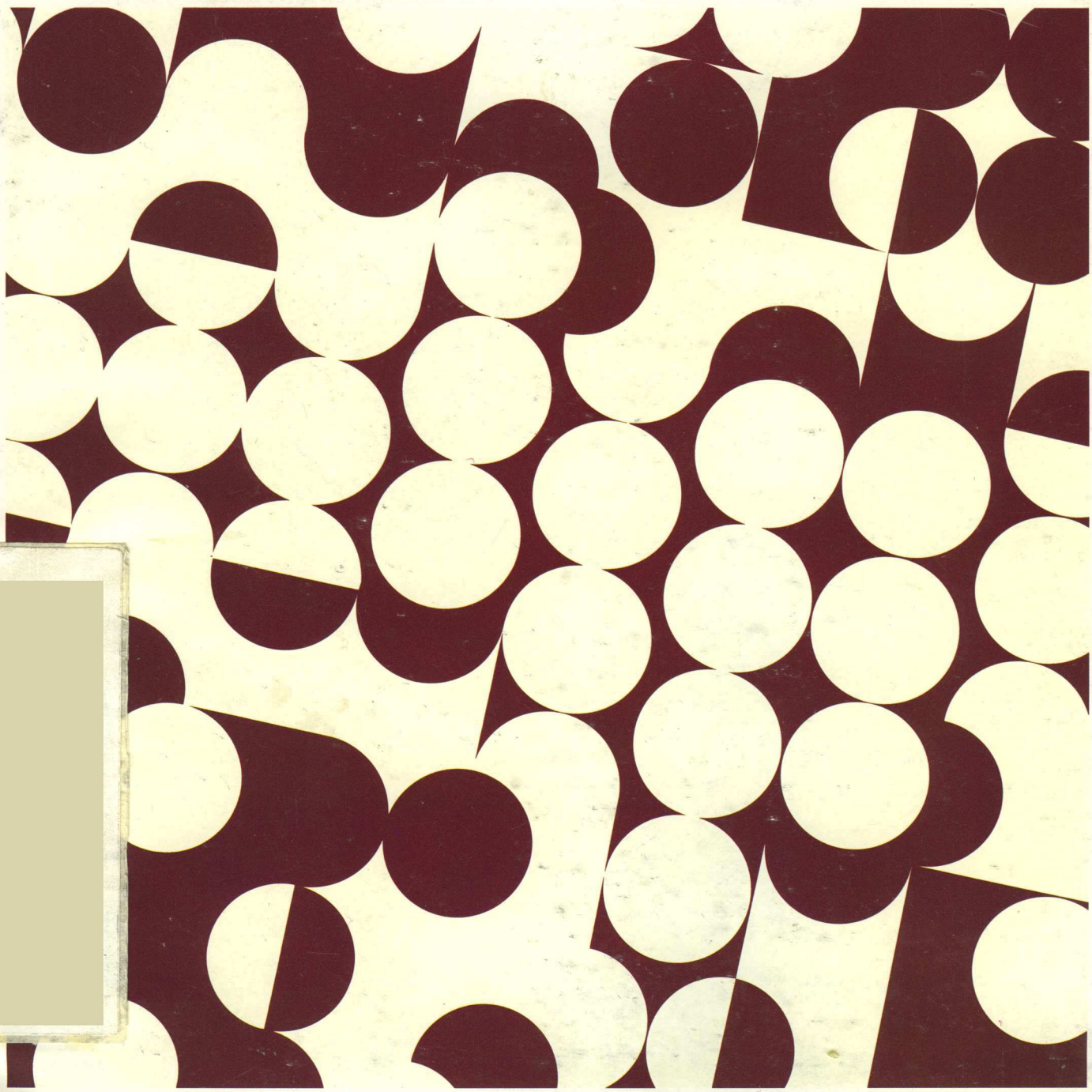
DATAMATION® 74
December

MANAGING SOFTWARE PROJECTS

Also: Microprocessors, microcomputers and batch vs. on-line



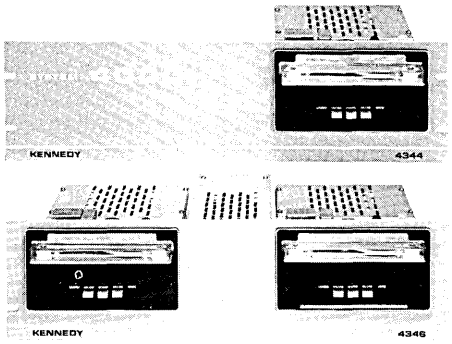
SYSTEM 4000

The World's First — and Only —

Total Cartridge Concept

t's nice to be first; it's better to be best. ystem 4000 is both. It's the first totally nodular "order by number" 1/4" cartidge system ever designed. It's the first o have a fully ANSI-compatible formater with a byte-oriented I/O, and a packng density of 1600 cpi. And, it's the first o allow you to design your own one, wo, three, or four deck system complete vith formatter, electronics, power supply, mounting panel, cabling — even a onnector to plug into your mini's controller.

System 4000 has a storage capacity of 3 million bits, with a data transfer rate of 5000 bytes, and the same great features of all Kennedy cartridge recorders: CRC generation and checking, error detection and gap generation, and simplified formatter commands such as "Write One Block," "Read One Block," etc.



System 4000 is the first truly versatile cartridge tape system. It was designed with minis in mind. It's just possibly the most significant advance in cartridge recorders since the cartridge itself.

CIRCLE 1 ON READER CARD

KENNEDY CO.

540 W. WOODBURY RD., ALTADENA, CALIF. 91001
(213) 798-0953

KENNEDY · QUALITY · COUNT ON IT

Don't buy a computer for where you are. Buy it for where you're going.

Let's face it, there's really no such thing as a cheap computer. A brain with any capacity at all represents a lot of bucks.

So if you're about to lay down a good piece of cash for a computer that can do the job you've got now, why not spend a little more for a computer that can do the jobs you'll have later.

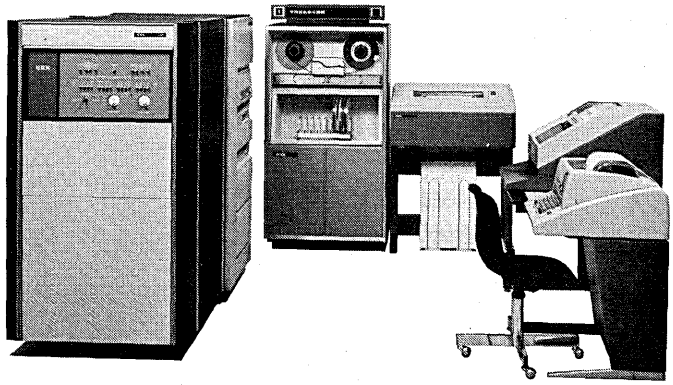
The Xerox 530 computer.

No dead-ender, this. The Xerox 530 is a high-performance, 16-bit, multi-use computer system. Right out of the box, the 530 can do real-time work and batch work simultaneously.

And as your needs get bigger, the Xerox 530 gets bigger, too. Its memory is expandable. You can add input and output channels as you need them. You can add special purpose peripherals. You can add central processor options.

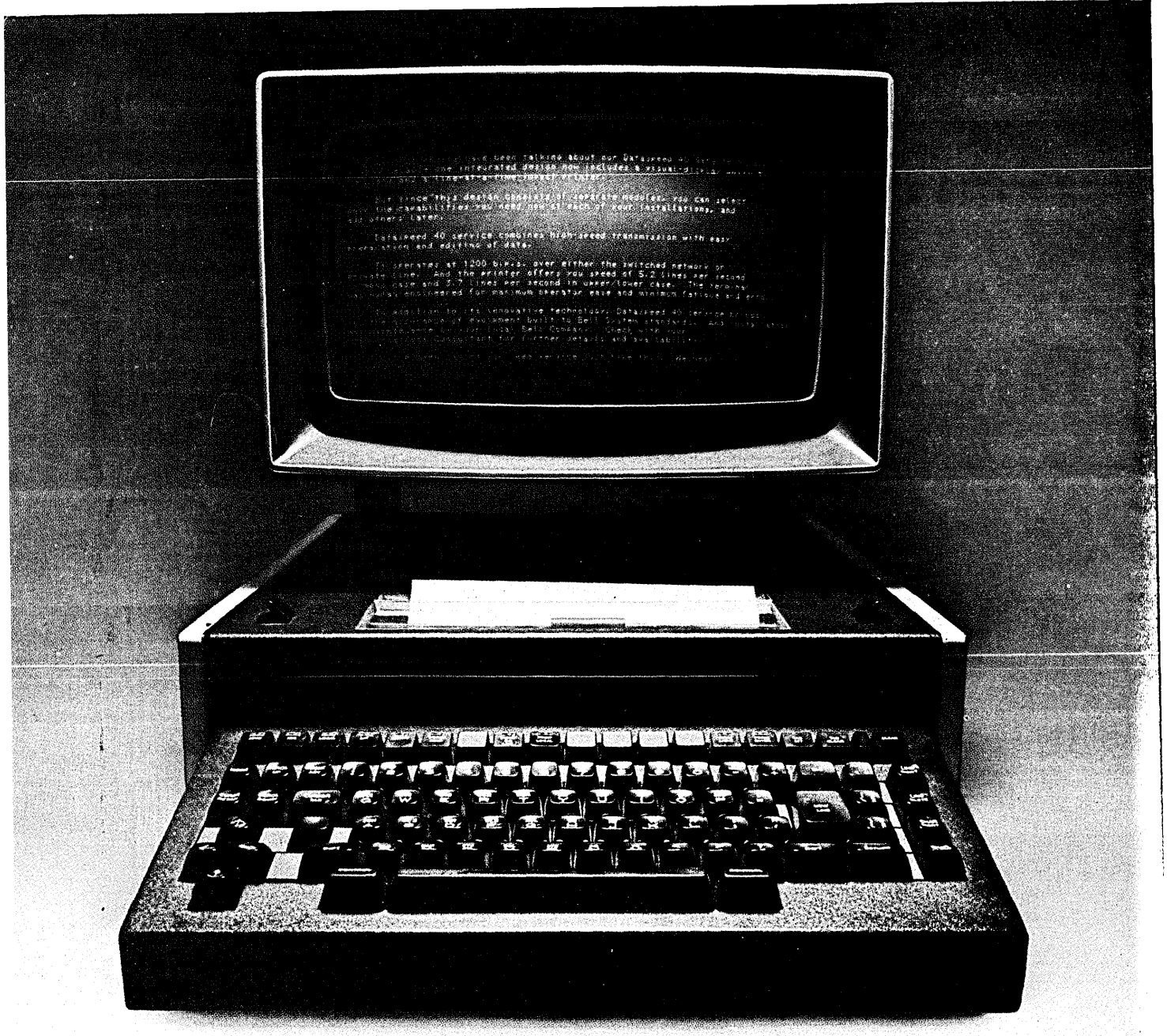
And using HASP protocol, you can even plug your Xerox 530 into a big computer.

So don't buy yourself short. Look into the Xerox 530. The little computer with a big future.



The Xerox 530 Computer.
Looks small. Thinks big.

XEROX



This is what all the talk is about: the new Dataspeed® 40 service from the Bell System.

Lots of people have been talking about our Dataspeed 40 data terminal. That's because one integrated design now includes a visual-display unit, a keyboard and a line-at-a-time impact printer.

But since this design consists of separate modules, you can select only the capabilities you need now at each of your installations, and add others later.

Dataspeed 40 service combines high-speed transmission with easy preparation and editing of data.

It operates at 1200 b.p.s. over either the switched network or private line. And the printer offers you speeds of 5.2 lines per second in mono case and 3.7 lines per second in upper/lower case. The terminal was human-engineered for maximum operator ease and minimum fatigue and error.

In addition to its innovative technology, Dataspeed 40 service brings you the assurance of equipment built to Bell System standards. And installation and maintenance by your local Bell Company. Check with your Communications Consultant for further details and availability.

You've been saying you need service just like this. We hear you.

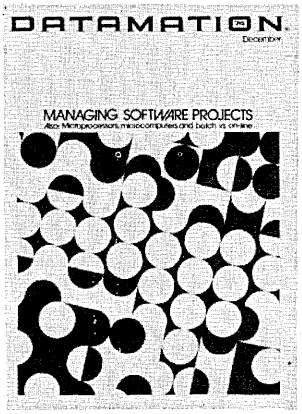
DATAMATION 74®

DECEMBER, 1974
volume 20 number 12
This issue 133,895 copies

managing software projects

Managing a software project, especially a large one, is more like managing other undertakings than programmers believe, but less like it than professional managers expect. The skills required must be developed, sometimes painfully, through studying good and bad examples, by learning the trade-offs, and mostly by doing.

departments



about the cover

Our survey art is reproduced from "Brown-White Structure", a serigraph in two colors by Zdenék Sýkora (Czechoslovakia) from the "SDL Collection", a portfolio of nine original computer art prints. Commissioned by Systems Dimensions Limited, a leading Canadian-owned company in the information industry, the portfolio was coordinated and produced by Editions Gilles Gheerbrant, 2130 Crescent, Montreal H3G 2B8, Canada. More of Mr. Sýkora's work appears elsewhere in this issue.

DATAMATION

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We've mastered the ABC's of EDP labels.

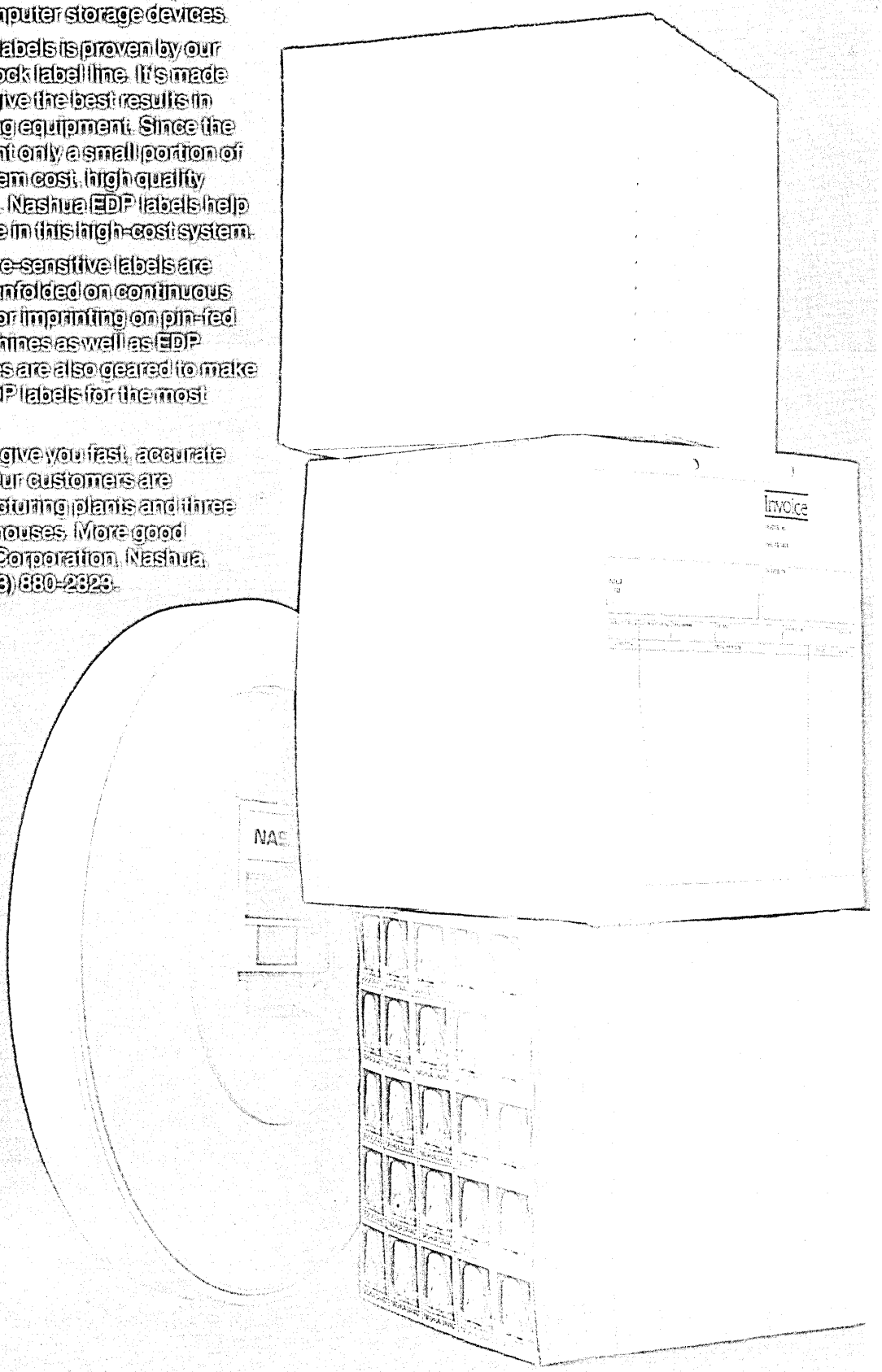
Nashua's at the head of the class in EDP labels. Hardly surprising, what with Nashua's expertise in coated papers and EDP products... such as Davac® dry gum label paper, Nashua Carbonless papers, and our high-performance computer storage devices.

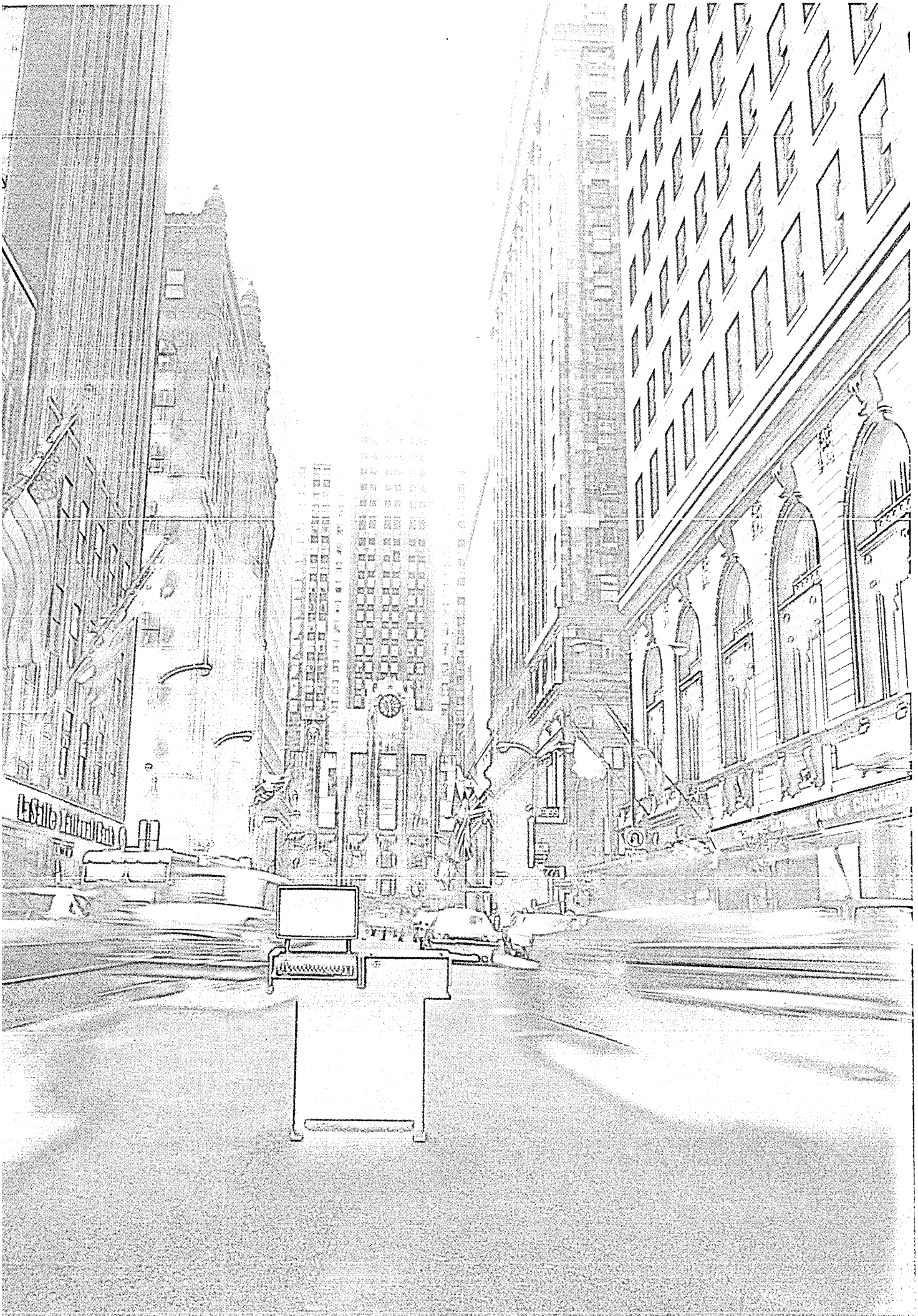
That we've mastered EDP labels is proven by our extensive multipurpose stock label line. It's made to tight specifications, to give the best results in high-speed data processing equipment. Since the labels themselves represent only a small portion of the total EDP labeling system cost, high quality labels are vitally important. Nashua EDP labels help assure minimum downtime in this high-cost system.

Nashua stock EDP pressure-sensitive labels are marginally punched and fanfolded on continuous carriers. We design them for imprinting on pin-fed typewriters and other machines as well as EDP equipment. Our capabilities are also geared to make a wide range of custom EDP labels for the most specialized requirements.

But the first thing we do is give you fast, accurate quotes right on the spot. Our customers are serviced from two manufacturing plants and three strategically located warehouses. More good reasons to talk to Nashua Corporation, Nashua, New Hampshire 03060 (603) 880-2823.

NASHUA





We think our data terminal system is so good nothing even comes close.

In fact, we believe the Teletype® model 40 system is so good it'll change the way business looks at data. We're that sure it's that good.

Here's why:

It's a complete, versatile, reliable terminal system delivering maximum efficiency in a wide range of applications. From message communications to computer input/output on switched network or private-line systems. Right now, the model 40 system is being used by airlines, news services, brokerage firms, manufacturers, law enforcement agencies and time-sharing services.

Significant features of the system are speed, ease of data preparation and editing, compactness and extremely low maintenance. And since the model 40 is completely modular, you can forget about obsolescence. It's designed to grow as your needs grow.

Data is presented with extreme clarity on the big, 13-inch screen. Characters are 35 percent larger than standard print size and are formed on a 7 x 9 dot matrix. Screen capacity is 24 lines of 80 characters each for a total of 1,920.

Teletype's exclusive solid-state design makes the model 40's fast (up to 2400 wpm), heavy-duty impact printer the most cost-effective unit on the market. Its simplicity of design makes it one of the most reliable printers we've ever made. And after more than 60 years experience building printers that set the standards for reliability, that's saying something.

It took a total corporate commitment to come up with something as good as the model 40. For example, we had to develop and manufacture our own MOS. It didn't come easy, but we think it's worth it. Because the solid-state components throughout the system deliver exceptionally high reliability. And the self-diagnostic circuitry and design modularity significantly reduce downtime and maintenance costs.

Operator comfort and efficiency are increased by human-engineering efforts like a brightness control and screen tilt, plus a glare-reducing display tube and an easy to operate keyboard.

The Teletype model 40 data terminal system.
It's every bit as good as you've heard. And probably even better.

For complete technical data, please contact our Sales Headquarters at 5555 Touhy Avenue, Skokie, Illinois 60076.
Or call TERMINAL CENTRAL at (312) 982-2000.

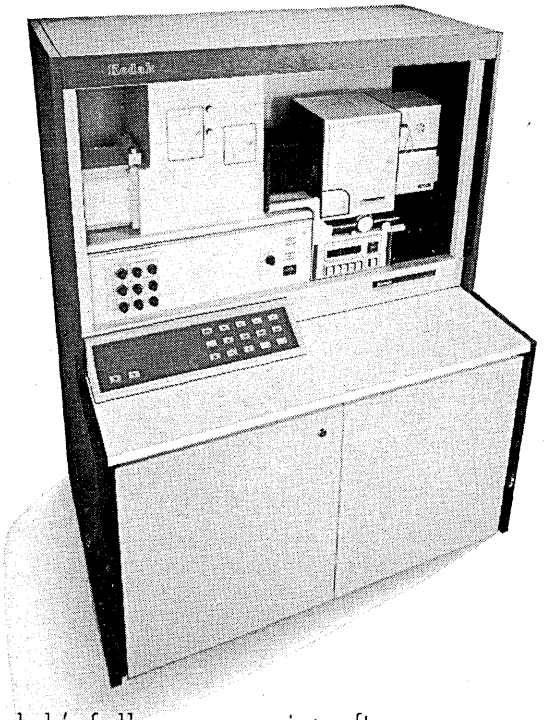
TELETYPE

Teletype is a trademark registered in the United States Patent Office

The Teletype model 40 system.

CIRCLE 62 ON READER CARD

How to improve computer data flow throughout your organization.



Kodak's full resources in software, service, and systems support to call upon.

Learn how Kodak KOM microfilmers can help you set up the data management procedures needed for the '70s.

Speed was the first thing everyone noticed about putting computer tape data directly on microfilm with a COM unit. But the real COM benefits come with the better use and handling of information it makes possible.

Besides cutting costs in data processing through more efficient use of existing hardware (and these savings can be very substantial indeed), the various user groups within your organization also benefit. By getting the data faster. By getting it in a more usable form—either in microfiche or roll microfilm, depending on your need. By having data easily coded for automated retrieval. All as part of the COM operation.

Another important reason for choosing a Kodak KOM microfilmer is that you have

Get the facts on COM.

Write for our informative new booklet, "The New Generation of Computer Output". And see how COM can benefit your organization. Eastman Kodak Company, Business Systems Markets Division, Dept. DP617, Rochester, New York 14650.

Kodak: for better use of information.

calendar

JANUARY

National Retail Merchants Assn.'s 64th Annual Convention and Business Equipment Exposition, Jan. 5-8, New York. An estimated 6,000 retailers will explore the theme of "People, Productivity and Profits" with sessions devoted to merchandising, fashion, shopping centers—and automation. The program includes discussions of electronic funds transfer systems (EFTS), edp merchandising systems, point-of-sale systems, computer applications, and a report on the standardization effort of optical character recognition and its effect on source marking. Fee: $65, members; $95, non-members. Contact: M. E. McGroary, NRMA, 100 West 31st St., New York, N.Y. 10001, (212) 244-8780.

Second Annual Symposium on Computer Architecture, Jan. 20-22, Houston. The Univ. of Houston hosts this meeting, co-sponsored by the Computer Society (IEEE) and the Special Interest Group on Computer Architecture (ACM). A one-day tutorial on Jan. 20 (with a separate fee of $50), will precede the conference opening that evening. Papers on the current state of the art and theory of computer architecture will include as topics large machine and parallel processors, the operating system and architecture interface, and computer system design languages. Fee: $30, members; $40, non-members (add $10 for registration after Jan. 13); $15, students. Contact: Dr. Willis K. King, Dept. of Computer Science, Univ. of Houston, Houston, Texas 77004, (713) 749-4791.

Second ACM Symposium on Principles of Programming Languages, Jan. 20-22, Palo Alto. About 300 programming language researchers are expected to attend this conference, sponsored by SIGACT and SIGPLAN. More than 20 papers will be presented on code optimization, programming language semantics, structured programming and the complexity of programming language related problems. Fee: $45, members (add $5 if non-member or for post-Jan. 3 registration), $10, student. Contact: Dennis R. Allison, 169 Spruce Ave., Menlo Park, Calif. 94025.

FEBRUARY

NEPCON '75 West and International Microelectronics Exhibition, Feb. 11-13, Anaheim. This combined show and conference will concentrate on the products and techniques required for development, production, packaging, processing and testing of electronic circuits, equipment and microelectronic devices. Technical program includes testing of MOS devices, wafer processing techniques, and thermal printing with thick-film hybrids. Attendance of 26,000 is expected. Contact: ISCM, 222 West Adams St., Chicago, Ill. 60606, (312) 263-4866.

PL/1—State of the Art and Future Trends, Feb. 25-28, Keystone, Colo. This winter symposium will explore the capabilities and uses of high level languages through various case studies and experiences in the use of PL/1. Commercial, scientific, teleprocessing and systems programming environments will be discussed, as well as alternatives to IBM implementations offered by Burroughs, Honeywell and Univac. In addition there will be a complete presentation on the ANSI standard. Fee: $125. Contact: Roger Jones, CIBAR, Inc., 2655 Janitell Rd., Colorado Springs, Colo., (303) 576-8211.

MARCH

EDP-V, Exhibition of Electronic Data Processing and Related Equipment, March 10-14, Stockholm, Sweden. Sponsored by the Dept. of Commerce at the U.S. Trade Center, this show provides an opportunity for U.S. manufacturers of mainframes, minicomputers, communications equipment, and peripherals to reach the Scandinavian market. Contact: James W. Lamont, U.S. Dept. of Commerce, Washington, D.C. 20230, (202) 967-4543.

APRIL

Structured Programming in COBOL: Future and Present, April 7, Los Angeles, sponsored by CODASYL in conjunction with the April Programming Language Committee meeting. Papers will be presented on writing structured programs in COBOL as it exists today, and on desired changes to the language to make it more amenable to structured programming techniques. Attendance is limited to 100 persons using COBOL in application programming environments. No fee; for reservations contact J. W. Lowrey, Jr., McDonnell Douglas Automation Co., 3855 Lakewood Blvd., Long Beach, Calif. 90846, (213) 593-7089, before Feb. 1.

IEEE INTERCON/75, April 8-10, New York. Approximately 30,000 design, applications and production engineers, and management/marketing personnel are expected to view exhibits and demonstrations by 300 companies in microelectronics, computers, peripherals, edp systems, and communications and data transmission equipment. Technical sessions will cover control and test systems, computers, communications and data transmission, and marketing and distribution. Fee: $8, members; $10, non-members, and $5, students. Contact: William C. Weber, general manager, IEEE Intercon, 345 E. 47th St., New York, N.Y. 10017.

24th Annual Conference and Exposition, National Microfilm Assn., April 8-11, Anaheim. Application seminars on the use of micrographics in government, commercial, engineering, health and education environments are part of the program planned on the varied uses, systems and applications, and technology advances in this field. Emphasis of the conference will be to show that "versatility of microfilm and microfilm systems permits businesses large and small to design information handling and storage systems which are convenient, efficient and inexpensive." More than 12,000 professionals are expected to attend. The $100 fee includes new or renewal memberships. Contact: Jack Hess, NMA, Suite 1101, 8728 Colesville Rd., Silver Spring, Md. 20910, (301) 587-8444.

Conferences are generally listed only once. Please check recent issues of DATAMATION for additional meetings scheduled during these months.

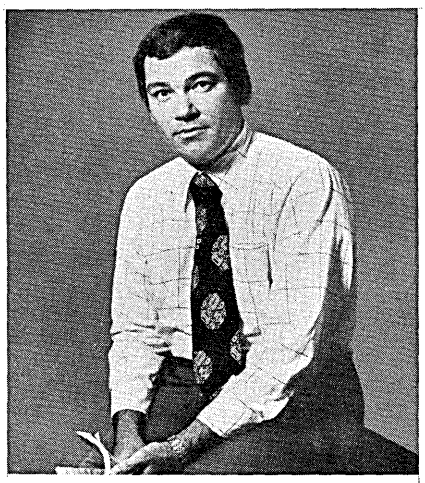
people

STILL PLAYING FOOTBALL

A first impression of Michael Brennan, president of Peripheral Interface Corp., (PICO) Santa Ana, Calif. is, "he should be a football player." He was once. He played football at the Univ. of California at Berkeley and while in the Navy. He's been a lot of other things since.

His company's main thrust is peripherals for minicomputers. Brennan left Orange county minimaker, Computer Automation, Inc., to found PICO five years ago because of a strong belief in the importance of peripherals for minis. "The cost of peripherals is often more than that of the mini and there's a better profit margin in peripherals." But he hasn't given up on minis. PICO recently added one to its product line.

Brennan and his two co-founders,



MICHAEL BRENNAN
The importance of peripherals for minis

Jim Villotti, now head of PICO's engineering department, and William Sprague, senior systems analyst, got no outside money to start the company. "We bootstrapped from day one," said Brennan. "We made $200,000 our first year, $400,000 our second, and expect to make more than $2 million this year." Villotti, like Brennan, had been with Computer Automation. Sprague joined PICO from Litton Data Systems.

Last December, PICO was acquired by Datum, Inc., Anaheim, Calif., strange on the surface since the two firms compete in mag tape units and disc drives for minis. "We sell differently," Brennan explained. "We sell boxes primarily and only occasionally put together a system. It's rare for Datum to sell only a box. They concentrate on systems and Datum had all the things we didn't have, like cash and manufacturing capability." The new PICO mini is being manufactured at Datum facilities under the Datum name.

Brennan is an electrical engineering graduate of the Univ. of Southern California which he attended after his football playing days at Berkeley. In 1967, after his stint in the Navy, he returned to USC to teach graduate students in the School of Psychology to use computers and instruments. He left SC in '68 to join Ampex Computer Products where he stayed for a year. He was part of the founding group in Computer Automation.

And his education continues. He currently is working for an MBA at Pepperdine Univ. in a special program for presidents and key executives.

So does his interest in football. He's an avid USC fan and attends every SC game he can. He still plays too. He lives at the beach and his brother is his next door neighbor. With "a half dozen other guys" they play regularly on the beach. Brennan described the games as "semi controlled mayhem."

Recently his football playing has been curtailed as a result of another love, sailing. He owns a 22 ft. boat which he sails on the Salton Sea, in the ocean, and on the Colorado river. Last summer he got his leg jammed between his boat and a dock at the Salton Sea, reactivating an old football injury and requiring him to spend three weeks in the hospital. But he's mending and looking forward to playing footba!! again.

"STATUS FROM THE JOB"

The credentials of the winner of the 1974 WEMA Medal of Achievement are both impressive and varied.

Dr. Robert N. Noyce, founder and president of Intel Corp., Santa Clara, Calif., has been called a dominant force in the development of the semiconductor industry. He also has been referred to as gregarious and independent and he has a sound track record in raising money. His office in Intel's Santa Clara headquarters is simple. His Mercury Cougar with a license plate bearing the name INTEL does not get preferred parking in the company lot. "We're trying to be sensitive to the things that turn people off," Noyce has been quoted as saying. "We want people to get status from the job they've done, not from walnut paneling."

The 46-year-old Noyce can claim a lot of status from jobs he's done. His "dominant-force-in-the-semiconductor-industry" role started in 1956 when he joined the Shockley Semiconductor Laboratory and directed the design and development of diffused silicon transistors.

In 1957, he was one of the founders of Fairchild Semiconductor and, as director of research at Fairchild, he was responsible for the initial development of the silicon mesa and planar transistor lines. Subsequently he became vice president of the parent company, Fairchild Camera & Instrument Corp. and general manager of Fairchild Semiconductor.

Associates say Noyce was unhappy with the big company atmosphere at Fairchild, that he preferred more direct contact with the people who worked for and with him, which was why he left to form Intel in 1968 with Gordon Moore, also from Fairchild.

At Intel, Noyce has overseen pioneering work in the field of semiconductor memories which have opened new electronic markets for microcomputers and such consumer products as electronic calculators and watches. He holds 16 patents on semiconductor methods, devices and structures, including application of photoengraving to semiconductors, and diffused junction isolation for integrated circuits. He also holds the basic patent relating to metal interconnect schemes which is considered one of the major developments in integrated circuit technology.

A graduate of Grinnell (Iowa) College in 1949, with a double major in physics and mathematics, he received his Ph.D. degree in physical electronics at Massachusetts Institute of Technology in 1953. From 1953 to 1956 he was the research division of Philco Corp.

When he set about to raise money to start Intel, Noyce first went to venture capitalist Arthur Rock, a heavy investor in Fairchild. Rock himself put $300,000 into Intel and, between Rock and Noyce they spent about two hours and got a total commitment of $2 million. Not too long after that Intel raised $4 million with another private placement and $7 million with another public offering.

"We have always had more money than we needed, and have had to turn away money," said a company official during the dark days of 1971.

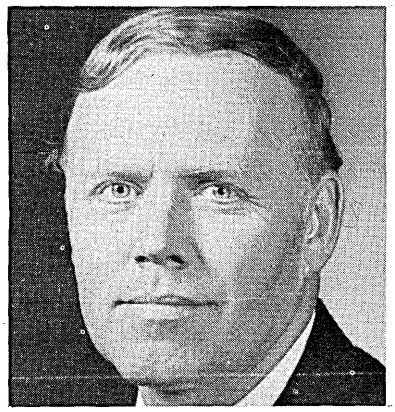
An unusual source of Intel's initial

money was his alma mater, Grinnell college. A college trustee is said to have told Noyce when he left Grinnell, "when you start your own company, give us a piece of the action." Noyce did just that and the college invested $300,000 which has had the effect in four years of just about doubling the slim $11.7 million endowment of the small liberal arts school.

A PRIME MOVER BEHIND THE UPC

The Navy got William E. Reidy interested in computers. It took IBM to get him interested in the food industry.

Now he's combining both interests as vice president, systems services for Kraftco Corp., a producer of processed, packaged foods whose operating divisions include Kraft Foods, Sealtest Foods, Breakstone Sugar Creek Foods, Kraftco International, and Kra-Pak (HumKo Products, HumKo Sheffield Chemical, Metro Containers, and Universal Packaging). In this position he is responsible for information systems design and computer services for the entire corporation, all of which is handled through a central computer center in Glenview, Ill., based on three IBM 370/158s and a private wire data communications system serving the U.S. and Canada.



WILLIAM E. REIDY
It started in the Navy

Both within his company and as chairman of the Administrative Systems Committee of the Grocery Manufacturers of America, Reidy has been a prime mover behind the Universal Product Code (UPC), the grocery industry's standard for a source marked, scannable symbol for supermarket products (Nov., p. 111). Kraftco is one of some 2,000 members of the Universal Product Code Organization, operated through Distribution Code, Inc., Washington D.C., to have been assigned a code. "We are in the process of converting it to use on all our packages," said Reidy. He declined to predict when Kraftco would be fully source marked.

A 1953 graduate of Notre Dame Univ. in Business Administration, Reidy went from college into the Navy where he served as a shipboard line officer for three years before becoming a personnel officer at Ninth Naval District headquarters. "All the personnel listings were handled by IBM tab equipment."

In 1958, he went to work for IBM as a sales trainee. He subsequently became a marketing representative and food industry specialist for IBM. From that job to Manager of Administrative Systems for Kraftco was a natural transition. Kraftco is an IBM user. □

IN NEW POSTS . . .

FRED A. ORDEMANN was named general manager of Control Data's new Memory Development Div. . . . DONALD R. HAWORTH was elected senior vice president, international operations for Computer Leasing Co., Arlington, Va., subsidiary of the Wyly Corp. . . . DR. TSE-YUN FENG, a faculty member in the Department of Electrical and Computer Engineering at Syracuse Univ., was named chairman of the IEEE Computer Society's Computer Standards Committee . . . FRED T. ALLEN, chairman of the board, president, and chief executive officer of Pitney Bowes, was elected to the board of directors of the Computer and Business Equipment Manufacturers Assn. (CBEMA) . . . J. TODD MURPHY was promoted to the new position of vice president, multinational relations by Control Data Corp. . . . DU RAY E. STROMBACK was elected vice president and group executive, Federal and Special Systems Group of Burroughs Corp. . . . HAROLD W. MILLER is the new vice president and director-operations for ITT Defense Communications Div. . . . Directors of Digital Scientific Corp., San Diego, appointed EUGENE W. COURTNEY as president and chief operating officer . . . DR. ARTHUR J. COLLMEYER joined Calma Co., Sunnyvale, Calif. as vice president, software development. . . . RONALD D. SPANIOL has been appointed director of computer services and professor of management at Eastern Illinois Univ., Charleston, was appointed chairman of the Data Processing Management Assn.'s (DPMA) committee to establish an educational research foundation . . . BEN L. ROUSE was appointed vice president and group executive, International Group, for Burroughs Corp.

"Black Watch" waits for the challenge to guard.

"Black Watch" tape has a special-textured back side which guards against cinching, shifting and scratching. You get this "Scotch" 700 tape from the people who developed the first computer tape in 1953. People who will go to any length to solve a customer's problem. People who thrive on assisting. The Data Recording Products Division of 3M. A proud clan.

Call out the clan.

"Scotch" and "Black Watch" are registered trademarks of 3M Co.

3M COMPANY

Announcing DECsystem 1080. Every major timesharing breakthrough now in a single system.

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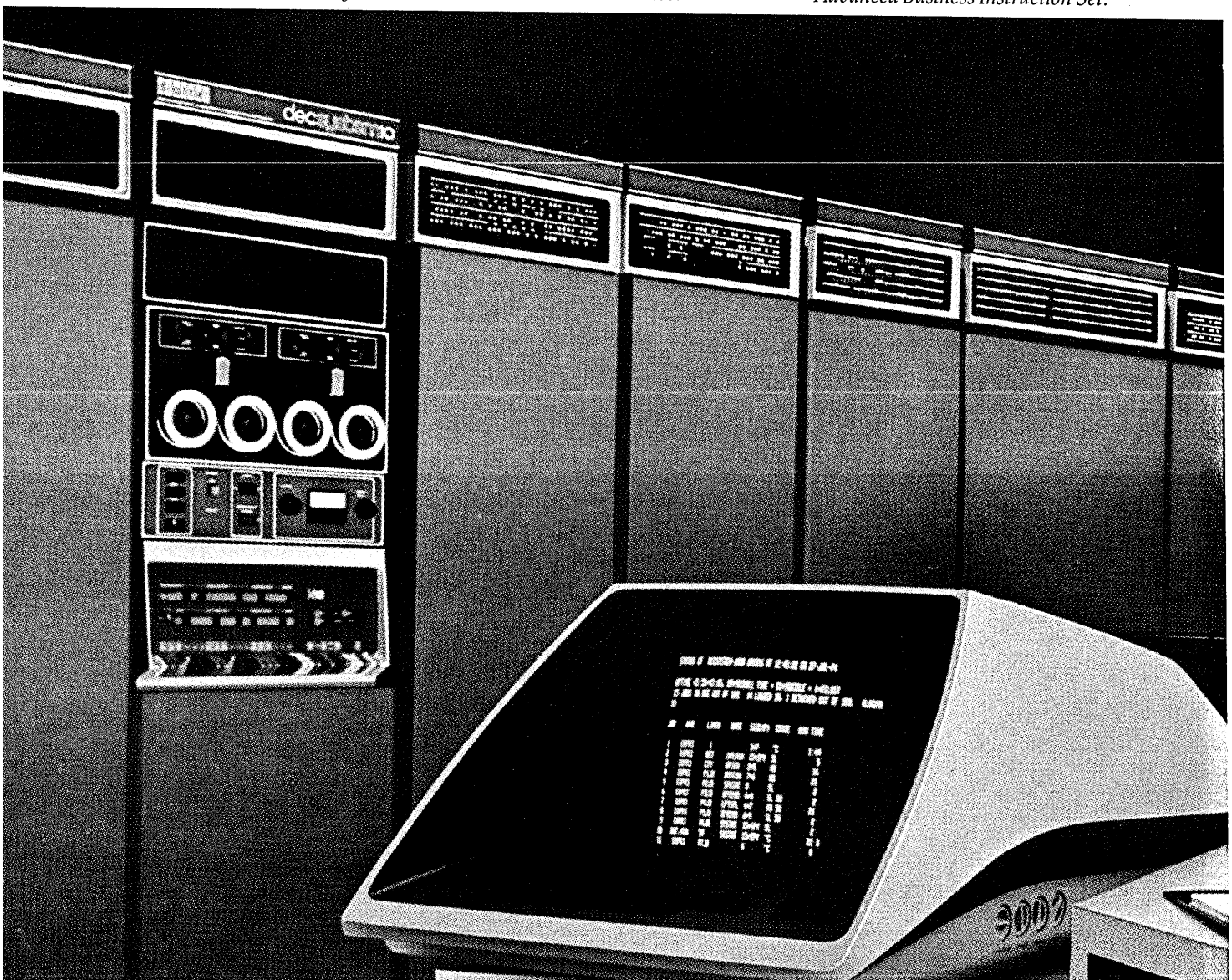

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BASF

LOOK AHEAD

BREAKUP OF AT&T: A DECADE OF LITIGATION?

If successful, the Justice Dept.'s antitrust suit against AT&T would resolve many of the issues affecting data communications, including interconnection of terminals to the Bell network and the viability of competing carriers that offer lower transmission rates. But will these be relevant issues in 1984? The Justice Dept. admits the suit won't come to trial for at least three years and many analysts think appeals could extend the case to 10 years or more. Enforcing this thinking was Ma Bell's announcement the day after the suit was filed last Nov. 20 that it will fight it to the end.

The more optimistic of the analysts think the existence of the suit might influence AT&T to tone down the vigor with which it's been fighting FCC efforts to encourage competition with the Bell system. But those who don't buy this optimism point out that IBM has been vigorously battling all kinds of competition despite its litigation with the Justice Dept. that is now more than half a decade old.

Most interesting speculation on the AT&T case: If Western Electric and Long Lines are sliced away, as requested, the second shoe will drop. The FCC will ask that the telephone operating companies be unglued from one another, as were the Standard Oil companies.

CONTROL DATA COULD BE GOING BACK TO COURT

Oppenheimer, Wolff, Foster, Shepard and Donnelly of Minneapolis is burning the midnight oil again and that could mean trouble for IBM. The law firm works for Control Data, which triggered the flood of antitrust suits against IBM when it filed its antitrust case against the computer colossus back in 1969. A settlement between the two firms outlaws CDC from suing again for any actions incurred before the Jan. 1973 settlement date. So, if there's any new action in the wind--and our intelligence tells us there is--it would have to be for alleged violations incurred after the settlement.

The Oppenheimer attorneys are said to be zeroing in on the peripherals market, which seems logical since CDC is now the largest manufacturer of peripherals in the industry. Oppenheimer, incidentally, received more than $1.5 million in fees from CDC in 1973 and some of that presumably was for handling the settlement with IBM.

AI GROUP OBJECTS TO CONFERENCE IN RUSSIA

The Special Interest Group on Artificial Intelligence (SIGART) of the Association for Computing Machinery (ACM) feels very strongly that the fourth annual International Joint Conference on Artificial Intelligence should not be held in Tbliski, Soviet Union, as is currently scheduled. In fact, SIGART called selection of the Russian city "unsatisfactory and ill considered" in a resolution adopted during ACM '74 in San Diego last month, a resolution it has forwarded to Erik Sandewall, chairman of the IJCAI, scheduled for Sept. 1975. Jack Minker, University of Maryland, one of the first to object to the Russian site, said the reasons are threefold: logistical--it is expensive and hard to get to Tbliski; technological--there is very little research being done in artifical intelligence in Russia; and political--Russian internal treatment of their scientists. Minker would prefer either Japan or Boston as a site for the 1975 conference.

ACM TAKES A STAND

The council of the Association for Computing Machinery (ACM) last month took a limited stand on the use of universal identifiers, modifying somewhat a 1969 stand in which the entire ACM membership voted two to one against the association taking any position on social issues. That vote followed a request by some members that ACM take a stand against the Viet Nam war. The latest stand is a watered down version of a stand recommended by the ACM Committee on Computers and Public Policy against use of the Social Security Number as a universal identifier. As passed by the council by a vote of 22 to 1, the resolution states "concern over the absence of legislational safeguards

LOOK AHEAD

against misuse of universal identifiers including the Social Security Number and urges prompt generation and passage of such legislation."

Meanwhile, ACM's executive director, Joe Cunningham, says ACM doesn't lose 8,000 members a year as implied in this column (November, p. 130). The figure is more like 3,000. However, membership in the 29,000 member society's special interest groups rose by close to 8,000 last year. As a sign of the computer industry's maturity, Cunningham observed that the society now has identifiable data on loss of members due to death. He also said preliminary studies show that 3 to 6% of its members are over 50 years of age.

DP SALARIES: KEEPING UP WITH INFLATION

There was a time when programmers could hop from job to job at fantastic increases in income. Today they may have to hop around simply to keep up with living costs. A survey of data processing salaries shows, for example, that applications programmers' salaries within the last four years have gone up only about 20% while living costs have soared 30.3%. In that four year period only dp managers' salaries have kept pace, rising some 38%.

Weekly paychecks for all dp people differ by as much as $200, depending on geography. Transportation industries pay the highest and construction and service industries pay the lowest. The dp managers at construction and services companies could earn about $540 a week where their counterparts in transportation firms get $677.

Results of Datamation's second annual salary survey will be published in the January issue.

THEY BALANCE THEIR DIET AND SELL IT TOO

Karen E. Brothers and Louise L. Silver of Wayland, Mass. have done more than combine roles as mothers of young children and as businesswomen. They've merged the two efforts. Roommates when they attended MIT and both former programmers, the two formed Consultus three years ago "so we could stay home with our families and keep up with our work." At first they did only contract programming using a PDP-8 in the Brothers' home. More recently they did some manual research into nutrition in the interests of their families, learning what they could about amounts of calories, protein, carbohydrates, fats, sodium, vitamin A, vitamin C, thiamine, riboflavin, niacin, calcium and iron in given foods and, with specific recipes, comparing these to recommended daily allowances. Now they've parlayed this research into Consultus' first product, Recipe Nutrient Analysis, a computer-based nutritional evaluation system for recipes. They're offering the system either as a service or on a licensing basis to nursing homes, newspapers and any other institution or organization which publishes or uses recipes. The two Consultus principals are so excited by their first product that they are looking at others including a possible cost analysis system for supermarket products.

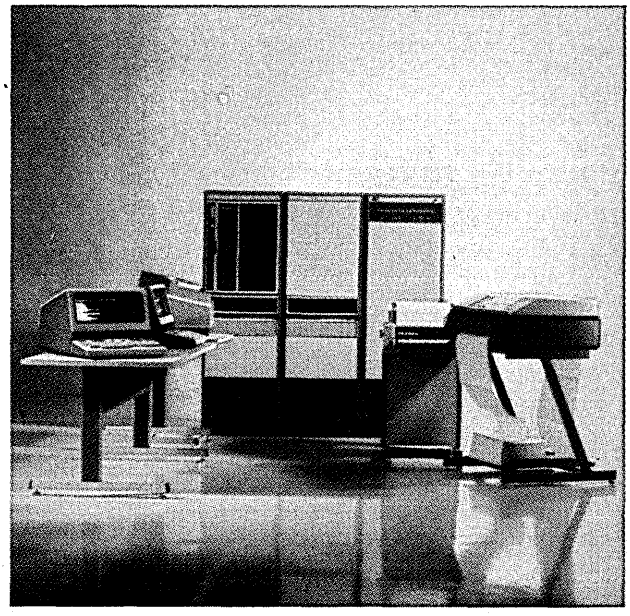
WHERE THEY'LL SEIZE AND NOT DESIST

If someone is doing your data processing or renting your equipment, protect yourself against his bankruptcy and the landlord's lien. This was underscored at the recent bust of Automated Business Systems, Inc., Memphis, Tenn.

The day of the bankruptcy, IBM came to cart out its 370/135 and Analysis & Programming Corp. was collecting tapes and materials that the Memphis firm was locally contracted to process. Down the hall came the landlord, owed back rent, and the IRS, owed back taxes, with liens against all ABS possessions. It took lawyers' fees and a court order for APC and IBM to reclaim what was rightfully theirs.

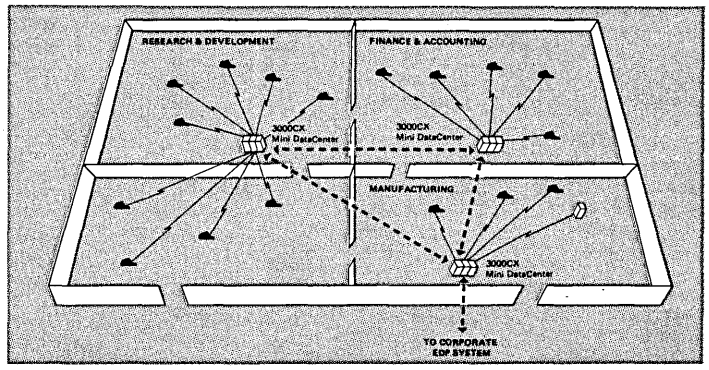
Other states are even tougher. One leasing firm has had its 360 tied up at a bankrupt customer's site in Albany for six months. Another lessor, Rockwood Computer Corp. protects itself by having landlords waive any right to attach Rockwood's machines in such cases. (Continued on page 138)

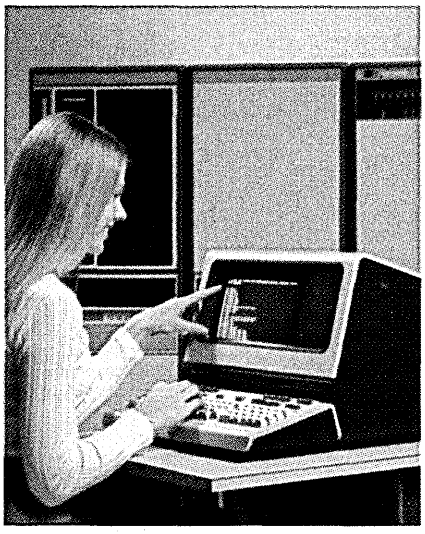
HP 3000CX Mini DataCenters



A big idea doesn't have to be big.

What's the big idea? HP 3000CX Mini DataCenters. Distributed power for your department, region or division. Power previously available only at your large EDP Center. Power you can afford.





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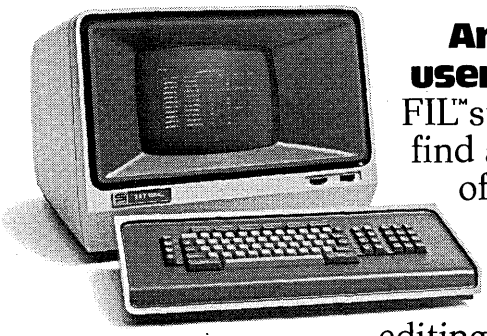

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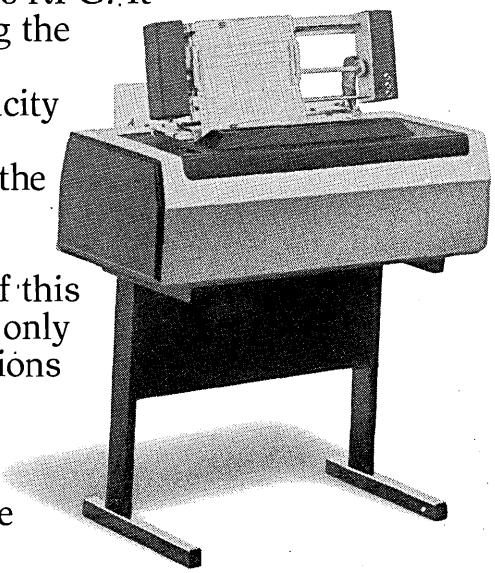

As a result, you can perform operations like capacity control, range checking, check digit verification, cursor control, arithmetics and many more. Before the data is sent to the CPU.

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letters

Standards by default

Regarding Mr. Gardner's article (Sept., pp. 115-117), let me first compliment him on a good job of getting the inside story with respect to IBM's policies but then criticize him for doing a lousy job on American National Standards. Having been a representative to X3 for several years and a member of working groups before that, I cannot concur with his inferences. While I have on infrequent occasions heard some representatives of IBM related groups bemoan the fact that it is pointless to vote contrary to the IBM position, it is not 100% sure (or even 99 $^{44}/_{100}$% sure) that the latter position has won the day.

In a corporation as conversant and aware of the times as IBM, it is not unlikely that the majority of times they will be found on the side of the ballot which prevailed, but that is not to say that IBM leads the way. On questions of technical substance, it is true that IBM has the resources to research and prepare a position. If that position is technically sound, why should not other ethical professional computer specialists concur and join to support that position?

What Mr. Gardner should really be complaining about is the fact that when a new standards requirement has been identified, it is often the case that IBM is the only company or group which is ready to offer a base for that development work. Unfortunately the majority of technical experts who accept the invitation to join a working group expect to be educated on the subject at hand as part of their committee duties. In that situation anyone who has done his homework and can deliver a substantial proposal will carry the day. Thus it is more often by the default of the non-IBMers that an IBM document becomes the basis for a standard.

JOHN A. N. LEE
Professor
Department of Computer Science
Virginia Polytechnic Institute
State University
Blacksburg, Virginia

Mr. Gardner replies: Professor Lee may disagree with us, but we thank him nonetheless for shedding additional light on the manner in which IBM sets de facto standards in the computer industry while others, without the resources to research and prepare positions in standards issues, remain virtually ineffective.

Breaking up IBM

There is one possible solution to the IBM problem ("The Breakup of IBM," Oct. p. 95) which has not surfaced to the best of my knowledge. IBM is deemed to be monopolistic because of its excessive market share. Breaking up IBM is quite complex and will have unforeseeable consequences which may be disastrous to the public as a whole, to IBM users, to the existing competitors, and to IBM employees. The solution I propose is simply this: *Control the growth of IBM to be less than the growth of the industry so that five to ten years from now IBM no longer has a monopolistic proportion of the industry.* For example, suppose the industry is growing at the rate of 15% per year and IBM has 70% of the market at present. If IBM were constrained to grow at no more than 10% per year, in five years the industry would double and IBM would have only a 56% market share. This would provide growth opportunities for the competition (probably as much as present and new competition could handle), and would keep IBM healthy.

We could let IBM judge how to control its growth. There are many ways. For example, it could control the number of salesmen it hires, or raise prices, or delay certain product replacements or new products. In any event, IBM (and not economics professors, antitrust lawyers and similar people unequipped for the task) would have the responsibility for picking the route which would best satisfy its survival needs.

THEODORE H. BONN
Newton Centre, Massachusetts

Our mistrake

One would have to assume that the typographical error of "mistrakes" was intentional, just to see how many letters might be sent in regarding com-

(Continued on page 165)

Public sector privacy

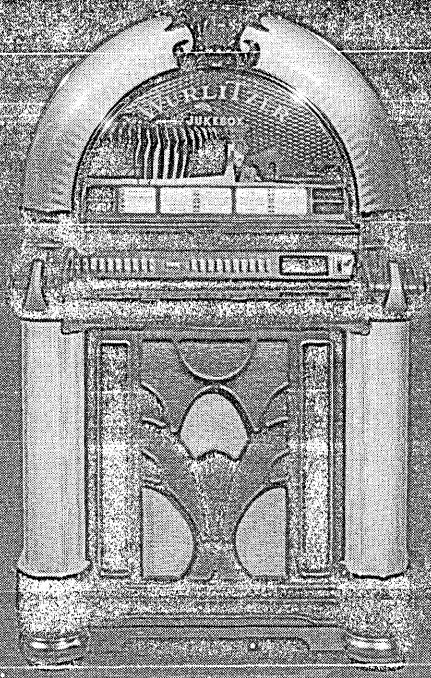
In the September issue of DATAMATION, Robert L. Patrick ("Proposed Law Threatens DP Users," p. 47) and Edith D. Myers ("Privacy Legislation: Public Sector First", pp. 130-1) properly call attention to the difficult task of developing comprehensive federal legislation, which will provide appropriate privacy safeguards for data in personal information systems. However, Mr. Patrick's comments are based on earlier drafts of pending legislation which have been superseded in both Houses of Congress by less comprehensive proposals.

As pointed out by Ms. Myers in her report on later Congressional developments, current versions of the bills are directed almost entirely to the record-keeping activities of Federal agencies. The Senate bill, SB 3418, reported by the Government Operations Committee on August 20, would affect the private sector in only three ways: (1) it would apply the requirements of the bill to contracts, grants or agreements with Federal agencies which have as their principal purpose the creation or substantial alteration of a system or file containing personal information; (2) it would require the Privacy Protection Commission, created by Title I of the legislation, to study the handling of personal data by non-Federal (including private) organizations; and (3) it would permit individuals to remove their names from mailing lists maintained by anyone engaged in interstate commerce. HR 16373, reported by the House Committee on Government Operations on September 24, deals only with personal data maintained by the Federal Government. It should also be noted that the Social Security number provision in the Senate bill has been deleted, and, in their present form, neither the House nor Senate bill requires a detailed record of *all* file accesses.

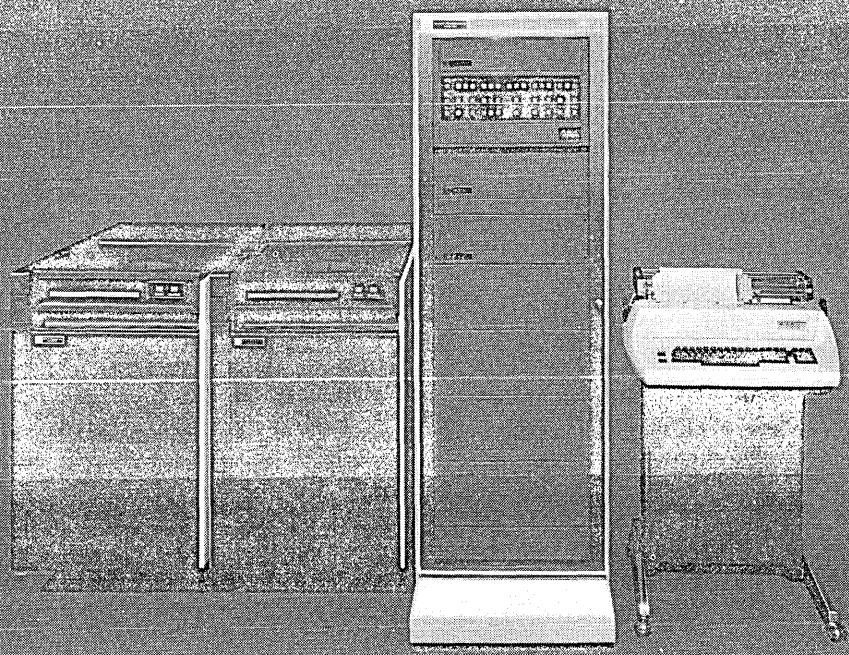
The Domestic Council Committee on the Right of Privacy is strongly in favor of confining initial legislation in this area to Federal agency record-keeping practices. Future Federal initiatives to encourage adequate privacy safeguards in other sectors of the society will require in-depth consideration of the views and experience of all who will be affected by such efforts. Hence, we endorse the suggestions of both authors that private organizations (and state and local governments) communicate their opinions and proposals for improved fair information practices to each other, the Congress, and the Domestic Council Committee.

DOUGLAS W. METZ
Acting Executive Director
Domestic Council Committee on
the Right of Privacy
Washington, D.C.

3 MINUTES-ONE DIME



60 MINUTES-ONE DIME



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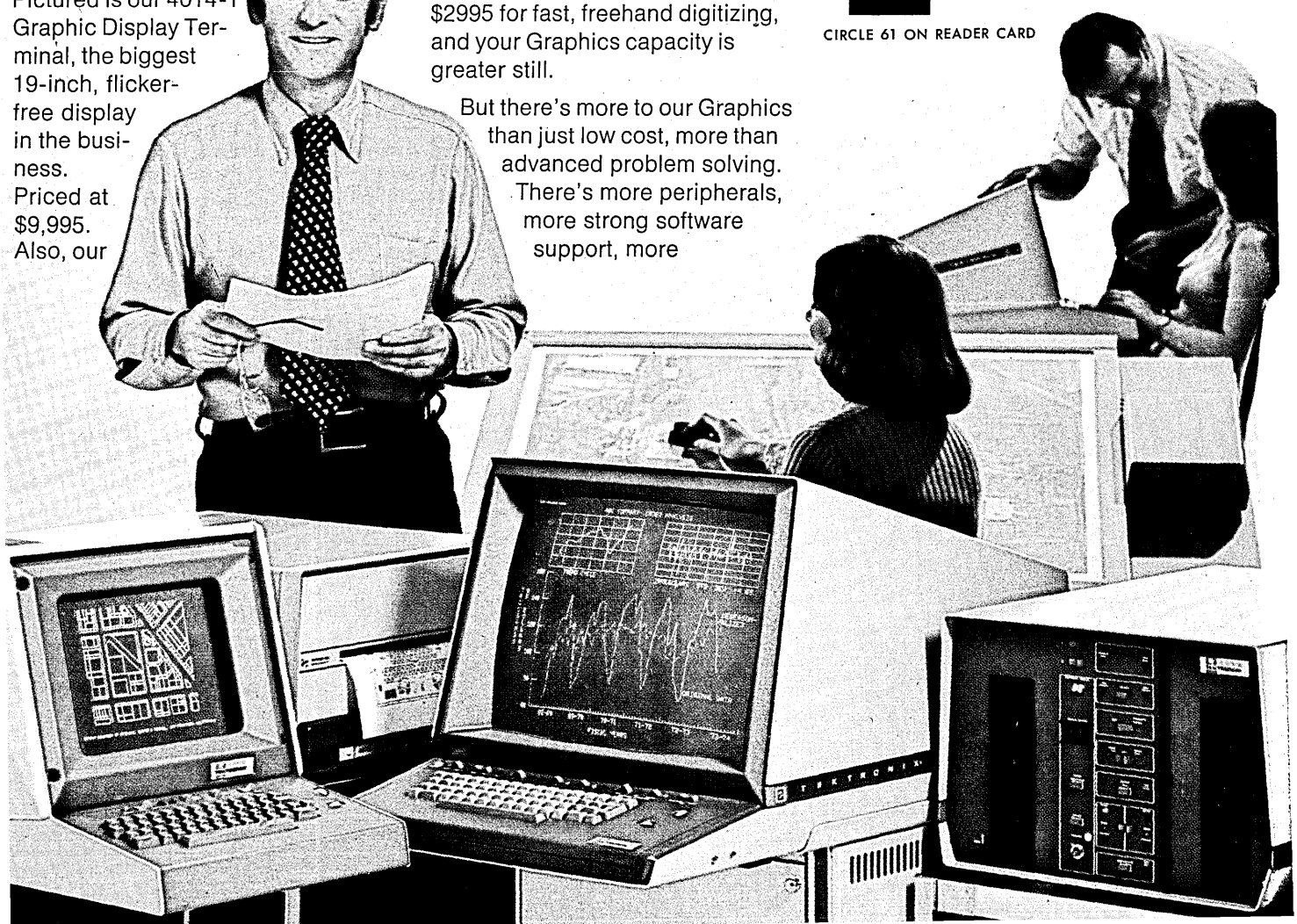


source data

SOURCE DATA provides information on books, courses, references, reports, periodicals, and vendor publications.

books

Managing a Programming Project

by Philip Metzger
Prentice-Hall, Inc., Englewood Cliffs, N.J., 1973
191 pp. $12.00

Meaningful books on software management are tough to write. Why this should be so is a separate discussion, but suffice it to say that one of the problems is keeping the discourse confined to a narrow area to avoid the "glittering generalities" type of discussion. Metzger chooses to limit his discussion of software management by positing the size of the programming development project to about 40 people—a good-sized project by any standard. A further gauge of a book is who can profit by reading it. For Metzger's book, the target audiences are: programming managers moving from small projects (say 8 to 10 programmers) to larger ones; managers experiencing a rough trip through a software project and trying to analyze what goes wrong; and as a refresher course for the rest of us who attempt to tell others how to develop software without excessive trauma.

Metzger sets out two important views: that software development can only succeed with good planning, and that a very formal discipline must be applied. The *degree* to which planning and formality are required may come as a "cultural shock" to managers who have been running smaller, ad hoc software projects.

In a section on the definition phase, Metzger outlines the twin objectives of problem analysis (what are we trying to do) and project planning (how shall we do it). Although the treatment of problem analysis is brief, as it must be without getting into specific applications, there is a good summary figure —the kind you ought to paste on your wall. One topic I would have stressed is the need to define clearly how the new system must interface with the company's current software systems and applications.

The project planning discussion is a mixed bag; Metzger should have concentrated on fewer subjects. The discussion of planning tools is a little fuzzy in spots (e.g., the discussion of activity networks); however the chapter begins a trend of providing good, long checklists of all factors bearing on key processes such as estimation. Since there's no substitute for experience in estimation, I think the author could have pointed out the need for asking for outside help here, or at least have provided references to established literature on the subject.

The design phase is probably the hardest to write about. Metzger, I think, does a good job in the first part in describing the design specification, although I disagree with his somewhat cavalier approach to "standards and conventions." The programmers' reference manual is, to my mind, a key and integral part of the design process. The discussion of design environment is not bad, but I would have preferred a more meaty discussion on designing an application within the confines of an operating system, or within control systems like CICS. This section could also have benefited from some of the more current work on software architecture. The design tools discussion is too miscellaneous and the reader would have been better served by covering fewer subjects well, such as coverage matrix, and then simply referencing others, like decision tables. The author winds up this discussion by correctly stressing the need in this phase for test planning, resource estimating, training, and documentation.

There is a good, if not original, discussion of the programming phase of a software project. I have only two comments on this chapter: Metzger doesn't really address himself to how the software architect's design is communicated to the programming group; on the other hand, he properly stresses the manager's job—the basics of communicating, assigning work, and buffering the workers from trivia. (He also has some good things to say about the "Staff Group" and its role.)

The next two phases, system test and acceptance test, are, as Metzger points out, the toughest to sell. Not that they are hard to understand; it is just that no one wants to pay the required tab to do the job right. The discussion in these two phases is rather brief, and some significant topics—the needs and problems of specifying generating "bonded" test tapes, methods of achieving strict configuration control, etc.—are slighted. Since this book isn't overly long, these are two phases which Metzger ought to consider beefing up for future revision. An additional phase, installation and operation, is also brief and rather sketchy.

Part II, which contains a very good, detailed project plan outline, is on special problems. Again the treatment may be brief but it is pertinent; there are some especially good words of warning in the section on customer controls. Configuration management and release control are topics usually omitted entirely, but his discussion is just too compact (unless you already know what it's all about). The biggest point of all—that software management is all about leading, inspiring, and controlling talented (and temperamental) people, he leaves to the very end, where perhaps we will all remember it.

In summary, I found myself more favorably disposed to Metzger's book as I dug into it. Perhaps the best way to state my opinion is to rate it on my personal four-point scale: (1) I'd buy it for myself; (2) I'd recommend the company buy it; (3) I'd copy a relevant chapter or two; (4) I'd forget it. Because the book is on target for the defined primary audience and is a good reference for those of us in the software development trenches, I recommend buying it.

—J. Patrick Haverty

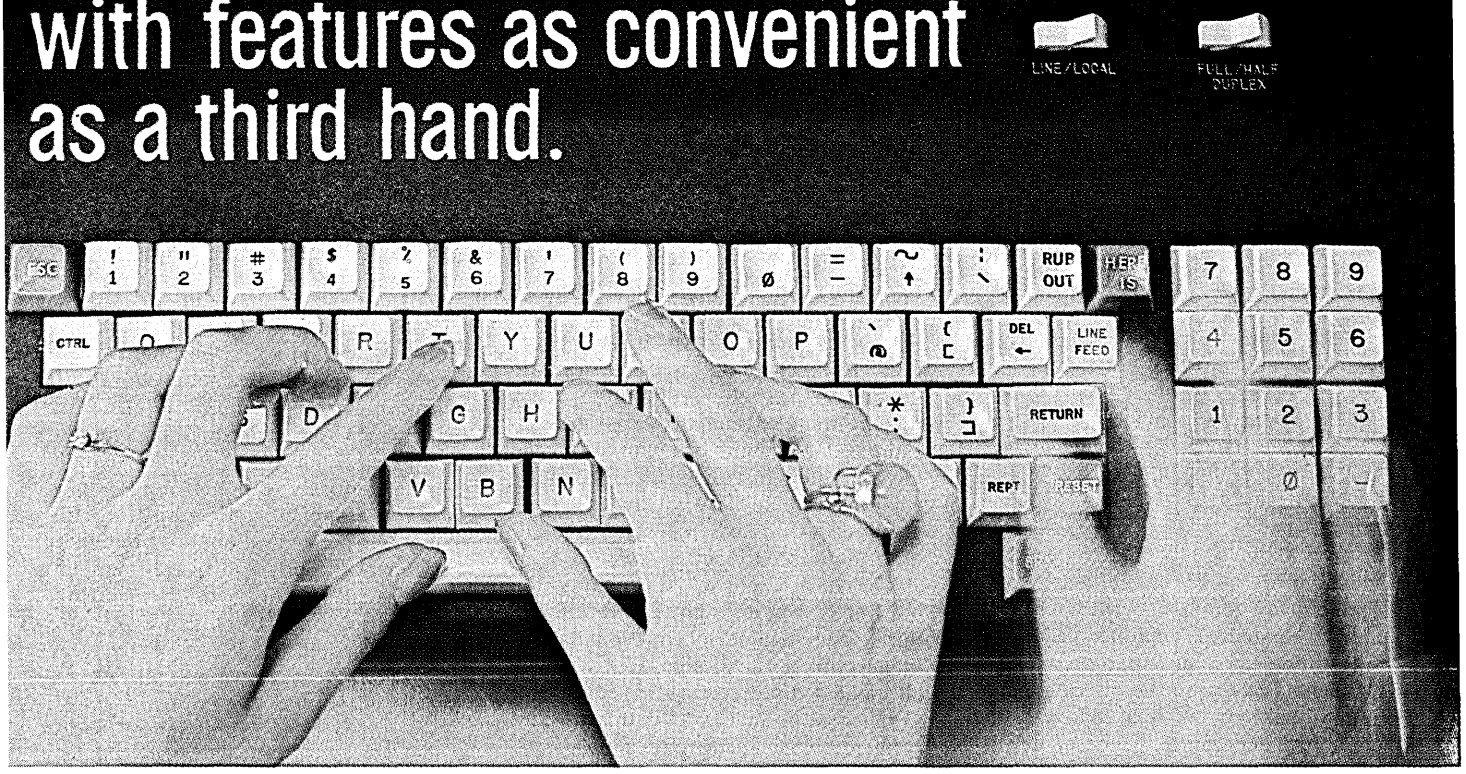
Computers and Management in a Changing Society

by Donald H. Sanders
McGraw-Hill, N.Y., 2nd ed., 1974
592 pp. $9.95

Business school textbooks on management and data processing continue to improve. This second edition by Prof. Sanders has an interesting format for each chapter: a discussion of a particular subject area, (e.g. planning for computers), some selected readings on the subject, an actual case history, and a brief summary. Of the eight chapters, four I would rate "good," one is a "ho-hum," and three are "poor." There are 29 readings—three I put in the "must read" category (4, 13, 15), nine are "good," nine are "mediocre," and eight "poor." In the seven case histories: two are "must read" (C, E), four are "good," and one is "off the mark." In my experience, that is a pretty good overall score for a potpourri-type book.

Sanders lists four uses for the book: 1) for introductory data processing courses (I disagree); 2) for basic man-

A low-cost time-share terminal with features as convenient as a third hand.



Choosing a low-cost terminal for time-share or mini-computer applications has often meant giving up a few nice-to-have features in the process.

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The new W1620 interactive CRT terminal is as easy to use as a typewriter. Same type of keyboard. Same typing technique. With a video screen instead of paper.

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(Characters shown actual size.)

It's also versatile.

A full 24 lines of 80 characters can be displayed, compared with 12 lines in many low-priced terminals.

7 switchable data rates from 110 to 2400 baud – not 2 as offered by others.

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Half/Full Duplex Switch and Parity Select Switches to match computer usage.

Simple form filling under computer assisted instruction.

Two peripheral ports for on/off line operation with a character printer, cassette recorder or both at speeds to 2400 baud.

What else?

Easily cleaned anti-glare screen. Single logic board for greater reliability and low-cost ease of maintenance.

You can also order the W1620 with an upper/lower case display and a composite video output for slave display.

For more information contact:
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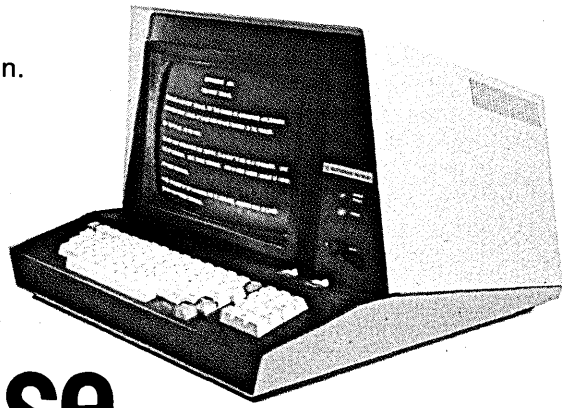
Westinghouse Canada Limited,
P.O. Box 510, Hamilton,
Canada L8N 3K2 (Tel. 416-528-8811).

Sales Representatives:
Information Display Products

Advanced Techniques, 3848 E. Colorado Blvd., Pasadena, CA 91107 (Tel. 213-681-1093).

The Exchange Telegraph Company Limited, 73-75 Scrutton St., London, England EC2A 4TA (Tel. 01-739-2041).



Westinghouse helps make it happen

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agement courses (yes); 3) for introductory systems analysis courses (probably too elementary); and 4) for practicing managers (yes). I believe its best use is as a good supplemental, not primary, textbook for the business school's basic courses in management. It would be a useful addition to a company library; however, I would not recommend it for personal purchase.

—J. Patrick Haverty

Mr. Haverty is director of software systems in the Defense and Space Div. of System Development Corp. He has been in data processing 22 years and was one of the original developers of the SAGE air defense system.

reports & references

Computers in Japan

A 42-page statistics-filled book provides a snapshot glance at various segments of the Japanese industry. It's called *Progress of Computer Industry in Japan,* and it looks at the census of installations through the end of 1973, facts on the user community, and historical development leading to the latest families of mainframes. There's market data on peripherals and service firms, and projections on the use of data communications and on-line systems. The study, made jointly with The Most & More Inc., a research firm in Tokyo, is priced at $8 plus postage ($2 by air mail, 50¢ by sea). JAPAN ELECTRONIC COMPUTER CO., LTD., Research Dept., New Kokusai Bldg., 4-1 Marunouchi 3-Chome; Chiyoda-ku, Tokyo 100, Japan.

User Surveys

Datapro continues its *All About . . .* series with three new reports. *All About Communication Processors,* a 30-page reprint from the Oct. *Datapro 70* supplement, reports a survey of 208 users' experience with 329 communication processors. In general, the report concludes, users are happy with the equipment but less so with the associated software and technical support. Comparison charts of characteristics of 79 current processors and controllers, as well as user ratings, are detailed.

All About Digital Plotters, a 23-page report, presents specifications of 54 currently available plotters from 19 companies. A total of 93 users were generally well satisfied with the accuracy and overall performance of 112 of these devices, but had reservations about their speed and the associated software and technical support.

A high level of satisfaction is reported in the 18-page *All About Voice Response.* A small number of users, 33, who however handle over 250,000 calls each day from more than 22,000 terminals, rated such voice response equipment as IBM, Periphonics, and Wavetek.

The price for each report is $10. DATAPRO RESEARCH CORP., 1805 Underwood Blvd., Delran, N.J. 08075.

Research Reports

Some very useful documents and reports on federally funded research in several areas of data processing are summarized in the NTIS *Weekly Government Abstracts: Computers, Control & Information Theory.* These reasonably priced government publications report on research carried out at such places as Rand Corp., Los Alamos Scientific Lab., and numerous universities. Recent reports are *Guidelines for the Acquisition of Software Packages* by Bennet P. Leintz (AD-782 477/4WC $3.00); *Minicomputers: A Review of Current Technology, Systems, and Applications* by Dennis Hollingworth (AD-783 316/3WC $4.50); *Computers in the 1980s—Trends in Hardware Technology* by Rein Turn (AD-783 323/9WC $3.00), and *Computers and Human Problems* by H. Sackman (AD-787 318/9WC $4.75). NATIONAL TECHNICAL INFORMATION SERVICE, U. S. Dept. of Commerce, 5285 Port Royal Road, Springfield, Va., 22161.

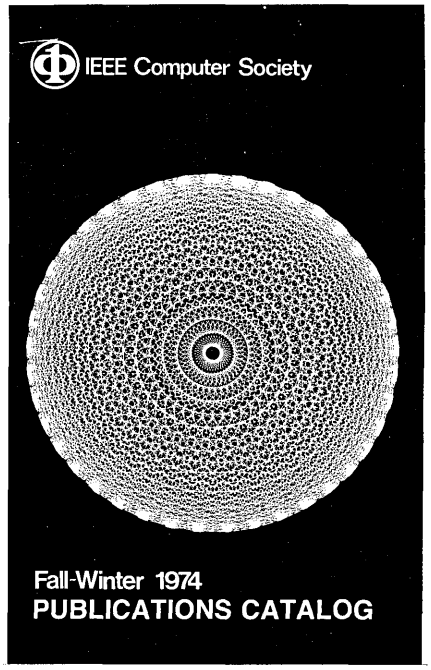
Computer Networking

A Technical Guide to Computer-Communications Interface Standards, a 111-page handbook, presents information on existing and forthcoming Federal and National standards on data communications pertinent to computer networking. Its purpose is to aid system designers interested in uniform data terminal interfaces, character sets and codes, keyboard arrangements, and communications line disciplines for effective message exchange between computers. This report (SD Cat. No. C13.46:843) is priced at $1.50. Superintendent of Documents, U. S. GOVERNMENT PRINTING OFFICE, Washington, D. C. 20402.

vendor literature

IEEE Catalog

The full line of computer technology books available from the IEEE Computer Society is listed in its Fall-Winter 16-page catalog. Included are topic outlines covered in Compcon Digests,



selected IEEE Press books, and proceedings of symposia such as DataComm, Fault Tolerant Computing, and Switching and Automata Theory. IEEE COMPUTER SOCIETY, Long Beach, Calif.

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Paper Shortage

A 12-page brochure, *The Paper Shortage. It's Real. It's Here,* suggests ways to save paper. The causes of the paper shortage, business' increasing consumption of the product, and rising costs are discussed. Included are tips on how to reduce the volume, waste, and cost of paperwork, such as reducing the size of office forms, and "duplexing"—using both sides of a sheet of paper. Multigraphics Div., ADDRESSOGRAPH MULTIGRAPH CORP., Mount Prospect, Ill.

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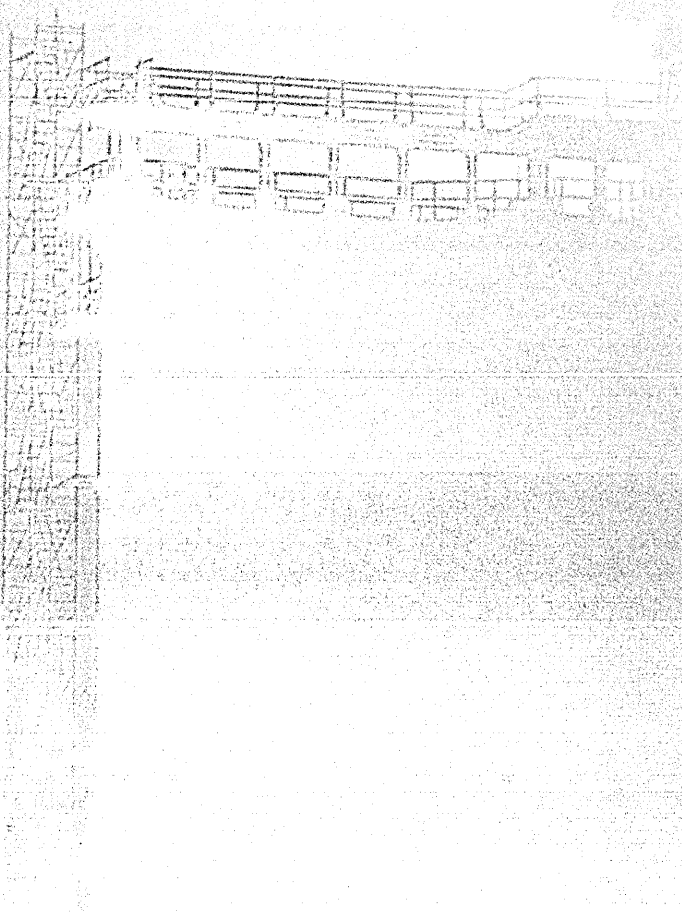
Scheduling Aids

To keep down the cost of idle computer time, more than 30 different kits for scheduling computers in various

"We're growing. Our active account files are growing. Can you help us find a better way to handle the volume?"



Ask us

By now, you know what microfilming can do for your routine procedures. But with growth comes the need for more advanced, more sophisticated forms of information retrieval with microfilm. For example:

A leading financial institution was running into unacceptable delays referencing credit card applications. We showed them how to find them in seconds on microfilm. And cut their costs by more than 20%.

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What you're saving now with microfilm is only the beginning.

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For small systems we offer our new Diablo Series 10 (Model 12) dual removable diskette drive. It provides the same design, engineering and manufacturing integrity that have made Diablo disk drives the recognized industry standard for reliability and quality. Model 12 provides 6.2 megabit capacity in a very compact dual drive. With copy capability, a cost efficient design, IBM 3740 compatibility and new ceramic/ferrite heads for longer life, Diablo Series 10 is competitive in any system application. For complete technical presentation, write Diablo Systems Incorporated, 24500 Industrial Blvd., Hayward, California 94545, or Diablo Systems, S.A., Avenue de Fre, 268, 1180 Brussels, Belgium.

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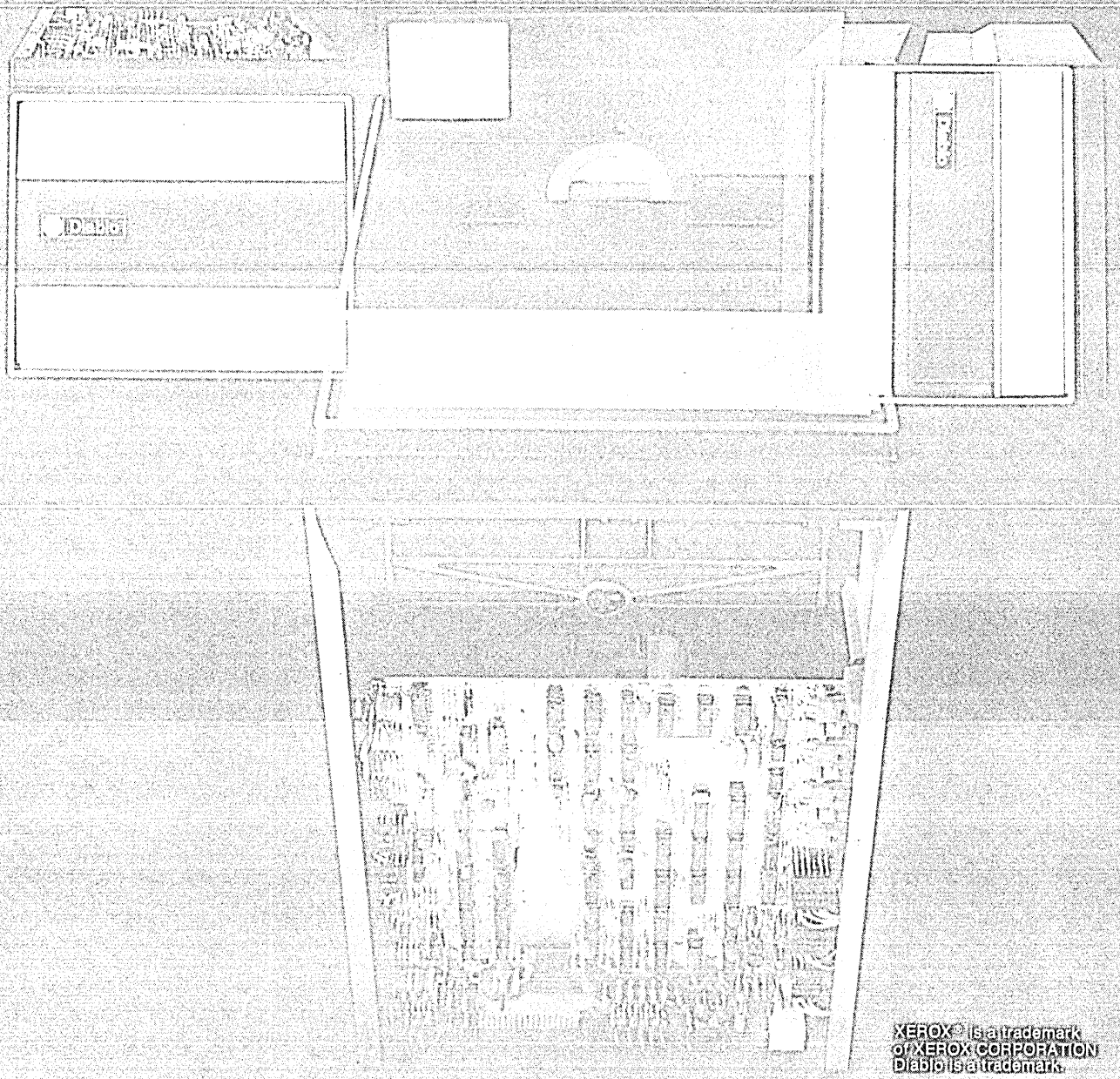

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time increments have been designed by Edward Ochman Systems, and are described in its catalog. Computer time scheduling aids are also described which schedule more than one computer, or which schedule for multiprocessing systems. The company claims to have virtually eliminated typing or writing in its systems, and this therefore is the key to its systems' success. EDWARD OCHMAN SYSTEMS, Fairfield, Conn.

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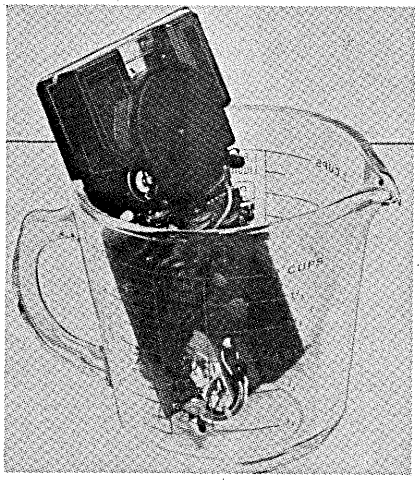
Subminiature Cartridge

This vendor provides complete operating performance and physical data for a digital data storage system using an endless-loop cartridge the size of a matchbook, in a four-page brochure. Besides the small size and flexibility of



packaging, other features such as low power consumption, logic interfaces, storage density and tape speed control, are discussed. MICRO COMMUNICATIONS CORP., Waltham, Mass.

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Hybrid Computers

Challenges, a 16-page brochure, describes this vendor's Pacer hybrid computers as solvers of complex scientific and engineering problems. Applications to solution of dynamic design problems in chemical processing, aerospace, instrumentation and control systems, mechanical design, and other disciplines are discussed. ELECTRONIC ASSOCIATES, INC., West Long Branch, N.J.

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New Computers

The recently introduced Cal Data 1 family of DEC-compatible computers is described in a four-page bulletin, which contains a general description, a photograph, and a list of features, plus a line drawing illustrating the emulation capability of the series. The computers are high-speed microprogrammed devices designed for a wide variety of computing and control applications. CALIFORNIA DATA PROCESSORS, Santa Ana, Calif.

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Oem Line

A comprehensive rundown of this vendor's complete line of oem products is presented in a new pamphlet. Details on 13 products, including I/O typewriters, alphanumeric strip printers, digital printers and tape punches, readers and cassette units, are supplied. Each product is described concisely and with photographs. FACIT-ADDO, INC., Secaucus, N.J.

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courses

Systems & Procedures

Described by the AMA as the definitive refresher course for senior systems executives, this four-day senior systems and procedures course will help keep managers and analysts abreast of the latest thinking in management system technology. Topics discussed will include when *to* and when *not to* use the computer, centralized vs. decentralized operations, how to choose a consultant, and barriers to systems improvement. The course will be held in Atlanta (Jan. 6-9), New York (Mar. 24-27), and San Francisco (Apr. 14-17). Price: $495 to AMA members; $570 to nonmembers (team fees are less). AMERICAN MANAGEMENT ASSNS., 135 W. 50th St., New York, N.Y. 10020.

Information Systems

A series of 14 half-day seminars, each seminar addressing one of the 14 courses of the ACM Curriculum on Information Systems, is scheduled for January through April 1975. Some topics covered are: information structures, modeling and operations analysis, software design, organizational functions, and systems design. These seminars will be held in five cities: Dallas, College Park, Md., Minneapolis, Baltimore, and Chicago. Fee: $195. INSTITUTE FOR SCIENCE AND PUBLIC AFFAIRS, 501 Slaters Lane, # 203, Alexandria, Va. 22314.

periodicals

Engineering Optimization

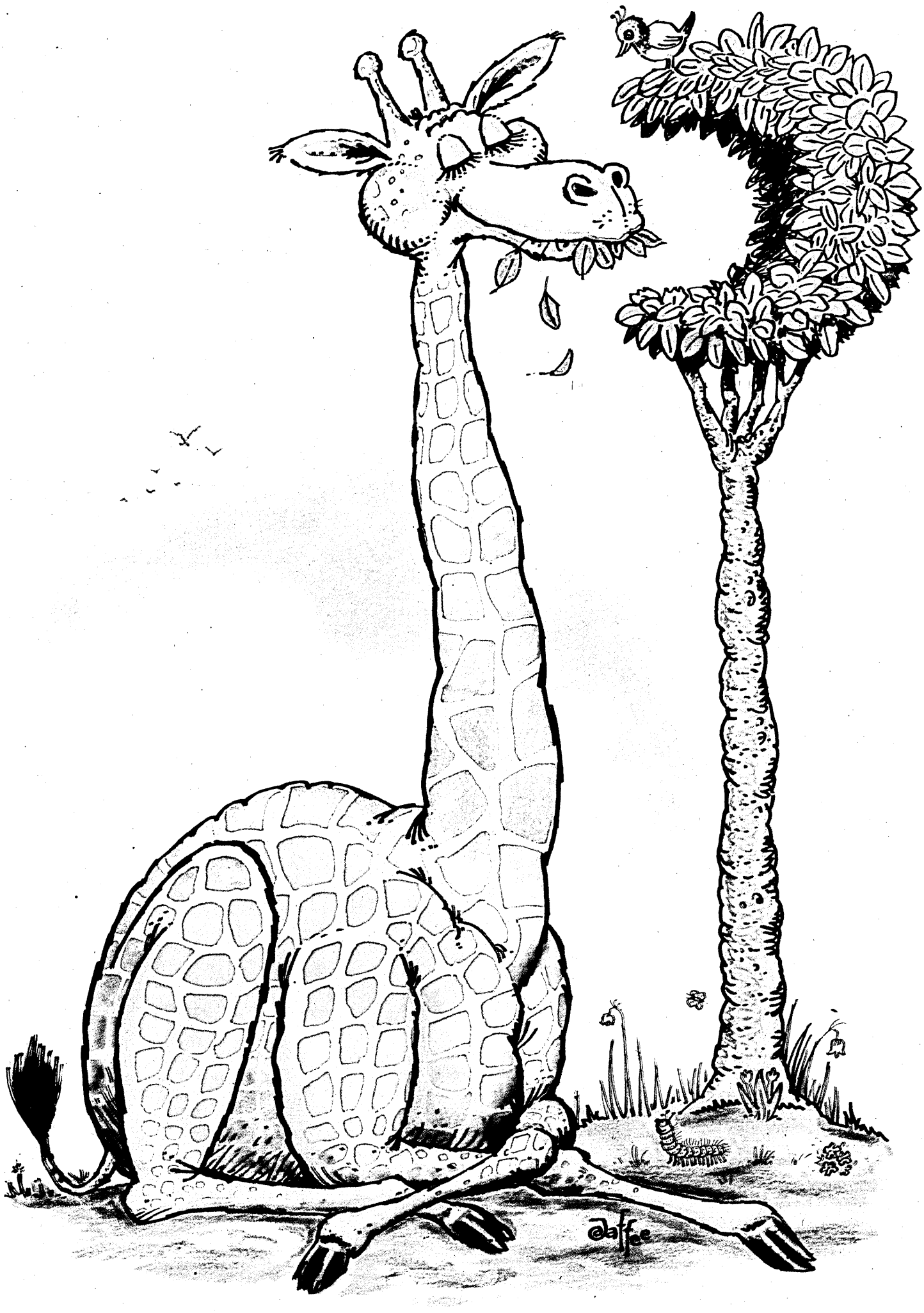
In recognition that engineering planning and design is an optimum-seeking process, a new quarterly journal, *Engineering Optimization,* has been founded. Not limited to formal mathematical optimization techniques, but also covering heuristic, intuitive, and statistical techniques, the journal, edited by A. B. Templeman of the Univ. of Liverpool, concentrates more on the applications of such techniques in papers, many of which are computer oriented. Original papers cover optimization applications in aerospace, mechanical, civil and structural engineering, including building and architectural design; the quarterly therefore fills a need for an interdisciplinary engineering journal on optimization techniques. Subscription rate: $15.50 for individuals; $52.00, institutions. GORDON AND BREACH, One Park Ave., New York, N.Y. 10016.

New Logic

"When the history of digital electronics is written, 1974 will be remembered as the year of the microprocessor explosion." So begins the first issue of *New Logic Notebook,* a new monthly devoted to helping engineers and product designers understand and apply "New Logic." This issue is a "microprocessor scorecard," given over entirely to the selection and evaluation of microprocessors. A wallchart summary of all processors available (more than 25) and a compendium of processor features are presented. Future issues will feature tutorials and practical examples on the use of programmed logic arrays, PL/M vs. assembly language, and calculator chips. One year subscription (12 issues): $95. MICROCOMPUTER TECHNIQUE, INC., 11227 Handlebar Road, Reston, Va. 22091.

Mathematical Software

A new ACM quarterly, *ACM Transactions on Mathematical Software (TOMS),* is scheduled for March 1975. TOMS will publish papers in the area of fundamental mathematical algorithms and associated software. Emphasis will be primarily on applications and on the utilitarian values of programs. The Algorithm section of *Communications of the ACM* will be phased into TOMS. John R. Price of Purdue Univ. is editor-in-chief. ASSOCIATION FOR COMPUTING MACHINERY, TOMS Order Dept., 1133 Ave. of the Americas, New York, N.Y. 10036. □



Relax...

System 1303 takes the hassle out of data entry.

Need to speed throughput? Cut down errors? Reduce corrections? The Inforex System 1303 is your answer... the key-to-disc system with processing power at the point of data entry.

Automatic functions assume much of the responsibility for first-time accuracy to reduce costly data validation and correction.

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Fewer keystroke requirements mean faster input.

Level-to-Level Duplication, automatically duplicates information from one record level into the next record with the same program control level... saves operators from rekeying the same field over and over again during data entry ...reduces the potential for errors, too.

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Simple to learn, easy to use — for a more productive operation.

Operators become fully productive in just a few days. The System 1303 comes with a *CRT Display* for system status messages and fill-in-the-blank prompting, plus the quiet, solid state, standard data entry *Keyboard* for noiseless operation.

And you get more than just data entry, too.

The BISYNC feature provides communications for local or remote locations, to and from IBM 360/370 computers, or other compatible BISYNC devices, at speeds to 9600 bits per second. Plus *Serial* or *Line Printers* for hard copy output. For System back-up, the *Keystation Channel Switch* allows keystation switching between control units for easier job distribution and greater uptime. And Inforex maintains sales, field service, and training personnel in major cities throughout the United States, Canada, and Europe. Distributors worldwide.

Inforex key-to-disc Systems. Already reliability-proven in installations around the world. No wonder our systems are head and shoulders above the rest. Contact our nearest office for more information. Inforex, Inc., 21 North Avenue, Burlington, Mass. 01803.

INFOREX

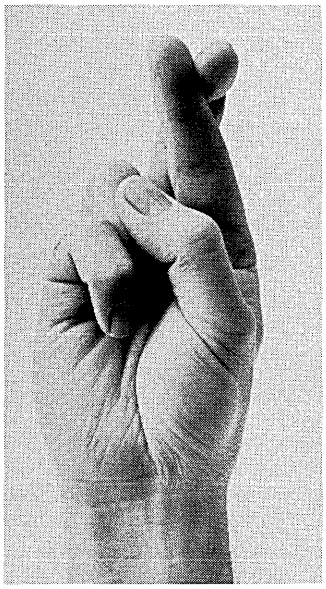
CIRCLE 34 ON READER CARD

Congratulations: you didn't have a computer fire again last year.

You're one of the lucky ones.

Unfortunately too many companies last year did suffer major business interruptions due to fires in or near their computer rooms.

What's even more unfortunate is the fact that a lot of the damage, clean-up and downtime could have been avoided.



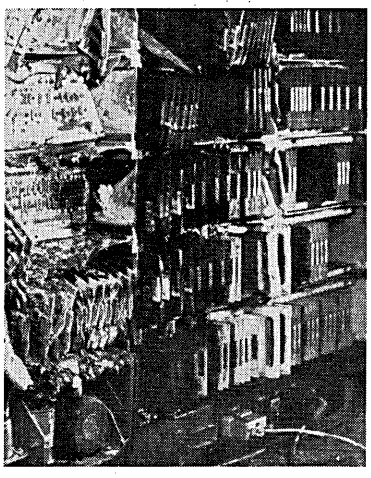
Days of Downtime vs. a Few Seconds of Halon

These companies could have been protected by a high speed Fenwal Halon Fire Suppression System.

The system that snuffs out fires dry. Just seconds after they start.

And lets you get right back to work. No wet mess to clean up.

With some systems you've got to evacuate a room before the extinguishing agent can go to work.



But because Halon 1301 is harmless to people, it can start snuffing out the flames immediately. Which gives you the fastest jump on the fire.

With ordinary systems there's usually at least 48 hours of clean-up before your computer can go back on line.

With a Fenwal system there's virtually no clean-up, no shorted-out wires. No electrical shock hazards. No damage to tapes or records.

Fenwal's unique, modular system permits rapid agent discharge and easy extension of existing systems.

Why Push Your Luck?

The consequences of a computer fire are a lot more devastating than you might think. Despite all the precautions you take.

At Fenwal we've got documented proof that our Halon Fire Suppression Systems are *the* solution to the damage and downtime of computer room fires.

It's proof you can see for yourself. In a film called "The Fireaters".

We think it will convince you that you need more than luck to keep your computer in business.

To arrange a viewing, call us at (617) 881-2000. Or write to Fenwal Incorporated, Ashland, MA 01721. A Division of Walter Kidde & Co., Inc. Our local, service-oriented distributors are listed in the yellow pages under "Fire Protection".

FENWAL

Nobody in the world has more experience in fire and explosion suppression systems.

FM Approved – UL Listed

Mixed vendor systems are bread and butter to a good service company.

We're good. And we're hungry.

We're in the single-source computer service business. That means we're in the mixed vendor system service business. We like it that way. But it means working with different combinations...a lot of System 360 and 370 mainframes and a long list of plug-compatible hardware. That's why we've built a world-wide staff of experienced service pros — ones who already *know* 360 and 370 service and maintenance and know how to handle other mainframes and peripherals as well.

When you service mixed vendor system customers, your performance *has* to be the best in the business — in technical quality, response time, price. Ours is. That's why a leading steel company, a large government agency, many international airlines, as well as 26 other companies are customers of RSC.

If you have a mix 'n' match system and if you're really looking for hassle-free service, look into Raytheon Service. Because good service is our bread and butter. And we're hungry. For the full story, call Mike Salter, Commercial Marketing Manager at Raytheon Service Company, 12 Second Avenue, Burlington, Mass. 01803. (617) 272-9300.

RAYTHEON

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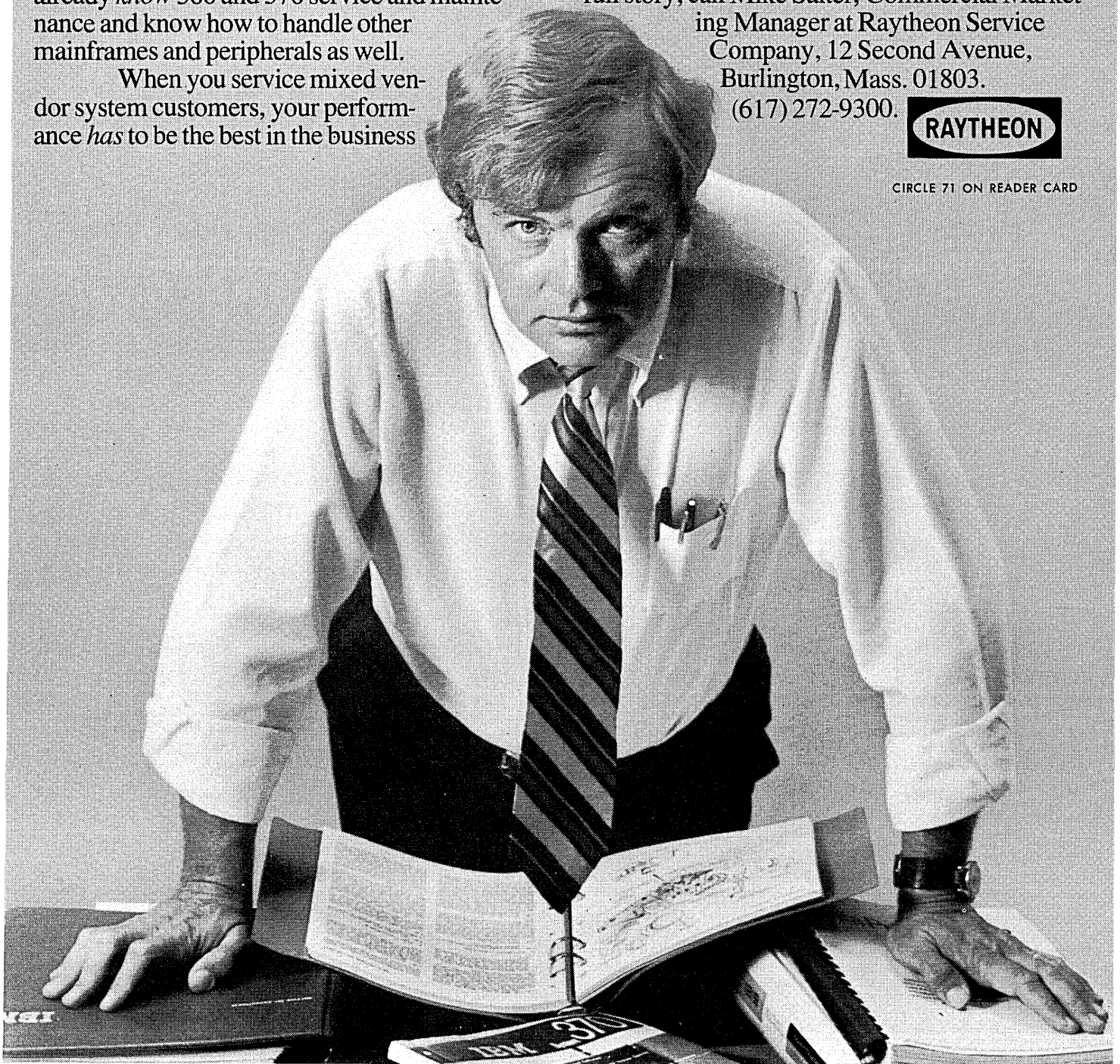
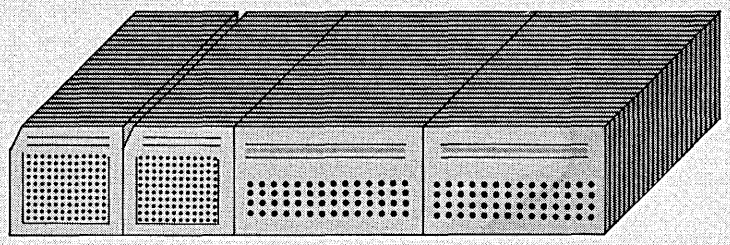
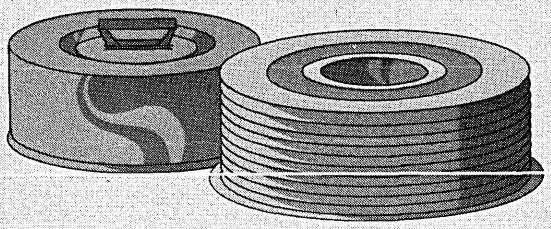


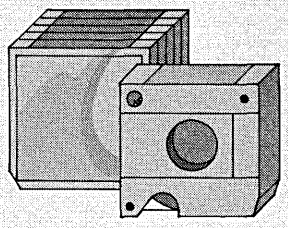
Tab makes one storage cabinet for cards,



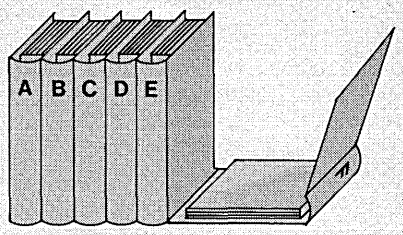
one for disks,



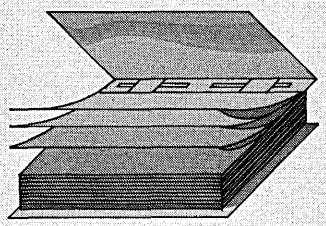
one for microform,



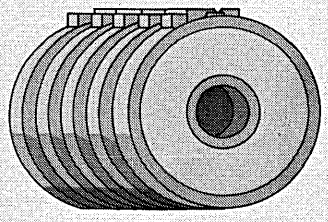
one for binders,

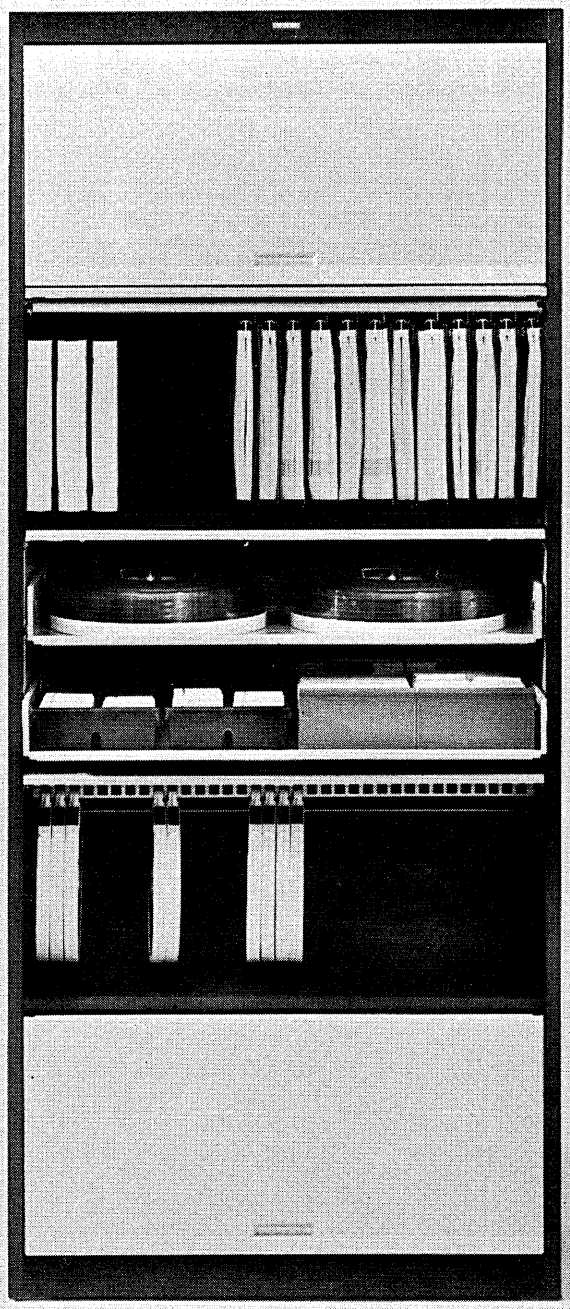


one for printouts,



and one for tapes.





This one.

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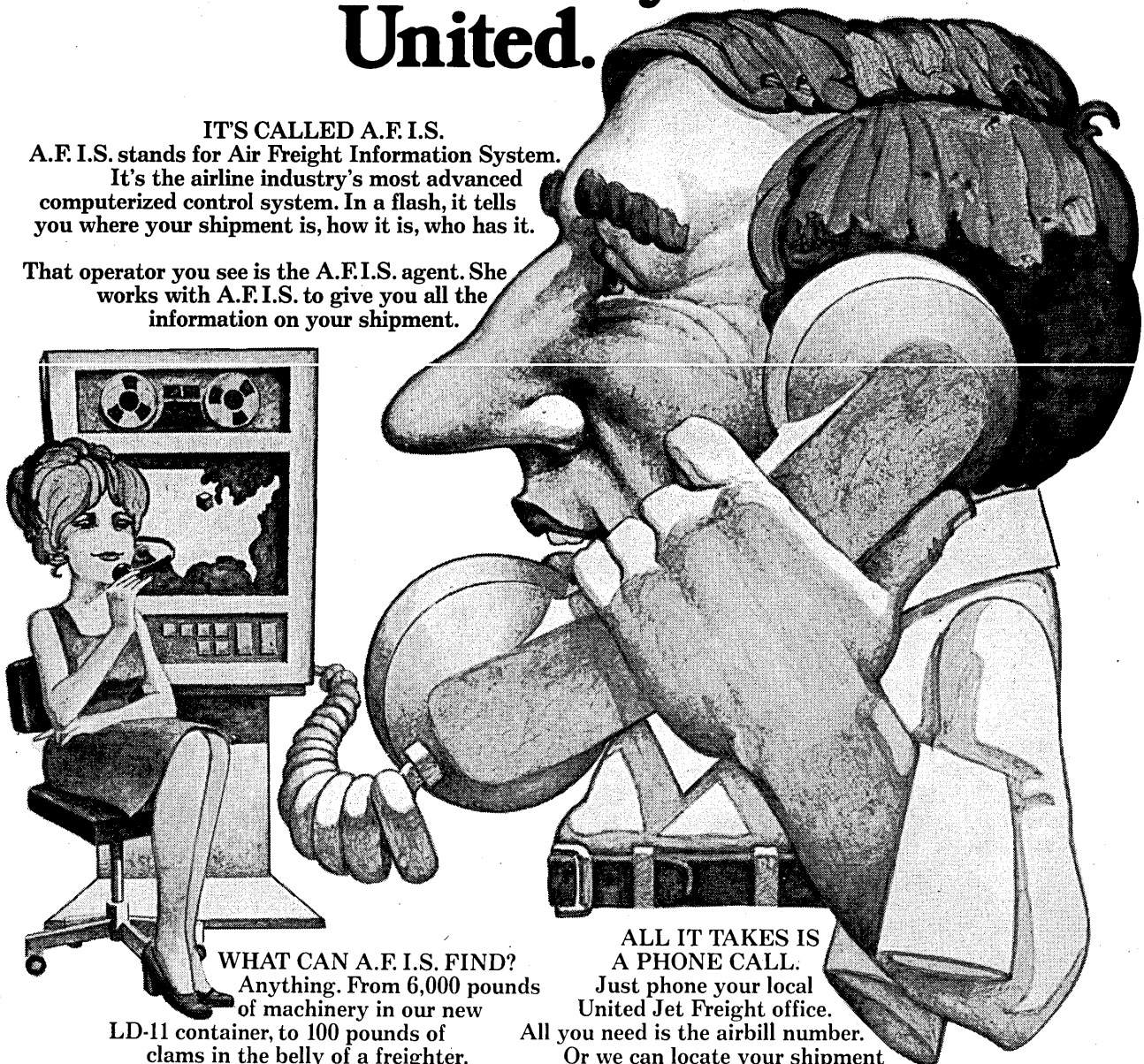

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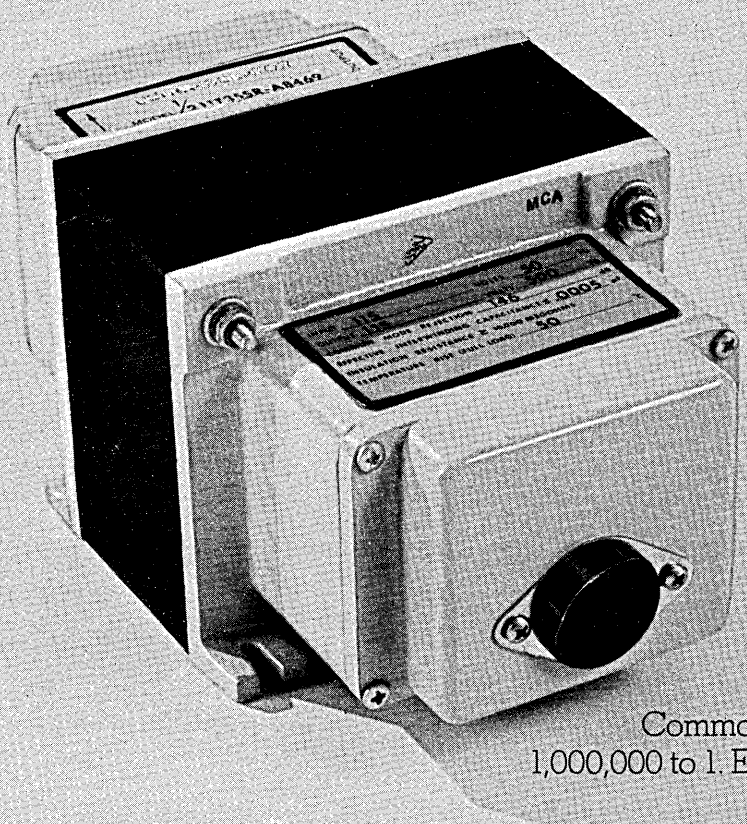

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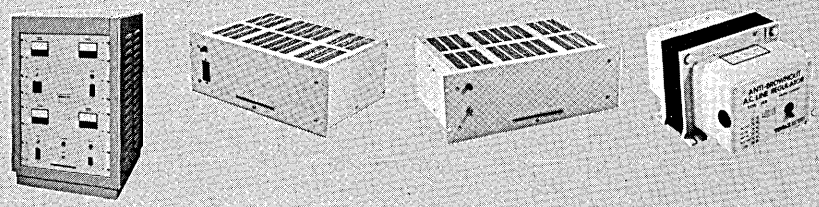

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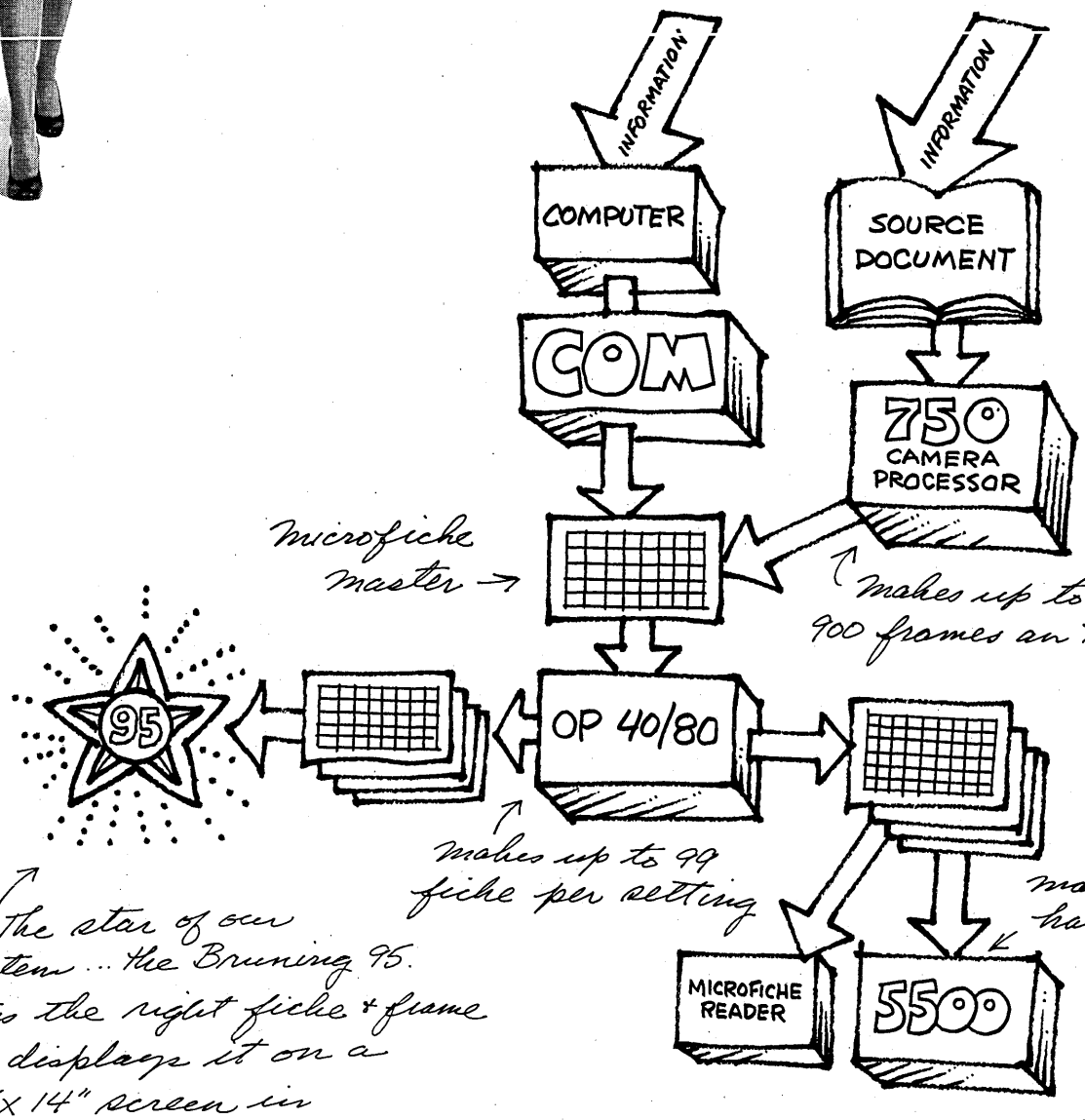

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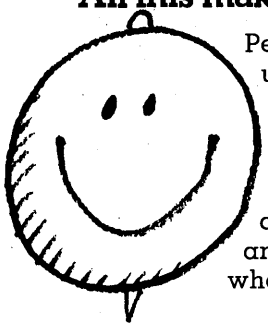

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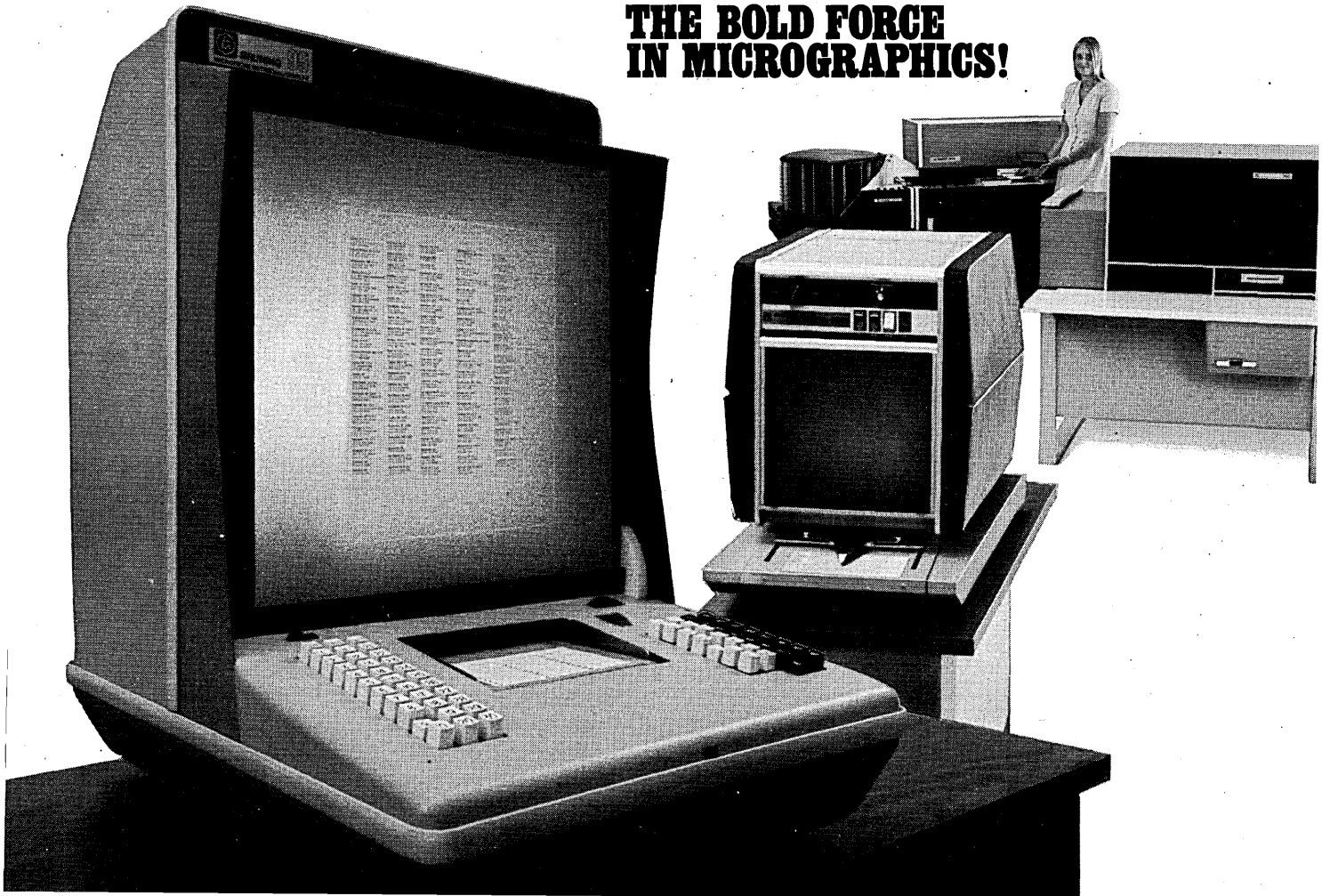
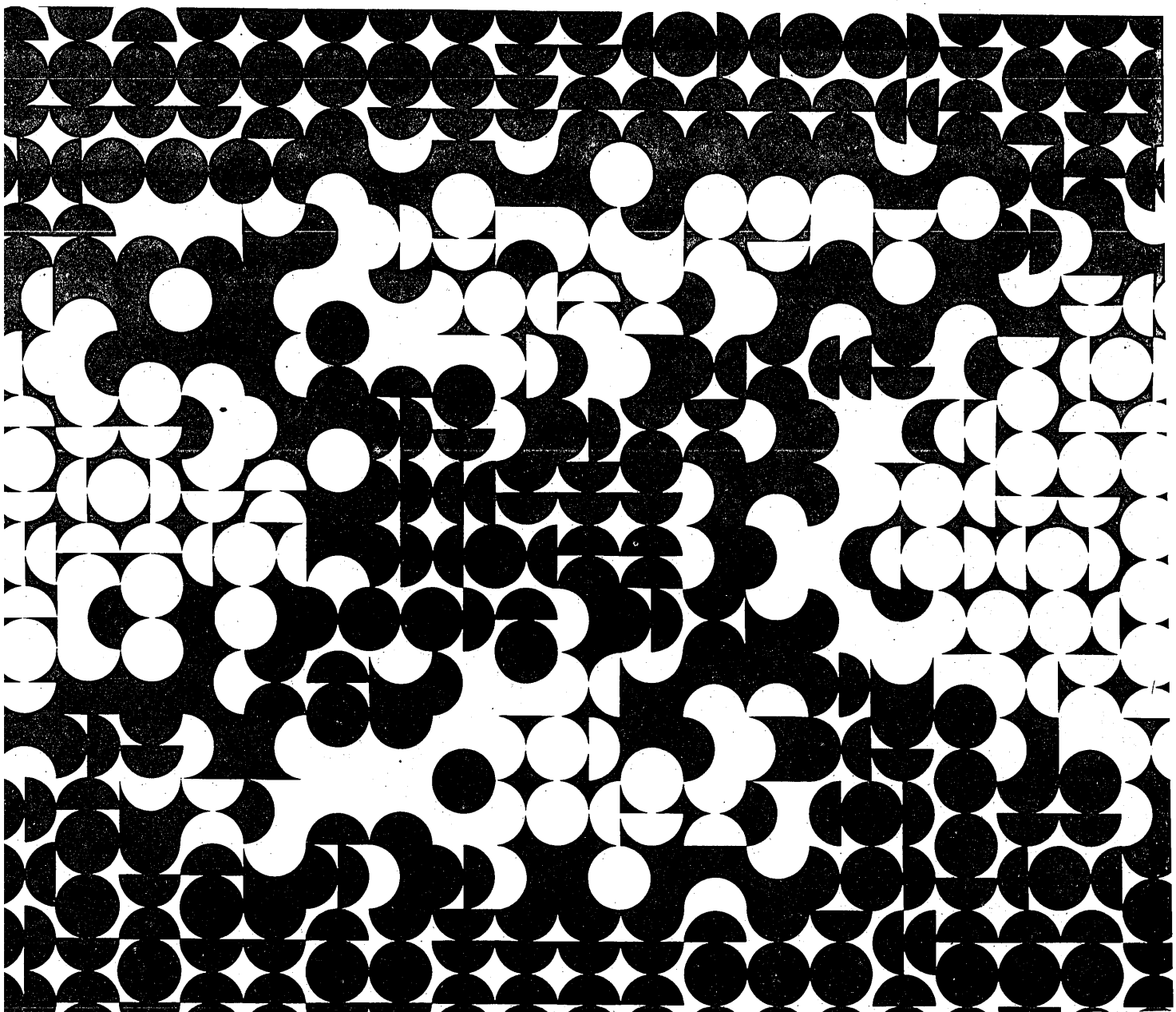


How does a project get to be a year late? . . . One day at a time

by Frederick P. Brooks, Jr.



THE MYTHICAL MAN-MONTH

Dr. Brooks was part of the management team charged with developing the hardware for the IBM 360 system. In 1964 he became the manager of the Operating System/360 project; this trial by fire convinced him that managing a large software project is more like managing any other large undertaking than programmers believe and less like it than professional managers expect.

About his OS/360 project, he says: "Managing OS/360 development was a very educational experience, albeit a very frustrating one. The team, including F. M. Trapnell who succeeded me as manager, has much to be proud of. The system contains many excellences in design and execution, and it has been successful in achieving widespread use. Certain ideas, most noticeably device-independent input/output and external library management, were technical innovations now widely copied. It is now quite reliable, reasonably efficient, and very versatile.

The effort cannot be called wholly successful, however. Any OS/360 user is quickly aware of how much better it should be. The flaws in design and execution pervade especially the control program, as distinguished from language compilers. Most of the flaws date from the 1964-1965 design period and hence must be laid to my charge. Furthermore, the product was late, it took more memory than planned, the costs were several times the estimate, and it did not perform very well until several releases after the first."

Analyzing the OS/360 experiences for management and technical lessons, Dr. Brooks put his thoughts into book form. Addison-Wesley Publishing Company (Reading, Mass.) will offer "The Mythical Man-Month: Essays on Software Engineering", from which this article is taken, sometime next month.

NO SCENE FROM PREHISTORY is quite so vivid as that of the mortal struggles of great beasts in the tar pits. In the mind's eye one sees dinosaurs, mammoths, and saber-toothed tigers struggling against the grip of the tar. The fiercer the struggle, the more entangling the tar, and no beast is so strong or so skillful but that he ultimately sinks.

Large-system programming has over the past decade been such a tar pit, and many great and powerful beasts have thrashed violently in it. Most have emerged with running systems—few have met goals, schedules, and budgets. Large and small, massive or wiry, team after team has become entangled in the tar. No one thing seems to cause the difficulty—any particular paw can be pulled away. But the accumulation of simultaneous and interacting factors brings slower and slower motion. Everyone seems to have been surprised by the stickiness of the problem, and it is hard to discern the nature of it. But we must try to understand it if we are to solve it.

More software projects have gone awry for lack of calendar time than for all other causes combined. Why is this case of disaster so common?

First, our techniques of estimating are poorly developed. More seriously, they reflect an unvoiced assumption which is quite untrue, i.e., that all will go well.

Second, our estimating techniques fallaciously confuse effort with progress, hiding the assumption that men and months are interchangeable.

Third, because we are uncertain of our estimates, software managers often lack the courteous stubbornness required to make people wait for a good product.

Fourth, schedule progress is poorly monitored. Techniques proven and routine in other engineering disciplines are considered radical innovations in software engineering.

Fifth, when schedule slippage is recognized, the natural (and traditional) response is to add manpower. Like dousing a fire with gasoline, this makes matters worse, much worse. More fire requires more gasoline and thus begins a regenerative cycle which ends in disaster.

Schedule monitoring will be covered later. Let us now consider other aspects of the problem in more detail.

Optimism

All programmers are optimists. Perhaps this modern sorcery especially attracts those who believe in happy endings and fairy godmothers. Perhaps the hundreds of nitty frustrations drive away all but those who habitually focus on the end goal. Perhaps it is merely that computers are young, programmers are younger, and the young are always optimists. But however the selection process works, the result is indisputable: "This time it will surely run," or "I just found the last bug."

So the first false assumption that underlies the scheduling of systems programming is that *all will go well*, i.e., that *each task will take only as long as it "ought" to take.*

The pervasiveness of optimism among programmers deserves more than a flip analysis. Dorothy Sayers, in her excellent book, *The Mind of the*

Maker, divides creative activity into three stages: the idea, the implementation, and the interaction. A book, then, or a computer, or a program comes into existence first as an ideal construct, built outside time and space but complete in the mind of the author. It is realized in time and space by pen, ink, and paper, or by wire, silicon, and ferrite. The creation is complete when someone reads the book, uses the computer or runs the program, thereby interacting with the mind of the maker.

This description, which Miss Sayers uses to illuminate not only human creative activity but also the Christian doctrine of the Trinity, will help us in our present task. For the human makers of things, the incompletenesses and inconsistencies of our ideas become clear only during implementation. Thus it is that writing, experimentation, "working out" are essential disciplines for the theoretician.

In many creative activities the medium of execution is intractable. Lumber splits; paints smear; electrical circuits ring. These physical limitations of the medium constrain the ideas that may be expressed, and they also create unexpected difficulties in the implementation.

Implementation, then, takes time and sweat both because of the physical media and because of the inadequacies of the underlying ideas. We tend to blame the physical media for most of our implementation difficulties; for the media are not "ours" in the way the ideas are, and our pride colors our judgment.

Computer programming, however, creates with an exceedingly tractable medium. The programmer builds from pure thought-stuff: concepts and very flexible representations thereof. Because the medium is tractable, we expect few difficulties in implementation; hence our pervasive optimism. Because our ideas are faulty, we have bugs; hence our optimism is unjustified.

In a single task, the assumption that all will go well has a probabilistic effect on the schedule. It might indeed go as planned, for there is a probability distribution for the delay that will be encountered, and "no delay" has a finite probability. A large programming effort, however, consists of many tasks, some chained end-to-end. The probability that each will go well becomes vanishingly small.

The mythical man-month

The second fallacious thought mode is expressed in the very unit of effort used in estimating and scheduling: the man-month. Cost does indeed vary as the product of the number of men and the number of months. Progress does not. *Hence the man-month as a unit for measuring the size of a job is a dangerous and deceptive myth.* It implies that men and months are interchangeable.

Men and months are interchangeable commodities only when a task can be partitioned among many workers *with no communication among them* (Fig. 1). This is true of reaping wheat or picking cotton; it is not even approximately true of systems programming.

When a task cannot be partitioned

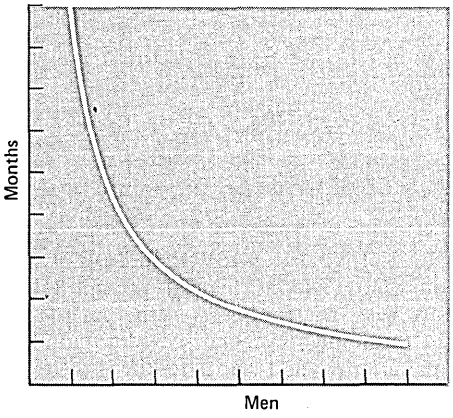


Fig. 1. The term "man-month" implies that if one man takes 10 months to do a job, 10 men can do it in one month. This may be true of picking cotton.

because of sequential constraints, the application of more effort has no effect on the schedule. The bearing of a child takes nine months, no matter how many women are assigned. Many software tasks have this characteristic because of the sequential nature of debugging.

In tasks that can be partitioned but which require communication among the subtasks, the effort of communication must be added to the amount of work to be done. Therefore the best that can be done is somewhat poorer than an even trade of men for months (Fig. 2).

The added burden of communication is made up of two parts, training and intercommunication. Each worker must be trained in the technology, the goals of the effort, the overall strategy, and the plan of work. This training cannot be partitioned, so this part of the added effort varies linearly with the number of workers.

V. S. Vyssotsky of Bell Telephone Laboratories estimates that a large project can sustain a manpower buildup of 30% per year. More than that strains and even inhibits the evolution of the essential informal structure and its communication pathways. F. J. Corbató of MIT points out that a long project must anticipate a turnover of 20% per year, and new people must be both technically trained and integrated into the formal structure.

Intercommunication is worse. If each part of the task must be separately coordinated with each other part, the effort increases as $n(n\text{-}1)/2$. Three workers require three times as much pairwise intercommunication as two; four require six times as much as two. If, moreover, there need to be conferences among three, four, etc., workers to resolve things jointly, matters get worse yet. The added effort of communicating may fully counteract the division of the original task and bring us back to the situation of Fig. 3.

Since software construction is inherently a systems effort—an exercise in complex interrelationships—communication effort is great, and it quickly

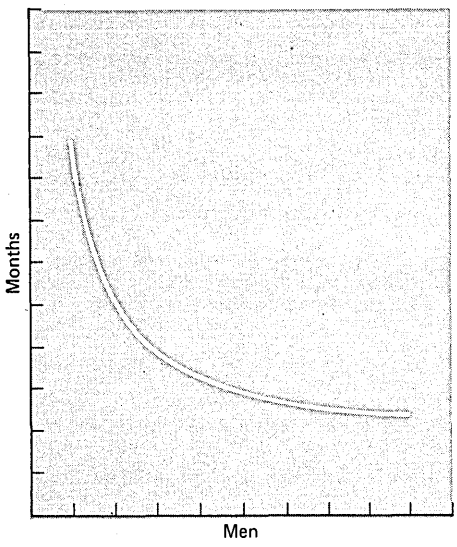


Fig. 2. Even on tasks that can be nicely partitioned among people, the additional communication required adds to the total work, increasing the schedule.

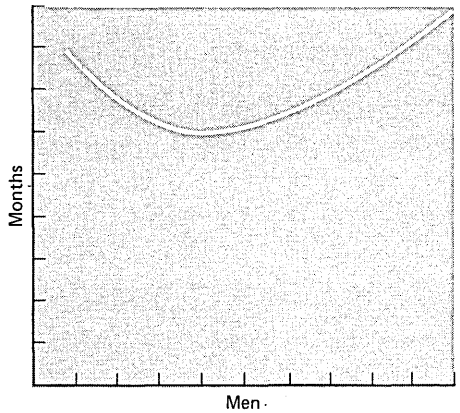


Fig. 3. Since software construction is complex, the communications overhead is great. Adding more men can lengthen, rather than shorten, the schedule.

dominates the decrease in individual task time brought about by partitioning. Adding more men then lengthens, not shortens, the schedule.

Systems test

No parts of the schedule are so thoroughly affected by sequential constraints as component debugging and system test. Furthermore, the time required depends on the number and subtlety of the errors encountered. Theoretically this number should be zero. Because of optimism, we usually expect the number of bugs to be smaller than it turns out to be. Therefore testing is usually the most mis-scheduled part of programming.

For some years I have been successfully using the following rule of thumb for scheduling a software task:

⅓ planning
⅙ coding
¼ component test and early system test
¼ system test, all components in hand.

This differs from conventional scheduling in several important ways:

1. The fraction devoted to planning is larger than normal. Even so, it is barely enough to produce a detailed and solid specification, and not enough to include research or exploration of totally new techniques.
2. The *half* of the schedule devoted to debugging of completed code is much larger than normal.
3. The part that is easy to estimate, i.e., coding, is given only one-sixth of the schedule.

In examining conventionally scheduled projects, I have found that few allowed one-half of the projected schedule for testing, but that most did indeed spend half of the actual schedule for that purpose. Many of these were on schedule until and except in system testing.

Failure to allow enough time for system test, in particular, is peculiarly disastrous. Since the delay comes at the end of the schedule, no one is aware of schedule trouble until almost the delivery date. Bad news, late and without warning, is unsettling to customers and to managers.

Furthermore, delay at this point has unusually severe financial, as well as psychological, repercussions. The project is fully staffed, and cost-per-day is maximum. More seriously, the software is to support other business effort (shipping of computers, operation of new facilities, etc.) and the secondary costs of delaying these are very high, for it is almost time for software shipment. Indeed, these secondary costs may far outweigh all others. It is therefore very important to allow enough system test time in the original schedule.

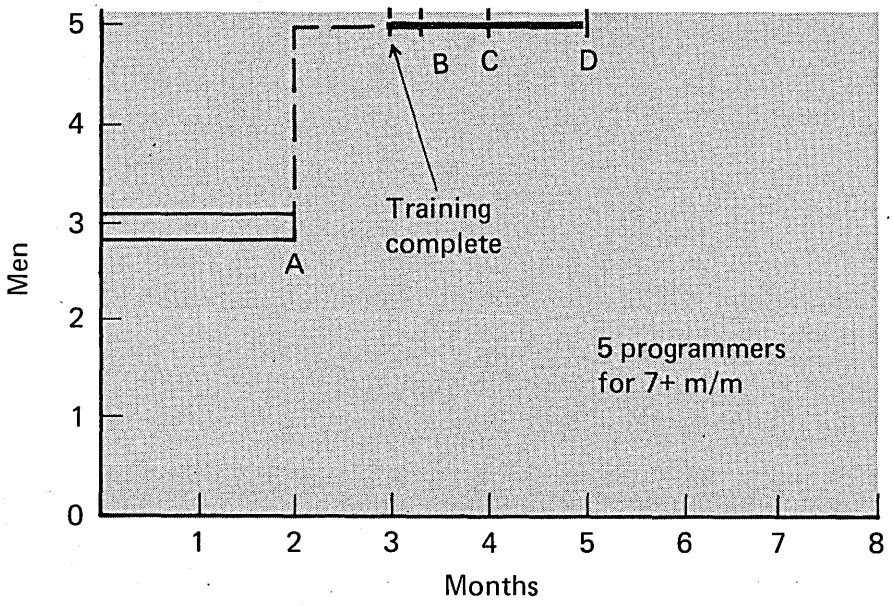


Fig. 4. Adding manpower to a project which is late may not help. In this case, suppose three men on a 12 man-month project were a month late. If it takes one of the three an extra month to train two new men, the project will be just as late as if no one was added.

Gutless estimating

Observe that for the programmer, as for the chef, the urgency of the patron may govern the scheduled completion of the task, but it cannot govern the actual completion. An omelette, promised in ten minutes, may appear to be progressing nicely. But when it has not set in ten minutes, the customer has two choices—wait or eat it raw. Software customers have had the same choices.

The cook has another choice; he can turn up the heat. The result is often an omelette nothing can save—burned in one part, raw in another.

Now I do not think software managers have less inherent courage and firmness than chefs, nor than other engineering managers. But false scheduling to match the patron's desired date is much more common in our discipline than elsewhere in engineering. It is very difficult to make a vigorous, plausible, and job-risking defense of an estimate that is derived by no quantitative method, supported by little data, and certified chiefly by the hunches of the managers.

Clearly two solutions are needed. We need to develop and publicize productivity figures, bug-incidence figures, estimating rules, and so on. The whole profession can only profit from sharing such data.

Until estimating is on a sounder basis, individual managers will need to stiffen their backbones, and defend their estimates with the assurance that their poor hunches are better than wish-derived estimates.

Regenerative disaster

What does one do when an essential software project is behind schedule? Add manpower, naturally. As Figs. 1 through 3 suggest, this may or may not help.

Let us consider an example. Suppose a task is estimated at 12 man-months and assigned to three men for four months, and that there are measurable mileposts A, B, C, D, which are scheduled to fall at the end of each month.

Now suppose the first milepost is not reached until two months have elapsed. What are the alternatives facing the manager?

1. Assume that the task must be done on time. Assume that only the first part of the task was misestimated. Then 9 man-months of effort remain, and two months, so 4½ men will be needed. Add 2 men to the 3 assigned.
2. Assume that the task must be done on time. Assume that the whole estimate was uniformly low. Then 18 man-months of effort remain, and two months, so 9 men will be needed. Add 6 men to the 3 assigned.
3. Reschedule. In this case, I like the advice given by an experienced hardware engineer, "Take no small slips." That is, allow enough time in the new schedule to ensure that the work can be carefully and

thoroughly done, and that rescheduling will not have to be done again.

4. Trim the task. In practice this tends to happen anyway, once the team observes schedule slippage. Where the secondary costs of delay are very high, this is the only feasible action. The manager's only alternatives are to trim it formally and carefully, to reschedule, or to watch the task get silently trimmed by hasty design and incomplete testing.

In the first two cases, insisting that the unaltered task be completed in four months is disastrous. Consider the regenerative effects, for example, for the first alternative (Fig. 4 preceding page). The two new men, however competent and however quickly recruited, will require training in the task by one of the experienced men. If this takes a month, *3 man-months will have been devoted to work not in the original estimate.* Furthermore, the task, originally partitioned three ways, must be repartitioned into five parts, hence some work already done will be lost and system testing must be lengthened. So at the end of the third month, substantially more than 7 man-months of effort remain, and 5 trained people and one month are available. As Fig. 4 suggests, the product is just as late as if no one had been added.

To hope to get done in four months, considering only training time and not repartitioning and extra systems test, would require adding 4 men, not 2, at the end of the second month. To cover repartitioning and system test effects, one would have to add still other men. Now, however, one has at least a 7-man team, not a 3-man one; thus such aspects as team organization and task division are different in kind, not merely in degree.

Notice that by the end of the third month things look very black. The March 1 milestone has not been reached in spite of all the managerial effort. The temptation is very strong to repeat the cycle, adding yet more manpower. Therein lies madness.

The foregoing assumed that only the first milestone was misestimated. If on March 1 one makes the conservative assumption that the whole schedule was optimistic one wants to add 6 men just to the original task. Calculation of the training, repartitioning, system testing effects is left as an exercise for the reader. Without a doubt, the regenerative disaster will yield a poorer product later, than would rescheduling with the original three men, unaugmented.

Oversimplifying outrageously, we state Brooks' Law:

Adding manpower to a late software project makes it later.

This then is the demythologizing of the man-month. The number of months of a project depends upon its sequential constraints. The maximum number of men depends upon the number of independent subtasks. From these two quantities one can derive schedules using fewer men and more months. (The only risk is product obsolescence.) One cannot, however, get workable schedules using more men and fewer months. More software projects have gone awry for lack of calendar time than for all other causes combined.

Calling the shot

How long will a system programming job take? How much effort will be required? How does one estimate?

I have earlier suggested ratios that seem to apply to planning time, coding, component test, and system test. First, one must say that one does *not* estimate the entire task by estimating the coding portion only and then applying the ratios. The coding is only one-sixth or so of the problem, and errors in its estimate or in the ratios could lead to ridiculous results.

Second, one must say that data for building isolated small programs are not applicable to programming systems products. For a program averaging about 3,200 words, for example, Sackman, Erikson, and Grant report an average code-plus-debug time of about 178 hours for a single programmer, a figure which would extrapolate to give an annual productivity of 35,800 statements per year. A program half that size took less than one-fourth as long, and extrapolated productivity is almost 80,000 statements per year.[1]. Planning, documentation, testing, system integration, and training times must be added. The linear extrapolation of such spring figures is meaningless. Extrapolation of times for the hundred-yard dash shows that a man can run a mile in under three minutes.

Before dismissing them, however, let us note that these numbers, although not for strictly comparable problems, suggest that effort goes as a power of size *even* when no communication is involved except that of a man with his memories.

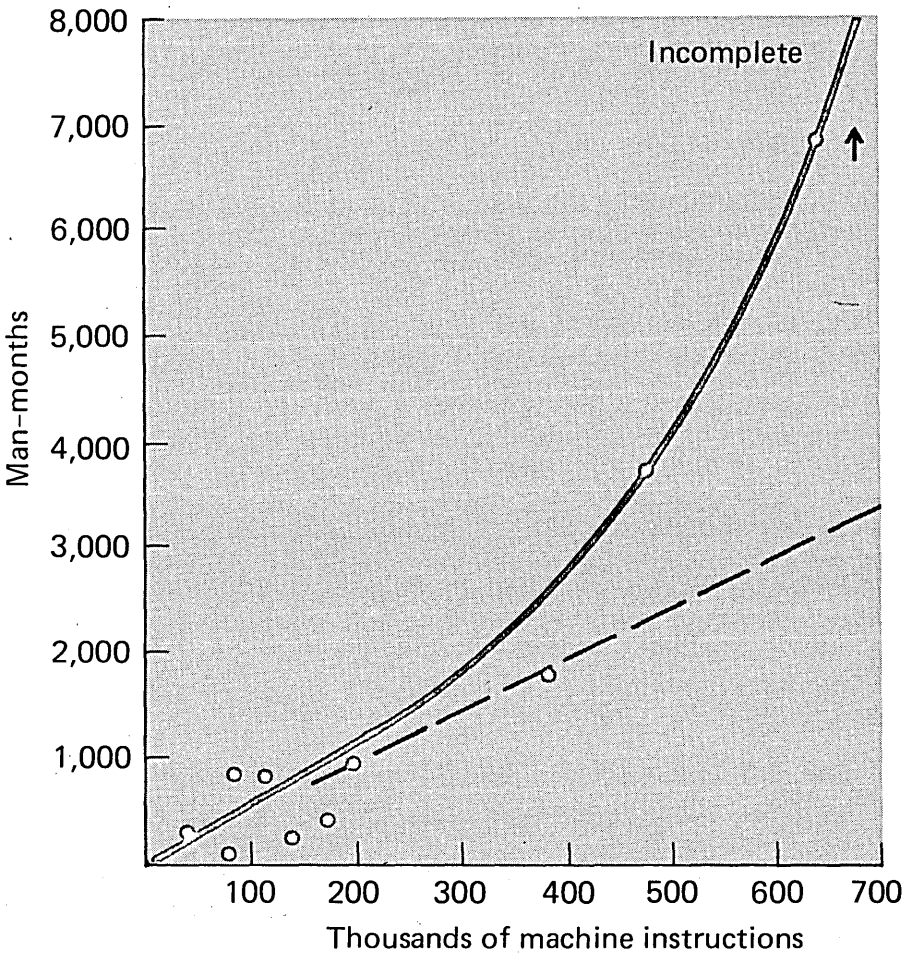


Fig. 5. As a project's complexity increases, the number of man-months required to complete it goes up exponentially.

Fig. 5 tells the sad story. It illustrates results reported from a study done by Nanus and Farr[2] at System Development Corp. This shows an exponent of 1.5; that is,

effort = (constant)×(number of instructions)$^{1.5}$

Another SDC study reported by Weinwurm[3] also shows an exponent near 1.5.

A few studies on programmer productivity have been made, and several estimating techniques have been proposed. Morin has prepared a survey of the published data.[4] Here I shall give only a few items that seem especially illuminating.

Portman's data

Charles Portman, manager of ICL's Software Div., Computer Equipment Organization (Northwest) at Manchester, offers another useful personal insight.

He found his programming teams missing schedules by about one-half—each job was taking approximately twice as long as estimated. The estimates were very careful, done by experienced teams estimating man-hours for several hundred subtasks on a PERT chart. When the slippage pattern appeared, he asked them to keep careful daily logs of time usage. These showed that the estimating error could be entirely accounted for by the fact that his teams were only realizing 50% of the working week as actual programming and debugging time. Machine downtime, higher-priority short unrelated jobs, meetings, paperwork, company business, sickness, personal time, etc. accounted for the rest. In short, the estimates made an unrealistic assumption about the number of technical work hours per man-year. My own experience quite confirms his conclusion.

An unpublished 1964 study by E. F. Bardain shows programmers realizing only 27% productive time.[5]

	Prog. units	Number of programmers	Years	Man-years	Program words	Words/man-yr.
Operational	50	83	4	101	52,000	515
Maintenance	36	60	4	81	51,000	630
Compiler	13	9	2¼	17	38,000	2230
Translator (Data assembler)	15	13	2½	11	25,000	2270

Table 1. Data from Bell Labs indicates productivity differences between complex problems (the first two are basically control programs with many modules) and less complex ones. No one is certain how much of the difference is due to complexity, how much to the number of people involved.

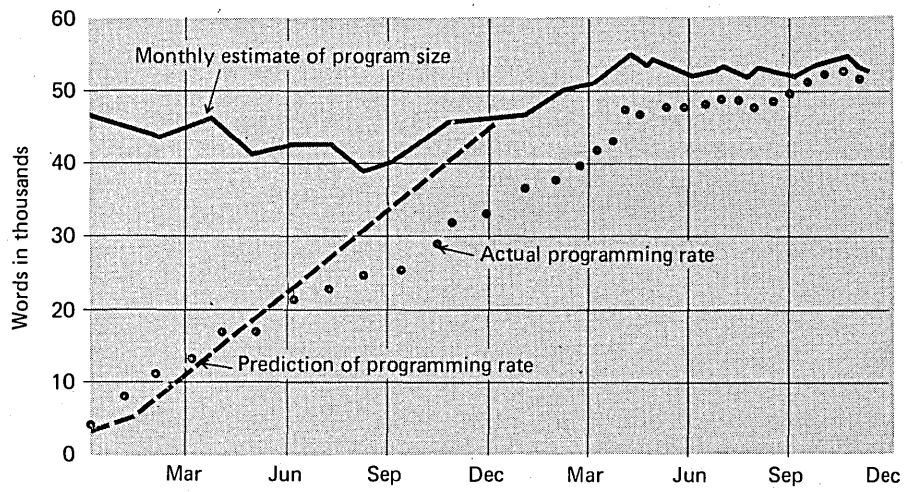


Fig. 6. Bell Labs' experience in predicting programming effort on one project.

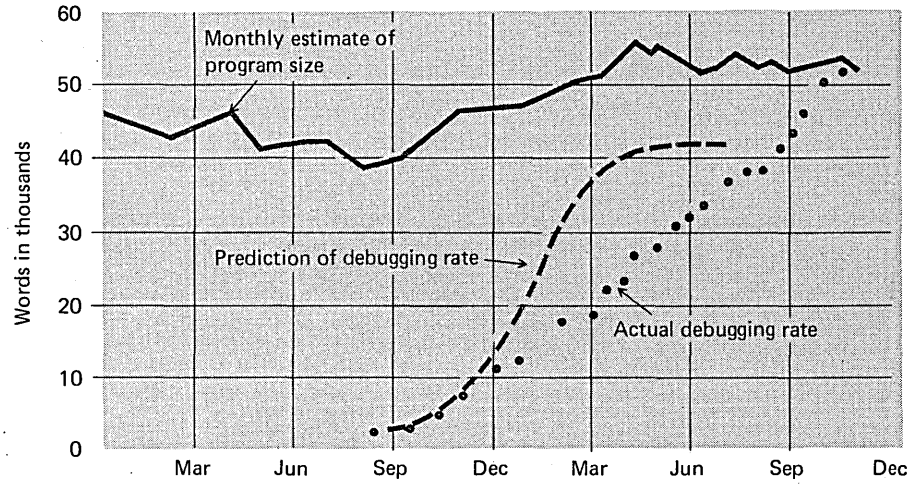


Fig. 7. Bell's predictions for debugging rates on a single project, contrasted with actual figures.

Aron's data

Joel Aron, manager of Systems Technology at IBM in Gaithersburg, Maryland, has studied programmer productivity when working on nine large systems (briefly, *large* means more than 25 programmers and 30,000 deliverable instructions). He divides such systems according to interactions among programmers (and system parts) and finds productivities as follows:

Very few interactions	10,000 instructions per man-year
Some interactions	5,000
Many interactions	1,500

The man-years do not include support and system test activities, only design and programming. When these figures are diluted by a factor of two to cover system test, they closely match Harr's data.

Harr's data

John Harr, manager of programming for the Bell Telephone Laboratories' Electronic Switching System, reported his and others' experience in a paper at the 1969 Spring Joint Computer Conference.[6] These data are shown in Table 1 and Figs. 6 and 7 .

Of these, Fig. 6 is the most detailed and the most useful. The first two jobs are basically control programs; the second two are basically language translators. Productivity is stated in terms of debugged words per man-year. This includes programming, component test, and system test. It is not clear how much of the planning effort, or effort in machine support, writing, and the

like, is included.

The productivities likewise fall into two classifications: those for control programs are about 600 words per man-year; those for translators are about 2,200 words per man-year. Note that all four programs are of similar size—the variation is in size of the work groups, length of time, and number of modules. Which is cause and which is effect? Did the control programs require more people because they were more complicated? Or did they require more modules and more man-months because they were assigned more people? Did they take longer because of the greater complexity, or because more people were assigned? One can't be sure. The control programs were surely more complex. These uncertainties aside, the numbers describe the real productivities achieved on a large system, using present-day programming techniques. As such they are a real contribution.

Figs. 6 and 7 show some interesting data on programming and debugging rates as compared to predicted rates.

OS/360 data

IBM OS/360 experience, while not available in the detail of Harr's data, confirms it. Productivities in range of 600-800 debugged instructions per man-year were experienced by control program groups. Productivities in the 2,000-3,000 debugged instructions per man-year were achieved by language translator groups. These include planning done by the group, coding component test, system test, and some support activities. They are comparable to Harr's data, so far as I can tell.

Aron's data, Harr's data, and the OS/360 data all confirm striking differences in productivity related to the complexity and difficulty of the task itself. My guideline in the morass of estimating complexity is that compilers are three times as bad as normal batch application programs, and operating systems are three times as bad as compilers.

Corbató's data

Both Harr's data and OS/360 data are for assembly language programming. Little data seem to have been published on system programming productivity using higher-level languages. Corbató of MIT's Project MAC reports, however, a mean productivity of 1,200 lines of debugged PL/I statements per man-year on the MULTICS system (between 1 and 2 million words) [7]

This number is very exciting. Like the other projects, MULTICS includes control programs and language translators. Like the others, it is producing a system programming product, tested and documented. The data seem to be comparable in terms of kind of effort included. And the productivity number is a good average between the control program and translator productivities of other projects.

But Corbató's number is *lines* per man-year, not *words!* Each statement in his system corresponds to about three-to-five words of handwritten code! This suggests two important conclusions:

- Productivity seems constant in terms of elementary statements, a conclusion that is reasonable in terms of the thought a statement requires and the errors it may include.
- Programming productivity may be increased as much as five times when a suitable high-level language is used. To back up these conclusions, W. M. Taliaffero also reports a constant productivity of 2,400 statements/year in Assembler, FORTRAN, and COBOL.[8] E. A. Nelson has shown a 3-to-1 productivity improvement for high-level language, although his standard deviations are wide.[9]

Hatching a catastrophe

When one hears of disastrous schedule slippage in a project, he imagines that a series of major calamities must have befallen it. Usually, however, the disaster is due to termites, not tornadoes; and the schedule has slipped imperceptibly but inexorably. Indeed, major calamities are easier to handle; one responds with major force, radical reorganization, the invention of new approaches. The whole team rises to the occasion.

But the day-by-day slippage is harder to recognize, harder to prevent, harder to make up. Yesterday a key man was sick, and a meeting couldn't be held. Today the machines are all down, because lightning struck the building's power transformer. Tomorrow the disc routines won't start testing, because the first disc is a week late from the factory. Snow, jury duty, family problems, emergency meetings with customers, executive audits—the list goes on and on. Each one only postpones some activity by a half-day or a day. And the schedule slips, one day at a time.

How does one control a big project on a tight schedule? The first step is to *have* a schedule. Each of a list of events, called milestones, has a date. Picking the dates is an estimating problem, discussed already and crucially dependent on experience.

For picking the milestones there is only one relevant rule. Milestones must be concrete, specific, measurable events, defined with knife-edge sharpness. Coding, for a counterexample, is "90% finished" for half of the total coding time. Debugging is "99% complete" most of the time. "Planning complete" is an event one can proclaim almost at will.[10]

Concrete milestones, on the other hand, are 100% events. "Specifications signed by architects and implementers," "source coding 100% complete, keypunched, entered into disc library," "debugged version passes all test cases." These concrete milestones demark the vague phases of planning, coding, debugging.

It is more important that milestones be sharp-edged and unambiguous than that they be easily verifiable by the boss. Rarely will a man lie about mile-

> None love
> the bearer of bad news.
> *Sophocles*

stone progress, *if* the milestone is so sharp that he can't deceive himself. But if the milestone is fuzzy, the boss often understands a different report from that which the man gives. To supplement Sophocles, no one enjoys bearing bad news, either, so it gets softened without any real intent to deceive.

Two interesting studies of estimating behavior by government contractors on large-scale development projects show that:

1. Estimates of the length of an activity made and revised carefully every two weeks before the activity starts do not significantly change as the start time draws near, no matter how wrong they ultimately turn out to be.
2. *During* the activity, *over*estimates of duration come steadily down as the activity proceeds.
3. *Underestimates* do not change significantly during the activity until about three weeks before the scheduled completion.[11]

Sharp milestones are in fact a service to the team, and one they can properly expect from a manager. The fuzzy milestone is the harder burden to live with. It is in fact a millstone that grinds down morale, for it deceives one about lost time until it is irremediable. And chronic schedule slippage is a morale-killer.

"The other piece is late"

A schedule slips a day; so what? Who gets excited about a one-day slip? We can make it up later. And the other piece ours fits into is late anyway.

A baseball manager recognizes a nonphysical talent, *hustle,* as an essential gift of great players and great teams. It is the characteristic of running faster than necessary, moving sooner than necessary, trying harder than necessary. It is essential for great programming teams, too. Hustle provides the cushion, the reserve capacity, that enables a team to cope with routine mishaps, to anticipate and forfend minor calamities. The calculated response, the measured effort, are the wet blankets that dampen hustle. As we have seen, one *must* get excited about a one-day slip. Such are the elements of catastrophe.

But not all one-day slips are equally disastrous. So some calculation of response is necessary, though hustle be dampened. How does one tell which slips matter? There is no substitute for a PERT chart or a critical-path schedule. Such a network shows who waits for what. It shows who is on the critical path, where any slip moves the end date. It also shows how much an activity can slip before it moves into the critical path.

The PERT technique, strictly speaking, is an elaboration of critical-path scheduling in which one estimates three times for every event, times corresponding to different probabilities of meeting the estimated dates. I do not find this refinement to be worth the extra effort, but for brevity I will call any critical path network a PERT chart.

The preparation of a PERT chart is the most valuable part of its use. Laying out the network, identifying the dependencies, and estimating the legs all force a great deal of very specific planning very early in a project. The first chart is always terrible, and one invents and invents in making the second one.

As the project proceeds, the PERT chart provides the answer to the demoralizing excuse, "The other piece is late anyhow." It shows how hustle is needed to keep one's own part off the critical path, and it suggests ways to make up the lost time in the other part.

Under the rug

When a first-line manager sees his small team slipping behind, he is rarely inclined to run to the boss with this woe. The team might be able to make it up, or he should be able to invent or reorganize to solve the problem. Then why worry the boss with it? So far, so good. Solving such problems is exactly what the first-line manager is there for. And the boss does have enough real worries demanding his action that he doesn't seek others. So all the dirt gets swept under the rug.

But every boss needs two kinds of information, exceptions for action and a status picture for education.[12] For that purpose he needs to know the status of all his teams. Getting a true picture of that status is hard.

The first-line manager's interests and those of the boss have an inherent conflict here. The first-line manager fears that if he reports his problem, the boss will act on it. Then his action will preempt the manager's function, diminish his authority, foul up his other plans. So as long as the manager thinks he can solve it alone, he doesn't tell the boss.

Two rug-lifting techniques are open to the boss. Both must be used. The first is to reduce the role conflict and inspire sharing of status. The other is to yank the rug back.

Reducing the role conflict

The boss must first distinguish between action information and status information. He must discipline himself *not* to act on problems his managers can solve, and *never* to act on problems when he is explicitly reviewing status. I once knew a boss who invariably picked up the phone to give orders before the end of the first para-

SYSTEM/360 SUMMARY STATUS REPORT
OS/360 LANGUAGE PROCESSORS + SERVICE PROGRAMS
AS OF FEBRUARY 01,1965

A=APPROVAL
C=COMPLETED

*=REVISED PLANNED DATE
NE=NOT ESTABLISHED

PROJECT	LOCATION	COMMITMNT ANNOUNCE RELEASE	OBJECTIVE AVAILABLE APPROVED	SPECS AVAILABLE APPROVED	SRL AVAILABLE APPROVED	ALPHA TEST ENTRY EXIT	COMP TEST START COMPLETE	SYS TEST START COMPLETE	BULLETIN AVAILABLE APPROVED	BETA TEST ENTRY EXIT
OPERATING SYSTEM										
12K DESIGN LEVEL (E)										
ASSEMBLY	SAN JOSE	04/--/4 C 12/31/5	10/28/4 C	10/13/4 C 01/11/5	11/13/4 C 11/18/4 A	01/15/5 C 02/22/5				09/01/5 11/30/5
FORTRAN	POK	04/--/4 C 12/31/5	10/28/4 C	10/21/4 C 01/22/5	12/17/4 C 12/19/4 A	01/15/5 C 02/22/5				09/01/5 11/30/5
COBOL	ENDICOTT	04/--/4 C 12/31/5	10/28/4 C	10/15/4 C 01/20/5 A	11/17/4 C 12/08/4 A	01/15/5 C 02/22/5				09/01/5 11/30/5
RPG	SAN JOSE	04/--/4 C 12/31/5	10/28/4 C	09/30/4 C 01/05/5 A	12/02/4 C 01/18/5 A	01/15/5 C 02/22/5				09/01/5 11/30/5
UTILITIES	TIME/LIFE	04/--/4 C 12/31/5	06/24/4 C		11/20/4 C 11/30/4 A					09/01/5 11/30/5
SORT 1	POK	04/--/4 C 12/31/5	10/28/4 C	10/19/4 C 01/11/5	11/12/4 C 11/30/4 A	01/15/5 C 03/22/5				09/01/5 11/30/5
SORT 2	POK	04/--/4 C 06/30/6	10/28/4 C	10/19/4 C 01/11/5	11/12/4 C 11/30/4 A	01/15/5 C 03/22/5				03/01/6 05/30/6
44K DESIGN LEVEL (F)										
ASSEMBLY	SAN JOSE	04/--/4 C 12/31/5	10/28/4 C	10/13/4 C 01/11/5	11/13/4 C 11/18/4 A	02/15/5 03/22/5				09/01/5 11/30/5
COBOL	TIME/LIFE	04/--/4 C 06/30/6	10/28/4 C	10/15/4 C 01/20/5 A	11/17/4 C 12/08/4 A	02/15/5 03/22/5				03/01/6 05/30/6
NPL	HURSLEY	04/--/4 C 03/31/6	10/28/4 C							
2250	KINGSTON	03/30/4 C 03/31/6	11/05/4 C	12/08/4 C 01/04/5	01/12/5 C 01/29/5	01/04/5 C 01/29/5				01/03/6 NE
2280	KINGSTON	06/30/4 C 09/30/6	11/05/4 C			04/01/5 04/30/5				01/28/6 NE
200K DESIGN LEVEL (H)										
ASSEMBLY	TIME/LIFE		10/28/4 C							
FORTRAN	POK	04/--/4 C 06/30/6	10/28/4 C	10/16/4 C 01/11/5	11/11/4 C 12/10/4 A	02/15/5 03/22/5				03/01/6 05/30/6
NPL	HURSLEY	04/--/4 C 03/31/7	10/28/4 C			07/--/5				01/--/7
NPL H	POK	04/--/4 C	03/30/4 C			02/01/5 04/01/5				10/15/5 12/15/5

Fig. 8. A report showing milestones and status is a key document in project control. This one shows some problems in OS development: specifications approval is late on some items (those without "A"); documentation (SRL) approval is overdue on another; and one (2250 support) is late coming out of alpha test.

graph in a status report. That response is guaranteed to squelch full disclosure.

Conversely, when the manager knows his boss will accept status reports without panic or preemption, he comes to give honest appraisals.

This whole process is helped if the boss labels meetings, reviews, conferences, as *status-review* meetings versus *problem-action* meetings, and controls himself accordingly. Obviously one may call a problem-action meeting as a consequence of a status meeting, if he believes a problem is out of hand. But at least everybody knows what the score is, and the boss thinks twice before grabbing the ball.

Yanking the rug off

Nevertheless, it is necessary to have review techniques by which the true status is made known, whether cooperatively or not. The PERT chart with its frequent sharp milestones is the basis for such review. On a large project one may want to review some part of it each week, making the rounds once a month or so.

A report showing milestones and actual completions is the key document. Fig. 8 (preceding page), shows an excerpt from such a report. This report shows some troubles. Specifications approval is overdue on several components. Manual (SRL) approval is overdue on another, and one is late getting out of the first state (ALPHA) of the independently conducted product test. So such a report serves as an agenda for the meeting of 1 February. Everyone knows the questions, and the component manager should be prepared to explain why it's late, when it will be finished, what steps he's taking, and what help, if any, he needs from the boss or collateral groups.

V. Vyssotsky of Bell Telephone Laboratories adds the following observation:

I have found it handy to carry both "scheduled" and "estimated" dates in the milestone report. The scheduled dates are the property of the project manager and represent a consistent work plan for the project as a whole, and one which is a priori *a reasonable plan. The estimated dates are the property of the lowest level manager who has cognizance over the piece of work in question, and represents his best judgment as to when it will actually happen, given the resources he has available and when he received (or has commitments for delivery of) his prerequisite inputs. The project manager has to keep his fingers off the estimated dates, and put the emphasis on getting accurate, unbiased estimates rather than palatable optimistic estimates or self-protective conservative ones. Once this is clearly established in everyone's mind, the project manager can see quite a ways into the future where he is going to be in trouble if he doesn't do something.*

The preparation of the PERT chart is a function of the boss and the managers reporting to him. Its updating, revision, and reporting requires the attention of a small (one-to-three-man) staff group which serves as an extension of the boss. Such a "Plans and Controls" team is invaluable for a large project. It has no authority except to ask all the line managers when they will have set or changed milestones, and whether milestones have been met. Since the Plans and Controls group handles all the paperwork, the burden on the line managers is reduced to the essentials—making the decisions.

We had a skilled, enthusiastic, and diplomatic Plans and Controls group on the OS/360 project, run by A. M. Pietrasanta, who devoted considerable inventive talent to devising effective but unobtrusive control methods. As a result, I found his group to be widely respected and more than tolerated. For a group whose role is inherently that of an irritant, this is quite an accomplishment.

The investment of a modest amount of skilled effort in a Plans and Controls function is very rewarding. It makes far more difference in project accomplishment than if these people worked directly on building the product programs. For the Plans and Controls group is the watchdog who renders the imperceptible delays visible and who points up the critical elements. It is the early warning system against losing a year, one day at a time.

Epilogue

The tar pit of software engineering will continue to be sticky for a long time to come. One can expect the human race to continue attempting systems just within or just beyond our reach; and software systems are perhaps the most intricate and complex of man's handiworks. The management of this complex craft will demand our best use of new languages and systems, our best adaptation of proven engineering management methods, liberal doses of common sense, and a God-given humility to recognize our fallibility and limitations.

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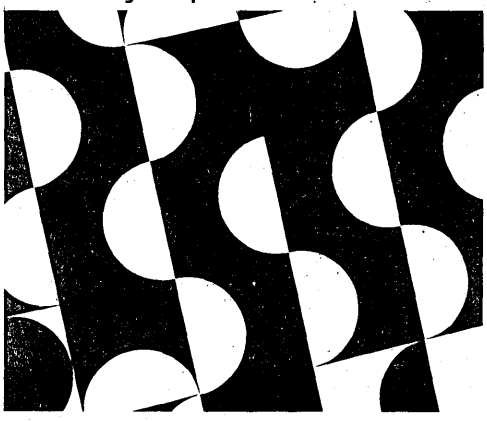
Dr. Brooks is presently a professor at the Univ. of North Carolina at Chapel Hill, and chairman of the computer science department there. He is best known as "the father of the IBM System/360," having served as project manager for the hardware development and as manager of the Operating System/360 project during its design phase. Earlier he was an architect of the IBM Stretch and Harvest computers.

At Chapel Hill he has participated in establishing and guiding the Triangle Universities Computation Center and the North Carolina Educational Computing Service. He is the author of two editions of "Automatic Data Processing" and "The Mythical Man-Month: Essays on Software Engineering" (Addison-Wesley), from which this excerpt is taken.

In contrast to Dr. Brooks' presentation, this portrait of failure is for those who learn best from looking at bad examples.

WHY PROJECTS FAIL

by Stephen P. Keider



ONE OF THE PRIMARY causes for the failure of data processing projects is that such projects are often not initially defined, and therefore may lack a beginning and an end. Once a project has begun, no one seems to know:

- how the project was started;
- what the staffing is, or was, at any one point in time;
- what activities have been performed;
- when the project will end;
- what the project will accomplish.

Essentially, because projects are rarely formally defined, they are rarely completed. Completion occurs usually upon the death—or resignation—of the user the project services, or when the system is due for conversion. Completion is also a prerequisite for success, but a project is considered successful only if completed within the original time or budget estimates, and by how well it satisfies the user's needs.

An unsuccessful project, however, can be identified during several phases of its life cycle; and I shall here try to point to those very indicators.

Logically, any project can be time-divided into five distinct phases:

a) Pre-initiation period (usually measured in weeks or months)
b) Initiation period (measured in weeks)
c) Project duration (in months or years)
d) Project termination period (in weeks or months)
e) Post-termination period (occurring several months after project termination)

In each of the above phases, errors of commission or omission can have major impact upon the success of the total project.

Pre-initiation period

1) No standards exist for estimating how long the project will take. That is, each project is treated as a new and novel system with some individual responsible for estimation. His estimate will be based upon his own understanding of the project and its tasks, and on how quickly *he* can accomplish the subtasks. Little use is made of a history file of similar projects and actual versus originally estimated times.

2) Estimation is not done by the probable project leader, but rather, by whoever happens to be available at estimating time.

3) The project is not adequately defined. The request for an estimate usually takes the form of "John, we're planning to redo the payroll system. What do you think it will require?" "Payroll" may mean a number of different things to different people. Does it involve labor distribution? personnel information? leave accounting? salary, hourly and executive payroll? Any of the above can measurably impact the estimate of the project.

4) Short lead times are allowed for estimates, with corresponding inaccuracy as a result.

5) Personnel availability for the project is unknown. Estimates are usually prepared irrespective of who will perform the work. That is, an estimate of 34 days may be made, but only very junior personnel may be available; this will inflate the actual time. Although the resulting price/performance ratio may be excellent, the success of the project is rated in terms of actual versus estimated time, and on that basis the project may be a failure.

6) Staff desires are unknown. A project may be very appealing to one staff member, but repugnant to another. In both cases the actual time will be affected. Consequently, the Systems Manager must understand staff desires and assign projects accordingly where possible.

Initiation of project

1) Little documentation is available for existing, similar, or interfacing systems to provide the project leader with a data base to build upon.

2) Project leader responsibility is undefined. The leader has no idea what is expected of him, in regard to the project or the personnel assigned to work on it. Should he recommend alternative solutions? Can he recommend terminating the project? Can he remove personnel from it? Can he recommend dismissal?

3) Paper flow is handled poorly (or is nonexistent). Documentation regarding responsibilities, acceptance criteria, system objectives, etc., is not developed. Rather, documentation is limited to the technical aspects of the project.

4) Knowledge of "tools" to perform the project more efficiently is lacking. Are there modules, or subroutines already available which can be used? Is there a test data generator available? What about system design or documentation aids?

5) Definition of the project is vague, misleading, or totally wrong.

6) The project, between the time of the original estimate and its initiation, has changed without a corresponding change in the estimate.

7) Little or no time is spent in planning the project. Rather, analysis design and/or coding is begun immediately upon the project approval. The project leader is not permitted the "luxury" of planning: how he will attack the project; what tasks will be done first, second or third; what approach he will use; or what similar projects he will investigate or review.

8) Problem avoidance is not understood or considered. Oddly

enough, all projects begin with the premise that everything will go smoothly. Items such as lack of test time due to year-end closing are not considered until after the problem has occurred. By then, the project has already lost several days, or it is too late to provide an alternate source.

9) Resource requirements are not scheduled for the project. Critical items, such as keypunch, test time, user manual typing, secretarial, and printing requirements become a problem, and are addressed only *after* they have affected the project.

10) The project team's activities are not clearly presented to the end user. Only too often, the result is a series of "I thought . . ." "I assumed . . ." "Isn't he . . . ?" comments.

11) Project completion elements are not defined. That is, the project leader is not aware of what constitutes completion of the project. What is the end product? What test/acceptance criteria will be used? Who must sign off on project turnover? What constitutes turnover?

Duration of the project

1) Posting or reporting of project information is not performed, resulting in the project leader being unaware of what the completion percentage is, and the user being unaware of the impact of changes upon the original system.

2) Project reviews are typically exercises in trivia. They constitute a "How's it going, Jack? Any problems? No? Good! See you next week." The weak systems manager does not ask probing, detailed questions. He does not require that his personnel anticipate problems, but is primarily concerned with identifying problems which his project leader already has recognized.

3) Change of personnel is one of the major reasons why projects fail. Personnel, including project leaders, are removed from the project, with no adjustments to the schedule for time lost due to the changes. Whenever a team member is added to a project, there is a learning curve which impairs his efficiency on the project. It may be a day, or a month, but unfortunately, people movement is considered to be transparent to the project completion.

4) Adherence to standards and specifications is either not defined or, if defined, not followed. More often than not, standards do exist, especially in larger installations. They address documentation techniques, labeling, file names, etc. However, once an initial indoctrination is provided for a programmer/analyst, follow-up is ignored. The most expedient solutions are followed, resulting in several steps (modules) in the same program sequence addressing the identical file with different mnemonics. It results for example, in sketchy operations documentation without consideration for restart procedures. Maintenance then becomes a major part of project development.

5) Resource requirements are not anticipated. The major offenders in this area are:

- Data entry. Inadequate time is permitted for turnaround of source code preparation and/or test file operation. Worse, verification may not be performed, which almost invariably adds at least one day to the program development cycle.
- Computer Test Time. The lack of adequate test time becomes extremely critical toward the end of a project, when only one or two programs are being finalized. If turnaround is overnight, each minor change to a program adds at least one full day to the duration.
- Design Level Reviews. Whereas most of the time these are considered in project planning, it is rare that anything longer than a minute is assumed for duration between submission of design specifications and approval.

6) "Brute Force" Approach. In this type of shop, everything is designed and implemented from scratch with no thought given to the use of past projects, tools, or work simplification methods available to shorten the development cycle.

7) Lack of a project manager. It sounds strange, but many projects flounder through to completion without a rudder. The "DP Manager" is normally the project leader and he provides as much attention as he can considering his other duties. In general, very few installations have one man accountable for an entire project, but rather fragment the responsibilities to the point where no one person is accountable.

8) Lack of a Project Log. A project log can be an invaluable tool in performing post-mortems. Further, in companies which charge-back to the user the cost of resources used, it can be the mainstay in justifying such charge-backs.

9) Lack of a project audit trail. Data audit trails are considered the key to the development of any financially

"This is the list of good little boys and girls from IBM, Eastman Kodak and Xerox families who, due to their fathers' promotions have been relocated since they wrote you their Christmas letters."

sound accounting system. Yet very few project managers concern themselves with maintenance of a project workbook to provide a similar audit trail for project development.

10) Lack of a skills inventory. Many projects are pursued with the project manager completely unaware of the skills available to him within his own shop. A skills inventory of past accomplishments of each staff member simplifies the staffing of a project and ensures that experience is "recyclable."

11) Lack of project milestones. Because project milestones are not determined at the onset of a project, percentage of completion is usually equated to percentage of hours expended. For example, a project for which 100 hours has been estimated is 60% complete when 60 hours have been expended; when 90% of the hours have been expended, it is 90% complete. This can likewise be extrapolated to 140% complete when 140 hours have been expended.

12) Staff members are considered "universally expert" During the estimation stage, and again during implementation, staff members are considered to be equally competent analysts, designers, programmers, librarians, documentation specialists, etc. They are assigned any of these functions with little consideration given to their ability. Invariably, this results in project delay.

13) Utilization Philosophy. A most fundamental problem which affects many large companies is one which demands maximizing the utilization of personnel, as opposed to a project-oriented approach. When a lull occurs in a particular project, staff members are reassigned, because it is anathema to have people not performing "useful" (that is, design or programming) work. Consequently, when the project restarts, the same people may not be available, or worse yet, are available part time. This is a disastrous approach, because while it assures that people are always assigned to a project and utilization is high, it places an emphasis upon effort, not results.

Termination of the project

In the first place, it is my opinion that projects never terminate. Rather, they become like Moses, condemned to wander till the end of their days without seeing the promised land. However, for those projects that do "terminate," the following are key deficiencies.

1) History/statistics are not determined or not updated. For example, at project termination, the project leader should make some attempt to determine performance in light of certain objectives, or measurable criteria: how many programs were written? how many lines of code generated? average lines of code per day? average source statements per programmer? cpu test time required per programmer? per program? All of the above can be invaluable tools in the estimating and evaluating of future projects. It becomes the first step in the development of a "cost/resource accounting system" for dp projects.

2) Quality Control. Typically, when a project is completed, it is never evaluated for quality. The QC criteria is "does the program run?" There are no grades (i.e., A, B, C, D, F) of programs. They are either "As" or "Fs."

The manager may evaluate personnel based upon quantity of code, programs or documentation produced, but in fact he never even considers evaluation based upon the quality of coding techniques used.

3) Knowledge gained is rarely transferable. Once a project is completed, it goes through a procedure similar to "de-Stalinization," wherein all vestiges of association with a project are forgotten lest one be stuck with program maintenance. Inadequate time is allowed at the conclusion of the project for staff members to "dump" the knowledge gained or even provide meaningful insight into techniques used.

4) Personnel are not evaluated. There is an ideal time, and only one, to evaluate performance of an individual on a project, and that is immediately at the conclusion of a project. Yet, only too often, personnel evaluation is tied into employment anniversary dates. Between the time an individual has completed a project and his next appraisal, a year may have lapsed. During that year he has had the opportunity to perpetuate mistakes initially made 12 months ago.

5) Lack of formal turnover. Typically, a project termination is first known by the appearance of a new report. More realistically, a formal presentation should take place addressing:

a) initial objectives of the project
b) performance against these objectives
c) review of the end product
d) designation of principal contact for maintenance, etc.

6) Recommendations for enhancement are not documented. At the conclusion of a project (if not earlier) the project team is in an ideal position to recommend enhancements to the system. If these are not quantified immediately, they will be lost forever.

Post termination

The key ingredient here is the conducting of user satisfaction surveys six to nine months after the completion of a project. The survey should address:

a) results versus objective
b) integrity of data
c) freedom from bugs
d) quantification of changes required
e) usefulness of information (i.e., should the system be continued?)

Summary

As a result of reviewing the development of a number of major systems, the above faults exist more often than not. However, the key problems appear in failing to understand the characteristics of a project:

- It has a beginning.
- It has an end.
- It uses multiple, finite resources.
- It has an objective.
- Its success can be measured in terms of time or dollars.
- It requires a leader.
- It requires a staff.
- It must be planned.
- Performance against plan must be reviewed.
- It coexists with other projects but is distinct from them.
- It is measurable (quantifiable).
- It may be a bad project (from the standpoint of usefulness). If it is, it must be altered, or terminated.
- Internal and external forces will affect a project; they must be identified.
- A project is a group of sub-projects.
- No project is unique.

Unless full attention is paid to each of these aspects of a project, the history of project failure will be played out once again. □

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There is an efficiency trade-off
between developing a program and running it.
Choosing which to emphasize may depend on pressures
of outside factors.

PROGRAMMING TIME VS. RUNNING TIME

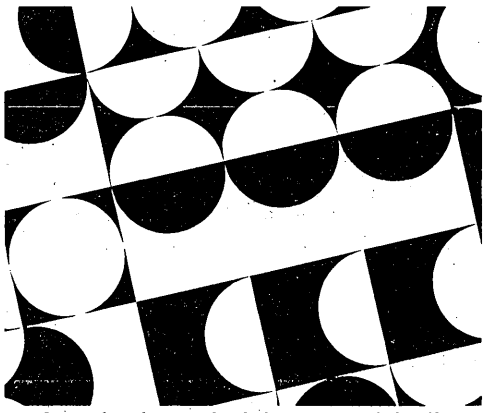
by Lawrence H. Cooke, Jr.

IN COMPUTER PROGRAMMING, one is frequently presented with trade-offs. In the earlier days, input/output to processing ratio was a major concern. Somewhat later, speed versus space became important. (In the really early days, there wasn't enough space to consider it a trade-off.) More recently, with the advent of higher level languages, the relationship between development time (the time needed to get the program operational) and the running efficiency has become the proper forum for managerial consideration.

An extreme example

Let us assume a major company such as an airline, a petrochemical firm, or a food processor, has evaluated a project, say, a linear program. The anticipated annual savings from the project will be $12 million. Such savings for a multimillion dollar corporation are not uncommon, particularly if the linear program is the first optimization tool used to schedule the company's many products among its departments or branches. The project is estimated to require nine months elapsed time and to cost $500,000 to develop.

Now, due to some unforeseen circumstances, which occur nonetheless, the project took 13 months. When the elapsed time has regrettably passed, the third project leader explains that the system cost only $400,000 to develop, or 20% less than originally estimated. That represents a savings over what would have been accomplished if the first or second project leader had



forced the schedule as originally anticipated.

Now in retrospect it's easy to see why the management is not elated. The four-month delay cost $4 million in opportunity costs that the firm might otherwise have saved. No amount of programming efficiency, nor any decrease in development cost, can recover the $4 million. Even if the program had run very *inefficiently*, and cost thousands of dollars more a month to run than anticipated, the project still would have been worthwhile. In this case, development time is not only the key consideration, it is virtually the only one.

The other side

Let us now assume that another company, a car rental service, a brokerage, or a bank, plans to install a service which must process five incoming messages a second. Further, a response back to any caller is expected within 30 minutes, no matter what. Analysis shows that a system which can process 25,000 messages an hour, or nearly seven per second, will provide enough tolerance to handle any unexpected peaks, and in case of a failure of 15 minutes duration (the maximum expected under backup arrangements), can have the system humming smoothly within an hour after failure. (Needless to say, two failures in a row are not permitted in this calculation.)

A system of this sort that processed only 18,050 messages an hour would not be allowed. In case of the 15 minute failure, it would take 90 hours to make up a backlog. While it might be theoretically possible to process all messages by processing the oldest messages first, it would require no failures over a much longer period than might be possible with contemporary hardware.

No amount of swift development, not even if a programming group could have the system overnight, would compensate for the stringency of the running efficiency requirements of the program. The case is even stronger if the program does not process the required five messages a second. In that event, an infinite queue would build from the beginning and the system will not work at all.

In this extreme case, running efficiency is paramount. All the calculations must be made quite carefully and

checked thoroughly so that each component of the system will perform adequately. Mistaken assumptions involving fractions of a millisecond become critical because timing is so vital here.

An experiment

The choice may appear easy in the extreme cases; however, most problems fall well between the bounds cited above. It is in this gray area that most programming decision making is required. Only if a programming assignment is perfectly designed will the trade-off between programming efficiency and running efficiency be absolute. Then, the best that can be achieved is to maximize one of these variables subject to some arbitrary level of the other. Optimizing both will be impossible.

For the bulk of programming tasks, standard or theoretically achievable performance is known only imperfectly. The programming manager then can exercise a wide latitude of discretion. In order to survey the domain over which these variables might range, an experiment was conducted by the author.

The experiment was to evaluate a programming problem using different higher-level languages and different computers of roughly comparable power, to test the trade-off between development time and execution time. (This, incidentally, is one of the few behavioral performance studies to use professional programmers rather than college freshmen or mice.)

As in most experiments in the social sciences, it was not possible to control all the variables. Personality and attitudes of the participants affected the results somewhat, but we don't know how or how much. As far as possible, however, the programming problem was constant, so that only the skill of the programmer and the basic properties of the language tools were allowed to vary.

The problem, performed at the Federal Reserve Bank of New York, was to compute Treasury Bill yields (or interest rates) given the price at which the bills were auctioned. (The method of computing was Newton's approximation, or the Newton-Raphson iteration technique.) The programs also required parameter information, such as the first coupon date, etc., so that it was not merely a mathematical exercise, but required some finesse in setting up prompts for terminal programs, or control card setup for the batch programs.

The problem was a "scientific" one, but was chosen primarily for other reasons. First, it was relatively self-contained and without complicated data requirements. Second, it was sufficiently complex to allow for some variation in programming approach. Third, it used enough machine processing that differences in running efficiency could be measured without large sample statistics. In these respects it served as a learning device to measure some of the considerations in development and efficiency.

The problem was coded by different individuals in FORTRAN, APL, ALGOL, and a Procedure Oriented Language (POL). Each program was run on a different computer, since these computers happened to support the problem languages. Different levels of programmer experience provided a further comparison within languages as well as between languages.

The languages used for the problem are divided into two groups. The first consists of interpretive languages, APL and a POL, which may be called very high level languages since they eliminate I/O considerations and explicit data storage. They achieve greater convenience with either some loss of generality or some loss of efficiency, or both. Procedure Oriented Languages are pre-specified to reach a given audience, and are generally useful only in that context. For example, APL would probably not be considered for a payroll application.

The other group consists of the compiler languages, FORTRAN and ALGOL. The properties of this class of languages are well known. Compared with the interpreters, they require at least one more pass through the computer while the language is transformed into machine object code.

The results

The experiment confirmed that interpretive languages provide faster development than compiler languages. However, there were wide variances within both groups. Most of these variances are explained by skill level.

Each programmer was given a complete set of specifications, including formulas and the desired output. He was instructed to make the program operational as quickly as possible, subject only to correct output. Table 1 lists the results. Development time varied from 3 to 29 hours, a range where the longest was nearly ten times the shortest.

Execution time was roughly the inverse of development time, programs developed more quickly generally taking longer to execute. Here the variance was wider; the fastest executed

TEST	LANGUAGE	DEVELOPMENT TIME	EXECUTION TIME
	Interpreters		
1	Procedure Oriented Language (Programmer A)	3 hours	192 sec.
2	Procedure Oriented Language (Programmer B)	5 hours	53 sec.
3	APL	5½ hours	4 sec.
	Compilers		
4	ALGOL (Programmer C)	8½ hours	1.3 sec.
5	FORTRAN	20 hours	0.5 sec.
6	ALGOL (Programmer D)	29 hours	5 sec.

Table 1. An experiment in programming the same problem using different languages, or the same language with programmers of different experience, results in a wide range between development time and running time. In general, the relationship is an inverse ratio.

TEST	LANGUAGE	DEVELOPMENT COST	EXECUTION COST	ONE-TIME COST
	Interpreters			
1	Procedure Oriented Language (Programmer A)	$190	$28.80	$218.80
2	Procedure Oriented Language (Programmer B)	$200	$ 7.95	$207.95
3	APL	$240	$ 0.44	$240.44
	Compilers			
4	ALGOL (Programmer C)	$315	$ 0.21	$315.21
5	FORTRAN	$600	$ 0.11	$600.11
6	ALGOL (Programmer D)	$680	$ 0.75	$680.75

Table 2. Run times vary, though not as widely as development costs do. The number of times the program will run, however, may make the most expensively developed program the most practical.

nearly 400 times more quickly than the slowest.

To many programming managers, though, speeds are less significant than costs. Table 2 (preceding page), lists costs of one-time development and of one-time execution, based upon imputed prices for programmer billing rates and machine rentals.

Once price data enters, it is possible to compute a break-even point for the number of runs. If one were to compare test (2) with test (5) from Table 2, the break-even point would be greater than 51 runs. Only if the program were to be run at least 52 times (without modification) would the higher development cost of (5) be worthwhile.

An instructive byproduct of the experiment was the value of experience when the problem language was held constant, as in programs (4) and (6). The more experienced programmer took less than one-third as much time to develop his program, and once it was developed, it ran nearly three times faster. If both factors were evaluated equally on some scale, one could say that program (4) was "nine times better" than program (6). Since an experienced programmer is not paid nine times the wage of a junior programmer (rarely three times as much), one could conclude that expertise is often undervalued.

The variance of skill level among the interpretive programmers was less marked, so the results are not so conclusive. In general, the more powerful languages narrow the differences among programmers.

Few programming managers have the option to take even two alternatives and compare them for efficiency. The purpose of this experiment was to show that a choice is real, and that it should be considered even if outcomes cannot be predicted with certainty.

Some conclusions

1. If development time is a primary concern, interpretive languages will usually offer faster development, and at lower cost, than compiler languages.

2. The superior performance of interpreters during development may become a liability if a program is run frequently without modification. Conversely, greater running efficiency can only be purchased by exchanging time and cost in development.

3. Both development time and running efficiency can be improved by judicious application of expert programmers to the critical areas of a system. Such an allocation may extend the design time, but should return improved performance in both areas.

4. If the payoff to quick development is high, a two-pass approach may yield the best results. First, an interpretive prototype is developed. Then, a compiled system follows when it is available. The combined approach allows the best advantages of both at a somewhat higher initial cost.

5. There appear to be two important considerations outside the realm of quantification. First, little appears to be more wasteful than dozens of programmers coding the ideal system that has yet to run. Perhaps a simpler system, delivered this year instead of in three years, would be more useful. Second, several rapidly developed but inefficient systems, arrived at more or less simultaneously, may bog down resources so that nothing can be accomplished. Which is the greater danger will require the judgment of the programming manager.

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To provide a broader discussion of the choices noted above, a provocative source for increasing development time possibilities is provided by Weinberg. Improved efficiency can be realized by techniques discussed by Martin and Yourdon.

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2. Weinberg, Gerald M. *The Psychology of Computer Programming*. New York: Van Nostrand Reinhold Company, 1971.

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"Miss Pendleton, does Amalgamated Cable and Conduit Inc. own a sled?"

Mr. Cooke is manager of systems and programming at Atlantic National Bank, West Orange, N.J. He has worked for the Federal Reserve Bank of New York and IBM, and is also currently at work on a Ph.D. in economics at New York Univ.

How many uses or users
a piece of software will have is
determined by some very early design decisions.

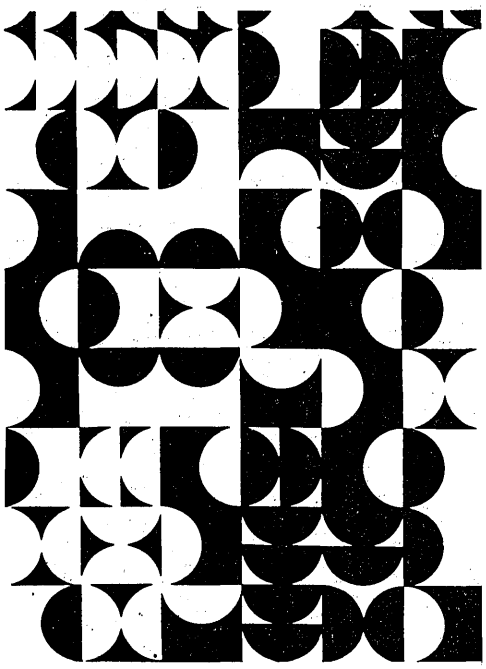
DESIGNING FOR GENERALITY

by David Frost

PROGRAMMING has begun to mature as a craft. With this maturity has come recognition that there are many frequently competing objectives which the programmer should keep in mind as he designs, implements, modifies, or reuses programs. Some major objectives are: usefulness, simplicity of form, clarity of understanding, efficiency of operation, modifiability, and generality. Of these, generality is especially important to cost reduction. It is through the application of the principles of generality that programs and parts of programs can be reused.

Some major approaches to generality are through concepts we can call:

- inclusion
- anticipation
- expandability
- exclusion
- parameterization
- use of macros
- external control
- interpretive systems



Inclusion

Inclusion is adding functions to a system to attract more "users." For example, for a subroutine, an added "user" may be another calling routine. For an operating system, an added user may be a new customer.

Of the various approaches to generality, inclusion is the riskiest, but: it is frequently necessary; it is very commonly used; and it is a good basis for comparison of other approaches to generality.

The process of inclusion results in system growth; and as the system grows in size it risks becoming uneconomical. Therefore, the reason for including an additional function must be to increase the number of users sufficiently to make worthwhile the resultant increase in cost, size, and complexity.

A large inclusive system is most likely to be successful when the user considers it to be a useful entity in itself (a product) rather than a component. Some examples of products that tend to be inclusively general are operating systems and application packages.

Even when applied to products, care should be taken when using inclusive generality, because it may work against other major objectives such as simplicity, clarity, efficiency, and usefulness (not only usefulness in general, but more often usefulness for users who don't want the added function and find it complicates the use of functions they *do* want—this is especially evident in user documentation, which can become very complicated). You may, as a result of inclusion, find your population of users smaller than you expect.

Inclusion should be used very conservatively on small systems such as individual modules. In this case, the *ex*clusive approach (to be discussed later) is far more likely to promote generality. Using inclusion with small systems almost inevitably results in less generality, not more; and the resulting systems are usually complex and hard to understand.

Anticipation

A technique related to inclusion is designing by anticipation. With this technique, you provide for the extra function in the design, but do not implement it until it becomes needed. This separation of design from implementation is like insurance; the extra cost of anticipation in the design is the insurance premium. You need to spend time, effort, and money on implementation only if the anticipated requirement becomes a reality; and if it does, the cost will be lessened because the work is already reflected in the design.

Expandability

Yet another related technique is to let the user do the inclusion himself. (Of course, the user might actually be you at some later date.) You provide the hooks, along with instructions on how to connect things to the hooks, but the user does the work of inclusion instead of you. Some examples of expandable systems are: (1) an extensible language; (2) an operating system designed to allow the user to easily write his own I/O device handlers; and (3) a direct digital control package which allows the user to add his own control algorithms.

Exclusion

Exclusion consists of removing extra functions. The ultimate of exclusion is the single-function module. Unlike inclusion, which works best at the product level, exclusion works best at the component level. The way to apply the approach to the product level is to design a set of exclusively derived components, primitives that can be put together by the user to do different things. (This is frequently called the "modular" approach.)

This can be an excellent approach, but describing how to assemble and use the components requires considerable ingenuity. This documentation effort, if not overlooked entirely, is frequently underestimated. Yet failure to do a good job in documenting is likely to result in disuse of the product itself.

In designing individual modules, the exclusive approach is extremely valuable. It promotes generality in that a single-function module has a higher probability of multiple usage, both in the current project and later. Probably more important, single-function modules usually have fewer connections to other modules, and decreasing the number of connections results in systems that are much lower in cost and much easier to understand.

Exclusion does not require as much knowledge of the total user population as does inclusion. For that reason there is a kind of serendipity that frequently occurs with exclusively general components. They not only might be usable in widely differing applications, but also in new and unexpected ways. The problem here becomes one of publicizing the existence and exact function of the systems.

Binding time

A few words are necessary about the concepts of "constant," "parameter," and "variable" in computing. Parameterization is often described as the process of changing a "constant" to a "parameter." But what is the essential difference between a "parameter" and a "constant?" Or for that matter between these and a "variable?" In computing, the boundaries between these concepts are very fuzzy. For example, what may appear to be a constant to a program is a variable to the loader of that program, and a variable in a program may appear constant to a routine in that program. Thus constancy is based on point of view. The idea of "binding time" provides a framework for various points of view.

The notion of binding time has to do with when something *becomes* constant; that is, when it can no longer be changed. Once a value is "bound" to a variable, the variable will be viewed as a constant by processes that come later. Some of the "times" at which binding can take place are:

- design
- coding
- compiling
- assembling
- loading
- initialization and activation (of the real-time operating system)
- setting a parameter for a subroutine in the process of activating that subroutine
- Storing a new value for a variable while in that subroutine
- any change to the computer's registers

This is by no means an exhaustive list, but it is a more-or-less ordered list, ordered by binding time. We say the value is bound at assembly time if there is no opportunity for "later" change, i.e., no action farther down the list can change the value.

Describing parameters

Although not really in the mainstream of parameterization, a digression is in order to discuss ways of describing parameters and constants. Just because the ideas of constant, parameter, and variable can be generalized to a single concept through the use of binding time does not mean we should discontinue using those words. On the contrary, they help considerably in communicating the relative stability of a value. But statements as to binding time should also be used. For example, "This is a constant bound at load time" is much more meaningful than either "This is a constant" or "This is a value bound at load time."

Thus a value's status as a constant, parameter, or variable should be stated *along with* its binding time in technical discussions.

Parameterization

The process of parameterizing consists of setting up a mechanism for binding a value to something at a specific binding time. That value will then appear constant to any processes that occur "downstream."

Two motives for parameterization are: (1) Flexibility of use by a downstream process, and (2) Ease and safety of changing the value of a "constant" that appears in more than one place, as well as providing a name for intellectual manageability. Perhaps this can be made clear by looking at some familiar examples of parameterization:

- Using an assembly language equivalence statement to name a "constant" and bind a value to it for use in some other statement, instead of having the value appear as an "immediate" in the assembled statement. Although both methods bind the value at assembly time, this type of parameterization promotes ease and safety in changing the constant. Thus motive 2 (safety) applies.
- Using a statement which names a constant, reserves space for it, and stores a value for it in memory, as opposed to the previous case where no space is allocated for the value. This statement defers binding to (probably) load time. Both motives 1 and 2 apply.
- Providing parameters to guide the function of a subroutine. Motive 1 applies.
- Using parameters to adapt an operating system to a particular configuration (changing binding time from "time of release of the operating system by system programmers" to "time of operating system generation"). Both motives 1 and 2 apply.

Use of macros

Macro processors provide a valuable method for promoting flexibility in parameterization of both program and data modules.

For data, macros can provide a mechanism for hiding the precise layout of and access into data structures (a variant of "information hiding" which is a very important design goal).

For programs, macros can provide a method for defining parameterized functions in line—an alternative to subroutines. (In many languages, including FORTRAN, it is impossible to tell from the function invocation whether it will be expanded and executed in line as a macro or executed through a subroutine call.) Years ago, what we now call a subroutine was called a "closed subroutine," and a macro was a form of "open subroutine." It is perhaps too bad that this nomenclature has fallen into disuse, because it shows the functional similarity of the two processes, yet also tells whether the function is executed in place or somewhere else.

External control

This approach to generality consists of taking control decisions out of a system and placing them in the hands of the users of that system. This is a form of parameterization which promotes flexible use of a downstream process (in the binding time sense). For example, the arguments to an averaging subroutine are viewed as parameters by the subroutine. The values of these parameters can dictate things like averaging interval, number of expected inputs, etc. Thus the sub-

routine's actions are controlled by something external to it.

Interpretive systems

Interpretive systems (and their variant, table-driven systems) take external control to its logical conclusion. An interpretive system can do no useful work without commands to direct it —commands which are interpreted as though they were a higher-level language. Indeed, programs written in some higher-level languages are frequently interpreted (decomposed and executed one statement at a time) instead of compiled in their entirety before execution.

An interpretive system can be very flexible. For example, TASC, an interpretive language for power plant start-up and shutdown, has been in continuous use for almost 15 years on four different computer architectures, with very little conversion cost.

Interpretive systems tend to run slowly, thus the advantages in generality must be weighed against efficiency, especially when using them in real-time systems.

Conclusion

The various methods for promoting software generality do not apply equally to all circumstances. Some of them are complementary; others conflict. Some concepts may be applied to a tiny module at the bottom of a hierarchy of subroutines, others to a sine routine in a math library, and still others, certainly, to a full-blown operating system.

Decisions as to the need for generality, and choosing methods for achieving it, are part of the programmer's job. Whatever the decisions or choices, they must be consciously made early in the design to be effective. □

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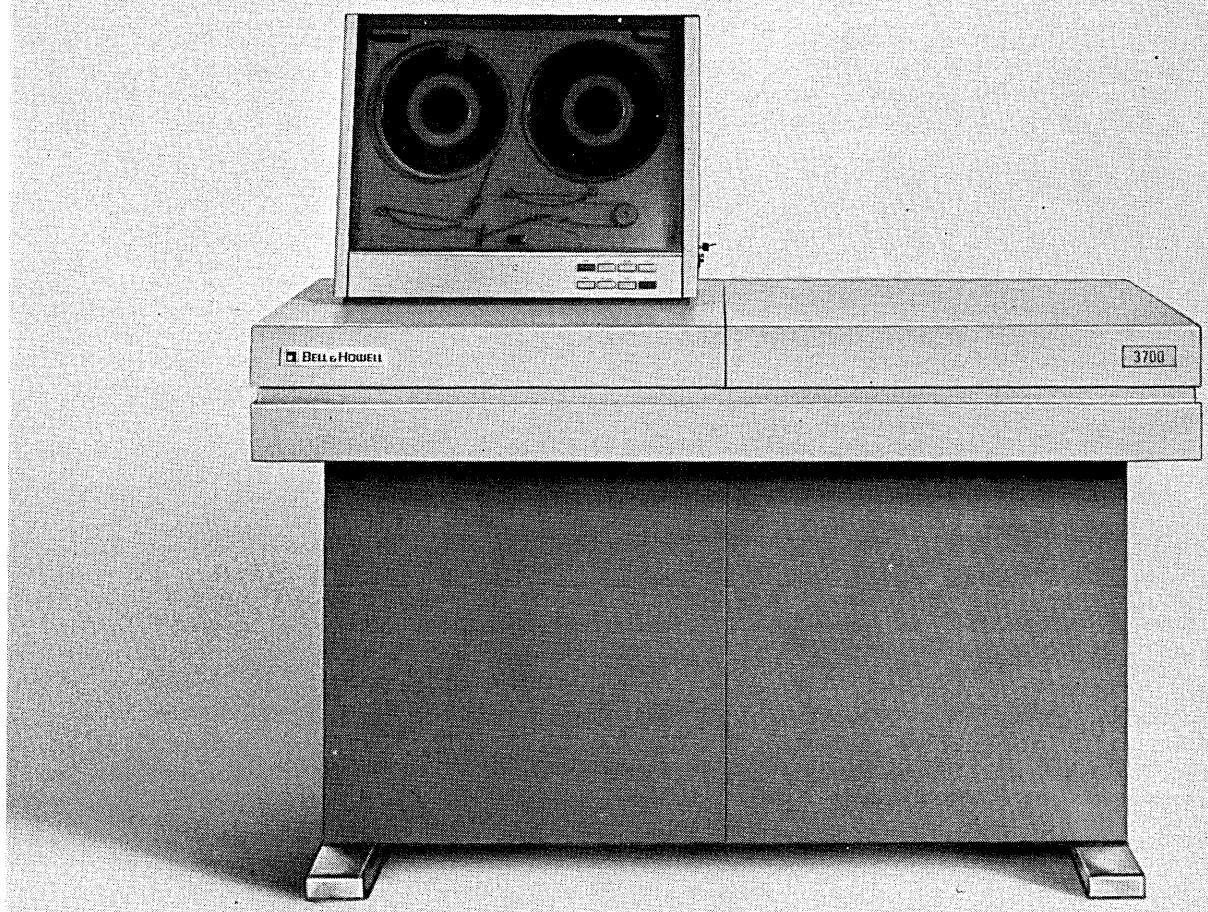

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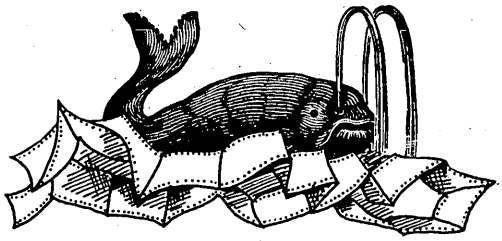


THE PEAPOD ODYSSEY

by Jackson Granholm

Call me Ishkabibble. Not so long ago, finding time on my hands, and having run out of unemployment insurance, I hied me upriver to the town of Poughkeepsie. There methought to try my hand as a programmer.

One night in the tavern called the Red Bull, I sat me next to a heathen savage, Quickcrock by name.

"Aye," says Quickcrock, "if programmin's your game, then Ackrab's the name. Well may you ask, 'Who be he?,' and then well may I answer, 'the Cap'n of the Peapod, none else'."

"What be the Peapod?"

"Aye, what indeed?" says Quickcrock, lowering his heathen voice and peering furtively through his beer. "He be the latest of the new development projects, that's all. He's a fifth-generation machine, the like of which ye never seen, and Ackrab be the captain. He be the chief of all code from here to Fishkill, and a braver man never pulled at the codesheets in the teeth of a blowing deadline."

So I signed me to the crew of the Peapod, and an odd lot they were: young hands fresh from Harvard Yard, and old hands, musty with the smell of univac. But we pulled together as a man, and the Peapod project was a trim one.

But of Captain Ackrab we saw nothing. He kept to himself in the dark office at the far corner of the third floor, and the project was run by his trusted mate, Starstruck, a fair and gentle man who breathed kindness to us all.

Only late at night, in the dark of the moon, when the codesheets were folded away and the diagnostics were stuffed in the desk drawers, we heard the stump of his wooden leg in the third floor hall, over against the water cooler, and we knew that Ackrab paced the floors and cursed the idiotic deadlines of the Peapod.

Then one bright day as we labored like happy lads at our code, we felt an awesome presence. There stood Ackrab on the poop deck athwart the blackboard, fixing us all with his staring eye.

"Men," says Cap'n Ackrab, "What do ye do when ye see a printout?"

"Scribble on it!" sings out the junior coder at desk nine.

"Aye, men, and what do ye do after ye scribble?"

"Write memos, Cap'n!" sings out the output routine bos'n.

"Aye, and memos of what?"

"Memos protesting the hardware design!"

"Aye, the hardware! The cursed hardware! The black vomit wrench it!"

"Do ye mean the Peapod, Cap'n?"

"Then ye've seen the Peapod, men?"

"Aye, forgive us, Cap'n, but we peered in at the laboratory door. The deadly curiosity had seized us."

"No matter, men. So ye know the Peapod do ye? Aye, his discs spin like the Norway Maelstrom, and his cards spew high like the fountain of the deep. His printer runs all askew like a ferryboat in muck, and his tilt lights glitter like the living eyes of Leviathan!"

"Do ye mean to check him out then, Cap'n?"

"Aye, men, I'll stuff cards in him till he sings 'enough'. I'll code him round the basement of building nine, and debug him from here to downtown Minneapolis. I'll stuff him with instructions till he spews black printout paper and the chief engineer writes 'approved' on the lubberly operating system documentation. Mr. Starstruck! Fetch me yon sorter needle! Do ye see this blue card, men?"

"Aye, Cap'n!"

"I'll affix it here on this cork border of the blackboard for all hands to see . . ."

"Now hear me, men! Whichsoever of ye—whosoever, I say—shall raise me up a sheet of checked-out code, he shall have this company bonus check!"

"Bless ye, Cap'n Ackrab!"

"Mr. Starstruck, break out yon cardboard case of stale beer. Drink around for all hands!"

"Thank ye, Cap'n."

"Now swear men! Swear ye sturdy hands all! For this be why ye've shipped on, men. Checkout to Peapod! Code him to the death, men! Swear ye'll see him

go down on schedule!"

"Aye! We swear, Cap'n."

"Ye coders all at yon desk! Dip your ballpoint pens in the stale beer here, men! Swear to checkout Peapod, all of ye!"

"We swear, Cap'n!"

"Perdition take the damnable hardware! May Lucifer himself breathe fire on yon bucket of printed circuits! It lurks there, waiting for us men. But ye'll overcome, men. We'll send that cursed machine to the blackest pit. And now, avast, men! To your posts!"

And we saw no more of Ackrab that day, but late at night we heard his stump upon the vinyl of the third floor hall.

And then, on a calm spring day, the Hudson like glass and the Vassar girls in the grass, Starstruck, the Mate of the Peapod Project, strode into Ackrab's darkened office.

"Cap'n, Sir," says Starstruck, "the men need the weekend off. They've bent to their codesheets like furies incarnate, but now the black ennui is upon them. They lag over their ballpoints. The schedule be damned! A weekend off, I say!"

"Do ye presume to cross my orders, Mr. Starstruck?"

"No, Cap'n. I'm ever loyal to ye, but the men . . ."

"There's one God in Heaven, Mr. Starstruck, and one chief of all code on the Peapod Project."

"Cap'n. A moment, Sir. Step with me here to the window. See yon river. Spring has come to us, Cap'n while ye moulder here in this tomb of a project office."

"Aye, Starstruck, ye touch me here, in my memories."

"See the Vassar girls gamboling there in yon grass, Cap'n, does it not stir your ancient blood?"

"Aye, Starstruck, it reminds me of my dear wife that I left there, mouldering, in Wappinger's Falls. I widowed that girl when I signed on to this gig, Starstruck!"

"A weekend off, Cap'n?"

"Open yon window, Starstruck. They're mowin' hay there on the slopes of Kingston, Starstruck. Do ye not smell it, man?"

"A weekend off, Cap'n?"

"Aye, Starstruck, why not turn back the clock. T'will do us all good . . ."

"Thar she shows!" sangs out the lookout coder at desk number one.

All hands ran to the fo'c'sle bulletin board. Cap'n Ackrab stumped his way to the fore, Starstruck making way for him. There, staring him fair in the bloodshot eye was the feared memo from on high, scheduling the Peapod acceptance tests for software on the morning of the Friday next, in the dark of the moon.

"The devil wrench thy putrid guts!" said Ackrab.

No man stood prouder and taller than Ackrab on his stump leg as he led his fearless crew into the mouth of hell that was the checkout laboratory, and up to the jaws of death itself: the card reader of Peapod.

"Now, Quickcrock," Ackrab said, "Into the breech, man. By all the heathen gods of far-off Santa Monica that spawned your ugly soul, lift your iron fist full of job control cards and cram them down the jaws of yon vile beast!"

Quick as a tiger on its prey, Quickcrock lifted his cards, pushed them into the yawning hopper, and, with a mighty blow, slammed home the lid.

The writhing of the monster Peapod was frightful to behold. His gleaming electronic eyes flashed with fury, and his tapes spun with a fearful lashing. Like a fiend from hell he ate the cards, gagging with each bite.

"The printer! The printer!" sang out the lookout coder as he went under for the last time, buried in the billows of fanfold that belched over him.

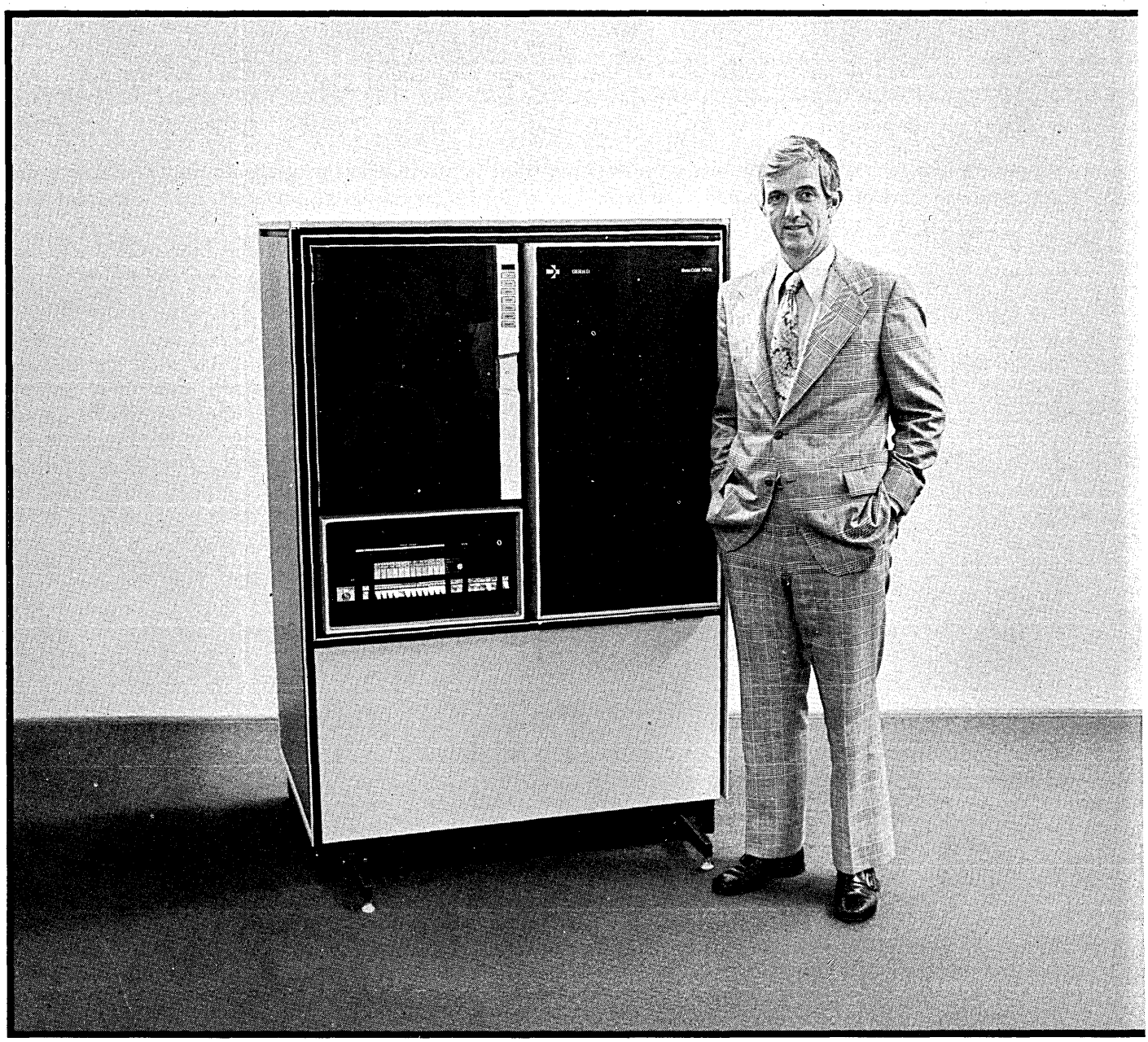
"Avast, men, the disc pack." cried Ackrab, and he grasped the pack from the hand of the dying Quickcrock as he disappeared under a ton of paper. With a mighty effort Ackrab hurled his ancient and scarred body upon the disc machine, tossing its cover to the floor. His sinewy arm drove the pack home on its spindle, then twisted mightily. Peapod was overcome.

But, alas, as he fell back from his moment of victory, Ackrab's stump was caught in the spinning pack. We, his loyal crew, saw him disappear, spinning, into the innards of Peapod in a blinding cacophany of blowing fuses and bursting breakers. Fair earth would not know again the glorious fury of Ackrab.

On the morn following came the mighty word from Armonk: "Scrap the Peapod Project!"

Somewhere along the banks of the Placid Hudson, deep at the bottom of the Poughkeepsie municipal garbage dump, Ackrab lies, entwined in the coils of the beast he vanquished. There, through long, Chinese years of pseudocodes and structured programs, the timeless battle goes on. Under the endless and rolling billows of trash, there is no rest for the weary bones of Ackrab, for he is, ever, both the victor and the defeated. □

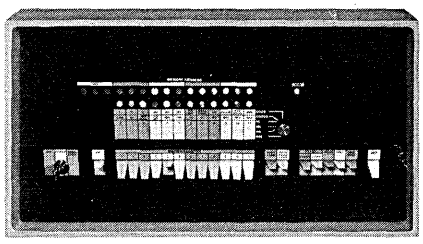
In June 1970 Lou Williams went into business with a couple of clients and 1 Gould Beta COM 700L



Four years ago, Lou Williams of Boston's COM Service Bureau went into business with a Gould Beta COM 700L and a lot of drive and determination.

COM Service Bureau's rapid and successful growth was the result of their ability to provide timely and efficient service to customers. Part of this success Lou admits was due to his Gould Beta COM 700L computer output microfilm system.

In June 1974 Lou Williams booked his 100th client and ordered his 6th Gould unit.



With its integral programmable mini-computer the Beta COM 700L will not only process virtually any computer generated print image tape without host computer reformatting, but will also simulate other hardwired COM recorders.

The result is microfilm output tailored to customer's system retrieval requirements. That means minimal systems and software support responsibilities by the customer.

With that kind of flexibility, COM Service Bureau could provide customers with service 24 hours a day, 7 days a week. With a schedule like that, the Beta COM 700L not only proves its efficiency, but its economy, as well. Which helps explain why Lou ordered five more.

Find out about the Gould Beta COM 700L by contacting Gould Inc., Graphic Systems Division, 20 Ossipee Road, Newton, Mass. 02164. Gould Instrument Systems, Europe S.A., Kouterveldstraat 13, B 1920 Diegem, Belgium.

GOULD

n 1945, computers couldn't remember a sentence longer than this

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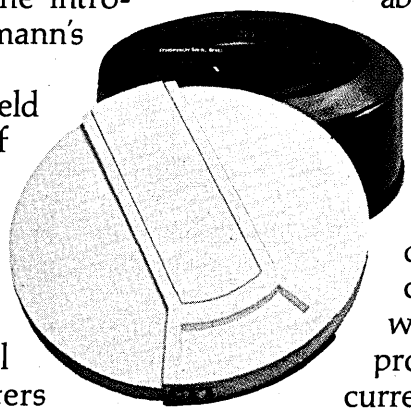
The UNIVAC II of 1958 held 2000 12-character words of core and, by 1965, computers could hold the contents of a large set of encyclopedias.

Now, the largest memory stores almost three trillion bits of data, while the internal memories of many computers contain millions of characters.

A parallel development in increasing data storage was the use of disk packs and cartridges, pioneered in 1961. These removable units gained popularity by providing a compact, secure, economical file for data. Experts agree that these rotating memory devices will be with us for at least the next decade.



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CIRCLE 16 ON READER CARD

For on-going data entry, file maintenance, and reporting, batch systems cannot compete with on-line methods.

ON-LINE VS. BATCH COSTS

by Edward J. Lias

Second-generation computers were capable of doing on-line work, but they did not make it convenient or pleasing. Few if any operating systems in the sixties had components which would encourage the sending of messages to terminals or the moving of a character string from a terminal to a file record for immediate updating. Some pioneers envisioned the benefits of communicating computer power, and occasionally coded such systems at tremendous personal and financial investment. Only a few CAI and terminal inventory systems arose on systems like the IBM 1401.

The normal procedures for maintaining data files on early machines—keypunching, verifying, 80-80 listing, etc., culminating in a batch file update —left little room for innovation in its basic process.

Contrasted below, modern machines with their extensive operating systems form the backdrop. The stage today is set with an abundance of system alternatives. On medium-scale machines (especially with virtual memory) servicing on-line terminals out of one or several partitions need not interfere with batch operations. If desired, entire machines can be devoted to advanced time-sharing operations with options for totally new capabilities never before available.

Two-year comparison

The costs presented below were documented in two years of operation at Ocean County Information Network. The shop, from the beginning, developed its government, financial and educational application systems to be communicable. The design of each application was essentially the same: a terminal user somewhere logs on, runs a program, and is prompted to enter data. The program updates master files on disc. If reports are desired, the user runs another small program and receives his report either on his terminal or on the printer at the center. All programs are written in assembly language. No tricks of coding were employed, but facilities in the standard (virtual) operating system were utilized fully, including modular programming, reentrant coding, and terminal communications. Any virtual memory system, whether based on IBM's VS/VM, Univac's VMOS, Sigma, etc. would have served. Univac's 70/46 VMOS was available.

For any application

Within the author's experience the comparison below could have been based on a government jury file of 100,000 records, a high school attendance system permitting on-line recording and printing of attendance records on 15,000 students, or a government payroll file of 2,000 records. For each of these the system design was the same: a terminal at a user location updates an ISAM disc file and reports are printed directly out of that file at any time.

In the dp world of 1974, the procedures for updating or maintaining data files need not follow second-generation procedures though they often do. In this article we ponder the reasons. If the traditional "batch" file update is safer, cheaper, less complex, faster, more rapidly coded or more easily explained to management, then it is justified in the modern shop. If more costly or complex, then it may be lingering due to prior momentum or inertia.

For purposes of this analysis, intermediate systems such as remote job entry, key-to-tape, key-to-disc, terminal-to-tape, optical scanning, intelligent terminals, or on-line inquiry to batch-updated files, were not analyzed. Only the two extremes of batch and on-line file keeping are analyzed. Experienced readers will extrapolate a third-column category specifying their local system type.

For this analysis assume that a moderately volatile file of 5,000 records is being established and maintained for two years. The records contain personal data on college students including name, address and 28 other data items. Source data originates in three places: (1) admissions office, (2) registrar's office, and (3) from students at registration time. The distance from the offices to the data center is seven minutes round trip. Address/phone changes in the files are about 15% each year. The college enrollment is 5,000.

As all major computer companies provide software for implementing file updating on-line, the comparison assumes that a contemporary machine is available. With IBM, either CICS or FASTER would perform line-handling functions without system modifications. On Univac equipment, VMOS, EXEC 8, or CAM drive terminals. With PDP-10s, Burroughs, Univac or Xerox, similar options are available permitting files to be updated *either* through batch runs or through terminals. Virtual memory machines further enhance the ease of terminal data entry.

The two approaches are so dissimilar that true relationships are hard to retain. The batch process consists of 14 distinct events. The on-line updating process consists of six events, none of which exactly parallels the former. The batch procedure produces a clean (but in many cases obsolete) file after each daily or weekly update. The on-line system will maintain a clean and timely file for which one might be willing to pay more.

Hidden costs

Some costs are too subtle to measure. For instance, some cost deserves to be added to the batch system as a complexity factor. The batch system demands frequent communications between people, offices and various service groups, phone calls, memos and people-dependency. (Are you sure the operator ran the job last night? He didn't leave word that he didn't run it.) The interleaving of 14 tasks into the other fires being put out increases costs, errors and chances for system breakdown. Its greater reliance on

ON-LINE VS. BATCH COSTS

BATCH

1. Office forms cost

Best case	$200
Worst case	$500

The registrar or admissions officer will type student data (addresses, phone numbers, etc.) on two- or three-part forms so that one copy may be safely sent to data processing. (Xerox copies may be used.) The pricing on 5,000 forms was supplied by forms salesmen with bulk price rates, rates which are likely to keep going up if the paper shortage continues.

2. People fill out 5,000 forms

Best case	$ 0
Worst case	$500

Office clerks or counselors may oversee the student as he completes the form or, if registering by mail, the student may complete the form unattended. Costs for the student's time are not included.

3. Transport forms to computer center

Best case	$100
Worst case	$300

Whether by courier, special delivery, or regular mail, the 5,000 forms must be delivered to the data center over the two-year period. Seven minutes for a round trip is assumed. Other mail may be delivered en route, of course. Data concerning adding or dropping courses, establishing new courses, etc., are not included.

4. Assemble and assign data to keypunching

Best case	$100
Worst case	$300

Costs here reflect grouping the data in daily or weekly batches. The keypunch supervisor or control clerk must interleave the batches into the queue.

5. Keypunch data

Best case	$1,302
Worst case	$1,800

5,000 records of 30 data items are punched on four cards. The keypunch is leased for $85/month and used 1/10 day each day for two years to key admissions data. No charge for card stock is included, but 1/10 of the operator's salary for the period is ($1,302).

ON-LINE

1. Office forms cost

Best case	$100
Worst case	$300

Mimeographed or single-part forms (which could be produced in the print shop) will be used since the source document will never leave the office. The data will be entered at the terminal, often in the student's presence, producing no hardcopy. The computer can later list, on plain paper or preprinted forms, a copy of the data for filing in the registrar's office. Moreover, the student can correct bad data on the spot; his actual disc record may be viewed in its final form.

2. People fill out 5,000 forms

Best case	$ 0
Worst case	$500

The cost is the same as for the batch system, but the procedure allows the counselor to have the display "ask" the questions and the student respond. "Open door" community colleges use this technique to advantage. It allows generating disc records immediately when a new student registers.

3. Transport data to computer center

Two-year actual case	$452
Worst case	$800

The terminal (a Datapoint 3300) was purchased for $1,600, two Bell 202-equivalent data sets for $1,000 from Syn-Tech, and a port in the computer front-end for $700. A 10-year life expectancy, and 10-year depreciation were used for all equipment. Inter-campus wire pairs are $2/month (up to two miles). Maintenance on all this totals $324/year.
Only ⅓ use for admissions is assumed. The terminal is used for many other tasks, displaying all college course status, viewing transcripts, opening new courses or sections, etc.

no parallel here

4. Enter the data through the terminal

Best case	$5,000
Worst case	$8,000

The data entry occurs in the local office. The computer center incurs no operations cost; the admissions personnel are working "free of charge" for the center. (Their costs are listed under Step 2 above.) Note that no one at the computer center is involved when the admissions

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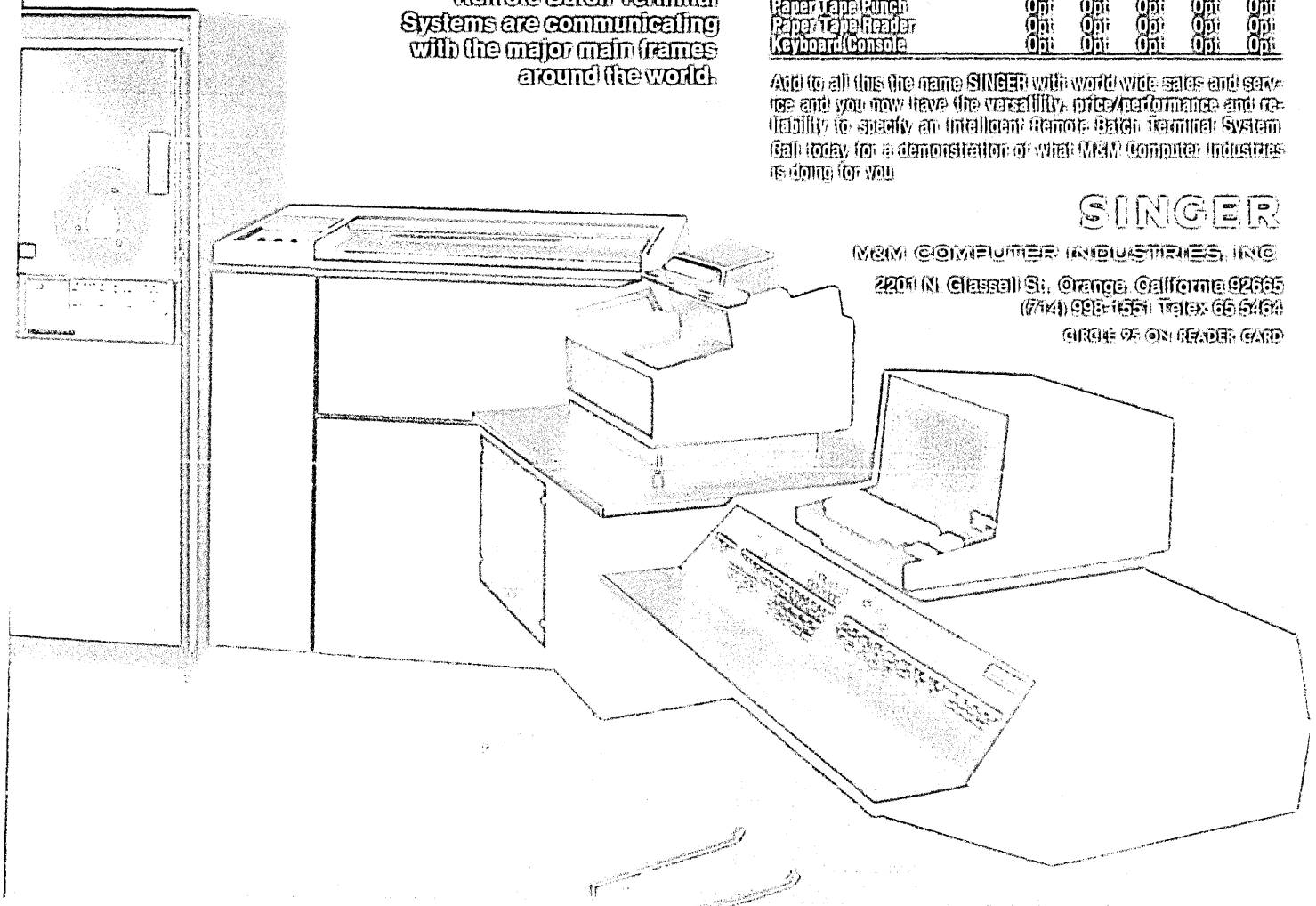

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300 cpm Card Reader	Std	Std	Std	Std	Std
600 cpm Card Reader	Opt	Opt	Opt	Opt	Opt
1200 cpm Card Reader	Opt	Opt	Opt	Opt	Opt
300 cpm OMR Card Reader	Opt	Opt	Opt	Opt	Opt
100 cpm Card Punch	Opt	Opt	Opt	Opt	Opt
225 cpm Card Punch	Opt	Opt	Opt	Opt	Opt
200 lpm Line Printer	Std				
300 lpm Line Printer		Std			
245-600 lpm Line Printer			Std		
600 lpm Line Printer				Std	
1200 lpm Line Printer					Std
Magnetic Tape	Opt	Opt	Opt	Opt	Opt
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6. Verify the cards

Best case	$1,302
Worst case	$1,800

The best keypunch operator will do the verifying, but this costs no more than the figures shown since not all fields are verified. When errors are found, however, the cards must be re-keyed two or three times. Assume 20,000 cards containing 30,000 data items are verified, and that costs parallel those shown in Step 5. More expensive check-digit features may speed verification, but cost more as well.

7. List the punched cards

Best case	$ 0
Worst case	$2,000

Commonly known as 80-80 listing, the printing incurs small cpu charges and requires little operator attention. The worst case occurs if done daily instead of weekly. (Again, the figures are based on two-year estimates.)

8. Write a program to verify the data

Best case	$200
Worst case	$450

This program will read each card image and analyze each field. If, for example, the "sex" column does not contain an M or an F, the erroneous data and some clue as to which card is involved will be printed. More important are numeric fields whose values must fall within certain limits.
This program will be 4-8K bytes in length and require four to ten hours of coding, four to eight hours of testing, four to eight assemblies, and two hours of documentation. It could be made part of the eventual "merge" program, but this would not affect its cost.

9. Schedule and run the verification program

Best case	$250
Worst case	$750

Over a two-year period, this program will be run 100 to 300 times. The $250 cost per run must cover scheduling, loading cards, operator salary, reshelving cards, distribution of printout, and cpu time.

office logs on and enters data.
The clerk in the admissions office enters data for ⅓ day each day; the cost for this is $3,000 to $5,000 including correcting rejected entries. Cpu time is also consumed, but the connect charges were already covered in Step 3 above. The actual program size is 8K bytes including all error-checking code. The program is maintained in virtual memory ⅓ day each day, incurring charges for housekeeping performed by the operating system. These charges are system-dependent and vary widely, for example, from $2,000 to $5,000 depending on virtual system design, use of reentrant code, etc.

no parallel here

Data entered this day or this hour does not deserve separate printing. The entire file or any portion or record can be viewed or printed at any time. Audit trail records may be sent to a secondary file for nightly dumping if desired.

5. Write a program to receive data from the terminal

Best case	$250
Worst case	$500

This user-oriented program will request each data element, error check each entry, maintain screen formats if desired, and write the ISAM record to disc. Actual program size is 8K bytes. It will require five to eleven hours of coding, five to ten hours of testing, four to eight assemblies, and two hours of documentation.

no parallel here

The on-line input program runs day or night, is used on an average for ⅓ the day, and requires no attention by anyone at the center.

no parallel here

Invalid data entries were costed in Step 4 above. A listing of the file can be supplied to the sending office at any time.

DP DIALOG

Notes and observations from IBM which may prove of interest to data processing professionals.

Milwaukee, which borders on Lake Michigan, as it looks after the computer has classified the different land use categories using the satellite data. The lavender areas are industrial; the red, older housing; orange, newer housing; light and dark green, agricultural and wooded areas; the blues, water.

Analyzing the Great Lakes Area from Space

Pollution of the Great Lakes—the largest body of fresh water in North America—continues to be a major concern to the governments of the United States and Canada. But new techniques are being pursued which can put a halt to the harmful pollutants now flowing into the lakes.

One of the best ways environmentalists can curb this pollution is to have information about the entire region showing how the land is being used. The trouble is, it would take years to prepare such data by conventional methods and by then some would be hopelessly outdated.

To tackle the problem scientists at the Laboratory for Applications of Remote Sensing (LARS) at Purdue University are using an IBM computer to help analyze multispectral scanner data taken of 82,000,000 acres of the Great Lakes region from a satellite orbiting the earth 500 miles up. The end result will be color-coded maps and statistical tables of each of the 191 counties in the United States with watersheds or water runoffs that spill into the Great Lakes.

"The U.S. Environmental Protection Agency will use these maps to pinpoint industrial and agricultural areas that may be causing pollutants to enter the lakes," explains Dr. Richard Weismiller, head of the Great Lakes project. "Once the sources are found, steps can be taken to minimize further pollution."

The official name of the project is The Great Lakes Pollution From Land Use Activities Study. It is a direct result of the Great Lakes Water Quality Agreement between the U.S. and Canada under the aegis of an International Joint Commission. The Commission will use the data gathered to evaluate the adequacy of existing pollution control measures and recommend remedial steps to be taken.

Remote sensing technology is not new in this country, but analysts have depended mainly on photographic data coupled with manual analysis. "With the advent of multispectral scanner systems in the mid-60's, we found there was a real need to find faster, more efficient methods for analyzing data," recalls Terry Phillips, director of data processing.

The answer lay in the computer, which could quickly analyze scanner data both from aircraft and later from space satellites. "Now data and computer-aided analysis techniques can be made available to any interested local, state or federal agency and to universities or industrial groups," says Phillips.

"In fact, we have trained other interested users to analyze our computer data themselves. We've installed terminals at six locations so they can use

(Continued on next page)

Advertisement

Computers and Mathematics Explore the Inner Ear

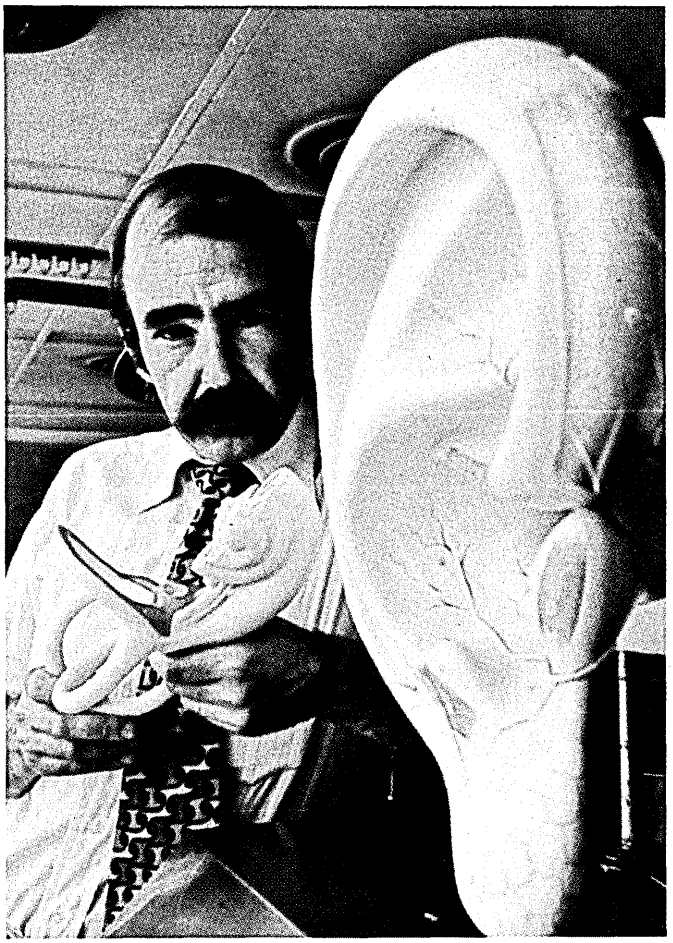
Close to 17 million people in the United States currently suffer from hearing problems. Of these, at least three million have severe hearing disorders due to defects in the inner ear or auditory nerve. Little can be done to correct or even provide some relief for this kind of deafness. The main problem is that specialists know little about parts of the inner ear called the cochlea, and inside the cochlea, the basilar membrane. This membrane, in particular, is not only hard to reach, but is so delicate that it's difficult to study without destroying it.

Over a century ago, the physicist Helmholtz came up with an idea for bypassing some of these experimental difficulties. He suggested that a mathematical description of the cochlea would provide important information. The only trouble was that Helmholtz was a century ahead of history—he didn't have all the experimental evidence he needed, and he didn't have the computational power of the high-speed computer.

Today, what Helmholtz had only dreamed of is being realized by specialists like Dr. Alfred Inselberg, a mathematician at IBM's Los Angeles Scientific Center. For 15 years, he has been developing mathematical models of the cochlea, first as a personal research interest, and later on as a full-time IBM project in collaboration with the Ear Research Institute in Los Angeles.

"We can generate a computer model based on the mathematical model," explains Dr. Inselberg. "We can then do experiments on the model that could not be done on the actual ear."

These experiments together with the mathematical analysis of the model have provided some important information. "We found, for example," says Dr. Inselberg, "that the ear's high-frequency threshold is determined by the properties of the cochlear fluids—like density and viscosity—and the elasticity of the basilar membrane.



Dr. Inselberg holds a model of the inner ear used in anatomy classes at UCLA medical school.

"By contrast, the low frequency threshold depends on the shapes and relative dimensions of the cochlea and the membrane. From this, the nature of Meniere's disease—a kind of deafness characterized by ringing in the ear, where the lower frequencies are primarily affected—can be better understood.

"We also found that certain defects could—in principle—be compensated for by changes in various properties of the cochlea. For example, changes in the stiffness of the basilar membrane could be compensated for by changes in the viscosity of the cochlear fluids."

This kind of information is of great assistance to Dr. Inselberg's colleagues at the Ear Research Institute. They hope to use the model to diagnose the hearing defect. Then by experimenting with different approaches on the computer model, they plan to determine the best one to take. **IBM**

The Great Lakes... *(Continued from first page)*

the data and the analysis techniques stored here in the Purdue computer any time they want."

On the Great Lakes project the scientists are working from data gathered by remote sensing devices located in a NASA-operated satellite called ERTS, Earth Resources Technology Satellite.

ERTS is essentially a flying observatory orbiting the earth every 103 minutes. It carries two independent sensors —one a camera system that is really three cameras in one. The cameras simultaneously photograph overlapping views of the same area segments, each one hundred miles square.

The other sensor is a multispectral line scanning device. It picks up the reflected energy of a scene in a line-by-line fashion. The optics of the system refract this beam of energy separating it into components according to wavelength.

The spacecraft can transmit the data to a ground station when it is in line of sight. Otherwise, it stores the information on tape for later transmission. In the United States there are three ground stations—in Alaska, California and Goddard Space Flight Center in Greenbelt, Maryland.

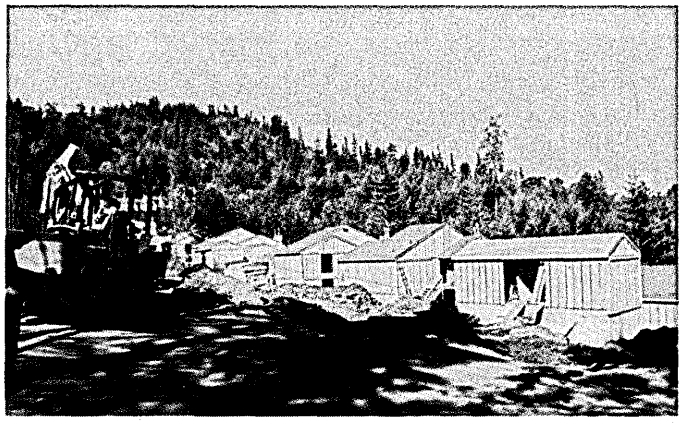
The data from all three centers is digitized at Goddard, which sends it to laboratories like LARS for analysis. Scientists at LARS run these scanner tapes against programs stored in its computer to generate either color images or printed statistical charts.

Dr. Weismiller believes the combined technology of the satellite and the computer offers us a chance to take a comprehensive inventory of our earthly resources. "The Great Lakes project is only one of many possible applications. We can now survey hundreds of thousands of square miles to identify regions of highly promising ore potential; map forests, determining types and volumes of trees in specific areas; make soil maps which sort out productive land from unproductive land; and determine such facts about the soil as iron content, organic matter and drainage patterns." **IBM**

A Model Approach to City Planning in Oregon

Eugene, Ore., nestled in the green Willamette Valley of the Pacific Northwest, is growing at about five percent a year, and its 90,000 citizens want to keep its growth orderly. In developing new areas under their general plan, the city fathers don't want to exceed the boundaries already set for urban services, such as street networks and sewer lines.

A series of computer programs utilizing a System/370 Model 155 is currently being developed to aid in the analysis of proposed zoning changes, development proposals and planning studies. Data on each parcel of land is stored in the computer—ownership of the parcel, its assessed value, address, current land use and, for certain parts of the city, topography, soil type, vegetation and slope characteristics.



Geographic modeling helps planners determine if new housing subdivisions, like this one, can be serviced adequately.

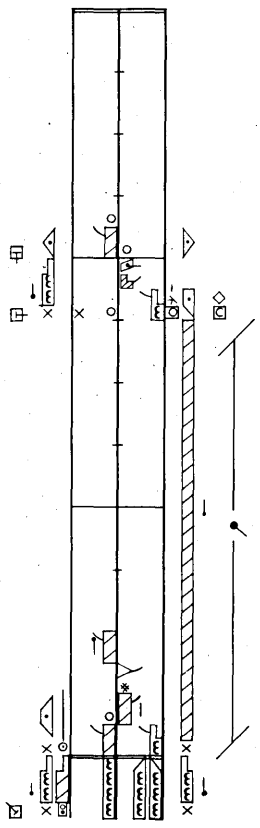
"By simulating different uses of land in the computer, we will be better able to predict what effects any change in zoning may have," explains John Porter, planning director for the city.

A plotter attached to the computer can sketch out any area of the city, from an entire downtown section to individual blocks or parcels. In addition to being able to specify certain geographic areas for data retrieval, the system can retrieve selected data elements. By initiating a job through remotely located IBM 3270 terminals, planners can obtain information in the form of printouts or plots.

The City Planning Department is not alone in the effort to develop a geographically-based information system and modeling techniques. The Public Works Department has implemented a sewer analysis model which has been used most recently to simulate the effects of population increase in one part of the city. The model is designed to compute, for varying levels of population, the amount of sewerage that must be carried by the remote collector lines through the major trunk systems to the treatment facility.

In another use of geobase modeling, traffic planners are completing environmental impact statements with the aid of an urban gas diffusion model. The system is able to predict emission concentrations at a given point based on such considerations as the street network and traffic volumes.

Through such geographic modeling projects, the computer can help make it possible to compare the effects of alternative courses of action for city decision-makers. Joe Williams, director of data processing, says, "The series of projects makes well-managed, orderly growth for the Eugene area a possibility instead of just a goal." **IBM**



A Typewriter for the Dance

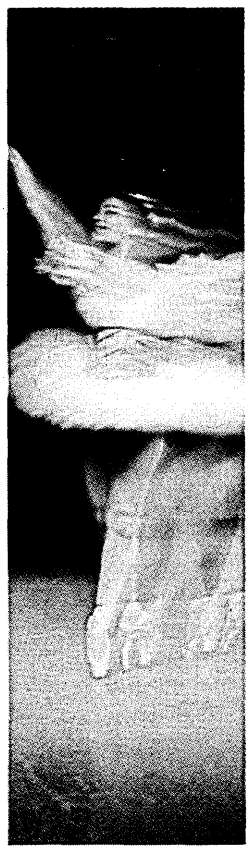
The illustration at left is not an architectural rendering but a part of a ballet score typed with an IBM Selectric® typewriter. It tells the ballet master that a "bourrée avec port de bras" is what is most called for, or more simply, a graceful step across the stage with an upward movement of the arms.

These notes are written in Labanotation—a system developed by Rudolf Laban 45 years ago. In short, it is to dance what a music score is to music. Until recently, it had one serious drawback: the notator had to prepare the dance script by hand. This required the skilled hand of an artist, trained in Labanotation, who could render the symbols with proper emphasis and clarity.

In an effort to speed up the process the Dance Notation Bureau of New York approached IBM to help find a way to reproduce dance notation symbols mechanically. Therein began a collaboration between a group of dancers and notation directors at the Bureau and a team of IBM engineers and type designers from IBM's Office Products Division.

The outcome was the development of a special ball-shaped typing element which, when used with a modified IBM Selectric® typewriter, permits the printing of the Labanotation symbols. The element contains 88 separate characters which can be arranged and built upon to form a complete vocabulary for recording movement of any kind.

In fact, Herbert Kummel, executive director of the Dance Notation Bureau believes the extension of the system to electric typewriters is "just the first step in making movement notation more accessible. Without question it will facilitate the use of Labanotation in the 90 colleges and universities now teaching the method. By describing the movement and recording it mechanically we hope to make comparative studies in physiotherapy, athletics, anthropology and the behavioral sciences." **IBM**



Advertisement

A comprehensive new approach to teleprocessing makes it possible for any terminal, on any line, to talk with any program in the computer.

Teleprocessing Landmark

As teleprocessing has evolved, so has the variety of terminals, line control methods and programming support —many of which are incompatible with each other.

A new development from IBM, called Advanced Function for Communications, is designed to expand communications capability and improve productivity. Available till now only for systems within specific industries, it combines new equipment and programming and uses System/370 computers under virtual storage.

This new approach applies a unifying design to an entire teleprocessing function. It permits users to move readily from one IBM terminal-based system to another with a minimum of application programming changes.

A single teleprocessing network is now available for many uses. The network can handle a broad range of multiple online applications. And terminals and equipment on any line can be shared by different applications.

For example:

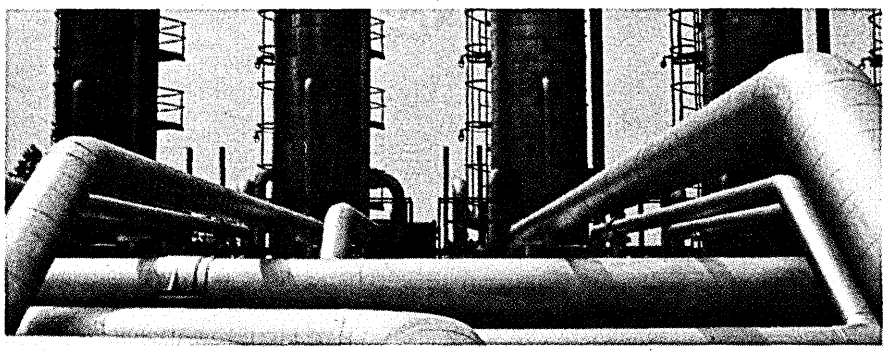
- In manufacturing and process industries, remote sales offices and plants can share communications facilities and terminals for sales, order entry, production reporting, and finished goods inventory.
- A motor freight company can enter freight bills and, with the same terminal, do message switching and equipment control transactions.
- Railroads can combine yard reporting, waybill entry and demurrage accounting.
- In insurance offices, terminals can be shared for claim verification and policy endorsements.
- In banks, making changes on CIF files, calculating yields on bonds and entering data in the trust department can be done on the same terminals.

Advanced Function for Communications includes three major software elements: the virtual operating system itself; the Network Control Program (NCP/VS) resident in the IBM 3704/3705 Communications Controller; and VTAM, the teleprocessing access method for System/370 virtual systems.

A family of terminals and communications products—most using advanced Large Scale Integration (LSI) technology—is available for use with Advanced Function for Communications. All utilize Synchronous Data Link Control (SDLC), a flexible, more efficient line control method.

The latest members are included in the IBM 3767 Communication Terminal, the IBM 3770 Data Communication System, and new models of the IBM 3270 Information Display System. For the 3767 and 3770 systems, an automatic terminal identification capability, an optional security key lock and an optional magnetic stripe reader (operating under SDLC) offer safeguards against unauthorized use of terminals or access to data files.

Other IBM terminal-oriented systems that offer Advanced Function for Communications are the 3600 Finance Communication System, the 3650 Retail Store System, the 3660 Supermarket System, and the 3790 Communication System.



In manufacturing and process industries, remote sales offices and plants can share communications facilities and terminals.

DP Dialog appears regularly in these pages. As its name suggests, we hope DP Dialog will be a two-way medium for DP professionals. We'd like to hear from you. Just write: Editor, DP Dialog, IBM Data Processing Division, 1133 Westchester Ave., White Plains, N.Y. 10604.

IBM®

74-6

10. Skilled study of the output

Best case	$100
Worst case	$600

The error list produced above must be studied. Recommended corrections will usually be hand-written. Over a two-year period, this examination will cost between $1 and $6 each time.

11. Correction cycle

Best case	$ 600
Worst case	$1,100

This correction includes re-keypunching, re-verifying, hand-sorting, merging the corrected cards into the right trays, and maybe 80-80 listing the deck. Also included is the inspection by all attending technicians, labeling of trays, and other handling.
At this point the card tray is assumed to contain correct data. Whenever reports contain errors, it will be because the procedures relied too heavily on human skills. Note that very little machine assistance can ease the physical process. A $ million processor awaits a hand operation.

12. Write a program to merge the cards onto the disc file

Best case	$200
Worst case	$450

The program will contain little or no error checking and may be less than 4K bytes in size. It will do both card and disc or tape processing using ISAM file macros. Four to eight hours of coding will be required, as well as four to eight hours of testing, four to eight assemblies, and two hours of documentation.

13. Run the file update program

Best case	$ 500
Worst case	$1,500

The program above will run 100 to 300 times over two-years to periodically bring the student master file up to date. The costs include scheduling the run, operator salary, and cpu time.

14. Maybe punch the master file onto cards

Best case	$1,000
Worst case	$2,000

Shops which have card punches often use cards to back-up the disc files. (The author's shop has no card punch.)

Result

The master file is clean, but obsolete by one day to one week.

Best case total	$ 5,854
Worst case total	$14,050

Number of tasks performed at the data center:

by people	8
by machine	4

no parallel here

The student records are not kept physically in this system. If the admissions office keeps a printout in its file, this is incidental to the process and not required by the system. Admissions officers can modify any record in the disc file day or night; this applies to all error checking and correction, too, and was costed in Step 5 above.

no parallel here

no parallel here

6. Create save-tapes of the disc file nightly

Best case	$1,000
Worst case	$2,000

File backup must be secure. Five-day running backup plus occasional special shelvings are routinely maintained.

Result

The file is clean, up-to-date, and ready for reporting at all times.

Best case total	$ 6,802
Worst case total	$12,100

Number of tasks performed at the data center:

by people	1
by machine	2

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people makes it susceptible to Asian flu, work slowdowns, etc.

Another factor: Is the center open to on-line work, or does it view the on-line program as pollution, tying up a section of (virtual) core for two years which should better be running "pure" batch jobs (of 70,000 byte size). If on-line updating is viewed as a "waste" of core, then the supporters of the center will be shown "proofs" of how much better the machine performs in batch style without "costly" communications gear. When believed, the staff at the center will be made much larger to accomplish the eight human tasks in the batch list above.

Intangibles such as the education of clerks who enter the data, training of the local office management, the use (or non-use) of the terminal for other functions (dropping and adding classes, reporting, and mailing list maintenance done on the same terminal in our instance) and the ability of the local office to run their reports when they want them do not significantly change the analysis above.

First- and second-generation software and systems can easily be perpetuated on modern machines. Somewhere there may yet be IBM 403 unit-record systems running unchanged on IBM 370/168 processors. If the remarkable capabilities of current machines and operating systems can be utilized with fewer personnel, fewer and smaller programs, and with six (not 14) tasks, and if double the services can be obtained for the same expenditures (or for double the expenditures), then the wide-scale perpetuation of batch updating systems may be questioned.

The argument stating that machines can be used more efficiently in batch mode fails to include the computer personnel and surrounding activities which incur tangible costs. It also fails to adjust to the newer operating systems which make communications systems feasible.

Personnel costs generally outweigh machine costs. If this is eventually accepted, and if the above analysis is borne out by other data centers, then Mack Truck-like systems will yield to the simpler personalized systems with communications. Those who automate other people's offices should automate their shop internally as well; modern operating systems encourage it.

The costs of disc files now compete with tape very well. The cpu time used when moving cards to tape or when moving data off-line from disc to tape or cards easily closes the cost gap between the media. In the author's experience on-line systems do not represent a substitution of one method for another, but rather new capabilities never before available, improving the integrity of the operational procedures. □

The Ocean County Information Network, the site of the cost comparison made in this article, maintains a computing facility to provide services to the county government, county college, and public schools in Ocean County, N.J. Mr. Lias is its director.

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CIRCLE 8 ON READER CARD

Micros are bringing increased capacity, flexibility, and reliability to terminals, peripherals, and everyday products.

THE EMERGING MICROCOMPUTER

by Edward K. Yasaki, Sr. Associate Editor

On the way to the electronic calculator, the microcomputer was born, destined to have a far-reaching effect not only on the classic data processing shop but also on people's everyday lives. Shoppers in grocery and retail stores are seeing electronic terminals where cash registers formerly stood. In the dp environment, one sees previously dumb terminals getting limited processing capabilities. In both instances, the microcomputer has made it possible to bring some of the so-called intelligence from the main processor out to the remote terminal device. More than this, it makes it economical to tailor terminals to specific applications.

The microcomputer is a general purpose, programmable device, available in a number of architectural designs and configurations, as detailed in the accompanying survey. If one were to grade devices by intelligence starting with the simple 4-function calculator, the list might progress to the programmable calculator, the scientific calculator, programmable controller, and finally to the minicomputer. The microcomputer fills the gap that formerly existed between the programmable controller, and the minis.

Interestingly, the latest addition to this spectrum began with an inquiry from a Japanese calculator manufacturer, Busicom, to Intel Corp. What Busicom wanted were some custom calculator circuits. But the Santa Clara, Calif., semiconductor company at that time had only a couple of circuits on the market and didn't wish to commit its scarce internal resources to such an undertaking. Instead, it proposed a building block, microcomputer approach, relying on only four large-scale integration (LSI) circuit chips. There would be one each for the central processing unit, a read-only memory (ROM) for the instruction set, a read/write or random access memory (RAM) for data, and a shift register for additional I/O. In this way, it was said, the four packages could meet the initial needs of the calculator maker and make possible additional models by the simple procedure of changing the ROM pattern and configuration.

What resulted was a four-bit micro. A follow-on eight-bit design was developed by Intel for a Texas terminal manufacturer, Datapoint. By the time the chip sets were completed, however, the customer had upgraded its terminal design and found Intel's 8008 microcomputer was too slow. Datapoint implemented its model 2200 with the more powerful and faster TTL logic (the dominant circuits for logic) using MSI (medium-scale integration).

Since that time, however, the microcomputer to an increasing extent is being used in place of those same types of MSI TTL logic circuits. Bob Wickham, market analyst at Creative Strategies Inc., San Jose, Calif., figures a microprocessor typically replaces from 50-200 TTL logic packages. A manufacturer of programmable calculators, supporting that statement, claims to have done away with 200, in the process reducing his costs in half for that part of the machine. In an OCR system, some 100 discrete components are said to have been replaced by a micro, the cost of the recognition portion similarly cut by 20%.

In such systems, of course, the user does not see the microcomputer. He receives only the benefits that accrue from its incorporation. But the benefits are said to be many and significant.

First, microcomputers reduce design time for new systems by up to 50%, says CSI's Wickham. In addition, the costs of reworking a system are also cut. Intel's Hal Feeney, marketing manager for Micro Computer Systems,

"That's a great innovation . . . microprocessors so small they're invisible . . . unless, of course, you're putting me on."

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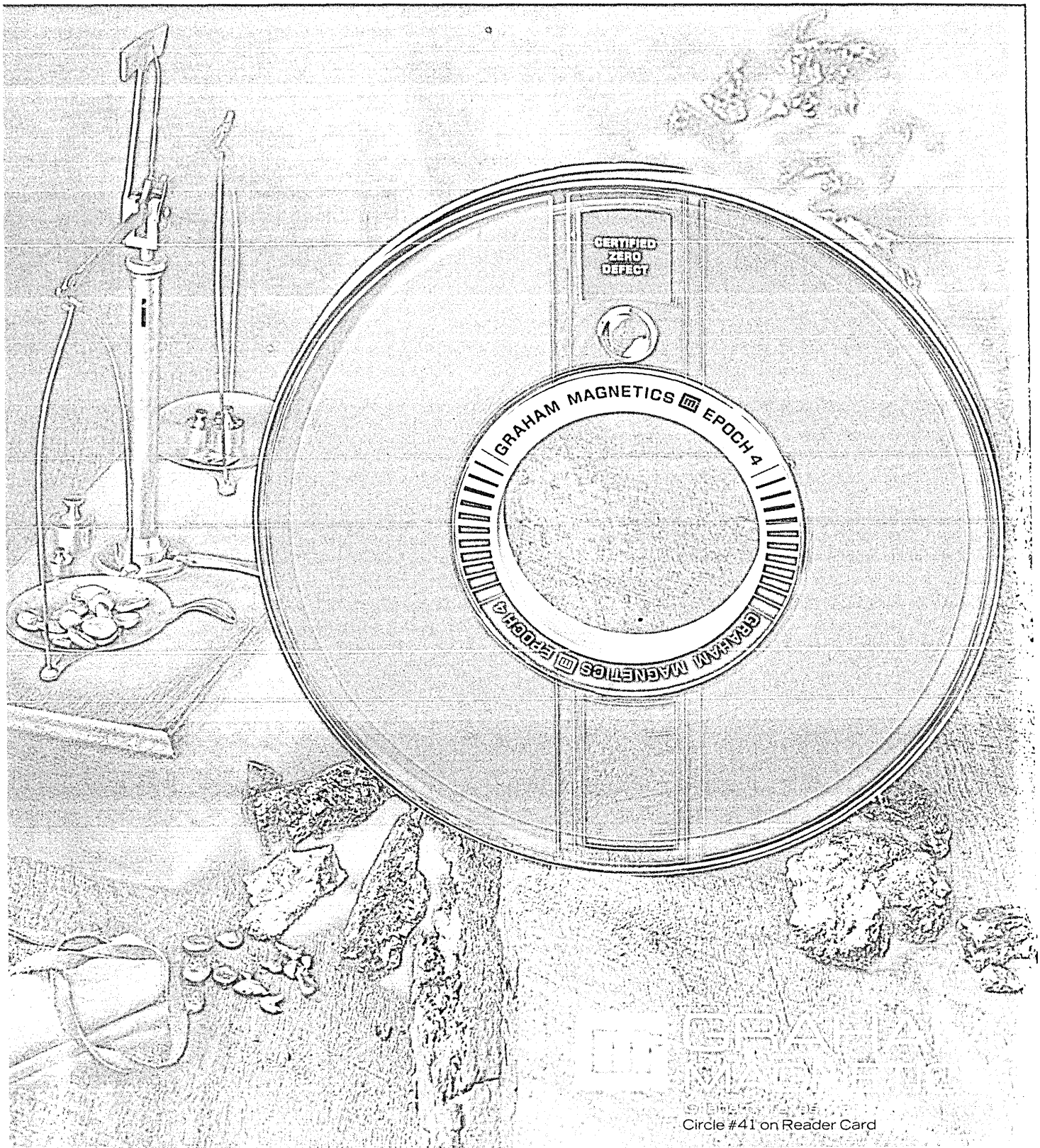

Circle #41 on Reader Card

says one customer reports his rework was only 30% of what it had been using TTL. What with 20-30 microcomputer chips replacing several hundred of another variety, the manufacturer saves money in his component expenses and inventory costs, the labor involved in stuffing those devices onto a printed circuit board, and in debugging a system (with only a few dozen packages instead of several hundred). How much of this cost savings is passed along to the customer, of course, is up to the vendor.

Tailored to fit the user

But there are ancillary benefits for the consumer. Reliability increases appreciably, this being related to the number of devices and their interconnections. Power consumption drops, space is saved, and portability is enhanced. Most significant, perhaps, there can be more capability and flexibility in the system. The manufacturer is able to program his device to meet the user's requirements. Says Intel's Feeney, "Once they develop the hardware, they could have an entire family of terminals, say, and change the characteristics of the terminals by changing the program or the amount of ROM in the system." He adds that the same electronics, with only changes in the programming, could be sold overseas to accommodate the languages of users there.

To the Intels and National Semiconductors and others that are delivering microcomputers, the customer is the original equipment manufacturer (OEM). And one such OEM is Calma Co., a Sunnyvale, Calif., systems house that produces turnkey graphic systems. Joe Sukonick, manager of R&D there, says his end user "will be seeing more and more equipment designed to bend over backward to accommodate users." He adds, "He'll be getting much greater capabilities . . . People are trying to make the hardware more usable for programmers, since it doesn't cost that much to add features." Others refer to the ease with which equipment can be upgraded in the field.

The catch, however, is in the size of the manufacturer's production run, the ability thereby to amortize the cost of programming the ROMs, as well as the speed difference between the TTL circuits being replaced and the microcomputer replacing them. (There can be a difference of as much as two orders of magnitude.)

The use of micros as replacements for hardwired random logic, either to upgrade an existing system or to add to system programmability — previously difficult or impossible to achieve economically—currently accounts for about 60% of microcomputer sales, according to the research firm of Gnostic Concepts, Inc., Menlo Park, Calif. But this will drop to some 23% by 1978. Less than 25% is going for minicomputer replacement, a fraction that will fall to 10% in '78. They see future growth coming not from either of these two markets but from new applications, which perhaps account for only 17% of microcomputer sales now but will grow to almost 70% by 1978.

COMPARISON OF TYPICAL MICROCOMPUTERS AND MINICOMPUTERS

Characteristic	1974		1978	
	Microcomputer	Minicomputer	Microcomputer	Minicomputer
Execution time (μsec)	2.0-25.0	0.5-2.0	0.1-10.0	0.1-2.0
Word length (bits)	4-16	8-32	4-16	8-32
Number of instructions	<70	100-200	<200	150-250
Memory capacity (K bits)	8-128	128-512	8-512	128-1024
Memory technology	Bipolar/MOS	Core	Bipolar/MOS	Bipolar/MOS
Price ($ thousands)	0.2-2.5	3.0-25.0	0.2-2.5	3.0-25.0

Courtesy Gnostic Concepts Inc.

Table 1

Market size becomes more meaningful when it's expressed in dollars. According to Quantum Science Corp., 1973 sales of microcomputers in the U.S. were about $9.4 million, but shipments in 1978 will come to $105 million. Sales abroad in '78 are said to add only $15 million. By contrast, minicomputer sales in the U.S. in '73 were $127 million, projected to drop to $122 million in '78.

It's been recognized that some minicomputer-based systems have more processing power than is required. Bob Wickman calls it "overkill." Still, a mini was the cheapest thing around, so it was used to perform the control function. In such applications, explains Helmut Wolf of Gnostic Concepts, a mini may be not only much faster than is required but also expensive and bulky. Here the micro steps in. It's smaller, cheaper, and usually slower, but still programmable. In addition, says, Wolf, "It can be used in extreme temperature ranges . . . A minicomputer can operate only between 0° and 50° C. But a microcomputer can operate almost over the entire military specifications range."

Bob Simko of Gnostic adds that micros can be configured as standard building blocks for an application, something that can't be done with a mini. Speaking of the San Francisco Bay Area Rapid Transit (BART) system and its troubles with train control, he says, "If microcomputers were around at the time BART was conceived, some of those problems could have been solved swiftly and probably more economically."

Intel's Feeney says micros are currently replacing minis for select applications to about the same extent that the minis originally replaced larger computers—where the processor is being under-utilized. But he says micros are also placing intelligence where previously there had been little. He cites things like games, measuring scales, and point-of-sale devices. But a micro is also sniffing for marijuana at the Mexican border, and is being used for depth measurement in a scuba diving program in Hawaii. In the latter application it is being used to control ascent to prevent a diver from experiencing the bends.

Other applications seen are microcomputers controlling appliances in homes, performing control and monitoring operations in automobiles, and in anti-skid systems on cars and trucks.

Programmable peripherals

"I think in five years every new terminal will be intelligent," says CSI's Wickham. He says micros will promote the distributed processing concept, featuring centralized control and centralized data bases but with an increasing amount of the processing being performed at remote sites. And he sees hardware becoming more applications-oriented. With a programmable ROM in the processor, he explains, a peripheral becomes a programmable piece of gear. This, he says, is what is leading to speculation that IBM's FS (future system) will go heavily into communications, will stress distributed processing, and feature peripherals that are heavily applications-oriented.

A technology known not solely to IBM, microprocessors will also make it easier for manufacturers to make things plug-compatible with IBM,

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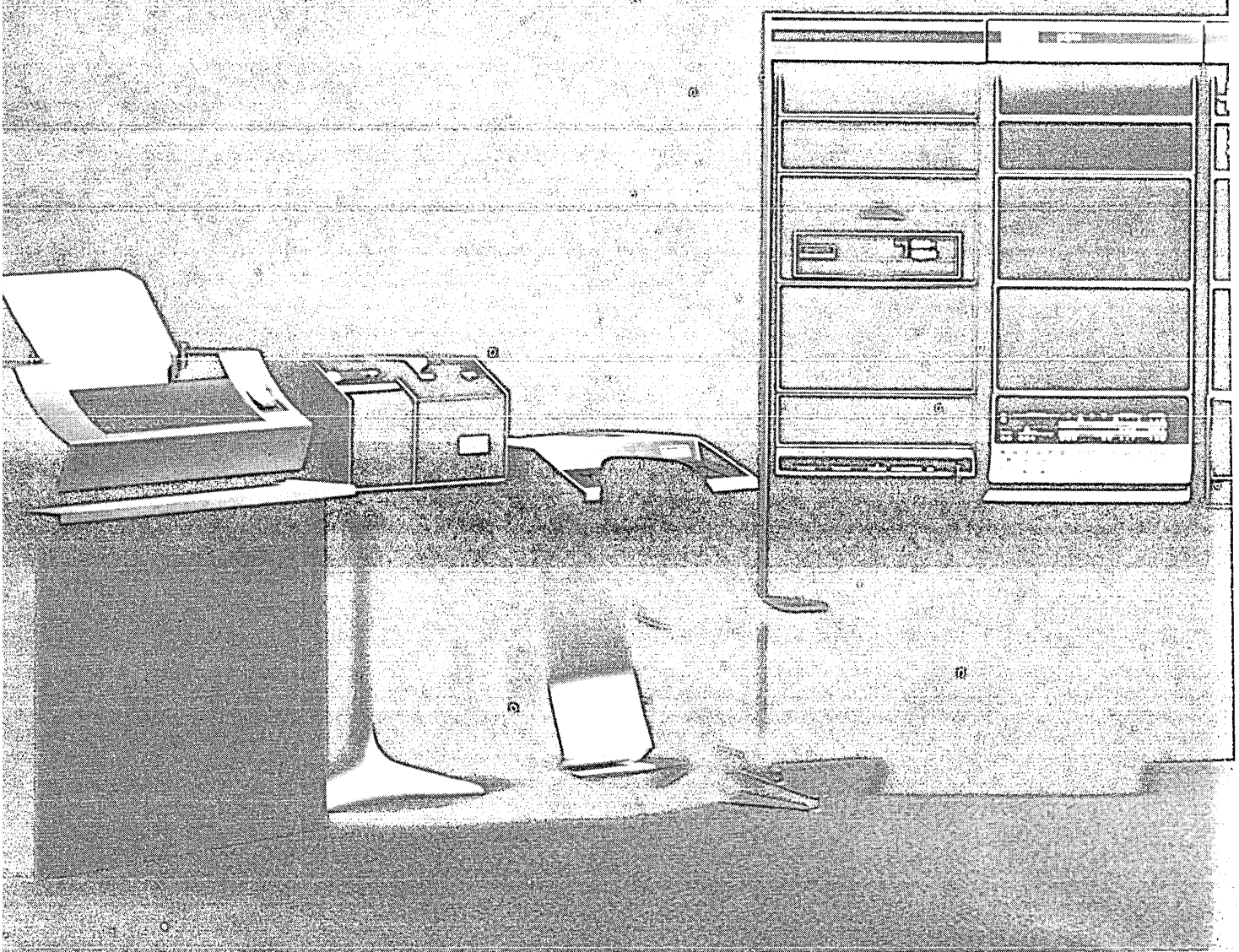

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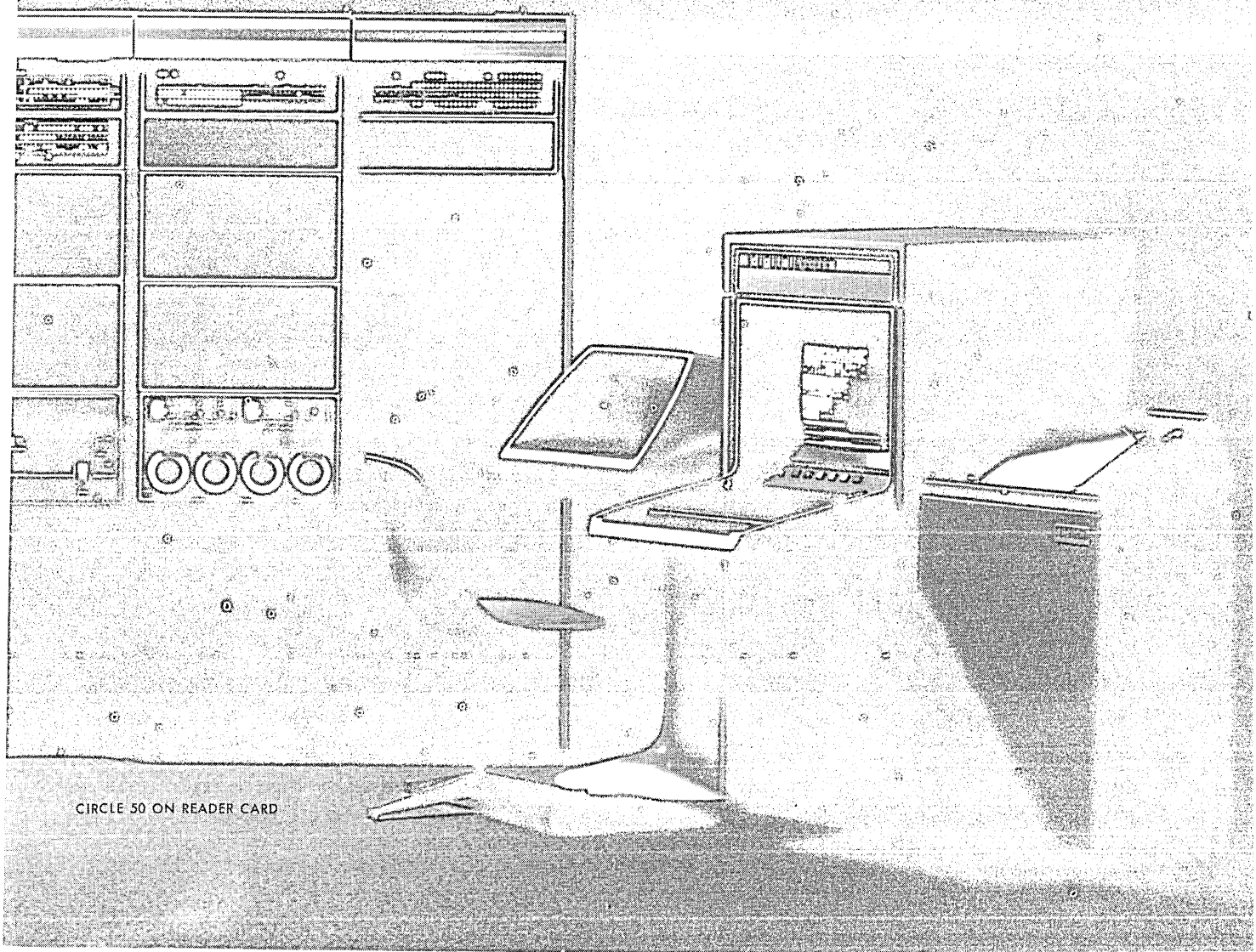


CIRCLE 50 ON READER CARD

Wickham continues. And, at least with peripherals, it will make it easier for the other mainframe makers to react to IBM's FS.

The third generation

These manufacturers, as well as those of minicomputers, are said to be the targets for the latest bipolar micros. Using the faster bipolar technology, instead of the MOS design of previous devices, these new micros operate at speeds comparable to those of minis. They could therefore be incorporated into the design of new computers and peripheral controllers.

In a mini, says Intel's Jim Lally, there might be 200-250 circuit packages in the cpu portion, a component count that could be reduced by some 80% by a bipolar micro. In terms of the total mini, however, the cpu portion represents perhaps a mere 20% of the cost.

The contrast between the current crop of micros and the mini, published by Gnostic Concepts before Intel announced its bipolar model, is illuminating. (See Table 1, p. 83) However, the figures indicate the gap between minis and micros will be closed in the next few years.

With prices in the electronics field falling historically about 30% a year, one might anticipate that prices of micros would similarly plummet. Instead of becoming cheaper, however, they are becoming increasingly complex and significantly faster. At the time of its introduction, the Intel 4004 4-bit processor was priced at $60 in unit quantities. The 8-bit 8008 cpu chip, which measures only ⅛th by 3/16th inch, was priced at $120, and the follow-on 8080 chip, only about 50% larger, costs $360. At Intel, those two are considered as second-generation microprocessors, while the latest bipolar model is already into the third generation.

With the increasing capabilities of these newer processors, it stands to reason that users are finding a broader range of data handling tasks for them. Similarly, and to the delight of memory manufacturers like Intel, one finds that a larger hunk of memory is being used with the fancier processors. Hal Feeney, pressured to generalize, says in control applications a 4-bit processor typically is used with about 1,000 bytes of memory. With a small 8-bit model like the 8008, used in data processing-oriented applications, there might be 2-4K bytes, while the 8080 more likely is shipped with from 4-12K bytes.

This prompts the observation from Manny Lemas that the cost of the microprocessor is often dwarfed by the cost of the memory. Lemas, president of newly formed Microcomputer Associates Inc. in Santa Clara, Calif., one of several consulting firms that recently have popped up in this field, notes that the microprocessor is an excellent vehicle to hypo the sales of memory chips. And he adds that to the systems developers, these hardware costs may be nothing in comparison with the additional costs of programming and interfacing the system.

Still, benefits of cost reduction, product flexibility, and improved reliability are there for manufacturers to pass along to users. Around the world, the interests of electronics technicians and systems developers is evident at the numerous seminars being held on the subject of microcomputers. The standing-room-only crowds at the several Wescon sessions on this topic in September attest to this. And one can see the same interest at seminars in Tokyo.

Now if only the end user, with his intimate knowledge of applications, could get into that design loop. □

In one coffee break CalComp's Automated Tape Library can find and load 40 reels.

This library doesn't run on coffee.

The only way it can load the wrong reel is if you tell it to.

Behind that innocent front it can store over 6,000 reels of ½" tape. It can find and mount any one of those reels in an average time of 15 seconds. And it can serve 32 separate tape drives.

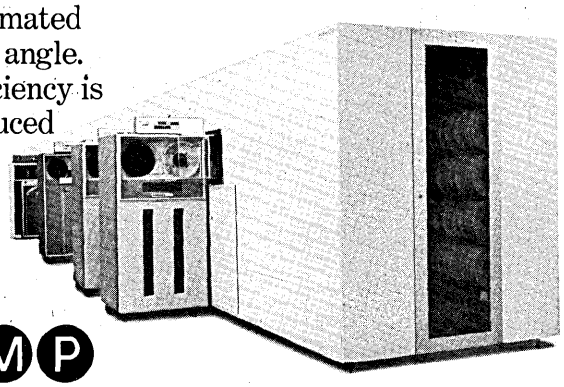
The tapes are automatically selected, mounted and then dismounted and returned when the job is done. Human hands never touch a thing.

The wrong reel never comes through those entry ports. And physical damage or loss of a tape is a thing of the past.

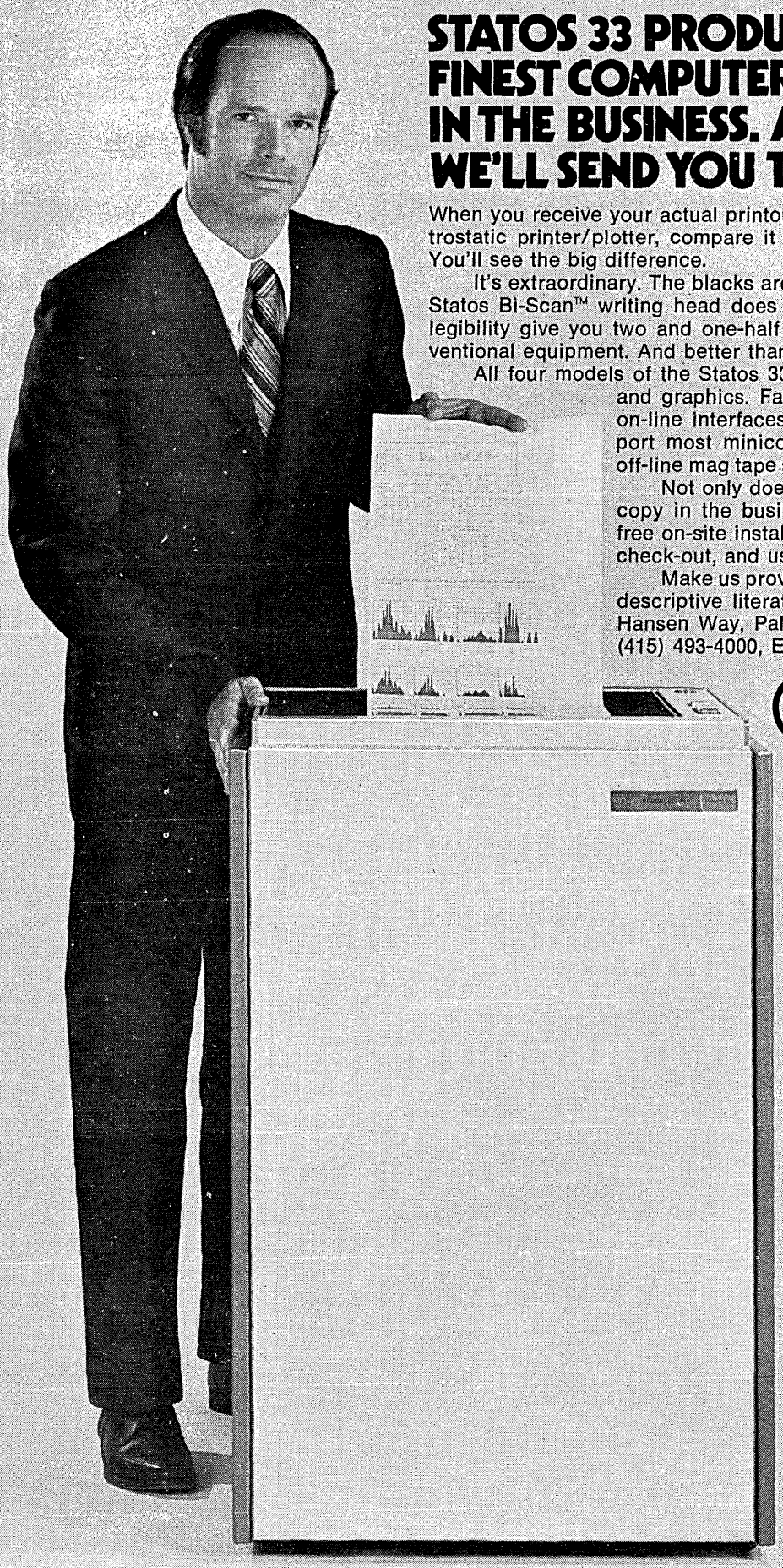
You could justify purchasing The CalComp Automated Tape Library from any angle.

The increased efficiency is obvious. So are the reduced operating costs. But just think of your valuable tapes, safe at last, 24 hours a day.

You've got to see it to believe it. Call or write your local CalComp office, or contact California Computer Products, Inc., DM-12-74, 2411 West La Palma Avenue, Anaheim, California 92801. (714) 821-2011.



CALCOMP



STATOS 33 PRODUCES THE FINEST COMPUTER HARD COPY IN THE BUSINESS. AND WE'LL SEND YOU THE PROOF.

When you receive your actual printout sample from a Statos 33 electrostatic printer/plotter, compare it to anything else on the market. You'll see the big difference.

It's extraordinary. The blacks are blacker, the whites, whiter. The Statos Bi-Scan™ writing head does it. Improved image density and legibility give you two and one-half times better contrast than conventional equipment. And better than anything else on the market.

All four models of the Statos 33 reproduce both alphanumerics and graphics. Fast and accurately. And we have on-line interfaces plus powerful software to support most minicomputers. For larger computers, off-line mag tape systems and software are offered.

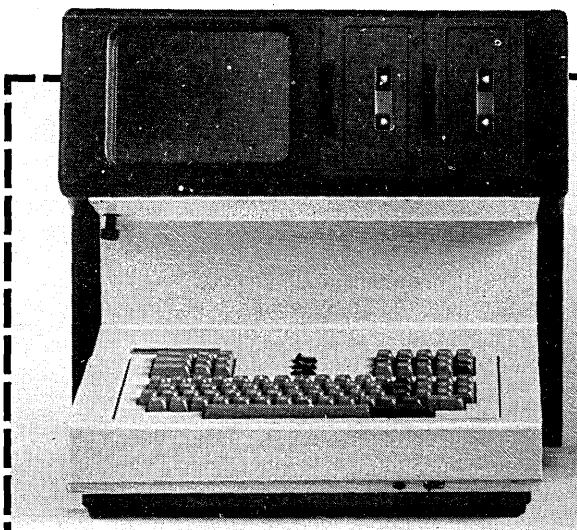
Not only does Statos give you the finest hard copy in the business, but you also get the only free on-site installation service. Uncrating, set-up, check-out, and user instruction.

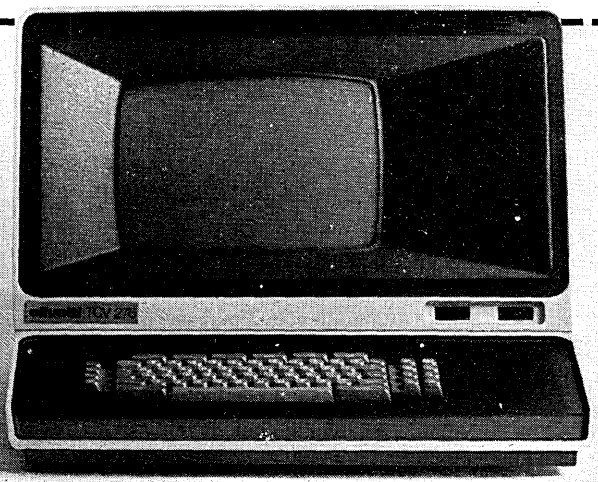
Make us prove it. Write for output samples and descriptive literature. Varian Data Machines, 611 Hansen Way, Palo Alto, California 94303. Or call (415) 493-4000, Ext. 6250.

varian data machines

CIRCLE 82 ON READER CARD

Precisely what are you looking for in an intelligent terminal?





DE-523 Intelligent Data Entry Terminal for recording, reading and verifying data on magnetic tape cassettes under rigid program control.

- ☐ To insure capturing correct data at remote locations for later transmission to a central site.
- ☐ To use in off hours for unattended reception of data processed at a central point, insuring maximum use of the terminal for data entry operations during working hours.
- ☐ To use in remote job entry environments: (IBM 2780, Univac DCT 2000) with card reader and 300 or 600 line per minute printer or magnetic tape cassette—replacing either the printer or card reader.
- ☐ To use as a media conversion tool:
  - ○ From paper tape into compatible mag tape, 7 or 9 track, 800 or 1600 bpi.
  - ○ From mag tape to printer at 125, 300, or 600 LPM, freeing main frames from time-consuming print operations.
  - ○ From 80 column punched cards into mag tape or printed lists.
- ☐ For commercial banks: installment loan, general ledger, new account data entry applications—and many more uses.
- ☐ For food manufacturing industry: entry of incentive payroll, quality control information—and many more uses.
- ☐ For ocean freight handling: bills of lading, arrival notices, billing, manifest preparation—and many more uses.
- ☐ To use in remote job entry applications—for payroll, accounts receivable, etc., etc.
- ☐ To use as an intelligent terminal, with powerful program control of data entry, flexible printing and forms handling capability, cassette output, high speed communications—and much more.

TCV 270 Series Video Display Terminal. Plug-to-plug compatible with IBM 3270 System, but with powerful additional programming features that give it greater capability.

- ☐ To use as an IBM 3270 replacement. (In every respect but cost!)
- ☐ To use as an IBM 3270 replacement—but with future capabilities. (When you are ready we can upgrade your machines with up to 6K additional memory and teach you the simplest programming language in the world. This will reduce response time, make better use of the line, reduce the editing problems of your main frame, and rigidly control the operator to insure accurate data at the source.)
- ☐ To use not only as an interactive terminal but also as a data collection device, with a random access memory connected to the terminal for off and on line operations.

olivetti

Olivetti Corporation of America, 500 Park Ave., New York City 10022
In Canada: Olivetti Canada Ltd., EDP Marketing
1390 Don Mills Road, Don Mills, Ontario M3B2X3

Attn: On Line Systems Division
I've checked the areas I'm interested in. Here is a brief outline of my precise system requirements:

_____

_____

I already am using the following Olivetti equipment:

_____

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____ CITY_____

STATE_____ ZIP_____ PHONE_____

D-12

The devices in each of these categories are only superficially alike. As other computers, they differ in word size, speed, architecture and application.

MICROPROCESSOR AND MICROCOMPUTER SURVEY

by D. J. Theis

Microprocessors bring us one step closer to having a whole computer on a single chip of silicon. No larger than a ¼-inch square, they contain all the essential elements of a central processor, including the control logic, instruction decoding, and arithmetic processing circuitry. To be useful, the microprocessor chip or chips are combined with memory and I/O integrated circuit chips to form a "microcomputer," a machine almost as powerful as a minicomputer which usually fills no more than a single printed circuit board and sells for less than $1,000.

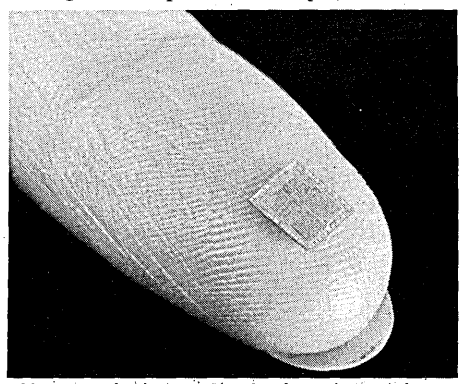
Microprocessors and microcomputers are the logical outcome of two trends, one technological and one economic. First, the technology was mature; integrated circuit manufacturers had developed the ability to produce very high-density chip products, placing as much as 4K bits of memory on a single chip. Second, the high cost of fabricating high-density integrated logic circuitry made it desirable to create a "building block" which could be flexible enough to fit many applications yet produced in large enough quantities to drive down the cost. The result was high-density programmable logic circuitry.

In general, because of their low cost and high reliability, these products will bring "intelligence" to hardware which previously had none. And because their programs are fixed as far as the end-user is concerned, though alterable by the oem systems designer, the devices will end up in hardware which we consider "hardwired."

Microprocessors will find homes in designs where they can displace at least 30 other integrated circuit chips. Microcomputers will be plugged into applications such as intelligent terminals where their low cost advantage will have major impact. Therefore, these machines will be purchased and programmed by oems, but they are of interest to the end-user because they will change his way of processing data.

Microcomputers are currently available from three kinds of suppliers:

1. the integrated circuit manufacturer offering a kit including the microprocessor, the memory, and an assortment of I/O interfaces;
2. the minicomputer manufacturer with special or standard (single- or multiple-source) chips for implementing an instruction set compatible with an existing minicomputer (like Digital Equip. Corp.); and
3. systems houses that build a microcomputer for specific applications using a microprocessor chip (or sometimes using standard TTL chips which are built into a microprogrammed control circuit). Most of the companies in this last category buy off-the-shelf microprocessor chips from companies in the first category.



How much the world of microelectronics is shrinking is best illustrated by a look at one of the microprocessor chips. This one is the Intel 8080, an 8-bit cpu with 78 instructions, a 2 μsec add time, a macro-assembler and a higher-level programming language.

The charts included in this article present information on both kinds of products from all three kinds of companies.

Reading the charts

Note that the listings for microprocessor chips have been separated from those for microcomputers; and in some cases the microprocessor tables provide additional information on processors used in the microcomputers.

Notice that all ten major integrated circuit manufacturers have microprocessor products in the survey except Texas Instruments, which is about to announce its 4-bit slice bipolar chip.

Note, too, the prices given in the microprocessor table are arbitrary even though given for quantity purchases, as large volumes drive these prices down significantly.

The prices shown for microcomputers are usually not the price for a fully operational computer. Some of these products are intended for single unit sales and some are not. Typically, the price includes the entire cpu, the memory control, I/O control, and small amounts of memory. Many times the power supply, I/O interface options, and main memory are not included. Again, the manufacturers should be contacted directly for clarifications.

Fixed words and slices

The first microprocessor chips were the 4-bit ones primarily used in calculator products. Two of the popular devices available in this category are the Intel 4004 and Rockwell 10660. Even though these designs were optimized for parallel operation on 4-bit decimal digits, they have sufficient flexibility to be effective in many other kinds of applications. Their instruction times range in the order of 5usec to 20usec. Some of these first 4-bit processor chips required the designer to provide off-chip registers to address memory, decoders to synchronize operations, and a clock generator. Then the IC manufacturers came out with the fami-

ly of tailored chips (e.g., Intel MSC-4 and Rockwell PPS-4) to eliminate this problem for the designer-programmer.

One important variation to the fixed-word length 4-bit microprocessor designs is the building block design with either 2-bit or 4-bit "slices" which can be used to build up 8-, 12-, 16-, 24-, and 32-bit wide architectures. The longer word length for both addressing and instructions provides higher throughput and easier programming while the shorter 4-bit word length uses less hardware and smaller memories. National's IMP-16 is an example of this modular approach where 4-bit slices can be used to build up the registers, arithmetic logic unit (ALU) and I/O data lines to 32-bit widths. This concept has been around quite a while but software support and I/O interfaces for all models has not been practical in the past.

The 8-bit chips started becoming available in 1972, and have seen the most interest this last year. These units are characterized by more complex designs, larger chips, and 40- or 42-pin packages. Probably the most useful advantages of 8-bit chips is the additional storage capacities (65K bytes vs. 16K bytes for the 4-bit chips). These 8-bit designs are very close in architectural features to minicomputers. The direct memory access (DMA) channel capability permits faster data transfer speeds. The basic approach is to bypass the registers and provide direct access to the memory bus. Another significant feature included in some of these is a vectored interrupt capability. The number of separate interrupt lines accommodated typically is four or more.

In fact, these newer 8-bit designs are being referred to as the second-generation in microprocessors. Second generation features include:

- separate address and data bus lines
- multiple address modes (e.g., direct, indirect, relative, and indexed)
- more instructions
- more versatile register stack operation
- vectored interrupts
- direct memory access
- standard RAM and ROM

The result of these improvements is 10 times faster operation for typical instruction times (i.e., 20usec to 2usec) over first generation micros. The newer devices, however, are 10 times *higher* in cost (e.g., $300 for the second-generation Intel 8008 compared to $30 for the Intel 4004).

Several 12-bit and 16-bit microprocessors are available and others have been announced. If, however, the 8-bit units can do the same job as the 16-bit ones, then it is not clear how much impact the 16-bit architecture will have. There are also variations on the 16-bit machine such as 8-bit memory, instructions consisting of both 8-bit and 16-bit word formats, and 8- or 16-bit I/O; so whether 8-bit or 16-bit machines predominate may be due more to semantics than to significant differences in architecture.

Cpu architecture

Word length is a good starting point from which to discuss the various microprocessor designs, and word length is a meaningful characteristic because it usually relates to the application. For instance, 4-bit chips are for decimal digit operations, whereas communication terminals use 8-bit words for character transmission codes.

Functionally, the microprocessor chip includes the arithmetic logic unit, the general-purpose registers and the control-bus structure. The architecture is to some degree dependent on the partitioning of the processor between one or more chips, the number of pins each chip has, the chip size, and the off-chip memory and I/O bus structure.

Speed or throughput is very depen-

Terms

Fabrication and packaging

IC Integrated circuit, a complex electronic circuit fabricated on a single piece of material, usually a silicon chip.

Chip A small piece of silicon impregnated with impurities in a pattern to form transistors, diodes, and resistors. Electrical paths are formed on it by depositing thin layers of aluminum or gold.

MSI Medium-scale integration is a measure of the number of circuit components, like transistors, formed on a single chip. Presently, chips with 50-100 components are considered to be MSI.

LSI Large-scale integration refers to a component density of more than 100 per chip.

DIP Chips are enclosed in Dual In-line Packages which take their names from the double, parallel rows of leads which connect them to the circuit board. DIPs are sometimes also called "bugs."

Technology and circuit types

Bipolar The most popular fundamental kind of IC, formed from layers of silicon with different electrical characteristics.

TTL (or T^2L) Transistor-transistor logic, a kind of bipolar circuit logic which takes its name from the way the basic transistor components are interconnected.

MOS Metal oxide semiconductor, a term referring to the layers of material, and indirectly to a fundamental process for fabricating ICs. MOS circuits achieve the highest component densities.

PMOS P-channel MOS refers to the oldest type of MOS circuit, where the electrical current is a flow of positive charges.

NMOS N-channel MOS circuits use currents made up of negative charges and produce devices at least twice as fast as PMOS.

CMOS Complementary MOS refers to a combination of P-channel and N-channel transistors which results in a device as fast as NMOS devices but consuming less power.

SOS Silicon On Sapphire refers tc the layers of material, and indirectly to the process of fabrication of devices which achieve bipolar speeds through MOS technology by insulating the circuit components from each other.

Hybrids Circuits fabricated by interconnecting smaller circuits of different technologies mounted on a single substrate.

Memories and fixed logic

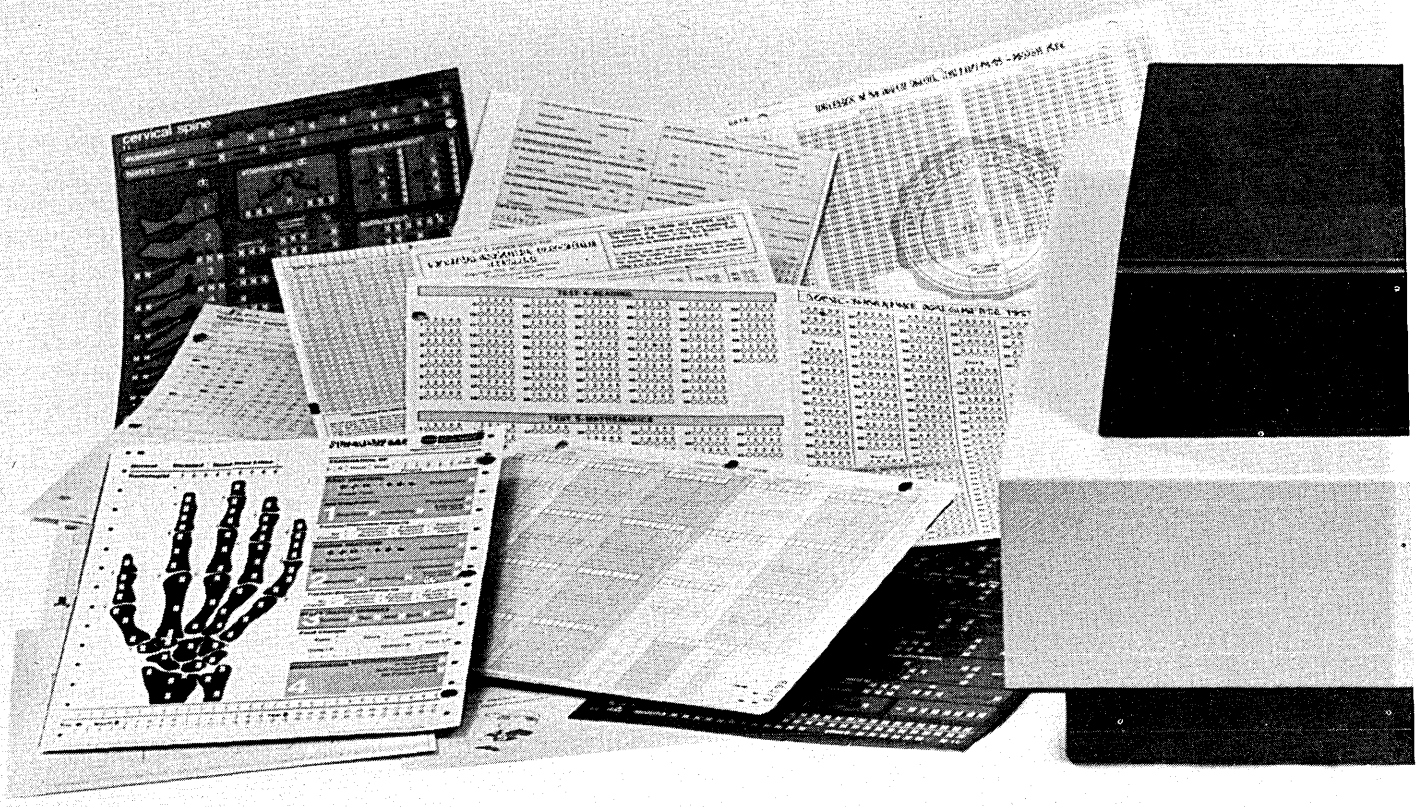
RAM Random Access Memory is any type with both read and write capability.

ROM Read-Only Memory is any type which cannot be rewritten; ROM requires a masking operation during production to permanently record program or data patterns in it.

PROM Programmable Read-Only Memory is any type which is not recorded during its fabrication but which requires a physical operation to program it. Some PROMs can be erased and reprogrammed through special physical processes.

PLA A Programmable Logic Array is an alternative to ROM which uses a standard logic network programmed to perform a specific function. PLAs are implemented in either MOS or bipolar circuits. □

One good decision...



Capturing input data more accurately and reliably—as well as more economically—is getting easier all the time.

And the DECISION OMR6500 optical mark reader you see here is one of the big reasons why. The long-standing promise of optics is now being delivered—even to small system users.

It's delivering in schools. To help teachers grade papers and collect important information on student performance.

It's delivering in hospitals and clinics. To collect medical histories and to help doctors do a better job with test results, research findings and diagnoses.

And it's delivering in business. To capture data directly from original source documents, eliminating the errors inherent in intermediate data-transfer and keypunching operations.

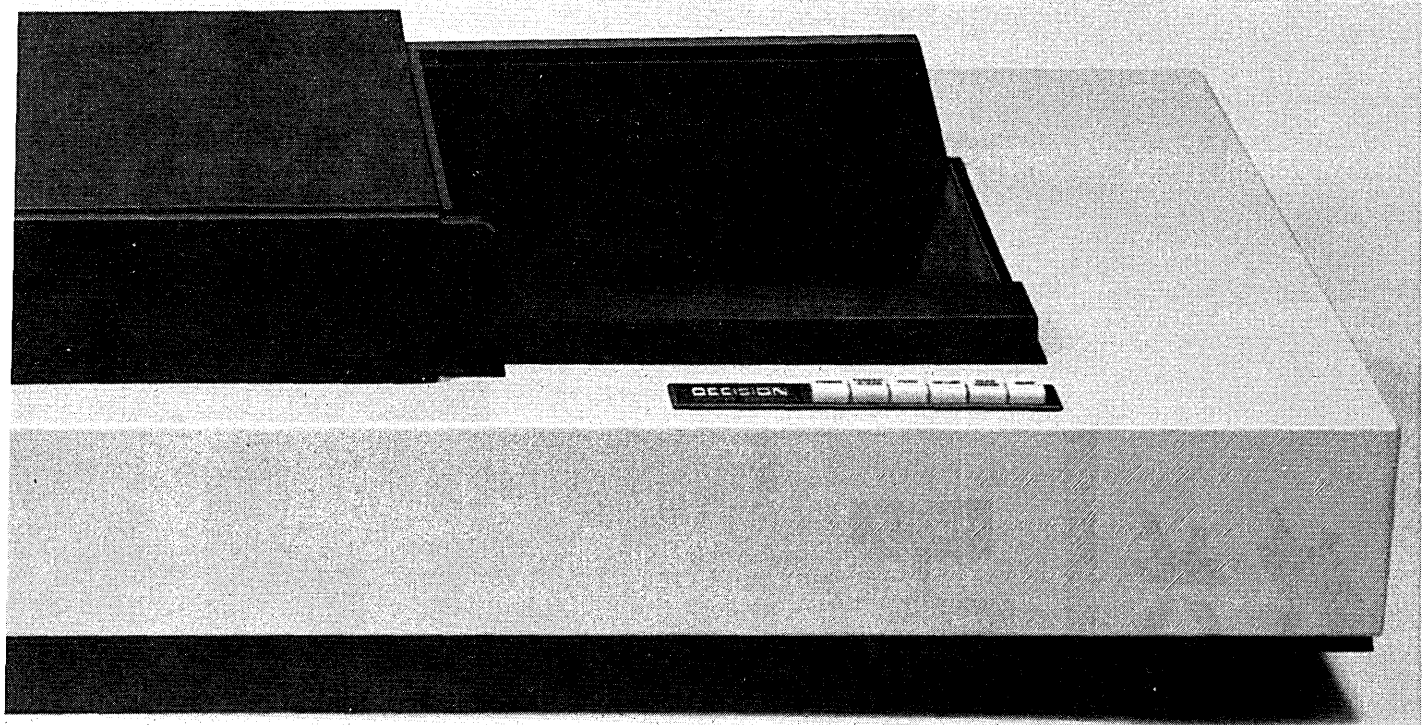
What it sees is what it gets.

The DECISION OMR6500 reads anything from pencil marks and pre-printed data to machine print and hand-printed data. It reads up to 6000 marks per form; up to 450 forms per hour. And it instantly translates it all into computer compatible signals.

Simplicity for reliability's sake.

Designed and built around the most advanced—yet field proven —technology available in scanning,

calls for another.



digitizing, recognizing and paper handling systems, the OMR6500 is simple, direct and reliable. It operates under complete program control, and employs a unique scanning mechanism that moves the optics instead of the document. Programmable error detection, not incidentally, is performed before the paper is advanced.

We build solutions.

We do a lot more than build mark readers, however. We build systems that may include a wide range of optical data entry systems, central processors, controllers, peripherals, power supplies, software, documentation and even training programs to make sure you get what you need. In. Up. And operating. In other words, we solve problems.

Last and most.

Our coup de grace is the OCR7600 —probably the most advanced, most reliable and yet most economical optical character recognition system there is. Period.

Which brings us back to more accurate, more reliable and more economical data input.

With DECISION, it's getting easier all the time.

Decision, Inc.
5601 College Avenue
Oakland, California 94618
(415) 654-8626

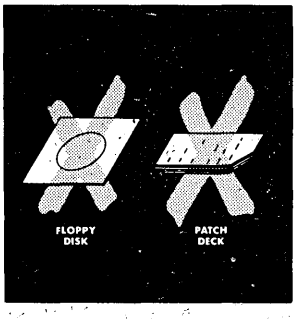
DECISION
A SUBSIDIARY OF BALL CORPORATION

Progress Report:

370/STOR 145

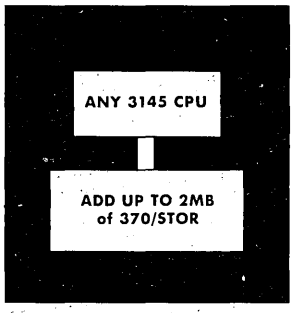
IT'S THE THINGS THAT ARE DIFFERENT THAT MAKE THIS MEMORY SO SUCCESSFUL.

370/STOR 145 is an expansion memory for IBM 3145 processors. In less than a year, it has become the dominant product in its market. Why? For one thing, security. Model 3145 users know Cambridge is the only independent supplier that designs, manufactures, sells and services the systems we install. For another, performance. 370/STOR 145 is different from any other 3145 add-on memory; and it is these differences that make it attractive. For example:



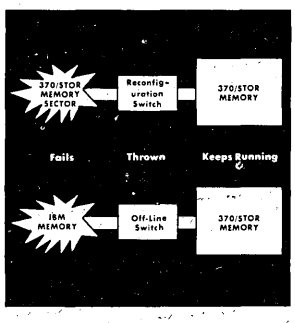
NO FLOPPY DISK MODIFICATION

A user can add 370/STOR 145 memory, in any size increment, without tampering with the console file. No patch decks are required, ever. So what happens on your "floppy disk" is between you and IBM. Cambridge doesn't get involved.



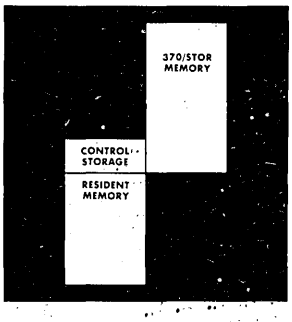
NO CPU ALTERATION

370/STOR 145 installs directly to your 3145 processor. No wiring changes. No model changes when you expand memory beyond your current model's capacity. That means Cambridge can increase your model 3145 memory to a full two megabyte capacity without any CPU alteration.



UNIQUE MEMORY PROTECTION

370/STOR 145 detects and corrects all single-bit errors, and detects multi-bit errors. So do other 145 memories. So to be different we add a reconfiguration switch to let you dial out failed 370/STOR memory, *plus* an off-line switch to dial out failed IBM memory. Either way, you keep running.



HIGHEST MEMORY ADDRESSING

Even IBM must change address lines when you add its memory. But not Cambridge. 370/STOR 145 is directly addressable up to 2048K without any change. It floats on top of any IBM address level. That's the secret of our modular expansion, lack of CPU alteration, and freedom from console file tampering.

CAMBRIDGE.

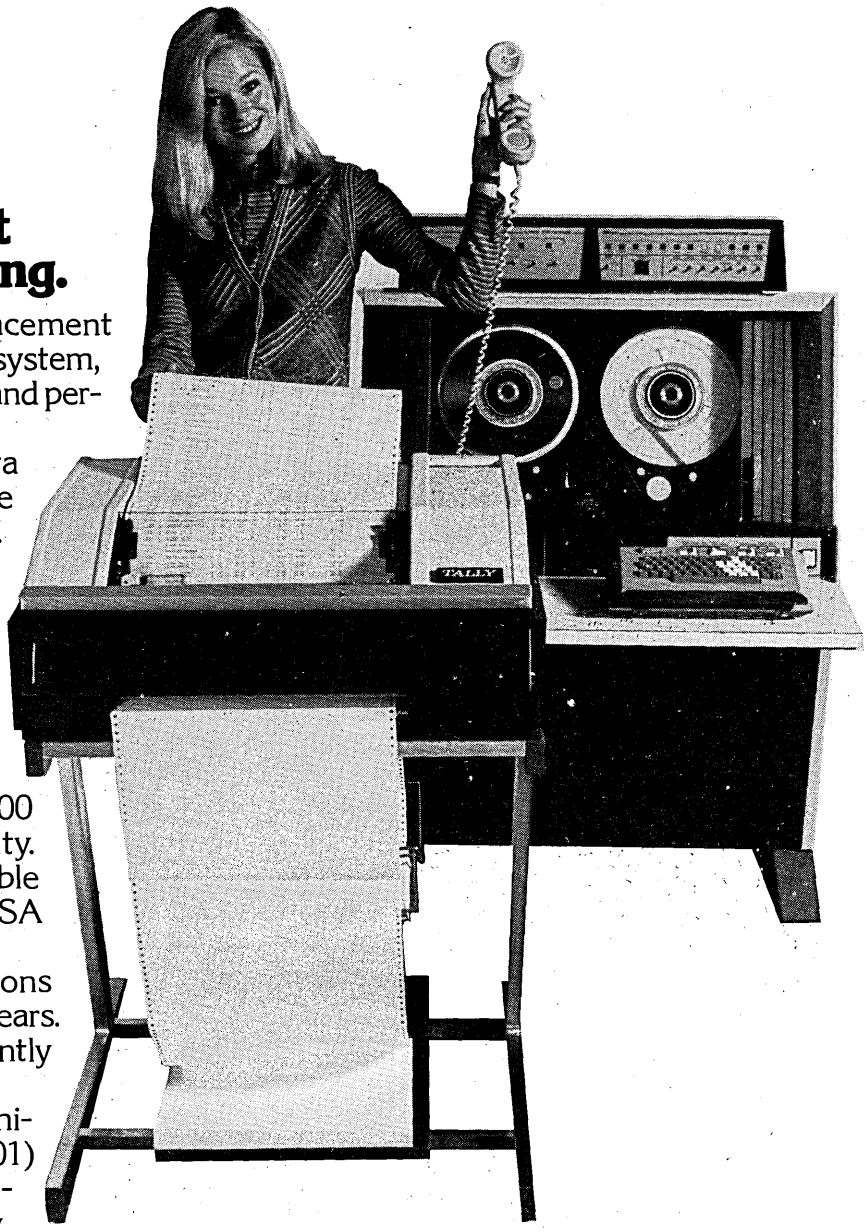
A good place to put your information.

cmi Cambridge Memories, Inc. 12 Crosby Drive, Bedford, Mass. 01730 (617) 271-6400

Contact our sales offices for further information: Boston (617) 271-6400 • Hartford (203) 633-8714 • Philadelphia (215) 295-1186 • Columbus, O. (614) 459-0154 • Kansas City (913) 371-3352 • Atlanta (404) 252-1382 • San Francisco (415) 692-4806 • New York City (201) 947-0184 • Rochester (716) 637-2229 • Chicago (312) 449-5260 • Detroit (313) 557-4080 • Washington, D.C. (301) 657-9015/6 • Dallas (214) 231-4804 • Los Angeles (213) 822-1166 • Charlotte, N.C. (704) 568-1787.

CIRCLE 52 ON READER CARD

MOVE UP TO TALLY



Get higher throughput and dependable printing.

Whether you're thinking replacement or considering a new off-line batch system, Tally terminals offer big, solid cost and performance benefits.

The Datascribe increases data throughput and decreases line charges using your present modem. Its unique data compression feature moves data at speeds equivalent to 3000 to 4000 Baud with 1200 Baud modems. Or get greater throughput using higher speed modems.

Choose a Tally printer matched to your data volume. 125, 200, or 600 lines per minute. Super reliability. Select from print formats compatible with Mohawk, Honeywell and ASA standard print image.

Tally and data communications have been together for over 12 years. We know how to move data efficiently and cost effectively. Let us prove it.

In Boston (617) 742-9558, Chicago (312) 956-0690, New York (201) 636-4484, Los Angeles (213) 378-0805. Or contact us direct, Tally Corporation, 8301 South 180th Street, Kent, Washington 98031. Phone (206) 251-5524.

TALLY®

MICROPROCESSORS

Manufacturer	AMI	Fairchild	Gen Instruments	Intel	Intel	Intel
Model Highlights						
Model number	S6800	F8	CP1600	3000 Series	MCS 4004	4040
1st shipment	new product	new product	new product	7/74	3/71	9/74
Chip technology	NMOS	NMOS	NMOS	bipolar	PMOS	PMOS
Chips in cpu/pins per chip	1 chip/40 pins	2 chips/40 pins	1 chip/40 pins	1 chip/28 pins	1 chip/16 pins	1 chip/24 pins
Add time (reg-to-reg)	2usec (8 bits)	2usec (8 bits)	2.4usec (16 bits)	300nsec (16 bits)	10.8 usec (4 bit)	8usec (4 bits)
Microprogrammed	yes	yes	yes	user microprogram	no	no
Architecture	8 bit parallel	8 bit parallel	16 bit parallel	2 bit slice, parallel	4 bit parallel	4 bit parallel
ALU/logic share chip	yes	yes	yes	no	yes	yes
Clock frequency/phases	1MHz/2-phase	2MHz/2-phase	5MHz/2-phase	8MHz/1-phase	750KHz/2-phase	1MHz/2-phase
Number of instructions	72 (8, 16, 24 bits)	101 (8 bits)	68 (16 bits)	variable	46 (8 bits)	60 (8 bits)
Reg. load time for instruc.	2usec (8 bits)	2usec (8 bits)	2.4usec (16 bits)	150nsec (16 bits)	10.8usec (8 bits)	8usec (8 bits)
Reg-to-memory add time	2usec (8 bits)	5usec (8 bits)	3.2 usec (16 bits)	variable	10.8usec (4 bits)	8usec (4 bits)
Input/Output						
Data path width	8 bits	8 bits	16 bits	variable	4 bits	4 bits
Interrupts	yes	chain	nested	vectored priority	no	vectored
Peripheral interfaces	through adaptor	—	none	—	display	display
Software		unbundled		unbundled	resident bundled	resident bundled
Resident assembler	—	✓	✓	—	✓	✓
Cross assembler	—	✓	✓	cross microassemb.	✓	✓
Monitor	—	✓	✓	—	✓	✓
Languages	—	—	—	—	—	—
Instruction simulator	—	✓	✓	—	✓	✓
Prototyping System	to be announced	yes	no	no	yes	yes
Pricing						
Chips/chip sets (lots of 100)	not released	not released	not released	not released	less than $99	less than $99

Manufacturer	Intel	Intel	Intersil	Monolithic	Mostek	Motorola
Model Highlights						
Model number	8008/8008-1	8080	IM 6100	6701	5065	M6800
1st shipment	12/71, 9/72	12/73	new product	7/74	1st Q 1974	7/74
Chip technology	PMOS	NMOS	CMOS	bipolar	PMOS	NMOS
Chips in cpu/pins per chip	1 chip/18 pins	1 chip/40 pins	1 chip/40 pins	24 chips/40 pins	1 chip/40 pins	1 chip/40 pins
Add time (reg-to-reg)	20/12.5usec (8 bits)	2usec (8 bits)	not released	900nsec (16 bits)	10usec (8 bits)	not released
Microprogrammed	no	no	yes	user microprogram	no	yes
Architecture	8 bit parallel	8 bit parallel	12 bit parallel	4 bit slice, parallel	8 bit parallel	8 bit parallel
ALU/logic share chip	yes	yes	yes	no	yes	yes
Clock frequency/phases	500/800KHz/2-ph	2MHz/2-phase	2MHz/1-phase	5MHz/1-phase	1.4MHz/3-phase	1MHz/2-phase
Number of instructions	48 (8 bits)	78 (8 bits)	50 (12 bits)	22 (16 bits)	51 (8/16 bits)	72 (8 bits)
Reg. load time for instruc.	20/12.5usec (8 bits)	2.5usec (8 bits)	—	1.2usec (16 bits)	8.5usec (8 bits)	—
Reg-to-memory add time	32/20usec (8 bits)	3.5usec (8 bits)	—	1.2usec (16 bits)	10usec (8 bits)	—
Input/Output						
Data path width	8 bits	8 bits	12 bits	16 bits	8 bits	16 bits
Interrupts	vectored	vectored	yes	1 level, priority opt	priority	yes
Peripheral interfaces	I/O port	I/O port	tty	—	—	Through adaptor
Software	resident bundled	resident bundled	unbundled	bundled	unbundled	unbundled
Resident assembler	✓	✓	✓	✓	✓	—
Cross assembler	✓	✓	✓	✓	✓	✓
Monitor	✓	✓	✓	✓	—	✓
Languages	PL/M	PL/M	—	—	—	—
Instruction simulator	✓	✓	✓	—	—	✓
Prototyping System	yes	yes	yes	yes	no	yes
Pricing						
Chips/chip sets (lots of 100)	less than $250	less than $400	not released	$95/$600	$58	not released

Manufacturer	National Semi	RCA	Rockwell	Rockwell	Signetics	Western Digital
Model Highlights						
Model number	IMP-8A/500D	COSMAC	PPS-4	PPS-8	2650I "PIP"	CP 1611/1621/1631
1st shipment	3/74	new product	1973 150K shipped	10/74 new product	new product	new product
Chip technology	PMOS	CMOS	PMOS	PMOS	NMOS	NMOS
Chips in cpu/pins per chip	3 chips/24 pins	2 chips/28, 40 pins	1 chip/42 pins	1 chip/42 pins	1 chip/40 pins	3 chips/40 pins
Add time (reg-to-reg)	4.2usec (8 bits)	18usec (8 bits)	4usec (8 bits)	4usec (8 bits)	4.8usec (8 bits)	300 nsec (8 bits)
Microprogrammed	user microprogram	no	yes	yes	no	user microprogram
Architecture	4 bit slice, parallel	8 bit parallel	4 bit parallel	8 bit parallel	8 bit parallel	8/16 bit parallel
ALU/logic share chip	no	yes	yes	yes	yes	no
Clock frequency/phases	715KHz/4-phase	2.67MHz/1-phase	200KHz/4-phase	250KHz/4-phase	1.25MHz/1-phase	3.3MHz/4-phase
Number of instructions	38 (8 bits)	59 (8 bits)	50 (8 bits)	109 (8, 16, 24 bits)	72 (8,16,24 bits)	over 80 (16 bits)
Reg. load time for instruc.	11.2usec (8 bits)	6usec (8 bits)	4usec (8 bits)	5usec (8 bits)	4.8usec (8 bits)	900nsec (8 bits)
Reg-to-memory add time	11.2usec (8 bits)	6usec (8 bits)	4usec (8 bits)	5usec (8 bits)	4.8usec (8 bits)	1.2usec (8 bits)
Input/Output						
Data path width	8 bits	8 bits	4 bits	8 bits	8 bits	8/16 bits
Interrupts	yes	maskable	none	3x16 daisy chain	1-level vectored	priority, 4 level
Peripheral interfaces	tty, display	—	display, tty, gp	display, tty, gp	—	—
Software	bundled	unbundled	unbundled	unbundled	unbundled	
Resident assembler	✓	—	✓	✓	—	—
Cross assembler	✓	✓	✓	✓	✓	—
Monitor	✓	✓	—	—	✓	—
Languages	—	—	—	—	—	—
Instruction simulator	—	✓	✓	✓	—	—
Prototyping System	yes	yes	yes	yes	no	to be announced
Pricing						
Chips/chip sets (lots of 100)	$181	not released	approx. $45	approx. $47	$200	not released

MICROCOMPUTERS

Manufacturer	Applied Computing	Applied Computing	Computer Auto	Comstar	Control Logic	Control Logic
Model Highlights						
Model number	CBC-4/CBC-4N	UMPS-4	LSI-1	System 4	L Series	Mighty Micro
1st shipment/no. shipped	11/72 119 shipped	4/74 10 shipped	new product	—700 shipped	1/73 200 shipped	10/74 new product
Most common application	controllers	intelligent term	——	process control	controllers	control, test
Add time (reg-to-reg)	30usec (4 bits)	15usec (4 bits)	9.2usec (16 bit)	10.8usec (4 bits)	20/12.5usec (8 bits)	2.0usec (8 bits)
Board size	7x7 inches	5x7 inches	15x16.9 inches	4.5x4.5 inches	4.8x3.2 inches	4.8x3.2 inches
Total number of chips	12 chips	5 chips	70 chips	1-36 chips	2-12 chips	2-16 chips
Price range	$495	$695	$985 to $2,020	$950	$335	$495
Applications						
Intelligent terminal	✓	✓	✓	✓	✓	✓
Peripheral controller	✓	✓	✓	✓	✓	✓
Point of sale terminal	✓	✓	✓	——	——	——
Process control	✓	✓	✓	✓	✓	✓
Other	heavy equipment	heavy equipment	——	traffic cont, calc	test equipment	——
Microprocessor	Intel	Rockwell	National custom	Intel	Intel 8008/8008-1	Intel 8080
Type	4 bit PMOS	4 bit PMOS	16 bit PMOS	4 bit PMOS	8 bit PMOS	8 bit NMOS
Chips in cpu/pins per chip	1 chip/16 pins	1 chip/42 pins	7 chips/40 pins	1 chip/16 pins	24 chips/18 pins	20 chips/40 pins
Number of instructions	45 (8 bits)	50 (8 bits)	168 (16 bits)	45 (8 bits)	48 (8 bits)	78 (8 bits)
Microprogrammed	no	yes	yes	no	no	no
Internal code	binary	binary/decimal	binary	binary/decimal	binary	binary
Random Access Memory	Intel special	Rockwell special	standard	special	standard	standard
Capacity/Technology	1.2K bits PMOS	4K bits PMOS	512K bits NMOS	20.58K bits PMOS	16K bits PMOS	64K bits NMOS
Read-Only Memory	Intel standard	Rockwell standard	standard	standard	——	——
Capacity/Technology	4K bits PMOS	16K bits PMOS	512K bits PMOS	256 bits bipolar	——	——
Programmable ROM	Intel standard	Intel standard	standard	standard	standard	standard
Capacity/Technology	4K bits PMOS	16K bits PMOS	512K bits PMOS	2.048K bits PMOS	16K bits PMOS	64K bits NMOS
Input/Output						
Maximum channels	16	16	248 (16 bits)	64 (4 bits)	32 (8 bits)	256 (8 bits)
Direct Memory Access	no	one	yes	——	——	——
Bus shared with memory	yes	yes	yes	yes	no	no
Interrupts	no	no	vectored	no	8 priority levels	8 level priority
Peripheral interfaces	——	display, printer, general purpose	disp, tty, paper tape, card read, print, mag tape	tty, display	tty, display EIA RS-232-C	tty EIA RS-232-C
Software	unbundled	bundled	bundled	unbundled	unbundled	unbundled
Resident assembler	——	✓	✓	——	✓	✓
Cross assembler	——	✓	✓	✓	✓	✓
Monitor	✓	✓	✓	——	——	——
Languages	——	——	——	——	——	——

Manufacturer	Data Architects	Digital Equip	Digital Equip	Digital Labs	Dynamic Data Sys	Fabri-Tek
Model Highlights						
Model number	CM 101	Kit 8/A	MPS Series	PB-96	DD-4i	MP12
1st shipment/no. shipped	9/73 16 shipped	not released	4/74 not released	3/74 not released	9/73 160 shipped	8/74 30 shipped
Most common application	pay tv controller	PDP 8/E compat	process control	control & acquis.	process control	process control
Add time (reg-to-reg)	12.6usec (4 bits)	3usec (12 bits)	10usec (8 bits)	2.9usec (8 bits)	22usec (4 bits)	not released
Board size	13.10x6.88 inches	15.75x8.5 inches	10.436x8.50 inches	9x15 inches	8.5x10.5 inches	9x15 inches
Total number of chips	92 chips	not released	not released	72-82 chips	not released	130 chips
Price range	$1,420	$895	$410	$685 to $1,155	$499	$890 to $1,340
Applications						
Intelligent terminal	——	✓	✓	✓	✓	✓
Peripheral controller	✓	✓	✓	✓	✓	✓
Point of sale terminal	——	✓	✓	✓	✓	✓
Process control	✓	✓	✓	✓	✓	✓
Other	——	——	——	——	——	data acquisition
Microprocessor	Intel MCS-4	TTL design	Intel 8008	TTL design	Intel 4004	TTL design
Type	4 bit PMOS	12 bit bipolar	8 bit PMOS	8 bit bipolar	4 bit PMOS	12 bit bipolar
Chips in cpu/pins per chip	1 chip/16 pins	——	1 chip/18 pins	72 chips	1 chip/16 pins	129 chips
Number of instructions	45 (8, 16 bits)	—(12 bits)	48 (8 bits)	18 (8, 16 bits)	46 (8, 16 bits)	40 (12 bits)
Microprogrammed	no	no	no	yes	no	user microprogram
Internal code	binary/decimal	binary	binary	binary	binary	binary/ASCII
Random Access Memory	standard/special	standard	standard	standard/special	standard/special	standard
Capacity/Technology	.32K bits PMOS	384K bits NMOS	32K bits NMOS	512K bits	.32K bits PMOS	48K bits core
Read-Only Memory	standard/special	standard	——	standard	standard/special	standard
Capacity/Technology	4K bits PMOS, NMOS	384K bits NMOS	——	512K bits	8K bits PMOS	2K bits bipolar
Programmable ROM	standard/special	standard	standard	standard	standard	standard
Capacity/Technology	4K bits PMOS	384K bits NMOS	32K bits NMOS	8K bits	8K bits PMOS	2K bits bipolar
Input/Output						
Maximum channels	32 (4 bits)	64 (12 bits)	256 (8 bits)	12 (8 bits)	256 (4 bits)	63 (12 bits)
Direct Memory Access	no	yes	no	no	no	yes
Bus shared with memory	no	yes	yes	no	yes	yes
Interrupts	polling	yes	yes	no	no	single level
Peripheral interfaces	tty	tty, display	——	tty, display	——	tty
Software	unbundled	unbundled	unbundled	unbundled	unbundled	bundled
Resident assembler	✓	✓	✓	✓	——	✓
Cross assembler	✓	✓	✓	✓	✓	✓
Monitor	——	✓	——	——	——	✓
Languages	——	✓	——	——	——	——

MICROCOMPUTERS

Manufacturer	General Auto	Intel	Intel	Intel	Microdata	National
Model Highlights						
Model number	LSI 16	IMM 4-42	8-82	8-83	Micro-One	IMP-16C
1st shipment/no. shipped	not released	not released	not released	not released	10/74 not released	6/73 not released
Most common application	SPC-16	controllers	terminals	terminals	process control	process control
Add time (reg-to-reg)	1.3usec (16 bits)	10.8usec (4 bits)	20usec (8 bits)	2.0usec (8 bits)	5.28usec (8 bits)	4.2usec (16 bits)
Board size	7.75x11 inches	6.18x8.0 inches	6.18x8.0 inches	6.18x8.0 inches	8.5x12 inches	8.5x11 inches
Total number of chips	145 chips	not released	not released	not released	95 chips	not released
Price range	$1,350 to $2,350	$395	$450	$590	$636	$950
Applications						
Intelligent terminal	✓	✓	✓	✓	✓	✓
Peripheral controller	✓	✓	✓	✓	✓	—
Point of sale terminal	✓	✓	✓	✓	—	✓
Process control	✓	✓	✓	✓	✓	✓
Other	—	—	instrumentation	instrumentation	—	—
Microprocessor	Rockwell custom	Intel 4004	Intel 8008	Intel 8080	TTL design	National 16A/500D
Type	16 bit SOS/MOS	4 bit PMOS	8 bit PMOS	8 bit NMOS	8 bit bipolar	4 bit slice PMOS
Chips in cpu/pins per chip	2 chips/40 pins	1 chip/16 pins	1 chip/18 pins	1 chip/40 pins	93 chips	5-6 chips/24 pins
Number of instructions	80 (16 bits)	46 (8 bits)	48 (8, 16, 24 bits)	78 (8, 16, 24 bits)	107 (16 bits)	43-60 (16, 32 bits)
Microprogrammed	no	no	no	no	user microprogram	user microprogram
Internal code	binary	binary	binary	binary	binary	binary
Random Access Memory	standard	standard	standard	standard	standard	standard
Capacity/Technology	256K bits PMOS	1.3K-10.2K PMOS	128K bits PMOS	512K bits PMOS	256K bits PMOS	2K bits PMOS, NMOS
Read-Only Memory	standard	—	standard	standard	standard	standard
Capacity/Technology	256K bits bipolar	—	128K bits PMOS	512K bits PMOS	16K bits bipolar	4K bits PMOS
Programmable ROM	standard	standard	standard	standard	standard	standard
Capacity/Technology	256K bits bipolar	8K-32K bits PMOS	128K bits PMOS	512K bits PMOS	16K bits bipolar	4K bits PMOS
Input/Output						
Maximum channels	64 (16 bits)	8 (4 bits)	16	16	256 (8 bits)	64 (16 bits)
Direct Memory Access	yes	no	no	yes	yes	yes
Bus shared with memory	no	yes	yes	yes	no	yes
Interrupts	vector	no	no	vectored	yes	vectored
Peripheral interfaces	—	tty, I/O port	tty	tty	tty	tty, display
Software	bundled	bundled	bundled	bundled	bundled	bundled
Resident assembler	✓	✓	✓	✓	✓	✓
Cross assembler	✓	✓	✓	✓	✓	✓
Monitor	✓	✓	✓	✓	—	✓
Languages	—	—	PL/M	PL/M	BASIC, FORTRAN	—

Manufacturer	Process Computer	Pro-Log	Pro-Log	R2E Micro Comp	SMS	Standard Logic
Model Highlights						
Model number	Micropac	PLS-400	MPS-800	Micral 1000 Series	200 Micro Cont	CASH-8
1st shipment/no. shipped	1/74 20 shipped	2/73 900 shipped	1/74 30 shipped	4/73 350	new product	2/74 50 shipped
Most common application	process control	terminals	controlled terminals	data acquisition	—	terminal, controller
Add time (reg-to-reg)	3usec (8 bits)	30usec (4 bits)	14usec (8 bits)	12.5usec (8 bits)	300nsec (8 bits)	200nsec (8 bits)
Board size	5x9.6 inches	4.5x6.5 inches	4.5x6.5 inches	3.5x7.5 inches	6.875 inches	5x10 inches
Total number of chips	20-40 chips	12-18 chips	30-100 chips	35-38 chips	9-61 chips	52 chips
Price range	$281 to $3,000	$395 to $690	$700 to $1,500	$410 to $1,250	not released	$300 to $595
Applications						
Intelligent terminal	✓	✓	✓	✓	✓	✓
Peripheral controller	—	✓	✓	✓	✓	✓
Point of sale terminal	—	—	—	✓	—	—
Process control	✓	✓	✓	✓	✓	—
Other	—	—	—	—	—	—
Microprocessor	Intel 8080	Intel 4004	Intel 8008	Intel 8008, -1, 8080	TTL design	TTL design
Type	8 bit NMOS	4 bit PMOS	8 bit PMOS	8 bit PMOS, NMOS	8 bit bipolar	16 bit bipolar
Chips in cpu/pins per chip	1 chip/40 pins	var chips/16 pins	—/18 pins	1 chip/18 pins	1 chip/53 pins	52 chips
Number of instructions	78 (8 bits)	47 (8 bits)	72 (8 bits)	74 (8 bits)	8 (16 bits)	52 (16 bits)
Microprogrammed	no	no	no	no	no	user microprogram
Internal code	binary	binary	binary	binary	binary	binary
Random Access Memory	standard	special	standard	standard	standard/special	special
Capacity/Technology	32K bits NMOS	4K bits PMOS	16K bits NMOS	8K bits	2K bits bipolar	1K PMOS, NMOS, CMOS
Read-Only Memory	standard	standard	standard	standard	standard	standard
Capacity/Technology	16K bits NMOS	4K bits PMOS, NMOS	16K bits PMOS, NMOS	8K bits	65K bits bipolar	1K PMOS, NMOS, CMOS
Programmable ROM	standard	standard	standard	standard	standard	standard
Capacity/Technology	2K bits NMOS	4K bits PMOS	16K bits PMOS	8K bits	65K bits bipolar	1K PMOS, NMOS, CMOS
Input/Output						
Maximum channels	256 (16 bits)	—	—	8 (8 bits)	—	16 (8 bits)
Direct Memory Access	—	—	yes	yes	no	yes
Bus shared with memory	yes	yes	yes	yes	no	no
Interrupts	multi-lev vector	no	8 level priority	priority	no	multi-level
Peripheral interfaces	tty, display	tty, display	tty, display	tty, display	—	tty, display
Software	unbundled	bundled	bundled	—	unbundled	unbundled
Resident assembler	✓	—	✓	✓	—	✓
Cross assembler	✓	✓	✓	✓	✓	✓
Monitor	✓	—	✓	✓	—	—
Languages	—	—	—	—	—	—

MICROCOMPUTERS

Manufacturer	Teledyne	Teledyne	Three Phoenix	Varitel
Model Highlights				
Model number	TDY-52A	TDY 52B	—	MC-8
1st shipment/no. shipped	2/74 4 shipped	10/74 not released	11/73 100 shipped	4/74 12 shipped
Most common application	demo	military systems	intelligent term	synchronizer
Add time (reg-to-reg)	10.8usec (4 bits)	4.55usec (16 bits)	20 usec (8 bits)	20usec (8 bits)
Board size	2x2 (hybrid pack)	2x2 (hybrid pack)	14x7 inches	12x9.5 inches
Total number of chips	40 chips	44 chips	58-60 chips	31-86 chips
Price range	$995 to $1,895	$995 to $1,895	$995 to $1,500	$315 to $800
Applications				
Intelligent terminal	—	✓	✓	—
Peripheral controller	—	—	—	✓
Point of sale terminal	—	—	—	—
Process control	—	✓	—	✓
Other	—	—	—	—
Microprocessor	Intel MCS-4	National MM5750	Intel 8008	Intel 8008
Type	4 bit PMOS	4 bit PMOS	8 bit PMOS	8 bit PMOS
Chips in cpu/pins per chip	1 chip/16 pins	6 chips/24 pins	1 chip/18 pins	1 chip/18 pins
Number of instructions	46 (8 bits)	60 (16, 32 bits)	47 (8 bits)	48 (8, 16, 24 bits)
Microprogrammed	no	user microprogram	no	no
Internal code	binary/decimal	binary	binary	binary
Random Access Memory	standard	standard	standard	standard
Capacity/Technology	2K bits PMOS	NMOS, CMOS	8K bits NMOS	8-32K bits NMOS
Read-Only Memory	standard	standard	standard	—
Capacity/Technology	64K bits bipolar	64K bits bipolar	24K bits PMOS	—
Programmable ROM	standard	standard	standard	standard
Capacity/Technology	32K bits PMOS	64K bits bipolar	24K bits PMOS	2-8K bits PMOS
Input/Output				
Maximum channels	8 (4-32 bits)	64 (16 bits)	16 (8 bits)	32 (8 bits)
Direct Memory Access	—	yes	yes	yes
Bus shared with memory	✓	yes	yes	yes
Interrupts	✓	vectored	no	8 level vectored
Peripheral interfaces	—	—	—	tty, display
Software	bundled	bundled	unbundled	unbundled
Resident assembler	—	✓	✓	✓
Cross assembler	✓	✓	✓	—
Monitor	—	—	—	✓
Languages	—	—	—	—

SURVEY

dent on architecture. Microprocessor chips are relatively slow because the number of pins (and hence the number of I/O lines) does not allow much parallelism. Having fewer pins means having less information on what is happening internally and what should happen externally. Therefore, more encoding is done and thus off the chip decoding is necessary. Clock speed (or frequency) is not necessarily indicative of execution speed. Speed is a function of data and address path widths, number of separate paths and overlap in the fetch and execute cycles. (As an example, the Intel 4004 uses a 750KHz clock and the Rockwell PPS-4 uses a 200KHz, four-phase clock and yet the PPS-4 does some computations faster.

Arithmetic and register operations in a microprocessor have evolved such that there is capability for both decimal and binary arithmetic. Because of the pin limitation off-chip to memory, most architectures use a pushdown stack of some sort. The stack helps the programmer minimize register transfers, facilitates counting and sorting, and limits needless transfers to and from main memory.

Finally, micro*programmable* architecture has proven to be a very practical approach for microprocessor design. The primary advantages of putting the instruction set in control store are cost, open-ended design and high utilization of LSI standardized products. These advantages, however, are not without some penalties. For example, when new instructions or functions are put in the microcode, the oem designer has to change the support software, such as the assembler. The advantage of a microprogram architecture is therefore limited if the instruction set is significantly modified.

Memory and I/O

The memory section of a microcomputer usually accounts for a major portion of the chips. All three kinds of memory are used. Random access memory (RAM) chips are used primarily for variable data and scratch pad. Read-Only Memory (ROM) chips are used to store instruction sequences. Programmable Read-Only Memory (PROM) chips are used for quickly tailoring the general purpose microcomputers for specific applications.

RAMS are expensive compared to ROMS, but the data in the ROMS must be stored at the time they are created, so there is a production delay associated with them as well as a "programming" cost. 'PROM chips, some of which can be erased by ultraviolet light and reprogrammed, are used in place of ROMS when small quantities are involved; they are not cost-justified in large runs.

To complete their microcomputer product line, each manufacturer tries to offer a complete set of I/O interface chips. I/O chips are implemented in MOS or bipolar technologies depending on the requirements. Those designed to fit a particular device to a microprocessor save the designer-programmer time in development and reduce the overall number of chips in the microcomputer. The next step will be to make these interface chips parameter selectable so that several models of one kind of peripheral can be handled by one chip.

Technology

The large-scale integration (LSI) technology used to build microprocessor chips primarily centers around metal oxide semiconductor (MOS) devices. Chip densities on MOS devices today range from 500 to 10,000 transistors per chip. The chip's size typically ranges from 0.15-inch square to 0.25-inch square. The chips are mounted into dual in-line packages (DIPS) which typically have 18, 24, or 40 pins for mounting on a printed circuit card. The p-channel MOS (PMOS) has been the predominate technology for the calculator chips and most of the 4-bit and 8-bit processors like the Intel 8008. The PMOS 8-bit microprocessors with especially good design (e.g., Rockwell PPS-8) are still sometimes competitive with the newer NMOS 8-bit chips. PMOS processors typically are offered with a family of interface chips tailored to reduce the demands on the programs to support external devices.

NMOS, however, has become the preferred approach by many of the IC manufacturers. In 1975 the industry expects NMOS 16-bit designs comparable in performance to the very low-end minicomputer like the PDP-11/05 (e.g., Western Digital has such a three-chip version).

Other MOS technologies have been developed and are being used in custom chip designs. One is called complementary metal oxide semiconductor (CMOS). RCA is currently making a CMOS unit. CMOS is used as well in many memory and interface IC products. It is well suited to electronic watches because of its low power requirements. It also has an inherent high noise immunity which provides reliable operation in applications with hostile environments.

Another variation with MOS technology is called silicon-on-sapphire (SOS) and is used in General Automation's LSI-12/16 microcomputer prod-

ucts. SOS achieves faster speeds than are currently available with other MOS devices.

Teledyne uses a hybrid approach which mounts the microprocessor chip onto a thick film substrate with several other chips (e.g., RAM, ROM). The interconnections are provided on the substrate, not on the printed circuit card.

Minicomputer manufacturers use a technology called bipolar in the cpu and I/O portions of their machines instead of MOS. This technology offers faster speeds but requires more IC packages because of its inherent lower circuit densities. Minicomputers do, however, use 1K and 4K-bit MOS RAMs extensively in their main memory since it is now very cost competitive with core. Many manufacturers have taken a minicomputer product and converged it to a microcomputer through different (non-MOS) technologies. For example, Computer Automation's LSI machines are microprogrammed, but the microinstructions are stored in programmed logic arrays (PLAs) instead of ROMs. Some 12-bit and 16-bit microcomputers (e.g., DEC PDP-8A, Fabri-Tek MP-12, Microdata One) have been implemented using TTL/MSI bipolar technologies.

A few months ago Intel made available the first bipolar LSI microprocessor chips in sample quantities. The new product (the Series 3000) features a machine cycle time less than 200nsec which is 10 times faster than the present NMOS microprocessors (which usually have 2usec machine cycles). The 3000's architecture is 2-bit slice building blocks and the instruction set is microprogrammable. This product was definitely intended for the oem manufacturer who has the capability to tailor it in word length and implement only the instructions necessary for a particular application. This intent is confirmed by the fact that Intel offers no macroinstruction set with this device. A few other companies (i.e., Texas Instruments, Monolithic Memories, and Raytheon) are also developing bipolar, multi-chip, microprocessor products.

Software support

In microprocessor applications the designer-programmer is trying to implement a design (previously done by logic designers on paper) through on-line programming of the microprocessor. Instead of using gate logic such as AND, OR, NAND and NOR, the designer-programmer uses the mask, compare, and jump instructions. Most microprocessor applications involve a mixture of control operations and application computations which are interleaved in the program mainstream. Assembly language is predominant. Because of modularity and the obvious repetitious nature of so many operations, subroutines are used extensively, and subroutine nesting is facilitated by the stack register organizations in all these units.

Software development for microcomputers is done several ways:

1) A designer-programmer may spend lots of time using paper tape to assemble with the microcomputer itself. In addition to the assembler, loaders for the assembled programs and diagnostics to check out the hardware are available to him. Though not always offered, a monitor or executive rather than a full-blown operating system is sufficient for microcomputers since the machines are used in dedicated applications, not for general-purpose programming.
2) The designer-programmer may instead use a large-scale host computer (e.g., IBM 370) available through a time-sharing service to access an assembler which is usually written in FORTRAN (such program products are usually referred to as cross assemblers). An instruction simulator (also written in FORTRAN) executes the cross assembler output code as if it were being executed in the microcomputer. Higher level languages (e.g., Intel's PL/M) are also available to save the programmer time, but do not relieve him from debugging and checking-out the compiled code, an operation which requires an understanding at the machine operation level.
3) A third approach uses a combination of hardware and software called a prototyping system. Prototyping systems provide program assembly, on-line execution and debugging. A general purpose prototyping system allows the designer-programmer to be more creative and productive in the design of a particular microcomputer application. As a result companies in this business either design a prototyping system as their first product or buy it. Using an on-line teleprinter, the designer-programmer assembles, edits, and stores the program in RAM associated with a computer in the prototype system. Switching to the "operate" mode the microprocessor in the application system accesses the program in the prototyping system as if it were in its own ROM and check-out begins.

Trends

As microcomputers and microprocessor products continue to grow in capability and availability, their greatest impact will be in propagating computer power to extend the reach of current computer hierarchies. By 1977, over one million general purpose and dedicated application terminals are expected to be installed. Each new terminal will likely use a microprocessor since the cost will continue to decrease with these large volumes. The speed demands in these terminals typically are not excessive because of their interaction with human operators, and so 8-bit microprocessors should be the dominant devices for this terminal market.

As microprocessor speeds become faster, as better support software and prototyping systems become available, as complete sets of interface chips are offered and as costs go even lower, the potentials are limitless. Microcomputers are already challenging minicomputers on the low end of the market and this trend seems destined to have impacts we are yet to foresee.

In the future, one chip will include the cpu, memory, and I/O interfaces, so we will truly have a computer on a chip. Peripherals, too, may be implemented by new technology chips. For instance, the functions of today's discs may be handled by charge-coupled devices, so that eventually a whole computer system will reside on one small board. The prefix "micro" denotes small size and connotes small cost; however, it certainly does not imply small capabilities. □

Mr. Theis is a member of the technical staff of Aerospace Corp., where his responsibilities include hardware and software evaluation, especially for real-time systems. He has been a senior consultant with Hobbs Associates, and a senior engineer with North American on the Apollo program. His MSEE is from USC.

Vendor Index

The information in the tables in this article was collected from the manufacturers. For clarification or amplification of the data, please contact the manufacturers directly through the office listed in the Vendor Index or by circling the appropriate readership service number on the cards bound into the back of this issue.

AMERICAN MICROSYSTEMS, INC.
3800 Homestead Rd., Santa Clara, CA 95051
Established 1966
Gross sales $58M
David L. Gellatly, mkt mgr (408)255-3651
FOR DATA CIRCLE 300 ON READER CARD

APPLIED COMPUTING TECHNOLOGY
17961 Sky Park Cir., Irvine, CA 92707
Established 1972; 15 employees
Gross sales $400K
Neil Gleason, dir mktg (714)557-9972
FOR DATA CIRCLE 301 ON READER CARD

COMPUTER AUTOMATION, INC.
18651 VonKarman Ave., Irvine, CA 92664
Gross sales not released.
D. Bush, mgr mktg serv (714)833-8830
FOR DATA CIRCLE 302 ON READER CARD

COMSTAR CORP.
7413 Washington, S. Minn., MN 55435
Gross sales not released.
Vern Carlson, natl sls mgr (612)941-4454
FOR DATA CIRCLE 303 ON READER CARD

CONTROL LOGIC INC.
9 Tech Cir., Natick, MA 01760
Subsidiary of Harnischfeger Corp.
Established 1961; 60 employees
Gross sales $1.5M
Geoff Hawkes, sls mgr (617)655-1170
FOR DATA CIRCLE 304 ON READER CARD

DATA ARCHITECTS, INC.
460 Totten Pond Rd., Waltham, MA 02154
Established 1967; 150 employees
Gross sales $3.2M
Thomas Gehman, sr engr (617)890-7730
FOR DATA CIRCLE 305 ON READER CARD

DIGITAL EQUIPMENT CORP.
One Iron Way, Marlborough, MA 01720
Established 1974; 200 employees
Gross sales not released.
Peter Connell, pro supv (617) 481-7400
FOR DATA CIRCLE 306 ON READER CARD

DIGITAL LABORATORIES
377 Putnam Ave., Cambridge, MA 02139
Established 1971
Gross sales not released.
William M. Kahn, chf engr (617)876-6220
FOR DATA CIRCLE 307 ON READER CARD

DYNAMIC DATA SYSTEMS CORP.
533 Stevens Ave., Solana Bch, CA 92075
Established 1973; 30 employees
Gross sales not released.
Lee Houser, sls mgr (714)755-5161
FOR DATA CIRCLE 308 ON READER CARD

FABRI-TEK INC.
5901 S. County Rd. 18, Minn, MN 55436
Established 1957; 2,500 employees
Gross sales over $39M
Karl Kulp, prod mgr (612)935-8811
FOR DATA CIRCLE 309 ON READER CARD

FAIRCHILD SEMICONDUCTOR
464 Ellis St., Mt View, CA 94042
Subsidiary of Fairchild Camera & Inst.
Gross sales not released.
Contact local sales office.
FOR DATA CIRCLE 310 ON READER CARD

GENERAL AUTOMATION, INC.
1055 S. East St., Anaheim, CA 92805
Established 1967; 1,450 employees
Gross sales $62M
John Dillon, pub mgr (714)778-4800
FOR DATA CIRCLE 311 ON READER CARD

GENERAL INSTRUMENTS
600 W. John St., Hicksville, NY 11802
2,000 employees
Gross sales $45M
Sales office (516) 733-3097
FOR DATA CIRCLE 312 ON READER CARD

INTEL CORP.
3065 Bowers Ave., Santa Clara, CA 95051
Gross sales not released.
Hal Feeney, mgr mktg (408)246-7501
FOR DATA CIRCLE 313 ON READER CARD

INTERSIL INC.
10900 N. Tantau Ave., Cupertino, CA 95014
Established 1969; 850 employees
Gross sales $24.6M
Hash M. Patel, mkt dir (408)257-5450
FOR DATA CIRCLE 314 ON READER CARD

MICRODATA CORP.
17481 Red Hill Ave., Irvine, CA 92705
Established 1967; 450 employees
Gross sales $14M
R.C. Stack, mgr mkt commo (714)540-6730
FOR DATA CIRCLE 315 ON READER CARD

MONOLITHIC MEMORIES, INC.
1165 E. Arques Ave., Sunnyvale, CA 94086
Established 1969; 520 employees
Gross sales not released.
Dale Williams, dir mktg (408)739-3535
FOR DATA CIRCLE 316 ON READER CARD

MOSTEK
1215 W. Crosby Rd., Carrollton, TX 75006
Established 1969; 2,000 employees
Gross sales $41M
Ken Davis, microproc mgr (214)242-0444
FOR DATA CIRCLE 317 ON READER CARD

MOTOROLA SEMICONDUCTOR PRODUCTS
5005 E. McDowell, Phoenix, AZ 85062
Information on sales and employees not released.
Van Lewing, micro mktg mgr (602)244-6228
FOR DATA CIRCLE 318 ON READER CARD

NATIONAL SEMICONDUCTOR INC.
2900 Semiconductor, Santa Clara CA 95051
Established 1959; 16,000 employees
Gross sales $213M
Philip Roybal, mkt mgr (408)732-5000
FOR DATA CIRCLE 319 ON READER CARD

PROCESS COMPUTER SYSTEMS (PCS)
5467 Hill 23 Dr., Flint, MI 48507
Established 1968; 90 employees
Gross sales $3M
Bill Bowling, sls mgr (313)744-0225
FOR DATA CIRCLE 320 ON READER CARD

PRO-LOG CORP.
852 Airport Rd., Monterey, CA 93940
Established 1972; 23 employees
Gross sales $800K
Edwin Lee, president (408)372-4593
FOR DATA CIRCLE 321 ON READER CARD

RCA SOLID-STATE DIV.
Route 202, Somerville, NJ 08876
Gross sales not released.
Dr. Lee Wu (201)722-3200
FOR DATA CIRCLE 322 ON READER CARD

R2E MICRO COMPUTERS
38 Garden Rd., Wellesley Hills, MA 02181
Established 1970; 115 employees
Gross sales $3.5M
M.W. Rohrbach, exec vp (617)235-3130
FOR DATA CIRCLE 323 ON READER CARD

ROCKWELL MICROELECTRONIC DEVICE DIV.
3310 Miraloma Ave., Anaheim, CA 92803
Subsidiary of Rockwell International Corp.
Established 1970; # employees not given
Gross sales not released.
R. F. Voigt, dir cust serv (714)632-3729
FOR DATA CIRCLE 324 ON READER CARD

SCIENTIFIC MICRO SYSTEMS
520 Clyde Ave., Mt. View, CA 94043
Subsidiary of Corning Glass Works
Established 1969; 60 employees
Gross sales not released.
M. Liccardo, prod mgr (415)964-5700
FOR DATA CIRCLE 325 ON READER CARD

SIGNETICS CORP.
811 E. Arques Ave., Sunnyvale, CA 94086
Subsidiary of Corning Glass Works
Established 1962; 7,500 employees
Gross sales $98M
George Rigg, mgr MOS (408)739-7700
FOR DATA CIRCLE 326 ON READER CARD

STANDARD LOGIC, INC.
2215 S. Standard Ave., Santa Ana, CA 92707
Established 1967; 160 employees
Gross sales $3.7M
N.G. Compton, vp (714)979-4770
FOR DATA CIRCLE 327 ON READER CARD

TELEDYNE SYSTEMS CO.
19601 Nordhoff St., Northridge, CA 91324
Subsidiary of Teledyne, Inc.
Established 1960; 1,500 employees
Gross sales $2,000M (corporate)
Frank Redding, prod mgr (213)886-2111
FOR DATA CIRCLE 328 ON READER CARD

THREE PHOENIX CO.
10632 N. 21st Ave., Phoenix, AZ 85029
Information on sales and employees not released.
John C. Dahl (602)944-2223
FOR DATA CIRCLE 329 ON READER CARD

VARITEL INC.
8857 Olympic, Beverly Hills, CA 90211
Established 1973; 7 employees
Gross sales $180K
Bruce Gladstone, president (213)659-5914
FOR DATA CIRCLE 330 ON READER CARD

WESTERN DIGITAL CORP.
3128 Red Hill, Newport Beach, CA 95051
Established 1970; 700 employees
Gross sales $13.5M
G. DesRochers, appl engr (714)557-3550
FOR DATA CIRCLE 331 ON READER CARD □

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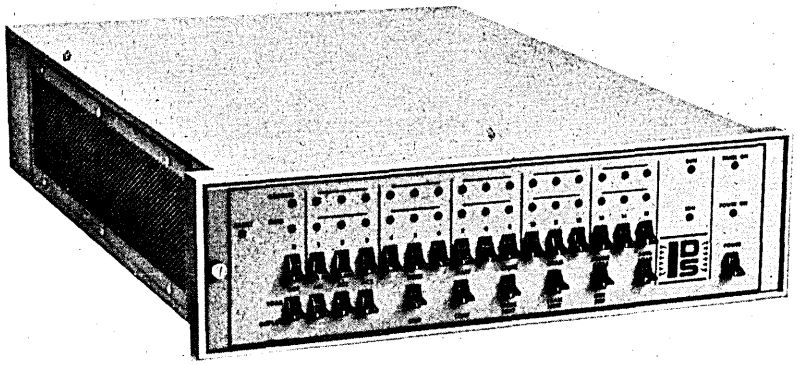
IDS minicomputers. 16-bit, 800, 1000, or 1200 nanosecond models with up to 65K words of directly addressable memory. A versatile applications-oriented instruction set. Front loading. And standard features you would order as options with a Nova. *



Our four models feature, as standard, power fail/restart. A hinged front panel to front load circuit boards. Forced air cooling and an easily serviceable power supply with 50% more power than our competition.

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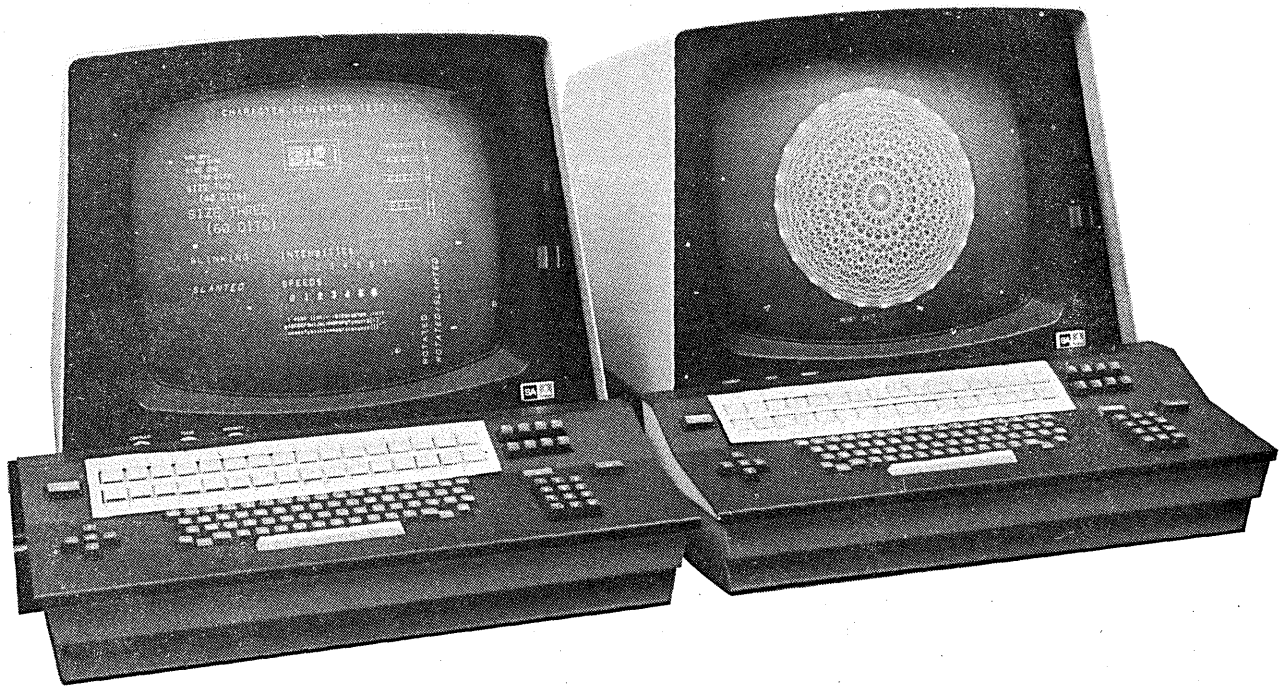
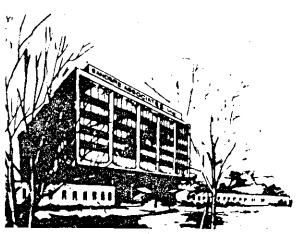
For more information contact Sanders Data Systems, Graphic Systems Marketing, NHQ 1-379, Daniel Webster Highway-South, Nashua, NH 03060. Or call (603) 885-5280.





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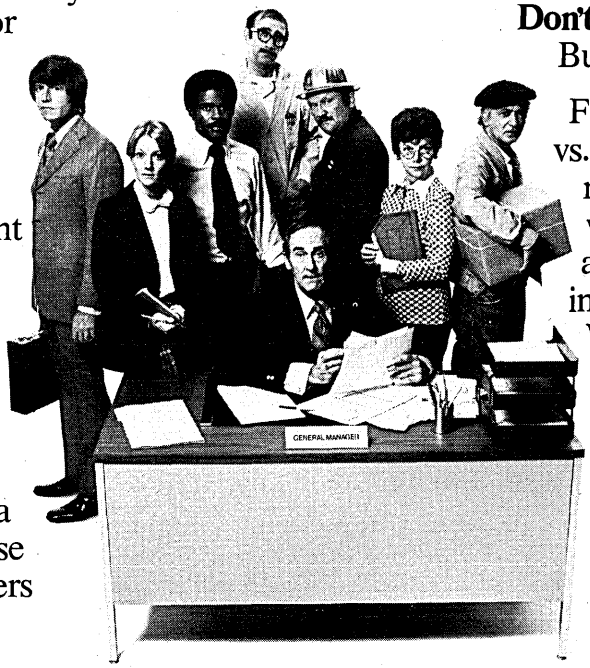
On top of that, what if each individual department not only knows where it stands on an up-to-the-minute basis, but also knows the status of all related departments?

What if we told you General Automation has a brand new answer for these questions and a lot of others just like them?



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Data management, or the lack of it, isn't a new problem.

What we offer is a totally new network approach. One that replaces a lot of time-consuming, non-productive status meetings, paperwork and guesswork with simple, economical, automated systems that tell everyone who needs to know, everything they need to know, whenever they need to know it. No matter where they are or what they do or how they do it.

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And so on.

When you've pinned down all the questions, we know where you can get all the answers.

We've got data management surrounded.
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If you're interested in high-performance systems offering decentralized control and custom applications software, our new DM-100 family is the right way to go.

If moderate performance, more centralized processing and a vast library of standard applications packages will work for you, you'll be interested in our DM-200 family.

The performance-oriented family.
Our DM-100 family consists of systems for remote job entry (DM-120), satellite processing (DM-130) and powerful central processing centers (DM-140)—each built around our high-performance SPC-16 computer. When tied together, they form a compatible network of products that can communicate with each other and provide upward expandability where you need it when you need it.

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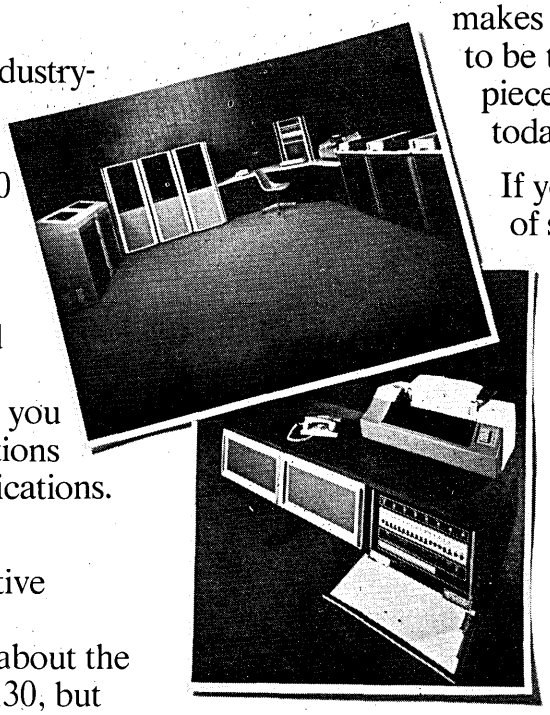

We also make a special low-cost, highly interactive system. It's called the DM-130/2 and has just about the same specs as the DM-130, but without the range of expandability. (It is available through a separate, nationwide network of distributors established to handle the special turn-key business system requirements of first-time users.)

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Lots of applications and less decentralization calls for our DM-200 family. It is based on our 18/30 computer and a vast library of standard software for applications in manufacturing, distribution, finance, engineering and publishing. To name just a few.

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General Automation is the only computer company that offers total as well as isolated data management solutions at a price that makes sense. Someone else may claim to be the expert at solving the piece of the puzzle troubling you today, but what about tomorrow?

If you consider the total package of system growth, compatibility, stability, power, software, field support, manufacturer involvement and price, nobody can beat us. Nobody.

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Talk to our salesmen.
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For further information on data management systems, write General Automation, 1055 South East Street, Anaheim, California 92803.
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news in perspective

SPECIAL REPORT: The scheduled trial date for the most complicated and significant antitrust suit in history is approaching. The Justice Dept.'s case against IBM generally is expected to go to trial in January, but there is considerable speculation that the six-year case may end with a consent decree. This special report (beginning on this page) reviews the Justice Dept.'s case against the computer colossus, traces the evidence being compiled from IBM's own internal documents, and inspects how the Justice Dept. thinks computer users have been affected by IBM's alleged monopolistic practices . . .

Singer may begin development of an intelligent terminal priced as low as $1,500, page 117. Nobody at the sewing machine company—fast becoming famous in the business machines field—will talk about the development which would provide all sorts of smarts to dumb terminals . . .

Is the ACM changing? And the old-timers passé? It seemed that way last month in San Diego where youth was predominant and "in talk" was out as the ACM held its 29th annual technical conference, page 117 . . .

Core memory manufacturers hold their own against the emerging semiconductor memory, but their days could be numbered, page 130. The advent of the 4K chip, and an overall slump in memory purchases, may hasten that day . . .

A flashback to the wheeling and dealing days of the late '60s is presented in a report on those taken in by promoters of computer stocks, page 131.

Antitrust

Can IBM Impeach Its Own Documents?

Government's Best Evidence Turns Out to be IBM's Data

In January of 1969, Thomas J. Watson Jr., chairman of the International Business Machines Corp., had a most important mission. His assignment was to attempt to convince the attorney general of the United States not to institute antitrust proceedings against IBM.

The administration of Lyndon Johnson was in its last days and while Johnson was friendly with Watson, attorney general Ramsey Clark had a reputation of being something of a maverick. There was no telling what Clark might do.

At any rate, Watson and IBM's attorney Burke Marshall, a former assistant U.S. attorney general, visited Clark in Washington. After the meeting, Watson wrote Clark a letter. In the letter, Watson stated:

"We entered into a consent decree with the Dept. of Justice in 1956, when we had about 90% of the business. As a result of that decree and the rise of vigorous competition, our present share of the business is somewhere between 55% and 70%, depending upon the criteria used; so that this decree has worked correctly and effectively."

Not only was the letter ineffective—Clark filed the case against IBM a few days later on the last day of the Johnson administration—but it is now returning to haunt Watson and IBM.

An admission by Watson

The problem, of course, is that Watson volunteered that IBM had at least 55% of the computer business and admitted that the firm could have as much as 70% of the business. IBM's attorneys are now arguing vehemently that IBM had nowhere near those percentages of the computer industry.

The Watson letter and the incident that surrounded it, however, are illustrative of what is probably the most important fundamental issue in the IBM-Justice Dept. case: the value of the overwhelming amount of incriminating IBM documents that have been churned up in the case.

The government, in its pretrial brief, slices right through to the heart of the matter: ". . . The weight to be accorded to contemporaneous documents over testimony at the trial by authors of the documents, for example, is of particular importance in assessing the purpose or intent of past conduct . . .

"The contemporaneous expression permits an evaluation of the business motives that occasioned it at the time of the business conduct or decision then under study or at issue. Not so the testimony, upon later deposition or trial, by the author of the statement or the perpetrator of the conduct—his motive then, consciously or not, is to soften or avoid the consequences of his earlier conduct or utterance."

The problem for IBM is that nearly all of the chief issues in the cases are punctuated and underlined by IBM documents, memos, studies, reports and the like. Since it is virtually impossible for IBM to repudiate or disown the material, the best way out for IBM—indeed, perhaps the only way out—will be for the company to enter into a consent decree with the Justice Dept.

Parameters setter

The paramount issue, the issue that will more or less set the parameters around the entire case, is the issue of market share. The court record is already replete with documents, particularly from Thomas Watson like the letter to Ramsey Clark, that support the contention that IBM has overwhelmingly dominated the core of what is generally referred to as the computer industry—that is, the general purpose edp systems business.

In one deposition, Thomas Watson discusses a memo he wrote in which he said: "Nevertheless, I think the main aim of this company must be to protect and expand our position in the marketplace and this must be a consideration well above that of profit." Watson said that had been the "main aim" of IBM since 1914.

In another celebrated Watson memo, the chief executive of IBM stated that

"IBM should attempt to maintain its market share in the immediate foreseeable future with the idea that with the industry growing as rapidly as it is, other companies can grow quite rapidly under this general mandate."

Moreover, the government had made it clear that it places great weight on IBM's commercial analysis statistics, many of which show IBM to have a commanding share of the general systems business.

IBM's defense on this issue has been

THOMAS J. WATSON JR.
"Protect and expand our position"

to attempt to disown its own internal material and to place great emphasis on a new census it has taken which IBM maintains proves that the firm has a smaller share of the business—a percentage as low as 38%. Simply put, IBM is attempting to view a computer market that is very broad. The firm even argues that GE and RCA are still in the computer business.

Bickering over census

In addition, IBM appears to be attempting to use a census taken by the Commerce Dept. which undoubtedly will show that IBM's market share is less than IBM's internal documents show. Pretrial bickering between IBM and the Commerce Dept. over the census has been threatening to delay the start of the trial which has been expected to begin in January.

The Dept. of Justice is stressing the importance of IBM's bundling practices—Justice talks of "the IBM bundle"—which it argues has tended to lock in customers to IBM equipment and to give the firm tight "account control" in violation of antitrust regulation.

Although IBM announced it was unbundling in 1969 after the Justice Dept. complaint was filed, the Justice Dept. still maintains that IBM has not unbundled.

Moreover, there are indications that IBM itself has had serious reservations about its unbundling practices. In a 1965 memo by T. V. Learson, the IBM president suggested that IBM "continue to look at separating charges for software. In the past, our motives for such studies have been to be more competitive and to protect programming. I believe a *new* motive may well exist for looking at this subject, in that we may be forced to do it—if not by changes in industry practices, then *by other sources.*"

Although it is not spelled out who or what might "force" IBM to change, there has been speculation that the only party strong enough to force IBM to do anything is the Justice Dept., so it is possible that IBM feared antitrust action on bundling back in the mid 1960s. The firm, however, decided not to unbundle at

T. VINCENT LEARSON
Forced to unbundle
"by other sources"

that time and one of the reasons given in IBM's internal documents against unbundling was the fear of "loss of account control."

Mass of evidence

In its pretrial brief, the Justice Dept. marshalled a mass of evidence against IBM on the issue of "fighting machines."

"One of the clearest abuses of IBM's monopoly power," the brief states, "has been the use by IBM of 'fighting machines' to restrain the entry, growth or success of its competitors. Such machines have usually taken the form of precipitious announcement or introduction by IBM of selected computer products, usually with low profit expectations, in those markets or segments of the markets where IBM's monopoly position had eroded or threatened to erode."

Perhaps the most interesting "fighting machine" in the eyes of the Dept. of Justice is the entire 360 line. The Justice Dept. maintains that the timing of the 360 announcement "was a marketing decision designed to create a competitive jolt and to prevent competition from making any further inroads into IBM's established market position."

The Men

Back in the 1960s, Thomas J. Watson Jr. was mulling over ways in which he and IBM could pat Albert L. Williams, IBM's president, on the back.

"We've considered all kinds of remembrances you'd particularly cherish," Watson wrote Williams. One answer Watson supplied was: "An endowed chair of monopolistic practices, in your name, at the Harvard Business School."

The idea was a natural since Williams, according to Watson, had ironed out the details of the Justice Dept.'s 1956 consent decree with IBM. The idea may have been somewhat facetious, too.

The incident is just one of many that throw light on the inner workings of IBM and on the personalities of the men that have made IBM the remarkable industrial power it is. The Watson communication to Williams is just one of many fascinating incidents that are revealed in the depositions and exhibits generated in the Justice Dept.'s current antitrust case against IBM.

In one deposition, Watson explained what he had in mind for Williams. "The last gift that I suggested," said Waston, "was a Siberian tiger riding a Bactrian camel . . . What I really wanted was a hot air balloon ascension but since I was paying for these birthday parties out of my own pocket, I found that the balloon ascension was going to run me 750 bucks and I cast it aside."

During the depositions, the attorneys representing the two sides—IBM and the Justice Dept.—appear to have changed their attitudes from one of overt hostility to businesslike camaraderie.

For instance, in July of 1973, the deposition of T. Vincent Learson, former IBM president, started off with his attorney claiming that the government attorney had "ripped" a piece of paper out

To back up its contention, the Justice Dept. quoted from memos found in the Watson brothers' files. In a 1965 memo, Thomas Watson said this about the announcement of the 360 line:

"By '62 we were beginning to hurt in the field . . . and in the spring of '64 our hand was forced and we had to, with our eyes open, announce a complete line—some of the machines 24 months early, and the total line an average of 12 months early . . .

Against the wall

". . . My own conclusion to this is that we were so up against the wall saleswise that had we waited another nine months to announce the line we would have lost position that we could ill afford to lose."

In a memo to Arthur Watson, an IBM executive discussed "the announcement of System/360 one year before engineering and manufacturing were really ready. Tremendous pressures were exerted at the time because of the inroads that the Minneapolis (Honeywell) 200 was making on the 1401 and our exposures at the high end of the line (from Control Data).

One interesting revelation about the 2360 line was that IBM later had regrets that it hadn't priced the line higher and the firm even considered retiring the series early and substituting higher priced models with greater capacity.

In his CDC deposition, Thomas Watson said there was nothing extraordinary about the idea. "This is very common practice in IBM," said Watson. "It's been going on for 35 or 40 years. We frequently change models and we drop the old model and substitute the new one. The new is always closely enough related to the old so that—or at least we attempt to have it so—that no customer is discommoded and nobody is made mad, and this is what we were thinking of doing here."

Some of the other "fighting machines" cited by the Justice Dept. are better known in that context. The model 90, for instance, was part of what the Justice Dept. termed a "stop CDC" program which was aimed at CDC's large scientific machines. The Justice Dept. maintained that IBM lost $100 million on

Who Ran IBM: "It's Embarrassing What You Forget . . ."

of his hand. The deposition was marked by other spirited arguments.

Warming up to "Ray"

By May of 1974 in the deposition of Thomas Watson, the attitude of the two opposing attorneys was such that the IBM attorney, F. A. O. Schwartz Jr. was offering to get coffee for those at the deposition including Justice Dept. attorney, Raymond M. Carlson. Schwartz was no longer referring to Carlson icily as "Mr. Carlson," but as "Ray."

T. Vincent Learson, of course, is a legend in the computer industry. The towering, hard-driving, blunt-spoken executive evoked tremors of premonition from IBMers and competitors alike. He lived up to his billing during his deposition, particularly concerning his bluntness.

Learson took umbrage with a suggestion by the Justice Dept.'s Carlson that IBM's model 90 was a "paper model" and that IBM wouldn't be able to "fill its commitments to deliver such a machine within the announced promised time."

Learson retorted indignantly: "Counselor, you are now getting (into a) very troublesome area with your vocabulary which I would appreciate if you would clean it up."

At another point, Learson indicated his feelings about a subordinate who might not follow one of his orders. "I would bounce him," said Learson. "I like to give my directives good attention."

As for the competition, a Learson document evaluating a new IBM machine stated that the proposed machine would "murder" some Control Data equipment.

At one point in his deposition, Learson complains that the Justice Dept. attorneys are "stubborn-headed" and that "all you are doing is bringing delay tactics into this whole proceeding and at $20 a day, I think, it's unfair. That is all I am getting for it." (Witnesses received that amount to testify. Learson is a multimillionaire.)

Learson also made it clear that Thomas Watson was the boss at IBM. In commenting on a communication in which Watson asked Learson why an IBM machine announcement was behind schedule, Learson said of Watson: "I would believe he was on the ball giving me a good needle then. I had that happen so many times."

FRANK T. CARY
"I always did what Mr. Watson told me to do"

Bad memory

Like most of the IBM executives, Learson appeared to be suffering from amnesia, particularly when sensitive subjects were touched on. "God," said Learson, "it's embarrassing what you forget in seven months of vacationing."

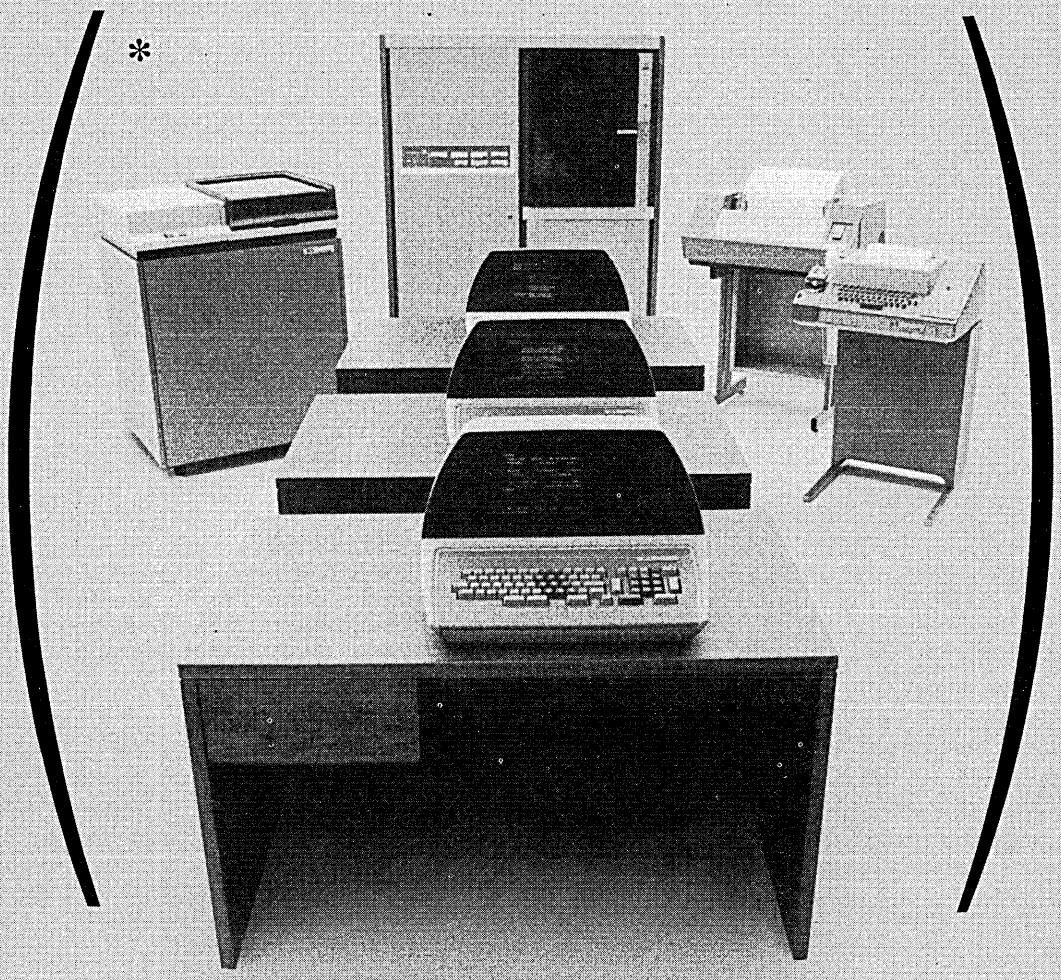
Watson had even greater difficulties in recalling documents and memos and events in which he participated or was involved. Furthermore, he made several comments which indicated his intense involvement in IBM may have begun to drop off in the mid or late 1960s.

He referred to the United Kingdom's ICL as International Computers and Tabulators Limited—an archaic name—and mentioned "another British company," Ferranti, which had long been a part of ICL. Watson couldn't remember the name of the "French governmental company"—an apparent allusion to CII. In addition, he mentioned France's "Machine Bull" company without apparently realizing it had been merged with Honeywell. When he gave an example of a computer trade journal he used the title "Automation." Later, after being prompted, he said he meant to say "Datamation."

Whether Watson tended to forget events, or whether his intense interest in the computer industry began to drift in the 1960s or whether his work with the company was far enough removed from the trenches at Armonk as to be in the ivory tower category, Watson was still the Chief to everyone. In the deposition of Frank T. Cary, IBM's current chairman, Cary said: "I always did what Mr. Watson told me to do."

At any rate, the main characters in the IBM-Justice Dept. case and their comings and goings and memos and depositions will receive further scrutiny and the cryptogram that has been IBM will be deciphered gradually in the coming months. □

GREAT COMPUTER SECRETS*



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Which we've never advertised.

For the past four years we've been developing our powerful GCS 2100 system and building its software support and service program. And we've never taken the time to tell enough people what a great system it is.

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And our competitors have loved us for keeping it such a secret!

The GCS 2100 is a complete data entry system: it lets you collect and edit data at the source (data is actually edited while it is being keyed).

Store the data on disc. Then transfer the clean data to an output media like magnetic tape.

(Conversely, data already on tape or cards can be re-submitted to the GCS 2100 for editing, reformatting, etc.)

By editing input data before it goes to disc storage, the GCS 2100 lets you quickly spot errors that could have become costly.

The GCS 2100 can interface up to thirty-two Touch-Tone telephones. Card readers. Medium and high speed line printers. Four-tape drives. Four fixed or moving head discs.

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The GCS 2100 provides extensive I/O functions that allow you to transfer data to and from disc storage and other I/O devices, and provides an audit trail (comprehensive statistical reports aid in monitoring the system and the operator's performance), all with minimum impact on a supervisor's time.

The GCS 2100 can accommodate up to 64 local or remote terminals: local terminals can be located up to 2500 ft. from the system's CPU. You get faster, more accurate data entry for functions like payroll, shipping, receiving and manufacturing, because the person most familiar with the data does the keying. (Note: we can supply a typewriter keyboard and a special CRT format so this person doesn't have to be a keypunch operator.)

In addition to data entry from local terminals, the GCS 2100 offers data entry from remote terminals (it can handle up to five remote terminals over one dedicated telephone line); touchtone data entry; remote batch communications; and word processing.

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And because these tables are not job assigned, they can be used on several different jobs. (Note: no programming experience is needed to work with PEP.)

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The GCS 2100 also provides up to 99 format levels per job; up to 255 balance accumulators; variable length record and blocking factors; and up to 255 jobs stored in the system.

GCS DataText: is a multi-purpose shared-processor approach to word processing. Designed for high-volume typing requirements, it is a fast, efficient, low-cost method for producing customized letters, envelopes, forms, labels and reports.

And since DataText uses a disc library, manual handling of storage media like cards, cartridges, etc. is eliminated.

GCS DataTone: is a low-cost, efficient and convenient method for collecting numeric data from remote sites. It is designed for updating inventory, shipping documents, orders, etc.

DataTone answers automatically and handles up to thirty-two incoming lines at once.

With DataTone, the GCS 2100 system can accept incoming telephone data without interrupting data entry from the terminals.

GCS DataTel: provides remote batch communications capabilities between the GCS 2100 systems and other 2780-compatible terminals and mainframes. And since the batch transmission of data is directly from disc to another mainframe, the usual step of transferring data to tape can be eliminated.

If you'd like to get in on more Great Computer Secrets, contact Agent 2100 at General Computer Systems, Inc., 16600 Dooley Road, Addison, Texas 75001. (800) 527-2568 toll free.

GCS2100

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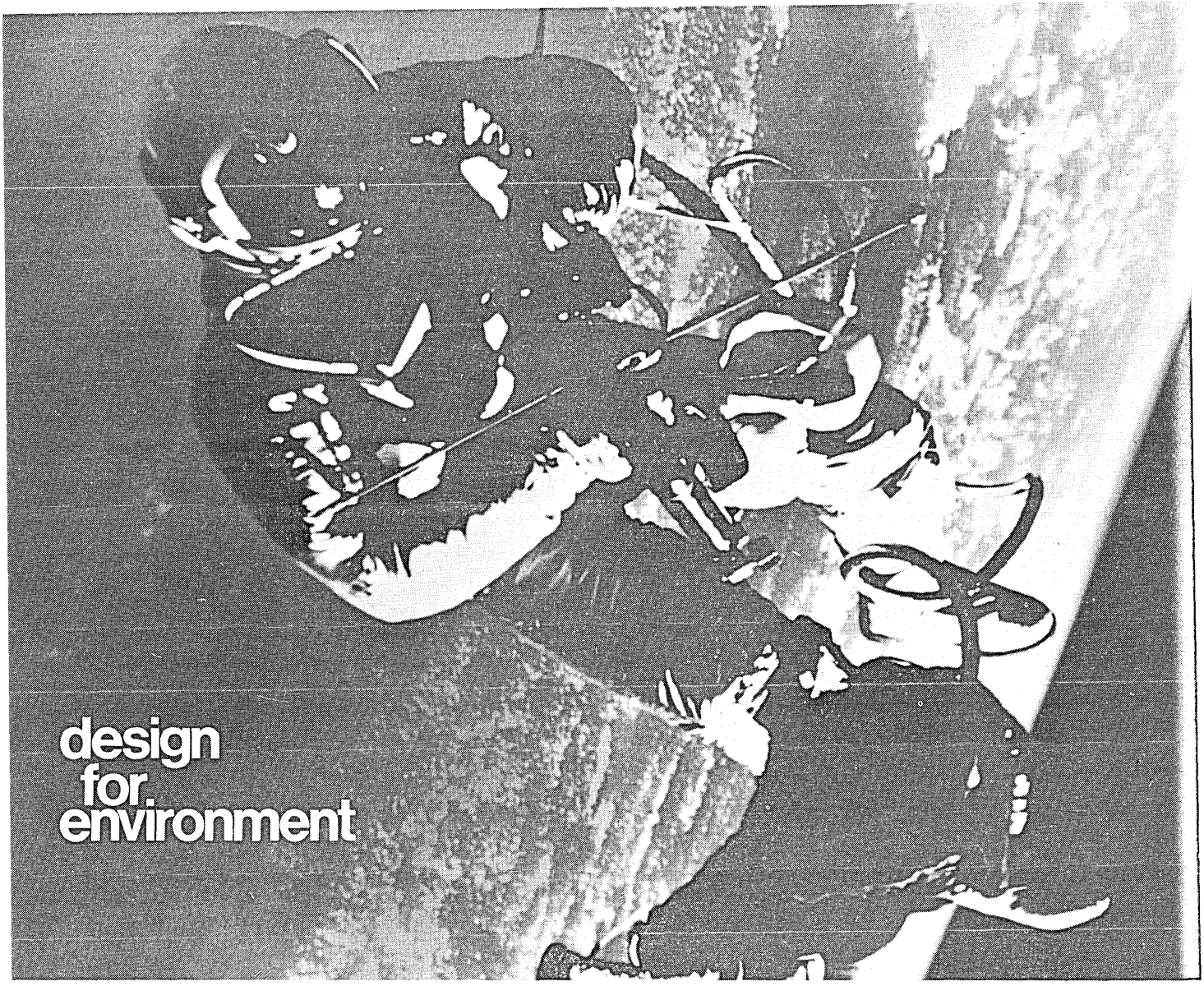

MARK iV System/270 for Virtual Storage.

Design—

The new MARK IV/270 is the only high-level language system designed specifically for VS users. The MARK IV System now takes advantage of the inherent capabilities of VS for optimized storage allocation.

Compatibility—

Introduced in late 1973, this new model of the MARK IV System is now in use on IBM System 370 equipment in 20% of the more than 800 world-wide MARK IV installations. All existing MARK IV programs are fully compatible with the new model. MARK IV/270 is for IBM OS/VS1, OS/VS2, and DOS/VS, and fully supports the new Virtual Access methods.

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CIRCLE 40 ON READER CARD

the model 90 program (IBM never delivered a model 90).

Not stopped completely

In its pretrial brief, the government charged that "while IBM did not attain its objective of completely stopping Control Data, , IBM's activities with regard to the model 90 program put Control Data in severe financial straits."

The model 90 was a most important milestone in the long antitrust trial against IBM in that Control Data instituted their first antitrust case against IBM in 1969 with that machine constituting the major issue in the case. Many feel that the rash of antitrust actions against IBM including the government suit were triggered by the CDC action. In the CDC case, IBM made an out-of-court settlement with CDC valued at about $100 million.

Other IBM equipment that the Justice Dept. charged were "fighting machines" were the 360/67, a large-scale time-sharing machine that was aimed at General Electric and CDC equipment; the 360/44 which was aimed at medium-scale scientific equipment produced by CDC and Scientific Data Systems; and the 2319A and 2319B disc drives, which were aimed at peripheral company equipment.

Besides bundling and fighting machines, the Justice Dept. lists the "discriminatory educational allowance" as a weapon used by IBM to maintain its market dominance. The government contends that IBM had a market share in the college and university market that hovered around the 85% mark throughout the late 1960s and contends further that IBM utilized a series of grants, discounts and giveaways to achieve that high percentage.

Moreover, the Justice Dept. draws upon IBM documents to illustrate that IBM's activities in education were not

How Justice Thinks the User Was Harmed

The underlying principle of government antitrust action is that the chief beneficiary of the legal action should be the consumer, or in the case of the computer industry, the computer user. But the computer user has seldom been heard from and indeed he has very seldom been mentioned in the case. In the Dept. of Justice's pretrial brief, however, the user, as seen by the Justice Dept., begins to surface. Some selections from the brief follow.

" . . . When IBM made the decision to attempt to convert its commercial customers from punch card record keeping to electronic computerized techniques, it found that it could most successfully accomplish the conversion by providing the customer with this same 'total system' package of equipment and services. The approach proved highly successful, particularly with the great majority of commercial customers, who at that time had no facilities or expertise to develop their own software, or to perform their own maintenance and other support services . . .

" . . . As IBM provided its customers a total systems package for a single price, users and potential users came to view the bundle of services supplied with the computer hardware equipment as 'free goods.' Internal memoranda of IBM show that such an impression was to a large extent conceived and nurtured by IBM itself . . .

" . . . By offering and providing a package of products and services for a single price, the actual costs attributable to developing and marketing each element of the bundled package could be disguised by IBM. As a result, the typical computer system user was, for the most part, incapable of objectively assessing the price to him and, therefore, the cost of the individual components of the bundled package. As a result, he lacked the basis for adequately evaluating his data processing needs.

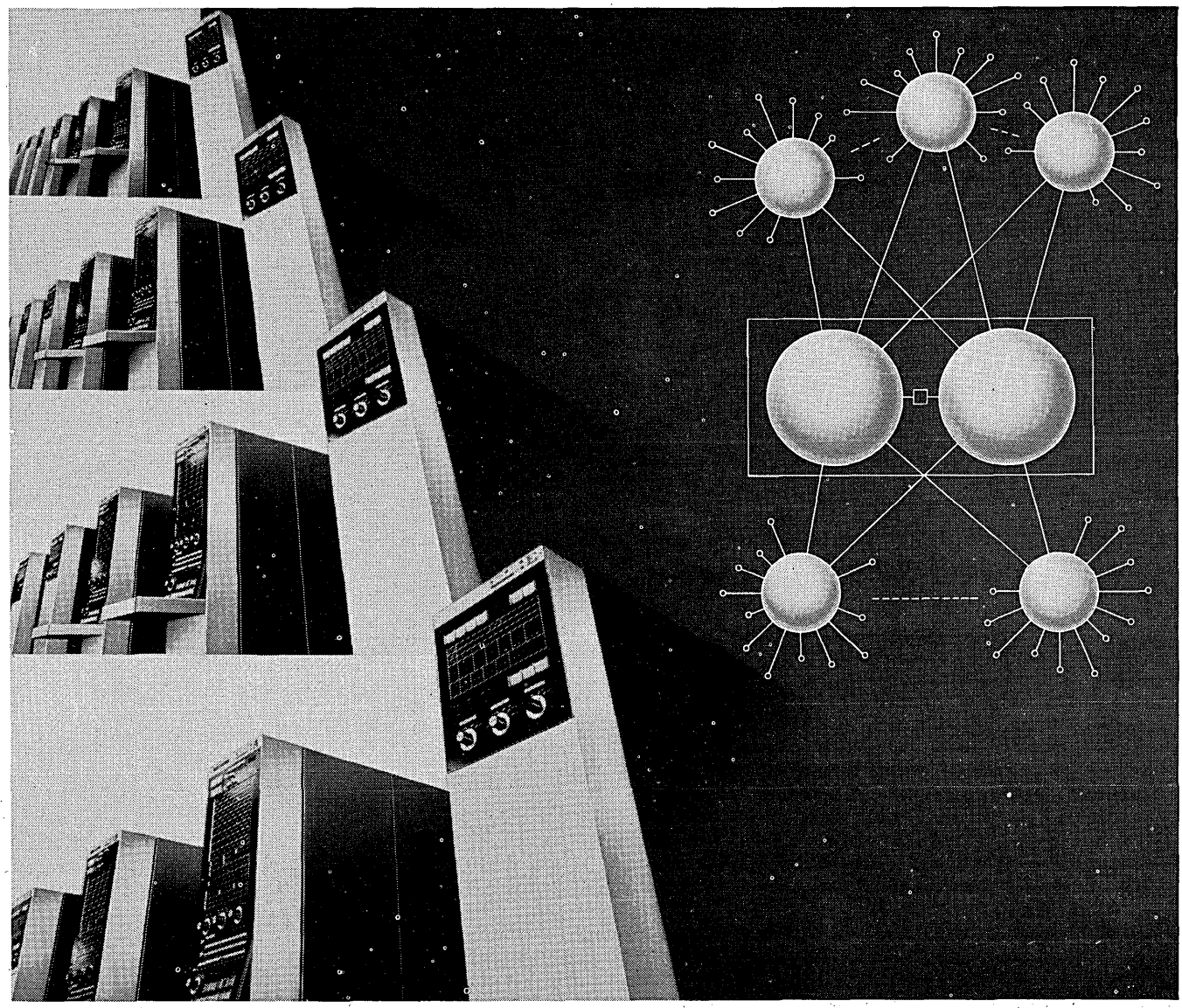
"It was understandable that out of this situation arose an environment where customers grew totally reliant and dependent upon IBM for all facets of their data processing operations . . .

Technical advisors

"Except for the sales representative, the systems engineer may be considered the single most important element in the IBM marketing arsenal. By being constantly available to the customer without charge from the initial sales contact through the design, installation, and implementation stages of the IBM marketing effort, the systems engineer became thoroughly acquainted with a customer's data processing facility.

(Continued on page 115)

How 89 Different Banks, with 7,200 Branches, Carry on Exchange.



Most people don't know it, but April 9, 1973 marks a very important day in the history of banking. On that day, in Japan, the first truly nationwide, inter-bank computer "message switching system" went into operation.

FACOM To help "rationalize" the handling of exchange transaction between 89 different banks and their 7,200 branches, FACOM computer played a major role in the creation of this gigantic data communication system for banking.

At the heart of the system are six Central Processing Units. By means of a "divided installation" system and a load sharing system, these processing units are connected with two or more terminals installed in individual banks by way of special computers.

This is just one contribution our FACOM computers, with more than dozen models ranging from large to small, have made to banking. If the task involves highly sophisticated data processing techniques in every field from business calculation to scientific computation, then you can rely on FACOM from Fujitsu — a pioneer and developer in electronics and communications the world over.

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motivated to help education, but to establish key prestige accounts that would influence the purchase of commercial computers and to train students who would later purchase IBM equipment. "The term educational allowance implies an intent to underwrite education," states one internal IBM document. "This is not our intent."

University situations

The Justice Dept. describes several university situations in its pretrial brief and one of the most interesting is the activities at Harvard Univ. T. V. Learson, a Harvard alumnus and later a member of that school's board of overseers, was involved in the Harvard situation.

IBM made a $500,000 grant to Harvard's Computation Center in 1961 and in 1965 when Harvard was considering acquiring time-sharing facilities, a member of Harvard's Computer Committee reported to IBM bluntly: "IBM bought the business at Harvard last time and if they want the future system they will have to buy it again."

According to the government brief, IBM gave another $500,000 to Harvard. The Justice Dept. then stated: "The effect of the grant was felt the next year, when IBM was again in competition with CDC. Although the IBM system then installed was 'down' 882 hours in 22 months and the proposed IBM system was rated below the CDC machine, it was predicted to T. V. Learson that IBM would be selected. The prediction came true. In fact, as of October 1968, of the 10 systems installed or on order for Harvard's Computation Center, only one was a competitive system."

The situation at MIT, however, was somewhat different where MIT's president made a "most reluctant" decision to go against IBM time-sharing equipment in favor of GE equipment (for

How Justice Thinks . . .

Because of his role as technical advisor and counselor, the systems engineer was responsible for establishing customer dependence on IBM. An IBM technical advisor would be unlikely to recommend anything other than IBM equipment.

"The systems engineer's ability to establish rapport with the customer and customer loyalty was counted on by IBM to a considerable degree for continuing marketing success. The role of the systems engineer, therefore, was not only a factor in IBM's initial success at any given account, but contributed to IBM's continuing success in retaining customers. As the customer's technical advisor, the systems engineer enhanced IBM's ability to upgrade equipment previously installed and to fend off potential competitive threats if they arose. Thus, it was through the vehicle of bundled prices for systems engineering service that IBM was able to exercise 'account control.' "

Different levels of support

" . . . By offering and providing customers with a total package of hardware and services for a single bundled price, IBM supplied all necessary support needed by any given customer to install and operate his computing system. Since customer needs obviously varied in accordance with their size, level of sophistication, and expertise, the amount of support services provided by IBM likewise varied. While customers acquiring the same computer hardware equipment would pay IBM the same price, they would receive different levels of support . . . "

" . . . IBM could subsidize certain competitive accounts at the expense of those accounts not needing or desiring the services IBM could provide. This permitted IBM the flexibility to provide additional services at prestigious or key accounts in their marketing plan resulting in the restraint of actual or potential competition. IBM's internal memoranda make it perfectly clear that the decision to increase or decrease customer support was, in the final analysis, a *sales* decision."

"IBM's 'free' software was written in machine language rather than what is known as 'higher level languages.' Examples of these higher level languages are FORTRAN, ALGOL, and COBOL. Because the programs were written in machine language, they would operate on IBM computer equipment exclusively. Had the programs been written in higher level language, a customer's internal programmers could modify the programs to make them compatible with the computer equipment of other systems manufacturers . . . " □

Project MAC.) Thomas Watson's reaction was quick and to the point. He said: "The fact that GE has now sold the MAC program to MIT is having quite an effect among computer users. They believe as a result of the sale that GE has better time-sharing ability than we have."

According to the court record, IBM then went to work to set up a prestige IBM installation at MIT. IBM's Dr. Herman Goldstine entered into negotiations with MIT's Dean Gordon Brown and IBM subsequently gave MIT various monetary concessions and in return got its MIT installation. Goldstine is quoted as saying: "I told Brown explicitly that we were out of patience with institutions which take our money then go competitive."

Called to educate

Goldstine, incidentally, has already been involved in the IBM-Justice Dept. antitrust case. IBM called him to help "educate" Judge David N. Edelstein on the subject of computers. Judge Edelstein is presiding over the case.

Another not-unexpected issue that has been introduced by the government in the case is the issue of peripheral equipment. Essentially, that issue parallels the antitrust case brought against IBM by Telex except that IBM adds the area of display terminals. Specifically, regarding the display terminal issue, the government mentions Sanders Associates, and it appears that the government case will parallel Sanders Associates' anticipated private antitrust complaint against IBM. Telex won its antitrust case against IBM, but IBM has appealed the decision. At this writing, a decision on the appeal had not been issued.

The final "conduct pursued by IBM in maintaining its market dominance" cited by the Justice Dept. concerns leasing. Essentially, the government maintains that IBM was "primarily responsible" for creating the leasing orientation of the computer market and that environment tended to restrict competition, and gave IBM "stricter account control" among other advantages.

The leasing section of the pretrial brief embodies much of the material revealed in an earlier antitrust case brought against IBM by Greyhound Leasing. IBM won that case, without even so much as having to present its own case. But Greyhound has appealed that decision, and at this writing, there had been no decision on the appeal.

Essentially, the Dept. of Justice case argues that IBM itself helped create the proliferation of leasing companies when it made it relatively attractive to purchase 360 equipment. (IBM needed the cash to help fund the enormous 360 project.)

Left with the lessors

However, as IBM's cash problems abated, it was at about the same time left with what it then targeted as its chief competition—the leasing companies. The government charged that IBM stopped the leasing company threat by utilizing a variety of weapons, primarily pricing actions. The leasing companies eventually disappeared as a significant threat to IBM.

Throughout its pretrial brief, the Justice Dept. brushes several other issues and subjects of interest. The government, for instance, charges that IBM sets de facto industry standards and states: "IBM expends a tremendous amount of manpower and money on standards committee activity. IBM sees standards committee adoptions as a threat to its power to unilaterally establish standards."

The government also discussed the "demise of RCA" at considerable and fascinating length. The Justice Dept. tipped its hand somewhat in that it indicated it will depict RCA as a fine company with "considerable talents and resources" that just couldn't compete against the withering firepower of IBM.

Fascinating new RCA documents are cited in which it is revealed that RCA complained privately to IBM about some of the computer colossus' tactics and that RCA, on at least a few occasions, appeared to be desperately seeking relief. RCA's general counsel, for instance, wrote to IBM's counsel, complaining that the 370/145 involved discriminatory pricing that violated antitrust regulations. The discriminatory pricing was presumably aimed at RCA.

Signs of desperation

By the summer of 1970, communications to IBM from L. Edwin Donegan Jr., head of RCA's computer operation, began to show signs of desperation. In a letter to T. V. Learson requesting interfacing information on the 3330 disc drive, Donegan wrote: "I should inform you of the extremely serious effects that failure on IBM's part to respond promptly to our request will have on RCA's

ability to compete in the data processing industry in the months ahead . . . This kind of standard setting impact makes it incumbent upon IBM to release the information requested promptly after announcement unless it is IBM's policy to destroy or foreclose competition."

Thus, it was clearly established that IBM had been put on notice by RCA that IBM's actions were potential antitrust violations and that they were severely hurting RCA. When RCA threw in the towel in the computer business, the firm cited the difficulties of competing against IBM's "uniquely entrenched competition."

Previously, it had been widely thought that IBM was surprised when RCA quit the computer business and that IBM had been aiming some of its tougher business practices against the peripheral companies and that RCA simply got hit by those inadvertently.

At this point, it is difficult to predict what IBM will represent as its defense in the antitrust case. IBM's chief problem, of course, will be to find ways to impeach its own internal material. IBM had not filed its reply to the government brief when this was written and long ago IBM pushed through a press gag order in the case that forbids the firm or the government from commenting publicly on any aspect of the case.

—W. David Gardner

Communications

Singer's Cheap, Smart Terminal

Singer is exploring development of an intelligent, microprocessor-based terminal with limited off-line data processing capability, which could sell for as little as $1,500.

Company officials emphasize that they haven't yet decided whether to manufacture the terminal, and probably won't for some time. They also refuse to speculate on what the price might be. The $1,500 price tag was inferred from the specs that were disclosed. It assumes that a suitable keyboard/character generator for the proposed terminal can be developed to sell for roughly 50% below present commercial prices.

Based on current LSI technology and trends, Singer said, this problem may well be on its way to being solved.

If the proposed terminal is built, it would be supplied initially to users of the company's worldwide in house data communications network. A key Singer source says, "The need for such a terminal in house is firmly established."

Significantly, a similar type of in house requirement launched Singer several years ago into the POS terminal business.

As presently conceived, the proposed microprocessor would be a communications front end primarily; it would interface with several kinds of terminals—including Teletype's crt, black and white commercial TV sets serving as crts and various peripheral I/O devices such as cassette recorders, floppy discs, and perhaps charge coupled storage devices.

Specifications

The basic configuration would have interchangeable read-only memory and possibly random access memory. The RAMs would be available in one, two or four kilobyte modules; the ROMs in two, four or eight kilibyte modules. The maximum memory that could be accommodated "as a practical limit," according to one knowledgeable source, would be about 20 kilobytes.

The microprocessor would have a multiple level priority interrupt, utilize ADCII as the internal code, have a 74 instruction set, and a cycle time of two microseconds. It would offer block/character transmission at synchronous/asychronous speed, and be attachable to a communication line via either acoustic coupling or direct wiring. It could address up to 256 devices.

Singer officials believe that within the next five years inexpensive microprocessor-based terminals, like the one they are now exploring, will be sold over the counter in retail stores, much like pocket calculators are marketed today. These officials contend that most companies which have in house computer systems today will get rid of them and instead use terminals to access nationwide data processing utilities offering similar services at a fraction of the cost.

This shift will largely eliminate the market for medium scale computer systems and shrink the mainframers' marketing/support requirements proportionately.

The new networks will be organized into a four-level hierarchy: there will be a large central system, consisting of multiple large-scale mainframes; regional centers using mini-based concentrators/multiplexors and, at the extremities of the network, systems consisting of an inexpensive microprocessor that interfaces several different types of data transmission device to the network and provides limited off-line data processing.

—Phil Hirsch

Societies

ACM '74: A Young Crowd

The old timers were there but not too easy to spot in a predominantly young crowd of some 2,000 attending ACM '74, the 29th annual technical conference of the Association for Computing Machinery, last month in San Diego.

And in talk was out and out talk was in. "Too many people feel ACM has been inward oriented," said Marcy Ann Chapman of Delphi Datasystems, chairman of the ACM Ombudsman committee. It's a feeling ACM, and particularly the Ombudsman committee, is working hard to dispel.

The youth of the group, and the industry, was underscored by James C. Browne, Univ. of Texas. As a participant in a panel on computer performance measurement, he was asked why performance measurement hadn't progressed much. His reply: "It's an infant industry. Why, nobody on this panel is over 40."

Keynoter Robert S. Barton of Burroughs Corp., brought a note of what some old timers might deem heresy to the conference when he told a jam packed general session, "Our only hope is to turn away from numbers, from scientific materialism, back to belief in God."

"The really important things in the world we live in are not quantifiable at all," said the Burroughs computer architect. "The thing that matters most in the long run is effective communication of people to people and it isn't communication unless it's two way."

In a lighter vein, Barton opened his talk by saying it had been suggested to him that he say something nice about ACM president Jean Sammet. He also said he felt it incumbent upon him to say something nice about IBM. He handled it nicely. "Isn't it nice that Jean works for IBM."

A bit more in keeping with traditional ACM thinking was the A.M. Turing Lecture delivered by this year's Turing award winner, Donald Knuth of Stanford Univ. Knuth's topic, "Computer Programming as an Art," and its substance probably made a lot of programmers feel pretty good.

"You shouldn't feel guilty about programs that are just fun," he admonished. He compared writing a "good program" to writing poetry or music. "Art is something that is derived from man's intellect and programming is definitely derived from intellect."

(*Continued on page 121*)

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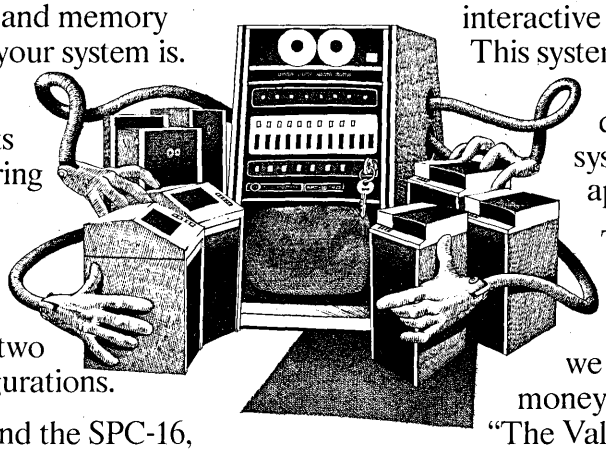

Six mighty minis.
The SPC-16 family consists of six minicomputers offering a choice of three memory cycle times (800ns, 960ns and 1440ns), memory expansion to 128K using efficient 16K boards, and two different packaging configurations.

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POWERFUL MINICOMPUTERS BY GENERAL AUTOMATION

Performance Measurement: Evaluating the Evaluators

To what extent do computer installation managers understand or even care about performance evaluation? There are stories going the rounds in support of the suspicion that many understand or care very little.

When a hardware performance monitor was used at an Eastern chemical company to disclose that a $250,000 system could be eliminated, the management immediately requisitioned additional monitors because "it is the best return on investment we've ever experienced in this business." They have yet to save much more than the $250,000, despite the additional equipment.

A technician who found a rare way to improve the performance of a CDC 6600 system at a government installation immediately was appointed to be in charge of performance evaluation, although he's been unable to find much more to improve since then.

"Performance evaluation often reaches the point of diminishing returns," says Navy dp official Jan Prokop who spoke on the subject during a session on computer center management at the annual ACM meeting last month.

Monitoring the performance of computer systems was a widely-discussed topic at the ACM meeting in sun-bathed San Diego. But it was a subject clouded by the question of how the technicians could sell performance measurement concepts to their management. Hardware monitors (which are expensive) and software monitors (which degrade system performance) grind out "tons and tons of reports which management simply cannot spend 24 hours a day evaluating," said Salvatore C. Catania of the consulting firm of Coopers and Lybrand of Philadelphia.

Same question

Many of the dozen formal presentations dealt in considerable detail with the technology of measurement—hardware monitors, simulators, modeling and many kinds of methods for analyzing and presenting data, including "Kiviat graphs" and "Merrill numbers"—but during each question and answer period, the audiences kept returning to the question of how to make it meaningful to their management.

"We need objectives from management, but how do we tell them what objectives to set," asked one questioner. James C. Browne, of the Univ. of Texas, said the specialists should educate their management on the subject, but at the same time learn how to translate any objectives they may be given into ones that are measurable.

Catania, who thinks managers should set broad objectives that also are measurable, offered a hypothetical installation as an example: a large company with many users whose computer operation is centralized and the applications are decentralized. The broad objective: To provide users with (1) a reliable system, (2) rapid turnaround of jobs, (3) at a competitive price.

He suggested that these broad objectives could be translated into measurable goals as follows: Reliability could be measured in terms of uptime, e. g. the system should be up 98% of the time from 8 a.m. to 8 p.m., Monday through Saturday. Turnaround could be measured as a factor of computer time used per job. Jobs using 10 seconds of cpu time, for example, could be turned around in an hour, 20-second jobs in two hours and so forth. Assuming that the hypothetical installation has a user charge-back method, the price would have to be 30% below the same work offered by service bureaus in the user's geographical area.

Using performance measurement tools, the installation measures whether the goals are being met and reports weekly to the dp manager. If problems are being encountered, the manager then turns to the reams of data generated by the evaluation systems with a specific problem in mind. "We (the managers) have gotten to associate performance evaluation with reams and reams of data for technicians, instead of something that can be evaluated at a higher level and then used in support of a problem," Catania said.

Neither science nor art

This, of course, is a subjective approach. Many persons wanted to know whether performance evaluation technology ever would reach the advanced stage to where it would be totally objective. The Univ. of Texas' Browne, noting that no more than a half dozen graduate schools offer courses on the subject, said it is "neither a science nor an art, but a skill that must be practiced by skilled analysts."

Meantime, according to the Navy's Prokop, there will be cases where performance evaluation will take on "the aspect of a fad" and be "clouded by claims of payoffs," citing a General Accounting Office report issued in the fall of 1972 (October 1972, p. 135) listing huge payoffs in government installations. (One agency was said to have reaped improvements of $433,000 a year from an investment of $60K in performance evaluation).

Prokop said such figures don't always take in all of the costs, such as the price of people to run the monitors, the time involved in analyzing the data and the system degradation when software monitors are applied.

So who needs performance evaluation and what can you expect to save?

During a panel organized by the ACM's special interest group on metrics, consultant Michael Morris said that as a rule of thumb, installations could trim costs by 5% through an evaluation program. (He included as costs the salaries for three persons working the equivalent of one man-year on a performance evaluation project, the same amount for supporting hardware, plus all the other costs of operating a computer installation).

As for who needs it, Thomas E. Bell, of TRW Systems, thought it to be essential for installations operating on a user charge-back system, but not that essential in an installation so big and so well funded that the prime problem was finding floor space.

At another session, a questioner suggested that since the price of hardware is decreasing dramatically and performance evaluation is expensive, why not forgo the latter and increase performance with "hardware overkill?" To which one of the panelists replied: "I thought we'd been doing that all along."

—Tom McCusker

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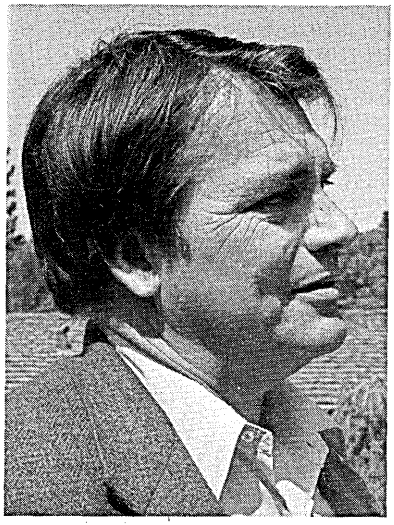
He warned against resisting advancing technology and sticking with restraints that technology has rendered unneccessary, drawing an analogy to film makers. "The early silent film makers resisted talking pictures because they thought they had achieved the illusion of sound so well. Today's film makers are achieving new things using sound." But, he suggested, there are times when artificial restrictions should be imposed on programmers to sharpen their talents.

Don't program

In comments not geared to endearing himself to programmers, Forest Carhart, Burroughs Corp., in a session on "Unpopular/Unacceptable Ideas in Computing," suggested that computers should not be programmed or programmable. "In the way we're doing it now, we are looking at the program as an end in itself when it really is only a means to an end . . . Users should be revolting at having to accept assemblers. You should refuse to accept assemblers. You'll never become professional as long as you accept assemblers. The hardware ought to be doing it."

Another speaker in the same session, consultant David Dahm, put down assembly language. "Assembly language is obsolete and it's been obsolete for at least 10 years." He urged greater use of higher level languages and suggested machines "should be tailored for the languages that are going to be run on them."



ROBERT S. BARTON
"Turn away from numbers"

A questioner wondered if greater use of higher level languages and their ease of use might not lower the quality of people entering the computer field. Dahm called this kind of thinking "a cop out."

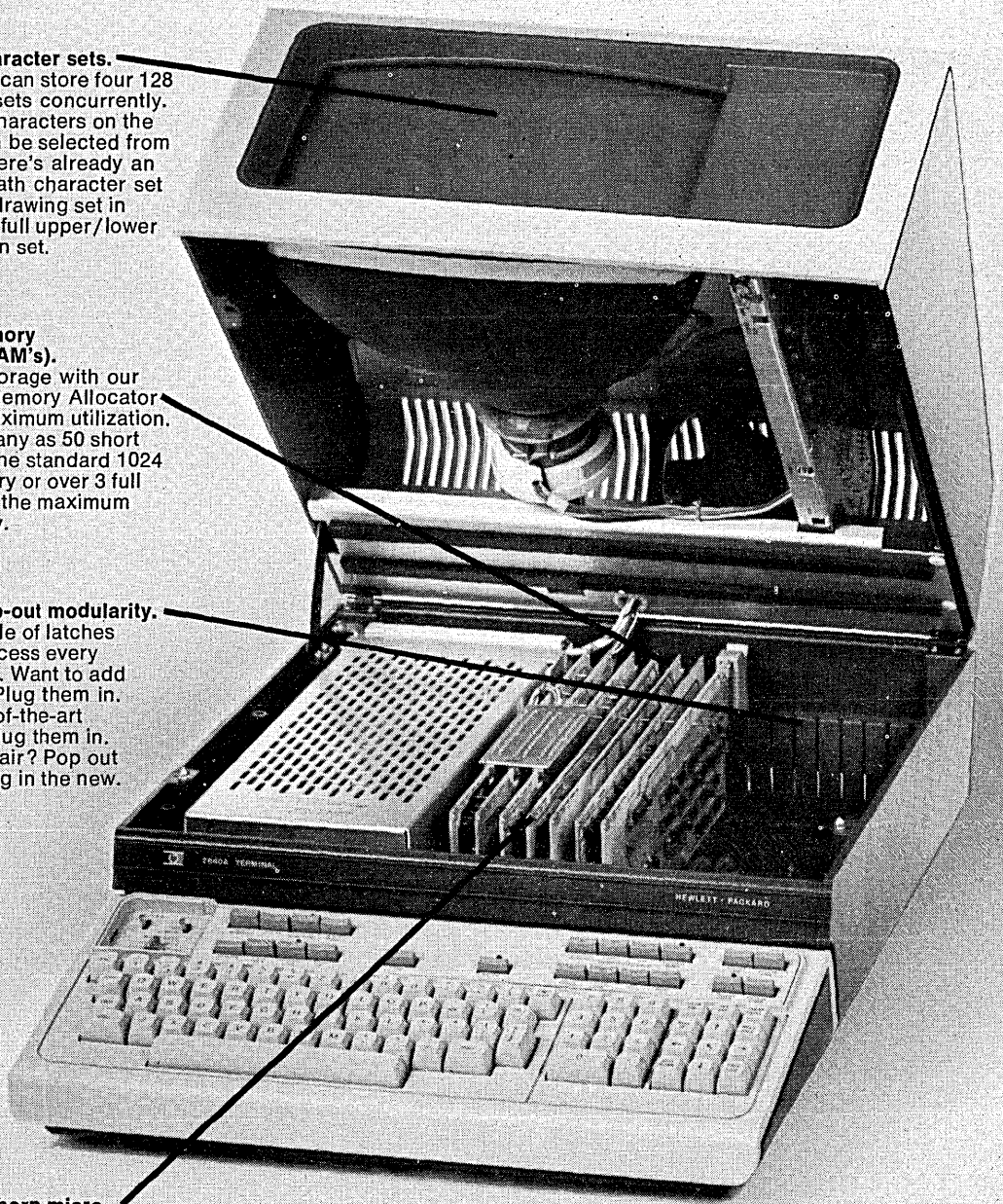
His attitude toward assembly language was shared by Burroughs' Carhart who told the group there is an edict throughout his corporation that "we will not use assembly language."

The third speaker in the "Unpopular/Unacceptable" session offered the provocative notion that "there is no valid reason for non-stack computers." G. Jack Lipovski, Univ. of Florida, said "there used to be three address machines, then two address machines. Then we said, hey, two is too many, one would be better. Stack machines are zero address machines. Two instructions have addresses, fetch and store. All other instructions are at the top of the stack."

Lipovski cited the Hewlett Packard 3000 as "an excellent stack machine. HP won't like this," he said, "but the HP 3000 is a 16 bit 5500."

The "Unpopular/Unacceptable" session took place in the afternoon of the

Now Hewlett-Packard next terminal an open



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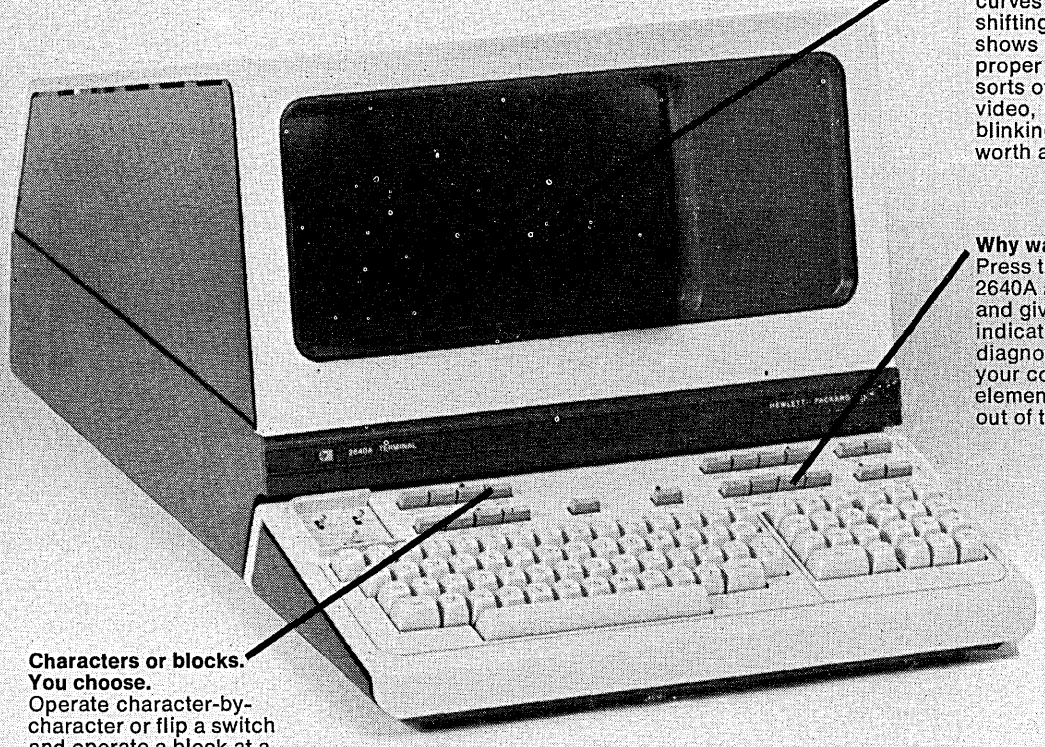

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conference's second day and had been rescheduled from a moderate sized meeting room on the second floor of the San Diego Convention center to a large hall on the first floor which comfortably accommodated the audience.

Many first day sessions didn't fare as well and there were cases of standees crowded along the wall and in the doorways and people sitting on the floor in the aisles. Conference officials said they'd scheduled room assignments based on last year's conference which had an attendance of 1,100. "We knew we'd have more people this year because of holding it in San Diego (last year's was in Atlanta)," said one, "but we didn't expect so many more."

One of the first day "sardine" sessions was on "Minicomputer Trends and Applications." The discomfort of a packed room didn't detract from the attentiveness of the audience and it was a lively session from beginning to end. Each speaker stuck to his allotted 20 minutes (perhaps due to the fact that session chairman, Ted Lewis of the Univ. of Southwestern Louisiana, was holding a large stop watch) leaving ample time for questions which the audience was eager to ask.

Lead-off speaker Phil Conklin, Computer Automation, Inc. said there really isn't any definition of a mini so "there isn't any point in using the term mini or micro any more." He prefers small or large.

In the small cpus he said, "there is an obvious trend to reduce size, to reduce cost, and increase power." He noted trends toward multiple processing in one computer and the use of multiple minis in networks of larger computers.

Of memories for small computers, he said their decreasing cost and the rapid increase of average size "are pushing cpu architecture more than any other factor." He sees trends toward more sophisticated memory management and to multiple word lengths.

Conklin called developments in peripherals for minis as the "most dynamic area" in implications for trends to future applications. "We've been stymied for lack of them."

"The floppy disc," he said, "will overshadow cassettes and become as ubiquitous as paper tape . . . Printer terminals will come down in cost . . . In charge coupled devices and bubbles there are great strides to be made."

Questioners were concerned about standardization, easier to use software, putting more into the hardware to get more out of the software, and commonality in peripherals.

On standardization, Conklin said, "that can't start with a manufacturer. It has to start with an association or a university." He said more money is going into software development and that there is a trend toward microprogrammed hardware.

On commonality of peripherals, he noted that his firm, "in a couple of months," will have "a floppy disc interface that *really* is IBM compatible."

A different language

Another panelist in the minicomputer session, Pat Arnold of the Tennessee Valley Authority, talking on "Application of Minicomputers to Data Base Systems," described a system implemented by TVA using Data General Novas. She drew a sympathetic laugh from her audience when she said the first problem TVA had to overcome was "communications with the hardware people. They don't talk the same language."

Communications on another level was a concern of a heated session on ACM's Ombudsman program. This was not a typical technical conference panel session. Dahl Gerberick, Southern California Edison Co. and ombudsman for ACM's Los Angeles chapter and national ombudsman chairman Chapman exchanged comments with three representatives of California state government who sometimes questioned, sometimes suggested, and other times played devil's advocates. There were some of the latter in the audience too.

The governmental representatives were Matt McDonald of the Intergovernmental Board on Electronic Data Processing; Charles Hennessey, a consultant to the Assembly Committee on Efficiency and Cost Control; and Charles Mobley, California Information Systems Implementation Committee.

ACM ombudsmen are supposed to act as a communications link between the computer community and the world at large. Just how, to whom, and to what end this should be done still seems to be a question.

His own problems

Gerberick told the group how, when he first became an ombudsman, he had tried to find specific computer related problems members of the general public were having where he could help. He couldn't find any. "So I decided to find problems of my own." These led to study projects and reports which he feels can be widely disseminated. He current-

ly is working on a statewide survey of computer-based election systems and a study of privacy and the computer.

The government men suggested roles for the ombudsmen. McDonald referred to a Social Security Administration computer problem which had caused many social security recipients to receive their checks late. "Where was the ACM ombudsman in that situation?"

Hennessey suggested a study on the advisability and value of the state's Department of Motor Vehicles selling its records as "a real good project." Mobley warned "if you're just acting as p.r. people for the computer industry, you're in trouble." He suggested the proper role for ACM should not be reactive but in working with legislators in terms of preparing legislation on such matters as security and privacy."

This feeling was echoed in a later session, a "Forum on Computers and Public Policy," in which a member of the audience said "ACM must take a more active role even to the point of suggesting legislation."

In the Ombudsman session, chairman Shulom Kurtz of K Inc., Denver, indicated there is some fear among members of the ACM board, that any activity bordering on lobbying could cause the association to lose its tax exempt status.

A woman in the audience in the Ombudsman session said she didn't feel one ombudsman per chapter could accomplish anything. "We should all be doing it (the ombudsman's job) as members."

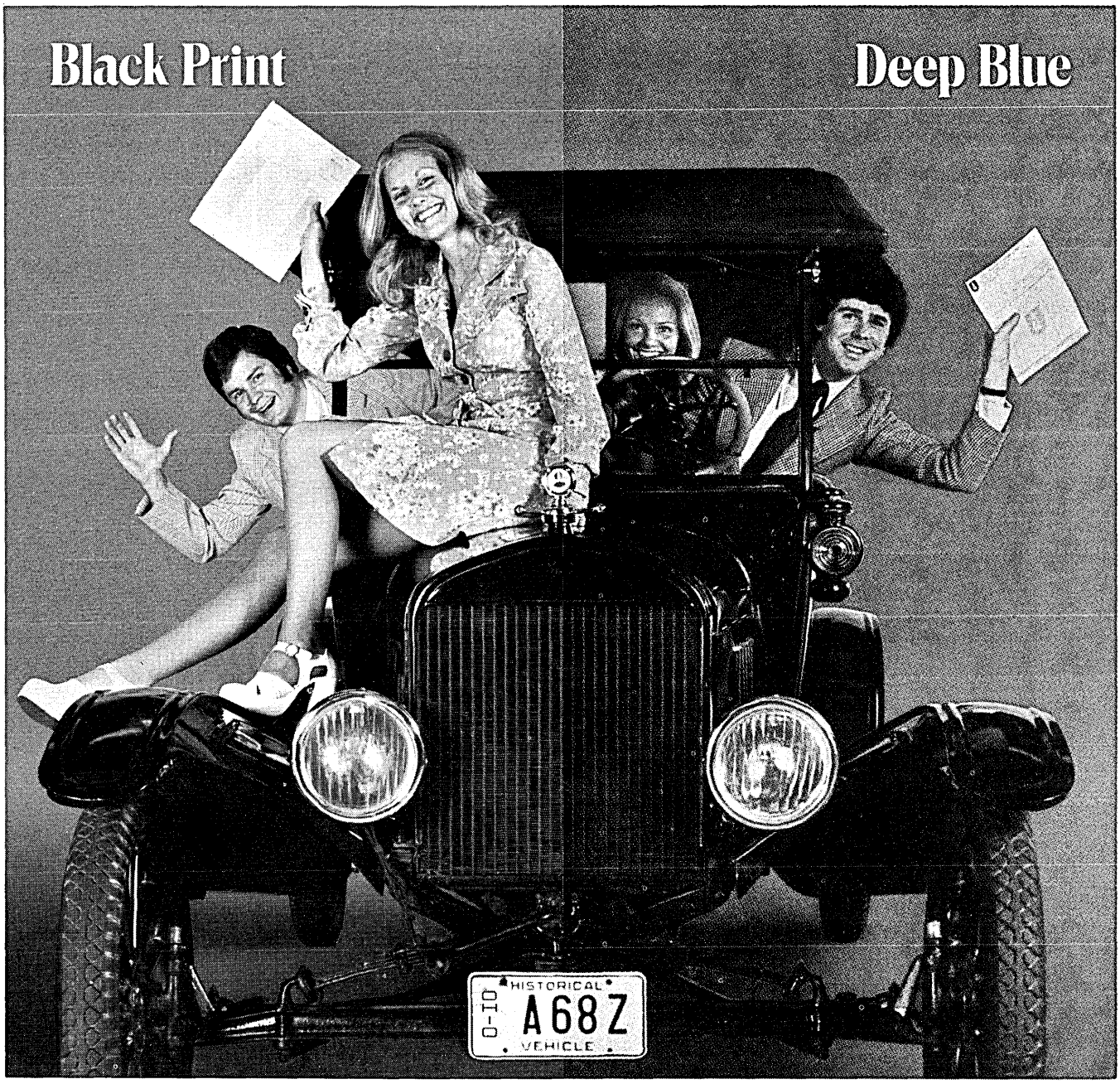
Where credit is due

Chapman said she feels ombudsmen should be as concerned with the computer getting credit as they are with the computer getting blame. She referred to headlines in an Austin, Texas newspaper in two different years which she found equally undesirable. The first: "Computer Jams Vote Tally." The second: "Computer Keeps Vote Tally Running Smoothly."

Hennessey wondered about the relationship of the ombudsman program with the ACM Committee on Computers and Public Policy. "Are you competing with them? Are you just a group looking for survival?"

And there was some question as to whether the ombudsman program should continue as an independent operation or become an adjunct to another ACM committee. In a lengthy evening meeting during the conference the ombudsmen hammered out a long list of goals which it presented to the ACM board. They left San Diego with a charter to continue as a separate operation.

Jim Parry, Ron Hansen, and Russell



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CIRCLE 38 ON READER CARD

news in perspective

Crook, Univ. of Waterloo, with their chess program, RIBBIT, run on a Honeywell 6050, left with first place in the Fifth United States Computer Chess Championship. Second place went to David Slate and Larry Atkin of Northwestern Univ. with a program called CHESS 4.0, run on a CEC 6400. Ira Rubin, Fred Swartz, Joe Winograd, Vic Berman and W. Toikka took third with CHAOS, run on a Univac 1108. Fourth place went to Ken Thompson of Bell Laboratories, with BELLE, on a DEC PDP 11/45.

And one of the youngest attendees, Bruce Hahn, a student at the Univ. of Waterloo in Canada, left with memories of a Southern California vacation, in perfect weather, that he would not have had, had he not won second place in the annual ACM Student Paper Awards, and had first place not been bypassed this year. In addition to a $250 honorarium, he received an airplane ticket to San Diego. Learning he could go to Los Angeles for the same fare, he exchanged his ticket and managed to spend three days in L.A., including a visit to Disneyland, before hitch hiking south for the conference.

—Edith Myers

Retailing

Dominant Role for The In-Store Computer in Tomorrow's Systems

A supplier of retail point of sale systems is forecasting drastic changes in the architecture of retail data processing systems, including greater use of minicomputers to do what large central systems have been doing.

Joseph Francini, vp of Litton Industries and head of that company's Monroe, Sweda and Kimball divisions, said in-store minicomputers will have multiprogramming and multitasking capability, be able to operate foreground and background jobs concurrently and provide expanded communications capabilities.

Essentially, all data collected within a store—not just sales transactions but everything else from sales clerks' commissions to petty cash disbursements—will be processed there. Francini made these predictions in his keynote address at the 16th annual edp conference of the National Retail Merchants Assn. (NRMA) this fall in Quebec.

Subsequently, he said, the in-store mini will format, integrate and summarize the detail data and transmit it on-line to headquarters. Francini indicated that POS terminals on the sales floor will communicate directly with a store's central computer only when a large file—containing credit authorization information, for example—has to be accessed.

"The principle is to achieve efficient data exchange between information collected at store level and data transmitted to the central computer," said Francini. "Today, a sizable percentage of the data recorded at store level is meaningless for the mainframe (at store headquarters), except from a system audit point of view . . . I estimate that reductions on the order of 20–40% can be achieved in the amount of data transmitted to the host computer."

news in perspective

Programmable terminals

Francini had other predictions, all of which some observers felt actually were predictions of new Litton products. He said that within the next five years, point of sale terminals will become "totally programmable," an allusion to Sweda's new line of more-programmable POS terminals expected to be announced within the next few months. To be called the System 800, the upcoming equipment will include a one kilobit random access program memory mounted on an LSI chip.

Present Sweda terminals, by comparison, rely mainly on read-only memories to hold program instructions. System 800 also includes a new backroom mini, the model 80, designed to support four to 32 sales registers.

Francini, in his NRMA keynote speech, also said that "in the next few years," electronic cash registers costing $1,200 to $2,000, "inflation permitting," will become available in quantity. Designed for smaller volume retailers, particularly specialty stores, this equipment will marry the traditional cash register to the billing/accounting machine and produce what Francini called "the cash machine."

New products

Three new and "more interactive" POS terminals were unvailed at the NRMA show: Sweda's model 725; Singer's 930, and NCR's 285/50. Each one offers centralized price lookup—i.e. the terminal automatically plucks the price of an item out of a back office or central memory instead of requiring the clerk to index it into the keyboard. The new terminals also print full alpha descriptions of each department, merchandise class, and item that has to be listed on the customer's sales slip. This information, like the price, is accessed from a back office or central memory.

Other new product announcements included a software package from NCR, designed to make its model 255 POS terminal more appealing to discount stores, and a new ocr wand from Singer, the model 720, which, according to the company, is the first one capable of reading NRMA's new OCR-A character set (see November, P. 130.)

There were several user-oriented, how-to-do-it sessions at the conference, but the only one that seemed to have much value was a presentation by attorney Lewis S. Reff, of J. C. Penney, who provided a number of tips on negotiating with system vendors.

The high point of the Quebec conclave was NRMA's formal approval of its long-heralded "voluntary retail identification standard." Basically, the standard consists of a 25-character subset of OCR-A, containing 10 numeric symbols (0-9), plus 10 alpha and five special symbols which serve as function codes. The standard also includes a format for imprinting these characters on merchandise tickets to represent vendor, stock number, department and other codes needed by a store's accounting department.

Norman Weiser, of Shillito's, a Cincinnati retail store, heads the NRMA task force that developed the ticket format. He contended that adoption of the new standard will save the typical retailer $1160 for every million dollars worth of merchandise he sells—by eliminating most of the ticket-preparation work now done at store level. Weiser explained that NRMA has created a standard set of data elements, codes, and formats per-

mitting this work to be done at the source, by the merchandise vendor. Weiser's estimated cost saving—$1,166 for each million dollars of sales—allows for a payment by the retailer to his source supplier for the marketing costs which the latter would assume under the new scheme.

However, coffee break conversations with a number of retailers suggest that Weiser may be unduly optimistic. One store operator called it "a pie-in-the-sky" speech. "*If* most merchandise vendors adopt source marking, and *if* stores can thereby eliminate most of the ticket-preparation work they're now doing, then retailers will save money. But as Weiser himself admitted, less than 200 vendors out of tens of thousands are currently source-marking. He wants us to persuade more of them to do it, but frankly I have better ways to spend my time, and I don't know whether our store is big enough to generate the necessary clout. In addition, I'm not sure that source-marking, to the extent suggested by Weiser, is really going to be feasible for our store."

If this attitude is typical, it could have a severe impact on the market for POS terminals. For, as Litton's Francini indicated in his keynote speech, ocr readers cost considerably more than magnetic or bar code systems. Thus, large numbers of retailers will have to buy ocr readers before costs come down to a competitive level.

But an official intimately involved in the NRMA standardization effort says that an adequate market for POS terminals will be created even if most retailers don't accept OCR-A and many vendors don't adopt source-marking. He contends that if only "the top 300 stores" accept the new standard, and they persuade 18–20,000 vendors (out of a total of about 36,000) to source-mark tickets, "more than two million POS terminals" can be sold. He adds that "Sears and Penney's already have persuaded some 2,000 of their vendors to install source-marking equipment, and NRMA is making "good progress" in convincing others. Under the association's plan, retailers would not only pay their vendors for the additional work involved in source-marking, but would also provide detailed sales analyses showing each vendor how his product was selling against competing brands. The details of this "reciprocity" plan are supposed to be disclosed next January, at a big NRMA conference in New York City.

Meanwhile, the association is continuing its efforts to develop a reading system that can operate equally well in supermarkets and department stores.

The basic problem at the moment is that the supermarketeers have adopted a "universal product code" (UPC) which includes a set of numbers coded in OCR-B. NRMA hopes the supermarket industry will switch to OCR-A. If they do, a POS system capable of reading the NRMA code could, with the addition of relatively few circuit cards, also handle UPC. The assumption is that this would reduce terminal acquisition costs in both industries.

John Strubbe, of Kroger's, heads the UPC Council, a grocery industry group that has been negotiating with NRMA. He told us that switching from OCR-B to OCR-A "can be expensive," considering the large number of supermarkets and suppliers which have accepted the present UPC. His group is now studying the economic tradeoff. The basic question, Strubbe explained, is how many products are marketed through department stores as well as supermarkets. Once that question is answered, he added, the UPC council hopefully will be able to decide whether a switch to OCR-A is justified.

The study is expected to be completed "within a couple of months."

—P.H.

news in perspective

Memories

Core Firms Hold Own With Semiconductors

Manufacturers of core memories have conceded for more than half a decade that semiconductors will replace cores as the dominant computer memory technology. The advent this year of the 4K MOS random access memory may have hastened the day when their customers turn away in hordes; but the memory houses aren't ready to say if that day is here. They have a more immediate problem: finding customers for any kind of memory, core or semiconductor.

"Business is rotten," says John Jory, oem marketing manager in the Memory Products Div. of Ampex Corp. Customers who in recent years have been maintaining 30 to 90-day inventories of memory systems can't get the financing to maintain these levels. Some are allowing them to go down to zero. J. T. Boren, manager of market planning at Electronic Memories and Magnetics, says industry-wide core shipments this year should fall at least 15% short of what had been forecast before the slump in orders set in late this summer. H. Joseph Cornyn, vp of Dataproducts' marketing div., says his company's large overseas base hasn't been impacted as much as in the U.S., but admits that growth has slowed in comparison with the first half.

Many see an improvement in January if customer inventories are exhausted at that time and if there is an improvement in economic conditions. However, the slump will affect the core makers in another way. It has given the semiconductor houses a breathing spell to improve their production of 4K rams to the point where some are expected to offer them for as low as $14 (or .003 cents a bit) by the third or fourth quarter of next year—and at a profit—and at $8 (or .002 cents a bit) by the end of 1976.

Huge market, maybe

At present the semiconductor houses offering 4K rams have been bogged down with fabrication, yield and reliability problems and are unprofitable in their efforts to compete on a .003 cent per bit price with 1K chips. If those problems are solved, a huge market could open for them. Mainframers who this year are expected to buy about 15 billion bits of core from outside suppliers are designing their systems so that semiconductor memory will be compatible with them.

This leads core manufacturers to feel that when economic conditions cause a rise in demand for memory, it will be hard to regain the share of the market they've enjoyed ever since 1950 when J. W. Forrester of MIT first suggested a memory using square-hysteresis-loop magnetic cores. Independent core manufacturers, nevertheless, will increase their shipments in 1975 but the ubiquitous semiconductor will force down the amount they'll be paid for them. The industry is expected to ship 52 billion bits of core next year valued at $150 million. This year, they're expected to have shipped about 40 billion bits valued at $160 million.

Overseas business is expected to contribute significantly, accounting for about a third of the dollar volume. Erwin Tomash, chairman of Dataproducts, recently told shareholders that anyone who thinks core is dead should look to Europe. He said his company has a "continuing arrangement" to sell cores in Europe for five years. "Our best European customer has extended to 1980."

Robert D. Miller, former director of corporate development with Dataproducts and now a consultant, says core is very far from dying. "Although the use of cores may decline in a few years, it's still too early to reach for the hammer to nail the coffin shut." Though not as glamorous as semiconductors, cores will remain the memory work-horse for years, Miller says, explaining that "cores are still more practical than semiconductors in a number of application areas."

Volatility issue

One of these is the minicomputer market, particularly in applications where the volatility of semiconductor memories is a factor. Customers may not want to invest in the additional memory required by sophisticated operating systems to protect against data dumps, Miller says. Volatility, environmental conditions and the need for continuous operations in the process control computer market will give core a considerable edge. In some instances, he says, there is simply no time to reload a semiconductor memory after a momentary power outage. "The penalty for control loss is so great that customers effect a highly conservative view toward new technologies. Instruments, once accepted, face a two-or-more-year test prior to installation. The time period be-

tween acceptance and volume orders is often five to six years."

So Miller thinks these factors will account for a rise in core use in process industries through 1978 at least. He also sees some of these factors contributing to a growth in core sales in the communications market for at least five years. Design considerations in that business are heavily influenced by such factors as a 20 to 40-year equipment life expectancy, less uniform climactic conditions, mandatory redundancy and less routine maintenance. So it is usually several years before new designs become operational, says Miller, noting that the core memory currently predominates in communications equipment.

Core also is solidly entrenched in military and aerospace systems where volatility, nondestructive readout and radiation hardening are critical. Miller thinks core sales to that market should maintain present levels for the next four years as R&D funds for sophisticated hardware become somewhat looser as the need for armament spending declines in a period of relative tranquility.

History repeated

Besides the traditional markets, core makers are now poised to attack others, reminiscent of what was done in the early '70s when all of the major houses—Ampex, Dataproducts, Electronic Memories and Magnetics and Fabritek—entered the end-user market with large core storage systems and main memory add-ons. Their strategy at that time was to offset a trend by customers to do their own assembly, buying loose core from the independents instead of the higher-ticket core systems. (Miller thinks this trend will be reversed as decreasing internal demand for core systems makes it economically advantageous to purchase complete systems, while devoting stringing capacity to other manufacturing processes).

Fabritek last spring introduced a bulk core memory system to replace drum memories on GE-Pac process control systems. Others also have fast access memory (FAM) systems out or on the drawing boards. Electronic Memories was expected to enter the market with a 20 megabyte FAM disc and drum replacement, selling at .15 cents a bit (or about 7 bits per penny), with an access time of one to five microseconds. Ampex was said to have one in the wings. The FAM market may be limited to very large government customers and utilities because the faster access times require alterations to customers' operating systems, but the core people think that there may be other applications where FAM's will be cost effective, such as auxiliary store in large telecommunications systems.

Ampex and Electronic Memories soon will offer add-on memories to the minicomputer market to make up for dwindling oem sales to mini makers going in house with their own core production or switching to semiconductors. Ampex, which calls them add-in's to differentiate from the separate memory boxes it makes for large systems, is thought to have a product for the Data General Nova 1200 and EM&M's first product may be a memory replacement for the Interdata 7 line. Dataproducts, which also sells line printers to the mini makers, has opted not to enter with an add-on product.

Other exotic systems may be down the road. Ampex said its very high density "multistate" core has been proven to work in the laboratory. It's a technique to pack six to eight bits into a single core in contrast with present devices where each core is a single bit. It would produce fantastically high yields to core makers—but nobody is saying how much of a price reduction could be effected with the new technique because they haven't figured out the cost of the extra electronics required to make it work. Some researchers at Electronic Memories, which calls its version "Multibit," think they'd be able to produce this high denisty core at half the cost of making conventional core.

Core soon may be dethroned, but Miller clearly indicated the hopes of core manufacturers in his title for a recent paper on the subject: "The Core is Dead, Long Live the Core."

—T.M.

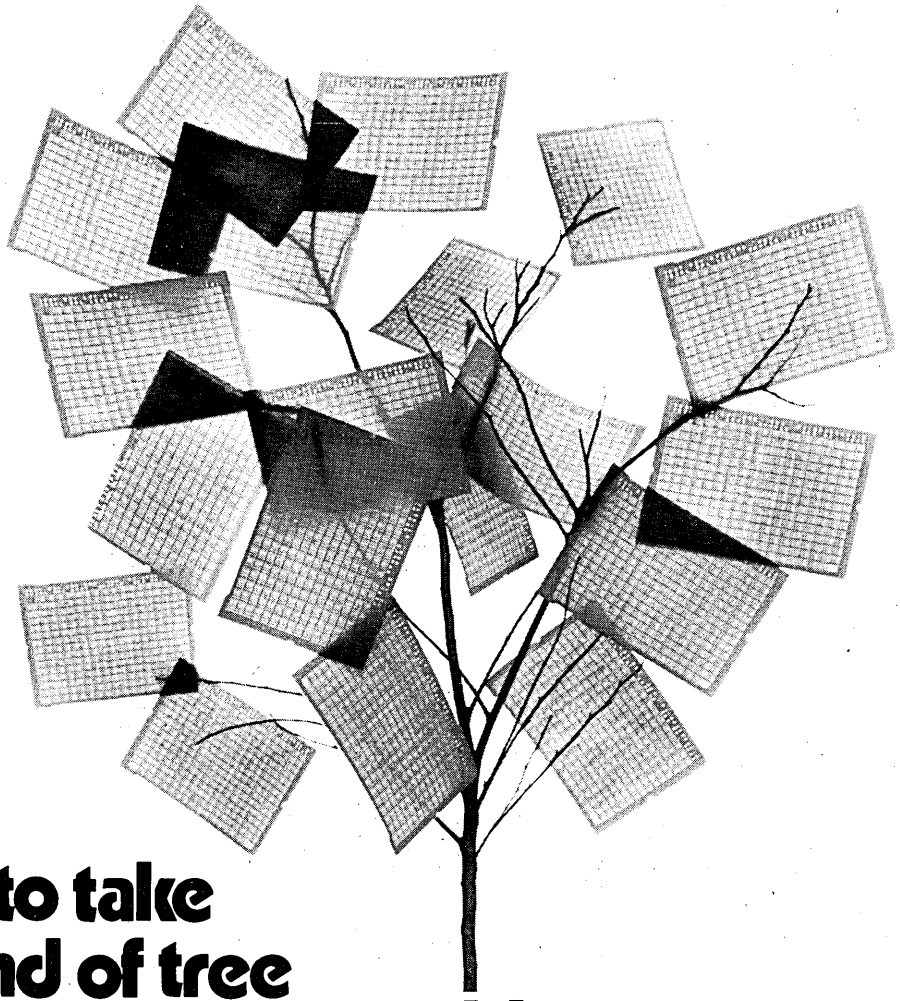
Finance

Widows, Orphans . . . and Missionaries

Widows and orphans, it would appear, were not the only pigeons taken for a ride by Wall Street hustlers. Missionaries are the latest victims and they seem to have had a liking for computer stock.

That, at any rate, is the picture that is gradually emerging from a tangled series of financial disasters suffered by Roman Catholic organizations that invested in several Boston area computer firms that subsequently went into bankruptcy.

The flagship company in the network of bad investments was a firm called Foto-Mem. Investments in that defunct firm—and others—spelled financial disaster for the St. Joseph's Trust Fund,



It's going to take a new kind of tree to solve your paper problems.

Why use miles of forest . . . when all you may need are inches of microfiche? One of our modular DatagraphiX System 4500 COM recorders can help you beat computer-crippling paper problems in several ways.

Take the short supply of paper, for instance. No need to worry with DatagraphiX System 4500 on the job. Your viewer replaces paper—unless you want an occasional printout.

Or consider paper costs—which have recently risen as much as 75%. Also, some computer stock is now being discontinued by suppliers, forcing you to upgrade to more costly paper.

And don't forget the storage situation. To keep ahead, you must buy in unnecessary volume—then find floor space for the paper until it's needed. We've got your record storage problems under control, too. Just compare inches of fiche with mountains of paper.

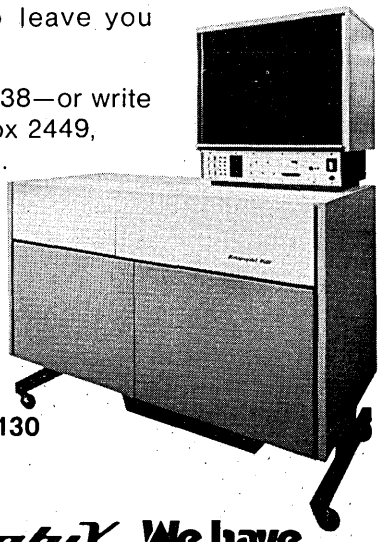
The System 4500 is designed in modular units to fit your exact needs now. But you can always add on as requirements grow.

The versatile off-line Model 130 COM recorder (shown) accepts magnetic tapes from a wide variety of computers. Incorporate a high-speed minicomputer and solid-state electronic data terminal—you have our Model 150, eliminating host computer handling and reformatting. Or consider the online Model 120 which interfaces directly with existing computer equipment. And there's still much more to come in the modular System 4500.

So, if you're not looking good on paper, look at our new technology in computer information handling.

We're not about to leave you out on a limb.

Call us—(714) 283-1038—or write DatagraphiX, P. O. Box 2449, San Diego, CA 92112.



System 4500 Model 130

DatagraphiX

Stromberg DatagraphiX Inc □ a General Dynamics subsidiary

We have the answers.

a $25 million investment plan in which Catholic groups pumped funds into Boston area computer companies.

A tight ring of secrecy surrounds the situation, but in a recent issue, *The National Catholic Reporter* indicated that nearly $20 million had been lost in the venture. The publication reported that the La Salette Fathers, a missionary order of priests and brothers, and the Diocese of Reno, Nev., were only able to avert bankruptcy by contributions from other Catholic organizations across the country.

The names of the other computer firms are not known, although a company closely linked to Foto-Mem—Geomet Inc. of Maryland—is said to have been involved in the debacle. The Catholic organizations invested in at least one firm that was profitable, Interactive Data Corp., of Waltham, Mass. Interactive Data, a time-sharing firm that specializes in financial and economic services, was recently purchased by the Chase Manhattan Bank.

Handsome profit

The key figure in the Catholic investment plan, Father Rene Sauve, former treasurer of the La Salette Fathers, once served on the board of directors of Interactive Data. According to a prospectus on Interactive Data, the La Salette Fathers invested $2 million in the firm. Another order of priests, the Augustinians of the Assumption, loaned some $500,000 to Interactive Data. However, there is no problem over the Interactive Data investments because that firm became profitable and the Catholic organizations presumably made a handsome profit on their investments in that firm.

With Foto-Mem and the other companies, though, it was a different story. Father Sauve apparently established the St. Joseph's fund as well as other investment vehicles. He then drummed up support among other Catholic institutions to invest.

Foto-Mem was never shy about its achievements and what it believed its achievements would be. In 1970, the company advertised in the financial pages of *The Boston Globe* that it had achieved a "successful breakthrough . . . which had opened an 8 Billion Dollar Market potential for our products in the Electronic Data Processing Computer Storage and Retrieval Fields."

The company, led by a Chinese-born engineer named Dr. Alber Eng, claimed to be designing just about anything anybody could think of in a high technology vein and technological breakthroughs were as plentiful at Foto-Mem as hamburgers at McDonald's. One technological breakthrough would enable Foto-Mem to store all the information contained in most of the world's great libraries in a small seven by seven foot room. The company had breakthroughs in designs for minicomputers, electrostatic data printing terminals, gigantic information storage and retrieval systems, keyboard terminals, high speed photocomposition machines, microfiche reproduction systems, and even sophisticated equipment for heating rubber and plastic at high speeds.

At least one breakthrough

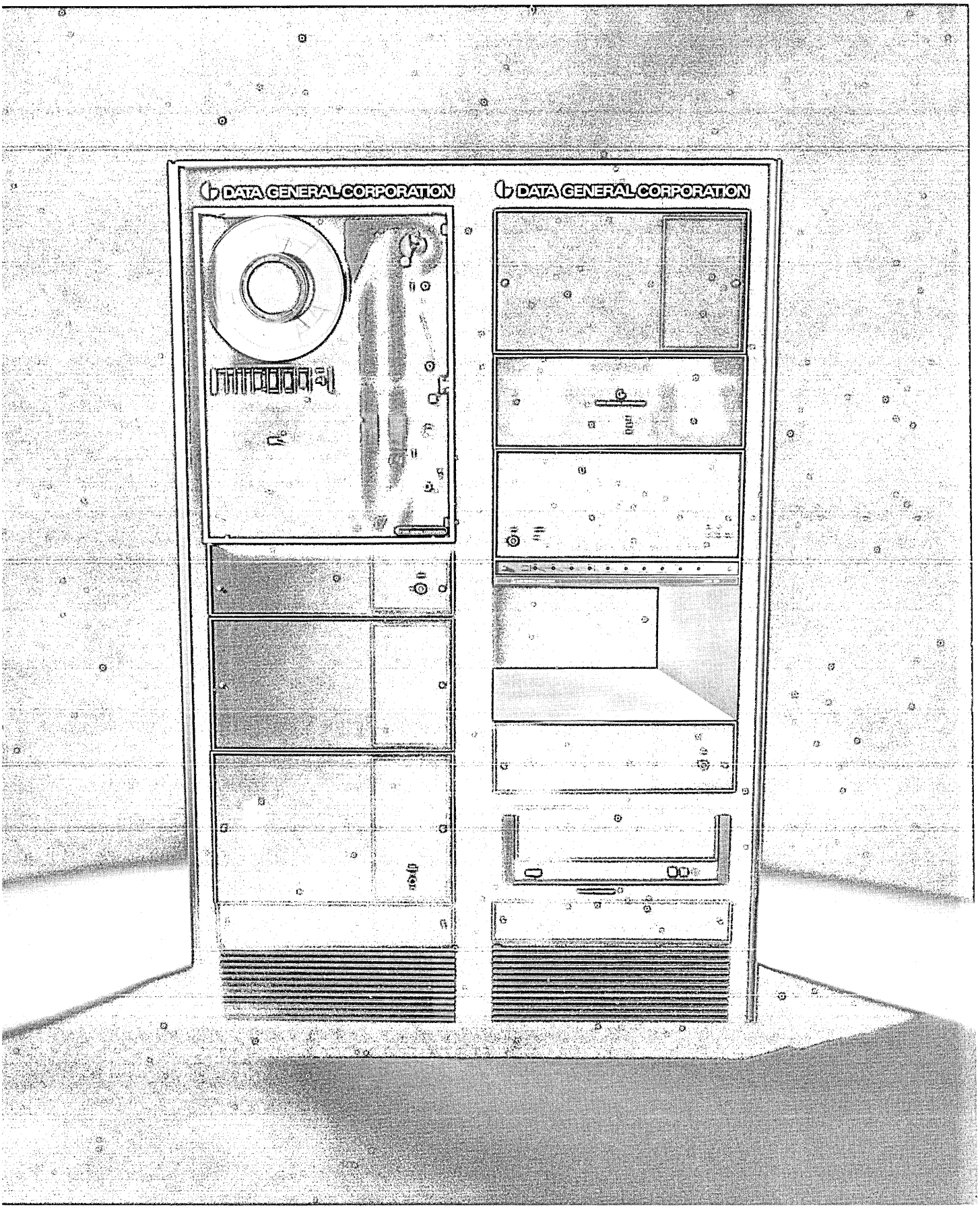
While Foto-Mem's technological breakthroughs would prove to be fantasies, its ways of raising money were indeed breakthroughs as was later learned by investors who lost their shirts in the firm. Foto-Mem constructed a financial thicket of public stock, warrants, promissory notes, bank notes, stock dividends, letter stock, and debentures, the likes of which was seldom—if ever—seen in the high flying computer industry.

It may be years before the situation is straightened out. The La Salette Fathers have been forced to put a former seminary up for sale on Cape Cod. In the case of the Reno Diocese, scores of separate loans were made to that Diocese by other Dioceses, bishops and religious organizations around the country in an effort to save the Reno Diocese from bankruptcy. Thousands of shares of Foto-Mem stock given to St. Michael's College in Vermont are virtually worthless since the firm is bankrupt and has no hope of revival. In addition, at least two other Catholic organizations, their identities unknown, are understood to have lost money investing in the Boston area company.

In addition to the various private investments in Foto-Mem, the firm successfully completed a public offering in the late 1960s. Offered at $8 a share, the firm's shares were bid up to $60 a share before it collapsed.

The Securities and Exchange Commission, which declined to discuss the situation, has investigated the case, but *The National Catholic Reporter* said the SEC would press no charges.

—W.D.G.



The Nova 830.
A little less of a good thing.

It has come to our attention that there are people who don't need all the speed of our 840.

So we've come up with a computer that goes a little slower. And costs a lot less.

The Nova 830.

The 830 uses our low-cost 32K byte memory boards.

But aside from that, you can't tell an 830 from an 840.

The 830 comes with the 840's Memory Management and Protection Unit that lets you expand up to 256K bytes, all of which are fully supported.

And it has the 840's Mapped Real Time Disc Operating System that helps you develop programs as much as it helps run them. (MDROS is one of Data General's family of compatible operating systems. So it can handle all our high level languages and all our peripherals.)

Like the 840, the 830 is a natural for dual operations: Timesharing and Batch, Remote Job Entry and Batch, Timesharing and Remote Job Entry, or if you're so inclined, Batch and Batch.

And like the 840, you can get an 830 in 45 days. Or less.

Unlike the 840, you can get an 830 with 128K bytes of memory for $23,150.

Data General

The computer company you can understand.

Data General Corporation, Southboro, Massachusetts 01772, (617)485-9100.
Datagen of Canada Ltd., Hull, Quebec (819)770-2030/Data General Europe, Paris, France 504-23-44.

News in Perspective
BENCHMARKS . . .

Takeover or Investment? Opposition continued to mount against IBM's plans to enter the domestic satellite business by buying a 55% interest in CML Satellite Corp. Objections have been filed with the Federal Communications Commission by Western Union, Data Transmission Co., Sperry Rand and Sanders Associates and the Federal Trade Commission wants an investigation by the FCC. The Computer Industry Assn.'s Jack Biddle in a recent speech on the question envisioned complete IBM control of a data communications network that would include "an IBM telephone instrument on your desk; an IBM PBX, IBM terminals, IBM cpus, IBM mass storage devices, IBM word processors, all tied together by an IBM satellite." IBM, meanwhile, told the FCC that CML would be operated as a separate entity, none of its officers would be an officer of IBM, and that "every effort will be made" to see that the Satellite serves all users of data processing "not just those with IBM equipment." Some financial analysts see the IBM move as simply an investment—and small at that when the expected revenues of $25 million from satellite operations are compared with IBM's total revenues of $11 billion. IBM, says another analyst, will be using satellites anyway, whether self-owned or owned by somebody else.

Matter of FAX: Burroughs Corp. has its sights set on the telecopier business which may become a key component of automated offices of the future. The company this fall said it reached an agreement with directors of Graphic Sciences, Inc. to acquire the Danbury, Conn. manufacturer of information transmittal equipment for about $30 million of Burroughs stock. Graphic Science, whose revenues were about $15 million last year, recently introduced a "more flexible" new/telecopier, the "dex 4100," which transmits facsimiles of documents and pictures over telephone lines.

Not Up to Speed: Upset that it lost out to Honeywell in a bid to provide the Air Force with 180 minicomputers for AF remote job entry sites, Data 100, the Minneapolis maker of remote batch terminals, says there are discrepancies in what the AF ordered and what it actually is getting from Honeywell. Its complaint to the General Accounting Office which audits government agency purchases, says that the rfp asked for higher transmission speeds than Honeywell is offering. RFP throughput requirements, it contends, would have necessitated six 9,600 bps modems and 68 3,600 bps modems and that Honeywell is providing neither, although upping the use of 2,400 bps modems to 335 from the 260 Data 100 claims would have been needed. As an example, a job in which Honeywell will offer a 4,800 bps modem will take 164 minutes longer to complete than asked for in the rfp. Honeywell won the $21.3 million order this fall. There was no immediate comment from either the government or Honeywell.

NCR Raises Prices: More than a month after price increases were announced by IBM, Univac, Honeywell and CDC, NCR Corp. raised rental and maintenance charges on its Century series computers, but dropped some purchase prices and eliminated extra shift charges to users running more than 200 hours a month. Rental charges on the large 200 and 201 models will go up to 2% and 1% respectively and 6% and 8% on the smaller Century 50 and 101. The company's large 251 and 300 models were exceptions to maintenance price increases of 8–9%. Purchase prices on some Century models, except the 50, 100, 200 and 201, were reduced 9–15% to promote more outright purchases.

What's Left?: When General Telephone and Electronics Corp. announced several product line cancellations and a $138 million "reserve" writeoff for the unprofitable operations of subsidiary GTE Information Systems, it announced simply that only the brokerage services and some "smaller operations" that

ALEXANDER E. PATTERSON

were profitable would be kept alive. Discontinued were the IS-5000 line of hard copy terminals, the aged IS-7000 video terminals, and the key-to-disc system produced by acquired Logic Corp. Alex Patterson, president of GTE Information Systems, called the "reserve" writeoff a contingency measure and assured that most of the remaining manufacturing and services operations will continue. The other manufacturing operations are "under study," he said, adding that besides the brokerage terminals, the IS-7800 video terminal and the IS-5000 key-to-disc system will continue to be manufactured and marketed by GTE/IS. Neither is profitable but both are relatively new and considered successful. The IS-1000 communications processor will be marked as part of custom systems, done almost exclusively for the government market served by GTE/IS Federal Systems Div. The profitable programming and consulting Programming Methods Div. also has an assured future. GTE/IS International, based in Brussels, will continue to provide its current products and services.

Air Force in an EFTS First: The first interregional exchange of paperless entries by banks working through Automated Clearing Houses (ACH) took place last month when the Air Force began direct payroll deposits for some members.

The pilot project was started with Air Force people having accounts at banks in California, Georgia, Colorado, New Mexico, and Wyoming. Federal Reserve Bank couriers delivered payroll records on magnetic tape to ACHs in San Francisco and Atlanta which electronically disbursed payments to banks in California and Georgia.

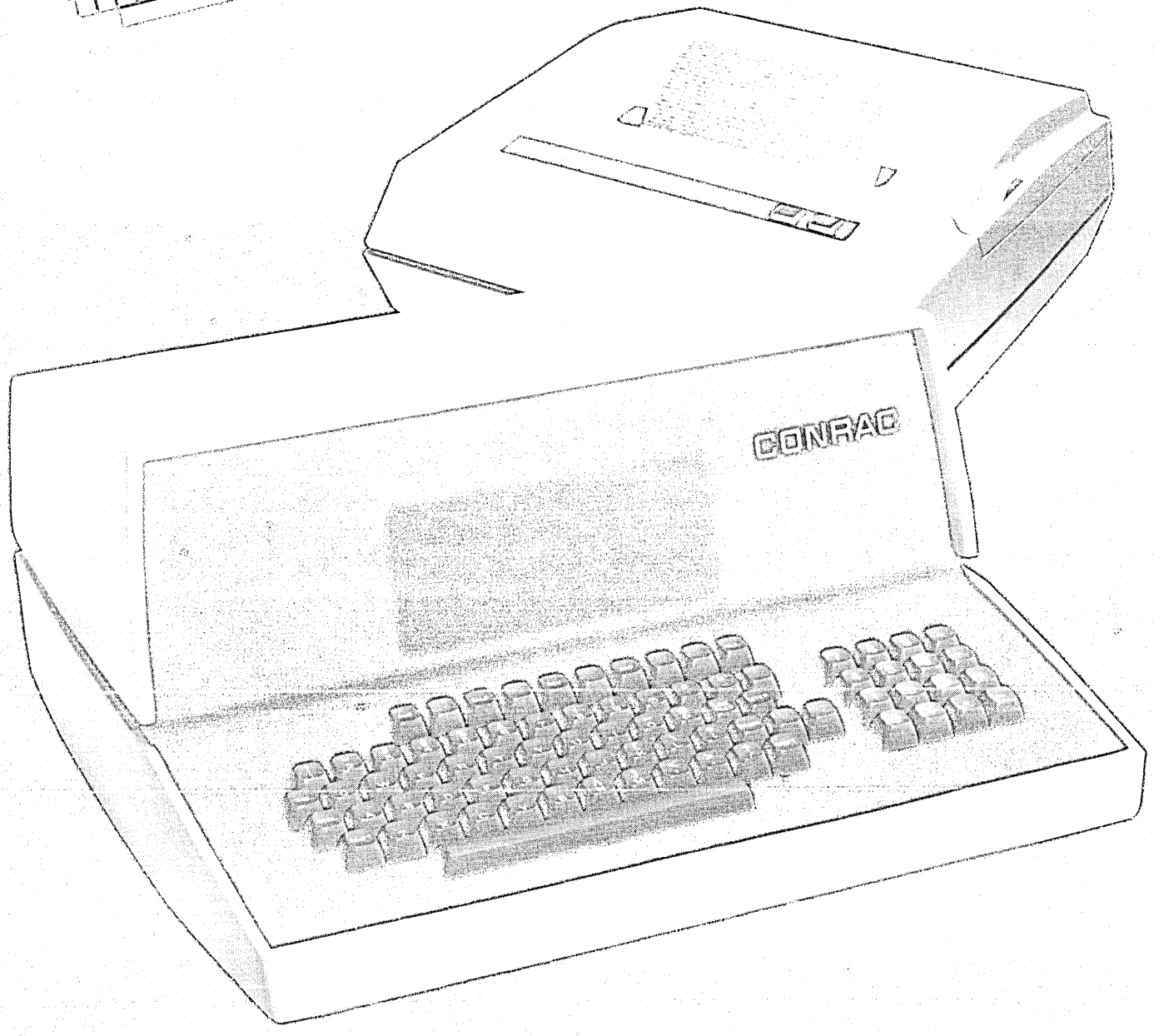
The Denver branch of the Kansas City Federal Reserve Board distributed payments to Colorado, New Mexico, and Wyoming where there is no ACH as yet.

Tentative plans call for expanding the program to the rest of the Sixth and Seventh Federal Reserve Districts by February 1975. The First (Boston) and the Ninth (Minneapolis) districts are scheduled to be brought into the system by the second quarter of 1975 and the rest of the country by the third.

Recession Helps: Advanced Memory Systems Inc., which says it has installed more than 600 add-on memory systems for IBM 360s and 370s, is in the preliminary stages of a marketing agreement with Memorex Corp. Earlier marketing arrangements with Itel Corp. and Control Data Corp. remain in effect. The agreement would enable Memorex to market and maintain AMS semiconductor add-ons for end-users worldwide, complementing the Santa Clara, Calif., company's line of plug-compatible discs and communications processors. Richard Andreini, vp-Systems Marketing for AMS, says sales have been very good. "People tend to look for less expensive ways to do their data processing (during a recession)," he says, "and that gives us that much more opportunity to sell our products." He observes that only two or three years ago there were maybe 15 or 17 companies in the IBM add-on memory business. But with the move to semiconductor memories, AMS has only four or five competitors. □

CONRAC TRENDSETTER

Conrac breaks the $2,000 price barrier with the Model 480 TTY PLUS/HIGH-SPEED TELEPRINTER combination. It can provide hard copy of the displayed information in less than 4½ seconds. Choose from 5-, 1/2- or 16-line versions. Contact Elton Sherman. Find out why Conrac is the OEM supplier to industry. CONRAC, Data Products Department, 600 N. Rimsdale, Covina, CA 91722 (213) 966-3511, Telex 67-0457. In the United Kingdom, call Penn 37/21. In Europe, call 089/37/ 65 28, Munich.



CIRCLE 21 ON READER CARD

LOOK AHEAD

(Continued from page 18)

A NOT-SO-FRENCH CII?

France's government this fall seemed less interested in a French-owned computer company than in one that could pull its weight in Unidata, the recently formed consortium of European computer firms. Maurice Allegre, a 41-year-old French government official who has fought for the concept of a purely-French company through government support has been dispatched to an obscure government post.

Under consideration now by Compagnie Internationale pour L'Informatique (CII) is the prospect of inviting Honeywell Bull to put money into the cash hungry company--something the Honeywell French affiliate has wanted for some time as an avenue for itself into Unidata. A CII official was saying late in November, "Honeywell Bull's possible participation dominates the consideration now." One other solution to the French company's plight: Lower CII's goals to make it in the big time; but that would jeopardize its commitments to Siemens and Philips, the other partners in the Unidata consortium.

EUROPEANS LOOK AT U.S. SMALL BUSINESS MARKET

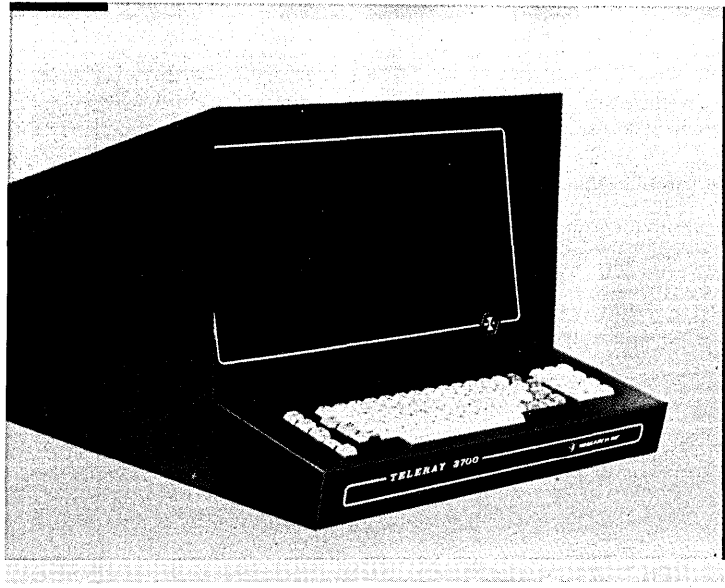
Olivetti, ICL and Nixdorf step up their activity in the U.S. small business computer market. Olivetti Corp. of America has started to market its Audit 5--an extension of its 10,000 accounting machines installed in the U.S.--and will announce it in January. No announcement date has been set for a larger version, the Audit 7, but it's being tested in local government markets in New Jersey. A banking terminal, the TC-800, will be announced in February for the Savings Bank industry. Olivetti has 400 in sales and support for the new U.S. effort.

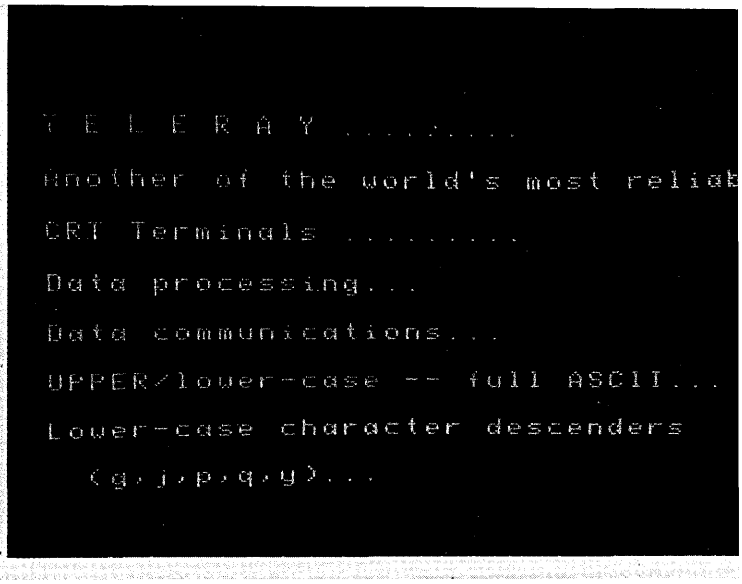
The UK's ICL seeks a U.S. partner to help it sell and service its IBM System/3 competitor, the 2903 (August, p. 17). Meantime, it concentrates on New York City where it has two installations and hopes to crack five of 50 System/3 installations it has surveyed there.

Nixdorf, we hear, has been looking for a suitable U.S. partner for two years with no luck. These days, though, most of the cash seems to be at IBM.

RUMORS AND RAW RANDOM DATA

Control Data's chairman Bill Norris dashed off a blistering letter to the financial magazine, Forbes, charging it with inaccuracies in a Nov. 15 article speculating that CDC was going out of the computer mainframe business. Besides the alleged inaccuracies, it's understood CDC is upset that IBM salesmen secured advance copies of the article and quickly distributed them to CDC computer accounts...Meantime, a poll of securities analysts taken by the Reuters news agency surprisingly shows that Wall Street looks at CDC as more of a finance company than a computer company. One publication ran the story under the heading, "Commercial Credit--The Dog That Wags Control Data"...With ample provisions of beer, snacks, musical instruments and a roast suckling pig, the flag football team and 260 supporters from minicomputer maker Interdata, of Oceanport, N. J., traveled to North Haven, Conn. to whip a team from rival Data General of Southboro, Mass., 19-12. Those who remember the Nov. 3 game said it was a roaring success and giant Digital Equipment Corp. may be asked to join in the "Data Bowl" next year...Once oem-oriented Computer Automation is preparing to announce in January a large user machine close to the size of DEC's 11/45 and Data General's Eclipse...Persons who refused to pay $3 for a 131-page report on Computer Abuse, offered free last fall in press releases from Stanford Research Institute, (May, p. 18), are being dunned in letters from SRI's Peter J. Valenti, manager of accounting services. The expletive of one dunee reacting to the letter is being deleted for obvious reasons...The UK weekly newspaper, Computer Digest, says it has a new staff member who is finding computer jargon rather heavy going: Her most recent plaintive cry: "Are card readers people or machines?"...IBM is said to have told Univac in a recent letter, "IBM has no plans for a (long rumored) 9-bit machine." Which led an official of Britain's ICL at a recent meeting in Europe to ask: "Do you think it might be 10?"





Our Teleray 3700 rests on its laurels!

We've kept the TELERAY tradition with the 3700. MSI circuitry and top grade components cut down the things that can go wrong and give you another TELERAY Uptime terminal with the quick repair feature of having all logic, character generation, drives and interface on **one plug-in board** with **every chip** a plug-in.

As one TELERAY user puts it, "We can work around a down tube for a while, but our operators aren't low paid clerks. They're high paid programmers, scientists and skilled personnel. Their lost time really hurts." TELERAY is, in fact, rarely down, but is quickly and easily repaired — by our nation-wide service network.

Standard features include:

- UPPER/lower case, 128 character ASCII set — 95 displayable
- 1920 character, 12″ CRT display (80 x 24)
- Dual data rates, to 9600 Baud
- Multiple interfaces — RS-232, Current Loop, TTL
- Wide character (40 x 24) format, switchable
- Character-mode, bottom line entry, scroll-up operation
- Bottom-line cursor control and screen clear
- Space-over-data, switchable — for fill-in-the-blanks (CAI)

Optional features include:

Printer Output, TTL parallel, Composite Video, Numeric Keypad, 15″ display, 50 Hz, Incremental Horizontal tab, Receive Only, Detachable keyboard . . .

Call collect (612) 941-3300 and ask for TELERAY! There's an Uptime TELERAY Terminal for your CRT application.

CIRCLE 58 ON READER CARD

For Multi-Application Multi-Location Business Data Processing:

AGI
ASCOT GENERAL INDUSTRIES, INC.
Route Salesman Order Sheet

Omaha, Nebraska — Date 9/30/74
Account Number 676
Ship to: UNIVERSAL IND. PRODUCTS
1010 N. 10TH STREET
OMAHA, NEB.
Bill to: SAME — Ship Via: MTR. FREIGHT

Catalog No.	Quantity	Description	Price
216	6	WHEEL MOUNTS	39.40
45	10	BUSHINGS	127.60
23	4	ELEC. MTRS.	337.84

Salesman: HARRIS
Office: OMAHA, NEB.

ORDER ENTRY

AGI
ASCOT GENERAL INDUSTRIES, INC.
CHICAGO DIVISION WAREHOUSE
Inventory Status Report
For: SEPT. '74

Item	Catalog #	Qnty. as of 9/30	Qnty. Shipped During Month	Qnty. Received During Month
BEARINGS	0849	2,740	150	280
FLANGE	9647	10,183	2,140	—
PISTON	6314	1,628	85	500
MUFFLER	9218	6,423	176	2,000
FILTER	6216	8,048	1,045	—

INVENTORY CONTROL

AGI
ASCOT GENERAL INDUSTRIES, INC.
31747 Van Alstyne · Chicago, Illinois 60666 (312) 748-9200
Invoice

To Universal Auto Products
1010 10th Street
Omaha, Nebraska 45215

Salesman	P.O. #	Job Description	Invoice Date	Invoice #
Harris	UI-453	Mixed	10/5/74	10284

Catalog #	Description	Quantity	Price
216	Wheel Mounts	6	39.40
45	Bushings	10	127.60
23	Elec. Motors	4	337.84
			504.84
	Sales Tax		25.24
	Shipping Charge		63.14
	TOTAL DUE		593.22

ACCOUNTS RECEIVABLE

AGI
ASCOT GENERAL INDUSTRIES, INC.
Date SEPT 30, 1974 — FINISHING Department

		Op. No.	Acct.	Production: Total Actual	Production: Expected per Hour	Hours: Expected	Hours: Actual	Diff.: Red-Loss	Diff.: Bl.-Gain
1	OTIS	195D20	502	2800	375	7	8		
2	JONES	100625	502	2800			7		
4	LEE	101R26	502	2800			6		
7	DUNN	195625	502	400	400	1	1		
9	KIDD	105D21	502	200			1		

PRODUCTION REPORTS

Invoice
AARDVARK ACCESSORIES
116 N. Buchanan Street
Albany, N.Y. 06478

To Ascot General Ind.
31747 Van Alstyne
Chicago, Ill. 60666

Date Shipped: 9/20/74
Shipped Via: Motor Freight

P.O. #	Inv. #	Salesman	Office	Invoice Date
A-545	86452	O'Brien	Chicago	9/27/74

Items	Catalog #	Quantity	Cost
Wheel Bearings	674	100	$ 431.16
Bushing Seals	1040	500	101.13
Motor Covers	8241	200	1,624.18
		Sub-Total	2,056.47
		Sales Tax	N/A
		Shipping Charge	105.24
			$2,161.71

30 Days Net/2% 10 Days

ACCOUNTS PAYABLE

AGI
ASCOT GENERAL INDUSTRIES, INC.
Transportation Division
Overhead Analysis
Month SEPT.

Indirect Labor	Budget	Actual Expense	Over or Under Budget
Supervision	775.00	756.00	(19.00)
Trk. Drivers Helpers			
Shipping			
General Labor	405.00	171.22	233.78
Repair and Rework			
Idle and Lost Time		1.77	(1.77)
Guaranteed Rate Cost	244.00	28.14	215.86
Overtime Bonus	75.00	32.98	42.02
Maint, Mchy, Equip.	150.00	38.26	(111.74)
Vacations		46.00	46.00
Paid Holidays			
Total	1,649.00	1,074.37	574.63

COST ANALYSIS

AGI
ASCOT GENERAL INDUSTRIES, INC.
Finishing Department
Time and Production
Date 10/5/74

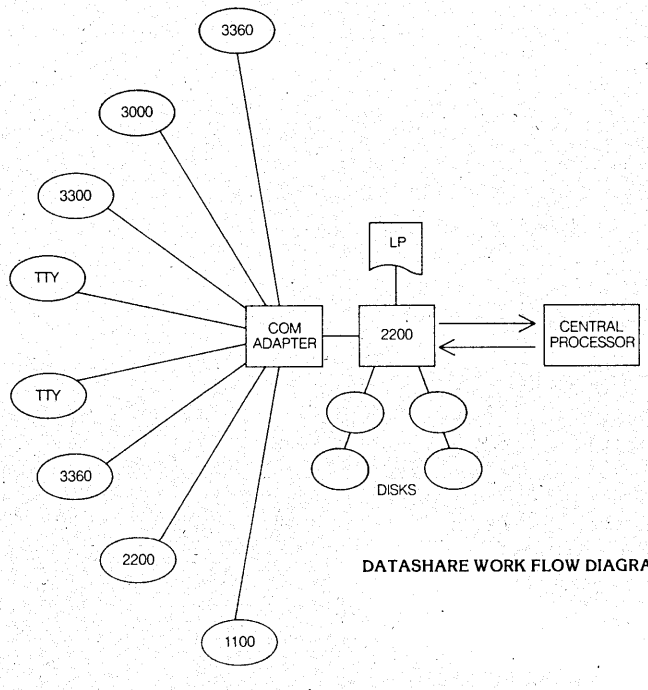
Order No.	Oper. No.	Time: Start	Time: Finish	Time: Elapsed	Labor or Piece Rate	No. Pieces	Cost
2068	31	7:20	12:00	4.8	2:30	350	8.05
2068	42	1:00	4:20	3.2	2.30	250	5.75
2069	37	7:30	12:10	4.8	2.30	350	8.05
2069	45	1:00	5.00	4.0	2.30	250	5.75

LABOR DISTRIBUTION

AGI
ASCOT GENERAL INDUSTRIES, INC.
Finishing Division
Employee Time Sheet

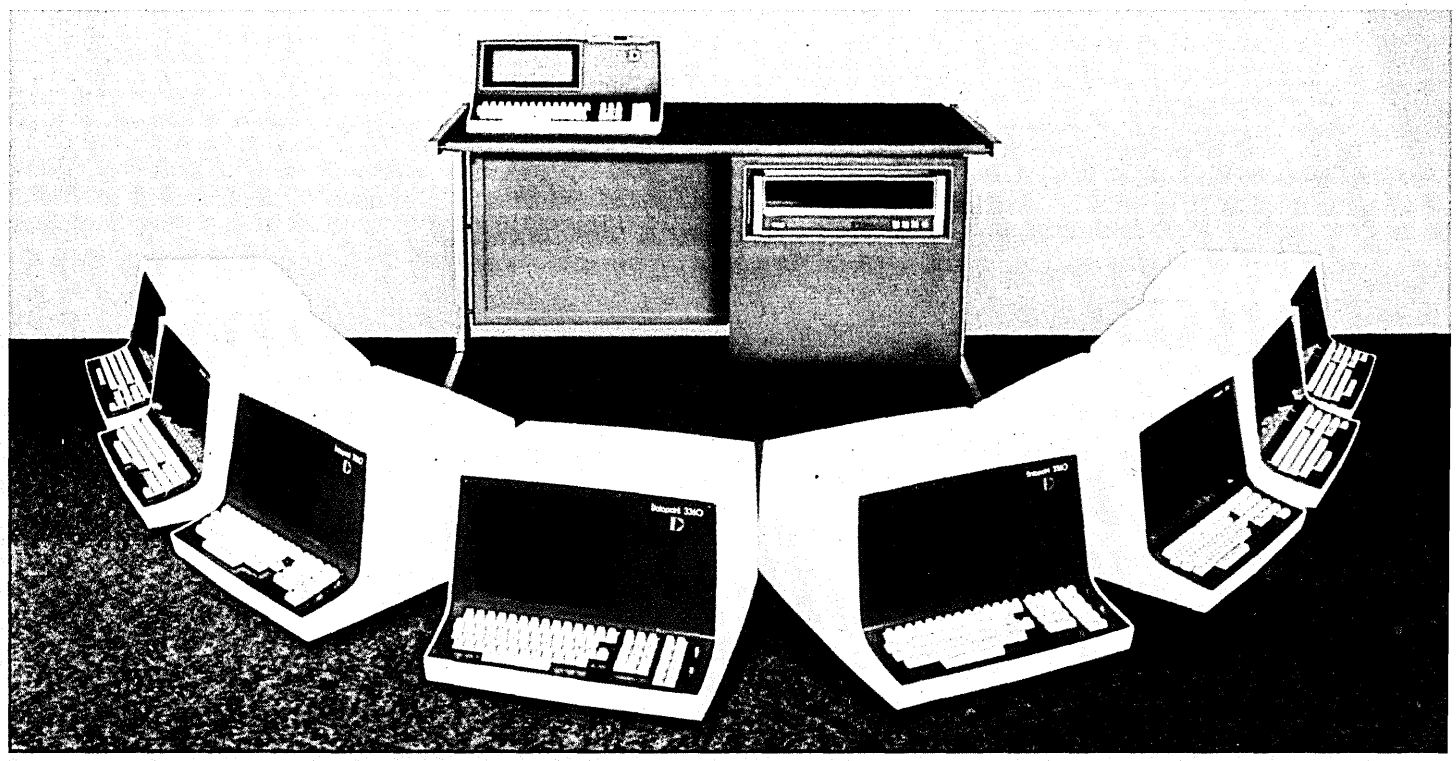
Employee/Number	10/7 RT/OT	10/8 RT/OT	10/9 RT/OT	10/10 RT/OT	10/11 RT/OT	10/12 RT/OT	10/13 RT/OT	Totals RT/OT
BENNETT 6417	8 0	8 1	8 0	8 0	8 0			40 1
CARLYLE 8214	8 0	8 1	8 0	8 0	8 0			40 1
LANE 6743	8 0	8 0	8 0	8 0	8 0			40 0
POWELL 0643	8 0	8 0	8 0	8 0	8 0			40 0
PARKER 9118	8 0	8 0	8 0	0 0	0 0			24 0

PAYROLL



DATASHARE WORK FLOW DIAGRAM

Datashare



DATASHARE is the comprehensive answer provided by Datapoint Corporation to the problem of providing a multi-application business data processing and intelligent data entry capability to multi-location organizations at a cost that's within today's inflation-pinched budgets.

DATASHARE's big plus for users is that it permits the full computing power of a Datapoint 2200 Terminal Processor to be utilized at up to eight dispersed work stations. At those stations, operators using Datapoint 3300, 3360 or other Datapoint terminals (with or without terminal printers) have full access via either local wire connection or telephone lines to the 2200's powerful internal computer and 128K of virtual memory for conversion, entry, processing and storage of data from sales orders, accounts payable and receivable, employee time sheets, inventory receipts and other important source documents. Under DATASHARE control, operators using terminals at these work stations can utilize programs stored in a central disk memory unit to aid in entering data for particular applications and other processing requirements, independent of and concurrent with, work going on at the other stations.

Physically DATASHARE is a master program stored in the central Datapoint 2200 processor which acts as controller for data traffic between the work stations and the disk memory file unit associated with the 2200 where file and program data is stored for each application and each work station. The DATASHARE program also allocates the internal processing power of the 2200 among these work stations in a manner akin to time sharing, so that each station functions as though it had total command of the 2200.

The basic advantages of the DATASHARE approach for multi-location, multi-application data entry and processing requirements are flexibility – each operator can work upon applications independently of what's going on at other stations (although stations can also share data files and programs if that's appropriate) – capability – the full capacity of four 2200/2.4 megabyte disks is available to each work station for processing and storage of program and file data – and, of course, economy – each work station in effect enjoys the power and capability of a 2200 via a terminal that costs a fraction of the 2200.

The DATASHARE program also provides each data station with automatic file maintenance, simplifying user creation of, access to, and storage of, data files stored in central memory. The program optimizes use of available memory space as well as makes it simple to create, combine or alter files. Further, with its communications interfaces and numerous emulation routines, the Datapoint 2200/DATASHARE System can be readily integrated into most functioning computer/communications networks. In some cases the Datapoint 2200/disk system will be used to edit and pre-process source data captured at the remote work stations before sending it on to a home office computer facility. However, the 2200 will most often be used as the central processor itself.

With DATASHARE, you can enjoy a proven business data processing and intelligent data entry capability in each of eight work stations at a cost well below a conventional upgrade. Scores of companies are making use of this unique Datapoint package with outstanding results.

For further information on DATASHARE, contact the sales office nearest you or write or call Datapoint Corporation, San Antonio, Texas 78284, (512) 690-7151.

Datapoint

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CIRCLE 17 ON READER CARD

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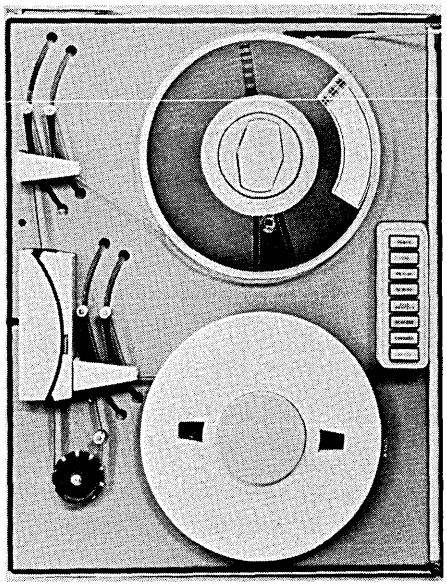
WANGCO's fast response helps you get your systems out the door quickly and profitably. How do we do it? By providing prompt support on technical questions, hands-on interfacing assistance, and quick deliveries keyed precisely to these changing times. And by providing low cost peripherals that are dependable and inexpensive to maintain.

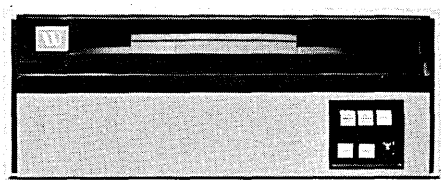
WANGCO tape drives include advanced dual-density systems, low-cost vacuum column models, and our new Autoload. All are designed to industry standard formats, from 200 cpi to 800 cpi NRZI ,and 1600 cpi phase encoded . . . or both.

WANGCO front- and top-loading disc drives can double your disc storage capacity in only 7 inches of rack height. Our fixed-disc models give you up to 100 megabits of storage, at one-sixth the cost-per-bit of floppy discs.

WANGCO responds in the field by maintaining sales and service facilities worldwide.

For detailed literature, or technical assistance, phone or write **WANGCO Incorporated, 5404 Jandy Place, Los Angeles, Calif. 90066. (213) 390-8081. TWX: 910/343-6246. Cable: WANIC Los Angeles.** *We'll respond!*





WANGCO

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Offices in France, Germany, Sweden, Switzerland, Australia, Brazil, Canada, Israel, Japan and South Africa.

TASK/MASTER is the best telecommunications monitor in the world...and we can prove it

ease of installation

TASK/MASTER can be generated and operational in hours. Simplified specification of the operating system to be used, programming languages, terminal support required, and system options insures a smooth and easy initial installation. Expert TSI personnel train your staff on-site and guarantee a rapid successful system implementation.

In a recent DATAPRO survey of ninety telecommunication monitor users (report 70E-010-40a), TASK/MASTER ranked ahead of CICS, ENVIRON/I, and INTERCOMM in ease of installation.

ease of application programming

TASK/MASTER allows direct and simple interfaces from COBOL, PL/I, FORTRAN, and Assembler programs. Application programmers can be trained to write efficient on-line programs *in hours.* Any level of IBM compiler can be used, without modification. Unlike CICS, no preprocessing of high-level language programs is required, further simplifying program creation, testing, and maintenance.

Not unexpectedly, in a recent user survey nearly two times as many INTERCOMM users and three times as many CICS users felt their system restricted the application programmer as did TASK/MASTER users.

resource utilization

TASK/MASTER's basic architecture and technical facilities allow significant resource savings. Survey after survey and installation after installation have shown that TASK/MASTER can be generated to run in 10%-50% *less* storage (including real storage required in a virtual environment) for any specific user requirement than can any competitive approach.

TASK/MASTER also saves on other system resources, including CPU overhead, disk space, and master terminal costs.

features

TASK/MASTER provides features totally unmatched in any competitive package. Among these are:

- a complete message queuing mechanism, including automatic disk overflow, station-by-station control, queue protection, and duplicate message suppression in the event of system failure and restart
- true terminal independence which makes device control characteristics transparent to application programs and is far more powerful and easier to use than any other message mapping facility
- file protection allowing automatic recreation of databases after system or file loss
- a *generalized* interface to *any* database management system, including TOTAL, DL/I, ADABAS, DBOMP, IDMS, and others
- automatic application restart in the event of a system failure *without* duplicate file updating due to message reprocessing
- terminal support which covers the widest choice of IBM and non-IBM devices in the industry

vendor support

TSI's support for TASK/MASTER users is the best in the industry. Once again using the DATAPRO survey as a reference, monitor users rank our support for TASK/MASTER well ahead of CICS, INTERCOMM, and ENVIRON/I.

In an independent user study approximately 85% of TASK/MASTER users felt the technical support provided with the package was good, versus less than 65% of INTERCOMM users and only half the CICS users.

Why? Possibly because of the four vendors involved, we are committed *exclusively* to excellence in on-line systems and have built a Customer Service organization committed to that single goal.

cost

Although the other advantages on this page translate into cost savings many times the price of the monitor itself, TASK/MASTER is *also* the lowest cost package on an out-of-pocket basis. TASK/MASTER's low price includes all installation support and education services.

performance

Whatever your environment – DOS, DOS/VS, OS, or OS/VS – TASK/MASTER will perform better than any alternative you could choose. Respondents to DATAPRO's survey once again ranked TASK/MASTER first in performance.

Other surveys have consistently placed TASK/MASTER at the head of the field in overall system performance considerations. In a VS environment, TASK/MASTER has nearly two years of demonstrated capabilities running in a fully virtual mode; an unmatched record with equally unmatched results in scores of VS shops.

user satisfaction

In the final analysis the overall satisfaction of existing users is possibly the most critical factor in selecting a monitor. In survey after survey TASK/MASTER users have expressed the highest level of satisfaction with their system. DATAPRO's results were once again typical: when compared against the other monitors on the basis of overall satisfaction TASK/MASTER came out ahead of the field by a significant margin.

In 150 installations around the world, TASK/MASTER is establishing new standards for simplicity of use, reliability, performance, and user acceptance. Any or all of these users are our best advertisement.

convinced?

If not, or if you want more details, why not attend one of the following *free* one-day seminars:

Location	Date	Location	Date	Location	Date
New York	12/4	Los Angeles	12/20	Atlanta	2/5
Indianapolis	12/4	Milwaukee	1/7	Minneapolis	2/12
Boston	12/5	Columbus	1/8	Dallas	2/20
Toronto	12/11	Montreal	1/15	San Francisco	2/21
Philadelphia	12/12	Washington D.C.	1/16	Los Angeles	2/24
Chicago	12/12	New York	1/22	Indianapolis	2/27
St. Louis	12/18	Chicago	1/29	Charlotte	3/5
Denver	12/18	Detroit	1/30	St. Louis	3/12
San Francisco	12/19	Boston	2/5	Pittsburgh	3/19
				New York	3/26

turnkey systems inc.
one eleven east avenue, norwalk, connecticut 06851
203-853-2884 Telex 964351

☐ Please enroll _____ people in the TASK/MASTER seminar in _____ (CITY) on _____ (DATE)

☐ Please send more information on TASK/MASTER.

☐ Please call _____

Name _____

Title _____

Company _____

Address _____

City _____ State _____ Zip _____

Phone _____

How we got ahead of the pack

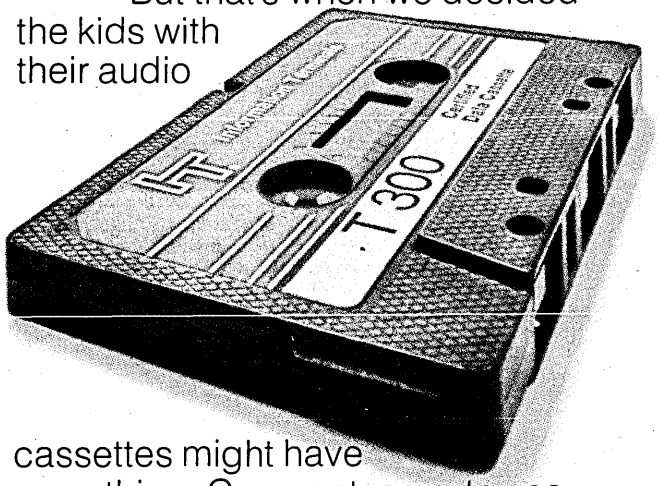
Five short years ago, we weren't number one in digital cassettes.

We weren't industry innovators in floppy disks.

We weren't first in certified word processing cassettes.

Fact is, we weren't. Period.

But that's when we decided the kids with their audio



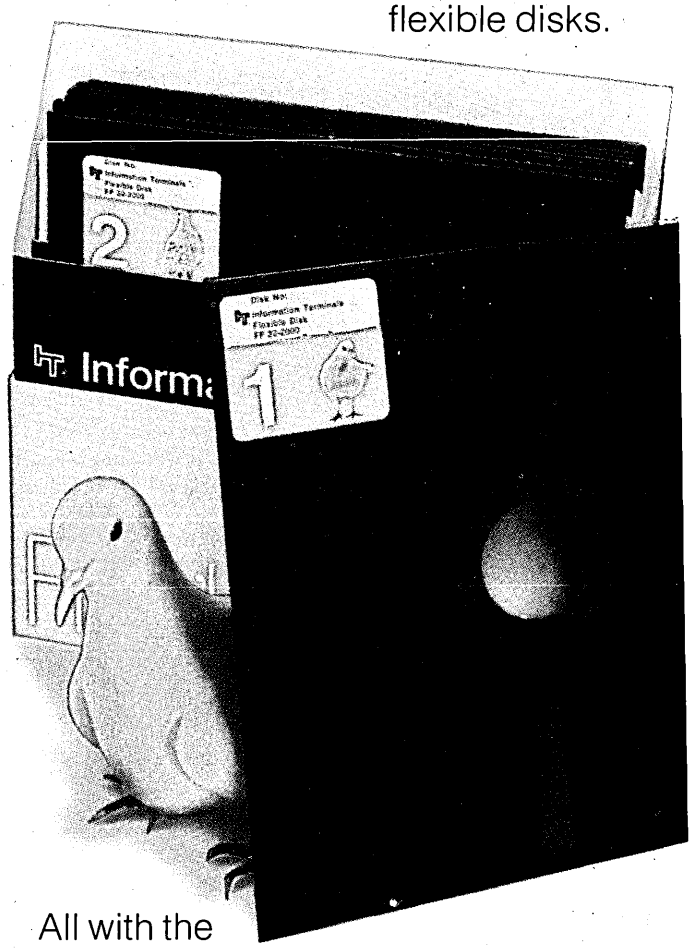
cassettes might have something. Compact, easy to use and—best of all—cheap. So we developed a digital cassette that combined all those features with the reliability necessary in the lofty world of data processing.

It was a winner. So much so, in fact, that it set the standards (ANSI and ECMA) against which the performance of all other cassettes are measured. And people asked us to similarly develop a series of special-purpose cassettes designed to be just as good under different specific operating conditions. Plus the instruments to test them. We did.

Today, more than half of all the certified digital cassettes in use throughout the world are ours.

Comforting, but not enough.

So, with a little help from a friend named Gus, we found and filled still another customer need—flexible disks.



All with the same stringent dedication to quality exemplified by 100% certification and initialization after final assembly.

And then we became the first

n data storage media.

company to introduce the "flippy", the world's first two-sided, double-capacity flexible disk initialized on both sides.

Now we offer flexible disks for every drive in use throughout the industry—flippy as well as floppy.

Even more comforting, but still not enough.

Because word processing is where it's happening now. And even though we make almost 100% of the world's supply of certified word processing cassettes, we've just announced a line of magnetic cards for word processing applications.

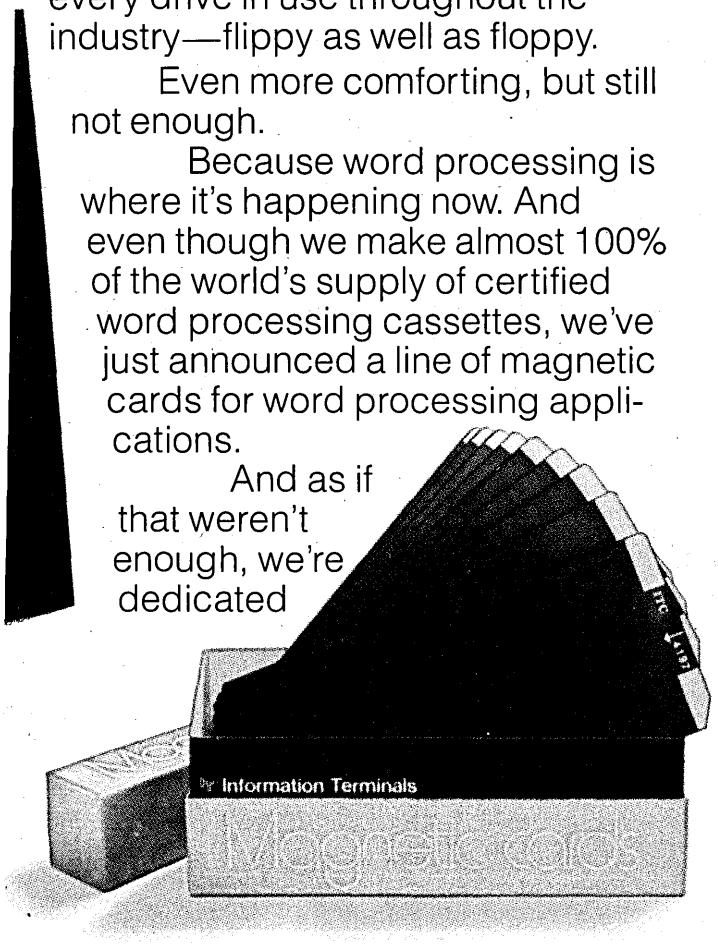
And as if that weren't enough, we're dedicated to finding new opportunities to use our expertise to produce more efficient, more reliable and more economical solutions to digital storage media problems wherever we find them.

We're now number one in digital cassettes.

We're now the industry innovators in floppy disks.

We're now first in certified word processing cassettes.

Despite how comforting those first five years have been, we can hardly wait for the next five to begin.



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Gentlemen:

- ☐ Send me more information on data cassettes.
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- ☐ Send me more information on word processing cassettes.
- ☐ Send me more information on new magnetic cards.
- ☐ Don't send me anything. Just call me. ☐ _____

Name _____

Title _____

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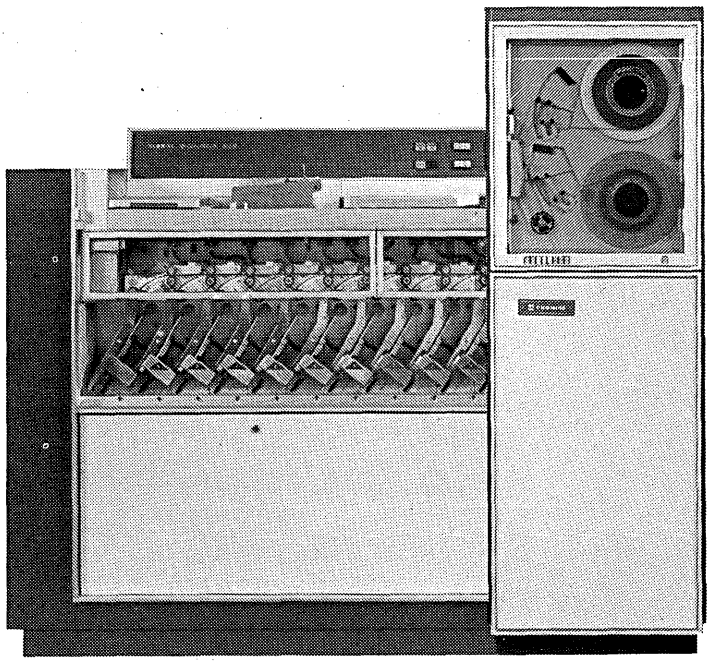
City _____ State _____ Zip _____

Look at scanning. Key/disk. Look at performance. And costs. Look at multimedia.

When you look at the best... you'll see the Cummins KeyScan™ Data Entry System.



Look at scanning. With KeyScan, a single key stroke of each unrecognized character provides re-entry of rejects without rehandling while still scanning the same block of documents. Data from all documents is edited and balanced by batch, in a single pass through the System.

Look at key entry. Cummins key/disk terminals provide more power per dollar than any other key entry system.

Look at both. KeyScan is a shared processor, key/disk scanning system that affords unparalleled flexibility. It's the first multimedia data entry system, the only high performance system *and* it's moderately priced.

Whether you need an OCR scanning system, a stand-alone key/disk system, or an off-line print station . . . KeyScan enables you to select what you need at a price you can afford.

And, as your requirements change, you can reconfigure your hardware and software to do the new job . . . the best way.

All this from a company with systems, programming, and forms design support, and over 45 branch sales and service offices located across the country. So write today for our new 4400 KeyScan System brochure. Write: Cummins, 836 Waukegan Rd., Glenview, IL 60025. Or better yet, call us at 312/724-8000 and make an appointment to visit our demonstration facilities.

And remember, when you think data entry, look at Cummins KeyScan Multimedia Data Entry System. Then look at other systems and you decide which is best.

4400

KeyScan Multimedia Data Entry System

CUMMINS
CUMMINS-ALLISON CORP.

29-1371

CIRCLE 22 ON READER CARD

hardware

Off-line

The 500,000th model 32/33 terminal that came down Teletype Corp.'s assembly line last October 25 looked pretty much like its predecessors--with one important exception. It was gold plated. Floyd C. Boswell, Teletype's President, then used the terminal to transmit a personal message to friends in the industry. While the Skokie, Ill. terminal giant may never catch up to McDonalds, 500,000 terminals of a single type in 12 years is an impressive achievement.

Unidata continues to amaze the world with quick benchmark and delivery schedules. The 7.730 and 7.750 models described in October (p. 126) are available now for benchmark exercises, with production models available for delivery before July 1975.

A team of three electrical engineers and a music professor at the Univ. of Michigan have succeeded in developing the first hologram projector and reader, an accomplishment that might lead to a revolution in audio/video tools. Approximately the size of a TV set, holographic film is mounted on two spools inside the device. Knobs on the front enable the user to rotate the film, which gives the impression that the object itself is rotating. The projector can do this, but it's restricted to two-dimensional displays. Why a music professor in on the project? Recording images of rare instruments on film is a safer way to "show" the instruments to students or the general public, and gives a more realistic impression than photographs.

Vector General, Inc., Woodland Hills, Calif. has won an award from the Univ. of California's Earthquake Observatory at Berkeley for a computerized system that will speed up the time it currently takes to determine the location and magnitude of earthquakes. Elaborate, time-consuming calculations typically require upwards of an hour currently, but it's expected that the new system, comprising a graphics terminal, data tablet, and associated peripherals will reduce the time to approximately 10 minutes.

Small-scale Systems

For some curious reason, Honeywell is just now bringing the level 61 machines to these shores, though they've been marketed in Europe since last April when they were announced with the rest of Honeywell's big series 60 announcement (see June, p. 140). At any rate, the machines are noteworthy because they are the smallest systems to date capable of supporting GCOS, a proven and reliable operating system, and the obvious bridge this makes toward the higher models in the 60 series lineup.

The 61/58 is an entry-level model for batch and direct entry processing that can be expanded to process four concurrent terminal programs and one batch job, with the batch job having priority. The 61/60 is a transaction processing system for servicing up to eight terminal programs and a batch job, with the communications programs having priority.

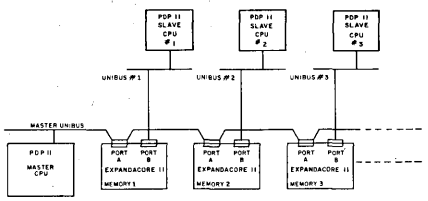
The hardware on the two models is basically the same: 8-bit plus parity, directly addressable across full memory range at byte level, with 1.2 usec cycle time. The data format is EBCDIC (significantly), but also uses ASCII for communications. The basic memory size is 5,120 bytes on the 61/58, expandable to 10K, with 10K the minimum size on the 61/60. A memory store of 16-64K bytes is optional. The 61/58 processes in MINICOBOL, ANSI COBOL-68 and EDITOR languages. The 61/60 speaks all these languages, and additionally offers ANSI COBOL-74 and BASIC. An orchestra of peripheral devices includes disc storage subsystems with capacities ranging up to 3.4 megabytes, printers with operating speeds of from 100 to 600 lpm, and various I/O devices including card readers and punches and an optical mark reader.

A 10K 61/58, card console unit with 100 cpm reader, 10-position display, alphanumeric keyboard, removable disc mass storage system with 5.76 megabyte capacity, line controller, and ability to attach one remote terminal rents for $1,937/month on a five year contract. A 10K 61/60 with a communications processor, 46 megabyte disc subsystem, 300 lpm printer, and capability for supporting five remote keyboard terminals rents for $3,135/month on a five-year lease and sells for $138,715. Both systems include the MINICOBOL compiler. Smaller configurations of these systems are available. Deliveries begin in the second quarter of the new year. HONEYWELL INFORMATION SYSTEMS, Waltham, Mass.

FOR DATA CIRCLE 216 ON READER CARD

PDP-11 Memory Sharing

With more and more computers being hooked up so they can talk to each other, this manufacturer has introduced a feature that permits two or more PDP-11 minis to be linked in a "daisy chain" configuration while sharing a series of the vendor's ExpandaCore-11 memory units. Additionally, the memory-sharing feature permits access to any memory unit from any



direct-access (DMA) peripheral device used on PDP-11 processors. The Dual Port feature is priced at $1,875 per memory system. ExpandaCore-11 memories are priced approximately 40% under DEC's equivalent boxes, it's claimed. CAMBRIDGE MEMORIES, INC., Bedford, Mass.

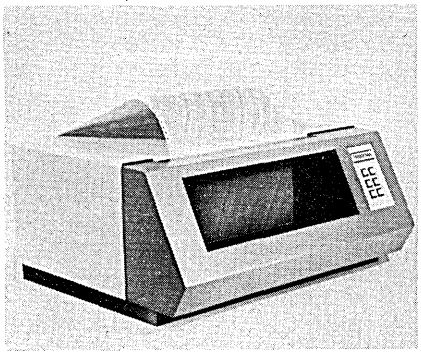
FOR DATA CIRCLE 217 ON READER CARD

300 Lpm Matrix Printer

This small, new firm has come up with an unusual printer design said to result in reliable 300 lpm operation, low maintenance costs, and a price of $3K for orders of approximately 100. The print fonts, 64-character upper case, a 96-character lower case (featuring tails on long letters like g and y that go below the print lines), and even a Japanese Katakana set, are printed by 44 hammers that shuttle back and forth along the print line to produce up to six copies of printout. The drive mechanism is said to have no frictional wear, no adjustments, and uncomplicated drive electronics, all of which should please oem's. Dots are printed in overlapping positions, resulting in characters that approach the appear-

hardware

ance of solid type. The printer can also be used to plot across the 132-character line length. With reliability tests out



of the way, production of the model 300 is slated to begin during the first quarter of 1975. PRINTRONIX, INC., Irvine, Calif.

FOR DATA CIRCLE 218 ON READER CARD

Intelligent Terminal

This five-year old manufacturer of intelligent terminal equipment has just announced its latest development, the model 200/10. It features a semiconductor RAM program memory expandable to 8K 16-bit words, eight-line vectored interrupt, floppy discs, dual tape cassettes, and printer options with speeds up to 250 lpm. The effective cycle time of the internal mini is 650 nsec. There are programmable keyboard and communications options, a 10-bit character screen memory for storing three attribute bits plus character code, and a 12-inch monitor for displaying up to 1,920 20x14 dot-matrix characters. A basic system, with character generator, 2000 character refresh memory, monitor, power supply, cabinet, and keyboard is priced at $4,200. The RAM ranges in price from $840 to $3,300 for 1-8K words.

Software is called MIDAS that includes a resident assembler, source editor, debugger, tape cassette utility program, binary interchange program, and a ROM loader. All the hardware and software is currently available with the exception of the floppy disc, and it's scheduled to be ready early next year. COMPUTEK INC., Cambridge, Mass.

FOR DATA CIRCLE 219 ON READER CARD

Large-scale Systems

Digital Equipment has announced the most interesting systems in its DECsystem 10 line, featuring cache memory, twice the performance of the previous top model, and a PDP-11/40 mini as an architectural element. Past PDP-10 models were considered by users to have approximately the power of a 360/50, so the new versions just might be competitive with a 370/155, making the new 1080 and 1090 models Digital's first true large-scale computer offerings.

Basic architecture remains the same: 36-bit word layout, with memory sizes ranging from 128K up to a whopping 4,096K words, or roughly the equivalent of having 16 megabytes on-line. There are 386 basic instructions in the model KL10 processor. Processing speed is improved by the use of a 2K word 125 nsec memory that holds a selection of words from main memory to reduce both access time and the number of main memory cycles needed by the processor. With the 1 usec main memories, the cache gives the KL10 processor an effective cycle time of 300 nsec. A radial memory bus architecture with up to four 36-bit data paths is employed, with the I/O bus bandwidth rated at 370,000 words/second. Some typical instruction times are: fixed-point add, 700 nsec; fixed-point multiply, 2.4 usec; jump, 500 nsec; single precision floating-point add, 1.9 usec; and 5 usec for a double precision floating point add.

A raft of new peripherals debut with the systems. There's a 3.2 billion character disc storage subsystem, 200 ips magnetic tape units, and a fixed-head disc that can be used as a virtual memory swapping device. New software includes an expanded data base management system, a message control system to handle large numbers of terminals (40-127) interactively, and virtual memory support. The monitor is TOPS-10. All software is compatible with previous DECsystem-10 models.

A typical model 1080 configuration,

product spotlight

Word processing

Xerox is betting a bundle on the automated office concept, generally conceded to bloom later this decade, or early next, of which word processing is only one component. It's an important one however: there are estimates that 150,000 automatic typewriters are already in use in the U.S., or 3.5% of a market expected to grow at 20-25% per year in the near future.

The Xerox 800 system operates at 350 words per minute, transferring information from magnetic cards or Philips-type cassettes. The cards can hold up to 72 lines of 150 characters, and cassettes can hold up to 25-letter size documents. In operation, the typist can type along at full speed, not having to worry about making the first copy perfect, until an error occurs, or is subsequently noticed. The backspace button is then used to enter the correct information. Subsequent editing operations can from time-to-time become drastic, and there is provision for altering 50 characters per line from tape-held letters, and 78 per line with card-based information. After the letter has been proofed, it is written out at the 800's maximum speed of 350 words a minute. Additional features include automatic carriage return while typing, reverse printing from right margin to the left, three spacing alternatives (pica, elite, and proportional), and 17 type faces. These type faces are available on a lightweight print wheel (shown in accompanying photo). To change faces, one merely removes one wheel and drops in a new one.

The 800 will not be sold outright, but leases ranging from $210-310/month depending on configuration and length of lease. First deliveries have begun. XEROX CORP., Rochester, N.Y.

FOR DATA CIRCLE 214 ON READER CARD

Buy the numbers.

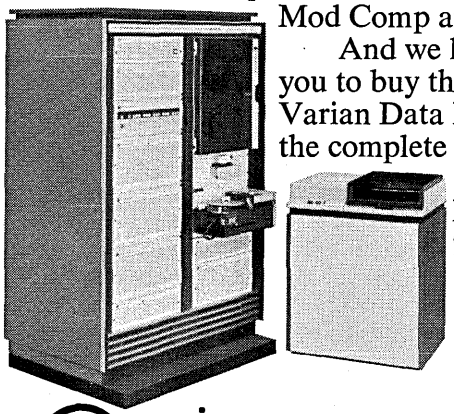
Typical FORTRAN execution times (microseconds)

	V74½	PDP-11/45	Nova 800	Mod Comp II	H.P. 2100
A=B+C	7	33	58	19	51
(double) A=B+C	10	82	61	29	98
A=B	4	14	35	7	13
Do Loop	4	22	10	11	17
A(I,J)=B	22	63	39	28	46
A=Sin(B)	100	251	266	197	1583

With all the claims being tossed around by various computer manufacturers, it's pretty hard to weed out the facts. What does winning horse races have to do with it?

We figure it differently. Buying our computer or somebody else's, should come right down to getting the most for your money. And as these numbers show, that's the V-74½.

It out-performed everyone else's. Flat. The tests weren't stacked. They're only a few months old. Run on the latest available operating systems and compilers. And the same FORTRAN benchmark programs were used in every case.



To understand why we've been able to come up with such conclusive performance figures, you've got to understand the VORTEX operating system. Augmented by the firmware FORTRAN accelerator and our new Floating Point Processor, no one can argue with the fact that it's the fastest, most powerful, most sophisticated FORTRAN IV processor in the business. DEC, Data General, Mod Comp and HP notwithstanding.

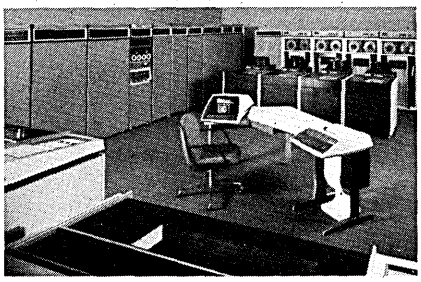
And we have more numbers to convince you to buy the V-74½. Call your closest Varian Data Machines office for your copy of the complete benchmark results on the V-74½.

Varian Data Machines, 2722 Michelson Drive, Irvine, CA 92664. Or call (714) 833-2400.

varian data machines

hardware

priced at $725K consists of the new processor and cache memory, 128K words of main memory, two tape drives, 32 communication lines, a line printer and card reader. This can be expanded to become a 1090 configuration. A 256K system with 1 million



word virtual memory swapping disc, 800 million characters of disc storage, six tape drives, 96 communication lines, a card reader, and two line printers goes for around $1.5 million—which seems like a bargain. First deliveries are scheduled for next June. DIGITAL EQUIPMENT CORP., Maynard, Mass.

FOR DATA CIRCLE 220 ON READER CARD

Serial Printer

Centronics' success with serial matrix printers is attracting other manufacturers to the marketplace (as evidenced by other products carried this month), and it just might have more trouble selling the model 102AL than it did with past offerings. The all LSI printer runs at 330 cps, or roughly 125 lpm. A 9x7 dot-matrix pattern is used to print up to five copies. Popular computer and communications interfaces (up to 9600) baud are available. Character sets range up to a full 128-character upper/lower case set, and there are special foreign fonts available. Delivery is 60 days ARO, and the 102AL is priced at $4,670 for onesies. CENTRONICS DATA COMPUTER CORP., Hudson, N.H.

FOR DATA CIRCLE 223 ON READER CARD

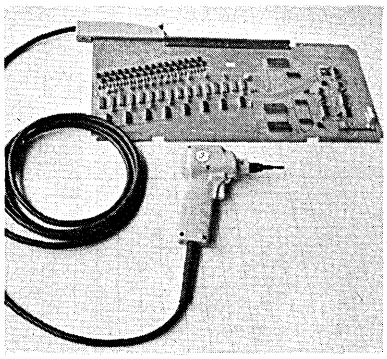
Optical Scanning Feature

The 1502 high-speed optical scanning unit has been on the market for about four years, but it's just now being equipped with a feature that considerably enhances its performance. Called "orbit", the feature releases the 1502 from being tightly tied to the computer for input. Stacker selection commands for all four stackers can now be selected independent of the time the 1502 is ready to read the input. The 1502 reads marks from the front and back sides of tab cards and punched hold data simultaneously. The "orbit" feature, which makes a 1502 into a 1502-TI (time independent) is priced at $75K. Two stacker versions are also

Intelligent Screwdriver

Don't laugh! There seem to be some very good arguments for high-volume manufacturing or testing businesses to investigate the advantages of using a computer controlled screwdriver in their operations, including speed and accuracy, with reliability a very close third. With adjustment tolerances held in the minicomputer, an operator can quickly set calibration pots, tuning screws, zero adjustments, phase alignments, and the like. With productivity often mentioned as a way to stem inflation, this tool, or one like it, might just help the campaign.

Two modes are available for the user. In the servo mode, the computer sets a reference value and a control unit drives the screwdriver until the circuit parameter dependent upon the adjustment is equal to the reference. In the iterative mode, the computer can measure a circuit parameter, compare it to a reference value, and drive the screwdriver a computed increment to bring the parameter close to the reference. Applications wouldn't seem to be limited to circuit adjustment, but the first potential customer, a large circuit board manufacturing house, wanted that in the unit, and got it. Up to eight servo gain values are selectable, and the device can be instructed to rotate clockwise or counterclockwise. The screwdriver is



priced at $550. The supporting circuit board is $600, and the manufacturer has the software drivers up and running, it's claimed. OPTIMIZED DEVICES, INC., Pleasantville, N.Y.

FOR DATA CIRCLE 215 ON READER CARD

hardware

available. CHATSWORTH DATA CORP., Chatsworth, Calif.
FOR DATA CIRCLE 224 ON READER CARD

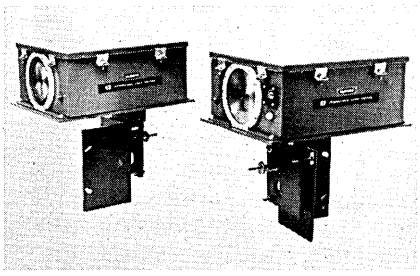
Document Processing

The S 1000 series of document processing equipment are interesting machines. They feature a 4-32K LSI processor that is used to perform a variety of operations on bank checks, deposit slips, utility bills, insurance premium notices, credit card slips, or similar documents. These operations include the capture and proofing of data, making it unnecessary to transmit the physical documents to another I/O device. The four models in the series all go online to a host computer. The operator uses a 10-key numeric keyboard, 21-column printer, and 16-character visual display for communication with the 1000 and the host cpu. A 25-cps

MICR encoding module is available on all models. The various models can be expanded from 2-20 sort pockets for handling sorting rates up to 7,200 items per hour, and a 160 lpm printer, tape cassettes, and a floppy disc are also offered for various customer requirements. A number of features are present to help cut down costly "can't read" documents. Purchase prices range from $10,500 for a two-pocket model up to $42K for an all-out system. Lease arrangements drop the rental into the $300-1,250/month range. Deliveries are scheduled for the third quarter of 1975. BURROUGHS CORP., Detroit, Mich.
FOR DATA CIRCLE 221 ON READER CARD

Laser Communications

For indoor line of sight communications at baud rates up to 100 KHz, this manufacturer has developed the TL-2 optical telemetry link. It operates at distances up to 2,000 feet in tempera-



tures of −20° to 60°C and humidity of 99%. The units are housed in a rugged steel box fitted with a precision alignment bracket. The TL-2 is priced at $4,995, and delivery is quoted as three to four months. INTERNATIONAL LASER SYSTEMS, INC., Orlando, Fla.

FOR DATA CIRCLE 222 ON READER CARD

PDP-11/40 Memory Buffer

The 4511 memory buffer is an unusual product offered to users of the PDP-11 model 45 minicomputer. The unit buffers the entire 124K words of main core memory of the 11/45 to achieve an effective MOS speed of 450 nsec. The performance gains to be realized are program dependent, but the developers claim that with good programming practices, it should be possible to double the cpu efficiency by using the 4511. The 4511 is contained on three pc boards that can be installed in minutes on the mini's Fastbus, it's claimed. The buffer has 512 words of available storage. An 8K word system with buffer sells for $11,810. The 4511 is in production and scheduled for delivery in less than 60 days. FABRI-TEK INC., Minneapolis, Minn.

FOR DATA CIRCLE 226 ON READER CARD

PDP-8/e Remote Front Panel

DEC's PDP-8 minicomputer is used in applications where a front panel isn't really required most of the time, thus a customer can save some bucks. For the occasional situation when someone would want to know what was running around inside the mini, this manufacturer has developed a calculator-like device that can be used to display various contents, such as current memory address, register contents, etc. An added bonus of the RFP-80 is that the user doesn't have to mentally convert binary information to octal and back to binary in order to enter or read data. The package includes a plug-in interface circuit board, a 10-foot interconnecting cable and plexiglass front panel cover. The RFP-80 can be used with a mini that has the front panel in place, and any number of remote panels can be attached to the mini. The price is $700, with delivery from stock. DOUGLAS ELECTRONICS, INC., San Leandro, Calif.

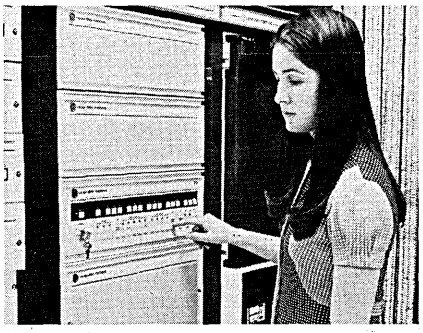
FOR DATA CIRCLE 225 ON READER CARD

Minicomputer

A lot of companies are trying to get out of the ailing oem minicomputer business, but Varian is trying to get

hardware

more deeply into it with its V-71 mini. A 32K 16-bit system sells for only $8K in oem quantities of 12. A basic system includes 16K words of 1.2 usec memory, I/O bus with direct memory access, power supply, and programmer console. Options include a writable control store, power fail/restart, teletype controller, automatic bootstrap



loader for tty's and a real-time clock. First deliveries are scheduled for March. VARIAN DATA MACHINES, Irvine, Calif.

FOR DATA CIRCLE 228 ON READER CARD

Oem Matrix Printer

The 9316 matrix printer may not be the most attractive looking model on the market, but the price of $2,350 for a unit that runs at 173 cps can quickly make looks relatively unimportant. A full-line buffer permits loading up to 132-character codes plus forms advance code, and synchronous printing of asynchronously received data. Each character set, 64 standard, with 96 and 128 optional, is contained on a ROM chip, allowing users to change sets by simply unplugging and replacing the existing chip. The standard printer also includes a self-contained test print exercise, and can accommodate a standard typewriter ribbon that can be used in place of a standard printer ribbon. Up to four copies, plus the original, can be printed with the 9316. The printer is designed for both the U.S. and international markets, with the 173 cps operation at 60 Hz jumping to 180 cps on 50 Hz current. First units are scheduled to come off the assembly line in February. CONTROL DATA CORP., Minneapolis, Minn.

FOR DATA CIRCLE 229 ON READER CARD

Remote Terminal

The DCT 475 is a tty-compatible unit that offers low-speed users a number of advantages. The new terminal operates in half- and full-duplex modes, printing a full 63 character ASCII set across 132 columns at 10 cps. The 475 may be leased for $80/month, including maintenance on a one-year lease, or $67/month on a five-year plan. It sells for $2,592. First units are just now going to the field. SPERRY UNIVAC, Blue Bell, Pa.

FOR DATA CIRCLE 230 ON READER CARD

Small Biz System Printer

An attractive 45 cps serial printer has been added to this manufacturer's list of options for its proprietary small business system. The 4301 is offered in two distinct versions: as a printing terminal, complete with keyboard for generation of up to 12 copies of output, or as a hard copy device for the crt console on the small business system, sans keyboard. In the latter function, two printers can be attached to the video terminals. The terminal version of the printer is priced at $5,950, and the auxiliary character printer, dubbed the model 4341, is priced at $5,650. QUANTEL CORP., Hayward, Calif.

FOR DATA CIRCLE 227 ON READER CARD □

the centronics phenomenon:

a printer that makes large-letter labels, bar codes—and regular printouts, too.

Now you can automate and centralize all the paperwork in your warehouse/distribution system. The new Centronics Model 101S printer can fill the page with a single letter, produce 132 10-point characters to a line—or anything in between.

Five Copies. Because it's an impact printer, the 101S can make up to five copies at a time—gummed for labels if you wish. Now, highly visible labels can be made neatly, rapidly.

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At 165 cps (for 10-point type), the 101S can be incorporated in many existing data processing systems. Simple software routine. It's unsurpassed for easy readability. Total versatility. And unmatched reliability.

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ITEM	QTY.	DESCRIPTION	WGT.
1	2	101S PRINTER W/SEG. CHAR. SET, 10 LPI PARALLEL INTERFACE, AUTO. MOTOR CONTROL	180 #
2	1	PAPER RECEIVING TRAY	5 #
3	1	101 PRINTER STAND	45 #
		TOTAL WGT	230 #

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HUDSON N. H. 03051
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SOMEWHERE
U. S. A. 01234

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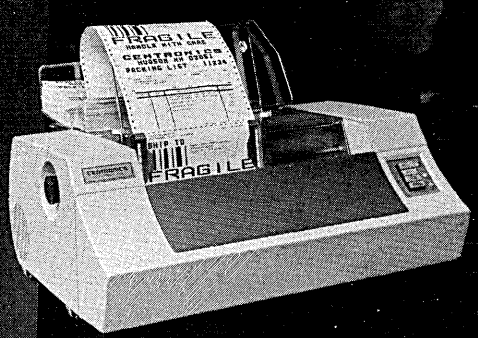
HANDLE WITH CARE



Everything on printout produced by 101S printer.

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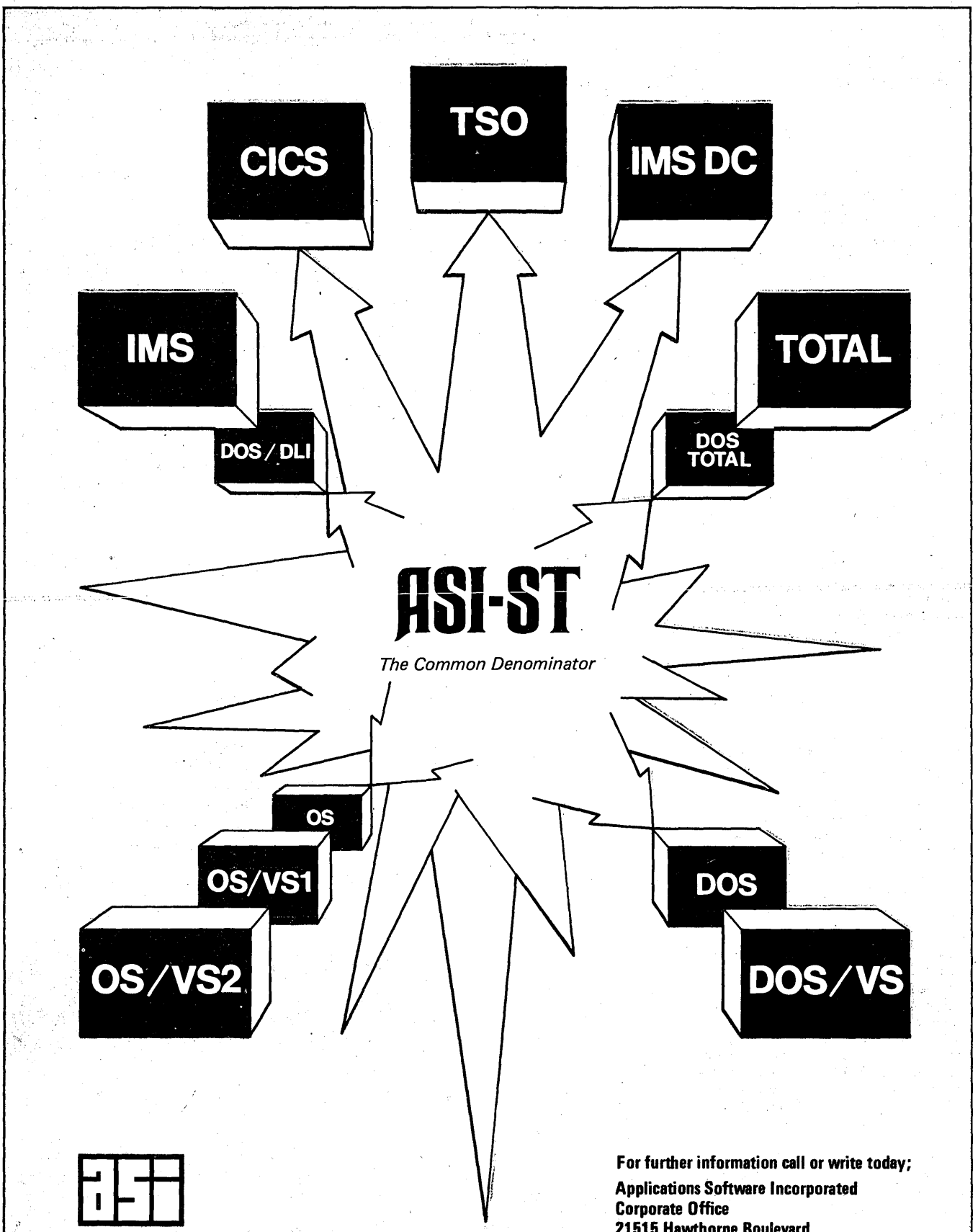
CIRCLE 75 ON READER CARD



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software & services

Updates

Caesars Palace, an opulent hotel along the famed Las Vegas strip, has gone into the software business through a division called CWI Software Services. The first offering for the hotel and motel industries is a system for reservations, check-in, check-out, and accounting called INN-TACT for facilities with 150 or more rooms.

SIMSCRIPT, the simulation and programming language, lives on. The U.S. Army has just signed up to acquire the decade-old language from C.A.C.I., the Los Angeles-based caretakers of the language. Version II.5 will be generated for the Army's Concepts Analysis Agency and its Univac 1108/1110 series computers. On a similar note, the Air Force has just completed evaluation tests on the latest version of Jovial, generated under a $400K contract to Computer Sciences Corp. Among the advantages claimed for the new Jovial are 60% better memory utilization, and a 300% improvement in run times.

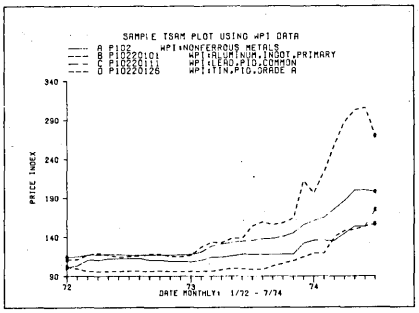
Programmers involved with voice and telex national, international and transit switching exchanges are invited to participate in the forming of a "switching exchange programmers" association. Additional information can be obtained from Mr. D. Lenz, 2535 NW 105 Lane, Fort Lauderdale, Fla. 33313 in the U.S., or Mr. K.R. Burman, 7910 Cote St. Luc., Apt. 510, Montreal, H4W 1R2, Quebec, Canada.

The MAXNET network operating systems just announced by Modular Computer Systems (Fort Lauderdale, Fla.) has already been responsible for a fat order from a major oil company. The standardized off-the-shelf operating systems link multiple cpu-centered systems together, and the company thinks it's an augur of the wave of the future in which measurement and control applications are blended into data communications.

Nippon Univac Kaisha, Ltd. and the Aoki Construction Company, Ltd. of Osaka, Japan have jointly developed a software package that calculates skyscraper shadow patterns in order to guarantee occupants of smaller buildings the "right to light" and help with city planning.

Wholesale Price Service

Wholesale price data on over 2,500 major U.S. products and commodities dating back (in most cases) to 1958 is now available on this vendor's nationwide time-sharing service. Prices are available for products and commodities such as chemicals, metals, lumber, textiles, machinery, rubber, transportation equipment, food, and agriculture. Virtually any type of I/O terminal is accommodated at rates of 100 or 300 baud, but crt terminals are initially proving the most popular, as a module called TSAM formats the output in graphic form. Hard copies can then be made of the desired information, or



the output can be directed to most common types of plotters, including Calcomp, Zeta Research, Houston Instruments, etc. For users not having access to a hard copy device, the vendor will do the plotting and mail the results.

There is a $25 front-end fee to access the Wholesale Price Index (WPI) file. Connect time is charged at $10/hour for cps terminals; $15/hour for 30 cps units. Cpu and disc storage billing algorithms typically get complicated, but a spokesman says that usage runs approximately $20/hour for the service. CYPHERNETICS CORP., Ann Arbor, Mich.

FOR DATA CIRCLE 209 ON READER CARD

Hierarchical Systems

Imagine the manufacturing facility of the future, complete with scores of minicomputers controlling critical processes and all under the control of a central, relatively large-scale mainframe, and you have a good idea of what IBM's Distributed Intelligence System control program is all about. The minis in this case are the sensor-based System/7s. Up to 64 of them can be attached to control units on 370 models from the 135 through the 168, and additional control units can be added, if ever required.

Operating under the new program, applications at the host can be activated by a satellite, while S/7 programs can be initiated either by the 370 or by any satellite processor. Data from any computer can be transferred to any application program through a control adapter ($130/month) attached to the System/7 at rates up to 277,777 bytes per second at distances up to one mile. The control unit on the host computer rents for $875/month.

IBM has considerable experience using configurations such as this in its own manufacturing operations, and it can reasonably be assumed that the software is fairly proven. Application programs can be written in PL/1 and FORTRAN on the host 370, and FORTRAN and APG/7 for the System/7. The control program is bundled: it comes free when you order the necessary support hardware. First shipments are scheduled for February. IBM CORP., White Plains, N.Y.

FOR DATA CIRCLE 210 ON READER CARD

PDP-11 Cobol

DEC has finally announced a COBOL compiler for the PDP-11 that will better equip the mini for business application usage. It's big—a full 48K minimum system is required—but on the other hand, the compiler seems to have a good number of 1974 ANSI bells and whistles: accept and display features; inspect, string, and unstring verbs; relative and sequential I/O modules; nested conditionals, a library function, and conditional variables at Data Division Level 88. Several features not found in Standard COBOL are also present, and one of them allows the user to enter free-form statements at a terminal and let the compiler take care of formatting them. The compiler works in conjunction with Digital's RSX-11D operating system. The price is $7K, including one year of "full" field service support. DIGITAL EQUIPMENT CORP., Maynard, Mass.

FOR DATA CIRCLE 211 ON READER CARD

IBM OS Enhancement

Easy Reader allows each user of an os/360 system to generate his or her

software & services

own procedure library for cataloging and executing JCL. In operation, the insertion of one procedure library (PROCLIB DD) statement into a job concatenates the system library (SYSL.PROCLIB) to the user procedure library and permits the use of procedures from the private PROCLIB. If no user PROCLIB statement is present, Easy Reader defaults to the system library.

What this does, in effect, is make it possible for distributed areas in a company, such as manufacturing, accounting, et al, to maintain more local control over their particular jobstreams, without having to negotiate the changes with the central computer site.

Easy Reader is priced at $1K and is said to require only one hour of programmer time and 15 minutes of machine time to install. SUBSYSTEMS, Sunnyvale, Calif.

FOR DATA CIRCLE 212 ON READER CARD

Network Design

AT&T's implementation of the "hi-lo" voice grade line tariff is the subject of

software spotlight

Jobstream Production Control System

An automated job set-up and production control system developed by one of the more sophisticated computer users in the nation is now available to other relatively large-scale IBM installations. SHOW is an on-line interactive terminal-oriented system that is used to insure that production jobs are properly prepared for submittal to 360 and 370 mainframes. Perhaps its principal advantage is that it obviates the need to handle manual JCL (Job Control Language) decks, and all attendant changes required for daily production.

At Fireman's Fund, even the eam area is on-line to the host 370. When the eam work for a production job is completed, the operator obtains a SHOW menu on a crt in the eam area. The operator selects which operations are required—anything from simple inputting to more complex operations —and the input is then posted with SHOW. The system edits and syntax-checks the JCL; JCL errors are returned to the terminal for correction; and the job is submitted to a "hold" queue. At this time, a set-up sheet is generated that lists which tapes are required. This information can be guided to a terminal in the tape library. Tapes are pulled before the JCL is released to the system. When the staging, or scheduling officer establishes that all input is in and that the job is cleared to be run, the proper SHOW option is selected and the job is released to OS or HASP for execution. Disc space monitoring, catalog, and data set maintenance and other housekeeping tasks are also handled by SHOW.

SHOW operates under MVT or release 1.6 of VS2 on IBM 360 or 370 hardware. It supports 2260 or 3270 crt displays, and 1053, 3286, 1443, 1403, and 3211 hardcopy devices for auto-

```
T=02          • • • •  SHOW SERVICE MENU 1  • • • •
                    OCT 30, 1973 (73,303)

1. SET UP JOBS FOR PROCESSING          7. DISPLAY HASP QUEUES
2. INITIATE CARD TO TAPE OR DISK       8. DISPLAY TRANSMISSION LOGS
3. CATALOG MAINTENANCE                 9. DISPLAY DISKS
4. DATASET MAINTENANCE                 10. INITIATE RPG SERVICES
5. INTERFACE TO TMS                    11. SCROLL SERVICES
6. DISPLAY ACTIVE JOBS                 12. SELECT NEXT SERVICE MENU

)------ SELECT OPTION NUMBER
```

FIGURE 1. Non-programmer production control personnel use CRT display "menus" such as this one to choose SHOW options.

matic set-up sheet preparation. The memory requirement varies with the number of terminals implemented, but the installation at Fireman's requires 192K for supporting 10 terminals in the data preparation areas.

SHOW is priced at $10K. The user gets the BAL source code and all updates free, and there is a 30-day trial period. The documentation, consisting of an installation guide, macro manual (so users can write their own routines), and a user guide, is said to be in "good order." FIREMAN'S FUND INSURANCE CO., San Francisco, Calif.

FOR DATA CIRCLE 213 ON READER CARD

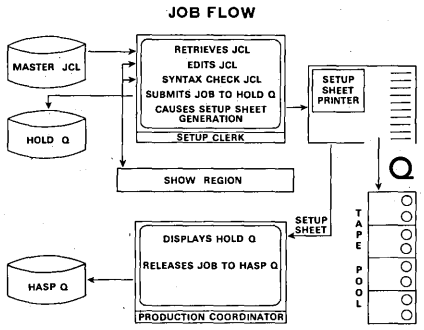


FIGURE 2. This system flow diagram for SHOW reflects the use of queues in controlling production jobs. The setup clerk handles the job through JCL preparation and automatic setup sheet printing, while the production coordinator may use SHOW in guiding the job into the system.

this service, called ARIES. Operating on customer-supplied data describing the current phone line network ARIES generates reports that show whether a point-to-point or multi-point leased line network would be more economical. The printouts are in 8½ x 11-inch format for convenient customer storage.

ARIES, which has been running inside GTE Information Systems since April (hence its name) is already credited with achieving significant cost reductions on the firm's world-wide brokerage network, and it's thought that the "hi-lo" tariff probably affects approximately 19,000 interstate voice grade private line customers. The service is run on Scientific Time Sharing Company's nationwide time-sharing network. The charge is $1.10 per cpu second, plus $24 or $30 per terminal-connect hour, depending on whether it is a 15 or 30 cps terminal, respectively, plus $20 per megabyte per day of disc storage. GTE also provides in-house seminars for users expecting to make extensive use of ARIES, GTE INFORMATION SYSTEMS, Mt. Laurel, N.J.

FOR DATA CIRCLE 231 ON READER CARD

In-house Time-sharing

This new service company has contracted with a number of software development and time-sharing firms to offer packages currently running on time-sharing services for in-house use. Initially, the DEC PDP-10 is the marketing focus, but the vendor is already eyeing the IBM TSO environment. One inherent advantage for users in this approach is that the packages can be tried out immediately by contacting the service bureau offering them to see if they are what the user wants. If they aren't, separate contracts can be initiated to modify the packages to particular user needs.

Contained in the initial offering are packages for data base management (IMARS) priced at $20K, financial planning and reporting systems, ($24K and $15K respectively), the RAID program debugging and utility library, a $10K statistical analysis package and numerous engineering applications that include optical analysis, PERT, and circuit design, among others. SOFCO, INC., Wakefield, Mass.

FOR DATA CIRCLE 208 ON READER CARD □

Sighed a robot, "I had to be nice
and live a life pure and precise,
so I'm asking in prayers
to be taken downstairs
when I break—and be programmed for vice."

—Gloria Maxson

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A good player makes the puck move pretty fast. He can predict its path because half of his brain does parallel processing (researchers say) while the other half operates in serial fashion, analyzing the other players' actions. The interaction of the two produces goals.

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letters

puter assisted proof-reading potential as discussed on page 149 of your October issue. Well, based on the letters received, statistically how many people read the article, and did you receive anticipated reaction?

LONNIE HAKALA
Director, Computer Technology
Department of Finance and Administration
State of Tennessee
Nashville, Tennessee

"Mistrakes" was indeed a test case to see how many people would notice and comment on a mispelled word. Since you were the only one who wrote, DATAMATION has decided not to investigate Bell's computerized proofreading program to minimize typographical mistrakes—which was the story's subject.

Unfair to Ma Bell?

Mr. Ritchie's article, "Evaluating Modems" (Oct., p. 48), is a valuable contribution to the art of benchmarking data facilities. Los Angeles County is fortunate in being able to perform these studies. There were a few points in the article which did, however, disturb me.

Ritchie makes the statement that one vendor makes "an exact functional copy . . . of the Bell 201B3." One must assume that either the copy was so exact that even the same transistor characteristics were present, as well as such details as layout, shielding, resistor tolerances, etc.; or else that the copy simply used the same nominal characteristics. In either event, there is many a slip 'twixt the schematic and the product. Has Mr. Ritchie or any of the editors ever attempted to build, for example, an FM tuner, knowing only the "schematics"?

If the benchmark was indeed a representative one, I wonder who was being protected by the anonymity of the manufacturers tested—it clearly was not Bell. Certainly several of the vendors know who they—and the others —are; Los Angeles County knows, and it is presumably easy enough for one to see which modems are installed in any location.

I wish the study would have given us a chance to see how bad—or good—each vendor was by name—including WECO's product. We all would have benefited thereby.

BRUCE HYMAN
Bell Laboratories
Piscataway, New Jersey

Still in Dark Ages

It seems a shame that in 1974, the very advanced languages are still using mnemonics such as ·EQ·, ·NE·, ·LE·, etc., when symbols such as $=$, $\neq$, $<$, $>$, $\leq$, $\geq$ (to name a few), have been in our mathematical notation since the year 1. Words like BEGIN and END could easily be replaced by left and right braces, and awkward notations such as (\$ and \$) could be replaced by left and right brackets respectively. The major printer manufacturers have these symbols on their print trains, bars, or drums, and they are also available on keypunches!

Why then are we still in the dark ages? Just think of the wasted time (precious at \$1000+/hour rates) used to translate those mnemonics. The readability of the programs with the ·LE·, etc., is difficult at best. At least we should be given the option of saying If A $\leq$ B rather than If A ·LE· B. Isn't it time for the compiler developers to start considering the programmers and to stop developing languages for their own satisfaction?

KENNETH R. WANDER
Evaluation Laboratory Computer Center
Applied Physics Laboratory
Johns Hopkins University
Silver Spring, Maryland

More on data bases

As a user of Intercomm (the GTE/IS—Programming Methods) teleprocessing monitor, I felt that the article, "A Brief History of Data Base Management" by Robert L. Flynn was slightly erroneous regarding the latest state of the art. Mr. Flynn said that "the single major problem left unsolved at our current technological level" was the "tremendous burden of complexity placed upon the applications programmer." He went on to enumerate these complex requirements.

Actually, most of these complexities have been overcome by Intercomm. An applications programmer using this monitor does not have to recognize the physical terminal network nor code in low level languages. Terminal dependent characteristics are transparent to applications programmers, and terminals are easily switched. The Intercomm package provides support for both reentrant and nonreentrant COBOL, as well as FORTRAN and PL/1.

Coding of reentrant programs to run under Intercomm is as easy as coding a normal batch program since the service routines establish and maintain all reentrancy criteria. Transaction context is maintained by another service routine called "Converse," available to

letters

reentrant and nonreentrant programs alike.

CHARLES C. GRAHAM
Senior Technical Analyst
Potomac Electric Power Company
Washington, D. C.

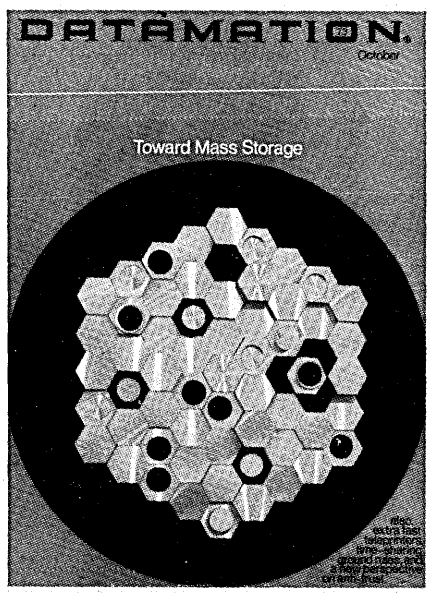
Data base update

Comments received following publication of "Directions in Data Base Management Technology" (Sept. p. 48) pointed up my failure to mention the successful CODASYL implementation of DBMS-10 on the DECsystem 10. This software was developed by Rapidata Inc. of Fairfield, N.J.

RICHARD F. SCHUBERT
Director of MIS-Technical Support
The B. F. Goodrich Company
Akron, Ohio

Foresight or deja vu?

After IBM's announcement of its 3850 mass storage system, the extraordinary foresight of the artist, Max Finkelstein, for the DATAMATION cover of October,



1973, with the title "Toward Mass Storage" simply must be noted as the remarkable apparent coincidence that it is!

In any case, please congratulate the artist in this very unusual instance of déjà vu.

FRANK H. WESTERVELT
Director, Computing and Data Processing Center
Wayne State University
Detroit, Michigan

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COMPCON will feature sessions and numerous papers on: how software can be made reliable; languages, program construction and the like in the human interface; software for microprocessors, plus a stimulating panel session on micros and the software revolution; there will be two fact-filled sessions on software engineering, including the latest in dynamic memory storage, compilers, extensible text editors, queueing network models and program languages; plus we're going to look at data bases (info to the people) and, finally, power to the people — how computers are being used at the grass roots. Hardware sessions will cover the wide gamut of computer games, architecture, pipelined structures, microprocessor design (with another first-level panel on design tradeoffs), I/O devices, hardware for consumer electronics and a complete look at mini and micro-based systems. There's more, too. Applications session will probe computer technology in the fields of retailing, banking, transportation, publishing, health, education, security and privacy. You can't afford to miss this important conference.

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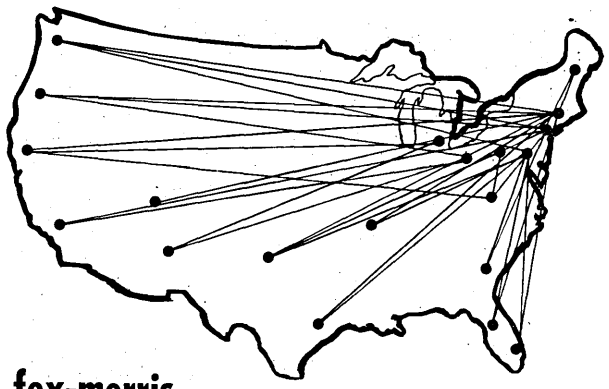

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This forum is offered for readers who want to express their opinion on any aspect of information processing. Your contributions are invited.

the forum

EVALUATING PERFORMANCE EVALUATION

In the early 1960's, dp managers were concerned with balancing channel and device utilization. Today we are using sophisticated hardware and software to measure everything from cycles per region to distribution of data per pack. Our concern with the measurement of devices has, unfortunately, masked the objectives these devices were installed to perform. I propose that, under the guise of "performance evaluation," we are "taken" with the machine and how it is performing, while ignoring what the machine was installed to do! This state of affairs can be attributed in part to the complexity of today's systems and to the departmentalization of the dp function. What we should be doing when evaluating performance is to relate that evaluation to the overall objectives of the organization. Reducing computer costs is not the only, nor the main, objective!

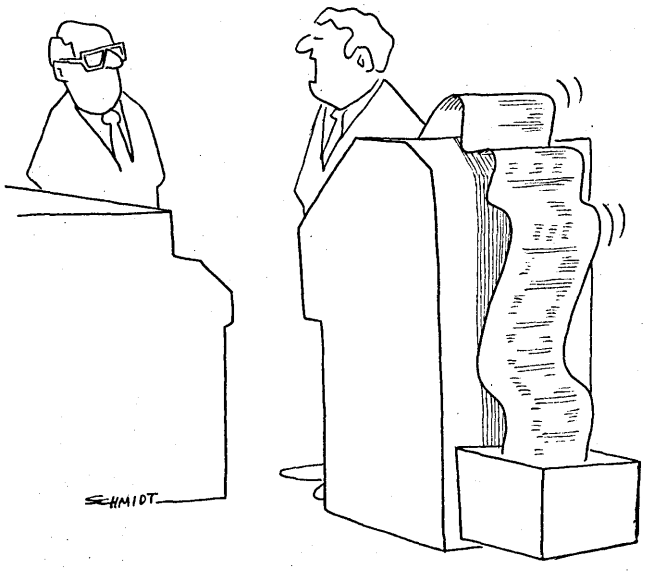
If bottom line profit, service, growth, or other stated goals are defined, the performance evaluator's function is to measure the contribution to these goals by the dp department, and to design tests to that end. It is just this view from the *outside* or from the *top down* which many of us miss, and which I believe is critical. Measurement is meaningless unless we first establish what it is we are looking for, and why.

With the maturing of data processing, traditional performance evaluations should now take the form of an industrial engineering task. The concept of the computer as an information factory indeed leads to this conclusion. The approach would consist of a hierarchy of assignments involving flow analysis, modeling, and finally, measurement. To be studied are the work flow throughout the data center, and possible standards to be set. Some results may be a change in the sequence of process steps, or a combining of department functions. Simulation and modeling would test balances of work load on the overall system, and provide a rational basis for alternative strategies of operation. Finally, measurement monitors and software tools would attempt to identify bottlenecks within individual programs, or in pieces of hardware.

A classic example

At the highest level, the evaluator must analyze how the information flow fits into the normal business cycle. Why optimize response time, for example, when information is needed only "within 24 hours"? In one installation I recently visited, close to $1 million was spent developing a new system to process orders in 8 hours using on-line order entry and warehouse output stations. This system replaced a batch-oriented system with 24-hour turnaround. Once in operation, the systems manager wanted to justify spending even more funds to improve response time. It was discovered, however, that the cycle time from point of sale to receipt of goods shipped was two weeks, and that the order processing had never taken more than two days of the two week period to begin with. In attempting to reduce order entry turnaround, they had been optimizing the wrong part of the business system, and in fact, were able to relax both response and turnaround times for this application.

We often point to the hardware as the bottleneck in the information system. Analysis of a data center may, however, reveal an inordinate amount of time spent in data preparation, control, checking, and rerun. How much better it would be if the solution to an overloaded facility involved, rather than upgrading the cpu, automatic data preparation at the source, elimination of extensive data checking routines, or elimination of unused reports. In large computer centers, work flow studies may reveal alternative procedures which could save every bit as much as the elimination of a core module.



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"Before we got this high speed printer it took us a full day just to run the useless reports."

A better technique

At the modeling level, we are just beginning to apply industrial engineering techniques such as simulation to equipment selection and evaluation. Mobil Oil, Conga Systems, and CBS management are using this approach to define optimum systems. Once the model has been established, variables such as cpu cycles, core, channel devices, line speeds, and job mix can be studied in relation to criteria which take into account response time, throughput, reliability, room for growth, and cost. At one major publishing house, an on-line system was modeled using the GPSS language. Management defined the performance objectives in line with their business goals in number of orders to be

the forum

processed (sales), customer inquiries for information (service), and reports for shipping and invoicing. Using this data, a system was designed and modeled having approximately three-second response time on batch processing of bills and reports at 30 order entry stations. Line speeds, terminals per line, core requirements, and files were budgeted. Using the simulation model, they were able to test the sensitivity of the system to different module design, message lengths, line speeds, etc. In fact, by using the model, the designer radically changed the location of I/O functions within the program, combined inquiry and update functions, and determined which of four other on-line systems could run alongside order entry in the cpu. The latter finding resulted in an ability to "piggyback" two applications on the same lines and provided backup within the company without degrading service to either application. After completion of the development effort, extensive measurements were made to determine how close to the objectives the programmers had come. Where they exceeded the budgeted core or cycles, reprogramming was initiated to bring the system back into line. Only then did the traditional method of measuring individual hardware component utilization, as well as switching devices to affect a "least cost," take place.

When organizing a performance evaluation effort, a few basic rules should be followed. The group must be independent of those charged with the development and operation of the systems, and should report to the lowest common level of management. This is analogous to the position of an industrial engineer in a manufacturing facility. In a large data center a "measurement and evaluation" group would logically report to the director of the center. When several divisions use the facility, each division should have a similar position reporting to the director of MIS. For a particular application, a team effort will be required during the evaluation process. In a smaller company having centralized systems development and operations, the performance evaluation function reports directly to the v.p. of MIS.

Finding people with the proper skills to man a performance evaluation group presents a further problem. If the group is to perform all of the functions described above, it should contain the following skills inventory:

- Industrial engineering: work measurement and work flow
- Computer science: assembly and high level language, and OS and JCL
- Engineering and mathematics: electrical engineering, statistics, and simulation and modeling

Generally, acquiring a staff with these skills means getting no more than two or three people. In some manufacturing companies, the performance evaluation function is filled by a member of the industrial engineering or operations research department, and a computer science graduate or ex-customer engineer. This type of two-man team can be particularly effective.

We now have at our disposal a raft of measurement tools. Before using them, we must determine what it is we are trying to do. Optimizing cost before we know the effect of cost savings on other parts of the business system, is attacking the problem from the wrong end!

—Paul D. Spindel
Mr. Spindel is a consultant to CBS Corp. He specializes in the design of information systems and technical solutions to management problems.

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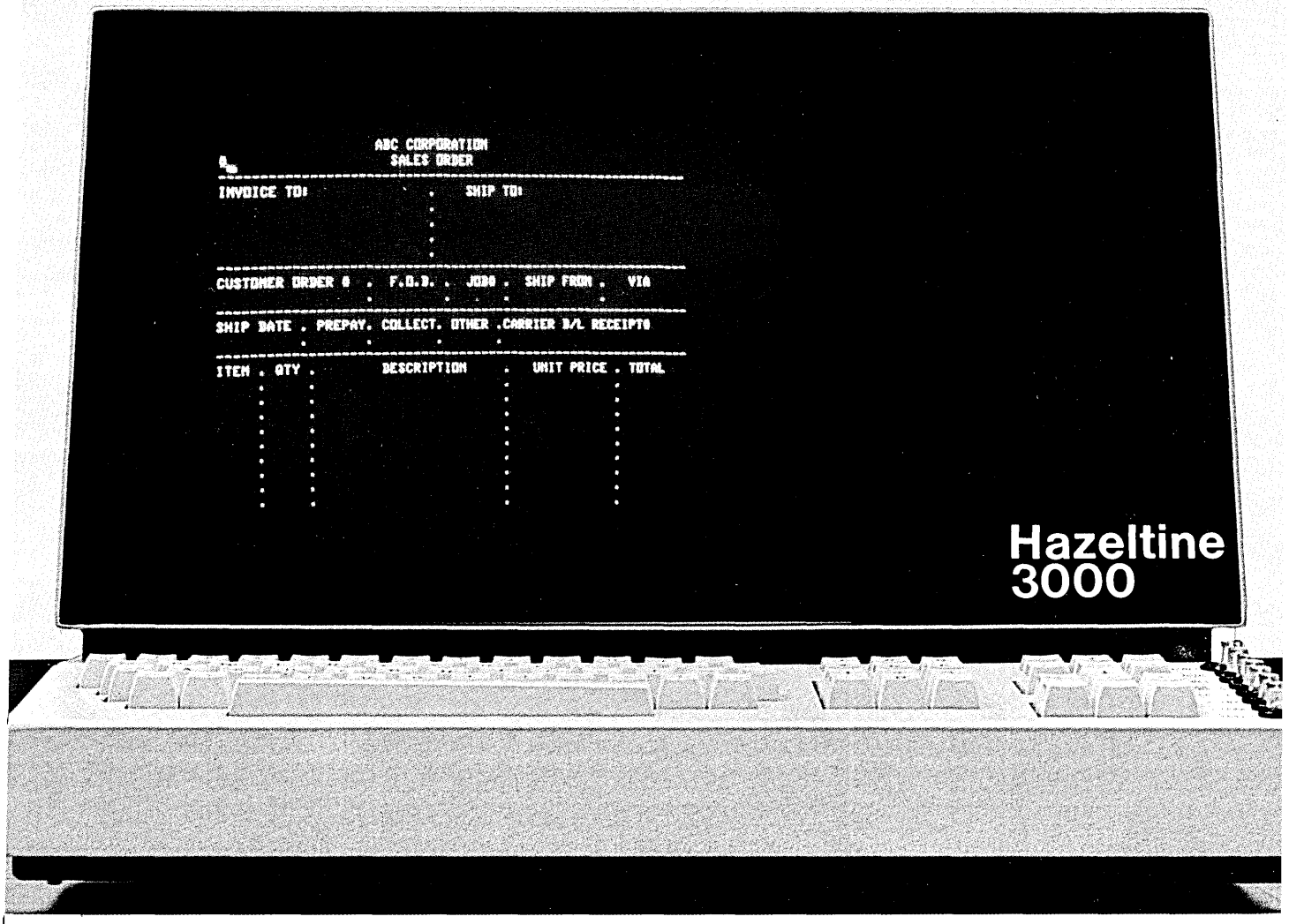

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