembles circuit switching than packet switching, notes Seitz. But "it's a curious hybrid for a special purpose, the best of both worlds, optimized for switching in two dimensions."

In a typical message-passing concurrent computer, each node would have a processor, local memory, and a Torus Routing Chip. Nodes are connected in a two-dimensional grid, each with an input and output channel in both X and Y directions, and each multiplexed into two virtual channels. The routing chip itself consists of five input controllers, a five-by-five crossbar switch, five output queues, and two output multiplexers.

Channels are 8 bits wide and eventually are intended to operate at 20 MHz, giving a bandwidth of 160 Mb/s in each dimension. The routing chip's operating speed, Dally says, makes it possible for adjacent nodes to communicate as quickly as a processor in a sequential computer accesses its memory, although a large network would obviously slow things down. The Caltech chip has shown 100-ns communication speed between nodes, which Dally says is critical to reducing overall concurrent computing message-sending performance down to "a few microseconds from several hundred microseconds, where it is now for the Cosmic Cube" [*Electronics Week*, Oct. 8, 1984, p. 29].

SEITZ AND DALLY. Charles L. Seitz, left, pioneer in concurrent processing, worked with doctoral candidate William J. Dally on the Torus Routing Chip.

Development of the chip moved quickly from the theory and concept stage in spring 1985 to design in August and fabrication late in the year, according to Dally, who is attending Caltech on an AT&T Co. fellowship. The work is also supported by Intel and the Defense Advanced Research Projects Agency. The next step is to get the chip to run at 20 MHz and then construct a computer using several hundred commercial microprocessors and memory parts. The eventual goal, according to Dally, is to build a machine around the chip that will "push concurrency to the limit." *–Larry Waller*

DIGITAL SIGNAL PROCESSING

TI SET TO SHOW 2ND-GENERATION DSP

HOUSTON

The market for digital signal processors is taking off like a jackrabbit as prices fall and more and more designers pick them over general-purpose microprocessors for their blinding number-crunching speeds. This rapid growth is now attracting several new U.S. and Japanese contenders that are tuning up speedy new entries in the general-purpose DSP fray. But Texas Instruments Inc. is moving fast to solidify its huge lead in this embryonic market.

The Dallas chip maker, which has grabbed an estimated 60% of the 1985 market for general-purpose DSP chips, hopes to stay out in front by announcing this week the first second-generation DSP chip. TI says the much speedier chip will be an enhanced version called the TMS320C25. The double-metal, 1.8-μm CMOS integrated circuit will run at half the cycle time of TI's fastest DSP chip, the 200-ns TMS32020. The chip also increases throughput by up to three times through additional on-chip hardware and new DSP instructions. Samples of the 320C25 will be available this month, with volume shipments expected in the second half of the year.

Meanwhile, Analog Devices Inc. of Norwood, Mass., plans to introduce in two weeks its ADSP-2100 programmable DSP. The 1.5-μm CMOS IC contains a 16-by-16-bit multiplier, 40-bit accumulator, program sequencer, two data-address generators, and an arithmetic logic unit, and has a 125-ns cycle time.

In addition, at this month's International Solid-State Circuits Conference in Anaheim, Calif., National Semiconductor Corp. will describe the LM32900, which operates at 100 ns and features a software-assisted floating-point multiplier. New DSP chips are also coming from Fujitsu, Matsushita, NEC, Philips Research Laboratories, and Ricoh-Panatech [*Electronics*, Dec. 23, 1985, p. 50].

Analog Devices and others will follow with their own DSPs

But if TI is making its splashy disclosure in an attempt to out-thunder competitors' impending announcements, it also has worked quietly behind the scenes for four years to have its TMS320 software and DSP programming techniques taught in more than 160 North American universities. The TMS320 family is being used in systems and DSP-algorithm research at laboratories in more than 20 universities, including Georgia Tech, Rice, and Rutgers.

And before competitors can get their new general-purpose DSP chips into volume production, TI is quoting 1988 prices for its existing 32010 and 32020 chips at around $8 and $15 each in large quantities. TI introduced the 32010 in 1983 at an average price of $85; the year-old 32020 now costs an average of $200. To many managers in TI's Programmable Products Division in Houston, the 320 family's early lead is a sweet success after recent failures in the microprocessor market.

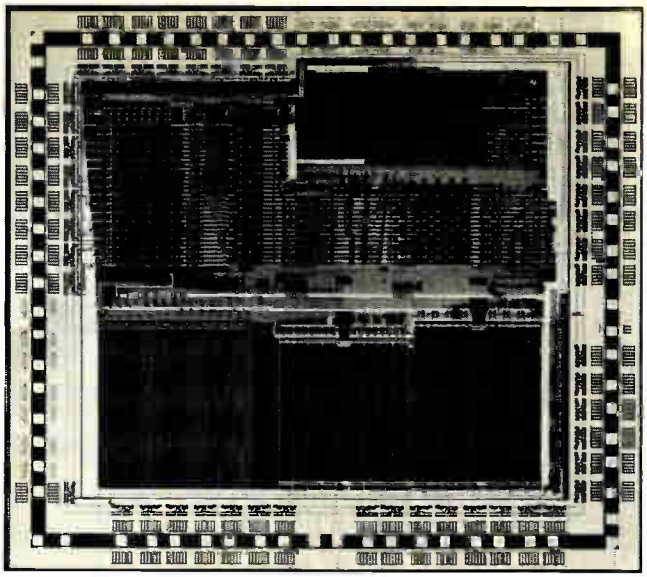
WINNING EVIDENCE. "We've got over 2,000 design wins in North America, counting by sales of development systems," claims John C. Scarisbrick, TI's manager for DSPs. "Those 2,000 wins represent an investment in digital-signal software in the hundreds of millions of dollars, if you figure at least a couple of man-years per application. That is already a significant investment that the industry has made."

A DSP market report prepared jointly by market researchers Forward Concepts Inc. and Gnostic Concepts Inc. apparently backs up TI's claim to a large early lead in general-purpose DSP circuits. The report, scheduled for publication this month, estimates that TI shipped 60% of the market's program-

mable DSP chips in 1985, compared with NEC's 16%, Fujitsu's 9.3%, and Gould/AMI's 6.7%. "TI has become the 'warm blanket' to this chip market, like IBM has been in many computer segments," notes William I. Strauss, coauthor of the DSP report and president of Forward Concepts in Tempe, Ariz.

Of the total signal-processing market, which reached over $500 million in 1985, sales of general-purpose DSP chips were $63 million, says Strauss. In 1986, the DSP segment will jump to over $90 million. "We see it as being one of the nice things to be in during 1986," adds Strauss, referring to industry expectations of a sluggish year ahead in other semiconductor sectors.

Growth for general-purpose DSP circuits is expected to maintain a 45% annual rate, approaching $500 million in 1990. "It will be like the earlier microprocessor movement, and we'll see in the next decade DSP chips everywhere—under the hoods of cars and in home appliances," says Strauss.



SECOND GENERATION. Texas Instruments' TMS320C25 digital signal processor is a double-metal, 1.8-μm CMOS chip.

The 320C25 announcement along with that of a CMOS version of the 32010 are directed at maintaining TI's momentum. Based on TI's experience in the DSP market, the new chip contains a number of additions to the 320 reduced-instruction-set-computer architecture. Additional hardware and instructions aim to boost throughput for emerging DSP applications. For example, the 320C25 will perform finite input-response filtering in a single cycle, as the 32020 does, but it will take only three additional cycles to make the FIR filter adaptive. The adaptive algorithms take five cycles on the 32020.

The 68-pin 320C25 contains greatly increased on-chip read-only memory—4-K by 16 bits—compared with the 32020. It also has a concurrent direct-memory-access feature, so it can address off-chip memory while executing algorithms from its own internal storage.

The new 110,000-mil^2 chip will have a number of other features, including a bit-reversed addressing mode to help speed executions of fast Fourier transforms, a double-buffered serial port to allow more time to service data in high-speed modem applications, support for U.S. and European telephony interfaces, more auxiliary registers for subroutines, and a power-down mode. *–J. Robert Lineback*

IC RELIABILITY

WILL STATIC CENTER SPARK RESEARCH?

ROCHESTER, N. Y.

The Rochester Institute of Technology wants to build on the success of a two-year-old U.S. Navy research program by setting up a center to study the effects of electrical overstress and electrostatic discharge on chips. The institute hopes that its Electrostatic Discharge/Electrical Overstress Research Center can cash in on contract work from industry and government agencies.

The ESD/EOS Center will use a technique developed for the Office of Naval Research to assess circuit degradation caused by static discharge and overstress. By measuring the circuit's noise parameter—a new approach to an old problem, according to director P. S. Neelakantaswamy—the extent of the degradation in actual performance can be determined.

"Noise represents the global degradation," Neelakantaswamy says. "All factors that cause degradation can be related to the noise parameter."

THE ZAP LEVEL. To discuss potential damage from electrostatic discharge and electrical overstress, Neelakantaswamy refers to a charge's "zap level." The level for a given part depends on many factors, including type of device, humidity, and feature size. If the zap level is high, he says, the result is catastrophic damage and the chip probably will be ruined. "But if the zap level is low and occurs repeatedly, then damages will not be catastrophic," he explains. Instead, "there will be gradual degradation that will drop the chips out of their specs." That gradual degradation poses the greatest problem for both chip makers and users because it is so difficult to detect.

"Implant loss and inadequate protective packaging cause up to half of all microcircuit failures," says David Olsson, director of the institute's packaging science department. He points out that these losses could be cut in half—boosting yield appreciably with no significant increase in cost.

Static discharge can cause degrading thermoelastic effects

Funded evenly by the packaging science department and RIT Research Corp., the university's wholly owned for-profit subsidiary, the center's objective will be to pinpoint where degradation occurs in chips and to develop materials and packages that can protect devices from damage in the first place.

To do so, RIT has assembled a multidisciplinary team to study the packages, materials, and procedures used in transporting and storing electronic components. The initial staff of four comes from the packaging science and electrical engineering departments, RIT Research's electronics program, and the ESD/EOS Association Inc., an industry group with members from such major corporations as Bendix, Hewlett-Packard, and ITT.

"There isn't any other joint effort by packaging and materials people" studying this problem, says Neelakantaswamy, a native of India who came to the U.S. in 1984. "Research is being done in a sort of piecemeal system, with packaging and materials and microelectronics people all working on their own. We thought it would be better to take up this problem by using an interdisciplinary approach."

But there is more to this marriage of an academic department and a profit-making holding company than a new business unit. What RIT is trying to do, says Deanna Wojcik, a packaging scientist and the ESD/EOS Center's junior member, is to concurrently develop a

profitable consulting company and a new course curriculum.

The plan, Wojcik says, is that once she has gotten up to speed on what for her is a new field of study, she can help design a program where students can study the relationship between static discharge and overstress and the packaging materials found in the trays, bins, and bags that come in contact with electronic components.

PROPER DESIGN. Neelakantaswamy, on the other hand, has spent the past two years studying the effects of electrostatic discharge and electrical overstress at RTI Research. He says his work has established how electrostatic discharge can cause thermoelastic effects that can degrade a device's performance. In addition, he says, he has discovered that a device that is mounted on a printed-circuit board is more vulnerable to damage than an identical device in an isolated package. But these problems, he says, can be avoided with proper design and the correct materials.

"We can educate the industrial people to create an awareness of the effects of overstress and static discharge on microelectronic devices. We would like to keep this a service center and continue with contract work. We want to get in touch with the industries that need our help." *–Tobias Naegele*

TELEVISION

LOW-COST DRAM PROMISES TO IMPROVE TV PICTURES

KAWASAKI, JAPAN

More-attractive, higher-definition pictures soon should be available from color TV sets, video cassette recorders, and video disk players, thanks to a family of inexpensive scan-line memory chips designed by NEC Corp.

The small, high-speed, dual-port, dynamic random-access memories perform a wide range of video signal-processing functions—including separation of luminance and chrominance signals, elimination of cross-color interference, jitter reduction in VCRs, interpolation for noninterlaced-scan display of TV images using double the number of scan lines per field, and implementation of the one-line delay needed in sets operating under the European PAL standards.

The asynchronous nature of the input and output circuits makes such byte-wide dual-port memories appropriate as first-in first-out buffers for speed conversion of a data stream in communications and other applications.

The single-line memory, which uses 256-K DRAM technology, is produced on fab lines for 256-K parts, says Shigeki Matsue, general manager of the Memory Products Division. He notes that line interpolation previously was implemented by multiple static RAMs teamed with gate arrays, multiplexers, and other logic [*Electronics*, Sept. 8, 1983, p. 77]. Separate versions of the new NEC DRAM will be available for the NTSC standards used in North America and Japan and for the PAL and Secam standards used in Europe.

Application-specific design provides the needed speed without requiring additional peripheral circuits, and proven fabrication technology makes for low cost. Initially, the sample price will be $20 for the slowest NTSC and PAL versions when NEC starts shipping samples in February. Volume production starts in April, at an initial monthly rate of 200,000 NTSC and 100,000 PAL chips. The relatively small 3.5-by-3.8-mm chip in a standard 0.3-in.-wide 24-pin package should allow for much lower prices after production has ramped up.

Scan-line chip aids interpolation to raise resolution

The single-line memory uses a three-transistor memory cell with completely independent input and output circuits. This dual-port design achieves asynchronous input and output without the arbitration circuitry that normally adds to the complexity of dual-port RAMs. No refresh circuits are needed because the 1-ms data-retention time is sufficient for TV applications, where storage is required for at most several lines, each of which represents a period of 63.5 or 64 μs.

Choosing the size of the one-line memory was simple. In the U. S. and Japan, most TV video-signal processing is performed at four times the 3.58-MHz color-subcarrier frequency. Because the standardized subcarrier frequency is 227.5 times the horizontal-sweep frequency, four times 227.5, or 910, samples are needed for one scan line for the μPD41101C chip. Each sample is 8 bits deep, the most commonly chosen resolution used for converting the analog signal into a digital one. Similar considerations mandate that μPD1102C PAL chips be configured as 1,135 by 8 bits.

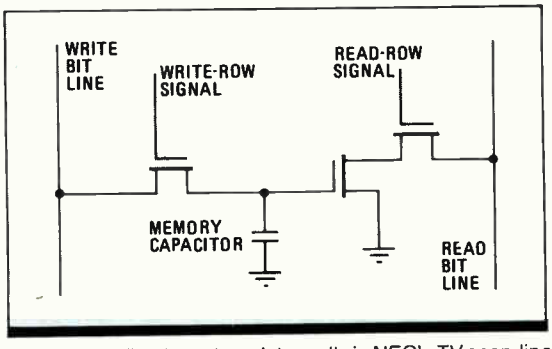
SIMPLE COUNTERS. The chips' input and output decoders are fast because they are relatively simple counters operating at independent write and read clock rates together with separate pointer resets to start the next line. Write- and read-enable functions are provided for applications that require storage of multiple scan lines—typically two to four—including noninterlaced-scan converters.

Noninterlaced-scan TV is expected to become increasingly popular with the trend toward larger screens. It is perhaps the most demanding application for these chips, because the horizontal-scan time is half that of standard TV. For this application, the fastest versions of these chips have read and write cycle times of slightly less than eight times the chrominance-subcarrier frequency, or 34 ns, and the maximum access time is 27 ns. (Cycle time for the fastest PAL chips is 28 ns, and access time is 21 ns.)

Separate input buffers are used for alternate groups of 8 bytes to facilitate high-speed operation. They are connected in a pipeline arrangement using dual-cell arrays that ensure that the word-line segment will be raised at the appropriate time. Read-word-line segments are connected in a similar pipeline arrangement at the output.

To further speed the array's operation, its designers divided the write-bit and read-bit lines into a number of short segments. The sense amplifiers connected to each read-bit line segment are much simpler than those used in standard DRAMs: unlike single-transistor DRAM cells, the three-transistor cells amplify their output signals so that they appear at logic levels.

The chip's designers faced a problem of an eight-cycle period after a forced reset of the device, during which the three-transistor DRAM cells cannot be written to because the write-word lines are not yet raised. To fix this, the first 8 bytes are built not with DRAM cells but with flip-flops—SRAM cells—for faster write and read after such forced-reset operations or during chip initialization. Even so, the first 8 bytes can't be read until 10 write cycles after the write operation. *–Charles L. Cohen*



IN OR OUT. The three-transistor cells in NEC's TV scan-line DRAMs provide independent input and output functions.

INSIDE TECHNOLOGY

SLAMMING THE DOOR ON DATA THIEVES

CAN THE NSA CREATE AND ENFORCE A NEW ENCRYPTION STANDARD?

by Robert Rosenberg

Stealing data from computer and information systems may be a game to teenage hackers. But to foreign adversaries systematically monitoring U.S. telecommunications traffic, it is serious business. In response to these threats to data security, the U.S. government is pushing a plan that it hopes will make cryptographic protection of voice and data transmissions commonplace by the 1990s. Under the plan—National Security Decision Directive 145—the security of both commercial and military information systems will be the responsibility of the National Security Agency—the federal government's supersecret intelligence and cryptographic organization.

Government officials are convinced that a common policy administered by a single authority is the best way to protect electronic information systems from unauthorized access. By signing NSDD 145 in September 1984, President Reagan made the NSA the nation's network gatekeeper; the executive order gives the NSA the green light to develop new encryption standards for unclassified government systems and to promote the new standards in the private sector.

But critics on Capitol Hill and among electronics-industry trade groups say the order puts too much power in the hands of the military. Standards for nonclassified government systems should be set by the National Bureau of Standards, say House critics. Trade groups worry that the military will soon be dictating standards for commercial systems on the grounds of national security.

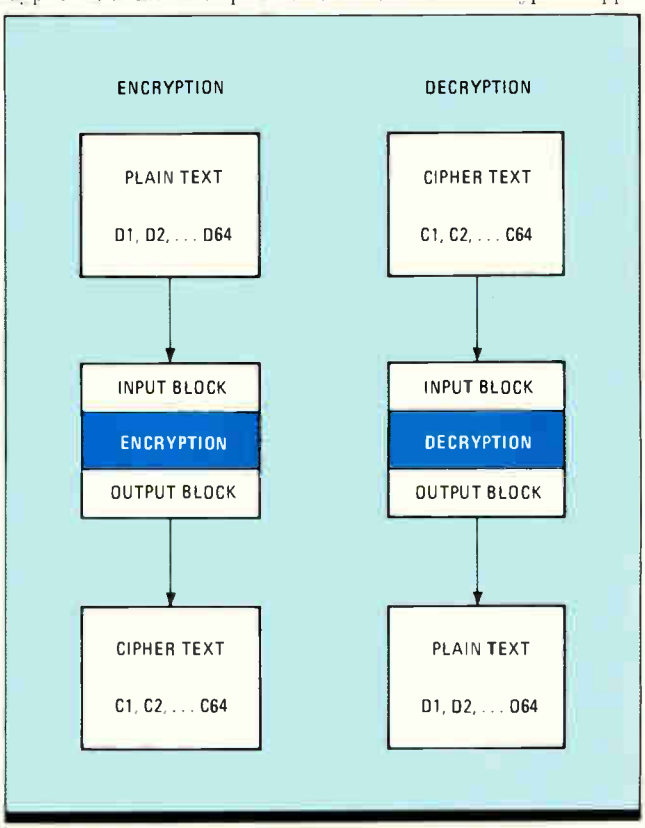
One of the NSA's early moves effectively puts the lid on new applications using the Data Encryption Standard—the only public-sector standard for encryption implemented in silicon. The NSA says it will no longer approve the DES algorithm when it comes up for review as a federal standard in 1988. Even though it says the algorithm remains "cryptographically sound," the agency intends to withdraw support because the algorithm's 10 years as a published standard and the cipher's widespread use in nonclassified (and some classified) systems "make it an increasingly attractive potential target for our adversaries."

But DES-based applications are likely to remain in use well into the 1990s, as federal offices and contractors slowly acquire the hardware that uses the NSA's new encryption algorithms. And electronic funds transfers, one of the largest markets for DES chips, will be unaffected.

In its new role, the NSA for the first time is taking the lead in developing security measures for commercial systems. With dozens of hacker penetrations of commercial systems recorded over the past year, the public has seen the vulnerability of commercial electronic information systems to microcomputer enthusiasts. The spate of recent espionage cases—including four arrests in five days in late November—has only strengthened the administration's hand in pushing its policy, because the government knows foreign countries are targeting commercial networks that transmit data dealing with strategic commodities such as oil and state-of-the-art computer gear.

The switch to the new chips will be gradual—in part because the NSA is taking an active role in the sales of all new chips as part of its Commercial Comsec (Communications Security) Endorsement Program. Vendors interested in using standardized subsystems or modules with the new chips in commercial products for the federal market must first approach one of the 11 companies qualified by the NSA to manufacture Comsec devices. Although these companies—AT&T, GTE, Harris, Honeywell, Hughes, IBM, Intel, Motorola, RCA, Rockwell, and Xerox—can provide unclassified information about chips and modules, they may provide applications information and sample parts only with NSA approval. If the NSA deems the interested vendor qualified, a four-phase design-in cycle begins.

The NSA's first foray into commercial development is off to a slow start. Harris Corp. has already encountered difficulty in getting the NSA's approval to release details of its HS3447 Cypher I, a CMOS chip aimed at unclassified encryption appli-



1. ELECTRONIC CODE BOOK. In this mode of the Data Encryption Standard, which is used to distribute secret keys, the same block of input plain text will always map to the same cipher text.

cations [*Electronics*, Jan. 20, 1986, p. 13]. The Melbourne, Fla., company wants to go to market with a 16-pin device that can transmit up to 20 Mb/s in either output-feedback or linear-cycle mode, but agency turf battles are stalling the approval process.

The first fruits of the new IC-development program should show up this year in both classified and nonclassified versions of a secure telephone. Presumably, the devices—which look like conventional multiline desksets—will digitize and encrypt the voice using a pseudorandom code. The cipher code will be routed through the telephone switch, a private branch exchange, or a cellular controller, and then will be decrypted at the receiving end.

SECURITY FEATURES

The handsets, which will cost about $2,000 apiece, will have enough intelligence to do a handshake to ensure positive authentication of the far-end terminal's classification level. The goal of the $44 million development program is to promote widespread use of secure handsets in government agencies and among government contractors.

The telephone contract—awarded in April 1985 to AT&T, Motorola, and RCA—is the first of many expected as part of the Commercial Comsec development effort. One source, knowledgeable about security affairs, speculates that a whole family of ICs is likely to evolve because the encryption of voice, high-speed data, and graphics would require different optimization schemes.

Presumably, all data would be encrypted before entering a network or going to disk, and different levels of security, which require different keys and key-management schemes, would be implemented in silicon. To protect the chips from reverse engineering, they could be coated with an opaque material to frustrate any attempt to view surface metalization or other elements. They could also be sealed with a volatile material that would cause the chip to fuse solid if any attempt were made to remove the encapsulant. Though the NSA will make every effort to control distribution of the chips and their embedded encryption algorithms, NSA's key-management scheme will keep the data secure even if the chips are lost to an adversary.

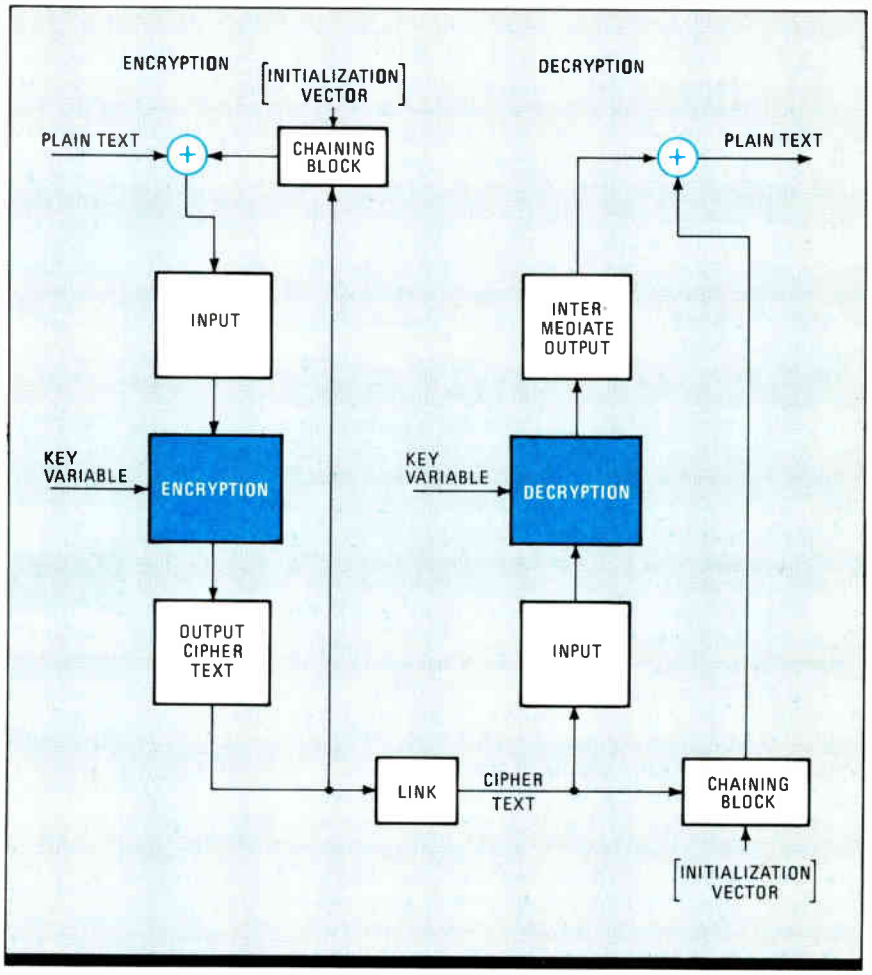
Administration officials say national security is the fulcrum that gives the President the power to move responsibility for developing commercial protection systems from the Department of Commerce's NBS to the NSA. However, the NSA will be going a step beyond the NBS's activities because it proposes to assign keys to all government and government-contractor encryption systems. It will transmit new keys for each system, probably as often as several times a minute. The agency will not comment on whether it plans to take the same role for strictly commercial communications.

NSDD 145 specifies that "systems handling . . . sensitive, but unclassified, government or government-derived information, the loss of which could adversely affect the national security," will become subject to the security policies set by a committee of high-ranking military and civilian government officials. In "systems which handle sensitive, nongovernment information, the loss and exploitation of which could adversely affect national security," the committee is to develop policies "encouraging, advising, and, where appropriate, assisting the private sector in applying security measures." The NSA will implement these policies.

The executive order mandates that the director of the NSA approve all federal standards for the security of telecommunications and information systems. As was the case with the NBS underwriting of DES, the NSA director would for all practical purposes be setting standards for the entire U. S. data-processing industry.

The breadth of NSDD 145 is stirring opposition on Capitol Hill. "I believe that NSDD 145 is one of the most ill-advised and potentially troublesome directives ever issued by a President," said Rep. Jack Brooks, the Democratic majority leader, in testimony given in June 1985 before a House Science and Technology subcommittee investigating computer security. Brooks says the order conflicts with existing statutes because the President is making national policy on computer security without the consent of Congress. He also questions the wisdom of giving the DOD the latitude to decide what information is labeled "unclassified sensitive," because "virtually any information system located in the civilian agencies or the private sector would fall under its domain."

Last fall, NSA's interpretation of its new mission under NSDD 145 was already drawing fire. According to an NSA representative, the agency's National Computer Information Center became involved in an investigation to determine whether a computer program used to tally 1984 election results was vulnerable to computer fraud. The widely reported NSA in-



2. CIPHER-BLOCK CHAINING. A favorite of banks concerned with message authentication, a cipher output is transmitted and also chained back into the circuit to become the next pseudorandom block added to the next block of plain text.

volvement caused further concern on Capitol Hill.

Brooks—along with Rep. Dan Glickman (D., Kan.)—kept the congressional spotlight on NSDD 145 in hearings on a bill that was initially meant to strengthen federal computer-security training but was later rewritten to restore the NBS as the standards setter for encryption of unclassified government communications and data traffic. The bill, H. R. 2889, remains in committee, and its prospects look dim unless the computer and communications industries press for its passage.

WHAT PRICE SECURITY?

One thing that might raise industry interest is the cost of implementing any NSA encryption scheme. In testimony on H. R. 2889, Milton J. Socolar, a General Accounting Office representative, testified that placing an agency with a military mission in the forefront of a commercial development program would lead to unacceptably high program costs. He warned that the "DOD, in its approach to security, seeks to counter identified or perceived threats to the national defense, treating costs as a decidedly secondary factor in determining the degree of protection required. The National Bureau of Standards, on the other hand, emphasizes a risk-management approach that uses costs as a primary determinant. Now that NSDD 145 has created a category of information designated as sensitive unclassified information, there is a potential, if not a likelihood, with DOD taking the lead, for excessive expenditures to protect unclassified information."

The cost of implementing the DOD's plan could add about $1,000 to the cost of a personal computer, according to a report published in *The New York Times*. The cost of implementing it across all the systems envisioned in NSDD 145 could be billions of dollars.

So far, industry officials have looked less after their pocketbooks and more at the policy implications of the new NSA role. The Computer and Communications Industry Association says NSDD 145 runs counter to existing law and "gives the DOD and the intelligence community vast and largely undefined power to shape national information policy." The Institute of Electrical and Electronics Engineers has gone on record warning against the "dangers we see in implementing the directive's rules for unclassified, sensitive, nongovernment information and private-sector telecommunications and automated information processing."

Jack McDonnell, vice president of the Electronics Industries Association's telecommunications section, expresses surprise over the NSA move into commercial encryption. "I served at the NSA during the development of the DES. This new NSA initiative takes me by surprise since the agency is stepping into a sphere they never had interest in before." Asked if the NSA chip development would have much effect on DES, McDonnell says, "If it truly takes the place of DES, it will have tremendous effect. It will hurt all those that have built systems around the DES."

Two important industry associations have yet to take a stand. Ted Heydinger, a spokesman for the Computer and Business Equipment Manufacturers Association, says "Cbema has been supplying off-the-record comments to the people on the Hill, but we haven't developed a position yet." According to Michael Nugent, a representative for the Computer Software and Services Industry Association (Adapso), "Adapso is very concerned with the implications of NSDD 145," and the organization is studying it.

Whatever the fate of NSDD 145, DES should remain commercially successful for several years. Operations that provide service to the federal government will be precluded from expanding DES-based encryption offerings once the NSA releases its new codes. But under the grandfather exception to the 1988 cut-over date, service providers are allowed to continue in operation.

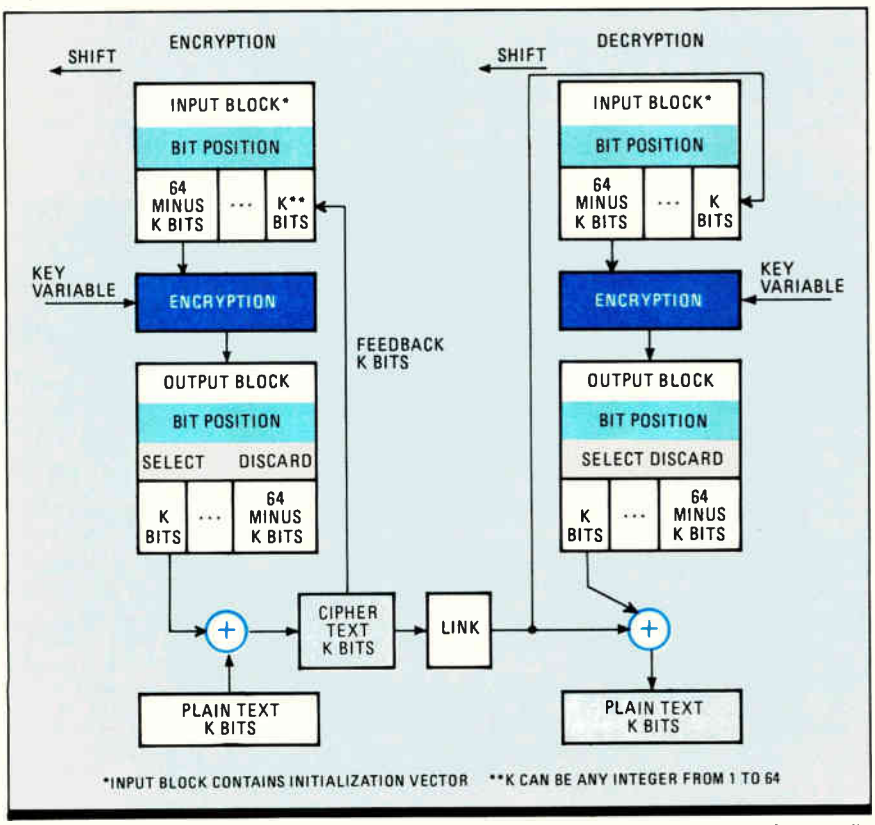
The NBS adopted the DES in 1977 as the federal standard for nonclassified encryption. The DES is based on IBM Corp. cryptographic research and has been published in the open literature. Although it was designed to be used in routine government data transmissions, it has proliferated into the commercial world. And much to the NSA's chagrin, it has also been showing up in some classified military systems.

One thing won't change: The DES market is small change by the standards of semiconductor makers. According to International Resources Development, Norwalk, Conn., only 80,000 DES ICs were sold in the U. S. during 1984—"not near the number you need to have a viable commercial product," says company president Kenneth G. Bosomworth.

Determining whether ICs show promise as commercial products depends on whom you talk to. "We did over $1 million last year on our original n-MOS chip," says Geoffrey Boyce, product manager for Western Digital Corp., Irvine, Calif., and first silicon is expected this month on the first of two new CMOS chips that will add cipher-block chaining and either 1- or 8-bit cipher feedback to Western's DES chips.

Fairchild Semiconductor Corp. had less luck with its offering. "We are no longer promoting our DES device. We never had any volume," says Dennis Kundsin, marketing manager for Fairchild's Microcontroller Division in Mountain View, Calif. "It was killed roughly a year ago."

AT&T Co., a big player in NSA's new chip-development effort, is convinced DES



3. CIPHER FEEDBACK. The self-synchronous features of the Data Encryption Standard's cipher feedback mode make it the favorite for transmitting data files. Errors propagate until the bits in error are cleared from the input register.

still has a healthy following and is starting to market a chip that operates in all the standard's modes, says Lynn Ditty, product manager for communications devices at AT&T Technologies Inc., Allentown, Pa. The current 588-kb/s n-MOS version of the chip should speed up to 1.56 Mb/s in a planned CMOS version.

A representative of Advanced Micro Devices Inc. says that demand for its offerings—three high-speed large-scale-integration chips—is satisfactory. But Charles McLear, technical marketing manager for Motorola Inc.'s 8-bit microprocessor outfit in Austin, says that Motorola's version of the DES chip "has never been popular." Intel Corp. says that it is no longer offering its chips.

The DES algorithm—a fixed-length block cipher—has been controversial since its adoption. The original IBM cipher project, dubbed Lucifer, called for a 128-bit key, longer than what the NBS incorporated into the DES. Critics claimed the shortened key size weakened the DES algorithm.

The DES algorithm has been controversial since its adoption

Controversy also surrounded the substitution tables used to transpose the input bit pattern to another bit pattern of the same size. Because the NSA advised the NBS not to publish the substitution tables, critics wondered if they contained a "trap door"—a concealed weakness somehow inserted by the NSA in the algorithm to simplify decryption.

A classified investigation mounted by the Senate Select Committee on Intelligence, a portion of which was declassified and released in 1979, absolved the NSA of tampering with the algorithm. "The official position of IBM is that the DES is still strong and adequate," says Steven M. Matyas, a member of the IBM Crytography Competency Center in Kingston, N. Y.

On the other hand, an axiom of cryptography is that any algorithm can be cracked with enough time and processing power. "If you have a huge budget and the processing power, you can break it," says Martin E. Hellman, the Stanford University professor well known for his work in public key cryptography, "but there are only a few agencies like the NSA—and its counterparts overseas—that could do it." An early and vocal critic of the NBS implementation of the algorithm, Hellman now says he is convinced no trap doors have been left in the DES.

The DES is a block cipher that operates on a fixed-sized 64-bit block of data. When a 64-bit block of plain text is ciphered using a 56-bit keying variable (the other 8 bits are parity bits), DES yields a block of ciphered text that maps to the original text and can be reversed using the same key. Because 2^{56} combinations of the keying variable are possible—and these keying variables can be changed readily—the algorithm is deemed highly secure.

The DES algorithm has several implementations, called DES modes of operation, and the simplest mode is called an electronic code book (Fig. 1). Using this mode, a 64-bit block of plain text is run against a specific 64-bit keying variable. The ciphered output block is a nonlinear function of the input block. If the same keying variable is used each time, the same block of input plain text will always yield the same cipher text, and any single-bit errors will propagate through the entire block but will not affect any other block. It is most commonly employed to cipher the keys used in key distribution systems.

In the cipher-block-chaining mode, the 64-bit block of plain text is modulo-two added to an initial 64-bit pseudorandom block (called an initialization vector) before being encrypted (Fig. 2). The cipher output of the operation is transmitted and also chained back into the circuit to become the next pseudorandom block added to the next block of plain text. Through the entire length of the message, the previous ciphered output is added to each new block of plain text.

To decrypt, the initial ciphered block is processed by the DES device in decrypt mode and the output is modulo-two added with the same initialization vector used to initiate the encryption process. The second cipher block is then decrypted by the DES device and added to the previous cipher block to yield plain text, and the process continues until the message is complete.

Because the same string of plain text will not produce the same cipher text each time, cipher-block chaining is safer to use than an electronic code book. However, cipher-block chaining does have error-extension characteristics that propagate through any two blocks following any bit that is in error. Because of its error-propagation characteristics, cipher-block chaining is not the best choice for noisy communications lines, though it is the preferred method to au-

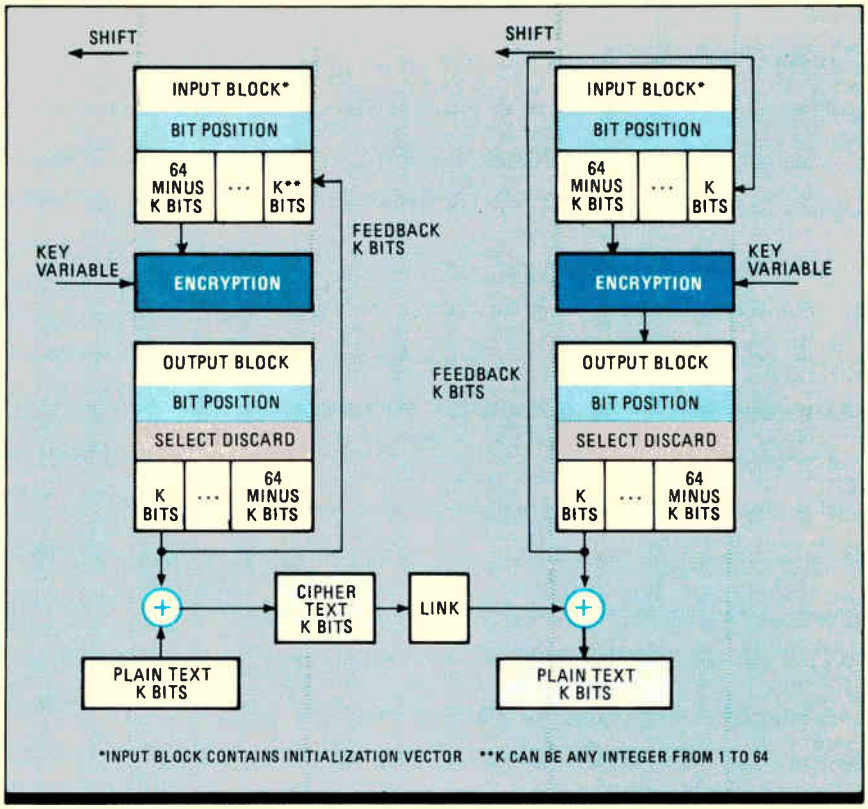
4. CRYPTO BOX. Racal-Milgo's Datacryptor 64-1027 won NSA approval for physical security. The encryption unit includes a tamper-proof housing with dual locks, the automatic rezeroing of the cipher keys during an attempted break-in, and an external alarm.

thenticate messages in such applications as banking.

The DES's cipher feedback mode (Fig. 3) is frequently used to transmit data files. Once an initialization vector is loaded into the DES chip, it generates a pseudorandom bit stream that is modulo-two added to plain text to produce a keystream. All or part of the keystream block (from 1 to 64 most-significant bits) is added back into the input register with the plain text block to produce a cipher block of text. The cipher block is then transmitted and also fed back into the input register, becoming least-significant bits. The register is then shifted by the same number of least-significant bits.

In this mode, the decryption process requires that the DES chip be in an encrypt mode so that it will generate at the receiver a keystream that is identical to the keystream coming from the transmitter. In cipher feedback mode, error propagation continues until the bits in error are cleared from the input register.

Cipher feedback mode is slower than the other modes because it does not use all the bits available for feeding back into the input register. But the system becomes self-synchronous if a 1-bit block is fed back. This is because the receiver will decrypt once it has received 64 continuous error-free bits.



5. OUTPUT FEEDBACK. This mode of the Data Encryption Standard is favored for noisy communications links because it does not have error-extension characteristics.

Racal-Milgo Inc., Sunrise, Fla., uses cipher feedback mode in its Datacryptor 64-1027, an NSA-approved encryption device that provides speeds of up to 64 kb/s synchronous and 19.2 kb/s asynchronous (Fig. 4). The device meets government standards for physical security of the device, including a tamperproof housing with dual locks, the automatic rezeroing of the cipher keys during an attempted break-in, and an external alarm, according to Richard Abruscato, engineering manager for security products.

The output feedback mode also uses the DES chip as a keystream generator, but in this mode the block of pseudorandom data is added on a bit-for-bit basis with each new block of plain text (Fig. 5). After initialization, the DES generates a pseudorandom block. The cipher output is added bit for bit with plain text to produce cipher text, which is transmitted. The output is also fed back into the DES chip's input register.

BETTER WITH NOISE

Because the cipher text is not put back into the input register, the output feedback does not have error-extension characteristics and is preferred for noisy communications channels—satellite links, for example.

Satellite Business Systems Inc., McLean, Va., has been using a variation on the DES output feedback mode in its 48-Mb/s Bulk Encrypted Transmission Service for its private-line customers since 1984. Last month, encryption services (which have NSA approval for protection of unclassified national-security-related transmissions) were extended to SBS's public network with the introduction of the Traffic Protected Service option to SBS's public-switched Skyline service.

SBS won the NSA's approval by taking the steps needed to ensure site security and the physical security of the encryption device, according to Frank Stein, project coordinator for communications protection. SBS is using a dual-key implementation of output feedback and providing a rigorous program for key management that got the OK from the the NSA.

"We use a set of two keys—a master key and a working key," Stein says. "The master key is used to decrypt a working key that is changed periodically. Since the security of DES is only as good as the security of the keys, we've been approved by NSA to manage keys in the public switched offering."

The only government DES application the NSA is willing to see expanded is the Department of the Treasury's electronic funds-transfer systems. Banks have long been using the DES and a secret key to derive a cryptographic checksum transmitted with a message. When the checksum is decrypted, it authenticates the integrity of the message and verifies the sender to the receiver.

"Authentication is a means of developing an electronic signature that works like a written signature," explains Martin Ferris, manager of data-processing security in the Treasury Department. "If an eavesdropper knows your payroll, and when and where it will be transmitted, it would be easy for the eavesdropper to capture your encrypted text and work backward to plain text. Authentication assumes that your data is publicly known but nevertheless ensures that the message is not tampered with and that you have an audit trail."

The NSA says its new rules do not apply to the EFT systems because their messages have very short useful lives that seldom have national-security implications. Though EFT will use the DES, it is unclear whether the banks, the Treasury Department, or the NSA will set up the automated key-management system for the EFT network.

Although DES ICs never became big-time commodity parts, the new chips the NSA is proposing should fare better. "Years ago, I told many manufacturers selling cryptographic devices they'd go broke, and many have," says Donn Parker, a computer-security authority with SRI International, Menlo Park, Calif. He now finds the situation changed dramatically. Cryptographic protection is becoming a standard business practice, he says. "It is acknowledged by business to be a yardstick of 'due care' that must be exercised in its operations. Without it, you open yourself up to legal liability." □

Hitachi's One-Time Programmable CMOS Microcontroller

Arctic foxes are incredibly resourceful. They have to be, to survive a harsh environment where others, less clever, can perish.

In today's competitive design environment, you too have to keep moving. The fast and clever win. Hitachi makes winning possible with ZTAT™—an 8-bit CMOS microcontroller with a built-in user-programmable ROM, in an economical package. ZTAT—Zero Turn-Around Time—eliminates the need to wait three to four months to receive your mask ROM devices. Think what this means to your entire design and marketing process.

The very *day* you finish development, ZTAT gets you into production. No mask charges. No minimum order quantities. No working sample approvals. No waiting for mask ROM devices. Just issue a purchase order. And, if you should decide to modify your software, you're not stuck with a useless inventory of programmed devices. That's because ZTAT lets you make code changes quickly—*even during production.*

High performance with unsurpassed versatility. ZTAT is a whole family of CMOS 8-bit microcontrollers that are code compatible with Motorola's 6800 series. These devices contain virtually all the subsystems *on-chip* that are necessary to design sophisticated systems. They include 4K of one-time user-programmable ROM, 192 bytes of RAM for data storage, I/O ports, and a serial communications interface. All of this comes in a cost-effective plastic package. The packaging is one of the reasons why ZTAT only costs slightly more than mask ROM microcontrollers, and is *a lot* cheaper than ceramic reprogrammable devices. Hitachi is the first to offer you this total CMOS system.

The features of ZTAT are impressive. And they will outperform the competition.

Clever

ZTAT is part of a total design package. ZTAT is a member of Hitachi's 6301/6305 8-bit CMOS microcontroller family, which includes ceramic reprogrammable devices, ZTAT devices and plastic packaged mask ROM devices. This means Hitachi is the only company to offer you a choice of CMOS microcontrollers that are right *for every phase of your product's life cycle:* development, pilot production, and large-scale production. The reprogrammable, ZTAT, and mask ROM devices are all pin-for-pin compatible, making it easy to shift from one phase to another. Key members of the 6301 family are second-sourced by Motorola.

And, if your marketing strategy focuses on niche markets with smaller production volumes, ZTAT saves you the expense of having to use ceramic devices in production. The cost savings are substantial, even in single lot quantities.

It's easy to be clever. ZTAT makes time work for you, not against you—without your having to make large commitments; while preserving your flexibility. To learn more, call your local Hitachi Sales Representative or Distributor Sales Office today.

Fast Action: To obtain product literature immediately, CALL TOLL FREE, 1-800-842-9000, Ext. 6809. Ask for literature number R15.

Hitachi America, Ltd.
Semiconductor and IC Division
2210 O'Toole Avenue, San Jose, CA 95131
Telephone 1-408/942-1500

HITACHI

We make things possible

Circle 33 on reader service card

Flexibility
the new dimension in HDDR.

The SE9500 Formatter is another significant advance in High Density Digital Recording (HDDR) from THORN EMI. It is unique in many ways and has unprecedented flexibility.

This standard unit can be readily interfaced with any IRIG recorder and with just four switches, can be reconfigured for a wide range of serial, parallel or word serial applications.

Data transfer rates as high as 144Mbps can be obtained, with switchable fan-out from 2 to 32 tracks. Unique also is the auto-ranging bit synchronization.

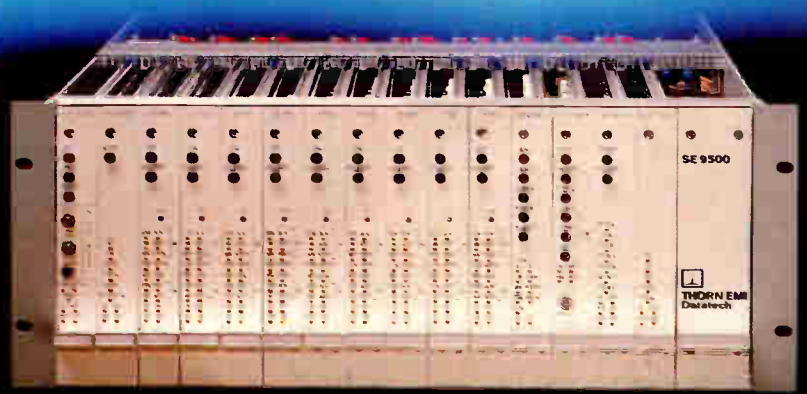
Previously, data rate changes required manual adjustments of all data channels and could take many hours. Today SE9500 does it automatically in about 2 seconds.

The encoding scheme, 3PM Format B, is an advanced development of the format pioneered by THORN EMI. It incorporates a powerful error detection/correction system to guarantee virtual error-free performance.

SE9500 is designed for today's 2MHz wideband recorders as well as the latest double-density and microgap systems. Wrap it around our SE9000HD recorder and you have a true Data-on-Demand facility with output controlled by an external data clock.

Such an advanced specification would normally require an expensive custom-built package only able to work with one particular recorder.

SE9500 is available off-the-shelf now, at about a third of the cost, to work with any IRIG recorder. For further information, please call us. We're always interested to talk HDDR; it's our specialty.



THORN EMI Technology

SE9500 HDDR FORMATTER

THORN EMI Technology Inc. Suite 301. 8601 Dunwoody Place, Atlanta GA 30338.
Telephone: (404) 587-0017. TWX: 810-766-2267.
A THORN EMI Information Technology company.

HOW THE SIERRA MAINFRAME GOT ITS NUMBER-CRUNCHING PUNCH

IBM 3090 NOW COMBINES PARALLEL, VECTOR, AND SCALAR PROCESSING

When the computer that generates more revenue than any other model—enough to affect the U. S. gross national product—is improved, the scientific and engineering community must take notice. IBM Corp. has packed new number-crunching muscle into its 3090 mainframe family, known as Sierra, by adding an integrated vector processor for each central processing unit. The result is the most powerful computer IBM has ever built. The twin-processor model 200, which IBM has been shipping since August, can have one or two vector processors installed (Fig. 1). Its big brother, the model 400 with two twin-processor CPUs, can have up to four vector processors. The model 400 will be ready for its first customers in the fourth quarter.

It was not too hard to integrate the vector processor into the 3090 CPU because the machine was developed with the addition in mind. The 3090 system has 64-bit internal data flows throughout to facilitate incorporation of a 64-bit vector processor. The vector processor is integrated into the 3090 CPU such that the pair operates as a single image processor (Fig. 2). That is, the vector processor operates directly on the memory using the same data image that the scalar processor uses. The two processors operate concurrently.

The Vector Facility has a register-based pipelined vector-processor architecture (Fig. 3) with eight 64-bit registers, which can serve as 16 32-bit registers as needed. Each register contains 128 elements. The vector hardware uses the same emitter-coupled-logic chips mounted on three-dimensional thermal-conduction modules as used in the 3090 CPU. The vector processor's 18.5-ns cycle time matches that of the 3090 CPU.

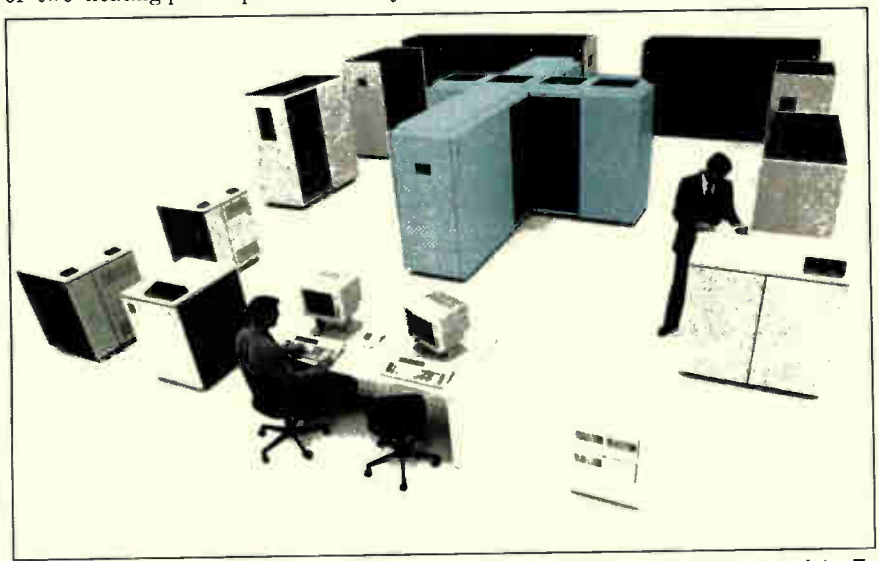
A total of 171 new vector instructions has been added to the 3090 instruction set. These include control instructions and memory-to-register, register-to-memory, and register-to-register operations. Compound operations can be done as single operations. Once the pipeline is full, instructions flow at a rate of two floating-point operations every 18.5-ns machine cycle. Though the execution units in the vector processor are pipelined, they still maintain interrupts precisely—instructions are both interruptible and resumable.

Engineers at IBM's Kingston Laboratory designed and developed the vector capability as a natural extension of the 3090 machine. "We did not have to make any quantum leaps to get vector processing," says Troy Wilson, manager of system management and performance at the New York laboratory. "It is well integrated into the standard mainframe architecture." Several goals were set for improving computation-intensive work on the machine.

A main goal of the vector project was to realize it on a familiar architecture—that of the IBM 370 family—rather than build a new one. New versions of the two standard operating systems, MVS and VM/SP, are ready to support the Vector Facility. The new VS Fortran version 2, consisting of a compiler, library, and an interactive debugger, provides vector capabilities. The library contains mathematical routines with improved accuracy and performance. Also added is an enhanced multitasking facility to allow a single application to execute simultaneously on multiple vector processors.

IBM chose to base vector processing on a standard mainframe so that high-speed floating-point tasks could be mixed easily with general-purpose computing. Blending general-purpose and floating-point tasks provides the user with maximum flexibility in solving scientific and engineering problems. Many problems have scalar, vector, and parallel parts. The user of the vector-enhanced 3090 has both scalar and vector computation units at his disposal. Users could even have multiples of each type of processing unit. The result is a combination of parallel architecture and vector processing with a scalar processor thrown in. IBM's rationale is that few computing jobs exclusively require parallel or vector processing. Most jobs contain scalar parts, and some lend themselves to a combination of vector and parallel processing.

Another goal was to keep the price/performance ratio consistent with current industry standards. IBM engineers accomplished this by using the technology developed for the 3090 series and integrating the vector processor into the CPU. The first add-on vector processor sells for $370,000, the second for $230,000. This applies to the model 200 and to each of the model 400's CPUs—putting four vector processors on a model 400 therefore would cost $1.2 million. The 3090 systems themselves run from $5 million to $10 million. Adding one or two vector processors to a model 200 will deliver a three to five times performance



1. A BIGGY. The vector processor is housed in the cabinet that forms the right arm of the T-shaped processor (center) of IBM's most powerful computer, the 3090.

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.*

improvement to floating-point calculations for 10% or less of the system's cost.

"We had to decide where to go as far as what vector- to scalar-processing performance relationship was optimal" for price/performance, says Wilson. "Should vector processing be twice as fast as scalar or should it be 10 times as fast? Or should it be more balanced?"

IBM engineers studied a large sample of independent computationally intensive code sets, or programs, and arrived at a three- to fivefold improvement in speed as the best balance point. This decision was supported by IBM customers, particularly the large number of engineers and scientists working in industrial companies, where many problems are engineering and physics oriented.

Because many of these client companies already have IBM's large mainframes installed, IBM development engineers integrated the vector processor into the largest and newest 3090 computers at customer sites so they could be used easily by the engineers and scientists.

Through customer-site testing, it was found that scientific and engineering programs tend to have high cache-hit rates. IBM thus took an unusual approach to ensure that data for both vector and scalar processors will be in the cache when needed. Instructions are fed to the vector processor through the CPU. The data for both vector calculations to be done by the vector processor and scalar calculations for the CPU are fed from the cache-memory buffer associated with each CPU.

EASY TO USE

The vector processor is quite easy to use. Programs written in Fortran can be compiled with VS Fortran version 2. This vectorizing compiler searches for Do loops, iterative sequences of statements, and then converts the commands within the Do loop into vector code using industry-standard automatic vectorizing rules. The operating system recognizes when a program with vector loops is first encountered and automatically sends that program to a CPU with a vector processor. Because vector processors calculate in parallel, the numeric processing sent to the vector processor is done much faster than it would be done on the scalar CPU.

Users can take code optimization one step farther. They can code critical programs or portions of programs using the vector assembler language and achieve higher performance.

In addition to vectorizing versions of the Fortran and Assembler languages, IBM offers more vector programming support. Included in the programming set is an extended scientific subroutine library that provides a quick and easy way to take advantage of the Vector Facility. The ESSL is a set of 95 program modules that serve as a basis for high-speed computational programming. The modules, which can be called from programs written in Fortran and Assembler, are coded with very efficient algorithms designed to wring the most from the machine's vector and parallel structure.

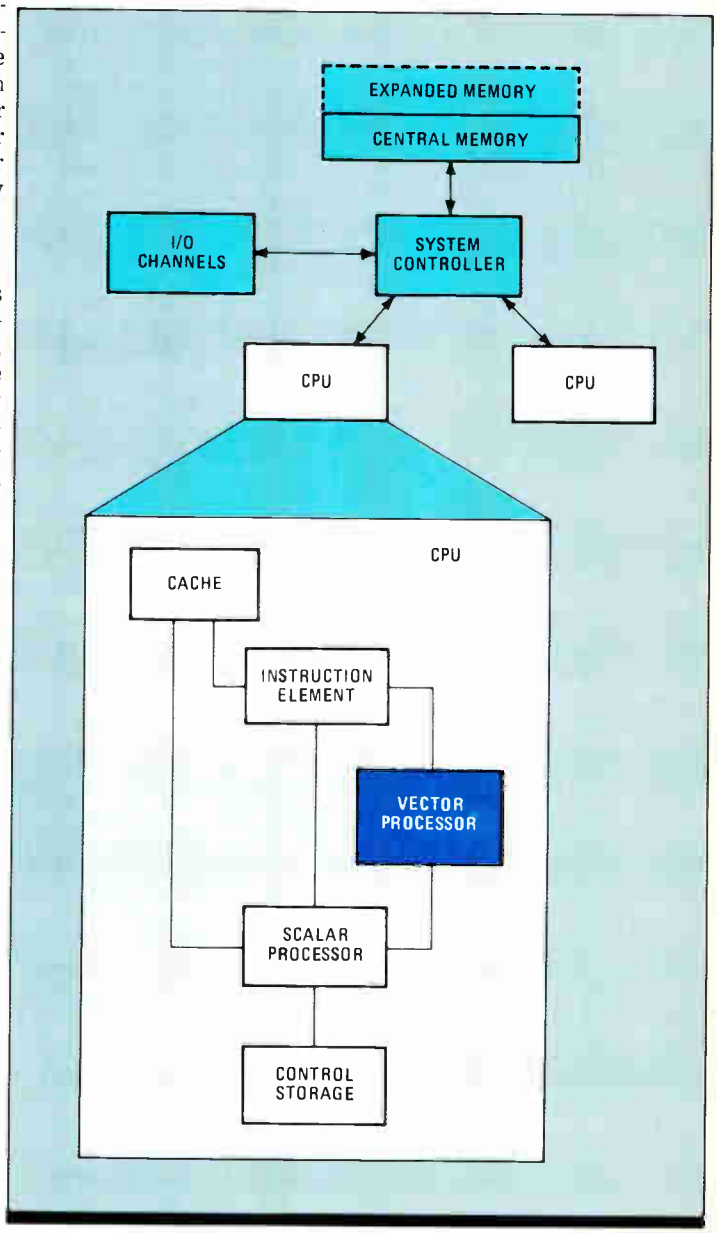
The development team did extensive work on the ESSL routines, which are a very important element in the Vector Facility package. One example of the ESSL's effect is that a large vector multiplication using the vector multiply module will be executed on the vector processor well over seven times faster than on the scalar processor. Because the average peformance-improvement factor for the vector processor is three to five times, the use of ESSL significantly increases processing efficiency.

The ESSL provides a range of mathematical functions for different types of scientific and engineering applications, such as structural analysis, fluid dynamics, simulations, seismic-data analysis, reservoir modeling, and nuclear engineering. These functions fall into six computational categories:

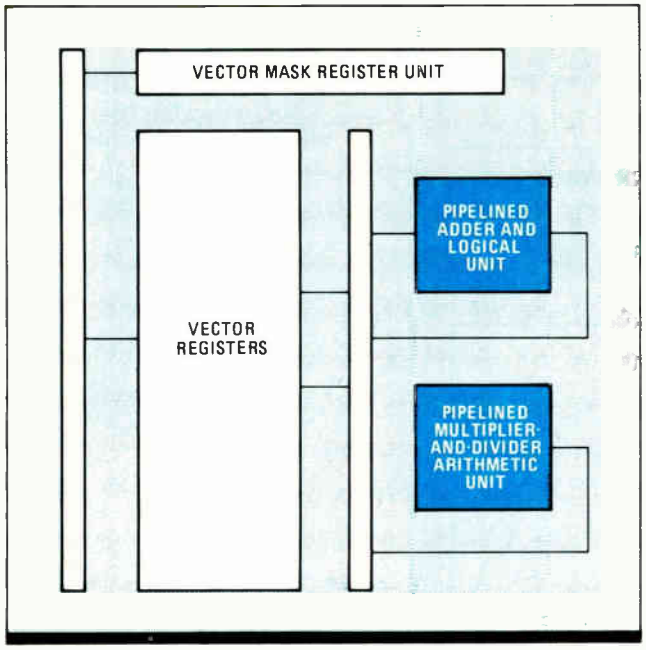
- Linear algebra.
- Matrix operations.
- Simultaneous linear algebraic equations.
- Eigenvalue systems analysis.
- Signal processing.
- Random number generation.

The ESSL vector subroutines are coded in Assembler and VS Fortran. To achieve high performance on the 3090 vector processor, these subroutines use state-of-the-art algorithms tailored to the machine's operational characteristics, such as cache size, number of available vector registers, number of elements in a vector register, and page size. Performance gains using ESSL routines are especially high for matrix multiplications, matrix-vector linear algebra, fast Fourier transforms, simultaneous linear algebraic functions, and symmetric eigenvalue systems.

Another programming and tuning aid is a load monitor that



2. UNITED. The vector processor in an IBM 3090 system is not only tightly integrated into the central processing unit but is fabricated in the same circuit and packaging technology as well. The vector processor gets its instructions from the CPU's instruction element and its data from the shared cache.



3. VECTOR PROCESSOR. The vector processor contains two pipelined computation units—one for addition and logical operations and the other for multiplication and division. Both units are supported by 8-K bytes of vector-register storage and a vector mask register.

tells the programmer what percentage of the time a job has "vector affinity" and what percentage of the time the vector processor is actually used. Vector affinity is a new software function of the operating system. Upon recognizing the first vector instruction in a program task, the operating system assigns the task its affinity to a CPU with an integrated vector processor. When the operating system determines that a task with vector affinity has not used the vector processor for a certain amount of time, it restores a less-restrictive affinity to allow the program to run on any CPU.

Knowing when vector affinity is assigned and how much vector-processor time a task uses guides the programmer in deciding when and where it is advantageous to start tuning a program for more-efficient operation. The user also can determine when to stop tuning a program—when the law of diminishing returns catches up with him.

Debugging programs is always difficult. Included with the Vector Facility is an interactive full-screen debugger with graphics assistance. This debugger, which knows about vector processing, can time subroutine executions and count statement entries within subroutines for use both when debugging or tuning parallel and vector programs. The debugger does not have dependency analysis for parallelizing programs. Nor are there any automatic parallelizing compilers for the 3090. Wilson believes that automatic parallelization will evolve as automatic vectorization did—slowly but surely.

But the good news for programmers is that they have several options when writing new programs or converting old programs to run on a machine with one or more vector processors. The optimizing compiler will flag and vectorize Do loops. The programmer can stop there if performance is adequate. But because the compiler has flagged the vectorized Do loops, the programmer can zero in on the tasks that contain many and large vectorized loops, remove coding barriers, or insert calls to appropriate ESSL routines. Programs require different levels of effort to optimize them. The team that developed the 3090 Vector Facility found that some programs benefited considerably from extreme tuning and code-rearrangement efforts. But they have no good rule of thumb to guide users in the amount of tuning that is necessary.

The vector processors added to the 3090 systems form a completely natural and logical extension to the machine. By adding from one to four vector processors to a 3090 model 400, customers can have a very versatile and powerful scalar and vector parallel computer that generally tops out at more than 100 million instructions per second. □

THE SAME TEAM THAT DESIGNED SIERRA ADDED THE VECTOR PROCESSOR

The best way to have a major computer enhancement fit smoothly with the original design is to enlist the same engineers who designed the machine in the first place. IBM Corp. did that for the 3090 Vector Facility. The task force at the company's Kingston Laboratory, headed by design manager Les C. Garcia, was essentially the same group that tackled the 3090 mainframe project. The design team was assisted by Hugh F. Walsh, program manager of engineering and scientific analysis, and Troy L. Wilson, manager of system management and performance in the Kingston Scientific and Engineering Processor Products organization.

Although the vector-processor project grew out of the design and development project for the main machine, the 3090 planning had been under way for about two years before it was decided to redirect the planning to make the machine a more effective scientific computer on its own and also to design it to allow the simple insertion of a vector processor later. After the basic machine project was finished, the complete Vector Facility project, which included both hardware and software development, took about the same time.

TOGETHER AGAIN. Former Sierra team members, manager Les Garcia, (left), Troy Wilson (center) and Hugh Walsh, created the IBM Vector Facility.

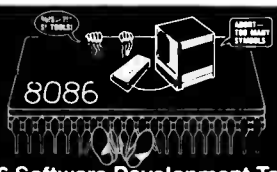
Wilson's responsibility at Kingston is to provide the analysis necessary to understand the processing behavior of scientific applications on large IBM systems. During the two years he was assigned to the vector project, Wilson derived the performance analysis and studied the migration of application programs to the 3090 with a Vector Facility.

A graduate of the University of Arkansas, Wilson is also responsible for supporting engineering projects to achieve high performance and to guide and encourage third-party software vendors in applications requirements.

From 1977 until taking over the Vector Facility project, Garcia was a manager of advanced processing for the 3090 structured-processor instruction element. He was the lead designer as well as manager of the project. Garcia, who holds an EE degree from the University of Florida and a master's degree from the Florida Institute of Technology, joined IBM in 1965 and for the first five years worked on the Saturn and Apollo space programs. He is currently a senior engineer in future processor development at the company's Poughkeepsie, N. Y., site.

Hugh Walsh is program manager for engineering and scientific analysis for the Kingston Laboratory. A 30-year veteran and apostle of scientific and engineering computation at IBM, Walsh has spent most of his career in planning the company's large systems, including the System 360, System 370, and most recently the 3090.

COMPUTER SOFTWARE



8086 Software Development Tools That Don't Pin You Down

MicroSET™ Tools
- Compilers for Pascal, C, FORTRAN, and PL/M
- Support for MTOS™, VRTX™, iRMX™
- Assemblers
- Linkers, Locaters, Librarians
- MicroSCOPE™ - A UNIQUE HIGH LEVEL LANGUAGE CROSS DEBUGGER
- Downloaders and Communications

Targets
- 8086/80186/8088/80188/8087
- 8080/8085/Z80/NSC800

Hosts
- DEC VAX/VMS™
- DG MV/Family
- HP 9000/500 HP-UX

For advanced tools that get your job done faster and reduce your costs, call **(213) 546-5581** today.

First Systems Corporation
865 Manhattan Beach Blvd.
Manhattan Beach, CA 90266.
Telex: (RCA) 298086.

WIRE WRAPPING SOFTWARE RUNS ON IBM PC

Conversion from schematic, either CAE or hand drawn, for wiring by wrapping or other termination on AAC wiring machine. Optimizes wire paths and provides full documentation. For prototyping or production

aac inc.
10946 W. 74 Terrace
Shawnee, KS 66203
(913) 631-2940

SPICE **up your *PC***

Z/SPICE professional circuit simulation
Full version $245 Student version $79
ZTEC box 737, college place, wa 99362
(509)-529-7025

POSITIONS VACANT

Gulf South Opportunities! Numerous openings in the Gulf Coast area for electronic engineers in the medical, computer and defense industries. All fees paid. For consideration send resume or call collect to Ann Jernigan, Snelling and Snelling, 428 Plaza Bldg., Pensacola FL 32505, (904) 434-1311.

Murkett Associates — Technical Mgmt placement with national affiliates-fee paid Box 527, Montgomery, AL 36101.

POSITIONS WANTED

Electronic Expert For Hire. I do Microprocessor hardware/software, assembly language. Analog, digital design in my N.Y. lab or worldwide. Project rates. Mr. Barry Masel (718) 476-1516.

BUSINESS OPPORTUNITIES

For Sale — Our prototypes ready for mass production (home security system). Call (514) 327-1962 4-6pm East.

HOT LINE

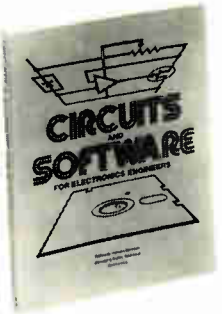
To place your recruitment message in **Electronics**

call Pat Clyne at

212/512-2557

DESIGN PROBLEMS?

CIRCUITS AND SOFTWARE FOR ELECTRONICS ENGINEERS focuses strictly on design problems!



Access stimulating, clever approaches that can speed your creative design concepts.

This indispensable source contains hundreds of circuit schematics, block diagrams and computer programs that are conveniently organized into 25 vital categories by function.

Design appropriate circuitry to meet challenging specifications.

Save time by adapting proven circuits and software to a wide range of applications.

Save money and increase productivity by avoiding costly design errors.

Don't take the chance of being less than on top of the latest circuitry developments.

ORDER YOUR COPY NOW!

Electronics Magazine Books
P.O. Box 541
Hightstown, NJ 08520
or
McGraw-Hill Int'l. Pub. Co.
Attn: ECC
McGraw-Hill House
Maidenhead, Berkshire SL6 2QL
England

Send me _____ copy (copies) of R370 for $19.95 each.
- ☐ Payment enclosed
- ☐ Send proforma invoice

Name _____

Company _____

Street Address _____

City _____ State _____ Zip _____

Allow 4-6 weeks for delivery.

MANIPULATING DIGITAL X RAYS ENHANCES DIFFERENT FEATURES

PHILIPS SYSTEM HAS IMAGE PROCESSOR AND PARALLEL ARCHITECTURE

Here comes the harbinger of the digital future of radiography. A highly versatile system called Philips Computerized Radiography (PCR) can produce high-resolution digitized X-ray images to meet the needs of a wide variety of radiologic imaging techniques. Developed by Philips Medical Systems Inc., PCR can emphasize a number of different aspects of an X-ray image, thanks to a combination of advanced image processor and software with parallel computer architecture.

The image processor digitizes X-ray images produced by conventional radiographic equipment and records them on an optical disk for electronic viewing and storage (Fig. 1). Different views of one picture can be printed out as hard copies or stored in peripheral memories. The system can also transmit the pictures to other diagnostic centers or convert them to film for viewing in a conventional X-ray station.

A key advantage is that X-ray pictures can be adjusted to enhance the features required for a particular examination through the use of a proprietary image-plate and reader combination. For example, the image of a compound fracture can be optimized to show soft tissue damage as well as bone fragments. Or one anterior/posterior chest X-ray can be processed to emphasize the detail of a cracked rib, while another picture from the same X-ray image emphasizes the soft tissue of the heart.

The fact that the Philips system can manipulate X-ray images after they have been taken is a significant benefit to both the physician and the patient, according to researchers at the North American Philips Corp. subsidiary. The physician can select the anatomical features most relevant to the treatment, while the patient benefits because a poor image can be enhanced by PCR, eliminating the need to retake the X-ray and expose the patient to more radiation.

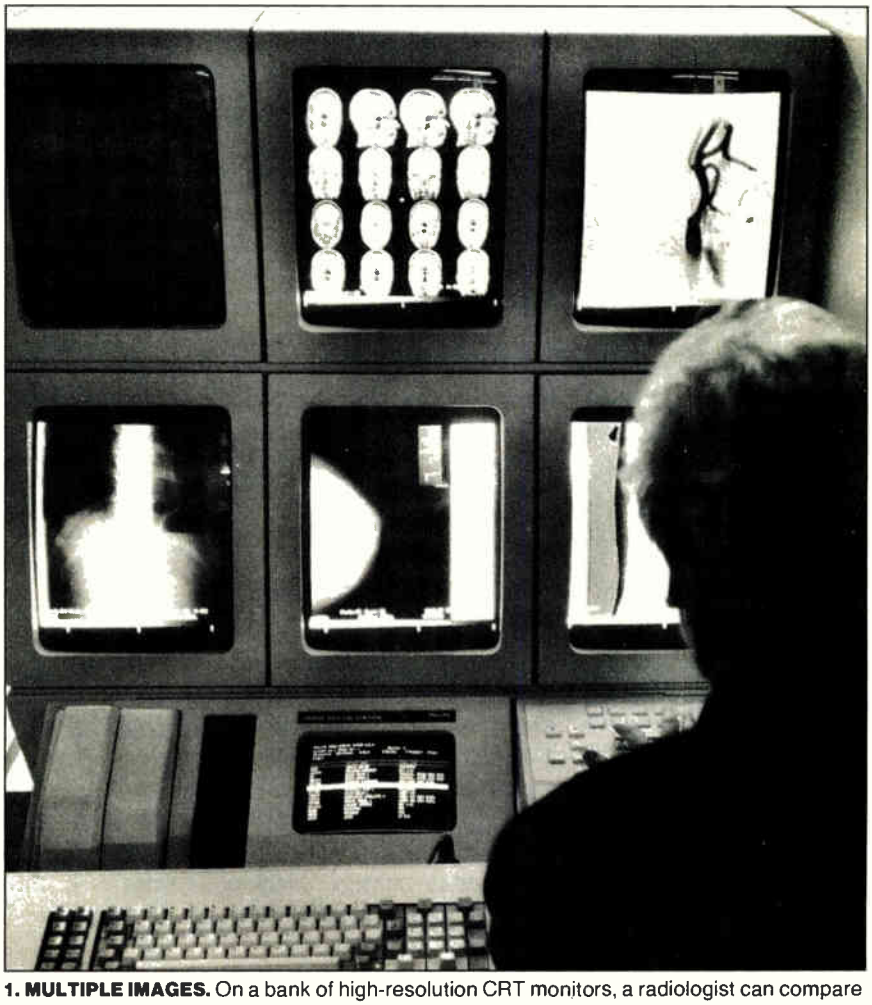
"The PCR can produce diagnostically useful images over a range of X-ray exposures, from 1/10 to 10 times the usual dose," says Frank Low, senior vice president of the Shelton, Conn., company. "It makes it possible to render an accurate diagnosis from fewer images than film would allow, and its sensitivity permits imaging at a much lower roentgen level than film X rays require, which can be vital when multiple exposures of children are taken."

Philips Medical Systems is positioning PCR as an integral part of a work station capable of multiple imaging techniques. With it, a physician has electronic access to a number of digital imaging methods that now figure prominently in diagnostic technique—nuclear magnetic resonance, computerized axial tomography, ultrasound, and digital-subtraction angiography.

With the addition of the PCR system to these imaging techniques, X-ray pictures—which account for over 80% of diagnostic imaging—can be manipulated on a high-resolution 2,048-by-2,048-pixel monochrome cathode-ray tube and compared with other imaging techniques to provide different diagnostic perspectives. Also, a physician can simultaneously view the various X-ray pictures that describe the time course of a given treatment.

Because Philips's aim is to make PCR as compatible as possible with existing radiology equipment, only the processing and storage of the image represent a departure from standard procedure. The X-ray camera and its use remain the same as with standard film X rays; no replacement of the system's front end is needed.

"Radiology is run by tradition. Film-based X-ray equipment is a security blanket and nothing will completely replace it," says Anthony Lando, Philips's product manager of computed radiography and imaging physics. "Even physicians who are already using CRTs for other diagnostic techniques and are



1. MULTIPLE IMAGES. On a bank of high-resolution CRT monitors, a radiologist can compare and contrast many views of a given anatomical feature.

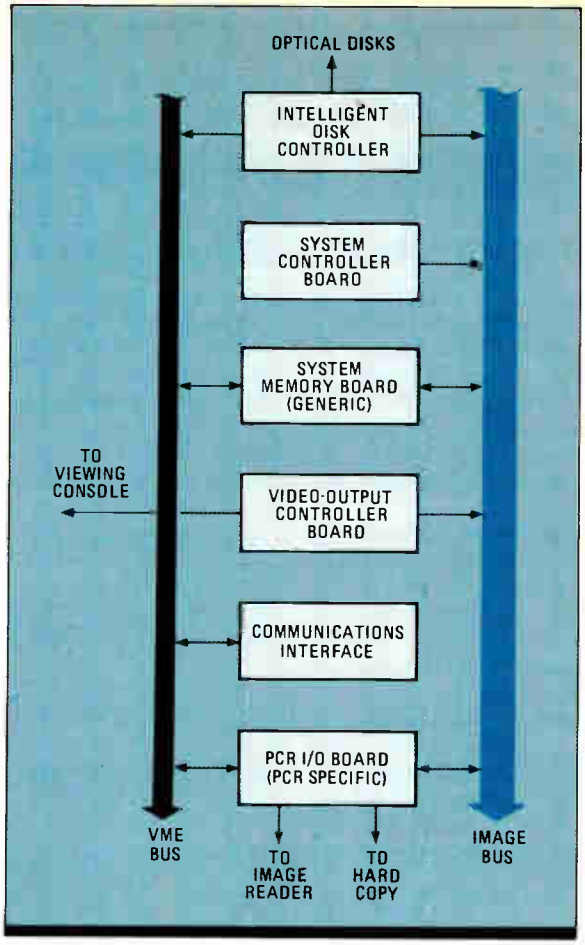
ready to accept video X-ray pictures are reluctant to give up the film images that they were trained on."

The PCR system is a modular system consisting of four main elements: an image-receptor plate with the same dimensions as a conventional X-ray screen; an image reader, in which the image plate is read by exposure to a laser scanner; an image processor that digitizes the X-ray picture for electronic display; and an image printer that generates a hard copy, if desired. Keyboard terminals at the system's front end are used to log in patient data. Conventional X-ray cameras need no modification to work with the system.

PCR's physical underpinnings center on the principle of scanning-laser-stimulated luminescence [*Electronics*, Nov. 18, 1985, p. 30]. When an X-ray picture is taken, the image is first stored on a 1-mm-thick flexible plate composed of europium-activated barium-fluorohalide compounds in crystal form held in a carbon-based organic binder. The plate can be placed in a standard film carrier so it can fit without modification into an X-ray camera's film slot.

But instead of being composed of silver halide—as in standard photographic processes—the crystals on the PCR's plate are made up of photostimulable phosphors that act as energy traps when the plates are exposed to ionizing radiation. After being exposed, the plates give off light similar to that from any intensifying screen.

It is not possible in a clinical setting to deposit a photoconductor between the phosphor and the plate's substrate, however: the current per pixel is small and handling it would require a sophisticated narrowband amplifier with a very long scan time. Half the X-ray energy remains trapped in the plates, however, and is released when scanned point by point with a high-power laser.



2. IN PARALLEL. A dual-bus architecture in the Philips system supports parallel operations. Distributed intelligence supports simultaneous processing of medical image data.

IMAGE RETENTION

The plates—which have the same resistance to mechanical stress, dust, and scratching as conventional intensifying screens—can retain an image for "at least a couple of hours" at room temperature, says Dr. William Angus, senior vice president at Philips Medical Systems. "But it only takes about 90 seconds to read out an image and store it in a buffer memory, from which it can be accessed as often as necessary," he says.

A plate's imaging lifetime is about 5,000 exposures. Fuji Photo Film Co., Tokyo, which holds the patents for the PCR's plates, has announced that it expects to improve on this figure. Reproducibility is usually better at the start of a plate's life cycle and grows progressively worse with the inevitable damage caused by successive X-ray exposures.

PCR uses a conventional Fuji 90-second wet-film processor attached to a conveyor that moves and stacks the film for later retrieval. The film processor is also connected through a VMEbus to a Motorola 68000-based recorder, which stores the image electronically after the optional film copy is made. An optical disk can provide permanent electronic storage if desired.

If identical image plates are stacked in the X-ray film carrier, several images can be obtained during one exposure. Though the images may not be identical, they are enough alike for the 68000-based parallel image processors to simultaneously work on optimizing different features of the same image.

Reading an image from the phosphor is a linear process because the integral of the total stimulable luminescence energy is linearly proportional to the stored charge concentration. Fuji gives the plate's spatial resolution as 8 pixels/mm—the only performance figure published so far. Angus emphasizes, however, that subjective tests by Philips Medical Systems and its customers of the imaging system's pictures show them to be superior to conventional X-ray pictures in contrast and dynamic range as well as in spatial resolution.

The company believes the image processor represents its most important technical advances in developing PCR. The processor is subdivided into modules to meet the requirements that the diversity of medical images impose. Thus the image-processing functions are clearly separated from the functions that control the operation of the system: coordination of PCR's four elements, data-base management, and resolution of multiuser contention. Those functions are handled by a version of AT&T Bell Laboratories' Unix operating system that is compatible with Digital Equipment, Intel, or Motorola hardware in an approach similar to that used by business or industry.

The image processor, on the other hand, has no control functions, but is dedicated to image manipulation and transfer. Its hardware has been designed so that a given module of the processor can be modified for a given diagnostic application or upgraded as imaging technology improves.

MULTILAYERED STRUCTURE

In PCR's present version, the image-processing software has a multilayered structure similar to the hierarchical architecture used in industrial-automation networks [*Electronics*, Sept. 9, 1985, p. 26]. At the top is a layer for handling the data pertaining to a patient's condition; this is entered by keyboard at the front end of the system. In the middle layer, software primitives can be designed that emphasize the features associated with a particular type of image such as chest X rays. At the bottom, hardware modules digitize the X-ray picture according to the instructions from the upper levels.

The most common site for the Philips system—which sells for $500,000—will be in the radiology departments of large hospitals, so it often will be used to make repeated images of a given part of the body on a wide variety of patients. Because no two patients' bodies are identical, any pattern-recog-

nition algorithms would have to be much more tolerant of variance than those used in industrial or even agricultural inspection. Such algorithms are not available for PCR.

A software designer can get around the problem, however, by knowing in advance the protocol and format of the directive calls that are necessary to generate an application program. By relegating the hardware-dependent control of image manipulation, enhancement, and transmission to the lowest chip-driver level, the higher software levels can be programmed independently of any changes in hardware that might be implemented later. Or, if new image-processing functions are added that can be implemented with existing hardware, only the application and control layers need be affected.

For use as part of an integrated imaging system—both within a hospital and in connection with other medical facilities—PCR uses a dual-bus architecture (Fig. 2). A VMEbus and a Philips-designed image-bus system handle the image-transfer requirements—with the rate of transfer being limited only by the state of the art in packaging technology.

The system works without modification to existing X-ray gear

In the Philips system, all data and control lines reside on four 96-pin Euro connectors, which handle the eight independent parallel 16-bit buses that make up the image-bus system. A pixel clock governs the transfer of 9 million pixels per second (or 144 megabytes/s). The backplane and processor modules are designed so that every module has access to all eight image buses as well as to the VMEbus. Gate and multiplexer arrays effect logical and data-transfer connections between module functions and the bus system.

Parallel-processing operations are asynchronous because the image processor can accommodate a wide range of simultaneous operating conditions without changing the clock rate. In practice, one user of such a multimodality diagnostic work station can review digitized film, where 512-by-512-by-16-bit images stored on an optical disk are retrieved and viewed at a rate of 30 frames/s (the rate set for NTSC TV), while a second user observes a single 2,500-by-2,000-by-12-bit radiograph on an adjacent high-definition monitor.

"Artificial intelligence in the form of pattern recognition is not an integral part of PCR software, but a limited amount of AI resides within its image-processing hardware," explains Lando. In essence, the AI composes a luminance histogram by arranging 1,024 contrast levels—versus 256 contrast levels for the most sophisticated industrial machine-vision equipment—on the stimulable plate. The user defines areas of interest according to pathology or body region, and thus an ordinary chest X ray can be processed in a number of different ways depending on the instructions that are entered into the keyboard terminal.

The image processor recognizes the selected images by their location on the histogram, which varies according to the body part being imaged. For example, the massive soft tissue of the lung contrasts in a predictable way with the hard tissue of the ribs. But the contrast relationship of the liver with the spine has different characteristics and can be plotted on the histogram accordingly.

"The PCR has to know in advance what it's looking for," says Angus. "There's no AI that will simply pick out the right [image] density level and feature enhancements. The keyboard operator must enter those instructions before the picture is taken." In that sense, PCR is programmed in a manner similar to any modern X-ray imager.

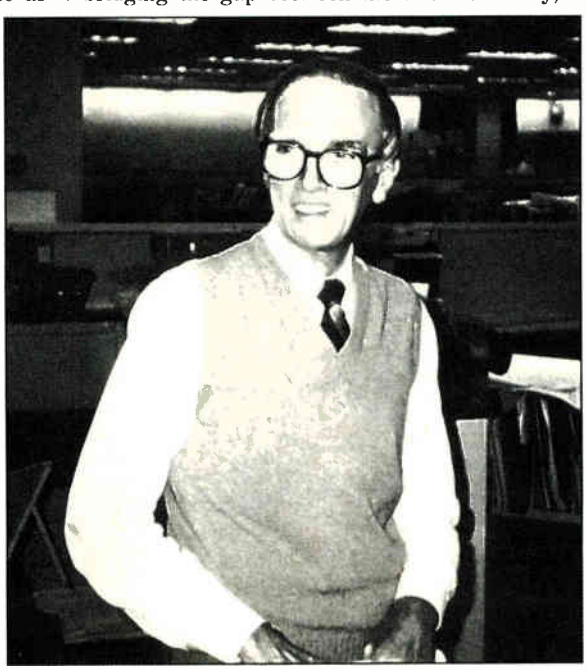
The development of multiple imaging techniques for diagnosis and the need to exchange images quickly, however, is driving the market for digitized X-ray systems and the communications equipment needed to move medical images from one site to another. The PCR system's ability to manipulate an image after it has been taken as well as connect with up to eight examination terminals will make it a key part of the electronic diagnostic stations of the future, Angus believes. □

PHYSICIAN DIRECTS DESIGN OF COMPUTERIZED RADIOGRAPHY SYSTEM

"Engineers and radiologists used to be able to talk to one another," says Dr. William Angus, a physician who joined Philips Medical Systems Inc. in 1959 after a residency in radiology. "Back in the days when the technology was simpler, a radiologist had the time to learn how the equipment was designed, and he and the engineer spoke the same language."

This is no longer true, he says, because medical imaging has grown infinitely more complex. Today, the radiologist has to be conversant with a variety of imaging techniques—from X rays to digital-subtraction angiography—and the engineer is charged with developing much more complicated equipment. Their training has diverged so much that the rare person with experience in both medical practice and equipment design becomes a valuable asset to a company such as Philips Medical Systems.

Angus, a Chicago native, sees himself bridging the gap between the two disciplines. "I was more interested in radiological science than in the practice of radiology. When I finished my residency, I could see that the technological base of that branch of medicine was expanding enormously, and that I could do my best work developing the equipment that radiologists use."



LIAISON. William Angus reconciles the needs of physicians with the design constraints of engineers.

Angus's role in developing PCR has been to listen to the wish lists of radiologists in the field and supervise the Philips team that designed them into PCR. Certain PCR features, such as a film backup and an ability to work with existing equipment, are two items from those lists.

Though there is still some resistance to digitized X rays, Angus expects the radiological community eventually to take them for granted. "They'll become part and parcel of medical information handling. And as image enhancements grow more sophisticated to show more anatomical detail, physicians will increasingly depend on them," he says.

THE SUPERCHIPS ARE HERE, BUT HOW TO TEST THEM?

DOD DECIDES A NEW GENERATION OF ATE NEEDS TO BE DEVELOPED

by Jerry Lyman

By all accounts, the Defense Department's Very High Speed Integrated Circuits program has been a tremendous success. Phase 1 has sired whole families of chips in 1.25-μm n-MOS, CMOS, and bipolar technologies, custom ceramic packages, and advanced lithography systems of all types. But VHSIC's rapid advances have left automatic test equipment in the dust: present-generation ATE is only marginally acceptable for testing these complex devices.

Phase 1 ICs average 120 pins—in most cases exceeding the pin-count capacity, data rates, and timing accuracy of today's ATE for VLSI circuits. Tomorrow's Phase 2 parts will only widen the gap. They can exceed 500 pins, a figure beyond the capacity of any ATE now available. That's not all: they are also very fast. Phase 2 chips will have a clock rate of 100 MHz. Available ATE systems can generate clock rates up to around only 50 MHz—and many reach that speed by multiplexing two pins.

Several large makers refuse to bid on new ATE

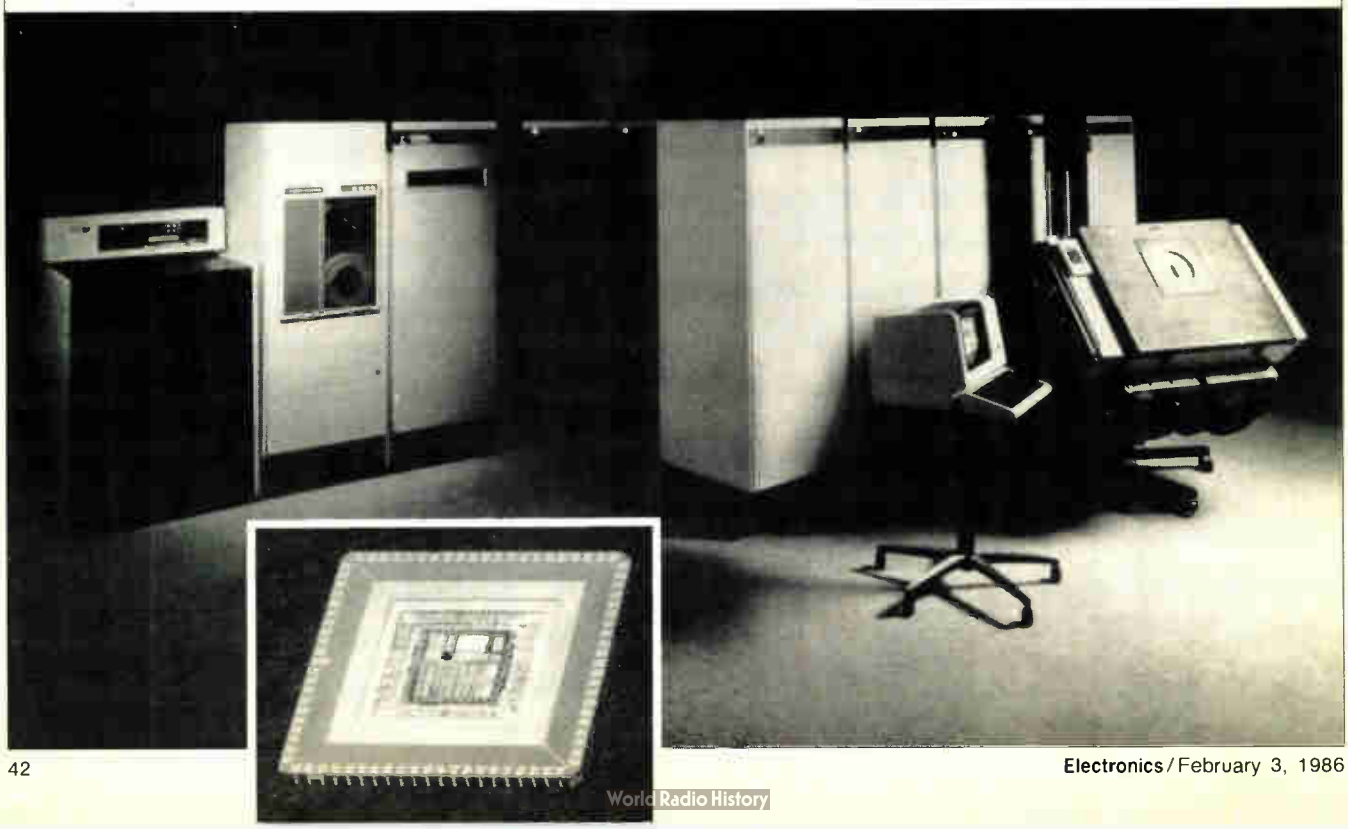
The VHSIC program's managers are eager to remedy this critical situation. They have assigned to Rome Air Development Center's Reliability Physics Section at Griffiss Air Force Base the task of developing ATE and techniques to meet present and future microcircuit test requirements. The Rome, N. Y., center got the assignment because it has had considerable experience with high-speed, very large-scale-integration and LSI testers. It put together such in-house equipment as a 14-pin 40-MHz tester in 1968, a 64-pin 20-MHz tester in 1974, and a 64-pin 20-MHz tester in 1980.

The staff at Rome has embarked on a two-part program whose ultimate goal is nothing less than a new architecture for the next generation of ATE. The first step is to give the military the ability to meet the test requirements of Phase 1 parts. But the program's overall aim is to develop a tester that can handle all Phase 1 and most Phase 2 chips.

Rome engineers started by establishing a current state-of-the-art ATE system as a baseline instrument. They then enhanced this unit so that it could effectively test both Phase 1 and Phase 2 devices. The engineers developed a set of specifications and analyzed commercial test gear to see which most closely matched the specifications. Their conclusion was that existing systems were at least an order of magnitude less accurate than was required. Realistically considering both expected ATE capability and essential test requirements, a set of values was established (Table 1).

Then, last spring, GenRad Inc.'s GR-18 was selected as the VHSIC baseline tester, beating out other VLSI instruments

TESTER AND OBJECT. GenRad's GR-18 is the baseline system in the Rome Air Development Center's search for a VHSIC chip tester.



from Tektronix Inc. and Sentry Test Systems. The GR-18, GenRad's entry in the VLSI tester arena, competes not only with those machines but with units from Teradyne, Megatest, and Trillium Test Systems in the U. S. and Takeda Riken and Ando Electric in Japan.

The standard GR-18, already installed at Rome, provides the DOD with a 16-clock phase system that can test 288-pin chips at 40 MHz. This standard system—seven have already been delivered to customers worldwide—will also include off-line test-program development and data analysis using a Digital Equipment Corp. VAX-11/750 and an integrated color graphics capability for enhanced timing and data analysis.

An enhanced GR-18, scheduled for delivery in December, will have a 576-pin capacity, 100-MHz clock rate, and 80-MHz data rate. Some key goals are to reduce test-head capacitance to 50 pF, improve the timing accuracy to ±500 ps, and boost the comparator response to 1 ns (Table 2). A thermal chuck will enable full testing of 288-pin wafers over −10°C to +125°C. For packaged devices, an advanced environmental unit will be linked to the enhanced test head to allow for the full range of military testing.

Three major improvements will make the existing tester meet the enhanced specifications, says Eugene P. Roth, marketing manager for GenRad's Semiconductor Test Division in Milpitas, Calif. The changes will require some enhancements in the tester's mainframe as well as a new test head and faster pin electronics with lower capacitance.

With so much activity in VHSIC phases 1 and 2, insertion of VHSIC chips in equipment, and similar programs at IC makers [*Electronics*, Dec. 16, 1985, p. 33], it seems certain the enhanced VHSIC tester will find a ready market. But several large ATE manufacturers, who wish to remain unidentified, refused to bid on the tester program. As one claimed, "VHSIC is too limited an ATE market to expend research and development money on."

Roth disagrees. "We don't view VHSIC as being entirely military. We feel that our future development programs were aimed at testing chips close to VHSIC capabilities anyhow."

Then there is the matter of retained value. As in other VHSIC equipment programs, GenRad retains rights to all the designs and will be allowed to sell its enhanced version commercially. Such was the case with Perkin-Elmer Corp.'s advanced direct-write electron-beam system, which also was developed on a VHSIC award.

At the same time that it is experimenting with existing testers, the Rome center is pursuing the second step of its program: designing test systems for tomorrow's VHSIC circuits. The main difficulty was outlined succinctly last November at the Government Microcircuit Applications Conference in Orlando, Fla., which is devoted to government electronics. There, Robert G. Hillman, an engineer in Rome's microcircuit test group, stated that present-day ATE has reached the point where costly modifications to the pin electronics produce only minor improvements in performance. Because these improvements are clearly inadequate to properly test next-generation devices, he said, it is necessary to understand the fundamental limitations in the architectures used in ATE today.

LAYING THE GROUNDWORK

The Rome center awarded Harris Corp.'s Government Support Systems Division a contract to study the problem. The Syosset, N. Y., division's task is to examine and quantify current architectural limitations, study promising new technological developments, perform a theoretical analysis of a general ATE architecture using these developments, and finally design an architecture for a high-speed, high-pin-count VLSI tester in sufficient detail to facilitate the start of full-scale development. The rough performance goals for this new system are a 250-MHz data rate, more than 512 pins, and ±200-ps accuracy (Table 3). The study's results are to be delivered in June.

Some of the new developments to be examined in the Harris study are supercomputer architecture and designs (those of Cray, ETA Systems, and others), per-pin tester schemes (that of Megatest), liquid-cooled test heads, and wafer-scale technology. Rome officials hope to land a follow-up program aimed at producing a brassboard of the advanced tester. Using the brassboard and computer simulations, a theoretical analyis of a generalized ATE architecture could be done to study such factors as overall timing accuracy, mass-storage bandwidth requirements, throughput, device-under-test interfacing, and test-head capacitance.

Fredrick G. Hall, an engineer at Rome who monitors the project, says his agency is particularly concerned with having the means to test the gallium arsenide circuits that should be developed within the next few years.

Two other programs at the Rome center are tackling VHSIC probing. The problem is that the probes used to check parasitic capacitance can cause erroneous test results. The University of Rochester, Rochester, N. Y., is investigating contactless probing using a laser and an electro-optical sampler. Stanford University's effort aims at building electro-optical pin electronics to eliminate the capacitance in the probe's test interface.

Finally, the Rome center is looking at the problem of test-software generation for VHSIC with the Tester Independent Software System, a VHSIC program awarded to the center to develop an automated test-program generation and specification system. □

TABLE 1: ADVANCED ATE ARCHITECTURE GOALS

Data rate	250 MHz
Device-under-test pins	512 (expandable)
Memory depth	1 Mb
Accuracy	±200 ps
Power range	0 to 3.3 V

SOURCE: ROME AIR DEVELOPMENT CENTER

TABLE 2: COMPARISON OF ATE CAPABILITY

	Standard	Enhancements
Test-head capacitance	93 pF	>50 pF
Power range	−12 V, +12 V	−2.25 V, +8 V
Comparator transient response	3 ns	1 ns
Clock phases	16	32
Overall timing accuracy	±1 ns	±500 ps
Precision parametric units	1	16
Gang-level programming	no	yes
Driver-level tracking	no	yes

SOURCE: ROME AIR DEVELOPMENT CENTER

TABLE 3: VHSIC REQUIREMENTS

	Phase 1	Phase 2
Gate count	50,000	100,000
Technology	Bipolar, MOS	Bipolar, MOS
Clock rates	50 MHz	100 MHz
Data rates	25 MHz	50 MHz
Pin count	200	200 to 500
Timing accuracy	1 ns	< 500 ps
Analog accuracy	5 mV/100 pA	2 mV/100 pA

SOURCE: ROME AIR DEVELOPMENT CENTER

PROBING THE NEWS

IT'S ALL-OUT WAR IN JAPAN AS IBM COMES OUT FIGHTING

TOUGH TACTICS BEGIN TO PAY OFF IN ITS DRIVE TO REGAIN NO. 1 SPOT

by Michael Berger

TOKYO

The battle for supremacy in the world's second largest computer market is getting brutal. IBM Corp. has come out fighting to regain supremacy in Japan, the only major national market in which it can't say, "We're No. 1."

"There is no doubt that there has been a dramatic change in IBM marketing tactics," says Yuji Ogino, a longtime industry observer who publishes *EDP Japan Report*, a Tokyo newsletter. Ogino says he has yet to see actual numbers, but industry sources predict IBM-Japan's 1985 fourth-quarter sales were 20% to 25% above the same 1984 period.

The outlook for IBM in Japan is much brighter than it was a year ago thanks to a combination of factors: new troops brought in from the U. S., much tougher marketing tactics, IBM's continuing legal pressure on Japanese makers of IBM-compatible machines, such as Fujitsu Ltd. and Hitachi Ltd., and an uncertain attempt by Fujitsu to get out from under Big Blue's technological thumb (see "For Fujitsu, being No. 1 brings big problems").

Six years ago, Fujitsu displaced IBM as the overall leader in unit shipments in Japan. IBM still leads in mainframes, both in shipments and in revenue—but it is, at best, second in other market sectors (table).

Until last year, IBM's position in Japan was eroding almost across the board—a major reason why it reorganized its Far Eastern effort early last year and sent over more than 300 employees to bolster operations in Tokyo. For several months, there were few signs of change. IBM-Japan's chronic problems, especially inflexibility on prices, spotty service, and unimpressive Japanese-language programs, remained.

Now things are changing fast. IBM group executive George Conrades has overseen a radical turnabout in tactics. For one, he indicated soon after he arrived in Japan last year that he is willing to deal on prices. "Those IBM guys are out there cutting and slashing, just like everyone else," says an industry executive who asks not to be identified.

IBM refuses to comment on its activities. But a variety of industry sources familiar with its operations in Japan say the creation of the Asia/Pacific Group and the arrival of Conrades have ended many of IBM's most serious internal problems. These sources claim that Conrades has learned to accept more fully the Japanese-style marketing tactics. "If you don't wheel-and-deal in this market, you don't rack up a lot of sales, even if you're IBM," according to another industry executive.

The latest example of IBM dealing is its win at the University of Kyoto, which needed a replacement for its Fujitsu mainframe. Even though the university had been one of Fujitsu's first mainframe customers, back in 1976, it is going with IBM-Japan, which offered a reported 90% discount. "They didn't make any money on that deal, but it must have been satisfying," says the executive.

Japanese universities are noted for their lack of funds for computer equipment, so such enormous discounts are limited to academia. But in the general market, substantial price-cutting of everything from mainframes to personal computers goes on every day. IBM-Japan cut its prices on all its computer products an average of 16% last year. Now it's making large off-price deals one by one, building the kind of relationships and reputation that it hopes will lead to greater volume in the future.

NASTY BUSINESS. As the price-cutting goes on, so does the bad-mouthing. Japanese companies rarely mention rivals' names in advertising, but behind closed doors there are no rules. "IBM is saying very nasty things about us," complains a Fujitsu employee. "They are spreading false rumors every day, criticizing our products, and warning customers that our software infringes on their copyrights." Market observers say IBM-Japan sales representatives simply are now doing what everyone else does.

The new IBM strategy, which involves a major drive to sell the company's Systems Network Architecture as a way to tie networks together, is a powerful long-range marketing tool, believes market-watcher Ogino. IBM's recent tieup with Nippon Telegraph & Telephone Corp. for value-added networks

[*Electronics*, Dec. 23, 1985, p. 17] is further evidence of the new directions the U. S. company is taking.

With the role of distributed systems growing in Japan, IBM's approach seems certain to build sales and regain market share, says analyst Bruce Johnson of James Capel & Co.'s Tokyo office. "Now that minicomputers are used as controllers, tying together groups of personal computers, the winners of the future here and elsewhere are going to be the ones who put together the best networks and integrated systems, and IBM is clearly headed in the right direction," he maintains.

ANOTHER CHANGE. IBM-Japan also has changed its practice of using dealers as service representatives. Some of its more than 100 dealers nationwide did their work well, but others drove customers to distraction—or to other vendors. Industry watchers say Conrades tried at first to stick to home-office policy by making dealers exclusively responsible for service. But he changed his mind last fall, approving a policy of direct IBM-Japan service support to dealers.

Other important reorganizations last fall changed sales and marketing operations into departments oriented by geographic area and industry, rather than by products, in order to offer more integrated service and support. The move also is said to have eased interdepartmental bickering that hurt IBM's marketing in the past.

IBM's Japanese-language software problems remain. However, many of the new staff members brought in from overseas were assigned to build improved and expanded programs.

In any event, the marketing turnabout in Japan is just half of what is called the "IBM double punch." Last fall, IBM said it was preparing possible new legal action because of its dissatisfaction with Fujitsu's response to a 1983 pact on alleged infringements of IBM operating-system software.

Now Fujitsu will offer a variant of AT&T Co.'s Unix for its new M-780 mainframe series. There is general agreement that the continuing legal problems posed by IBM make this shift essential not only for Fujitsu but also for Hitachi. Even though it is not named in the latest IBM action, Hitachi must still pay damages and submit software data to IBM in accordance with the 1983 settlement.

The latest Fujitsu M-780 series is the first step in its strategy of "getting out from under" its IBM compatibility, says analyst Ogino. He adds that Fujitsu's goal is to complete the transition by the early 1990s, but he and analyst Peter G. Wolff of Prudential Bache (Far East) Ltd.'s Tokyo office both note that the well-known Japanese weaknesses in software development could drag out the process so much that it becomes excessively expensive.

But whatever happens, Big Blue is not going to rush the Japanese off their feet on their home ground. Hitachi, which is strongest in mainframes and large business computers, claims more than 40 orders and 10 shipments so far for its M-680 mainframe series introduced last spring. The company expects mainframe growth of around 20% this year and similar growth in its 1.2-Gb disk-drive series.

NEC Corp., with its non-IBM-compatible operating system, has a strong position in Japan's personal computer market and overall is second only to Fujitsu in terms of installed units. It is expected to report computer sales of close to $900 million, mostly in Japan, for the fiscal year ending next March 31.

"NEC may not be doing too much overseas, but it can go toe to toe with IBM in Japan in the low- to midsection of the market," says analyst Wolff. He adds quickly that NEC "knows that its real threat is not Fujitsu, but IBM." □

AS COMPUTERS GROW, SO DOES IBM

Company	Small[1]		Medium[2]		Large[3]		Mainframe[4]	
	Units (%)	$ share (%)	Units (%)	$ share (%)	Units (%)	$ share (%)	Units (%)	$ share (%)
Fujitsu	47.1	46.9	32.4	31.4	22.5	24.1	29.5	24.2
IBM-Japan	6.9	7.3	14.1	19.5	20.8	20.9	30.8	35.2
Hitachi	12.4	10.0	15.3	11.5	25.0	22.1	24.5	24.2
NEC	24.5	27.0	17.9	18.4	15.5	16.6	3.0	2.4
Nippon Univac	0.5	0.4	8.5	10.6	6.7	9.0	6.7	11.0
Burroughs	7.2	6.8	5.9	3.9	6.0	2.8	5.5	3.0
Mitsubishi	–	–	4.3	3.5	2.1	1.9	–	–
NCR	1.4	1.6	1.6	1.2	1.4	2.6	–	–
Totals								
Japanese makers	**84.0**	**83.9**	**63.9**	**64.8**	**65.1**	**64.7**	**57.0**	**50.8**
Foreign makers	**16.0**	**16.1**	**30.1**	**35.2**	**34.9**	**35.3**	**43.0**	**49.2**

[1] Small = $13,000 to $43,000
[2] Medium = $43,000 to $213,000
[3] Large = $213,000 to $4.2 million
[4] Mainframe = $4.2 million and over

SOURCE: *NIKKEI COMPUTER*

FOR FUJITSU, BEING NO. 1 BRINGS BIG PROBLEMS

In the tough, all-out fight for the Japanese computer market, leading the pack does not guarantee peace of mind. Fujitsu Ltd., which displaced IBM-Japan Ltd. as the top unit seller of computers in Japan six years ago, is definitely not feeling all that comfortable. IBM is making sure of that.

Fujitsu is being forced to spend a great deal of energy and money trying to build its own operating system—"to find a way to escape from being IBM compatible," as one Japanese executive puts it. This comes after Fujitsu's successful move from a telecommunications company into the computer market. In fact, it has doubled its computer sales since it started shipping its first M series machines at the end of 1975.

The company is also spending an enormous amount on legal fees for a large team of Japanese and U. S. attorneys that is handling the latest IBM challenge: its claim that Fujitsu's operating software continues to infringe on IBM copyrights. The disclosure last fall that IBM believes Fujitsu has not fully complied with a software agreement the companies reached in 1983 prompted at least one investment company to recommend that its clients sell their Fujitsu holdings.

There have been reports that Fujitsu faces indemnity payments that could reach $100 million. "IBM compatibility is inherently risky, but even if that problem didn't exist, there's the question of systems integration," says analyst David Keller of James Capel & Co.'s Tokyo office. "Fujitsu doesn't yet have a real network to talk about."

Fujitsu board director Mutsuro Umezu disagrees. "Of course, our final goal is to build systems that can be linked to form multitask networks. But this is a new era. You can't just look at office uses. You must consider home uses, too."

For Fujitsu, other alternatives are further codeveloping Unix-based systems with its U. S. partner, Amdahl Corp., as well as participating in a government-supported program to produce a new type of Unix-based operating system intended as a standard in Japan and perhaps in other markets. *–M. B.*

HARD CARDS ROAR ALONG DESPITE NAGGING QUESTIONS

DOUBTS ABOUT MARKET SIZE CLOUD EARLY SUCCESS

by Larry Waller

LOS ANGELES

What could be the fastest-growing product in the short and mercurial history of the personal computer add-on business is still raising basic questions as it steamrolls along. The highly popular product—a hard-disk drive mounted on a single plug-in card—has been on the market for six months. Yet manufacturers still haven't figured out how to price it, what features to add, or what the ultimate market will amount to.

There is no question though that the new peripheral has caught the fancy of manufacturers, retailers, and users in a big way. In the six months since Plus Development Corp. announced the first plug-in card, more than a half dozen suppliers have jumped aboard the bandwagon. And sales are ramping up dramatically even though the price-feature-demand equation still has its fundamental parts missing. That is considered remarkable even for the undisciplined personal computer peripherals business, which has been swept by so many product trends since 1981.

Plus Development, the subsidiary of disk-drive maker Quantum Corp., both of Milpitas, Calif., got the idea of building a card-mounted Winchester drive that any user could easily insert into the back slot of an IBM Corp. Personal Computer or PC/XT. It announced its 10-megabyte $1,095 Hardcard in the middle of last year and began shipping in October to meet an avalanche of orders. These cards and rival products are also compatible with Compaq Computer Corp.'s Portable and Plus computers, along with AT&T Co.'s PC 6300.

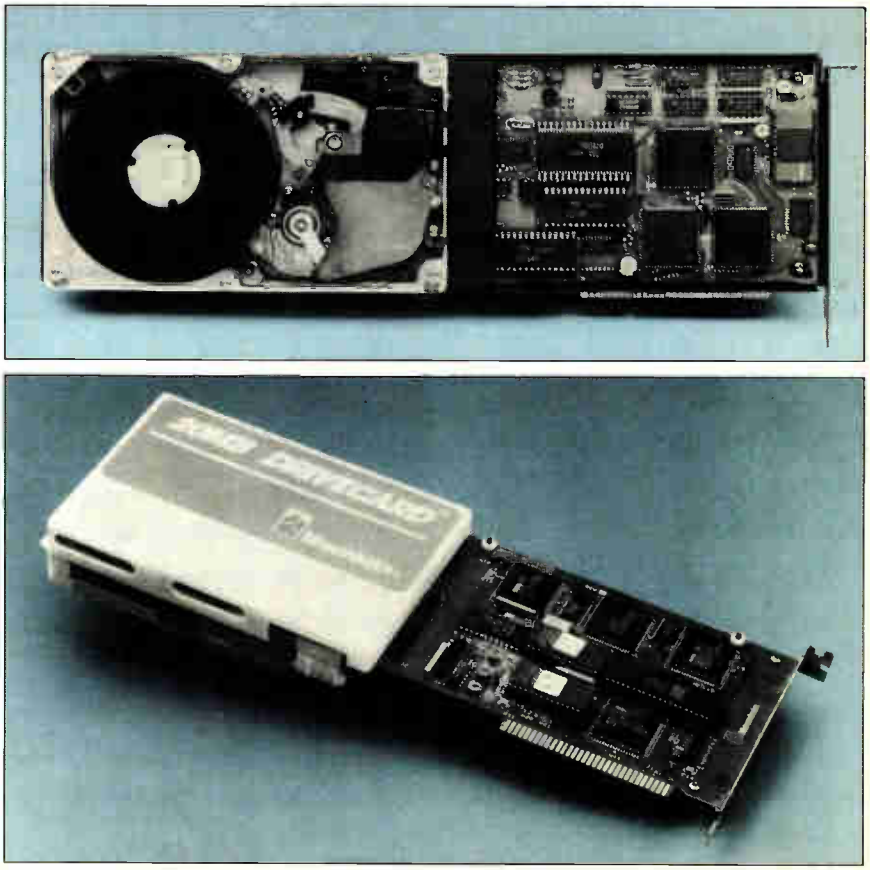
Perhaps never before have so many manufacturers entered a market for an add-on product so quickly. By the November Comdex show, more than a half dozen competitors appeared, and the total continues to mount. One reason for the fast response is the simplicity of the cards, most of which use proven off-the-shelf components, although some use custom chips to cram more function into a tight space. "It's merely a repackaging job of existing stuff," admits a marketing official at one competitor.

Second off the mark, in November, was tiny Mountain Computer Inc., which sells its DriveCard in a 20-megabyte version for $1,195 and a 10-megabyte model for $100 less. As far as can be determined, the Scotts Valley, Calif., company held a solid second place in shipments behind Plus Development's estimated 15,000 units by year end.

Nevertheless, peripherals experts say that Western Digital Corp. and Tandon Corp. have the best shot at overtaking Plus Development. They both have the advantage, like Plus Development, of leveraging from established, sizable related businesses—disk controllers in Western Digital's case, drives in Tandon's.

Western Digital, in Irvine, Calif., has set up an Enhanced Peripherals Division at considerable expense to handle its 10-megabyte FileCard, along with other products aimed at retail sales. Like the other cards, the FileCard costs $1,095. Tandon, a Los Angeles company recognized as a leader in low-priced drives, is intimating that it will continue the tradition with its 21-megabyte Diskard. It has not yet set a suggested price for dealers or distributors.

Solid market data remains tough to come by. Market analysts say it's still too early in the hard-disk-card game—product pipelines have just started filling—and most estimate that no more than 25,000 units were shipped by the end of 1985. Computer market consultant Future Computing Inc., for one, is only beginning to track the cards in its



PLUG-INS. Hardcard 10-megabyte drive (top right) was industry's first hard-disk card. Mountain Computer's DriveCard (right) comes in 10- and 20-megabyte versions.

retail market surveys and will not have initial figures until mid-February. But chairman Egil Juliussen sees good prospects for the cards: "I think they'll do quite well—it's such a neat product."

Still, the basic question is the potential market. Before decisions are made about pricing and additional features for the products, that question must be answered. The target market is the IBM PC and its compatibles. Chester A. Brown, vice president of Western Digital's Enhanced Peripherals Division, says that there are nearly 4 million computers in the target group worldwide. He breaks that figure down into 2.5 million IBM PCs, 800,000 PC/XTs with floppy disks, and the remainder compatibles without hard-disk drives. Furthermore, the IBM PC aftermarket keeps growing, with only about one third of the computers being shipped leaving the factory with Winchester drives, according to Future Computing.

The consensus among sales executives is that the potential market for plug-in hard-disk drives amounts to some 10% of that installed base of 4 million per year, or a total of some 400,000 hard-disk cards. But the most optimistic think that 80% of IBM PC users now limited to floppy-disk storage could be live prospects. Falling between those two extremes is Mountain Computer sales manager Donald Cochrane, who predicts 1986 industry sales of at least 300,000 units, and believes the first flush of excitement could push totals as high as a half million. "That's a pretty good market—it won't disappear next year," adds Western Digital's Brown.

But disk-drive market expert James Porter warns that competitive realities could shatter those rosy expectations when prospective buyers are asked to pay $1,095. A consultant who closely follows the drive business for clients and his own Disk/Trend report, Porter cautions that card makers are ignoring an important fact: external 5¼-in. drives. They can be attached easily when extra space is not a problem, and prices for 10-megabyte models have fallen as low as $500 ($100 more for 20 megabytes), including controller. Computer dealers moved about 200,000 units in 1985.

"That's the real competition. At $1,095, sales will not hit 300,000 this year even though the hard card is a more elegant solution," he advises. Porter, in fact, admires Plus Development's coup of defining the market and coming up with a solid product to exploit it. "It's a great concept and getting a response from dealers, too." But, he cautions, "once the pipeline is filled, only a minority will pay $1,095."

Pricing is a subject that marketing executives at the four leaders would prefer not to discuss—at least, until market forces make it paramount. But other players seeking to make inroads have no such inhibitions. "Let's face it—price is the most important thing, given reliability and functionality of the product," says Allen G. Taylor, director of marketing at CMS Inc. The privately held Santa Ana, Calif., company, with annual sales in excess of $45 million, manufactures expansion subsystems and boards for IBM PCs (see "Getting into a market in three days").

Only a third of new PCs have built-in hard disks

Taylor points out that the realities of the IBM PC add-on market have proven that manufacturers' suggested retail prices "are fictitious numbers that don't hold up." Tandon's planning manager for disk drives, Robert Abraham, agrees. He explains that computer equipment dealers and distributors know better than manufacturers what gear has to cost to be successful. In the case of Tandon's Diskard 21, a price of around $1,000 would offer good profit margins—most dealers like the 30% range, Abraham notes.

With the holiday season over, the next few weeks should see marketing intensify. Plus Development already is stressing reliability, which was the prime design goal, explains marketing manager Hank Chesbrough. "Only 14 board failures have come back from the field, of many thousands," he notes. Only 1 in. thick, the Hardcard is the thinnest board, which means it needs only a single slot. Thicker competing drives edge over into an adjacent slot. The company reportedly spent in the multimillions of dollars to design and engineer its product, which includes custom very large-scale-integration control circuitry, and came up with a product that even competitors admire.

MORE CAPACITY. But rivals are taking aim at the Plus Development capacity, which cannot be scaled up without a redesign, they say. "No 10-megabyte drive is cost effective," maintains Tandon's Abraham, who is touting a 21-megabyte drive. Accordingly, all major players are either selling or preparing to build a 20-megabyte card that will sell for only a little more than their 10-megabyte models. Meanwhile, Chesbrough steadfastly insists his 10-megabyte card will satisfy most needs.

There are differences other than capacity. For example, Western Digital's card requires 5 W, compared with 8 W and more for others. Limited power supplies on IBM PCs make this aspect important, says Western Digital's Brown. Tandon's edge is the fact that it is turning out 20,000 3½-in. drives a month as a separate peripheral, Abraham believes, which will quickly bring economies of scale to bear on the market. And CMS has three 20-megabyte models, including a high-performance version with the Small Computer Systems Interface, which is fast catching on for peripherals.

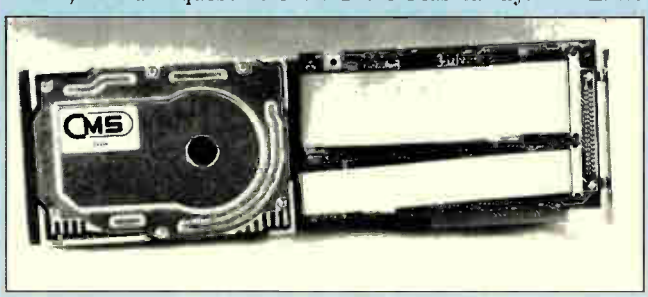
Enthusiastic board suppliers who expect to enjoy a boom in the next few months also might recognize some warning signs about pitfalls farther down the road. First is the matter of price declines among all hard disks, says Joseph Jaworksi of controller consultant Peripheral Concepts Inc., Irvine. "They're dropping so quickly that OEMs will include them in most PCs."

Disk/Trend's Porter gets more specific: "Another variable is IBM itself, which will add 20-megabyte drives to the XT. That will reduce the [board] opportunity considerably." Even Tandon's Abraham concedes, "I wouldn't be surprised to see [the drive-board business] saturate quickly as early entrants lock up the dealer shelf space." For a price leader, this happening presumably would not be unwelcome. □

GETTING INTO A MARKET IN 3 DAYS

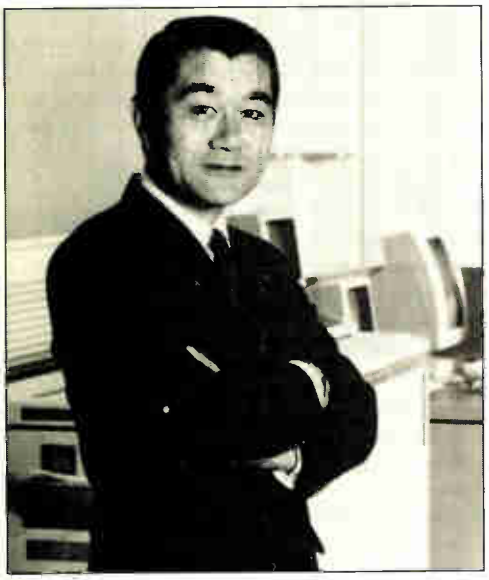
If there are any doubts that one must move fast in the market for IBM Corp. Personal Computer peripherals, consider the way one engineering director spent a week last fall.

Director of engineering James D'jen of CMS Inc., a Santa Ana, Calif., add-on maker, heard requests from computer dealers for 3½-in. hard cards on the Tuesday before the Comdex computer show in late November at Las Vegas. He promptly boarded a plane, went back to work at his plant, and had a working model at Comdex by Friday. This prototype became the basis for CMS's Drive Plus family. *–L. W.*



RICOH MOVES TO COPY ITS PAST SUCCESSES

ITS GOAL IS TO LEVERAGE COPIER AND FAX TECHNOLOGIES INTO NEW MARKETS, SUCH AS IMAGE PROCESSING



RICOH'S HAMADA: Reducing dependence on copiers.

TOKYO

An aggressive product-development philosophy helped Ricoh Co. grow 20% annually for the past three years. That's only the start. Now Ricoh wants to step outside its mainstream business—plain-paper copiers and related supplies—and boost its presence in other office-automation niches.

The Tokyo company plans to ride the crest of a sales boom in facsimile products [*Electronics*, Dec. 9, 1985, p. 19] while still relying heavily on copier sales for the bulk of its future revenue. Its goal by 1990 is to leverage copier and fax technology in the emerging market for image-processing systems, products that include computer-controlled information-retrieval systems, microcomputer-controlled offset printers, and image-filing systems based on optical disks.

"Even the biggest names, like IBM, NEC, Fujitsu, and Hitachi, are still developing their image-processing technology," says Ricoh president Hiroshi Hamada. "I believe ours is of the top rank. That is the level at which we intend to compete."

But Ricoh's image-processing business has yet to pay off. Sales in this division actually dropped 5% last year, to $52 million, because of sluggish offset-printer sales. But Hamada optimistically predicts that the market for image-processing systems will come into its own by the end of the 1980s.

Another major growth market that Ricoh has targeted is Japanese telecommunications. It is offering telephones through a joint venture with AT&T Co. And if protectionism gains ground in either Europe or the U. S., Ricoh stands ready to boost production in those areas.

Ricoh first made a name for itself in the U. S. as a manufacturer of plain-paper copiers that were sold under private label by American companies, and then as a vendor of its own brand of machines. In the future, though, Ricoh will depend more on sales of its fax machines, especially in the U. S. That market will grow 40% this year to 210,000 units, say industry analysts, for a value of almost $400 million at current exchange rates.

In the Japanese fax market, Ricoh is running neck and neck with Matsushita Electric Industrial Co., Osaka, and its 60%-owned unit, Matsushita Graphic Communication Systems Inc. In the U. S., Ricoh has a 32% share, well ahead of the other major players—NEC Corp., with 18%, and Matsushita's Panafax brand, with 17%.

Ricoh's U. S. sales efforts have been helped by a three-year original-equipment-manufacturer contract with AT&T, valued at an estimated $125 million, which runs through 1986. The desktop fax models that Ricoh makes for the U. S. giant also serve to parry rival Canon Inc.'s aggressive marketing efforts in the lower end of the market.

The completion last year of a new, highly automated fax production plant at Gotemba coupled with the conversion of copier lines at its Atsugi plant give Ricoh the flexibility to build its fax sales base if the strong U. S. demand continues. The added capacity will be important when the market switches to the new G-4 fax standard, which will cut the time needed to transmit a page of text to 4 seconds from about 9 seconds for a G-3 machine. Japanese makers have been testing G-4 machines for industrywide compatibility but are postponing marketing until next year, perhaps to maximize the benefits of the strong current demand from small and medium-size businesses, which are satisfied with the speed of G-3 machines.

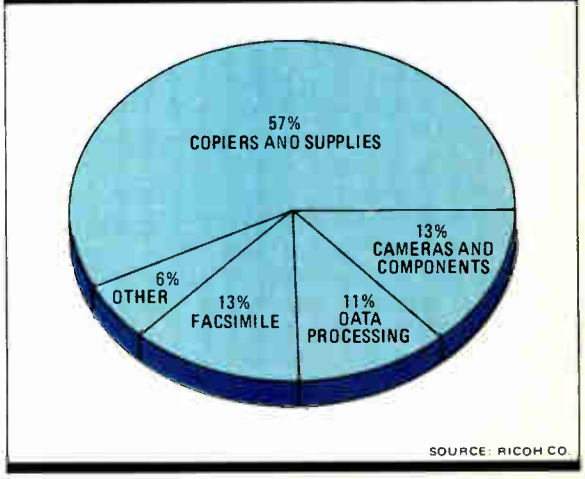
The paper copier that shifted Ricoh's emphasis from cameras to business equipment 20 years ago still dominates the company's revenue, which will total almost $2.6 billion when fiscal 1986 ends on March 31. Although copiers and copier supplies accounted for about 68% of sales just three years ago, their percentage of total sales has fallen to about 57% now. Hamada, who started work at Ricoh as a copier salesman, hopes by 1990 to strike a 50-50 balance between copier sales and the company's other major sectors, which include fax, data processing, image processing, cameras, and electronic components.

Ricoh's continuing reliance on copier sales is seen by some market sources as a weakness, but analyst Michael Connors of Jardine Fleming (Securities) Ltd.'s Tokyo office disagrees. "Ricoh's strength in faxes and laser printers stems from its copier know-how. This is a perfect example of how an enabling technology converges with other technologies to make new products viable."

CLOSER WITH AT&T. That convergence of technologies led Hamada and Ricoh to a growing relationship with AT&T. The January 1984 OEM deal was followed by an agreement last spring under which Ricoh is marketing AT&T's 32-bit 3B2 minicomputer and 5620 terminal in Japan. Then, last September, the firms announced a joint venture—called AT&T Ricoh Co.—to make and market modified versions of small-size AT&T telephone systems. Ricoh is also negotiating with AT&T to market in Japan a smaller version of the U. S. company's System 75 private branch exchange.

AT&T Ricoh vice president John J. Keating III, who estimates the 1986 Japanese telephone market at $700 million, says his company's goal is to gain the

RICOH BROADENS ITS REVENUE BASE



No. 3 market spot within five years. By then, the market will be worth close to $890 million. Nippon Telegraph & Telephone Corp. leads key telephone suppliers in Japan with 28% of the market, followed by Iwatsu Electric Co., with 22%, and Matsushita, with 18%. Ricoh is now planning its strategy for introducing larger-scale telephone systems and other products into the home market.

AT&T, which has a 51% share in the venture, selected Ricoh as its partner, Keating says, "because they have the strong marketing and service network, which is crucial to success in Japan." With Ricoh's manufacturing capability, he adds, the venture can produce key telephones "at very competitive prices."

"The AT&T link is Ricoh's foot in the door of the telecommunications market," says analyst Darrel E. Whitten of Prudential-Bache Far East's Tokyo office. "And at current exchange rates, with an oversupply of equipment in the U.S., it's a real opportunity for them to maximize profits."

But questions remain, among them whether AT&T Ricoh can overcome its lack of total system integration and the so-so reputation of the AT&T 3B2 minicomputers.

Yet another OEM deal is helping Ricoh's laser-printer business. Its contract with Digital Equipment Corp. calls for delivery of 1,000 laser printers a month. Ricoh's fiscal 1986 laser-printer sales should total about $85 million, with unit production up more than 70% over 1985.

Still, it's not all good news at Ricoh. For one thing, prices of fax machines are falling. "Our unit growth looks impressive, but the value growth isn't keeping pace," Hamada says. There also are pressures to boost overseas production because of Japan's trade surpluses with the U.S. and Europe, and the recent appreciation of the yen versus the dollar has forced Ricoh to lower its profit forecast. Unlike many of its rivals, though, Ricoh has a relatively low export exposure. About 40% of its sales come from exports, and of this amount, about 40% are in dollars.

EC COMPLAINT. The most immediate problem facing Ricoh and its competitors is a dumping complaint filed by European suppliers with the European Communities against all Japanese copier makers. A decision is expected shortly, and industry sources think the ruling will go against the Japanese. Such an outcome would lead to the imposition of import duties.

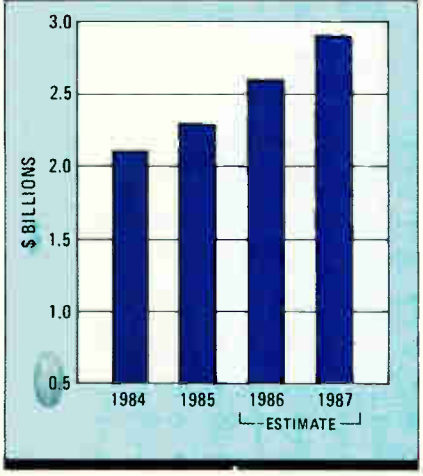
Hamada's expanded production strategy in Europe seems clearly linked to that decision. Ricoh UK Products Ltd., Telford, began producing copier toner and sensitive drums last year, and Hamada indicates that a more full-scale operation probably would follow an EC decision against the Japanese makers.

In the U.S.—where Ricoh's sales grew 27%, to $592 million, in fiscal 1985 and should exceed $700 million this year—the company has a research and development center in San Jose, Calif., and a copier and toner production plant in Irvine, Calif. As sales in the U.S. grow and as pressure from the U.S. government increases over the trade imbalance, Ricoh production facilities there will surely increase, Hamada says, though he can't say when this will occur.

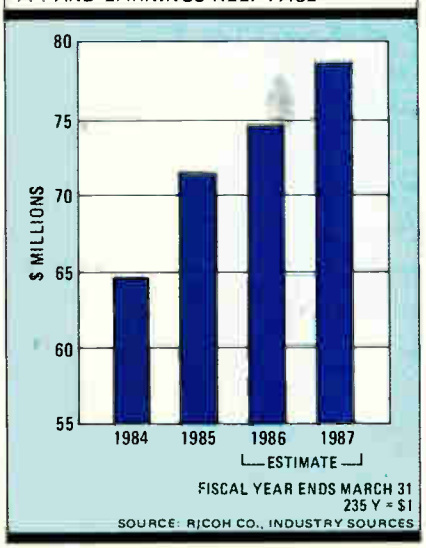
Hamada, of course, isn't the only office-automation company executive who's trying to position his company in new markets. Canon, which forged into the U.S. copier market ahead of Ricoh and still leads it in sales, also is aggressively winning market share at the lower end of the fax market and seems headed for the same markets as Ricoh.

Hamada seems undaunted by the challenge. "Our goal is not to compete head to head," he says, "but to develop our image-processing systems so that they are used by everyone, including IBM." *—Michael Berger*

RICOH SALES KEEP GROWING . . .



. . . AND EARNINGS KEEP PACE



BOTTOM LINES

PERSONAL COMPUTER SALES TO GROW A BIT

Don't expect the personal computer business to change much this year. Worldwide sales of the machines in 1985 were up just 3.6% in units and 31.6% in dollars—versus 46% in units and 73% in dollars in 1984—and the outlook for this year "is not significantly better," says Dataquest Inc., the San Jose, Calif., market researcher. Dataquest sees unit sales rising 5.4% in 1986, while growth in the market's dollar value "will decline sharply to only 7.8% due to cutthroat price competition among survivors and fire-sale prices from desperate and/or dying companies." The market "as a whole is still holding up well and perhaps even better than could be expected." Only a few companies went out of business last year, "while a few dozen actually entered the market," it says.

SUMMATION OBTAINS THIRD FINANCING

Summation Inc. has completed a $4 million third round of venture financing. The Woodinville, Wash., company says it has raised $10.34 million since its founding in 1984. Summation makes and markets the personal-computer-based SigmaSeries testing system, which includes both analog and digital testing capabilities.

CYBER DIGITAL CLOSES FINANCING AGREEMENT

Cyber Digital Inc. has completed a new $7.25 million financing agreement. The Bohemia, N.Y., company received a $1 million loan from the Regional Development Corp. of New York and a $2 million line of credit from Empire of America Federal Savings Bank, Buffalo, N.Y., for working capital. It also received $4.25 million in loans from Empire of America to finance machinery and equipment. Cyber Digital markets the MSX digital switching system, which integrates data and voice communications over twisted-pair wiring.

SUN MICROSYSTEMS FILES TO GO PUBLIC

Engineering work-station maker Sun Microsystems Inc. plans to go public within the next two months. The Mountain View, Calif., company has registered with the Securities and Exchange Commission for an initial public offering of 4.6 million shares, to sell for $16 to $18 a share. After the offering, Sun says it will have a market value of about $450 million.

MANLEY SEEKS SOFTWARE SOLUTIONS AT SEI

JOHN MANLEY: Coping with software crisis at the DOD's Software Engineering Institute.

PITTSBURGH

The Software Engineering Institute's first year saw it begin an ambitious assault upon some of the most challenging software engineering problems. "Our focus is on making things happen," says John Manley, the former Air Force officer, professor, and ITT executive who took the helm last August.

The Defense Department established the Pittsburgh-based institute with a five-year budget of $103 million to grapple with the oft-discussed crisis in software engineering [*Electronics Week*, Feb. 4, 1985, p. 27]. "SEI is supposed to be a catalyst," Manley explains. "If we're successful, we can have a tremendous impact."

Manley is well qualified to handle that role. His background includes two years as vice president for engineering and technology at Nastec Corp., Baltimore, which creates computer-aided-design software. For three years before that, he was ITT Corp.'s corporate director of programming applied technology and developed and installed the company's first programming measurement system. He also spent five years as assistant to the director of the applied physics laboratory at Johns Hopkins University, after 21 years in the Air Force.

All that experience won't hurt in dealing with the problems at SEI, which can be summarized in three words—backlog, money, and reliability. One important achievement to date, according to Manley, is the development of a methodology to evaluate Ada environments, such as the Ada Language System developed by Softech Inc., Waltham, Mass., for the U. S. Army. And the institute is beginning work with the National Aeronautics and Space Administration on evaluating Ada for use in flight software on the upcoming space station program.

"Part of SEI's charter is to help relieve the shortage of software professionals," says Manley. To that end, the institute is developing curricula for a specialized professional degree in software engineering. Working with major publishers, SEI will issue a series of curriculum "building blocks," or course guidelines that universities can use to establish their own programs.

"In the immediate near-term, we have to take advantage of off-the-shelf tech-

PEOPLE ON THE MOVE

DONALD P. AIKEN

☐ Rexnord Inc.'s new subsidiary, Rexnord Automation, will have Donald P. Aiken as its executive vice president. He will also serve as president of the subsidiary's Industrial Automation Group, which will provide systems and support services. Previously, Aiken was president of the Controls Division of Electronic Modules Corp., Timonium, Md., which was acquired by Rexnord in 1985 and is now part of Rexnord Automation, whose headquarters are in Hunt Valley, Md.

ROLAND PAMPEL

☐ Apollo Computer Inc., the Chelmsford, Mass., engineering work-station pioneer that faces increasingly stiff competition and has recently suffered several key personnel defections, has named Roland Pampel to the new position of senior vice president of technology and marketing. Pampel comes to Apollo from AT&T Co., where he was vice president of systems marketing and development for the computer group. Earlier, he was vice president of research and development at Prime Computer Inc. Apollo hopes the new job will help bridge the engineering and marketing departments.

CHARLES T. MASTERS

☐ Ramtek Corp., Santa Clara, Calif., has appointed Charles T. Masters senior vice president in charge of new-product development worldwide. Masters cofounded De Anza Systems in 1976; when it was later acquired by Gould Inc., he stayed on as vice president of product development. Previously, he did a stint at Ramtek as vice president of marketing and product development and also worked for IBM Corp.

WILLIAM A. GRACE

☐ Joining Distributed Logic Corp. as director of product and technology planning is William A. Grace. This is a new position for the Anaheim, Calif., manufacturer of peripheral and communications controllers for the Digital Equipment Corp. computer market. Grace will be responsible for product and new technology planning and development, potential joint ventures, and corporate acquisition. He comes to Dilog from Applied Information Memories in Austin, Texas, where he managed an engineering team developing Small Computer System and Extended Storage Device interfaces for disk drives. He earlier worked for DEC's Storage Systems Development Group.

PAUL B. SILVERMAN

☐ Telecommunications veteran Paul B. Silverman has been named president and chief executive officer of a new group aimed at funding new ventures in domestic telecommunications. Silverman, 41, brings 17 years of experience to the Venture America Telecom Group, a division of Venture America, Oakton, Va. He had been general manager of international services for Satellite Business Systems Inc.

HOMER L. HUDDLESTON

☐ Leaving Honeywell Inc. as vice president and general manager of the Communications Networks Division in Dallas, Homer L. Huddleston has been named general manager of Ericsson Inc.'s Information Systems Division. He is also being nominated to the board of directors for election to vice president of the Richardson, Texas, subsidiary of Sweden's LM Ericsson. Previously, Huddleston was president of Action Communications Systems Inc., Dallas, which was acquired by Honeywell.

BRIAN MANLEY

☐ AT&T Co. and Philips Telecommunications BV have appointed Brian Manley chairman and chief executive officer of AT&T and Philips Telecommunications (UK) Ltd. The joint venture has its headquarters in Malmesbury. Manley will continue as a director of Philips Electronics and Associated Industries Ltd., the UK holding company of the international Philips group.

niques for efficiency and quality improvement," says Manley, who has allocated 10% of SEI's budget to this effort. "We're exploring anything and everything that has promise." At the same time, SEI has embarked on a massive technology identification and assessment project. The goal is to collect a comprehensive data base on the state of the software arts.

Still in temporary quarters—the move to a permanent facility near Carnegie-Mellon University is slated for next year—SEI has turned itself into a testbed for new technologies by way of its showcase engineering project. Whenever an important new work station, computer, or program hits the market, Manley has one hooked into SEI's system. Every staff member, from engineer to secretary, uses a computer.

SEI has 89 employees, but expects to have more than 500 within five years. A staff of 1,000 would be a critical mass, given the size of the software engineering problem, according to Manley. "I think we will make a very significant dent in the problem." *–Alexander Wolfe*

PEOPLE

RODGERS STAYS CLOSE TO THE CUSTOMERS

SANTA MONICA, CALIF.

The popular view is that the defense business has little to teach the commercial side of the industry. But Barry Rodgers of Lear Siegler Inc. believes otherwise. He bases this on his recent experiences in both markets. For nearly a year, he had headed the company's Electronics/Materials Handling Group. And before that, he was president of the highly diversified company's Astronics Division, which sells aerospace and other military gear.

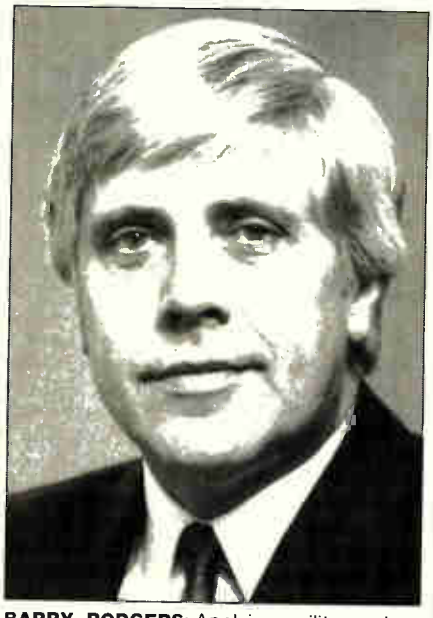
"Planning skills and a really honed planning system are good things on the military side," he says. "And being really focused on customer needs—that's central to survival."

Rodgers is determined to get his six commercial electronic divisions to do as good a job in product planning as their military counterparts do. He says that the military does a good job of conceptualizing, identifying its market, and devising products to satisfy that market.

The military environment does not change as rapidly as commercial market. But even so, he says, the commercial sector doesn't do as good a job as the military does in staying close to the customer. He believes that is the essence to product planning and drills his staff in the absolute need, learned from the military, to define concept, development, delivery, and follow-up.

RIGHT PLACE, RIGHT TIME. For example, the telecommunications divisions, which build analog and digital plug-in repeaters and other gear, sell mostly to the big telephone companies, which buy new products only every several years. "You have to be there with the right product, or else," he notes.

Switching the 47-year-old Rodgers into a commercial operation is not an unusual move for Lear Siegler, a company that values fresh approaches. Although such transitions are tough challenges to executives, they may also signal that even higher responsibilities lie ahead. Rodgers rose through the engineering ranks and holds two advanced degrees—an MS from the College of Aeronautics, Cranfield, England, and an ME degree from the University of California at Los Angeles.



BARRY RODGERS: Applying military planning skills to the commercial side.

Rodgers' divisions, which have total annual sales of more than $125 million, represent varied segments of the industry, including hearing aids, sound paging systems for schools, terminals, pollution sensors, and telecommunications.

But Rodgers intends to push the innovation and productivity improvements that are necessary to face ever-tougher foreign competitors. One way is more offshore production, and a decision has already been made to move the Data Products Division's terminal manufacturing into Mexico. *–Larry Waller*

8.

Meets high technical requirements made nowadays on dual-in-line relays

7.

Low power consumption

Extremely low power consumption of only 75 mW without fixed polarity of current means a lower circuit power demand and less heat dissipation.

6.

Broad switching range

Reliable switching from low-level signals to 150 V/1.25 A at 30 W/50 VA, also withstanding cable discharge.

5.

Dielectric strength

Increased protection of circuitry and systems by resistance against surge voltage of 1500 V (10/700 µsec) or 1000 V (1.2/50 µsec).

4.

Broad ambient temperature range

Wide application range at ambient temperatures from –55 °C to 70 °C.

3.

Modular design

Increased reliability by effective intermediate operational checks during production process.

2.

Easy workability

Meets broad range of soldering equipments and automatic washing process thanks to solderability of 10 sec/260 °C or 3.5 sec/350 °C and seal integrity for 10 min/75 °C or 20 sec/125 °C.

1.

High reliability

Achieved by an optimum quality assurance system to maintain the characteristics over the lifetime. The MT relay is therefore made for a reliable future.

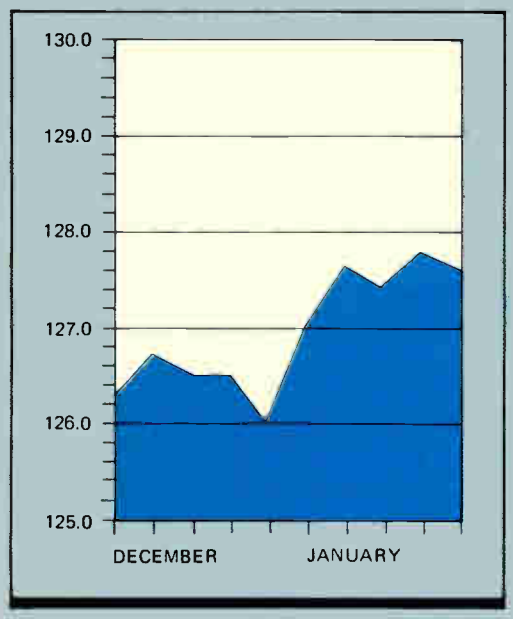
MT Relay
For a reliable future.

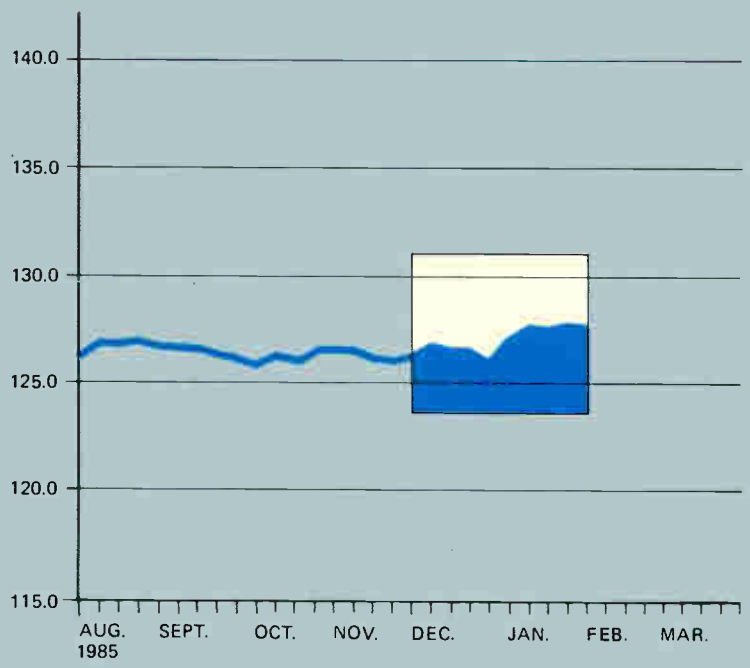
ITT's new dual-in-line relay. Manufactured by Standard Telephone and Radio AG Components Division, 8027 Zurich/Switzerland Tel. 01 201 42 55, Telex 815 385

For more information and address of your local sales representative contact reader service.

ITT

ELECTRONICS INDEX





THIS WEEK = 127.6
LAST WEEK = 127.8
YEAR AGO = 129.6
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. ELECTRONICS INDUSTRY EMPLOYMENT

Production workers (thousands)	November 1985	October 1985	November 1984
Office and computing machines	172.8	173.7	206.7
Communications equipment	286.4	288.4	291.3
Radio and TV receiving equipment	58.3	58.2	63.1
Components	349.1	353.0	413.6

U. S. GENERAL ECONOMIC INDICATORS

	December 1985	November 1985	December 1984
Average prime rate (%)	9.50	9.50	11.06
Retail sales ($ billions)	117.862	115.620	110.519
Unemployment rate (%)	6.8	6.9	7.1

Even though U. S. unemployment is still edging down, the continuing slump in the computer industry has forced U. S. electronics companies to keep trimming their payrolls and other production costs. The 0.8% drop in electronics-industry employment in November, the latest month for which statistics are available, nudged the *Electronics* Index down another notch in the latest week and brought industry employment down to 11% below its level of a year ago.

Declines in production-worker ranks have hit almost every sector of the electronics industry. Manufacturers of communications equipment fared the best last year, but now even they have been forced to trim their payrolls as demand for their products lessens. November's 0.7% decline in communications-industry employment brought labor ranks in this industry to 1.7% below levels of a year ago—and 3.6% below the industry's peak employment for the year, reached last March.

On an annual basis, labor cuts in the office- and computer-equipment sector have begun to exceed the employment drops at components manufacturers. Though employment at computer companies fell 0.5% in November, less than the 1.1% falloff for components makers, their payrolls are off 16.4% from year-ago levels, while components-worker ranks fell 15.6%. The only part of the electronics industry that added workers in November was the TV- and radio-equipment segment, though the increase was less than 1%. But employment in this industry was still down almost 8% from levels of a year ago.

NEW PRODUCTS

NOW ANALOG CIRCUITS CAN BE DESIGNED ON PCs

WITH LOW-COST SOFTWARE, IBM PC AT CAN DO MODELING, SIMULATION

Personal computers increasingly are filling the needs of digital-circuit designers who cannot justify the expense of dedicated computer-aided-design work stations. Now a software package called PC Workbench gives analog-circuit designers the same option.

PC Workbench retains nearly all the capabilities of Analog Workbench, a software package already on the market for work stations from Sun Microsystems, Apollo Computer, and Hewlett-Packard. Both products come from Analog Design Tools, which concentrates solely on analog CAD [*Electronics*, Nov. 11, 1985, p. 52].

The IBM PC version has "virtually all the features of the original product," says Michael Carroll, vice president of marketing. Both products enable the analog engineer to construct circuits from the schematic phase all the way through breadboarding, testing, and performance analysis. The software duplicates work situations and lets the designer test a design by connecting it to simulated instruments and analyze its performance under simulated operation.

The basic platform is an IBM Corp. Personal Computer AT equipped with 512-K bytes of random-access memory, IBM's Enhanced Graphics Adaptor card, an IBM color monitor, a 20-megabyte hard-disk drive, and a plug-in board with a 32-bit microprocessor. A mouse is used to select menu items and move circuit elements. The upgrade board carries a 32032 microprocessor and 4 megabytes of memory. The IBM PC's own processor is turned into a coprocessor for subsidiary tasks.

Software developers paid particular attention to modeling and simulation, since modeling analog circuits is harder than modeling digital ones. PC Workbench's capabilities go far beyond those of other personal-computer-based modeling programs such as Spice, says James McGregor, vice president of engineering. Though Analog's product includes Spice Plus, the company's own enhancement of the Spice 3 software, McGregor maintains that Spice is restricted to time-domain analysis. Workbench, by contrast, provides sophisticated analyses such as worst-case simulation, extreme-performance modeling, random variance of component values, and parametric plotting, which enables designers to look at both threshold sensitivities and trade-off values.

ON THE WAY. PC Workbench runs slower than the work-station version but costs thousands of dollars less.

Another problem with Spice is its obscurity, which requires "significant effort on the engineer's part to learn," McGregor says. Workbench's interfaces are intuitive—organized to follow a designer's workflow. Therefore, he adds, they require only half-day training periods to learn, and many engineers begin designing after only a couple of hours.

STILL FAST. Workbench runs only a little more slowly on a PC AT than on a work station. "We worked hard to get the switching capability near the time of the work-station-based product," McGregor says. The main functional difference is that PC Workbench does not support the multiple-windowing feature of the dedicated work-station product.

But the lack of windows gives the customer a significant savings. A typical configuration of the work-station-based Workbench costs $40,000; fully configured, Analog Workbench can cost as much as $80,000, including the work station. But PC Workbench—excluding the computer—sells for $12,500. That covers seven basic software modules: a circuit editor, Spice Plus, a simulated dc multimeter, time- and frequency-domain test setups, a spectrum analyzer, and parameter-entry capability.

Options include modules for parametric plotting and statistical analysis, and device libraries ranging from a basic 50-member group to the 500-member general device library. These can add $2,500 to $12,000 to the price of the system.

Analog has already provided for compatibility between the two Workbench products: a $500 package makes file transfer possible over an RS-232-C interface or an Ethernet.

Future plans include support of IBM PC graphics adapter cards and monitors from other vendors, and the inclusion of a software-simulated noise-measurement instrument for design testing. Because Analog already has a marketing arrangement with Hewlett-Packard Co. for Analog Workbench, a PC Workbench adaptation for HP's IBM PC-compatible Vectra seems natural.

PC Workbench is in beta-test sites and will be ready for shipment by the end of this month. *–Eve Bennett*

Analog Design Tools Inc., 66 Willow Place, Menlo Park, Calif. 94025. Phone (415) 328-0780 [Circle reader service number 338]

CHECKING SOLDER DOTS VISUALLY

Synthetic Vision Systems is adding a new wrinkle to surface-mounting automation by heading off paste-application problems at an early stage. Whereas other inspection systems check boards after surface mounting, its SPI-3500 optically inspects the placement of solder or epoxy paste dots on a hybrid or printed-circuit board before devices are applied, says Dixon T. Jarvis, chief

If the cards below have already been used, you may obtain the needed information by writing directly to the manufacturer, or by sending your name and address, plus the Reader Service card number and issue date, to Electronics Reader Service Department, P.O. Box 2713, Clinton, Iowa 52735.

Electronics February 3, 1986 This Reader Service Card expires May 3, 1986

Name _____ Title _____

Phone _____ Company _____

Street address (company [ ] or home [ ] check one) _____

City _____ State _____ Zip _____

Signature _____ Date _____

Was this magazine personally addressed to you? [ ] Yes [ ] No

5 Source of Inquiry-Domestic

Industry classification (check one):

A. ☐ Computers, Computer Systems and Equipment
B. ☐ Communications, Communications Systems and Equipment
C. ☐ Military/Space Systems and Equipment
D. ☐ Industrial Systems, Controls and Equipment
E. ☐ Electronics Subassemblies, Components and Materials
F. ☐ Test and Measurement Equipment
G. ☐ Consumer Products
H. ☐ Medical Systems and Equipment
I. ☐ Software
J. ☐ Research & Development
K. ☐ Educational 2-4 Year College, University
L. ☐ Other _____ Please specify

Your principal job responsibility (check one):

A. ☐ Corporate/Operating and General Management
B. ☐ Design & Development Engineering
C. ☐ Engineering Services
D. ☐ Basic Research
E. ☐ Manufacturing & Production
F. ☐ Other _____

Estimate number of employees (at this location): 1. ☐ under 20 2. ☐ 20-99 3. ☐ 100-999 4. ☐ over 1000

1	16	31	46	61	76	91	106	121	136	151	166	181	196	211	226	241	256	271	348	363	378	393	408	423	438	453	468	483	498	703	718
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212	227	242	257	272	349	364	379	394	409	424	439	454	469	484	499	704	719
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213	228	243	258	273	350	365	380	395	410	425	440	455	470	485	500	705	720
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214	229	244	259	274	351	366	381	396	411	426	441	456	471	486	501	706	900
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215	230	245	260	275	352	367	382	397	412	427	442	457	472	487	502	707	901
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216	231	246	261	338	353	368	383	398	413	428	443	458	473	488	503	708	902
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217	232	247	262	339	354	369	384	399	414	429	444	459	474	489	504	709	951
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218	233	248	263	340	355	370	385	400	415	430	445	460	475	490	505	710	952
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219	234	249	264	341	356	371	386	401	416	431	446	461	476	491	506	711	953
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220	235	250	265	342	357	372	387	402	417	432	447	462	477	492	507	712	954
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221	236	251	266	343	358	373	388	403	418	433	448	463	478	493	508	713	956
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222	237	252	267	344	359	374	389	404	419	434	449	464	479	494	509	714	957
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223	238	253	268	345	360	375	390	405	420	435	450	465	480	495	510	715	958
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224	239	254	269	346	361	376	391	406	421	436	451	466	481	496	701	716	959
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	347	362	377	392	407	422	437	452	467	482	497	702	717	960

AFFIX POSTAGE STAMP HERE

Electronics

P.O. BOX NO. 2713
CLINTON, IOWA 52735

Electronics Reader Service

For additional information on products advertised, new products or new literature, use these business reply cards.

Complete entire card.

Please print or type.

Circle the number on the Reader Service postcard that corresponds to the number at the bottom of the advertisement, new product item, or new literature in which you are interested.

To aid the manufacturer in filling your request, please answer the three questions.

All inquiries from outside the U.S. that cannot reach Electronics before the expiration date noted on the Reader Service postcard must be mailed directly to the manufacturer. The manufacturer assumes all responsibilities for responding to inquiries.

Subscriptions & Renewals

Fill in the subscription card adjoining this card. Electronics will bill you at the address indicated on the card.

AFFIX POSTAGE STAMP HERE

Electronics

P.O. BOX NO. 2713
CLINTON, IOWA 52735

2

Electronics

February 3, 1986 This Reader Service Card expires May 3, 1986

Name _____ Title _____

Phone _____ Company _____

Street address (company [ ] or home [ ] check one) _____

City _____ State _____ Zip _____

Signature _____ Date _____

Was this magazine personally addressed to you? [ ] Yes [ ] No

5 Source of Inquiry—Domestic

Industry classification (check one):

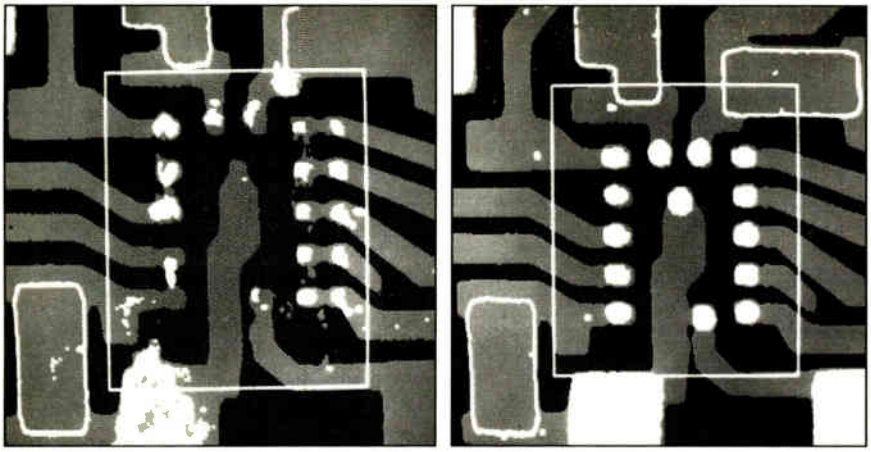
A. ☐ Computers, Computer Systems and Equipment
B. ☐ Communications, Communications Systems and Equipment
C. ☐ Military/Space Systems and Equipment
D. ☐ Industrial Systems, Controls and Equipment
E. ☐ Electronics Subassemblies, Components and Materials
F. ☐ Test and Measurement Equipment
G. ☐ Consumer Products
H. ☐ Medical Systems and Equipment
I. ☐ Software
J. ☐ Research & Development
K. ☐ Educational 2-4 Year College, University
L. ☐ Other _____ Please specify

Your principal job responsibility (check one):

A. ☐ Corporate/Operating and General Management
B. ☐ Design & Development Engineering
C. ☐ Engineering Services
D. ☐ Basic Research
E. ☐ Manufacturing & Production
F. ☐ Other _____

Estimate number of employees (at this location): 1. ☐ under 20 2. ☐ 20-99 3. ☐ 100-999 4. ☐ over 1000

1	16	31	46	61	76	91	106	121	136	151	166	181	196	211	226	241	256	271	348	363	378	393	408	423	438	453	468	483	498	703	718
2	17	32	47	62	77	92	107	122	137	152	167	182	197	212	227	242	257	272	349	364	379	394	409	424	439	454	469	484	499	704	719
3	18	33	48	63	78	93	108	123	138	153	168	183	198	213	228	243	258	273	350	365	380	395	410	425	440	455	470	485	500	705	720
4	19	34	49	64	79	94	109	124	139	154	169	184	199	214	229	244	259	274	351	366	381	396	411	426	441	456	471	486	501	706	900
5	20	35	50	65	80	95	110	125	140	155	170	185	200	215	230	245	260	275	352	367	382	397	412	427	442	457	472	487	502	707	901
6	21	36	51	66	81	96	111	126	141	156	171	186	201	216	231	246	261	338	353	368	383	398	413	428	443	458	473	488	503	708	902
7	22	37	52	67	82	97	112	127	142	157	172	187	202	217	232	247	262	339	354	369	384	399	414	429	444	459	474	489	504	709	951
8	23	38	53	68	83	98	113	128	143	158	173	188	203	218	233	248	263	340	355	370	385	400	415	430	445	460	475	490	505	710	952
9	24	39	54	69	84	99	114	129	144	159	174	189	204	219	234	249	264	341	356	371	386	401	416	431	446	461	476	491	506	711	953
10	25	40	55	70	85	100	115	130	145	160	175	190	205	220	235	250	265	342	357	372	387	402	417	432	447	462	477	492	507	712	954
11	26	41	56	71	86	101	116	131	146	161	176	191	206	221	236	251	266	343	358	373	388	403	418	433	448	463	478	493	508	713	956
12	27	42	57	72	87	102	117	132	147	162	177	192	207	222	237	252	267	344	359	374	389	404	419	434	449	464	479	494	509	714	957
13	28	43	58	73	88	103	118	133	148	163	178	193	208	223	238	253	268	345	360	375	390	405	420	435	450	465	480	495	510	715	958
14	29	44	59	74	89	104	119	134	149	164	179	194	209	224	239	254	269	346	361	376	391	406	421	436	451	466	481	496	701	716	959
15	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	347	362	377	392	407	422	437	452	467	482	497	702	717	960



SPOT CHECKER. In addition to distinguishing bad solder spots (left) from good spots (right), Synthetic Vision Systems' SPI-3500 reports the total number of flaws according to type.

executive officer of the company.

The company plans to ship the first SPI-3500 to Ford Motor Co. within the next 60 days. "We won't have any hard data until the Ford system goes operational," says Jarvis. But he notes that the system is expected to boost product quality and yields in high-volume surface-mount production.

Designed as a turnkey system, the SPI-3500 includes a circuit-image acquisition station that uses a standard 512-by-480 pixel camera and a multiple-pipeline image-acquisition processor that runs at peak speeds of 80 million pixel operations/s in its largest configuration. It also has a 13-in. color monitor for operator feedback, a 68000-based host system with keyboard and terminal, and 20 megabytes of hard-disk storage. Software includes statistical-analysis and report-generation packages as well as a menu-driven interface designed for easy use by shop-floor personnel.

FIXED OR MOVING. The SPI-3500 image-acquisition station scans substrates up to 6 by 8 in. It not only detects the presence or absence of paste dots but also determines to the nearest mil the exact location and the amount of area covered by the paste. The station is available with either a fixed overhead camera and a moving fixture for positioning the circuit or with a moving camera and a fixed stage.

The SPI-3500 can be used in an off-line mode for qualitative sampling, but is also fast enough to operate in a closed-loop system at production-line rates, the company says. System speed will vary according to the number of solder or epoxy dots on a substrate. A circuit that contains 144 dots, for instance, could be inspected in 8 to 13 seconds, depending on the number of stages that are employed in the image processor.

Each stage in the processor is based on a proprietary CPU built on a 2,500-gate high-speed CMOS array, and the system's speed increases linearly as more stages—up to eight—are added.

Software supplied with the system can perform a variety of control, analysis, and report-generation functions. The SPI-3500 can compute the percentage of good or bad circuits in a run, for example, and can also produce a quantitative-defect report—a total of flaws detected according to type.

To give feedback to line operators during the production process, an accumulative histogram can be plotted and displayed on the system's monitor showing the size of the solder dots being placed. Likewise, a plot showing the amount of offset from the actual versus desired paste-dot locations can be displayed. This lets the operator tell at a glance if the paste application is slipping out of tolerance.

The SPI-3500 can be linked with the application system so that it stops the process when it detects a paste flaw. It then displays an image of the bad circuit, with a circle around the flaw and a description of the problem.

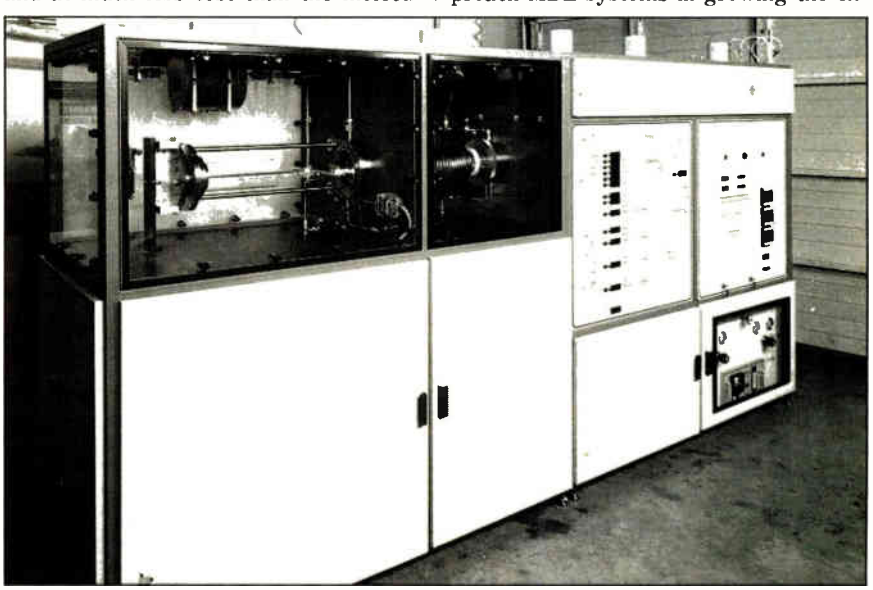
Pricing varies according to the number of stages. A system equipped with a single-stage processor sells for $100,000 and a system with the maximum eight-stage configuration sells for $125,000. The SPI-3500 is available 90 days after ordering. *–Wesley R. Iversen*

Synthetic Vision Systems Inc., 3744 Plaza Drive, P. O. Box 1910, Ann Arbor, Mich. 48106. Phone (313) 665-1850 [Circle 339]

REACTOR GROWS EPI LAYERS AT HIGH SPEED

A fast new contender for epitaxial work in semiconductor research laboratories has hit the market: Crystal Specialties' metal-organic chemical-vapor-deposition system. The model 425 can grow epitaxial layers much faster and at much less cost than the molecular-beam-epitaxy systems that now dominate research on high-electron-mobility transistors, solid-state lasers, and heterojunction bipolar transistors.

Unlike previous MOCVD machines, Crystal Specialties' new unit can approach MBE systems in growing the ex-



VARIETY. Crystal Specialties' epitaxial reactor grows precise films of a variety of semiconductor materials for a range of applications from LEDs to HEMTs.

tremely thin layers, and junctions needed for advanced semiconductor devices. Also, the new system's repeatability and uniformity have been improved over other MOCVD systems.

MBE systems, whose prices start at $500,000, can handle only one wafer at a time; the model 425 MOCVD reactor, which works with group III-V and II-VI compounds, accommodates two 2-in. wafers or one 3-in. wafer per run. In a single cycle, the system can grow precisely dimensioned films of gallium arsenide, indium phosphide, cadmium telluride, and other materials, as well as various multilayer films for applications ranging from LEDs and FETs to lasers and HEMTs.

The reactor grows 50- to 100-Å-thick epitaxial layers with 10- to 25-Å junction transition thicknesses. The system's heart is a radial manifold, which switches rapidly among process gases. The manifold has multiple ports, which eliminate dead space, and its hydrogen flush lines establish constant flow into the reaction chamber, contributing to precision in growing the layers.

Users can fit up to 12 valves on the manifold, all at equally short distances from the reaction site. Such a large number of valves facilitates balanced injection of multiple process gases and dopants for quaternary (four-element alloy) and more complex materials.

Shaping the flow channel in the radio-frequency-heated process tube as a funnel, rather than as a cylinder, keeps the reaction area as small as possible and promotes laminar flow over the wafer carrier, whose aerodynamic design promotes uniform heating.

The model 425's vacuum system is also designed to ensure predictable, repeatable results. Two closed-loop control subsystems stabilize reactor pressure—one sets processing pressure, the other works with the manifold to keep pressure exact during a growth run.

The standard model comes with a horizontal, 85-mm-diameter ultrapure quartz process tube; an eight-loop gas-handling system with three metal-organic sources; a low-impedance exhaust system; and a programmable sequencer for process development and execution.

Several options are available for the 425, including additional gas lines, metal-organic gas bubblers, and facilities for reduced-pressure processing. Another option is automated control by an IBM Corp. Personal Computer or a Hewlett-Packard Co. HP 9836 computer.

Typical growth specifications for GaAs on GaAs are a sheet resistance uniformity of ±5% across a 6-cm² area; an n-type doping range of 10^{15} to 3×10^{18} atoms/cm³; a p-type doping range of 10^{15} to 10^{20} atoms/cm³; a doping and thickness uniformity of ±5% across a 3-in. wafer; and a 0.1-μm/min growth rate.

The model 425 sells for $159,000; delivery takes five months. A version that can hold 12 wafers should be available in the last quarter of 1986. *–Jerry Lyman*

Crystal Specialties Inc., Systems Division, 10160 S. W. Nimbus Ave., Portland, Ore. 97223. Phone (503) 684-0470 [Circle 340]

PROGRAM EXTENDS LIFE OF GENRAD TEST SYSTEM

A test-software compaction package that uses a pattern-recognition algorithm aims at extending the useful life of an aging but widely used portable diagnostic system: GenRad Inc.'s 2225 Portable Service Processor.

Texas Programming Services' package, called PSP*PAK, is targeted at reducing the memory size required to execute board-test programs on the 2225, which contains only 40-K bytes of memory. The portable 2225, which is still widely used in the military, is running out of memory for today's test programs, notes Elise Wade, president of the five-year-old software house, and functional test programs continue to get larger as pc boards that contain very large-scale integrated circuits get ever more complex.

The company has seen PSP Basic software, the programming language used by the 2225, automatically reduced as much as 13:1. The largest reduction was a test plan that originally required 650-K bytes. It fit into the memory of the 2225 system, adds Wade.

"As boards have gotten more complex, engineers have started using simulators in the design and development of test plans," she says. "The simulators often produce wordy programs."

The PSP*PAK software, which runs on Digital Equipment Corp.'s VAX line with a megabyte of memory, will go through a test plan and look for repeated sequences. The software will place groups of repeated sequences into subroutine blocks located at the end of the program.

Using subroutine commands such as Gosub or For/Next, the tester will execute these blocks and repeat loops of subroutines in the correct order. "It is important to preserve the order in which test plans are structured, since the system is performing a functional test," says Wade.

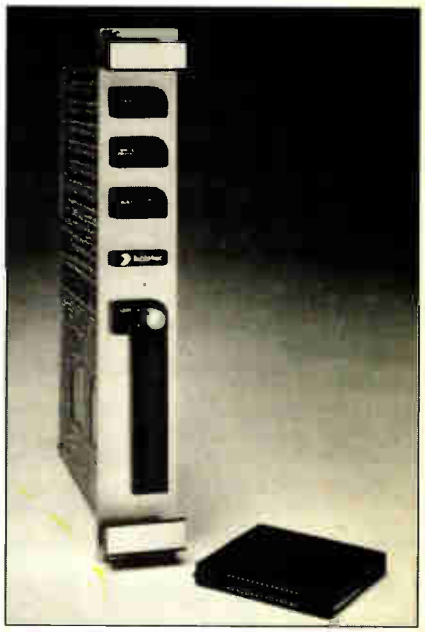
The package is menu driven and contains on-line help files. It also has debugging parameters as well as utilities to compact and decompact lines of code. And although the PSP*PAK program is aimed at test plans running on portable GenRad 2225 systems, Wade says, the embedded pattern-recognition algorithm could be applied to compacting code for other programming languages, such as Ada, Fortran, and Pascal.

PSP*PAK can be licensed for $9,500 per site and is available for delivery now. *–J. Robert Lineback*

Texas Programming Services, P. O. Box 7539, Dallas, Texas 75209. Phone (214) 526-9706 [Circle 341]

BUBBLE MEMORY FITS ON VMEBUS BOARD

The VMH-1 Bubbl-Board, a magnetic-bubble mass-storage system for VMEbus microcomputers, uses plug-in cartridges to hold 512-K bytes of nonvolatile data storage. It consumes much less



power than a disk drive, its manufacturer says. The unit, which can withstand shock and vibration in industrial environments, is also unaffected by dust and smoke.

The VMH-1 consists of three fixed 1-Mb bubble-memory chips with the associated circuitry, housing, and connectors for the mass-storage cartridges. Its controller operates as either a master or slave on the VMEbus and has a built-in

AT&T presents maxims for better international communication.

Sometimes, it's better to put all your eggs in one basket.

AT&T International Services offer the strongest, sturdiest basket for your telecommunications needs.

Because AT&T has a long history of making international connections and developing international services.

AT&T offers a wide range of international services for your company, whether you're involved in manufacturing, distribution, marketing or any other function. AT&T International Long Distance Service, for example, helps your company build better business relationships. AT&T International 800 Service encourages the steady flow of contact between customers, salespersons and suppliers, so you can maintain a competitive edge.

But how do you choose the services that are right for you? It's simple. Just contact your Account Executive or Sales Specialist at AT&T. They're experts in a wide range of businesses, and they can offer you our entire basket to accommodate your needs. Together you and your AT&T representative can tailor services and applications that work for you.

To learn more about AT&T's state-of-the-art telecommunications and the applications they have for your business, please contact your Account Executive at AT&T Communications now. Or call a Sales Specialist at the toll-free number below.

1 800 222-0400 Ext. 515

AT&T
The right choice.

testing capability. Typical access time is 21 ms. A simple command set, the Universal Bubble Interface, executes data transfers.

Units will be delivered in 30 days. The 512-K-byte version of the VMH-1, with a single Bubbl-Pac, sells for $2,899; additional Bubbl-Pacs are $135 each.

Bubbl-Tec, 6800 Sierra Ct., Dublin, Calif. 94568. Phone (415) 829-8700 [Circle 354]

MICROVAX II GETS 8-MEGABYTE CARD

The NS638 quad-wide memory card adds 8 megabytes of RAM to Digital Equipment Corp.'s MicroVAX II computer. The card is equipped with an on-line/off-line switch with an LED indicator that permits the memory to be electrically removed from the system without physically removing it from the backplane.

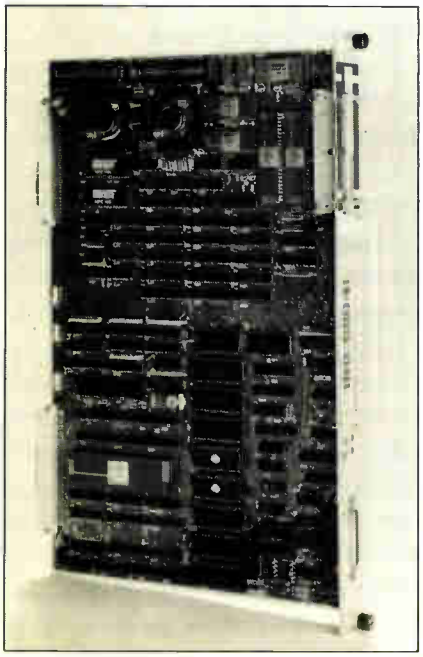
The memory card will be delivered in the first quarter of the year. Prices are unavailable.

National Semiconductor Corp., 2900 Semiconductor Dr., P. O. Box 58090, Santa Clara, Calif. 95052. Phone (800) 538-8510; in California, (800) 345-4006 [Circle 355]

COMPUTER HAS 16 ANALOG INPUT PADS

An industrial single-board computer, the IND-68041, combines a 16/32-bit computer with a large I/O capability. To its 40 digital bidirectional I/O points, the IND-68041 adds 16 analog input pads, two analog output pads, two optical-encoder input pads, and two counter-timers.

The analog inputs feature 12-bit resolution, software-programmable gain, and a throughput of 25 kHz. The encoder inputs are optically isolated and contain 32-bit up-down counters for position feedback.



The Motorola 68010 CPU, which operates at clock rates of 8, 10, or 12.5 MHz, works with up to 128-K bytes of on-board memory. Other features include interrupt-handling logic and a real-time clock. The board sells for $1,774 in quantities of 100, and delivery takes two weeks.

Indocomp Inc., 5409 Perry Dr., P. O. Box 157, Drayton Plains, Mich. 48020. Phone (313) 674-2294 [Circle 357]

512-K CMOS EPROM RUNS AT 150 TO 250 ns

For high-performance microprocessor-based applications, three CMOS EPROMs—in 64-, 128-, and 512-K versions—have access times of 150 to 250 ns. Automatic power-down, controlled by the chip-enable input, saves substantial power at the systems level. The output enable eliminates bus contention.

All three EPROMs come in 28-pin ceramic DIPs and are fully TTL-compatible. In quantities of 5,000, the models VT27C64, VT27C128, and VT27C512 sell for $4.50, $7.81, and $15.28 each.

The 64- and 128-K parts are available now in volume; samples of the 512-K EPROM are available now; production quantities will be available later this month.

VLSI Technology Inc., 1109 McKay Dr., San Jose, Calif. 95131. Phone (408) 942-1810 [Circle 363]

256-K EEPROM SELLS FOR $120

The X28256 256-K EEPROM boasts a high density that gives it possible applications in military, automotive, telecommunications, and computer markets, the manufacturer says. Samples of the part sell for $120.

Engineers using the company's X2864A 64-K EEPROM can easily upgrade to the new memory. Samples of the X28256 are available now. Production quantities are scheduled to follow in mid-1986.

Xicor Inc., 851 Buckeye Ct., Milpitas, Calif. 95035. Phone (408) 946-6920 [Circle 364]

DRIVE STORES AND TRANSFERS PC DATA

Easi-Disk is a storage and transfer system that moves floppy-disk data between IBM Corp. Personal Computers and non-IBM equipment over an RS-232-C interface. Its varied applications include field-data logging, software distribution, and off-line printing.

The flip of a switch changes the baud rate from 110 baud to 19.2 kilobaud, and data verification occurs automatically. For more data protection, Easi-Disk is shielded against power failures.

System I, for original-equipment manufacturers, comes without the case, power supply, and manual controls. Various disk formats are available. The end-user System II includes a floppy-disk drive, controller, RS-232-C card, case, power supply, and manual controls. It features a 4-K-byte addressable RAM buffer.

Unit prices for the System I start at $935 and drop to $809 for orders of 50 or more; for the System II, they start at $1,095. Evaluation samples are shipped within one month.

Analog & Digital Peripherals Inc., 815 Diana Dr., Troy, Ohio 45373. Phone (513) 339-2241 [Circle 372]

STORAGE UNIT WORKS WITH MICROVAX II

The model 41 advanced data-storage subsystem operates with any Digital Equipment Corp. MicroVAX II to create a VAX-like system at low cost, the manufacturer says.

Combining up to 280 megabytes of

hard-disk storage with floppy-disk and tape-drive options, the model 41 is said to move data two to three times faster than DEC systems. Its 5¼-in. Winchester drives offer a transfer rate of 625 kb/s and an average access time of 27 ms.

Its foundation module integrates the mass-storage-device controller, all backplane circuitry, and a sense monitor on a single board without using a backplane slot.

The sense monitor contains resident firmware and hardware used for sys-

tem-status analysis, system utilities, and diagnostics. Its user interface can be customized for the user's ability.

A single model 41 costs $18,000; lots of 50 or more cost $6,000 each. Production quantities are available now, and delivery takes 30 days.

Scientific Micro Systems Inc., 339 N. Bernardo Ave., Mountain View, Calif. 94043. Phone (415) 964-5700 [Circle 373]

CALCULATOR DISPLAYS GRAPHS ON LCD PANEL

The FX-7000G pocket scientific calculator displays equations in graph form on an LCD panel that contains 96 by 64 dots and measures 2.17 by 1.5 in.

As the user enters changes in the numeric values, the display changes to reflect this input. Two or more function equations can be displayed simultaneously as a graph, and the intersection and approach of different functions can

be displayed at a keystroke.

Retailing for $69.95, the calculator is available now.

Casio Inc., 15 Gardner Rd., Fairfield, N. J. 07006. Phone (201) 575-7400 [Circle 369]

PROBE FINDS EMI HOT SPOTS

The HP 11940A close-field probe is a magnetic-field sensor that locates electromagnetic-interference sources and makes highly repeatable relative measurements from 30 MHz to 1 GHz. The handheld instrument works with radio-

frequency and microwave-spectrum analyzers for troubleshooting at the design stage.

To eliminate errors due to stray capacitive coupling, the HP 11940A uses a dual-loop configuration and a balun, which provide common-mode rejection of electrical-field components. Calibration is accurate to ±2 dB for a 377-Ω field impedance.

The price of the close-field probe is $500, with delivery in 12 weeks.

Hewlett-Packard Co., Inquiries Manager, 1820 Embarcadero Rd., Palo Alto, Calif. 94303 [Circle 370]

CHART RECORDERS COME WITH 10 PENS

The PrimeLine R-50 series of flatbed strip-chart recorders comes with 2 to 10 pens. Each pen is driven by its own dc servo motor, with accuracy better than ±0.25% and sensitivity better than ±0.1% of full scale. The user can select chart-drive speeds from 2 cm/h to 120 cm/min and either Z-fold or roll-chart paper.

Standard features of the R-50 series include 32 switch-selected calibrated ranges from 0.5 mV and a vernier scale that can extend each range up to 250% for continuous-range adjustment between each calibrated step.

The price of the midrange model R-54 with four pens is $4,495, and delivery is from stock.

Soltec Distribution, P. O. Box 818, Sun Valley, Calif. 91353.
Phone (818) 764-5400 [Circle 371]

SOLIDS MODELER TURNS 2-D INTO 3-D

AC/Solids takes either a surface model or a two-dimensional outline and creates a true three-dimensional solid model. It also shows the model from any position—with hidden lines displayed or suppressed—during the design process and lets the user incorporate doubly curved surfaces. Engineering calculations such as mass and surface area can be carried out at any time, and interference checking is also performed.

AC/Solids is available for Digital Equipment Corp.'s VAX and MicroVAX and Apollo Computer Inc.'s Domain computers and is an option to AC/Diad, the company's 2-d drafting and design system. The per-user license price for VAX or Apollo systems is $9,000; for a MicroVAX system, the package is $18,000. An evaluation kit is available now.

American Channels Inc., 1050 Waltham St., Lexington, Mass. 02173.
Phone (617) 862-4441 [Circle 358]

SOFTWARE CLEANS MAILING LISTS

To clean mailing lists of duplicates and near-duplicates, CleanMail performs very fast character-string comparisons—400,000 characters/s—and calculates the degree of similarity between each record and all others. Similar records are then presented to the data-base administrator for comparison and elimination of duplicates.

CleanMail is compatible with most data-base software packages, and the company says it is far more accurate than other available merge-purge methods. It consists of a plug-in circuit card and software for the IBM Corp. Personal Computer. The package sells for $995 and is available now.

Proximity Technology Inc., 3511 N. E. 22nd Ave., Fort Lauderdale, Fla. 33308.
Phone (305) 566-3511 [Circle 359]

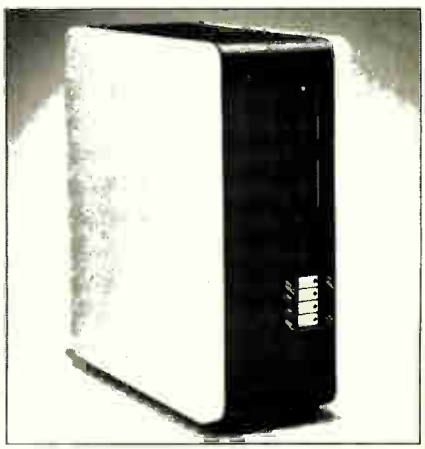
COMPACT COMPUTER MIMICS MICRO PDP-11

The Q-bus-based Qube computer is compatible with Digital Equipment Corp.'s Micro PDP-11/73 and supports all DEC operating systems. The 25-lb computer, which comes in either a floor-standing or desktop configuration, measures only 14 by 14 by 6 in. Prices for the system start at $6,500.

A complete Qube consists of a Q-bus backplane with eight dual slots, two floppy-disk drives, a hard-disk drive with 22- or 44-megabyte formatted capacity, and a controller for the disks. Users have a choice of CPUs, main memory ranging from 256-K bytes to 4 megabytes, and serial interfaces for four or eight terminals.

Additional hard-disk or tape-cartridge storage can be substituted for the floppy disk. Delivery is from stock.

Unbound Inc., 15239 Springdale St., Huntington Beach, Calif. 92649.
Phone (800) 862-6863; in California, (714) 895-6205 [Circle 366]



NEW LITERATURE

RADIATION HARDENING. "Radiation Effects on CMOS" describes the use of rad-hard semiconductors in commercial, industrial, and defense applications. Besides defining the term "rad-hard," it covers types of radiation and the major problem of CMOS—ionization radiation. The brochure also details the level to which major tactical-weaponry systems can be protected and from what types of radiation. Requests for free copies should be on letterhead. Write to Harris Semiconductor, P. O. Box 883, M/S 53-035, Melbourne, Fla. 32902. [Circle reader service number 421]

SENSORS. F. W. Bell details its PI series of current-watt sensors in new literature. In addition to specifications, the illustrated literature discusses measurement theory and how to measure ac and dc power. Requests should be sent to the company at 6120 Hanging Moss Rd., Orlando, Fla. 32807. Phone (305) 678-6900. [Circle 422]

LINEAR ICs. "Circuit Ideas for Linear ICs" offers 102 circuits using RCA linear ICs and MOS FETs—all for industrial and consumer applications. Included are sections on timing, measurement, data conversion, and communications. A full schematic is illustrated for each circuit idea along with a brief description of its function. For a free copy, write to RCA Solid State, P. O. Box 2900, Somerville, N. J. 08876 [Circle 423]

DIGITAL-TO-ANALOG CONVERTER. An application note describes how to connect a dual 12-bit digital-to-analog converter, model AD7549, to microcomputers in the MCS-48 and MCS-51 families. The three-page note concentrates on solutions that require little external hardware and a minimum number of components. Requests for the free literature should go to Analog Devices Inc. Literature Center, 70 Shawmut Rd., Canton, Mass. 02021. [Circle 428]

DICE. For estimating the die size of cell-based designs, International Microelectronics Products offers a free slide rule. The slide rule takes design parameters into account and includes an IC yield estimator. Write on letterhead to IMP Marketing Department, 70 E. Daggett Dr., San Jose, Calif. 95134. [Circle 425]

MARKETING. A catalog of publications on how to market high technology comes from the creators of "Mainly Marketing," a 12-page monthly report that publishes industry surveys and "how-to" articles. Books listed in the catalog include *The Handbook on Marketing for High Technology's Top Managements* and *Forecasting Electronic Business*. Published by Schoonmaker Associates, P. O. Drawer M, Coram, N. Y. 11727, the catalog is free; a sample copy of "Mainly Marketing" sells for 50¢. Phone (516) 473-8741. [Circle 426]

TEST HEADS. Augat/Pylon describes its test fixtures for GenRad 2272 test systems with the Speed Plus option, including a modular design interface panel and an alignment method to guarantee proper test-head/receiver interfacing. The company makes a series of Vac-Tuated test heads for the GenRad 2272. For copies of Bulletin GR2272-SP, write to Augat/Pylon, P. O. Box 2510, 452 John Dietsch Blvd., Attleboro Falls, Mass. 02763, or call (617) 699-7646. [Circle 427]

SURFACE MOUNT. "PLCC: Plastic Leaded Chip Carriers" covers thermal characteristics of the plastic leaded chip carrier, device availability, and device pinouts. Types of devices in the overview include PROMs (diagnostic and registered), Programmable Array Logic devices, first-in first-out devices, and Double-Density-Plus interfaces. For a free copy, write to Monolithic Memories Inc., 2175 Mission College Blvd., Santa Clara, Calif. 95050, or call (408) 970-9700. [Circle 424]

PROCESS CONTROL. A full-color 12-page brochure introduces Icon/1000, a distributed, microprocessor-based control system that features computer-aided process-engineering software. CAPE permits a complex process application to be configured by means of graphics icons rather than using one of the programming languages. The hardware is based on the IBM Corp. 7531/2 industrial personal computer and a 68000-based plant-floor controller. Write to Data Acquisition Systems Inc., 349 Congress St., Boston, Mass. 02210, or call (617) 423-7691 for a free copy. [Circle 429]

Advertisers Index

Classified and employment advertising

▪ For more information of complete product line see advertisement in the latest Electronics Buyers Guide
* Advertisers in Electronics International
‡ Advertisers in Electronics domestic edition

Advertising Sales Staff

Atlanta, Ga. 30319: Joseph Milroy
4170 Ashford-Dunwoody Road N.E.
[404] 252-0626
Boston, Mass. 02116:
M. E. "Casey" McKibben, Jr.
575 Boylston St.
[617] 262-1160
633-0155 Mobil Phone
Chicago, Ill. 60611: William J. Walker
[312] 751-3738
645 North Michigan Avenue
Cleveland, Ohio 44113:
[216] 496-3800
Costa Mesa, Calif. 92626: Fran Cowen
3001 Red Hill Ave. Bldg. # 1 Suite 222
[714] 557-6292

Dallas, Texas 75240: Harry B. Doyle, Jr.
5151 Belt Line Road, Suite 907
[214] 458-2400
Englewood, Co. 80112: Harry B. Doyle, Jr.
7400 South Alton Court Suite 111
[303] 740-4633
Houston, Texas 77040: Harry B. Doyle, Jr.
7600 West Tidwell, Suite 500
[713] 462-0757
Los Angeles, Calif. 90010: Chuck Crowe
3333 Wilshire Blvd.
[213] 480-5210
New York, N.Y. 10020
Matthew T. Reseska [212] 512-3617
John Gallie [212] 512-4420
1221 Avenue of the Americas
Stamford, Ct. 06902
Albert J. Liedel
777 Long Ridge Road. Bldg. A
[203] 968-7115
Palo Alto, Calif. 94303:
Larry Goldstein, Jeffrey C. Hoopes,
Lauren Scott
1000 Elwell Court, [415] 968-0280
Philadelphia, Pa. 19102: Joseph Milroy
Three Parkway, [215] 496-3800
Pittsburgh, Pa. 15222: Matthew T. Reseska
Suite 215, 6 Gateway Center, [215] 496-3800
Southfield, Michigan 48075:
4000 Town Center, Suite 770, Tower 2
[313] 352-9760
San Francisco, Calif. 94111:
Larry Goldstein, Jeffrey C. Hoopes,
Lauren Scott
425 Battery Street
[415] 362-4600

Frankfurt/Main: Fritz Krusebecker, Dieter Rothenbach
19 Liebigstrasse, Germany
Tel: 72-01-81
Milan: Savio Pesavento
1 via Baracchini, Italy
Tel: 86-90-656
Paris: Jean - Christian Acis, Alain Faure
17 Rue-Georges Bizet, 75116 Paris, France
Tel: (1) 47-20-33-42
Scandinavia: Andrew Karnig
Finnbodavagen
S-131 31 Nacka
Sweden
Tel. 46-8-440005
Telex: 17951 AKA S
Tokyo: Hirokazu Morita
McGraw-Hill Publications Overseas Corporation,
Kasumigaseki Building 2-5, 3-chome,
Kasumigaseki, Chiyoda-Ku, Tokyo, Japan
[581] 9811

United Kingdom: Art Scheffer
34 Dover Street, London W1
Tel: 01-493-1451

Business Department

Thomas E. Vachon
Director of Operations
[212] 512-2627
Leon Irgang
Circulation Director
[609] 426-5542
Roseann Lehmann
Office Administrator
[212] 512-3469
Linda Tamburello
Customer Service Manager
[212] 512-6643
Frances M. Vallone
Reader Service Manager
[212] 512-6058
Patricia Parks
Billing Specialist
[212] 512-2589
Thomas M. Egan
Production Director
[212] 512-3140
Carol Gallagher
Production Manager
[212] 512-2045
Evelyn Dillon
Production Manager Related Products
[212] 512-2044

Classified and Employment Advertising

[212] 512-2556

ELECTRONICS WEEK

JAPAN TELECOM PRODUCTION SAGS

Japanese telecommunications production last year registered one of its slowest rates of increase ever. For the 12-month period ending November 1985, production was up only 1.9%. The Communications Industry Association of Japan says the slowdown was directly related to the rise in the value of the yen against the dollar. Japanese exports of telecommunications equipment dropped 5% during the month of November, and imports decreased by 17.3%. Production for the month was valued at $654 million. Big losers were push-button phones, down 20.2%; exchanges, down 5.3%; and wireless communications gear, down 8.5%. Leading the product increase for November were dial phones, up 48.4%, and facsimile machines, up 22.3%.

U. S. SALES OFF 2% IN 3RD QUARTER

U.S. electronics companies sold more than $168 billion of domestically produced goods and services during the first nine months of 1985, up 2.3% from the same period a year ago, the American Electronics Association reports. But third-quarter sales, which totaled an estimated $55 billion, declined 2% from the $56.1 billion reported for the same quarter a year earlier. Electronics sales in September were $20.6 billion, down 1.9% from September 1984.

RCA WINS JAPAN SATELLITE JOB

RCA Corp.'s Astro-Electronics Division in East Windsor, N. J., will design and manufacture major subsystems for the BS-3 spacecraft communications bus, as part of Japan's third-generation direct-broadcast satellite. Japan's National Space Development Agency, which will launch two satellites in 1990 and 1991 on a native-designed rocket, awarded NEC Corp. of Tokyo the prime contract based on a design created by NEC and RCA.

FRENCH BUY INTO SETPOINT

Moving to expand into the U. S. market, CGEE Alsthom, an electrical and instrumentation contractor and subsidiary of France's nationalized Compagnie Générale d'Electricité, has taken a 35% interest in Setpoint Inc. The Houston company supplies process computer control software, engineering services, and technology that is applied to the oil-refining, petrochemical, and chemical industries. The aim is to take 6% of the world industrial-control market by the end of this decade.

WYSE TO BUY MONITOR MAKER

Amdek Corp. of Chicago has agreed to a buyout by video-display maker Wyse Technology for an estimated 650,000 shares of Wyse. The San Jose, Calif., company might repay Amdek's bank debt as well. Still awaiting shareholder approval, the buyout would provide Amdek with the resources to help maintain its position in the market for industry-standard monochrome and color monitors.

Wyse has also filed a registration statement for a sale of about 3.3 million shares of its stock—including sale of all 2.7 million shares held by Altos Computer Systems Inc., San Jose.

IBM PICKS INI FOR MAP WORK

In a surprise announcement at the MAP Users Group meeting in Toronto, Canada, John Klein, general manager of IBM Manufacturing Systems Products, said IBM Corp. and Industrial Networking Inc. will jointly develop Manufacturing Automation Protocol products. INI, Santa Clara, Calif., is a joint venture of Ungermann-Bass Inc. and General Electric Co. Although he refused to give details, INI president and chief executive officer Joseph P. Schoendorf said initial development efforts will focus on the IBM industrial computer family.

FIRST ROCKWELL GaAs CHIPS READY

The first fully functional chips, 1-K random-access memories, last week rolled off a new gallium arsenide pilot production line Rockwell International Corp. built for the Defense Advanced Research Projects Agency. The $19 million facility at Newbury Park, Calif., is a foundry at which Defense Department contractors can have GaAs chips fabricated to their own designs. The pilot line can handle up to 250 3-in.-wafer starts per week, with minimum feature sizes down to 1 μm, Rockwell says. The line will fabricate more-complex 4-K RAM parts during the process evaluation phase, and eventually will produce 16-K RAMs and 6-K gate arrays.

WANG WINS USAF CONTRACT

The Air Force has awarded Wang Laboratories Inc. a $480 million contract for management information systems at bases around the world. Under the agreement, Wang will supply about 1,600 computers over the next five years for the Air Force's Minicomputer Multiuser System program. The equipment will come from the full range of Wang's computer line, with a concentration in VS 100 minicomputers. Wang, which has headquarters in Lowell, Mass., will also provide maintenance and support for up to eight years. The entire Air Force procurement will be off-the-shelf equipment, Wang says.

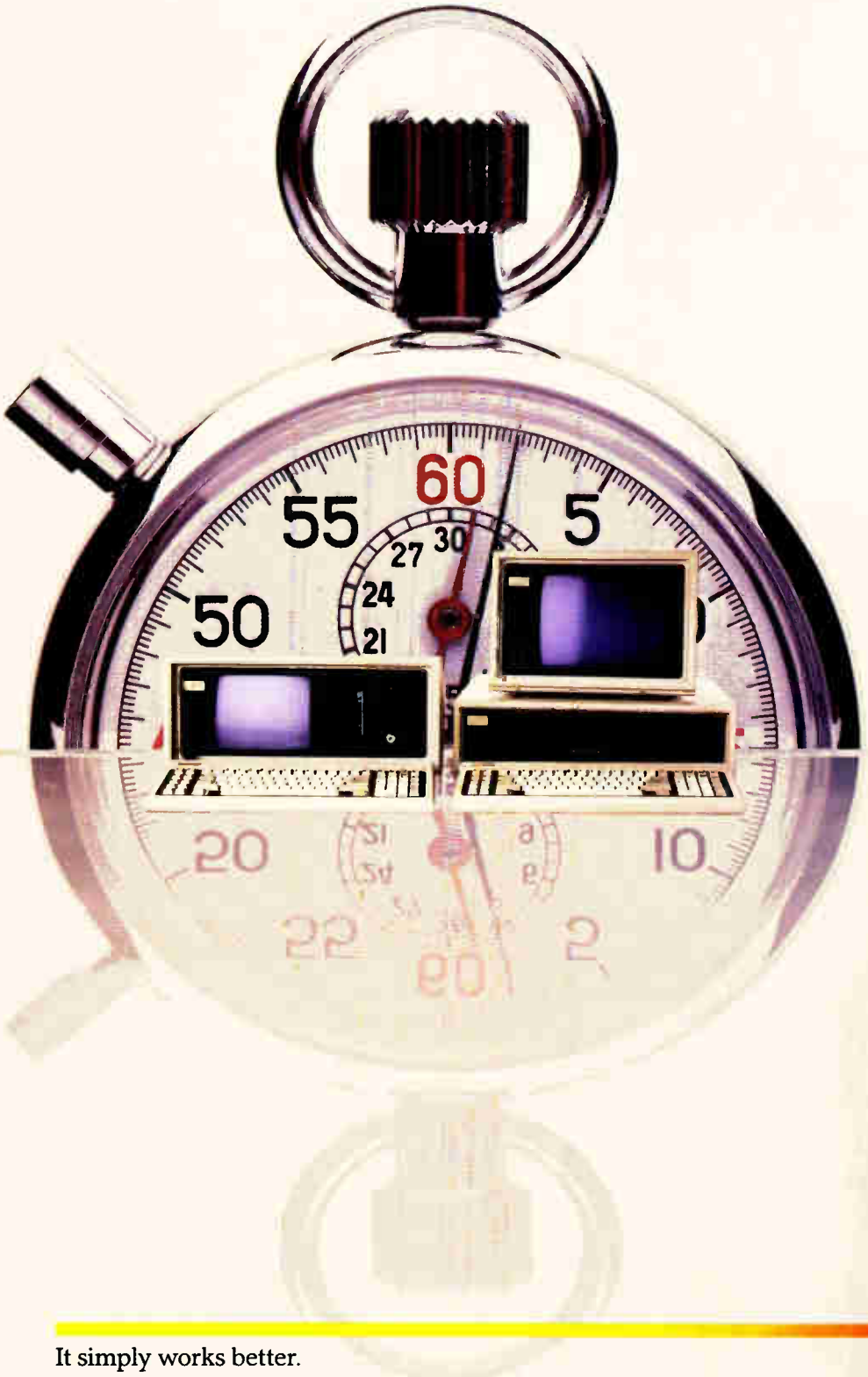
PACBELL TO TEST PUBLIC ISDN

Pacific Bell plans its first major test of a public integrated-services digital network this fall when it will interconnect different switches in three Northern California cities—San Francisco, San Ramon, and one to be chosen in Silicon Valley. An analog-to-digital subsystem, manufactured by Japan's NEC Corp., will make the hookup between the digital network and the various switches at the local level. Those switches will include the common analog switch No. 1 AESS, and digital switches DMS100 and the No. 5 ESS. Spokesmen expect trial customers on the network by spring of 1987. However, they say the commercial viability of such a network will depend on developing a tie-in of ISDN to Pacific Bell's existing packet-switching capability and to a Signaling System Seven process. The Signaling System Seven technology gives the ability to separate out a data-control signal from a transmission on the same telephone line.

XEROX SEES GAIN IN DATA SYSTEMS

Xerox Corp. aims to have half its revenue coming from its information-systems business in the 1990s and will take a stride toward the goal this year with a gain of better than 15% in the sector, chairman David Kearns told security analysts in New York last week. For 1985, he reported, better than expected business in the high end of the copier and duplicator market and a strong performance in information-systems operations helped Xerox boost its revenue by 4% to $8.7 billion and its operating income by 8% to $351 million. Industry analysts estimate that information-systems sales accounted for about 25% of Xerox's revenue last year.

It's not just that someone buys a COMPAQ Computer every 62 seconds of every business day...



It's why.

For three years now, COMPAQ® Personal Computers have sold at the rate of nearly one per minute of each business day. That's made COMPAQ the fastest growing computer company in the world. Because when people take the time to learn about computers, they learn that COMPAQ Computers simply work better.

Our portable computers are built with innovations that surpass most desktop computers. Our rugged COMPAQ PORTABLE 286™ runs software 30% faster than the IBM® PC-AT™. And can come with an *internal* tape back-up system to protect your data—an exclusive in our portable computer.

Our desktop computers are packed with more advances. Our COMPAQ DESKPRO® Series runs faster than the IBM PC or IBM PC/XT™. The COMPAQ DESKPRO 286™ is even faster than the IBM PC-AT.

Our desktops store more. Add up to four *internal* storage devices, including a tape back-up.

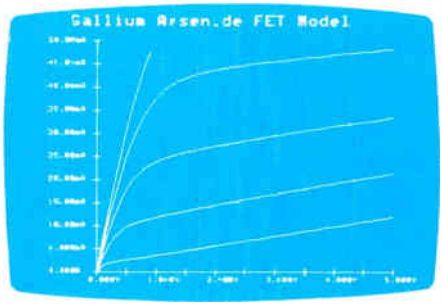
In fact, all COMPAQ Computers are expandable *and* compatible. No compromises. That's why, of the nation's 1000 leading companies, more of them use COMPAQ Computers than any other brand, except one. And we're closing the gap.

For a free brochure or the location of your nearest Authorized Dealer, call toll-free 1-800-231-0900 (in Canada 416-449-8741) and ask for Operator 10.

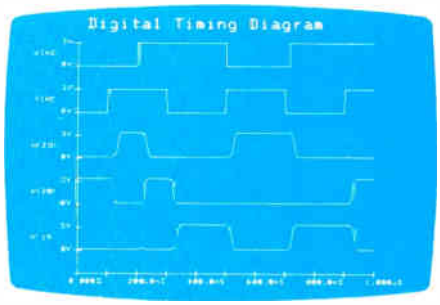
COMPAQ®

It simply works better.

CAE Software
Electronic Circuit Design & Analysis



I-G SPICE



The most widely used program of its type in the world. Already serving most major aerospace & electronic firms.

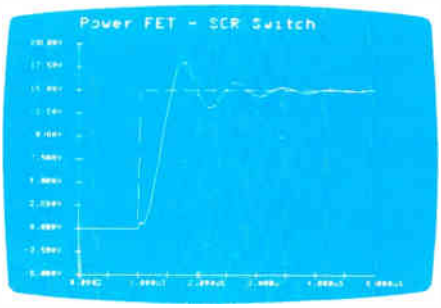
The Interactive-Graphics SPICE can handle all your circuit and chip design & analysis needs: **Analog, digital & hybrid,** low & high frequency, solid-state discrete & IC, low & high power. **One program does it all!** A complete, self contained, stand-alone package or may be integrated into a work station. User friendly. Easy to learn. Excellent documentation & support.

ANALYSIS

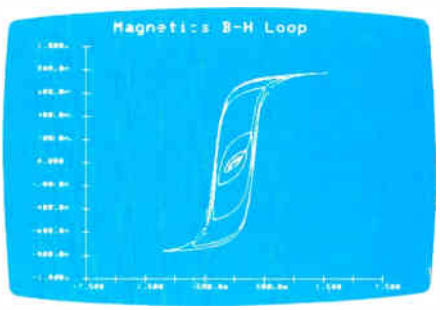
- DC • AC • Transient
- Noise • Sensitivity
- Temperature Sweep
- Transmission Lines
- Fourier • Distortion
- Transfer Impedances

UNIQUE FEATURES

• Equations & tabular functions • Multi-plots • User defined FORTRAN sub-programs for complete modeling flexibility • All digital blocks & functions built-in • Defined parameters • Discrete & IC model libraries • Automatic reruns • Worst-case • Monte-Carlo • Optimization • All these features only available on I-G SPICE • **COMPARE!**



CALL OR WRITE TODAY for a detailed brochure to see why I-G SPICE is No. 1, and what it can do for your company. Now available on the CRAY, CDC & IBM **mainframes** and the DEC/VAX, PRIME & APOLLO minicomputers.



AB Associates, Inc. • P.O. Box 82215 • Tampa, FL 33682 • (813) 932-9853

Circle 902 on reader service card