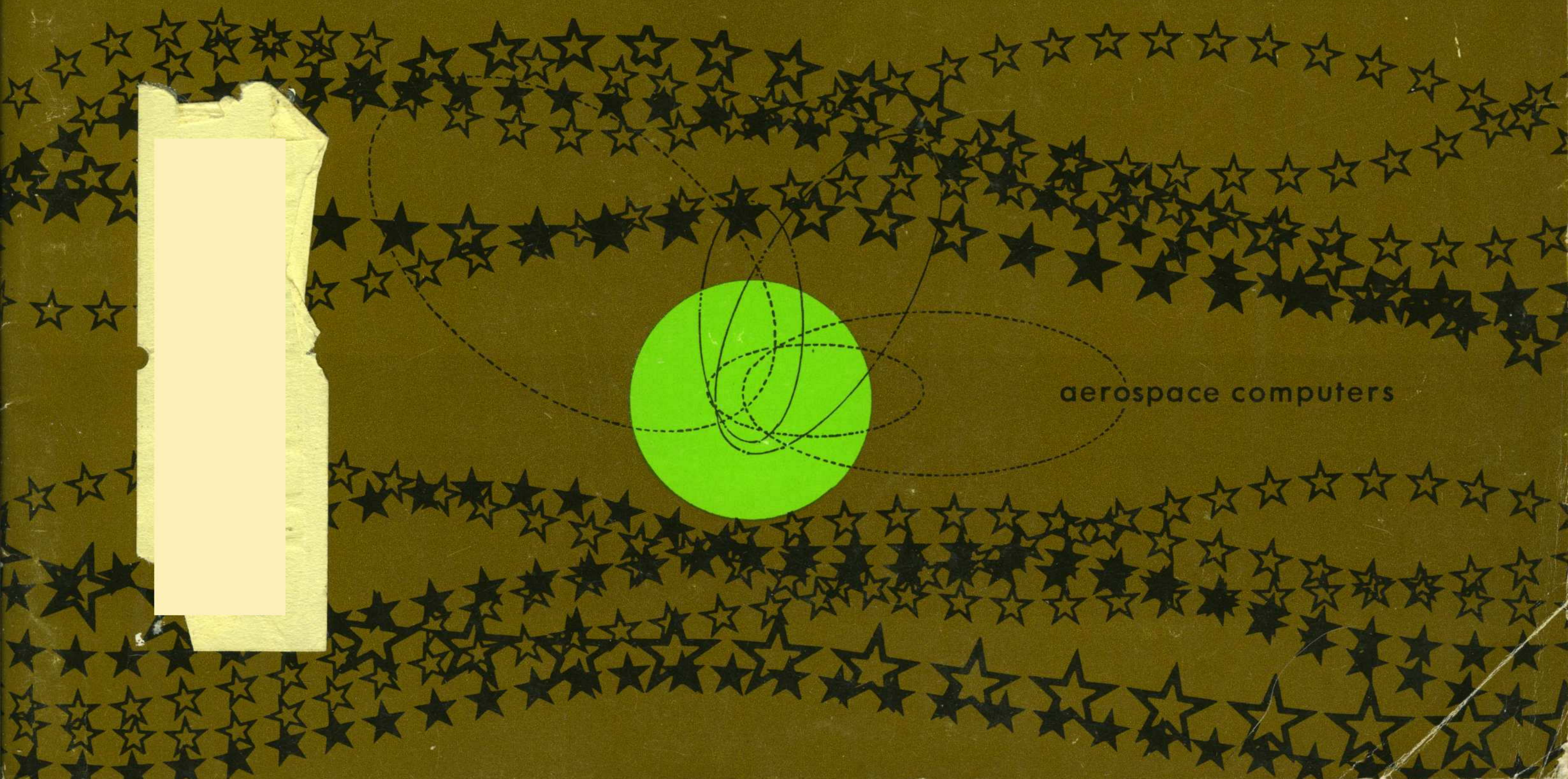
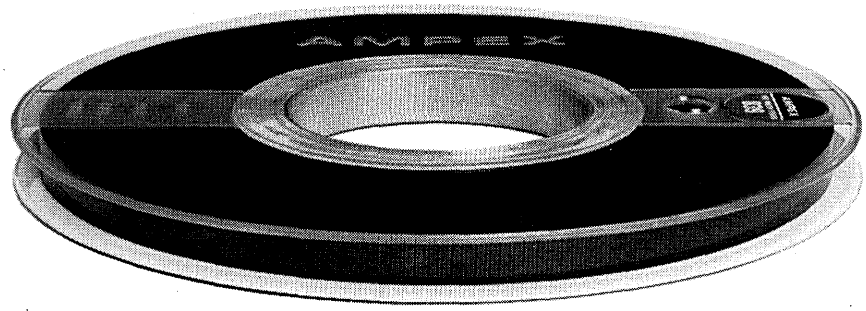
DATAMATION

67

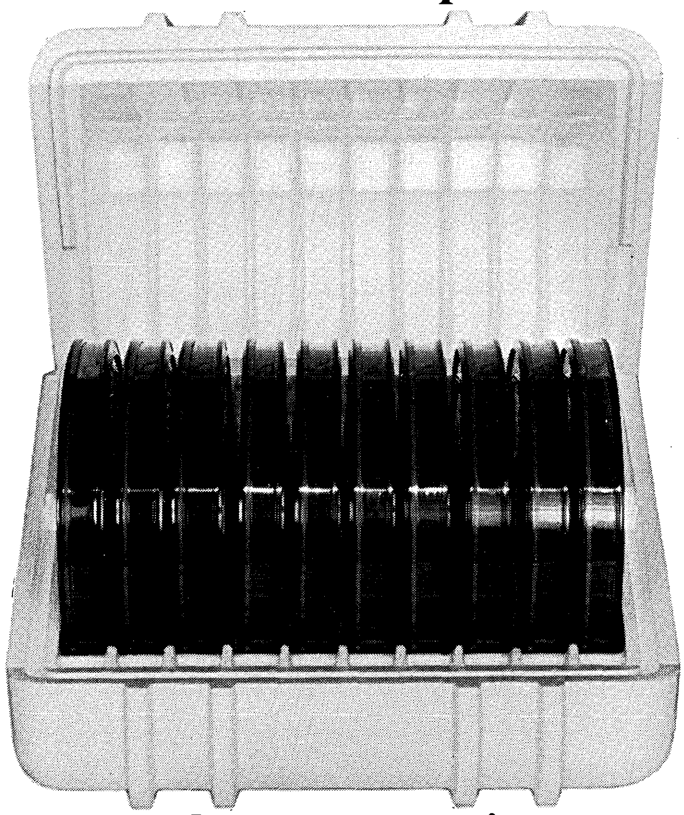
November



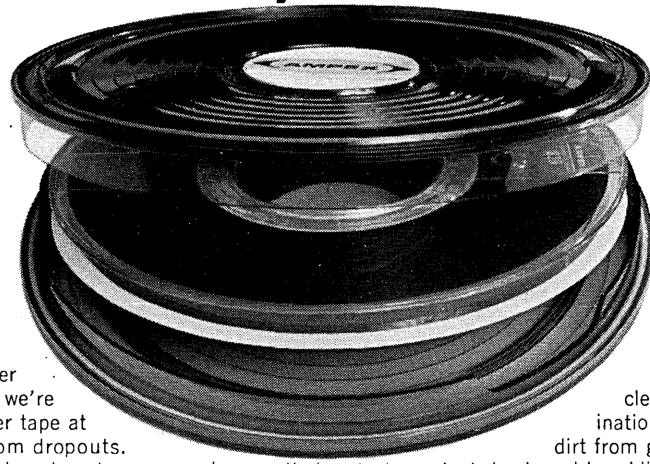
Clean and comfortable



when we ship it



when you store it



Our computer tape is clean and error-free. We think that our superior cleaning process makes it cleaner than anybody else's, but of course we're prejudiced. Point is, to be computer tape at all, it has to be clean and free from dropouts.

But we don't stop at merely making clean tape; we make sure that it gets to you clean and that you can keep it clean. Here's how:

Our exclusive environmental shipper which we call the Tape-Safe keeps dust out and your tape "clean and comfortable." Clean, because the polystyrene foam won't shed like cardboard; comfortable, because it cushions the tape in transit against shock and damaging fluctuations of temperature and humidity. Best of all, it's free with your minimum order of Ampex tape for IBM and IBM-compatible computers.

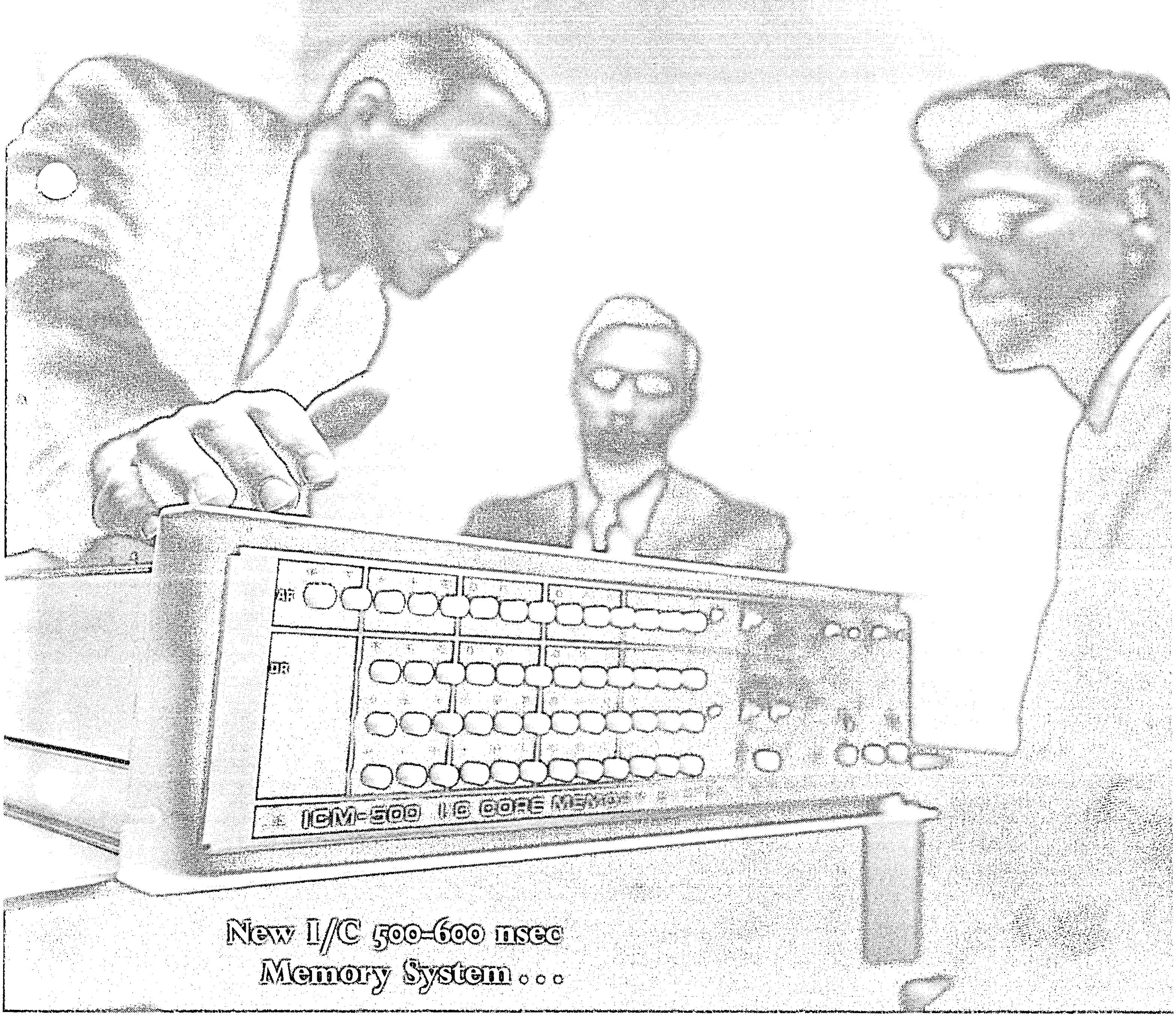
Then, for the only sure protection in storage, we pack our tape in a unique all-plastic canister. It keeps tape clean because it cannot generate contamination and its positive seal prevents outside dirt from getting in; comfortable because it protects against shock and humidity. This canister is even encased in an airtight poly bag during shipment. From then on, it's up to you.

FREE! If you'd like a few suggestions on how to keep tape clean, write Tape-Safe, Ampex Corporation, 401 Broadway, Redwood City, California 94063, for a copy of our TRENDS Bulletin No. 12, "Care and Storage of Computer Tape."

AMPEX

Career opportunities? Write Box D, Redwood City, California 94064.

CIRCLE 1 ON READER CARD



. . . Stores 1/4 million bits in single 5-1/4″ high unit, features MTBF of 12 years under normal 40-hour week operation

Now you can get the new μ-STORE ICM-500 in standard systems: 600 nanoseonds full cycle time Special systems: cycle times as low as 500 nanoseconds. Up to 16,384 words with 54 bits/word; or up to 4096 words with 72 bits/word. (Over 3/4 of a million bits in little more than 15″ of vertical rack space — including power supply). You also get I/C construction for all major functions including X-Y current drivers plus a choice of mechanical packaging.

Get the full story. And take advantage of our eight years' experience in solving core memory problems. Write today for our new brochure. Honeywell, Computer Control Division, Old Connecticut Path, Framingham, Massachusetts 01701.

*Patent applied for.

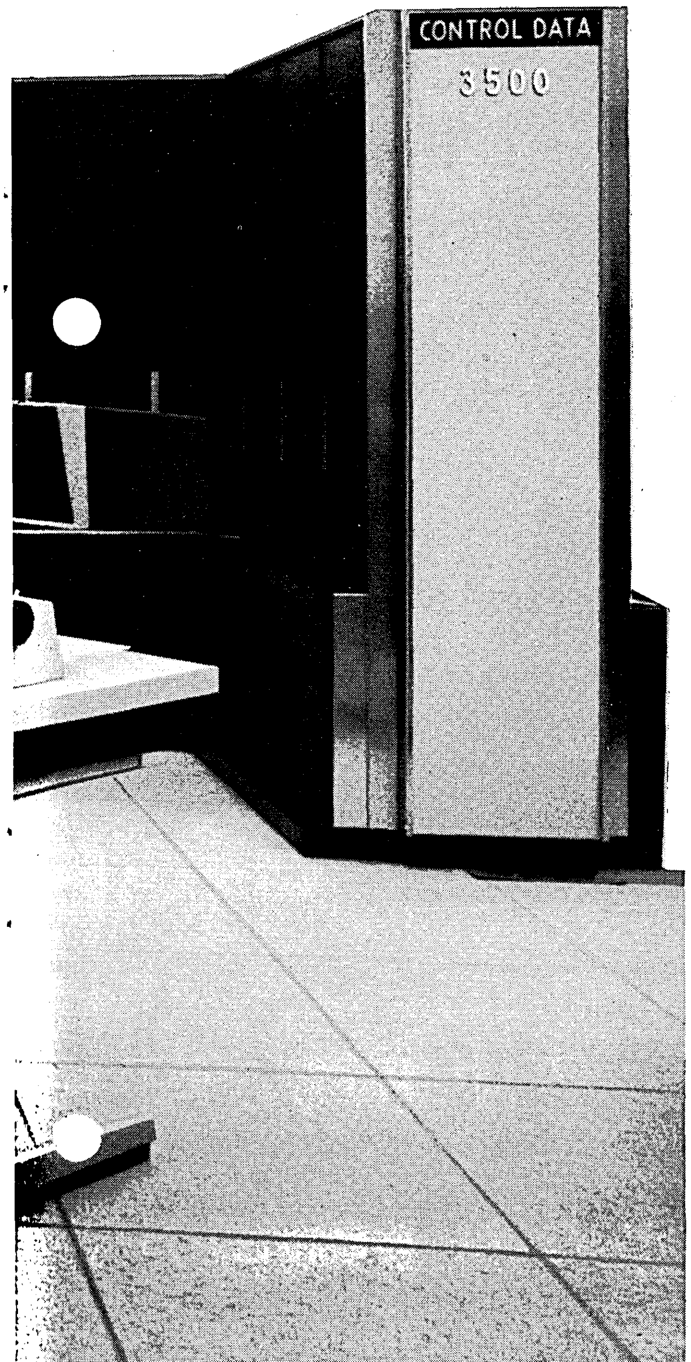
Honeywell

COMPUTER CONTROL DIVISION

CIRCLE 84 ON READER CARD

Really serious about a better information management system?

our new 3500 system is ready, if you are!



If you are looking for better ways to handle information, data communications, production control, scientific and engineering problems, you will want to know more about the new CONTROL DATA® 3500 computer system.

The CDC 3500 is a large-scale, multi-programming system designed for general purpose and time-sharing applications. It is the most advanced computer in our compatible family of systems that includes the 3100, 3150 and 3300 — hundreds of which are on the job throughout the world today. Each offers the advantage of fully computerized, automated information handling.

People-oriented peripherals

Along with the new 3500 computer system, Control Data gives you a wide choice of advanced peripheral products: Remote entry-and-display stations provide direct communication with the computer system. DIGIGRAPHICS® light-pen systems make computer-aided designs a reality. Remote-processing terminals extend the capabilities of the 3500 to remote plants, laboratories, distribution facilities, etc.

All software is available now

Control Data's advanced operating system, known as MASTER (mass-storage oriented, multi-programming operating system), lets you efficiently handle mixed business/scientific work loads in your organization. Your costs are lower because MASTER makes maximum use of all hardware features. Software includes compilers, assemblers and job-oriented systems such as COBOL, MASS STORAGE SORT, FORTRAN, PERT/TIME, PERT/COST, ALGOL and COMPASS. All software is field-proven and available now.

INTEBRID circuitry

Specially developed by Control Data for use in the 3500, INTEBRID® circuitry combines the advantages of both monolithic-integrated and hybrid circuits. The results are higher speed, reduced space requirements and greater reliability.

If you are genuinely interested in a fully computerized information management system for your company, the coupon below will bring complete details.

CONTROL DATA
CORPORATION

CONTROL DATA CORPORATION, DEPT. H-117
8100 34th Ave. So., Minneapolis, Minn. 55440

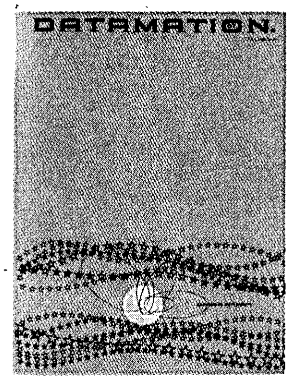
Please furnish us with full details concerning your new CDC 3500.

NAME ______________________ TITLE __________

FIRM ______________________________________

ADDRESS ___________________________________

CITY ______________________ STATE __________ ZIP ___



1967
volume 13 number 11

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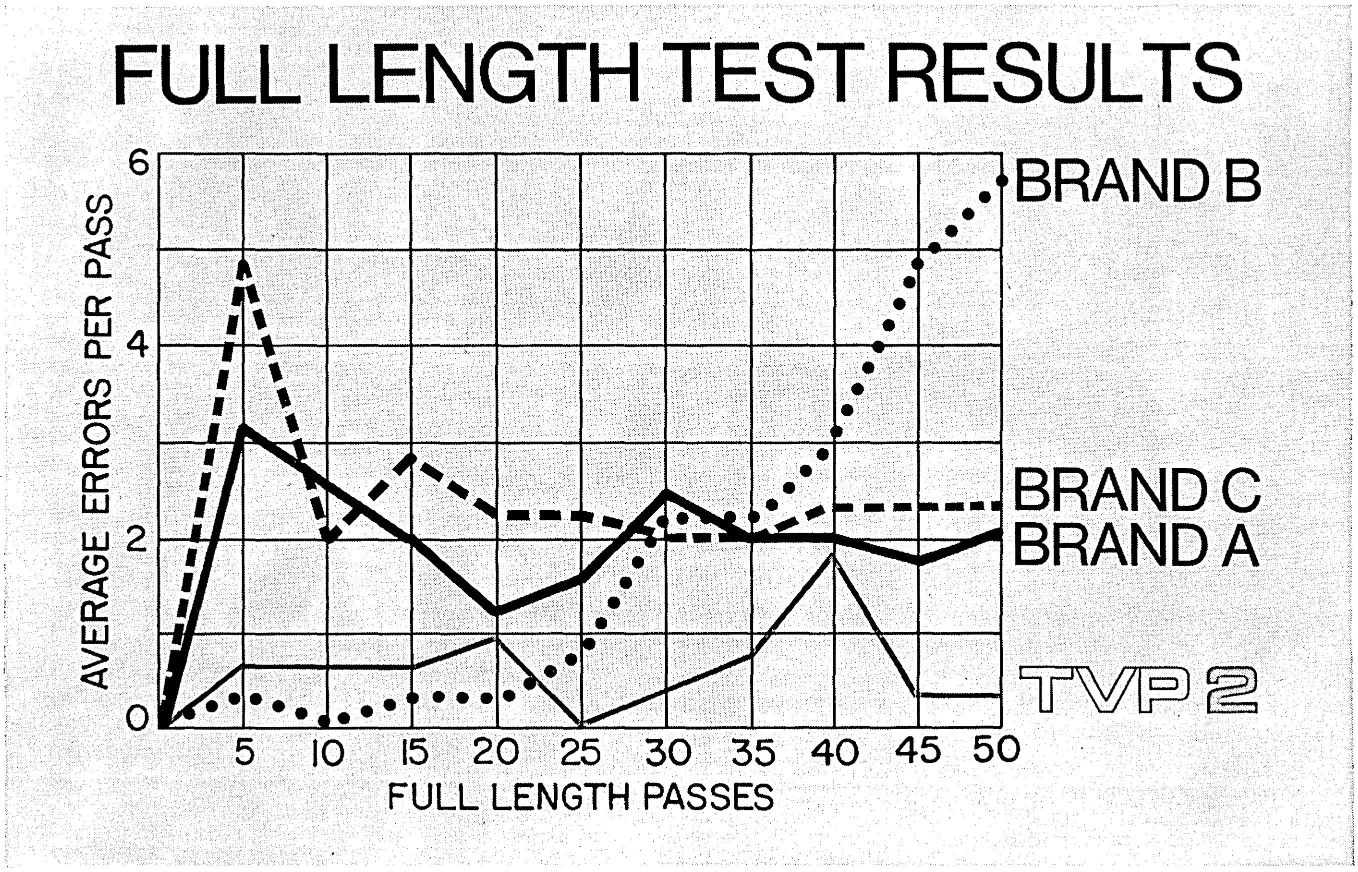


NOW... pick your computer tape

□ The only meaningful way to evaluate computer tape performance and reliability is to test it, over a series of full-length passes, under actual operating conditions.

□ The above graph reflects a recent performance study in which Computron's new TVP2 was compared directly with three leading "premium" tape brands. The curves above illustrate typical test results in terms of total errors (bits below 50% dropout level) for all tracks, during each of 50 passes.

□ Note that Brand C showed a rapid error build-up over the first few passes then leveled off at a relatively high error rate. Similarly, Brand A showed high initial error build-up, which then dropped to a somewhat lower level. Brand B had good initial error characteristics, but exhibited rapid error build-up during the remainder of the test.

□ Only TVP2 demonstrated a consistently low average error rate throughout the test. This is another example of TVP2's Total Value Performance.

□ Consider this the next time you select your computer tape.

TEST PROCEDURE

1. Equipment calibrated and adjusted, according to equipment manufacturer's specifications, and cleaned, prior to testing each reel of tape. (No further cleaning allowed during test).

2. A new unused 2400' length of tape which has been certified at 800 BPI free of permanent errors is used for this test.

3. Write 3000 character (all bits) records in the start-stop mode at a density of 800 BPI.

4. Read while writing checking for all errors, in all tracks, which fall below the 50% dropout level.

5. Count all errors. No retries allowed. Error count includes temporary and permanent.

6. High speed rewind to the beginning of tape and repeat steps three and four until 50 passes (120,000 head feet) are completed.

TVP2

COMPUTRON INC
CROSBY DRIVE, BEDFORD, MASSACHUSETTS 01730
GENERAL ELECTRIC/BASF GROUP

CIRCLE 5 ON READER CARD

DATAMATION®

november 1967

volume 13 number 11

automatic information processing for business industry & science

datamation departments

If your company is listed here, you can get a third-generation computer to process your existing 7044 programs.

American Oil Company
Whiting, Indiana

Atlantic Richfield Company
Los Angeles, California

AVCO Corporation
Lycoming Division
Stratford, Connecticut

Cleveland Trust Company
Cleveland, Ohio

Educational Testing Service
Princeton, New Jersey

General Electric Company
Apollo Support Department
Daytona Beach, Florida

General Electric Company
Ordnance Department
Pittsfield, Massachusetts

General Electric Company
Utica, New York

General Telephone & Electronics
Sylvania Electrical Products
Mountain View, California

Hercules Powder Company
Salt Lake City, Utah

Humble Oil & Refining Company
Bayway Refinery
Linden, New Jersey

Humble Oil & Refining Company
Baytown Refinery
Baytown, Texas

Mobil Research Laboratory
Princeton, New Jersey

Phillips Petroleum Company
Idaho Falls, Idaho

The RAND Corporation
Santa Monica, California

WE JUST OBSOLETED EVERYBODY ELSE'S COMPUTER GRAPHICS.

Our new CRT computer terminal makes all other graphics systems suddenly look like Theda Bara vamping Rudolph Valentino. Nostalgic, maybe, but very, very obsolete. □ The difference is that the Adage Graphics Terminal is a fully-integrated general-purpose system. It has its own internal computer and is delivered complete with operating software for communicating with the remote central computer and for local image control and console I/O. □ Hybrid processing techniques exclusive with Adage (our Ambilog 200 hybrid computer is standard in every terminal) produce dynamic displays of 3-dimensional objects which really move continuously. Pictures are bright and clear. Even complex images don't flicker. □ You can start with the Model 10 Graphics Terminal at $75,000, and get 4K of 30-bit core memory, CRT console, and Dataphone interface to the central computer.□ For around $250,000 the top-of-the-line Model 50 buys you 16K of core, extended arithmetic capability, and disk memory for local storage of image and program libraries. The console has a full complement of operator's controls for image translation, rotation, and scaling. Options include a hard copy display recorder and an analog input tablet. □ Would you like a demonstration? In your office? Write David Sudkin, Manager of Marketing Services, at Adage, Inc., 1079 Commonwealth Avenue, Boston, Mass. 02215, on your company letterhead. We will send you a 16mm demonstration film showing the system in action. □ The movie is on us. You bring the popcorn.

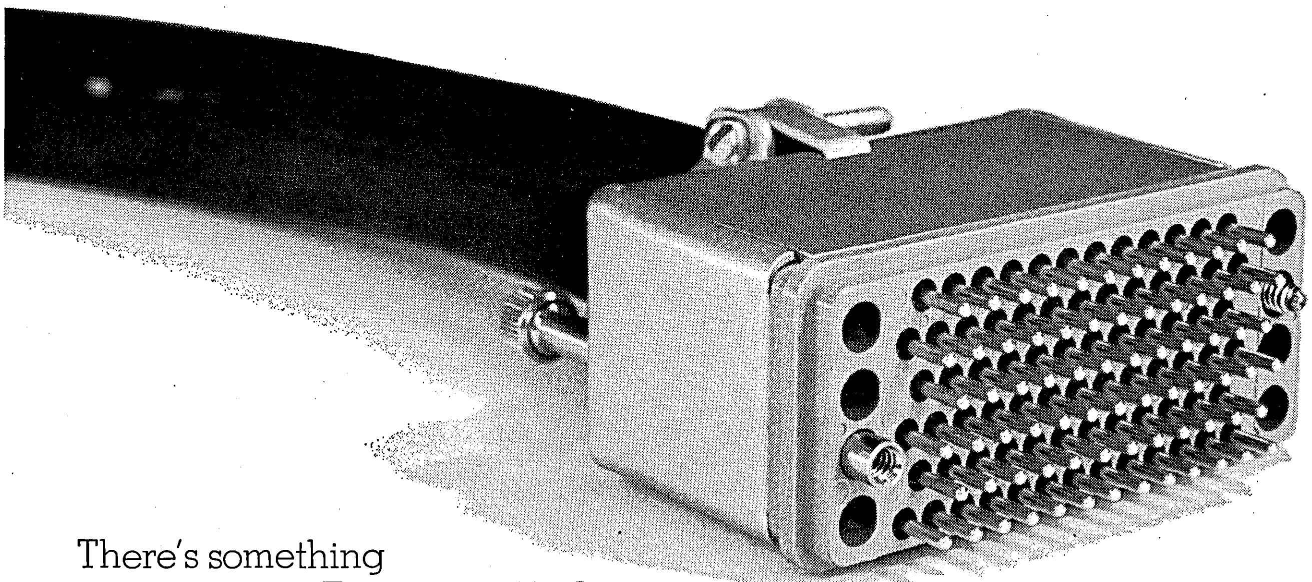
Adage INC

CIRCLE 7 ON READER CARD

calendar

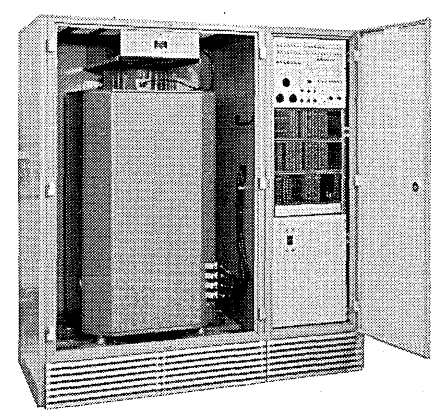
DATE	TITLE	LOCATION	SPONSOR/ CONTACT
	Seminars in:	Regency Hyatt House Atlanta, Ga.	Mgt. Development Inst., 130 West Lancaster, Wayne, Pa. 19087
Nov. 27-28	Mgt. Info. Systems		
Nov. 29-30	Simulation		
Nov. 30 & Dec. 1	Decision Tables		
Nov. 27-29	Conf. on Administrative Mgt. in Electronic Era	Americana Hotel New York, N. Y.	Amer. Mgt. Assn., 135 W. 50 St., N. Y., N.Y. 10020
Nov. 27-28	Inst. on Computer Aids to Systems Effectiveness	Univ. of Wisconsin Milwaukee	D. P. Hartman, UW-Milwaukee, 600 Kilbourne
Nov. 28- Dec. 1	Inst. on Computers & Hospital Admin.	Gramercy Inn Washington, D. C.	American Univ., Ctr. for Tech. & Adm., Washington, D. C. 20006
	Seminars on Time-Sharing		ACM, 211 E. 43 St., N. Y., N.Y. 10017 Cost: $15-20
Dec. 4		Sheraton Cape Colony Inn, Cocoa Bch., Fla.	
Dec. 5		Holiday Inn Tallahassee, Fla.	
Dec. 6		Sheraton Motor Inn Huntsville, Ala.	
Dec. 7		Sheraton Motor Inn Memphis, Tenn.	
Dec. 8		Howard Johnson's Motor Lodge, Shreveport, La.	
	Seminars on File Structures for On-Line Systems		ACM Cost: $40-50
Dec. 11		Marriott Motor Hotel Atlanta, Ga.	
Dec. 12		Royal Orleans Hotel New Orleans, La.	
Dec. 14		Sheraton Lincoln Hotel Houston, Tex.	
Dec. 15		Statler Hilton Hotel Dallas, Tex.	
Dec. 13-15	Inst. on Process Control	Univ. of Wisconsin Madison 53706	Institute Dir., 432 N. Lake St. Cost: $70
Jan. 18-19	First Annual Simulation Symposium Dec. 4 reg. deadline	Sheraton-Tampa Hotel Tampa, Fla.	Ira M. Kay, P. O. Box 1155, Tampa 33601
Jan. 22-26	Course in Computer Oriented Circuit Design	UCLA Los Angeles 90024	Eng./Physical Sci. Ext., 6532 Boelter Hall

Plug your information gap



There's something new on the circuit: The Bryant XLO 1000 Controller. A complete memory system that plugs into almost any computer made. One plug. And general or specific software to suit, including handler and maintenance routines.

The Controller can operate in several different modes—serial or parallel—with word transfer rates from 50 microseconds per word to 900 nanoseconds per word. Talk to two central processors. And handle as many as eight Bryant Auto-Lift Drums, PhD's or Disc Files. So you get fast, direct access to up to 4 billion bytes of information.



If you're adding on to your current system, Bryant men can add the Controller and memory devices for you. Just like they've already done for many commercial, industrial and military applications.

Call your local Bryant representative or write to 850 Ladd Rd., Walled Lake, Mich. 48088. We'll make a Bryant Believer out of you, too

BRYANT
COMPUTER PRODUCTS

XLO

EX-CELL-O CORPORATION

CIRCLE 9 ON READER CARD

letters

rpg

Sir:
After reading the verbose COBOL program in Mr. Leslie's article on RPG (June, p. 26), I am in agreement that there is a shortage of programmers. Simple programs like this are easily written in half- to three-quarters of an hour by anyone with COBOL experience. If Mr. Damico took *two hours* to author this gem, perhaps he should use RPG for all his programming needs, including resume generation.
KENT HUCKSTEP
San Diego, California

program budgeting

Sir:
The article, "Program Budgeting" (Sept., p. 37), by Charles J. Hitch—now president of the Univ. of California—was excellent. I have subscribed to Mr. Hitch's philosophy since I first investigated cost effectiveness in the early '60's.

I think it is unfortunate, however, that most long-range planning verbiage borders on the nebulous. With decision planning so critical when related to present technology, it is a shame that our jargon confuses and intimidates middle- and upper-level "planning" management.

Just as with all endeavors, long-range planning—with "effectiveness" criteria—will make real strides when it is displayed and tested in practice.
PHILIP P. CARVILLE
Oakland, California

more pl/I

Sir:
Hedley Voysey mentions ICI's technical computing language K Autocode. This language is also implemented on System/360 under OS and provides an efficient alternative to PL/I for technical computing. (On a 360/40 it compiles five times faster than version 3, and it does not use Linkage Editor.) The language provides procedures, file handling, symbol manipulation, good diagnostics and is backed up by an extensive library of mathematical and engineering programs. Further details may be obtained from: Information Officer, ICI Management Services, Harefield House, Fulshaw Hall, Wilmslow, Cheshire, England.
A. GIBBONS
Cheshire, England

Sir:
In PL/I in the U.K. (Sept., p. 73), Hedley Voysey asks, "Is PL/I easy to (1) learn, (2) write, and (3) debug?" In many cases, for example the publication of algorithms and the production of very large programs with long lifetimes, a more significant question would be "Is PL/I easy to read?"

I am not trying to suggest that PL/I is either easy or difficult to read, but only that I would have been interested in the answers, had the question been asked.
HENRY S. WARREN
Linwood, N.J.

information retrieval

Sir:
Because of our interest in information retrieval, we were pleased to see the article (Sept., p. 95) concerning the legal information retrieval system developed by the Air Force, LITE.

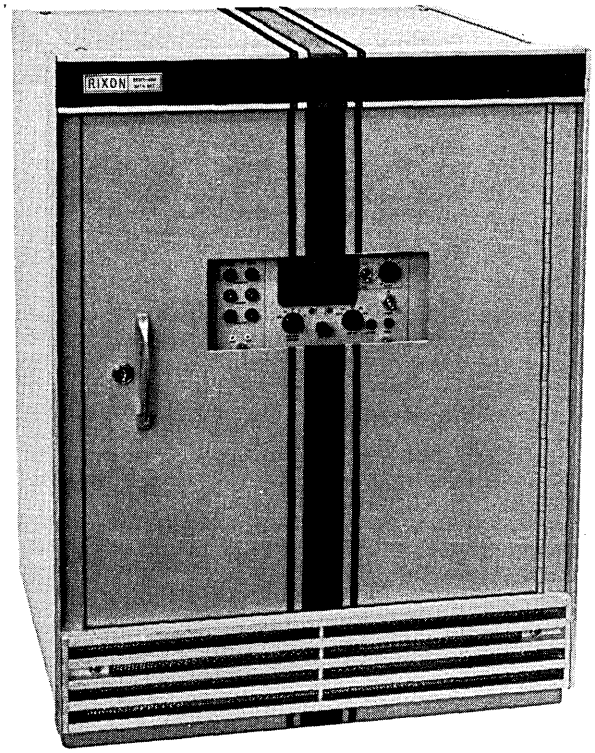
From your report, one can feel it is meeting a real need in the legal community, but perhaps your comment "LITE . . . is the only operational, full-text computerized retrieval system. . . " should be amended to read " . . . in the legal community."

In the chemical community, CAS has had an operational text search program on an IBM 1401 since early in 1965, searching *Chemical Titles* and *Chemical-Biological Activities*. In 1966, these capabilities were made operational on a 360/40.

The computerized text search capabilities of *Chemical-Biological Activities* have been twice demonstrated in 1967. At two conventions held in Chicago—Federation of American Societies for Experimental Biology and American Chemical Society—we transmitted questions and answers via Dataphone between there and our Columbus office.

Several of our subscribers are searching these publications on a regular basis at their own installations.

We recognize the tremendous amount of achievement that needs doing in this area, but are therefore



The Rixon 4800 bps SEBIT-48M Data Set. Cabinet and striping optional.

IF THE SPEED DOESN'T IMPRESS YOU THE ECONOMY WILL

With an automobile you usually sacrifice economy for speed. Not so in data communications. The Rixon Sebit-48M Data Set which operates at 4800 bits per second proves that speed produces significant economies. You achieve higher throughput, increase off-line time, ease schedules and make more efficient use of communication circuits. These benefits help you effectively reduce many of your costs. The 48M, like all of Rixon's data sets, will interface with all EDP equipment and uses voice grade telephone channels. We've just published a brochure that details the economies that Rixon data sets can give you. May we send you a copy.

RIXON ELECTRONICS, INC.
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CIRCLE 11 ON READER CARD

proud of our operational system.
DAVID R. HEYM
Chemical Abstracts Service
Columbus, Ohio

patenting computer programs

Sir:
In the September Forum (p. 160), Mr. Jones presented an appeal for making computer programs patentable. He implied that only the manufacturers (with selfish interests) and the Patent Office itself opposed patenting programs. As a former programmer and current supervisor of a programming group, I would like to voice my opposition with the following answers to his reasons for action:
1. The technology is so dynamic that patent action, investigation of possi-

ble infringements, etc. would slow the productivity of the field in general.
2. Programming needs the encouragement provided by a creative environment in which the participant concentrates on how to program well, rather than how to collect patents.
3. Competent and industrious programmers have the same protection (job security and rapid advancement) and opportunity to profit (among the best of today's salaries) as do most practitioners in other technologies.

As a taxpayer I shudder to contemplate the added federal payrolls that could be generated in order to examine today's explosion of computer programs for patent action.

The computing community exhibits far more professionalism than Mr. Jones gives it credit for. The best professionals in any field are creative primarily because of their intense interest in the field, not because of the lure of inventive profits. Where would computing be today if people like John von Neumann had patented their revolutionary new techniques?

In my opinion the only segment of the community that could profit from patented programs would be independent software firms—all others, including the large government installations, would suffer.
E. C. WITT
Knoxville, Tennessee

erma again

Sir:
Re: Thomas Lang's letter (Oct., p. 14): In a large systems project like ERMA, it is always difficult to satisfactorily identify just who made what contribution. The original design work *was* done by B of A and SRI, though there was substantial rework of both hardware and software when GE became involved in 1957. If Mr. Lang had been around at the time, he would have been able to observe that the ERMA system was not designed by "programmers," but by the combined efforts of bank officials, systems engineers, logical designers, transducer specialists, mechanical engineers, etc.

He would also have noted that the GE 100 and the GE 210 were the *same* machine. The computers delivered to B of A were designated as 100's and those subsequently installed at Security First National and elsewhere were labeled 210's, but they were identical right down to the "asterisk compare" and "tumble" instructions. The reader is referred to the July-August 1967 issue of the *Journal of the Systems and Procedures Association,* for a more thorough discussion of the ERMA project.
ROBERT V. HEAD
Los Angeles, California

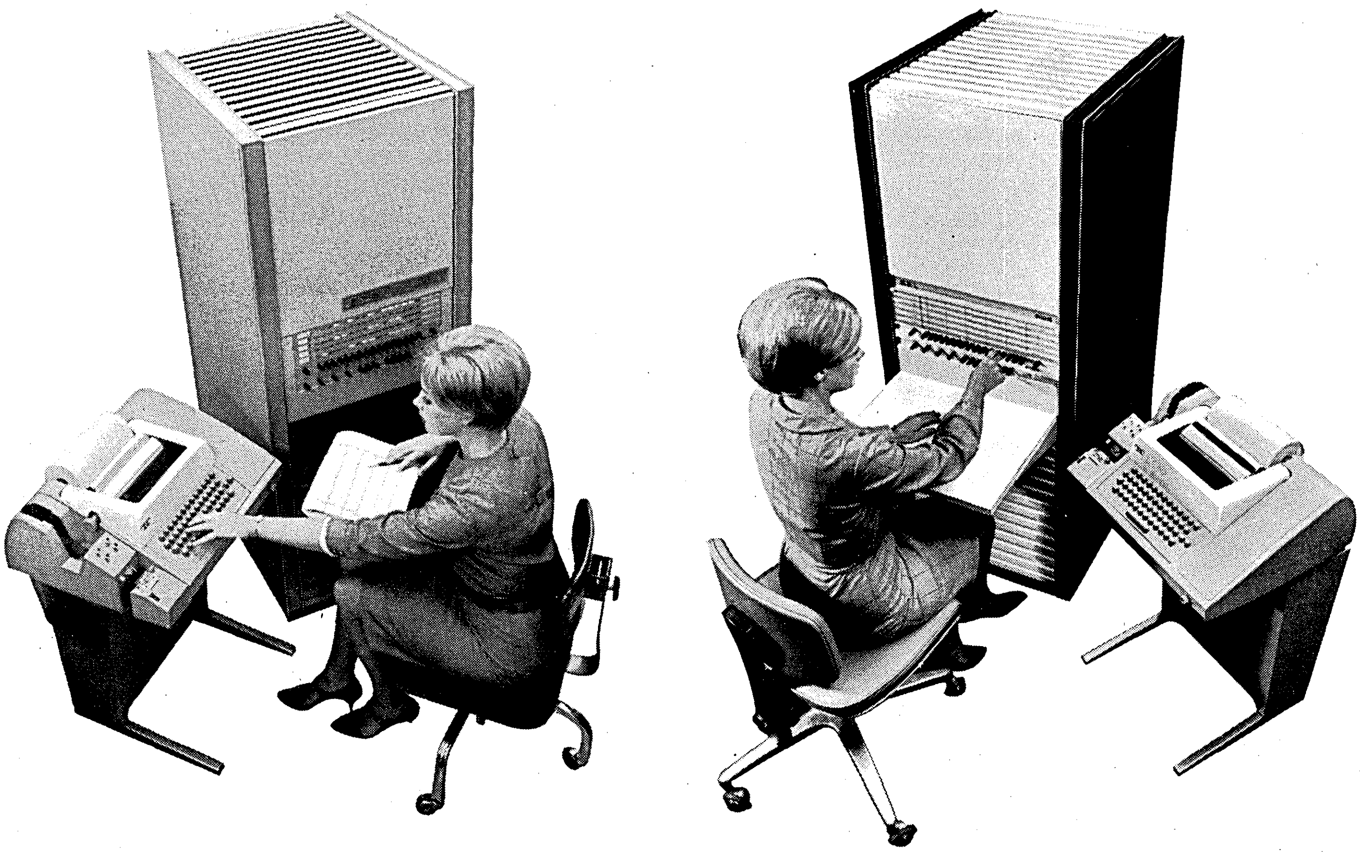
israeli edp

Sir:
Dr. Frank Moser's article, "EDP Progress in Israel" (Aug., p. 29), states "Control Data has a fairly limited market in Israel since they aim mainly for the medium- to large-scale scientific systems."

Since opening our office in Israel in 1965, we have received orders for the two largest business processing computer applications in Israel. A CDC 3300 computer was ordered by the Israel Aircraft Industries and installed in September 1967, and two 3300's will be installed with the Israel Post Office in 1968.

The above orders, together with the currently installed 3400 and 1604 systems, give Control Data the lead over its competitors in Israel in the medium- and large-scale market.
D. FAMILIANT
Tel-Aviv, Israel

Anything the SEL 810A can do, the new SEL 810B can do twice as fast.



Over 50 SEL 810A, 16-bit computers have been supplied for data acquisition and control. Now meet the SEL 810B, with twice the speed of the A. Yet only about 20% more in price. Same great features: all integrated circuits, 2 levels of priority interrupt, memory expandable to 32K, I/O typewriter, high-speed hardware multiply and divide, and real-time I/O structure. And the software package of the 810B has been proven in the A.

Fixed point execution times of the B are: add/subtract—1.58 microseconds; multiply—4.74 microseconds; divide—6.32 microseconds; cycle time—790 nanoseconds. If you don't need the speed of the SEL 810B, buy the A. For either, call or write: Systems Engineering Laboratories, 6901 West Sunrise Blvd., Fort Lauderdale, Fla. 33310. Area Code 305 587-2900.

Systems Engineering Laboratories

See the 810B at FJCC Booth D1-2-3-4.

CIRCLE 13 ON READER CARD

look ahead

WESTERN UNION STILL
STRUGGLING INTO COMPUTER AGE

As observers have long suspected, the major proponent of the total information utility, Western Union, has trimmed its ambitious plans to blanket the nation with a dp/message switching network INFOMAC by 1970. The last two years have seen: about 100 dp people come and go, most unhappily; money problems; the delivery of 1108's slowed (the first is due in momentarily, but plans for six more are getting vaguer all the time).

WU, undaunted, is definitely going ahead with its Automated Computer Telex services (battling Advanced Computer Techniques over its copyrighted acronym ACT), and will integrate its telegraph network with Telex. Four Univac 418 switching systems replace electromechanical units. Two, dedicated line services, SICOM and INFOCOM, will be offered if and when tariffs are blessed by FCC. (See Washington Report.) SICOM provides brokers with a private network to link them with branches and exchange floors and to computer-store records. INFOCOM, planned for April, gives SICOM service to anyone. Hopefully dp will be phased in to the "manana" utility.

In the meantime, WU continues to barter with AT&T over the price of TWX. WU-customer Law Research Service is trying to fight off a copyright infringement suit by West Publishing (filed 1966), and suits by some franchises for non-performance of contract. And state employment agencies are seriously asking if PIX personnel data bank service, partly WU-owned, should be considered an illegal agency operating sans license.

SOFTWARE SLIPPAGE
HITS UNIVAC

Like all operating systems, Univac's Exec 8 is months behind schedule, due, the firm says, to the happy problem of an unexpected high number of 1108 orders (130-140 rumored). Revision 3 of Unit Processor Exec 8 was out in August, seven months late. This month Revision 4, including Fortran V, appears, four months late. UP Revision 5 should arrive early in '68, with multiprocessor Exec 8 due out in the first quarter. On schedule is 9200 and 9300 software and the 494 extended Omega multiprogramming system (due in Oct.)

GSA PLANS MASS TAPE ORDERS
AS VENDORS TRY TO QUALIFY

Mag tape makers, who have wondered about what they feel are inadequate federal government tests and wondered if the feds would centralize tape purchases, may soon have some answers...and more questions.

GSA's plans for mass purchase of mag tape are nearly final. Early next January, they'll release invitations to bid on a year's supply of 800-bpi tape for a particular geographical area. The bids will apply only to purchases above a certain amount. (The ceiling is $25K right now, but this may rise to $50K.) Procurements will be bid in up to 10 different areas,

Moving?

If you're going to have a new business address, please fill out the form at the right now and return it to us. We'll make sure that DATAMATION keeps up with you. To save time, we need your old address, just as it's printed on the mailing label, (or the whole label is better yet) as well as your new address.

Name__
Title__
Company
Address__
City__

NEW AD
Name__
Title__
Company
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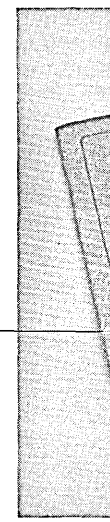
What is e
Your Sign



an intro
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Whatever your work in information processing, you'll communicate better with the help of this authoritative glossary.

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to give smaller suppliers a shot at a share of what may amount to a total buy of 5 megabucks or more. Reportedly, GSA hopes to pay less than $16 a reel, vs. $23 or more now.

The request for bids will go to makers' plants represented on the Product Quality List. Right now that's four firms—CDC, IBM, Memorex and 3M. But three of them are really 3M, although others will be able to qualify before bids open in Feb. or March.

Tape makers, including one qualifier, claim GSA test procedures are obsolete, inadequate. For instance: temp. and humidity requirements reflect unrealistic military needs; durability requirements are not rigorous; there's no allowance for tests on vacuum capstan drives; tests are for 200 bpi only. And tests are run behind locked doors at the Nat'l Security Agency: vendors don't know what test gear is used, how to correct failures.

GSA says it's upgrading the tests for both 200 and 800 bpi, hopes to establish a new clean room, probably at NBS, pending Congressional approval of the adp revolving fund appropriation. The facility would involve tape certification and acceptance, which would later be replaced by quality assurance. And GSA stresses it's anxious to change test specs, is wide open to suggestions.

THREE 360'S IN THE WINGS AND A CUE FOR ONE

IBM now has three new members of the 360 family backstage—with one about to be pushed into the footlights.

Biggest—by far—and most talked about is now known as the Model 85. It's said to have up to 6 million bytes of main storage and use some of the Mod 91 logic. Performance should be 5 to 10 times that of the 65 at about 1½ times the price. Probable announcement time is early January, with deliveries scheduled to begin about 15 months later.

Next smaller may be called the Model 58. It could be about twice the speed of the 50 but sell down with the present Mod 40. It's apparently aimed directly at the SDS Sigma 7 market.

Last, and least, is the relatively tiny Mod 7—reportedly as fast as the 20 but much cheaper.

TAPE STANDARD CLEARS LAST(?) HURDLE

Adoption of USASI's proposed 800 cpi mag tape standard was virtually assured recently when IBM vp J.A. Haddad, in a letter to USASI's X3 computer committee withdrew his company's opposition, informally. But formally the company is still opposed.

This month or next, USASI will recommend adoption of the standard, probably by a 15-1 vote. Soon after, BOB will issue an executive order making USASCII mandatory for all related federal applications 18-24 months later. The order will cover input-output devices and communications equipment as well as mag tape format.

Adoption of the code reportedly poses big problems for IBM, whose 360 operates internally on EBCDIC, which can't be mated to USASCII without expensive hardware changes or processing delays. The 360 also can operate on IBM's version of ASCII, which poses less of a translation problem. But IBM hasn't yet developed any USASCII-compatible software; even after it does, the company might be at a disadvantage in competition with other systems designed to process and store USASCII without translation. Some observers

(Continued on page 167)

LET'S CLEAR UP THE MYSTERY

Computer professionals who are curious about how the federal government tries to direct and control its use of information processing systems may want to read or at least skim through a recently published volume called *Data Processing Management in the Federal Government*. The 384-page document contains the hearings before a House Government Activities Subcommittee of the Committee on Government Operations, held three days last July.

The subcommittee is primarily concerned with the federal government's edp activities and is headed up by Jack Brooks, a Texas Democrat and the father of what is known as the Brooks Bill, which set forth the organizational structure and policies by which the government is attempting to more efficiently coordinate its huge edp investment.

The volume offers a peek into the painful process by which the people's elected representatives attempt to grasp a new complex technology and to see that it is sensibly directed and applied, although the primary emphasis is upon economy. Still, there are several instances where Congressmen begin to see the hopeful implications of using this new and mysterious tool to help them perform more efficiently and, perhaps, more wisely.

Here we see the Congressmen attempt to understand such shadowy and esoteric concepts as the third generation, the significance of standards, Management Information Systems, time-sharing, etc., thrown at them by a bevy of spokesmen for the new technology from the Bureau of the Budget, General Services Administration, Civil Services Commission, National Bureau of Standards and other organizations and offices.

Despite the rather impressive array of titles and talents, the real star of the hearings is Congressman Brooks himself. Although Brooks declares himself "somewhat held in awe by computers," he has obviously done some homework. He reminds one witness from the GSA that he hasn't covered software, and later asks him if he has examined "the feasibility of procuring software separately from hardware . . . ?" Then he wonders if they "have developed criteria for evaluating these various packages?" You know the answer. He wonders why the government can't get volume discounts. He wonders if enough good edp training and orientation for people like himself and other government officials is being developed and offered. With the aid of his shrewd, hard-nosed assistant, Ernie Baynard, Jack Brooks has learned enough about edp to ask some solid, tough questions.

And while it's reassuring to know that *someone* on the Hill has some insight into our special, complex world, it would be even nicer if there were more of them. Early in the hearings, Congressman Randall of the Government Operations Committee says, " . . . these computers are still something of a mystery to me." And, he goes on, "I would hope, Mr. Chairman, that somewhere along the line, you or some of your staff can explain more to me about the operation of these [little black boxes], or how these things work."

We would hope, too, that somewhere along the line some way is found to introduce our Congressmen, our Senators, our key government officials to the mysteries of our little black boxes.

We understand that an edp orientation course for Congress is now being formulated. We hope that it is encouraged, expanded, put into action soon. The implications of information processing are immense. If the nation is to make the best possible use of this vital resource, then it is essential that our lawmakers and top policy makers have some insight into the basic concepts of computers and information processing.

TRENDS IN AEROSPACE COMPUTERS

reach for the ground

by R. L. HOOPER and L. D. AMDAHL

The purpose of this article is to present a survey of the hardware and software characteristics of current U.S. aerospace digital computer systems, and then to describe our concepts of trends we would expect to see during the next few years. This article is intended to be of interest to computer professionals who are involved with general purpose computer systems, but wish to know "what's happening" in other application areas.

P. Dickson[1] describes a recent government survey which estimates that the Department of Defense will purchase 10,000-20,000 airborne digital computers during the next five to seven years. The same article suggests up to 3,000 aerospace computers will be purchased for commercial purposes in the next five years.

These figures can be compared with over 45,000 general purpose computers installed today in the United States and a current annual shipping rate in the neighborhood of 13,000 general purpose systems. It is difficult to compare value of types of systems shipped, but in numbers of systems, the aerospace market represents a significant chunk of the total computer market.

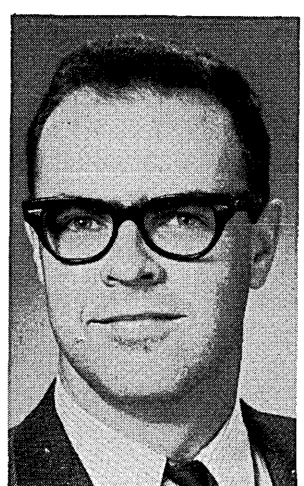
Aerospace computers have typically ranged in cost from $15,000 to $500,000 per system. The typical hardware cost per system has probably been in excess of $200,000, reflecting unusual reliability and packaging requirements. However, small computers in large production runs are expected to significantly reduce these costs in future systems.

Aerospace computers, as defined here, are those stored program digital computers designed primarily to meet the needs of airborne or spaceborne applications. No attempt has been made to include all aerospace systems in the survey of current systems. Representative systems from a variety of manufacturers are described in Table I *(p. 24)*.

Reliability, power consumption, weight, and size are those physical characteristics which are generally of greatest concern to the aerospace computer system designer. In most cases, a computer system that fails in flight cannot be repaired in flight, and the semi-automatic back up which exists may be unsatisfactory in terms of mission goals. Depending on the application, reliability may be of considerably greater consequence than any of the other physical parameters. Typically, mean time between failures of 2,000 to 20,000 hours are quoted. Power consumption, weight and size may have varying emphasis, depending on the characteristics of the host vehicle. Obviously 300 watts, 1 cubic foot of space and 50 pounds have a different significance, depending on whether the host is a C-135 or an unmanned satellite.

Performance characteristics are the focus of this article, however, and in this area the parameters of concern are memory size and speed, word length, average instruction execution time, and input/output capability (there is frequently a requirement for high speed scanning of sensors and output of control signals).

[1] *Electronics*, Feb. 20, 1967, pp 203 ff.



Mr. Hooper is the director of systems programming at Compata, Inc. He was previously leader, design engineering, at RCA, and programming manager at Packard Bell. He holds a BA degree in mathematics from Colby College.

As physical characteristics become more satisfactory, performance characteristics get more and more emphasis by the system designer, who once asked, "Will it work for the length of the mission and can we fit it into the space available?" Now he is beginning to ask about things like programmability and software support.

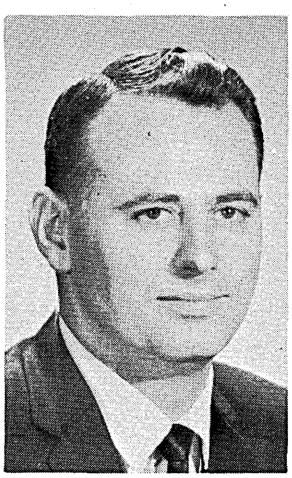
Therefore, aerospace computers, which were once considered a breed apart from ground-based general purpose computers, are coming more and more to resemble them functionally. That is the conclusion to be drawn from some of the representative systems shown in Table 1. Input/output and packaging areas seem to be two exceptions to this rule. However, in terms of circuit technology, memory speed, memory capacity, register organization, instruction repertoire and software, there is a growing resemblance. This trend is also noticeable in the process and industrial control area where use of higher level languages, foreground and background processing, and standardized I/O interfaces are becoming prevalent.

Circuits and packaging. Monolithic semiconductor circuits are almost universally employed for arithmetic and control functions in the computers of Table 1. These circuits are usually packaged in the 14-pin flat-pack configuration. Where emphasis has been on extremely small size, 50 to 100 or more flat packs have been attached to individual specially-designed multilayer boards. These multilayer boards may have a dozen or more layers of signal interconnection, and may in turn connect to a multilayer board for a higher level of interconnection.

With less emphasis on size and more emphasis on ease of repair, computers such as the Raytheon R-11 and the Univac 1830A offer pluggable circuit modules. Others, such as the Nortronics 1051, use a "stick" structure for utilizing small component groupings attached to a mother board.

Memory speed and capacity. The Univac 1830, Raytheon R-11, IBM 4 Pi (EP) and Litton L304 all can address memories of 131,072 words. The GE A605 can address 262,154 words. Typical capacities are 4K to 32K words. The Raytheon R-11 has a memory cycle of 950 nanoseconds; however, typical memory cycles are from two to four microseconds. Some systems pull three or four words from memory at a time, with a resultant improvement in program execution time.

Most of the computers of Table 1 use magnetic core memories; however, the Univac 1824 employs a thin magnetic film memory. Protection for fixed programs and constants is achieved in a variety of ways. Some computers, such as the IBM 4 Pi, employ an additional memory protect bit with each word to prevent errant instruction execution from destroying protected words. Other computers employ non-destructive readout (NDRO) memories that are implemented, for example, with multiple aperture cores or magnetic thin films. The NDRO memories are usually electrically alterable in conjunction with support equipment. Still other computers employ permanent memories that are implemented by techniques such as "missing core" and "rope" memories. Rope memories are constructed with somewhat larger cores than usual, with a number of wires selectively laced through or around them as a function of the desired bit pattern. The missing core memories are more nearly like standard core planes with cores omitted according to the desired bit pattern. Rope memory is used in the Apollo Guidance Computer (not shown in Table 1), and missing core memory is used in the IBM Pi (EP) for storage of microprograms.



Mr. Amdahl, technical advisor to DATAMATION, is president of Compata, Inc. A participant in the design of several computers, he has a BS in engineering and physics from S. Dakota State and an MS in physics from Kansas Univ.

Register organization. The L304 and IBM 4 Pi (EP) series both employ the general register concept. The L304 has eight registers for each of 64 interrupt levels. The 4 Pi (EP) has 16 registers. Many computers utilize an upper and lower accumulator, and provide three to seven active (flip-flop) index registers.

Instruction repertoires. The GE 605, IBM 4 Pi (EP), CDC 5400, 5500, Litton L304, Raytheon R-11 and Univac 1830A systems all have large capable instruction repertoires. Not only are single precision, binary fixed point arithmetic instructions provided, but character handling, memory search and bit manipulation instructions as well.

Software. Compatibility with ground-based processors (see below) immediately makes large software libraries available. In addition, JOVIAL is to be available for the Litton L304 and Raytheon R-11, FORTRAN for the R-11 and Univac 1830A, and PL/I for the 4 Pi (EP). All systems listed have an assembler (which runs on another computer), a simulator (likewise) and libraries of math function subroutines and diagnostic or fault detection routines. Operating systems are developed for particular applications on a custom basis only.

Compatibility. The Burroughs D840, GE A605, IBM 4 Pi and Univac 1830 are all "instruction compatible" with ground-based computers. This concept can sometimes take advantage of the software developed for the ground-based system, particularly if the instruction repertoires are nearly duplicates of each other. In addition, it may be unnecessary to develop a separate simulator program for program debugging.

what are they used for?

In terms of applications, multipurpose use is becoming more common in aerospace computers. Previously, a single use was normal in all but a few cases. Greater reliability and capability have been the stimuli for the change in thinking here. Some multipurpose applications include E2A, ANEW, and AWACS. Today, more is being required of computers which occupy the same or less physical space than their predecessors. The E2A aircraft is produced by Grumman and the on-board computer system supports navigation, display, tracking and intercept functions. ANEW is the electronic system aboard the Lockheed P3C and assists in anti-submarine warfare. AWACS is a future Air Force System on a large jet such as the Douglas DC-8 or Boeing 707 and supports both Tactical Air Command and Air Defense Command requirements.

There are currently two divergent approaches to aerospace computer design. One is the "sparse," low component count approach which tends to avoid such features as index registers, large instruction sets and longer word lengths. These computers are notable for relatively low cost, good to excellent reliability, and small size and weight. Very often these computers have been hand tailored for a particular single purpose application (space missions, for instance) and are generally more difficult to program. The other approach is the "general purpose" approach, which presents a longer word length, considerable modularity in memory sizes, index registers, indirect addressing and extensive instruction repertoires. These are often "off-the-shelf" machines, designed for multipurpose use and therefore don't necessarily represent the most hardware-economical design for a given application, if large numbers of the system are to be produced.

If only a few systems are required, off-the-shelf computers will often show a better cost tradeoff than custom computers because of design cost amortization.

Table 1
REPRESENTATIVE U.S. AEROSPACE COMPUTERS

Manufacturer	Computer System	Size (cu ft)	Weight (Pounds)	Power (Watts)	Manufacturer Est. MTBF (Hours)	Instr. Word (Bits)	Data Word (Bits)	Instruction (Words) X Min
ARMA	MICRO D	.07[1]	4	17[1]	>20,000[1]	13[2]	13[2]	1920 × 13
AUTONETICS	D26J	.7	35	200		12	12	4096 × 12
CDC	5360	.6	26	95	7545	24	24	4096 × 24
CDC	5400	1.1	60	140	2500	24	24	12288 × 24
CDC	5500A	.7	45	125	8000	13/26	13/26	2176 × 52
GEN. ELECTRIC	A224	.44	21	108	10000	24	24	4096 × 24
GEN. ELECTRIC	A605	.78	36	150		36	36	4096 × 24
GEN. PRECISION	GPK-20					10	20	4096 × 10
GEN. PRECISION	L-90-3		35	100	2000	14	14/28	8192 × 28
HONEYWELL	SIGN III	.45	22.	90	14000	20	20	2048
HONEYWELL	ALERT	.98	60.5	140	20000	24	24	4096 × 24
HUGHES	HCM 205	.2	13.3	100	4500	18-24	18-24	4096 × 18
IBM	4 Pi (EP)	1.88	75	365	3000	16/32	32	16384 × 32
IBM	4 Pi (CR2)	.86	47	240	4000	16/32	16/32	8448 × 32
IBM	4 Pi (TC)	.37	17.3	60	6300	8/26/24	16/32	8192 × 8
LITTON	L304	.3	34	100		32	16	4096 × 16
LITTON	LC-728	.55	32.9	200	4250	16/12	38	4096 × 28
NORTRONICS	1051	.5	29	94		24	24	2048 × 24
RCA	VIC-36A	3.0	120	325		36	36	4096 × 36
RAYTHEON	R-11	1.9	100	500	3500	24	24	8192 × 24
RAYTHEON	R-25	.75	38	390		24	24	4096 × 24
SPERRY	MARK 14	.66	32	250	3500	21	21	6144 × 21[3]
SPERRY	MARK 16	1.5	60	250		21	21	8192 × 21[3]
TELEDYNE	AAFSS	.52	33.5	250	2500	20	20	1024 × 20
UNIVAC	1824	.49	28	110	10000	16	24	3072 × 16
UNIVAC	1830A	2.7	190	567	4500	30	30	32768 × 30

KEY: 1. WITH 2048 WORD MEMORY BUT NO POWER SUPPLY
2. EXPANDABLE ON ORDER 3. NDRO/DRO COMBINATIONS AVAILABLE

what's next in hardware?

LSI. A strong trend toward large scale integration (LSI) is expected, but its widespread application appears to be several years away. LSI will have a profound price effect upon large quantity buys, thus encouraging standardization.

An intermediate step to LSI is anticipated that will have a significant impact on design tradeoffs—the complex integrated circuit. The complex circuit will have hundreds of gate functions per chip, rather than thousands per chip as projected for LSI. Its header will provide 40 or 50 terminals, much like the old discrete component circuit module. The yield for this type of integrated circuit may be sufficiently high that discretionary interconnection to avoid faulty circuits may not be required.

Control memories. If LSI techniques can supply a standard, undifferentiated structure to processors, control memories might be the means of providing application dependent structure to a computer. Our thinking in this regard parallels that of Ascher Opler[2] who describes fourth generation general purpose computers with no order set and no data structure, until "firmware" is supplied for the microprogrammed memory. It may be desirable to have an electrically alterable control memory rather than permanent control memories such as ropes or capacitors. Perhaps LSI will provide this function as well.

General registers. An increasing trend to the use of general registers can be expected. This will come about for three reasons: cost, size/weight, and function. Special bus-oriented integrated circuits permit general registers to be implemented with relatively small increases in cost and size/weight. Use of general registers reduces the number of loads and stores in a program, thus reducing memory requirements and providing faster program operation by register to register operations. The use of general registers for indexing functions eliminates specialized index manipulation instructions. Multiple sets of general registers permit rapid context switching when interrupts occur, and thus can be expected to be offered as options.

Word length. A polarization around 16, 24 or 32 bits can be expected. Eight-bit codes for character representation are now becoming standard. Sixteen- and/or 32-bit instructions combined with multiple general registers appear highly bit efficient, and the size of memory will still be a concern. Twenty-four- and 32-bit data appears to have considerable utility for computations associated with airborne navigation.

Floating point arithmetic. There is an increasing demand for the convenience of built-in floating point operations to minimize the need for undue attention to scaling. Floating point is optionally available now on some aerospace computers, and is expected to become more popular in future machines.

[2] DATAMATION, January 1967, "Fourth Generation Software."

Memory. Options permitting larger memories (32K-256K words) will become more common. One microsecond cycle times and less will become customary. The availability of batch fabricated memories will provide bulk memories of high reliability, moderate weight and reasonable cost available to support multipurpose use. Memory protect features will also be required for multipurpose use.

what's next in software?

A fairly safe prediction about software for aerospace computers over the next three years would be that there will be more of it. However, this is too easy and compels us to ask more specific questions. Three topics are specifically considered: compilers, executive programs and simulation. These subjects were chosen despite the knowledge that assembly language will still be the most used development tool over the next few years.

Compilers. The use of compilers for program development will become more frequent during the next three years. Historically, the use of compilers for airborne computers has been limited (see Table 1). This can be explained in part by the relatively low performance of earlier aerospace computers, due to the use of rotating memories for program and data storage. Today, however, performance of aerospace computers is quite comparable with that of ground-based computers. Compiler implementation techniques have also improved: 10-20% penalties in memory required and in execution time are typical today for compilers like FORTRAN IV and JOVIAL, as compared with "hand-tailored" code written in machine language. Language designs which are suitable for real-time/on-line usage are also appearing: FORTRAN (with additions), JOVIAL, PL/I and SPL (Space Programming Language). SPL has been recently specified by System Development Corporation.[3] These three factors—language suitability, language efficiency and computer performance—taken together suggest greater use of compilers by aerospace computer programmers. Benefits to be derived are well known, but are restated here:

- faster program preparation, checkout, and documentation
- ease of communication
- reduction in computer time for checkout
- simplification of program updating

It is assumed that compilers will be written to operate on ground-based computers, since they have the I/O and bulk storage resources needed. Even a compiler development cost of $100,000 to $300,000 could be justified, if the program to be developed were sufficiently extensive. This assumes an improvement of approximately 50% in program production rate when using a compiler, as opposed to machine language programming.

Memory (Bits) Max	Memory Cycle (μ secs)	Data Memory (Words) Min	Max	Memory Cycle (μ secs)	Number of Instr.	Index Registers	Add Time (μ secs)	Multiply Time (μ secs)	Compiler
2	2.0	128		2.0			12.	168.	
8192						0	8.	18.	
8192	6.0				41	28M	12.	90.	
	2.5	4096		2.5	73	4A	2.5	25.	
8192	2.5	256		7.5	70	7A	5.	25.	
262154	3.0				68		6.	17.	
	3.0				142		8.	34.	
16384	4.0				32	0	20.	100.	
16384	2.4				32	2A	3.3	41.1	
16384	2.0				59	4M	4.	24.	
32768	1.0	4096 × 24,	32768	2.0	64	6M	2-4	12-14	FORTRAN
16384	2.0				41	3A	4.	22.	
131072	2.5				70	16 G.R.	5.	10.4	PL/I
33792	2.5				36	3A	5.	19.4	
65536	2.5				54	0	18.	54.	
131072	4.0				30	0	8/4	58.5/56.5	
32768	2.2				61	8M/LEVEL	7.2	31.6	JOVIAL
8192	2.0				38	7M/LEVEL	8.	70.	FORTRAN
32768	3.0								JOVIAL
									FORTRAN
131072	.950				70	1A	1.9	5.6	JOVIAL
65536	3.0				40	1/2A	6.2	20.	
	8.0			8	13		18.	60.	
16384	6.0			6	14		12.	34.	
16384	5.0				29	3A	12.	40-60	
12288	4.0	256 × 24	1024		45	3M	8.	44-92	
131072	2.0				62	7A	2.	18.	FORTRAN

A—Active
M—Memory

Executive programs. Standardized executive programs for today's aerospace computers appear to be unknown. Typically, these control programs are custom tailored to a particular application. However, we expect to see manufacturer-designed modular executive systems made available during the next three years. This will be attractive when the number of computer systems to be produced is small and the application is "typical" in the sense of requiring foreground-background type of multiprogramming. Functions provided will include:

- input/output control
- interrupt analysis
- fault response, including diagnosis
- bulk memory control (where required)
- allocation of time as a resource to be divided

As hardware costs continue to decline, greater emphasis will be placed upon reduction of programming costs. This will be accomplished in two ways: building in previous software functions as hardware features (interrupt response, floating point) and providing standardized software modules for user application. The executive control program seems to fall partly in the latter category.

Multiprocessing, which can be expected to gain in favor as presently remote functions are centralized, will still

[3]SSD-TR-67-11, Vol. III, *Recommendation for a Common Space Programming Language,* January, 1967.

demand customized executive programs to provide reconfiguration capability in the event of subsystem failure.

Simulation. Instruction simulation of aerospace computers (by interpretive programs) on ground-based computers for program checkout has been common in the past, for the following reasons:

- unavailability of the actual computer
- lack of I/O devices and of bulk storage

Simulation typically involves a penalty of 15-30 instructions per instruction simulated, with a resulting time penalty. This penalty can be eased or removed if aerospace computers possess upward instruction compatibility with ground-based computers or if an emulation mode permits making the ground-based computer hardware "look like" the aerospace system being simulated. This appears to be another ripe field for "firmware."

Another factor to be considered is the availability of generalized I/O interfaces on the aerospace computers. There will probably always be a need for specialized I/O interfaces, but the advent of displays and bulk storage in some aerospace applications will make the standardized interface more probable. Therefore, it should be possible to configure an aerospace computer in a computing center environment to provide reasonable program checkout facilities. Performance validation of a real-time control system can also be achieved through operation of the control system in a simulated environment.

conclusions

The architecture of aerospace computers is maturing toward a close functional similarity to ground-based computers, with general registers, modular word lengths and larger memories already in evidence. Ease of initial programming and of making programming changes is becoming more important as aerospace computers assume multipurpose use. Many of the design features that facilitate programmability can now be afforded because of changing tradeoff factors due to integrated circuits. Higher level programming languages have had low utilization in the past, but their use is expected to steadily increase.

Aerospace computers are big business, and the companies that will penetrate this market most effectively are likely to mix expertise in design for the aerospace environment with hardheaded commercial ground-based practice —in nearly equal proportions. ■

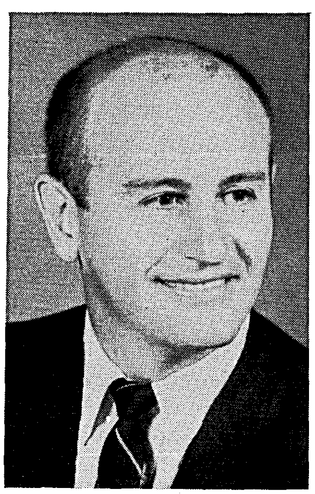
AEROSPACE SOFTWARE

for now and later

by VILAS D. HENDERSON and R. DEAN HARTWICK

We have often heard that the development of software for controlling an aerospace vehicle is not inherently different from the development of other kinds of software. True—if operational requirements are ignored. But it is precisely the operational requirements placed upon a system that distinguish it from all others. A stringent accuracy/performance requirement is what makes the software for aerospace missions unique: when a multimillion dollar system and human lives are at stake, there is no room for errors of any consequence, no second chance. Some organization, some person, must sign on the dotted line to certify that the controlling flight computer program is ready for its operational mission.

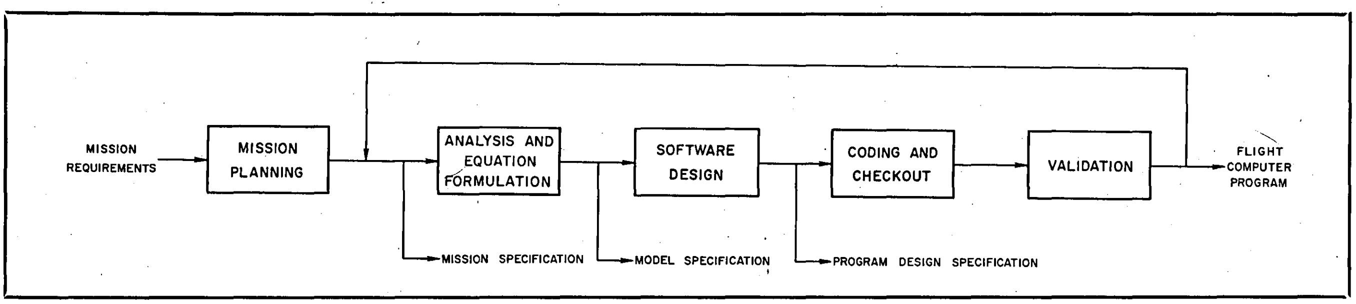
Through its program, the flight computer performs navigation, guidance, and control functions, communicating in real-time with external devices to obtain data and to issue commands. Many other functions are normally performed—telemetry data processing, sensor calibration and alignment, digital control, processing of experimental data, and so forth—but the central computer function as part of a closed-loop system is to participate in sensing, directing, and controlling the state of the aerospace vehicle throughout the mission. The complexity of the functions to be performed within the demanding accuracy/performance requirement causes a great impact upon the process for developing flight computer software and the environment in which it is developed—the responsibility is tremendous.



Mr. Henderson is manager of the computation and software dept., Logicon, Inc., San Pedro, Calif. He has directed projects such as simulation system development; software analytical, design and development support to the Air Force and Aerospace Corp. on the Titan III program; and software project support for the Airborne Tactical Data System. Previously with Space Technology Laboratories, he has an MS in mathematics from the Univ. of Wisconsin.

It is difficult to convey the total interaction that takes place during a major flight computer software development cycle. Ideally, the process can be viewed as a sequence of functional activities as shown in Fig. 1, which is a greatly simplified representation. Starting from a set of mission requirements, a mission specification that principally details the mission/vehicle data descriptions is developed during the mission planning activity. This then becomes the input to the analysis and equation formulation activity, which produces and justifies the equations and main logic content to be used for guidance, navigation, flight sequencing, and so forth. The output of this activity becomes the input for the programming activity, which is usually a two-step mechanization process, particularly if different contractors are involved in it: first, transforming the model specification into a program design specification; and second, developing and checking out the program for the flight computer. Finally, the validation activity is undertaken to assure readiness of the flight computer program for the intended mission.

Fig. 1



sequential flow

A sequential flow has been suggested, and ideally, this is the way the process should work. In practice, however, there is considerable parallelism, feedback, and recycling among the activities. Frequently a real bottleneck develops between the mission planning and analysis and equation formulation activities for the simple reason that performance and analytical data generated during the latter activity are required before the former can be completed.

Another reason for the failure of the functional flow to be straightforward is that various responsibilities are customarily split among several contractors, generally along hardware lines but spreading across all of the functional activities in the software development process. Sandwiched in between the other hardware contractors is the one that builds the flight computer and is frequently responsible for all program coding and checkout. This division of responsibility causes great interfacing and communication problems and is certainly one of the outstanding characteristics of the environment within which aerospace software is developed.

Another factor that has been found to be influential in the development cycle is the flight computer itself. Until now, flight computers have been designed or selected with little concern for programming problems. The emphasis has been on low weight, low unit cost, and high reliability, notwithstanding the fact that high hardware reliability is very expensive. The computer hardware cost limitations have invariably unfavorably affected the software development process. Existing flight computers have been difficult to program; there have been few coding and debugging aids; and thus far, fixed-point arithmetic has been used exclusively—a good example of the adverse effects of a hardware cost savings on the software development process. Despite large advances in hardware, we cannot expect widespread use of general-purpose aerospace computers for some time. There will continue to be significant advances toward making the flight computers compatible with general-purpose ground-based computer systems, but this is an over-stated advantage in view of the inherent limitation in the compatibility that can be achieved in the all-important input/output areas. While size and weight problems will become less significant, cost will always be important, as will the availability of proven hardware; paradoxically, an aerospace mission is not the occasion for rapid innovation.

Flight computer software developments will certainly continue to suffer from schedule pressures. In spite of painstaking planning, the entire software effort is often disrupted by additional requirements to perform new functions that were to have been handled by some portion of the hardware. Among the variety of reasons, two stand out: There may be no other way out of a development dilemma without extensive additional system costs or schedule slippage; or project personnel may obtain more understanding of the flight computer's capability and choose to exploit it further. This all contributes to the truth of one maxim about aerospace computers: software requirements will tax them before they are ever flown, leading to speed and memory size conflicts very early in the development cycle. We do not expect this situation to change in the foreseeable future.

This, then, has been a broad description of the nature of the flight computer software development cycle and its uniquely complicated environment. The imposition of the very stringent accuracy/performance requirement upon the end-item programs only serves to make this environment even more demanding.

We have said that the one distinguishing operational requirement placed upon the software for a computer-

As associate manager of the computation and software dept. at Logicon, Inc., Mr. Hartwick is presently directing the software development for a real-time redundant computer system that performs vehicle verification and conducts the launch countdown of the Titan III. Formerly with Aerospace Corp., he has a BS in engineering physics from the Univ. of Illinois.

controlled aerospace vehicle is that confidence in it must be achieved before the start of the mission. This dominant accuracy/performance requirement affects not only the development and checkout of the flight computer code, but all software aspects that influence the computer's jurisdiction over the vehicle: equation formulation, parameter specification, program design, and so forth. The necessary confidence is obtained via a technical activity that has become known as validation.

While validation is the final development activity, it is actually directed at confirming the accuracy and performance of all the products of the software development process. The correctness of the object code relative to the program design specification comprises but part of the necessary confidence that the software is correct. Also to be validated is the performance of the flight equations themselves, and all mission and vehicle targeting data. This means that *all* assumptions made during the development cycle must be placed within the purview of all validation participants. In short, the validation process is a software systems engineering activity that climaxes the overall development effort.

Who performs the validation activity and how do they go about it? Typically, validation is the responsibility of one or more organizations that have not participated in mission planning, analysis and equation formulation, or programming, although they should have been technically cognizant of these activities. Now no one will soberly certify with absolute certainty that a complex computer program will operate correctly under all conceivable conditions. However, it is reasonable to check out the software to a point that there is a very high probability that no errors of consequence exist in it for the expected range of operating conditions. So it is in the validation of aerospace flight computer software: the final software is put through an exhaustive checkout and performance analysis to achieve confidence that it operates correctly within this range; mathematically, that the probability of consequential errors is near zero.

The checkout process now used is beyond the experience of many computing professionals, particularly those outside of the aerospace industry. The procedures used are staggering in their intensive analysis and devotion to thoroughness. Ascertaining the adequacy of the flight computer software necessarily involves studying the behavior of the entire aerospace system under its control. Simulation on a support computer is the only practical method of studying this behavior, and it will continue to be a principal validation technique. Simulation is costly, however: a 6-hour aerospace mission may well require 30 hours of computer time for a single comprehensive simulation. Longer missions and greater complexity of the total aerospace system are rapidly making it prohibitively expensive to use simulation as the sole validation tool.

At first glance, some of the simulation and other validation techniques now current may seem to be slavish attempts to verify the correctness of a given program by brute force—possibly because validation of code for the relatively primitive aerospace computers now in use can be done only at the very basic branch and equation level. Nevertheless, a great deal of imaginative effort is required to assure that the programs are properly qualified. To this end, a wide range of validation aids such as independent mathematical checks and balances and highly sophisticated simulation tools are employed.

Validation technology offers a source of great potential benefits to the software industry at large. It is currently the only means of obtaining confidence that a computer program is ready for operational use before the fact, and we feel sure that the additional costs incurred in applying it would be more than offset by increased customer satisfaction. In this area also lies the source of greatest difficulty for aerospace computer systems of tomorrow; for much work must be done toward developing an improved validation technology capable of coping with the increased computational requirements of forthcoming aerospace systems.

future needs and trends

What is the future of aerospace software? The hardware to come will have much greater capacity, speed, and sophistication; the rotating memory computer will soon be a thing of the past. Keeping pace with hardware advances —forcing them, in fact—will be the far more complex requirements of the operational environments to come. Man in the loop is already a fact and will become increasingly important. Onboard programming is another future requirement expected to lead to more complex software. The more sophisticated hardware, coupled with the more sophisticated missions and the ever-present accuracy/performance requirement, will impose ever-increasing burdens upon the aerospace software development process. For one thing, the time now allotted to the development cycle is already close to insufficient. With the more complex requirements, an immediate problem will be how to develop the software in the *same* time period as in the present. For another, the ability must be developed to validate the more complex programs within reasonable cost and time factors; while the need for validation will not change, the difficulty of doing so will increase enormously.

Obviously a major improvement in the development process will come from the creation of on-line development tools made possible by the multi-processing capabilities of third-generation general-purpose computers; in this respect, aerospace software is certainly not unique. One of the principal problems facing the developer of aerospace flight computer programs is the need to complete them in a very short time. As a consequence, he often asks for voluminous (and thus hard-to-comprehend) amounts of computer output to assure himself that he is not forced to wait for more information from the typically overloaded batch-processing computer center. With on-line development tools he will be able to request less output, which is more easily diagnosed, and quickly regain access to the processor when he requires different information.

To accommodate the increasing computational burdens of the future, the aerospace software industry is devoting a great deal of attention to the development of common higher level programming languages for their applications. For the newer flight computers and those of the future, an effective higher level language could significantly reduce the amount of effort required in program development. The time required to modify existing programs could also be greatly reduced.

The chief requirement of a higher level language is that it be optimized to satisfy the very specific needs of the limiting, critical use: that of developing code in an efficient manner for aerospace flight computers. Such a language must above all be practical; the ability to implement it optimally will be far more important than its comprehensiveness. While it is theoretically desirable that the language be extended to all aerospace software efforts (mission design, support software, and so forth), the need to do so is subordinate. If the language implementation on flight computers is not completely satisfactory, it is very unlikely that such auxiliary roles will be considered at all. Another requirement for a higher level aerospace programming language is that it be tailored to existing flight computers while accommodating the expected transition to more sophisticated machines. It is likely, for example, that future computers will perform floating-point arithmetic. However, since most computers planned for use in the next few years are fixed-point machines, the language and its implementation should contain new and sophisticated means to generate efficient coding in the fixed-point arithmetic mode. Interpretive floating-point packages usually result in coding that is unable to meet the stringent timing constraints of flight computer software; requiring the programmer to specify the complete details of scaling and shifting would eliminate much of the advantage in using a high-level source language. For the most part, the language requirements for the more sophisticated flight computers of the future will very likely be compatible with and even a subset of the languages used for today's general-purpose computers.

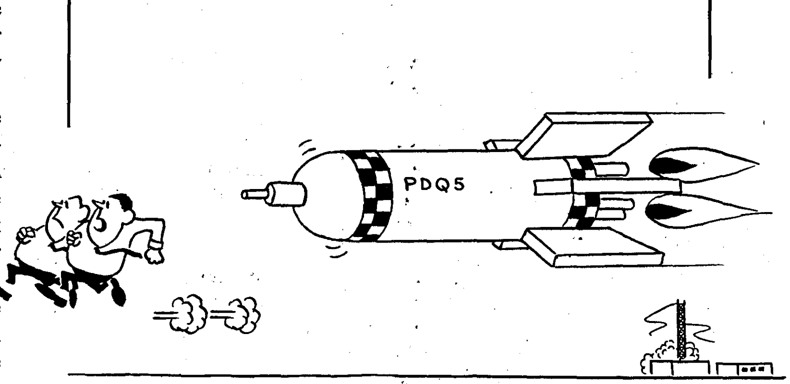
We feel, therefore, that the principal effort of developing and mechanizing higher level languages should be directed toward achieving a minimal language that can be used to write flight computer programs of the present. Once proven successful in this application, its compatibility with other aerospace programming applications can be considered. This is not to suggest that a super-language usable for all aerospace applications does not have a place. To the contrary, development of a problem-oriented source language has been suggested; such a language could greatly reduce both the communication problems between the many people working on a project and the turnaround times for follow-on missions within a project. This language should be complementary with the new higher level aerospace programming language and any other procedure-oriented languages, such as FORTRAN, now in use. Statements from the problem-oriented language could then be compiled into a specific procedure-oriented language for a particular computer, depending on what application is being used. For example, such statements could serve as input both to develop a FORTRAN program to perform mission analysis on a general-purpose computer, and to develop a guidance and control program that operates on a flight computer.

Although not a prerequisite, the acceptance of a standard higher order language would greatly enhance the utility of another new concept for relieving the increasing aerospace software burden: an aerospace software library to be shared throughout the industry. This idea centers on the development of program modules for use on a variety of missions with minimum changes. For example, if a particular explicit steering block were coded modularly, it might be possible to use it for dissimilar missions. Developers of flight computer programs could contribute to a library of available modules just as user groups for general-purpose computers now do. This type of library might prove to be even more useful for aerospace users because aerospace problems are so similar, especially in the navigation and guidance areas. It would certainly impose an additional validation burden, however, since each module entered into it would have to be validated to assure that it operated correctly in the context of the program it was developed for and also when combined with any other programs.

As we have said, the difficulties of developing software for the more complex missions of the future will be much greater. Almost certainly, simulation will still be the backbone of any development effort, but there will probably be less of today's very accurate and very expensive closed-loop simulations requiring exhaustive checks down to the level of the vehicle dynamics and bit-for-bit simulation of the flight computers. Once the individual program modules had been developed and validated, more sophisticated simulation techniques reaching only to the interfaces would substantially reduce the complexity of the checkout for a given mission. Such techniques would also reduce the development burden when only minor changes were to be made in a program used on a previous mission.

Our discussion of the increasing development and validation problem and possible ways of alleviating it has thus far ignored the fact that validation is an after-the-fact approach to satisfying the accuracy/performance requirement. It fails to extend to the far more basic problem of how to achieve quality in the flight computer programs, and does not provide a means of evaluating this software early in the development process when empirical knowledge of its quality would be most useful. The approach commonly taken by quality control functions in overseeing the development of software is the same as that taken in the development of hardware. This approach is hampered, however, by a lack of quantitative tools; traditional notions of statistics and of reliability terms are meaningless because errors in program design or coding are not analogous to hardware failures. If software is correct at one point in time, it cannot be wrong at a subsequent point for the same set of operating conditions. What is needed, then, is a set of quantitative tools for evaluating the flight computer software at any point in its development. They should be capable of identifying troublespots precisely so as to be useful in specifying re-work to be performed. A model which would generate a single number summarizing the program—the quality quotient, perhaps—would be of little use even in accepting or rejecting the software totally. The real need is for the intermediate numbers from which the final quotient could be derived. Studies to develop such quantitative quality measures are now being conducted. The resultant quality evaluation criteria should prove beneficial to the entire software community, for there is every reason to expect that the majority of these criteria will be directly transferable to many other areas of software development.

In summary, the present flight computer software development process is characterized by thoroughgoing development and validation techniques made necessary by the demanding accuracy/performance requirement. These techniques are faced with obsolescence owing to flight computer hardware advances and the increasing demands imposed by more complex missions. Thus the challenge to the aerospace industry is to find new and better ways of developing software that satisfies these increased demands, yet retains today's high level of confidence that it will operate successfully when first used. ■



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"I never did understand what Fail-Safe meant."

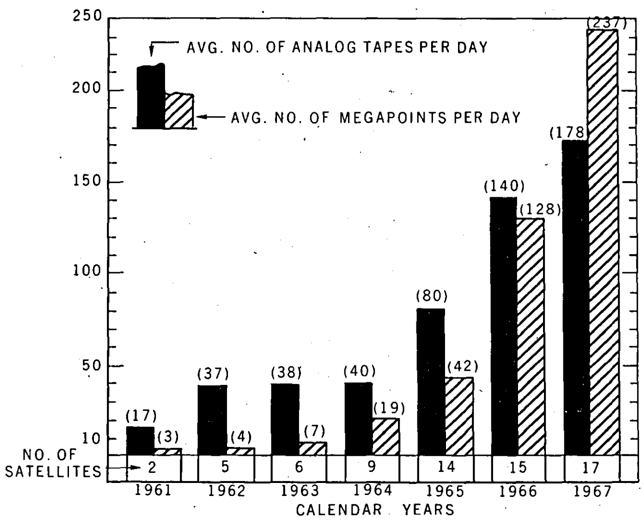
SPACE SCIENCES DATA PROCESSING

by GEORGE H. LUDWIG

In the pre-satellite era of the 1950's, experiments flown on sounding rockets and balloons produced from a few minutes to a few hours of data—analyzed during the next several years by the experimenters and, at universities, by their groups of graduate students. Even the first artificial earth satellites greatly expanded the data base by providing data for months of operating lifetime. Since then, the data rate has increased rapidly from a few bits per second to 64,000 bits per second in the case of the Orbiting Geophysical Observatory (OGO) series, and from operating lifetimes of a few weeks to several years.

Fig. 1 illustrates the manner in which the data volume has grown from 1961 to the present time for space sciences satellites. Only the figures for the Explorer,

Fig. 1. Growth in space sciences data volume, in millions of data points per day.



Interplanetary Monitoring Platforms (IMP), Orbiting Solar Observatory (OSO), OGO, Orbiting Astronomical Observatory (OAO), Application Technology Satellites (ATS) and Biological Satellites (BIOS) series are included. Excluded are the international satellites (for which data processing services are normally provided by the experimenters' countries), NIMBUS satellites (which actually do, in fact contain a number of scientific experiments), TIROS, Environmental Sciences Service Administration (ESSA), Department of Defense (DOD), and the University Satellite series. These manned, lunar, planetary, meteorological, and communications spacecraft, not discussed here, have larger requirements for real-time and near-real-time processing—both for operational purposes and because of the more volatile nature of their data. Data processing is done within the large scale Goddard Space Flight Center (GSFC) Central Processing Facility for all the projects discussed here.

(This article has been prepared from information presented by the author at the IBM Scientific Computing Symposium on Environmental Sciences held in Yorktown Heights, N.Y., Nov. 14-16, 1966 and at the NASA/EIA Briefing held in Cambridge, Mass., May 3-4, 1967. Proceedings of the IBM Symposium are available from IBM.)

the information system

For the purposes of this paper, the "information system" refers to those portions of the electronic system that collect outputs from the experiment sensors on the spacecraft, process these data on the spacecraft, transfer them to the ground receiving stations, and prepare the information for the experimenters so that they may reach conclusions about the phenomena being measured.

A generalized information system for space experiments is illustrated in Fig. 2. The sensors on the spacecraft are furnished by the individual experimenters and convert physical quantities, such as temperature, charged particle energy, and magnetic field intensity into electrical quantities. Signal conditioning circuits aboard the spacecraft—such as amplifiers, feedback networks, and charge integrators—are frequently associated directly with the sensors to simplify processing and telemetering of the electrical quantities. These are often followed by additional processing circuits to count pulses, measure the amplitudes of pulses and of more slowly varying analog quantities, and to measure time intervals to further simplify telemetering.

This processing is indicated in Fig. 2 by the elongated box on the left. The box is subdivided by dashed lines indicating that some of this additional processing may be done within individual experiment assemblies, while some of it may be done within a central data processing subsystem. Additional processing of two basic types may also be done on the spacecraft within this same block. The

Dr. Ludwig is chief, information processing division, tracking and data systems, at NASA's Goddard Space Flight Center. He was co-discoverer of the Van Allen radiation belts and project scientist for the Eccentric Orbiting Geophysical Observatory series of satellites. He has an MS in physics and PhD in electrical engineering from the Univ. of Iowa.

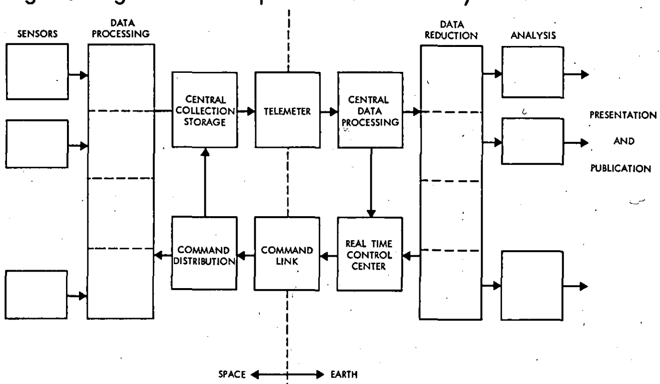
first includes processing to reduce the amount of raw data without reducing the information content—eliminating redundant information and meaningless zero readings—and to take care of the reformatting operations which involve simply the rearrangement of data. The second type of additional on-board processing is that which reduces the information content of the raw data, and which includes such processes as curve fitting, statistical analysis, spectral analysis, and mathematical manipulation.

The central collection and storage block in Fig. 2 includes provision for gathering the data from all of the individual sources—frequently by means of a time division multiplexer and the equipment for bulk data storage—either for time scale compression or expansion, or to permit reception of data for extended periods by the use of a few localized receiving stations. This is followed by the telemetry link, which includes the transmitter, receiver, antennas, space path, and encoding and decoding where employed.

For the spacecraft which contain command systems permitting modification of the operation of the experiments or spacecraft, the data are relayed in real-time or near-real-time to control centers at the GSFC and are displayed for operational analysis. Decisions are made which result in the initiation of commands to the spacecraft through the command link to modify the spacecraft configuration.

After the data have reached the ground, a number of additional operations are performed before they can be used by the experimenters in their analyses. A number of these functions are performed within the Central Processing Facility (CPF) for the satellites under discussion, including the establishment of data synchronization, noise removal, time decoding, and quality determination. These steps result in the shipment to the experimenters, and other users, of data tapes which contain the best estimations of the original data from each experiment output, along with the necessary status, performance, time, quality, command and validity information. It is also common

Fig. 2. A generalized space information system.



practice to supply orbit and spacecraft attitude information necessary for the experimenter's analyses.

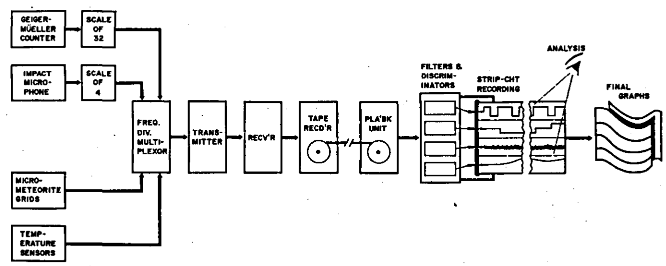
These operations are followed by a number of additional processing steps in which the data are edited, sorted, stored, and used in mathematical analyses and other manipulations to provide results in a form which can be readily interpreted. This function, too, is shown as one large block with dashed subdivisions, again indicating that portions of this function are performed by the individual experimenters and other portions are performed within the Central Processing Facility.

The final step is analysis of the information by the experimenters to ascertain some characteristics of the phenomena being investigated and the presentation and publication of these results.

representative systems

An example of an extremely simple space information system is shown in Fig. 3. This is the Explorer I system, which was successfully launched on Jan. 31, 1958, and led to discovery of the Van Allen radiation belts surrounding the earth. Pulses from a single Geiger-Muller (GM) counter were accumulated in a five-stage binary register capable of storing 32 counts. The state of the output stage was continuously transmitted. In addition, a number of temperatures and the continuities of a number of micrometeroid detection grids were also telemetered. Each signal source controlled a subcarrier oscillator so that the oscillator frequencies were proportional to the voltages from the sources. These oscillator signals were frequency multiplexed by the addition of the outputs from the oscillators. The resulting composite signal modulated the transmitters directly, and the output of the receiver on the ground was, in turn, demultiplexed by passing the signals through a number of bandpass filters and frequency discriminators. At the output of the frequency discriminators on the ground, the signals (identical in form to the signals that modulated the subcarrier oscillators in the spacecraft but with noise added) produced strip chart recordings. These recordings were manually reduced by a number of data readers to provide tabulations of the GM counter pulse rates, temperatures, and the rates of break-

Fig. 3. The Explorer I information system.



age of the micrometeoroid grids. This very simple system employed very little on-board data processing and very little machine processing on the ground, and was used in the first satellites to give a high probability of success at a time when instrumentation on satellites was still an undeveloped science, and when large volume data processing techniques on the ground were relatively unknown for this application.

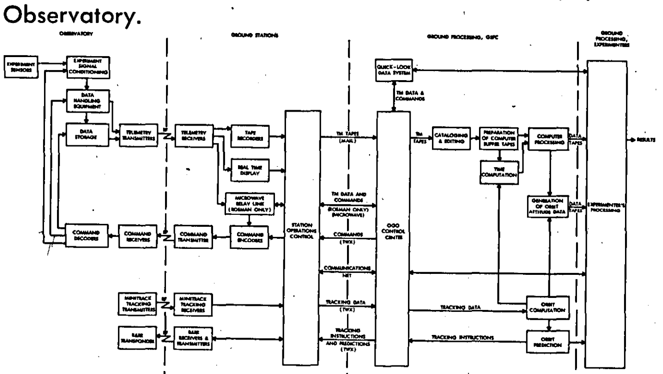
Since that time, technology has advanced until quite complex electronics systems are now placed on spacecraft and operated reliably for a year or more. We now perform many more experiments that are individually much more complex than those on the early Explorers since, as we investigate various phenomena in more and more detail in order to study their detailed characteristics, we must make more and more discriminating measurements, which involve a higher order of data processing. To illustrate, on Explorer I only the omnidirectional intensity of all particles above a threshold energy determined by the thickness of the GM counter wall was measured. Now, in the continued investigation of cosmic rays and energetic trapped radiation, the directional characteristics, the types of particles, the intensity as a function of particle energy and type, and the temporal variations of these parameters must all be determined. Therefore, where one could once simply count the number of pulses, one must now perform a multiparametric pulse height analysis of the outputs of rather complex detectors. These additional requirements impose a requirement of increased capability for the entire information system.

The information system for a recent large spacecraft is illustrated in Fig. 4. It is for the Orbiting Geophysical Observatory, a spacecraft in the 500-kg category, which was designed for a variety of orbits ranging from low, near-circular, polar orbits to very highly eccentric orbits.

Instrumentation for OGO experiments ranges from extremely simple generators of analog signals corresponding to, for example, currents in ion collectors, to extremely complex digital data processing subsystems involving digitization and manipulation of pulse heights from a number of detectors. Each of the two digital data handling subsystems on the spacecraft consists of a main time-division multiplexer with 128 data inputs, three slower sub-multiplexers, and a flexible format multiplexer that can be set at any one of 32 different input data formats by ground command. The last multiplexer is intended for use with extremely high information bandwidth experiments for relatively short periods. Two large-capacity tape recorders are included on the spacecraft. They can record at 1000 bits/sec for 24 hours or 4000 bits/sec for 8 hours, depending on the mission. In addition, digital information can be telemetered directly without the tape recorder at bit rates up to 64,000 bits/sec.

Data processing in the Central Processing Facility on the ground involves four major steps. The recordings containing the raw outputs of the receiver detectors are first passed through a set of equipment which estimates the values of original data bits, establishes bit, word and frame synchronization, and decodes the times recorded on the tapes at the ground receiving stations. The equipment produces a computer buffer tape. The second major step involves editing this computer tape to ascertain that there were no errors in its production and to determine data

Fig. 4. The information system for the Orbiting Geophysical Observatory.



quality. The third step involves establishment of the relationship between data as recorded on the spacecraft and Universal Time (U.T.). The fourth step is the decommutation (sorting) of buffer tape data and the generation of individual experimenter's data tapes and status and performance data tapes used for subsystem analysis. These data tapes, along with orbit/attitude tapes, are forwarded to the experimenters for additional processing.

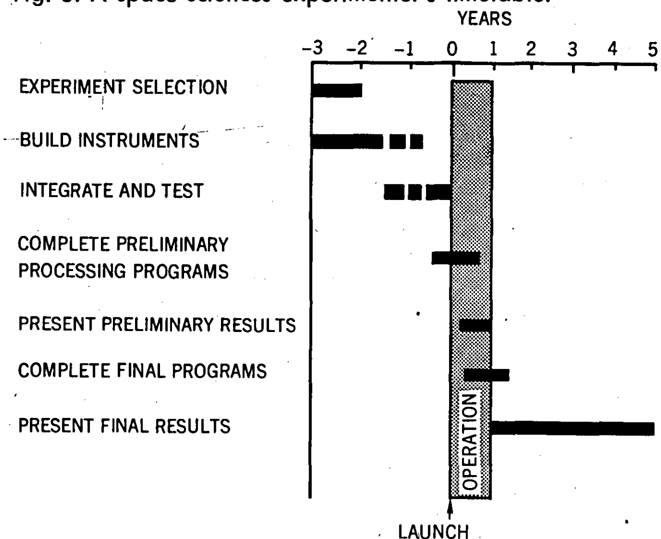
an experimenter's timetable

Each experimenter invests a considerable effort in conducting a specific space experiment. The timetable shown in Fig. 5 is representative of the Explorer, IMP, and Observatory missions. It indicates that a specific experiment may require from seven to nine years for its completion, including the time from the beginning of the actual building of the experiment hardware to completion of work on the data.

It must be kept in mind that the experimenters are frequently not able to predict the detailed characteristics of their expected data accurately enough to permit them to write the final processing programs before launch. Thus, although experimenters can sometimes present preliminary results a few months after launch by the use of interim processsing systems, it is common for them to require from six months to a year after launch for the preparation of the final processing programs. Their detailed reduction and analysis then occurs over a period of from two to five years.

A very strong effort is being made at the Goddard Space Flight Center to reduce the processing backlog in the Central Processing Facility and to maintain the processing on a current status. It is believed that progress

Fig. 5. A space sciences experimenter's timetable.



in shortening the experimenter's time scale can be made by additional work on on-board processing equipment and techniques and by the development of improved programming and display techniques for experimenter's ground data reduction. The remainder of this paper will discuss these three activities in more detail.

on-board processing

In the earlier programs data processing on the spacecraft was kept relatively simple to obtain high equipment reliability and high confidence in our ability to interpret the results after flight. However, some steps have already been made in the direction of increasing the amount of data processing on the spacecraft. A very simple example is the inclusion of floating point counters on several spacecraft which count pulses in a non-linear manner to provide a very large dynamic range and a fixed accuracy with a minimum amount of circuitry.

Processing in many current experiments is considerably more complex, involving, for example, the accurate digitization of a number of photo-multiplier and solid state detector pulse heights from cosmic rays when a given logic condition is met. Specialized computers for the computation of an autocorrelation function and for performing statistical analyses are being built for some of the IMP-F experiments.

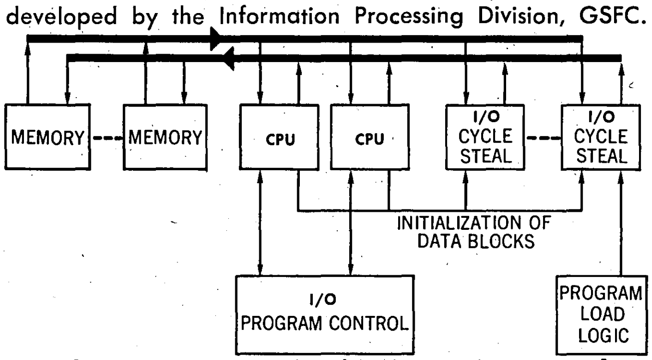
There are a number of arguments at this time for developing more extensive on-board processing techniques. One is that the volume of data being returned from the satellites is becoming extremely large, and the task of processing the data on the ground both in the central facility and by the individual experimenters is expensive and time consuming. On-board processing may check the present high rate of growth of data volume by reducing the volume of unused data. Another strong argument is that the on-board computers may make it possible to obtain information that might not otherwise be recoverable because of telemetry link bandwidth limitations.

A system designed for significant on-board data processing should be able to handle any degree of processing from essentially zero to a larger amount by reprogramming from the ground after launch. Thus, the spacecraft can be launched with a very simple data processing program and then, as the characteristics of the phenomena and the behavior of the instruments are ascertained in orbit, additional degrees of data processing can be added. It should also be designed so that it can, at any time, be reprogrammed for very simple processing to verify the proper operation of the experiments and data handling equipment. This is necessary to provide a high level of confidence.

On-board computers with stored but replaceable programs are now being developed. Some of these computers may also have the ability to control the calibration of experiments, the computation of spacecraft attitude relative to the sun or magnetic field (with resulting control of experiment sampling times and programs), and may interface with the spacecraft attitude control, power and thermal control subsystems.

The computer project under way within the Information Processing Division at the GSFC is illustrative. This on-board computer, illustrated in Fig. 6, employs a data bus with a variable number of memory modules (1 to 8) and central processing units (CPU's) (1 to 3) to provide a multimission capability. The input/output (I/O) provisions are also modular to adapt the basic computer to a large variety of experiments and spacecraft. The memory modules are woven, plated wire, random accessed, and true non-destructive readout. Each module will provide 8,192 18-bit words of storage with a 2 microsecond cycle time.

Fig. 6. The organization of the on-board computer being developed by the Information Processing Division, GSFC.



The CPU employs a full parallel adder and parallel transfer at register and I/O interfaces. It uses automatic scaling for binary point bookkeeping and hardware multiply/divide. Add and multiply times will be about 7 and 45 microseconds, respectively, including operand fetch. An alternate CPU employing serial arithmetic is also planned for those missions which do not require the speed of the parallel system. The I/O equipment will be customized for each mission but will have an over-all capability exceeding the requirements of any single application. It has a cycle steal capability for rapid direct exchange of data with the memory, priority interrupt for entry of data by external control, and external request scanning for entry of data by programmed control. The computer can be used as a multi-processor, and digital tape decks may be added when they become available. The single memory module, single parallel CPU, average I/O version of this computer is expected to weigh approximately 12 pounds and have a volume of about 0.25 cubic foot. It will consume from 3 watts (idling) to 13 watts (400,000 word per second memory exchange rate) and will be ready in the 1969-1970 era.

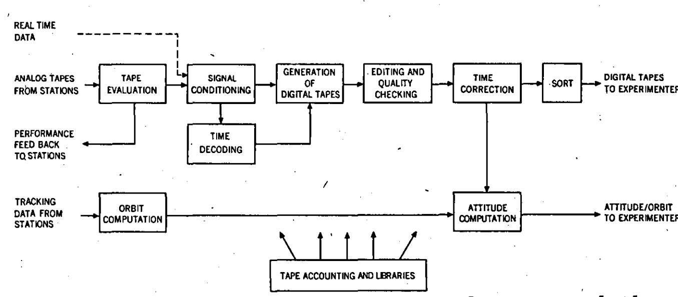
The use of general purpose on-board computers will have an important effect on the data processing performed on the ground. The early spacecraft, which had no command capability, depended on the ground network and the Central Processing Facility to gather the data as transmitted for later analysis by the experimenters. There was very little requirement for real-time and near-real-time processing since there was no possibility of modifying the operation of the spacecraft or experiments. As the spacecraft systems have become more complex and extensive command capabilities have been added, it is now necessary to perform a large amount of processing within the various Mission Control Centers (MCC's) in order to ascertain the performance of the spacecraft and to control its operation. When general purpose on-board computers are used, even greater reliance on real-time and near-real-time processing will be necessary for on-board processing to be more effective. Thus, we can expect a shift toward more real-time and near-real-time processing in the Mission Control Centers and Central Processing Facility.

It is possible that, for spacecraft employing the general purpose on-board computers, most data processing will be done immediately by the use of data transmission links from the data acquisition stations to the Goddard Space Flight Center and by the use of additional data transmission links directly to the experimenters' laboratories. One of the eventual functions of the Data Reduction Laboratory, which is described in a later section of this paper, will be to ascertain the desirability and practicability of this.

data processing in the central facility

After the satellite telemetry data are recorded on tape at the 12 data acquisiton stations, these tapes are forwarded to Goddard for processing. The initial processing is done in the Central Processing Facility. The output of this facility is a set of tapes for each experimenter, plus the necessary auxiliary information and the spacecraft orbit and attitude. The functions performed by this Central Processing Facility are illustrated in Fig. 7. One tape from each shipment from each data acquisition station is evaluated soon after receipt to determine whether the equipment at the data acquisition station was operating properly. After evaluation, the tapes are mounted on one of the Satellite Telemetry Automatic Reduction Systems (STARS) for initial processing. Signals are conditioned and bit, word and frame synchronization are established. In the signal conditioning operation, a best guess is made as to the original content of the signal on a bit-by-bit or tone-burst-by-tone-burst basis. This operation usually includes the integration of the signal for the duration of the bit or tone-burst period before a decision is made. At the same time that these operations are occurring, the times recorded on the tapes at the data acquisition stations are decoded and continuously compared with a locally running clock. Both the reconstructed telemetry data and the times are buffered in a core

Fig. 7. The functions performed within the GSFC Central Processing Facility.



memory and then recorded on a computer compatible buffer tape.

In the latest model of the processing lines, referred to as STARS Phase II, a CDC 3200 computer is included to perform two major functions. The set-up of the processing line is under computer control. Initial computer pre-editing is performed during this first pass to determine the quality of the data as early as possible. In addition, a simulator is included for system checkout.

After the first processing operation on the STARS lines, all additional processing is performed on general purpose computers, also indicated in Fig. 7. Further editing of the buffer tapes checks the internal consistency and the quality of the data. The times, either telemetered with the data from the spacecraft clock, or recorded with the data from a ground clock, or both, are converted to Universal Time (U.T.). Corrections are made for clock errors and propagation times. This step is crucial, since it is common practice to use time to correlate the flight data with orbital position and with other housekeeping and experimental data during the analysis phase.

The data, now including U.T., are arranged into a convenient format, and sorted (decommutated) onto separate tapes for each experimenter.

In parallel with the telemetry data processing, the spacecraft orbit is computed for each minute. This smoothed orbit, along with attitude control system error signals and attitude sensor output signals obtained from the telemetered spacecraft data, is used to compute the instantaneous look directions for the detectors. Both the orbit and attitude information are shipped to the experimenters along with their telemetered data tapes.

Since the identification of each command received by the spacecraft is not contained in the telemetered data, it is also necessary to decode the commands from the original acquisition station tapes. The complete command list is then furnished to the experimenters in the form of a magnetic tape, punched cards, or a listing. This task may be quite large by itself, since tens of thousands of commands are transmitted to some of the spacecraft.

In connection with these operations, it is necessary to conduct a number of bookkeeping and library functions. The original data acquisition station tapes are cataloged when received and eventually placed in permanent storage in the analog tape archive. An intermediate digital tape, the "edit tape," is also placed in permanent storage for use if it is necessary to redo the computer processing.

Several significant changes from the data flow indicated in Fig. 7 are being made. These include the movement of some of the pre-editing and quality checking functions to the STARS Phase II data processing lines, permitting determination of the quality of the data and success of the processing operation during the first pass.

A second change under way is the movement toward the generation of a master digital data tape near the end of the processing in the Central Processing Facility. This tape will contain all of the raw telemetered data, commands, corrected time, orbit, spacecraft attitude and quality information in chronological sequence with, most probably, overlapping portions of data removed. This tape will be the source of all further sorting and processing. In addition, it will become the prime archival medium, replacing the earlier analog station tapes and edit tapes.

additional ground data reduction

After the data are available in raw form, the experimenters must still reduce them into forms from which they can reach meaningful conclusions about the phenomena being investigated. This reduction commonly includes reformatting, sorting, merging, accumulation, statistical analysis, and mathematical manipulation. It includes some provision for outputting the summarized data in a readable form, such as line printer tabulations, x-y plots, motion pictures, etc.

It is useful to remember that most experimenters make four different uses of their data:

1. *Scan All Data.* It may not be necessary to perform a detailed analysis of every piece of data received from a particular experiment. It is generally necessary in these cases to scan all of the data to select the interesting portions, since it will not be possible to predict the time periods or regions in space which will produce those interesting data. To illustrate, bursts of particles are occasionally emitted by the sun. One of the objectives of many of the experiments is to detect these unpredictable bursts and analyze them in detail.

In order to simplify the process of scanning all the data, it is common to reduce them to strip chart or some other form for rapid viewing. One of the most recent techniques which shows great promise is the production of motion pictures generated by taking sequences of photographs of a suitable display of the data.

2. *Analyze Selected Portions of Data.* Limited portions of the data may require detailed analysis. These may include, for example, data obtained during transversal of the magnetospheric boundary surface, the transition region, and the shock front if one is studying the interaction of the solar plasma with the earth's magnetic field. Another example is the detailed study of the ionized layers surrounding the earth at heights of from one hundred to several hundred kilometers.

3. *Map in Either Space or Time.* A frequent scientific objective is to determine the spatial extent of specified phenomena. Thus, it is necessary to take the data from various periods during which the spacecraft moves from position to position in its orbit, and the location of the orbit moves in a sun-earth coordinate system. A complete mapping in space may require a year or more. It is frequently necessary to reduce these data to one or a few plots to provide a map of the phenomena.

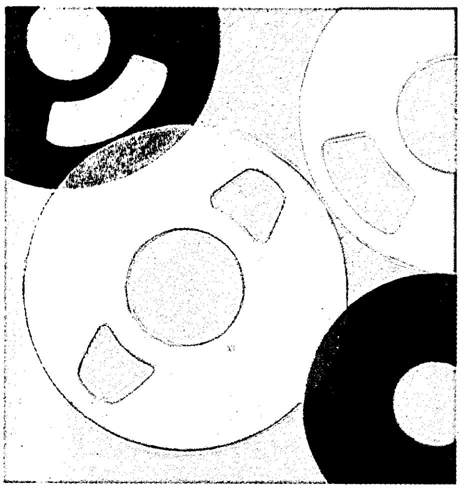
It is also frequently necessary to provide a map in time, with scales ranging from minutes or hours to many years. For example, in studying numerous solar-related phenomena, some changes occur in a few minutes during the buildup of a solar flare. On the other hand, other changes involve a time scale equal to the length of the sun spot cycle of 11 years. Thus, it may be necessary to investigate the data from a particular type of sensor for at least that period of time in order to have a complete understanding of the phenomena.

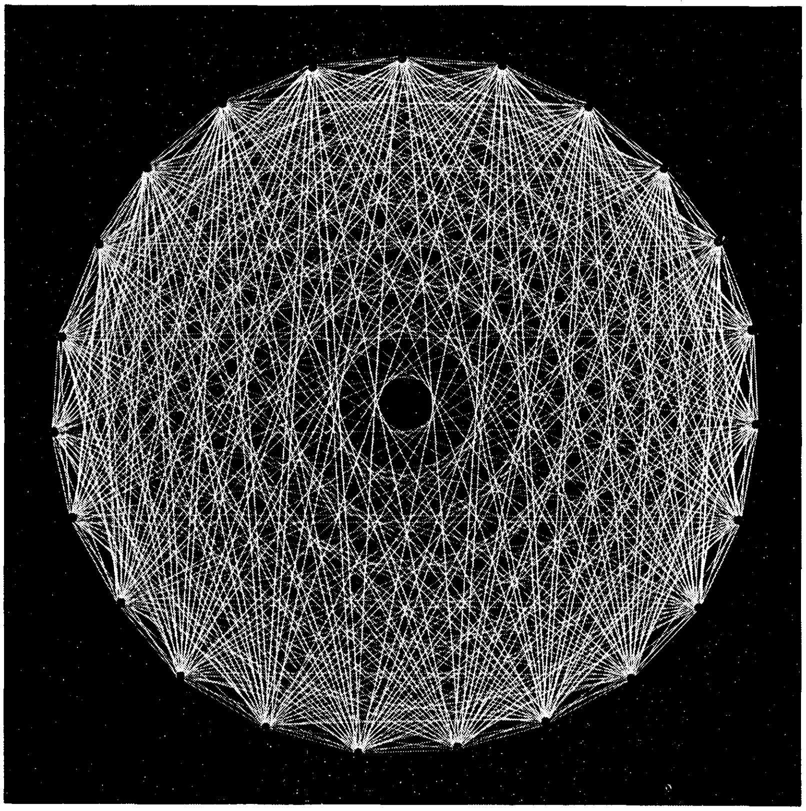
4. *Analyze All Data.* Some experimenters may require the full analysis of all of the data for extended periods of time. Most generally, this will be for those experiments which have event accumulation rates low enough to require data from long operating periods to obtain statistical significance. An example of this type of experiment is a cosmic ray experiment, where only a few heavy particles of some types may be seen each week.

Note that the processing techniques for meeting each of the four data analysis requirements listed above may be considerably different. Any one experiment may require processing programs for several of these four analysis functions.

At the present time these reduction programs are usually prepared by the individual experimenters, with frequent parallel development of similar subroutines by different groups. To assist the experimenters in their tasks, several new development activities are needed:

1. *Basic Computer Programming Techniques for Telemetry Data Manipulation.* Present programming tech-





niques using FORTRAN, COBOL, etc., are rather poorly suited to the rapid development of new programs for data manipulation. New modular programming systems for data manipulation are required.

2. *Subroutine Organization.* Subroutines for performing specific functions (e.g., scale factor correction) need to be assembled into a library system and made available to the community of users. This subroutine structure needs to be built into the program structure discussed above.

3. *Better Display Techniques, Devices, and Programs.* Many experimenters still obtain their data outputs as printed tabulations and then reduce them to charts manually; CRT displays, motion pictures, the use of color, and three-dimensional displays can be expected to provide a more rapid and comprehensive understanding of the phenomena being investigated.

Several efforts are under way to develop some of these techniques. The Data Reduction Laboratory (DRL) is being developed by the GSFC Information Processing Division to provide several operator stations with two consoles each. One alphanumeric CRT and keyboard at each station will provide dialog communication with the central Univac 1108 computer for rapid program development. The second CRT will display alphanumeric and graphic data in either static or dynamic form. It will be possible to add remote communications consoles later so that experimenters may develop programs from their own laboratories. It will be possible to enter data either in real-time via the data link from several of the STADAN stations, or off-line from either analog or digital tapes. In addition to its capability for rapid program development, its dynamic display capability will provide operational real-time and near-real-time data presentation for the support of experiment/spacecraft operations, especially during critical operating periods. This basic DRL is scheduled for completion early 1969. ■

casing venus

THE ROLE OF COMPUTERS IN MARINER V

by EDWARD K. YASAKI

Last month, the spacecraft Mariner V passed within 2,000 miles of Venus, the planet that is both the closest to Earth and also one of the most mysterious in the solar system. Similar to Earth in mass, density and size, Venus is so enshrouded with clouds that no one has ever seen its surface and, until the U.S.S.R's recent exploration, the world had very little knowledge of its characteristics. To get a clearer picture of this surface, to make measurements of the Venusian atmosphere, and to perform other scientific experiments and measurements were the roles set out for Mariner V, as it is now called.

It was known as Mariner Venus 67 when it was launched from Cape Kennedy last June 14. That was the first day of a two-week period during which a shot to Venus could be optimally made. A launch during this time required the least power, or escape velocity, to get to Venus—a function of the relative positions of Venus and Earth as they revolve around the sun. Another such opportunity would not be around for another 19 months. Still, it was a 114-day, 212-million-mile trip.

During all this time, both ground-based computers and on-board digital systems have played major roles.

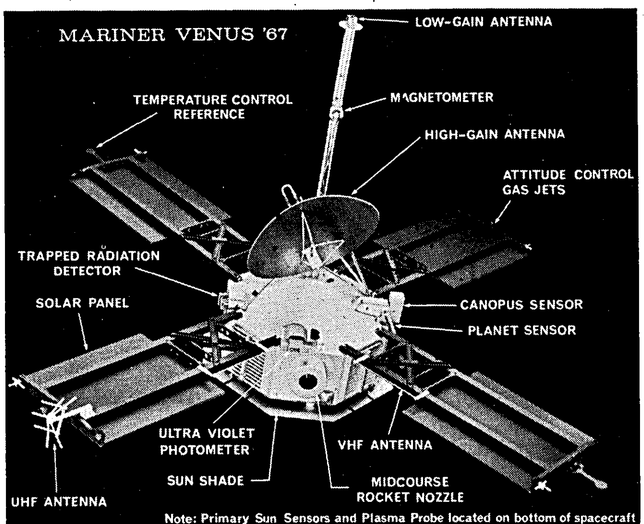
One of the on-board systems is the Central Computer and Sequencer, an 11½-pound unit that functions as a timer to initiate spacecraft events. Not really a computer, the CC&S consists of three counters, each with a one-second clock rate.

The launch counter is started three minutes before the launch and continues for 1,000 minutes (16⅔ hours). This counter initiates the deployment of solar panels (to generate electrical power) and the activation of the attitude control subsystem and Canopus sensor. The latter consists of light-sensitive diodes that look for and lock onto the star Canopus, one of the brightest in the galaxy. By finding Canopus, the spacecraft is able to point its high-gain antenna toward Earth and also have a celestial reference on which to base the midcourse maneuver.

The midcourse counter, initiated from a ground command, can run for 200 minutes. It tells the spacecraft how far and in which direction to turn on its pitch and roll axes and how long the midcourse rocket engine must fire.

The third counter controls those events that occur during the cruising portion of the flight and the subsequent encounter of Venus. It starts three minutes before the launch, but has the capacity to continue beyond the duration of the mission. This counter, some 30 days after launch, switches the spacecraft's telemetry transmission to an 8⅓ bps rate, down from the 33⅓ bps at the start. The faster bit rate at the start is to ensure the capture of much meaningful data about the condition of the craft, which is needed during the launch and early flight stages. During the cruise phase, the transmission rate is slowed down to allow good data recovery when the signal level from the spacecraft becomes lower.

Data telemetered from the spacecraft consists of engineering and science measurements prepared for transmission by a data encoder. This information indicates voltages, pressures, currents, temperatures, and other values



measured by the spacecraft telemetry sensors and scientific instruments. During the launch and cruise stages of the flight, information sent to ground stations is a mixture of about two-thirds engineering—relating to the performance of the craft—and one-third scientific. As the craft encounters Venus, engineering data comprises only about 3% of the transmission. And after the encounter, as Mariner V passes from behind Venus (as viewed from Earth), science data is read from mag tape—with periodic insertions of real-time engineering measurements.

The tape recorder for this uses 50 feet of mag tape in an endless loop. Science measurements formatted by the Data Automation System are recorded simultaneously on two tracks at 66⅔ bps, the tape moving at 0.80 ips. Playback of the data after the spacecraft passes the planet takes approximately 36 hours at 8⅓ bps.

The Data Automation System, a 20-pound solid-state sequencer, controls and synchronizes five of the seven scientific experiments that are a part of Mariner V's mission. The DAS also records the information and converts it into a suitable digital form for transmittal to Earth. The experiments:

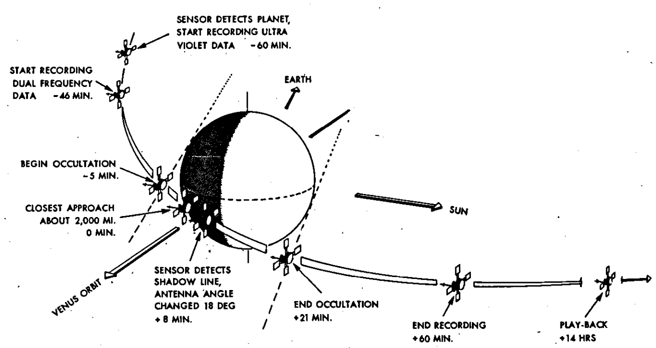
- Ultraviolet photometry experiment, designed to measure atomic hydrogen and atomic oxygen in the upper atmosphere from which atmospheric scale height and a temperature profile of the upper atmosphere of Venus can be calculated.
- Radio occultation experiments, which should provide data on the refractivity profile of the atmosphere. Temperatures, pressures and densities can then be deduced by assuming model atmospheres composed of various constituents.
- Magnetic field measurements, designed to determine the direction and strength of any magnetic field that may exist around Venus, as well as provide data on interplanetary magnetic field.
- Trapped radiation experiment, which will observe charged particles of various energies during interplanetary cruise and around Venus.
- Solar wind experiment, which will study density, velocities and direction of the relatively low energy particles of the solar wind and their possible interaction with Venus.

Other experiments, not controlled by the DAS, are the S-band occultation, an attempt to determine the density of the Venusian atmosphere by transmitting radio signals from the spacecraft through the atmosphere of Venus to Earth, and the celestial mechanics experiment. The latter is an attempt to refine basic information on the masses of Venus and the moon, on the astronomical unit (the distance from Earth to Sun), and on the ephemerides of Earth and Venus.

Two-way communication with Mariner is accomplished with a radio link between the spacecraft's dual-transmitter/single-receiver radio system and the 10 tracking stations on Earth. The stations, in turn, are connected by Teletype (30 bps) and high-speed (1200 bps) lines to the Jet Propulsion Laboratory in Pasadena, Calif., a NASA facility run by CalTech.

The 10 space communications stations, situated on four continents and a South Atlantic island, are a part of NASA's Deep Space Network. They are located geographically so that at least one station always has a clear communication line to any spacecraft. The facilities are located at four sites in Goldstone, Calif., in the Mojave desert; two in Australia, at Woomera and near Canberra; two more near Madrid, Spain; and at Johannesburg, South Africa and on Ascension Island. Not all stations are actively engaged with any one space mission, but it requires at least three to maintain 24-hour tracking.

MARINER 1967 FLY-BY OF VENUS



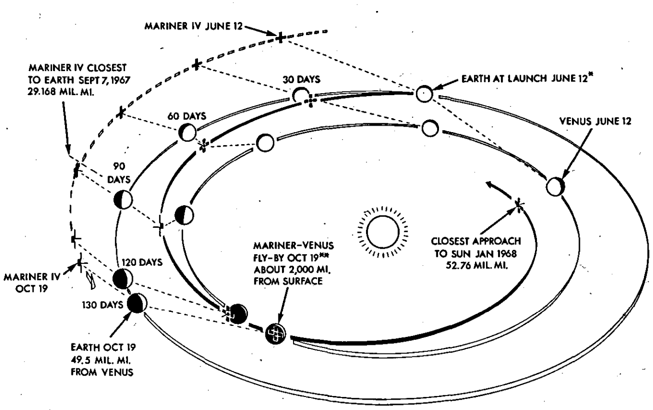
At each site is an 85-foot-diameter parabolic antenna (a 210-foot model is a feature of the Mars station at Goldstone), plus transmitting, receiving, data handling, and interstation communication equipment. Microwave frequencies (S-band) are used in all communications with the spacecraft. In addition, there are four SDS 900-series computers.

In a dual-mainframe configuration—for redundancy—one pair of 8K 920's forms a Telemetry and Command Processor. It performs telemetry decommutation and editing, writes a log tape, and formats and buffers data for transmission to JPL. An 8K SDS 910 controls the antenna, operating from a driver tape (paper tape with trajectory data supplied by JPL) and also generating its own ephemeris—the position of the spacecraft as seen from the station. When the craft is far out, this means merely compensating for the Earth's rotation. A third 920, also an 8K unit, is the Digital Instrumentation System, which monitors the tracking system. It oversees the configuration at the site, the tracking mode, and compares the actual performance with expected results.

The tracking stations and the central computation facility that supports them cannot be said to operate in a closed-loop fashion with the spacecraft. Telemetry and tracking data, before they reach the Space Flight Operations Facility (SFOF) at JPL, must enter the Nascom communications network. As a JPL official describes it, this means that telemetry data might be received at the Earth station and relayed (in real-time) bit by bit over Teletype lines to NASA's Goddard facility in Greenbelt, Md. There the bits are poured into the buffer of the communications processor, a Univac 494, whence it is sent on to JPL. In Pasadena, the buffers of another communications processor, this time a Univac 490, are filled before the data is sent on to an IBM 7044, which places the raw data on a disc. By the time an IBM 7094-II, which also has access to the same disc, is able to act upon that data, much time has passed and many miles have been logged by the spacecraft.

Thus the computers at SFOF, in contrast to those at the Manned Spacecraft Center in Houston, are used mostly for analytical purposes. Since JPL manages unmanned space launches with scientific experiments aboard, the acquisition of data about these experiments and their subsequent analysis are of great concern. Perhaps the best known of this type of activity are the photographs of the moon's surface taken and transmitted by Surveyor spacecrafts.

MARINER-VENUS 1967 FLIGHT PATH



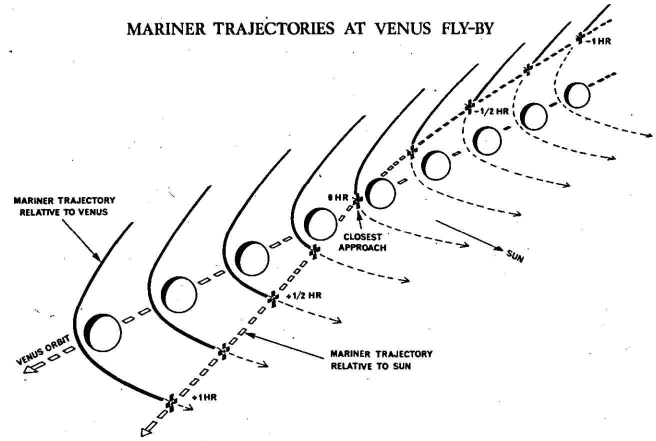
*Launch period June 12–24 **Fly-by same for all launch days

At the SFOF, are three "processor strings," or identical sets of computers. Each consists of a 64K IBM 7044 and a 32K 7094-II, both linked to four modules of 1301 discs (a total of 18 million 36-bit words). The computers are also connected by a direct data channel (DDC) and by sense lines. The DDC is used, for example, when the '94 calls for a change in a constants file on which it is operating; through the sense line, the 7044 is able to tell the '94 what to do with new data for the constants file. In short, the DDC is principally for the transfer of program data, and the sense line for control information. The shared discs transfer spacecraft and tracking data. The 7094 also has two 8-drive tape channels, both loaded, and the '44 has another eight drives.

Two of the processor strings can be used in support of a mission in one of its critical phases—during launch and encounter, for example—and another string could then be devoted to another space mission in a noncritical phase—as during the cruise phase. The '44 and '94 can also be operated independently, as indeed they usually are. Since so little of the computation is not in real-time, jobs can be run in the batch mode weeks ahead of their anticipated need. Once a spacecraft is placed into orbit, scientists are able to compute its trajectory a week in advance and notify the tracking stations where they can expect to begin tracking the vehicle as it rises over the horizon. This computation accomplished, then, they need only ship this information to the tracking station for use each day.

On-line to these processor strings are the user stations, also called analysis areas because they are occupied by the Flight Path Analysis group, Space Science Analysis group, and others. There are six such areas, each having one or two sets of I/O equipment. A typical set might include a Tasker Instruments message composer and status display console, by which messages and commands for the computer are input; a bulk printer (SC 3070) for high-quantity output; an administrative printer—another electrostatic unit, this time a Motorola mod 3000—for indicating operating conditions, the status of data going to and from the computers, and for program status; a Milgo 30 x 30 plotter for trend indication; and a Burroughs card reader that has been modified by Lockheed Electronics for interface compatibility, used as a back-up to the message composer.

MARINER TRAJECTORIES AT VENUS FLY-BY



A fourth processor string, similar to but not identical with the 7044/7094 complex, is used mostly for the production and testing of software.

One can get an idea of the magnitude of the software effort required for an unmanned shot by a look at one program, that for orbit determination. Twenty core loads in size, this program starts with the raw tracking data. This is placed on the disc by the 7044, where it is accessible by the '94 (see Fig. 1). The Mission Independent Editor in the '94, operating under the SFOF System, calls in the raw Teletype data from the disc, separates the telemetry from the tracking data, and stores it back on disc in the Raw Tracking Data file.

The Tracking Data Processor (TDP) program retrieves this data, edits and reformats it, and places it back onto the disc in the Master Tracking Data file. The Orbit Data Generator (ODG) program uses this file to prepare a block of data for the Orbit Determination program. Essentially, the ODG program extracts a subset of the Master Tracking Data and formats it, using control inputs which have been provided to the program.

The Orbit Determination program (ODP) retrieves the block of ODP data, compiled by the ODG program, and, employing a least squares curve fit and an iterative technique, determines the orbit of the spacecraft. The injection, or epoch, conditions are placed on the disc and

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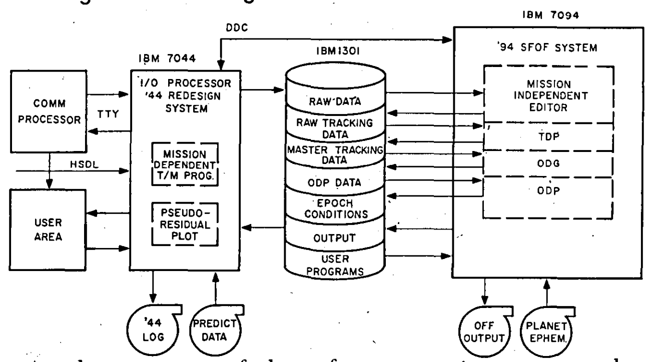
The area on the disc (Fig. 5—this page) marked "User Programs" contains the actual programs called up by the system and brought into the 7094 for operation. The normal output of these programs can be accessed by the 7044 from the "output" area on the disc and sent to the user areas for display.

Similar programs exist for trajectory computations; the predicts computation which computes the predict data for up to 15 stations, along with the station view periods; one for selecting a midcourse maneuver that satisfies all trajectory constraints; and many more.

When the spacecraft goes into its cruise phase, only the 7044 is used. The '94, then, can run in the batch mode for job-shop work. All real-time processing and display capability, however, continues, and incoming data is still recorded on the 7044 log for subsequent processing.

Tracking data handling and orbit determination



Another measure of the software requirements can be seen from the manpower expended. Something on the order of 11 man-years of programming effort went into the Mariner V shot. And yet most of the software used was taken from previous space launches. One of the changes made in time for the Mariner V mission was the processing of more telemetry data in real-time. In previous missions, such data was processed in real-time, "near real-time," and the post processing performed during the two to three months following the mission. By getting rid of the "near real-time" processing they should be able to complete in some two weeks the post-processing phase.

One of the functions of post processing is to take data from the log tapes of the 7044, as well as the 920's at the tracking stations, and come up with the most accurate stream of telemetry data possible. The ideal stream can be broken down into spacecraft data frames, each consisting of engineering sync words at the beginning and end of 19 (7-bit) words. An Edit program comes to some conclusions about the quality of the stream based on the proper or improper locations of the sync words, and by looking at some of the data words that contain information on the status of the processing, recording and receiving equipment. The Edit program then produces a standard Master Data Library (MDL) tape and a Bad Data Listing tape; the latter is formatted for off-line printout and eyeballing to see how much additional processing is required to improve the quality.

The MDL tape is then subjected to a Re-edit program. One of the problems detected is that of inconsistent times, for which there are many potential sources. At the DSN stations, for example, they may begin recording time on the time track before they begin recording the spacecraft's analog signals. Inconsistency also can occur from bit errors in the time track, in the recording of days, hours, minutes or seconds. By looking at bad data flagged by the Edit program, much of it can be corrected.

A third program, Merge, processes a number of tapes (up to six) from various sources, covering the same period of transmission, and merges them into one "best possible" tape. The tapes processed by the Edit and Re-edit programs are from a variety of sources; therefore, many tapes can contain telemetry data for identical tracking periods. This occurs during station overlaps—when more than one station is tracking the spacecraft at one time—and from overlaps within a station—when a second recorder is started while the first is still running. (Approximately three analog tapes are required for one pass of the spacecraft over a station.)

The resulting MDL tape can be used by engineers concerned with the performance of the spacecraft and its various subsystems, and by scientists. A magnetometer experimenter, for example, can extract all magnetometer data.

The production of software to perform these functions is obviously an enormous undertaking. One applications program—for the computation of the trajectory—can take almost an hour for the printout. And while there are critics of the software being used, the fact is it works. Not examined in this article is the computation that precedes a launch, sometimes years before the actual lift-off.

Not only does this include a determination of the optimum launch date—a two-week period in mid-June of '68 for a Venus shot—but also the correct injection velocity, 2,515 miles per hour relative to Earth. Because the Earth is orbiting the sun at 66,000 mph, an observer on the sun would clock the spacecraft at 72,255 mph. This velocity, plus the Earth's speed, is imparted to the spacecraft at injection. But the two quantities are added vectorially, or in different directions; only if the two were in the same direction would the total be 91,515 mph.

Some 1.5-million miles out, when Earth's gravitational effects are cancelled, the speed relative to Earth becomes 6,740 mph, allowing the craft to orbit the sun closer than Earth and to curve inward toward Venus. At encounter, the craft passes Venus at an estimated 18,440 mph relative to Venus.

Designers of the trajectory also had to keep in mind that Mariner must pass Venus ahead of its orbit around the sun. The fixed arrival date, Oct. 19, was derived from the need for a set position of the sun, Venus and Earth as Mariner occulted (went behind) Venus, as seen from Earth. And during the entire trip, it was imperative that the craft's solar panels be exposed to the sun and that the reference star Canopus always be visible.

Further, the trajectory engineer must see to it that Mariner not impact Venus, lest there be contamination of the planet by Earth micro-organisms. The distance of Mariner from Venus at its closest approach, ideally 2,000 miles for this mission, is also influenced by the launch accuracy and the midcourse correction's accuracy. These accuracies are illustrated in this way: The injection velocity can vary by only ±30 mph or the resulting trajectory will not be within the correction capability of the midcourse motor. At midcourse maneuver, an error of one mile per hour in the velocity change will result in an error at Venus of 2,000 miles.

While no computer was aboard Mariner V, the use of stored-program computers to automate more and more of the functions carried out from within the spacecraft are in the planning stages. Mariner VI will have such a CC&S. Indeed, a fully automated laboratory under the direction of a computer and suspended in space has been proposed. And if missions with durations of several years are to be accomplished, something on the order of a multiprocessor with so-called "graceful degradation" features may be the only way to fly. Meanwhile, the computers on the ground that are engaged in mission simulation, pre-launch checkout, tracking, data collection and analysis will continue to play their supporting roles. ■

TIME-SHARING TALLY SHEET

it's harder than it looked

by ROBERT L. PATRICK

DATAMATION's interest in time-sharing began in earnest in an editorial conference in mid-1963. At that time, the concept of time-sharing had been demonstrated experimentally at MIT some 18 months earlier. MIT was then proceeding in the implementation of a full scale time-sharing system. Also in 1963, SDC was proceeding with the implementation of a time-sharing system of their own similar to, but different from, the MIT system. Both of these efforts were heavily underwritten with Federal R&D funds. As DATAMATION became interested in this area, the literature and the conferences were replete with grand claims of "increased productivity" if this new mode of operation was adopted.
From preliminary analysis, it seemed that these claims were mere hopes, completely unsupported by fact. In October 1963, DATAMATION published its first article (3) lamenting the state of affairs and calling for a careful approach to a difficult problem. Unfortunately, that approach was not taken and we stand, four years later and many millions of tax dollars poorer, still requesting a careful approach to a difficult problem.
In the article below, DATAMATION deviates from previous policy by reviewing some material which has been published elsewhere. Time-sharing appears to be a valuable technique for solving certain kinds of problems. In an effort to assist our readers in determining where this useful technique should be applied, five experimental studies have been reviewed.

In searching the literature prior to writing this synopsis of the state of development of time-sharing systems, five measurement studies were obtained. The first (21) was published by a team from IBM's Cambridge Research Laboratory. The next pair were published in summary form by SDC (18). The last two are contained in an as yet unpublished doctor's thesis*. The viewpoints of each of the authors is different; their methods of presentation are quite varied. In an attempt to reduce these five studies to a common denominator, they are summarized below.

the IBM comparison

In the late summer of 1965, a team from IBM's Cambridge Scientific Center undertook an experimental comparison of time-sharing systems and batch processing systems. They were interested in obtaining a measure of the effectiveness of time-sharing systems in the problem-solving context. They, like those to follow them, immediately encountered a series of difficulties. Initially they had problems of definition. What is effectiveness? How does one grade the effectivity of the man/machine interaction? How does one classify computer applications? What computer applications should be considered typical? What are the external facets of the process which can (or cannot) be ignored?

Without really coming to grips with the total problem, they chose four problems and four individuals and designed an experiment. They wished to measure elapsed time, analysis time, programmer time, computer time, number of compilations, and total cost. They meticulously designed a statistical experiment to try and eliminate the differences in individuals and in the four problems shown. They attempted to gather experimental results to assist in the evaluation of competing computing systems.

The results, and these are supported by only eight precious data points each, show that time-sharing saves about 50% of the elapsed time for a problem solution when compared with an equivalent batch processing technique. To do this, time-sharing requires more analysis time, more programmer time, a larger number of compilations, and 50% more total cost!

For reasons academic or political, the authors neglected to draw any hard conclusions from their experimental measures. The dissertation trails off into a lengthy discussion of mathematical statistics, primarily of interest to those who do not produce results for a living. So, with boldness, let us review what can be concluded from the experimental data presented.

First, IBM selected four quality programmers as guinea pigs and still found a significant spread in their performance. Even though their spread was 3 to 1 in total cost for the four problems, this may even be atypical since many of our industrial shops have a wider spread in programmer performance than that demonstrated in this exercise. Second, for some strange reason, the authors were coy about the rates they chose for their various components of cost. An hour on the time-sharing system cost them $840. An hour on the batch system cost only $560, and for some reason they figured programmer time at only $3.00 an hour. In preparing this paper, I refigured all their costs with a more reasonable programmer rate of $9.00 an hour. This changes their numbers somewhat, but not the conclusions.

The eight solutions were obtained under time-sharing in 29.5 elapsed days for a total cost of $2,138. The same eight solutions were obtained under IBSYS in 46 elapsed days for a total cost of $1,350. The conclusion is inescapable. If elapsed time is precious to you, then time-sharing delivers the goods sooner at a greater cost. Conversely, if your budget is tight and you have programming work backlogged to the ceiling, then give each programmer two jobs (so he has something to do while he waits for his batch work to return from the computer center), save your budget, and get more work done.

The study showed that the programmers worked considerably harder under time-sharing, accumulating 5,672 working minutes in the 29-day elapsed period. The

*Unfortunately the full citation of this worthwhile thesis cannot be given: The university administration forbids any quotes or citations of unpublished work even though the facility described is subsidized by Federal funds.

programmers solving batch problems accumulated only 2,737 working minutes in the longer 46-day elapsed period. The work covered in these time periods consisted of all programming, analysis, and debugging related to producing a computer program.

Missing from the report is any explanation of what the programmers did with the remainder of their time. Under time-sharing, supposedly the programmer had ready access to computers. They logged about 2½ weeks of work out of a 6-week elapsed period. No explanation is given for the other activities. In the case of an industrial setting, a programmer would probably log a far higher percentage of his time to his job assignment. If he were waiting for computer service, this delay would be translated into additional cost. Each industrial supervisor recognizes that it is impossible to keep his programmers working 100% of the time due to unavoidable delays in administrative red tape and in machine service. The statistics gathered in the IBM study appear to bill the problem solution for only that time the programmer spent actually working on the assignment. This is quite optimistic: if full time (including lost time where the programmer had no other useful activities) had been billed to both time-sharing and batch, the time-sharing system *might* have shown more brightly.

Another interesting piece of data which was omitted from the published study is any definition or measurement related to turnaround time on the batch system or to console availability. For some unexplainable reason, it took the programmers using the batch system 16 more working days to complete their assignments than it took their time-sharing brethren. The paper neglects to provide any indication of how much of this time can be ascribed to total lost-time while waiting for runs to return from the computer and the fact that no alternate work activities were available.

Another interesting oversight is the lack of any mention of the quality of the product produced by these four programmers. Were the programs produced under the two systems comparable in size, execution time, completeness and flexibility? The individual differences in programmers varied by several hundred percent. Was this because some programmers produced a higher quality product but took longer to do it?

Finally, it must be noted that no mention of documentation was made in either case. In the batch case, the work is forced to spread out as it is paced by the turnaround time supplied by the computer center. During times of low activity, documentation can and *should* be done in parallel with program development. Thus, when the program finally runs, the report is almost complete. The same work mode does not seem to apply in the time-sharing case. If machine time is always available, then there are no dead spaces when the programmer cannot work. Thus, documentation time must be *added* to the solution time because the programmer cannot be reassigned until the documentation is completed.

To conclude, the experiment was well designed, the sample was small, they tried to be objective, they left a few questions unanswered; time-sharing produces results sooner, and the batch mode is the cheapest.

the SDC studies

The SDC Studies were published in late 1966 and exhibit some of the same garrulous qualities as did the IBM one. After a rather good introduction, the description of the experiment deals heavily with statistics and only slightly with the phenomenon being investigated. In one study, a programmer was allowed to use the full facilities of SDC's time-sharing system. The competing data was gathered by causing a programmer to submit his work to a second party, who then made a time-sharing run in accordance with the written instructions he had been given, and then waited until two hours had elapsed (total) and returned the printout to the programmer.

While the statistics are very impressive, the experimental technique is fundamentally fallacious. To simulate a batch operating system as described above changes the environment in an uncertain way. Most batch shops have debugging tools which are devised for the batch environment. The same program deck can be put in several times and several tests can be run back to back with no interference in a normal batch shop. The results of each test can be made completely available both through the normal printouts and through rather massive off-line dumps. None of these tools is available to the programmer when the batch shop is being simulated by a second party sitting at a Teletype.

Further, the raw hardware efficiency of a batch shop is superior to that of a time-sharing facility. Thus, for a straight computational run, the milliseconds of CPU time required to read the input, process it, and write a line of output are considerably less in the batch mode than in the time-sharing mode. However, in the SDC experiment, no mention is made of any credits applied for this efficiency phenomenon. Thus, the raw data on CPU time used is biased strongly in favor of the time-sharing system.

In the first of SDC's two experiments, they tried to compare only checkout performance under the two methods (time-sharing and simulated batch). In both cases the analysis and the programming were done beforehand. After the programming had been completed, the unchecked-out programs were entered into the computer. At that moment measurements started. They gathered data on debug man-hours and CPU time for debugging. Thus, any differences in total solution time having to do with analysis or programming are not contained in the measured results. One additional facet of the first SDC experiment is in the high quality of guinea pigs involved. Twelve programmers with seven years average experience were chosen as the experimental subjects.

Data was gathered on only two measurement criteria: debug man-hours and CPU time. Typical of SDC's non-profit bias, no calculation of total cost appears anywhere in the report, nor are dollars mentioned. To get comparable data, I worked up the total costs using the same rates as in the work reported above: $9.00 per hour for programmer time, $840 an hour for time-sharing time, and $560 an hour for batch time.

SDC assigned an algebra problem to their 12 experienced programmers and found that the mean programmer required 34 debug man-hours on-line and 50 debug man-hours off-line. Similarly, they required 1,266 seconds of CPU time on-line and 907 seconds of CPU time in the *simulated* batch mode. Total cost to debug on-line was $605, and $593 to debug off-line. (Note: The off-line CPU time is inflated since it was obtained by simulating the batch mode. This inflates the total off-line cost slightly since dumps are more expensive on a time-sharing Teletype than on a high speed printer.)

In a second problem having to do with the logical manipulations of a rat running through a maze, the 12 experienced programmers required four debugging hours on-line and 12.3 debugging hours off-line. They required 229 seconds of CPU time to debug on-line and 191 seconds of simulated batch mode time. The total cost for the on-line maze problem was $99.60 whereas the total cost to debug off-line was $139.20. Now what do these numbers mean?

Clearly the problems chosen for the experiments have a strong effect on how the experiments turn out. In the algebra case, the time-sharing system showed its usual benefit by saving programmer time. And it accrued the usual expense of increased machine time. The total cost is slightly in favor of the batch system even though it was simulated.

The maze problem is one of those problems where interaction evidently really pays off. The reduction in mean programmer time is impressive (3:1), and the additional machine time required is slight. In this case and for this class of problem, time-sharing not only saves programmer time but reduces the total cost as well. The mean total cost for solving the maze problem on-line was only $99.60. The mean total cost for the off-line solution was $139.20. As before, the measured CPU time for the off-line case is biased in favor of the on-line system, since the off-line condition was simulated. No allowance was made for the superior efficiency of the batch. However, in this case the error is not sufficient to distort the conclusion: the time-sharing system produces both a shorter elapsed time and a lower total cost for this class of problem.

In summary, this experiment involved 12 programmers with average experience of seven years. The analysis time was not part of the measured data, nor was the programming and initial problem preparation. Debug man-hours and the CPU time were measured for actual time-shared service and for *simulated* batch service with a two-hour turnaround time. The CPU numbers for the batch process are in error since no allowance was made for the higher efficiency of the batch process when doing things the batch process does well. The experiment definitely shows that time-sharing is valuable (any criterion) for a certain class of problems. This however had been previously discussed elsewhere (7).

SDC proceeded to evaluate the results by individuals and found that the differences between programming personnel were quite profound. In a small sample of 12 individuals, the range of hours required for debugging varied by 25:1. The program sizes varied by 5:1, and the running times varied by 13:1. Thus, some other variables, as yet unisolated and unmeasured, significantly cloud the issues. The differences between people are greater than the differences between the programming systems. From small sample sizes with randomly chosen individuals, one can still get a wide discrepancy in performance.

Being charitable for a moment, it may be that some of the wild claims made by the proponents of time-sharing in the early days were in fact true (although no comparative data had been gathered at that time). It may be that their subjective feelings about the benefits of time-sharing for *them* were correct since most of the time-sharing pushers were vastly superior to a random selection of programmers.

However, this gives industrial types another point to ponder: Based on the data gathered, SDC felt obligated to paraphrase a nursery rhyme:

> *"When a programmer is good,*
> *He is very, very good.*
> *But when he is bad,*
> *He is horrid."*

In conclusion, SDC found an apparent correlation between programming speed and those programmers who were experienced in a higher order language. Interestingly, they also found a correlation between those experienced in machine language and short programs which ran quickly.

In the second experiment, SDC did not fare so well. They had nine programmer trainees attempt two different problems. One group was allowed to use the interpreter provided within SDC's time-sharing system in an interactive manner. The other group also used the interpreter within the time-sharing system but were arbitrarily required to use it in a run-to-completion manner. When a programmer, trying to run-to-completion was unsuccessful, he had to leave the system, enter a queue waiting for a console, and log back on for another run-to-completion session. This was another rather inept attempt to simulate a batch system on a time-shared system.

As before, all analysis and programming were done before the time measurement was started. Thus, only debug time was measured. Again, they failed to credit the batch for the inflated times obtained when the batch was simulated. The CPU time was logged as used. This severely handicapped the personnel who were not allowed to interact with the machine because the full system overhead *and* the lower performance associated with time-sharing were logged against the batch. The log times were not adjusted for this bias.

Since we have no way to adjust for programmer learning, it is useless to have the same programmer do the same job in both systems and try to measure meaningful results. Therefore, they split the nine trainees into two groups of four and five. Since the programs were not equally complex, they tried to normalize this uncertainty in the absence of accepted measure of difficulty: they attempted to get a performance measure by computing CPU time per instruction. This, of course, is one of the most misleading metrics ever devised by man, since it rewards the writing of long, inefficient code and thereby credits the marginal producer with an excellence he does not deserve.

To make a long story short, one of the problems given to this group of trainees in this strange and probably meaningless experiment, took less than a man-hour to debug interactively and almost five man-hours to debug using a simulator and run-to-completion. During this fiasco, the interactive trainees used only 11 seconds of CPU time and the run-to-completion trainees used 109 seconds of CPU time.

During the second problem assigned in this strange experiment, interactive debugging required nine man-hours and run-to-completion debugging required 13 man-hours. Interactive machine time amounted to only 290 seconds while run-to-completion machine time was 875 seconds. If additional reasons are required for discarding this study, choose one from the following list:

No measure of programming skill was attempted for the trainees and we know nothing about the quality of the product they produced. We are given no information about their previous background or training, or whether they had ever used the time-sharing interpreter before or not. Further, we can assume that each one of the trainees was in a steep part of his own personal learning curve, and we are probably seeing more of the differences in learning rate than an evaluation of the benefits of the interaction.

From all of this, SDC surprisingly draws the right conclusions. Considering both experiments, they apologize for the small sample sizes and note that the performance measures "were marked by a large error variation and wide ranging individual differences." They question the representativeness of the problems assigned to the two groups, and proceed to properly note that on-line conditions result in "significantly better performance for debug man-hours than the off-line condition." They question whether reasonable comparisons can be gathered when an on-line system is used to simulate an off-line one. (I can answer that for them: No. The checkout tools are different; the modes of analysis are different, or should be; and the intrinsic efficiency of the two machines is different. One should go about his programming processes differently on-line or off.)

They also conclude in a manner not quite original with them, "As off-line turnaround time approaches zero, the performance differential between the two modes with regard to debug man-hours tends to disappear." This coincides with an hypothesis stated at an earlier debate: "If we compare the two systems at an equal level of funding, the batch system might be almost as readily available as the time-sharing system and due to its increased efficiency might compete quite handily."

Finally, SDC lays out eight areas which seem to require further study. These are: build a data base of statistics about computers, perform comparative studies on different modes of operation, develop some cost-effectiveness models incorporating both the man and the machine, analyze in detail what a programmer does for a living, collect some data on programmer performance, develop some tests to predict programmer performance, detail some case histories on problem solving by man and machines, and, finally, digest the data gathered to increase our understanding of man-computer communication.

the thesis

The thesis was completed early this spring as a piece of behavioral research. The author, not a computer professional, was trying to study the way time-sharing systems affected the behavior of the *users* of the computer systems. After a rather incomplete literature search (he failed to find most of the articles listed in the bibliography at the end of this article), he proceeded to set up two rather interesting independent experiments.

In one experiment, two homogeneous groups of graduate students are required to use a computer as part of their normal course work. A pair of compatible software packages are available which are identical except that one package runs interactively under time-sharing and the other runs under a batch operating system. Otherwise the two software packages were the same, with the same diagnostics, the same formats, same features, and same capabilities. In this experiment, data was gathered which should shed some light on the benefits and costs of interactive programming facilities under near real-world conditions (if that is what a university can be called).

The batch system provided its users with two shots a day, whereas the console system provided virtually immediate feedback. The thesis fails to state whether consoles were reserved full-time for the students taking part in the experiment or whether students had to queue up and wait for console time. If there were fewer consoles than there were students, then there was a queue at the consoles which looks suspiciously like the delay associated with the batch system. In both cases the delay provides the computer user with "think time" that he would otherwise not set aside were machine time truly instantaneously available to him at any time of the day.

About 60 students took part in the first experiment. In the experimental design a rather lengthy set of hypotheses were enumerated, described fully, and discussed. Many of these stemmed from previous statements made by those avid proponents of time-sharing living in the Boston area. After the experiment had taken place, the experimental data was processed and the results were reported. As in the previous work by IBM, the reader is overwhelmed by the statistics involved and underwhelmed by the lack of solid conclusions drawn. One possible explanation: the political pressures within the academic arena were sufficient that conclusions, even though drawn, could not be stated clearly. However, after two Alka Seltzers to help digest the 120-page tome, one concludes as follows:

For the problem being solved (the development of a simulation model to assist in devising management policies), the time-shared systems allowed the students to prepare and run their simulated model in 31 hours of man-time whereas the batch operated system required 39 hours. Similarly, the time-sharing system required 14 CPU minutes whereas the batch system required 2.5 CPU minutes. For some strange reason, total cost is not computed as an absolute dollar amount and only break-even conditions are defined. To get comparative values, some slide rule work was necessary.

Again using second-generation machine time at $840 an hour for the time-sharing system, $560 for the batch system, and $9.00 an hour for the men (don't the graduate students wish they were worth that?), I find that the total cost for a time-sharing solution was $482 whereas the cost for the batch system was only $390.

Using the third-generation rates given in the thesis, the time-sharing computer costs $540 an hour, and the batch machine costs $360 an hour. Using these two rates, the costs for solution under either system would be equivalent if the man's time were equal to $15.00 per hour. In the industrial setting many analysts and senior programmers cost their corporations $12 to $18 an hour (including burden), but the mass of people actually preparing runs for the computer consist of programmers and coders who earn less than the $15.00 per hour stated as the breakeven value when third-generation equipment and costs are considered.

In grading the work done, the instructor found little difference between the two groups based on total grade points. However, this same instructor felt that the perceptiveness and understanding of the problem demonstrated by those who used the time-sharing system was greater. The experiment also verified that the solutions came quicker to those using the time-sharing system, e.g., more time-sharing students had sufficient time to complete the assignment than did the batch students.

Finally, based on admittedly intangible results obtained from questionaires, the thesis indicates a higher degree of satisfaction in addition to the higher degree of learning for the students using the time-sharing system.

In the second experiment, a different group of students was split into two homogenized groups. The results of their labors were used to evaluate two non-interactive software packages which differed in the quality and quantity of the diagnostic messages provided in case of error. The system with the better diagnostic messages required only 120 hours of machine time to solve the assigned problem, whereas the system with the standard diagnostic messages required 146 hours to achieve the same results. The system with the better diagnostics was interpretive in nature, whereas the standard system was compile and go. In both cases, they were completely compatible at the source language level. The data gathered showed equivalent speed of problem solution for the two systems and superior satisfaction with the system which gave better diagnostic messages.

Additional data was gathered regarding the behavior of the users between consecutive runs with the computer, and how useful each trip to the machine was for each type of user. The results were rather inconclusive as the detail of quantitative data gathered was not sufficient for analysis.

In conclusion, the thesis indicates that the time-sharing system produced a higher quality of learning experience and greater understanding of the problem than did the batch. Further, more students completed the problem under time-sharing than did under the batch. Reluctantly the thesis concludes that there seems to be some evidence to predict more computer dollars and less manpower dollars under time-sharing.

On the second experiment, the thesis concludes that

perhaps better diagnostics pay for themselves and that the manufacturer's standard compiler is a little austere. Other metrics (solution time, level of learning) showed no significant difference.

In the discussion section, a new hypothesis appeared which states that perhaps instantaneous interaction from a time-sharing system is not universally good. For instance, he indicates that perhaps turnaround time can be too fast since people are inclined to try another run before they have completely analyzed the results of the previous run. He proceeds to suggest that a built-in delay might be programmed into a time-sharing system to force the man at the console to intellectually digest the previous output before allowing him to input another request. This hypothesis was originally stated by Herb Simon of Carnegie and there seems to be some indication that perhaps the hypothesis is valid outside of Pittsburgh.

odds and ends

It is interesting to note that neither the SDC study nor the thesis reference the earlier IBM work. The references cited in the SDC paper exhibit both objectivity and thoroughness. The references cited in the thesis exhibit the usual Eastern narrowness. In all five cases, the experiments involved applications programs which were small by industrial standards. None of them involved programs which used external files or extensive I/O.

In contrasting the three studies, it should be noted that their conclusions cover the full spectrum. The IBM study showed time-sharing saved elapsed time but used programmer talent and machine time to achieve a higher cost. The SDC study covered only the debugging phase and found the costs were about equal, but that time and manpower were saved under time-sharing. The thesis concluded that the data were inconclusive but perhaps we could forecast higher computer cost and lower man cost with time-sharing. Further, the thesis points out that there is some breakeven point involving an expensive man and an inexpensive computer where time-sharing results in a quicker solution at less cost. Unfortunately, third-generation machines and 1967 salaries don't achieve that breakeven cost on many problems.

superior work

In the course of the literature search for this article, yet another interesting paper was uncovered (23). The recently published description of a micro-simulator prepared at Stanford for configuring time-sharing systems is a sample of an excellent piece of analysis and implementation in a related area. In the recently published article, they quietly and consciously state the objectives of the simulator and indicate why it was constructed and for what purpose. In subsequent pages they proceed to indicate how well the simulator they constructed matched those goals and objectives. They finally indicate a series of results obtained with the simulator and how this series of results aided them in understanding and configuring a hypothetical System/360 Mod 67.

If the goals and objectives of the time-sharing systems had been stated back in 1962 with the clarity and lucidity demonstrated by the boys at Stanford, perhaps we would have different time-sharing systems available for selection today. A system designed in a cost-conscious environment is a fundamentally different system than one which is designed to function, and then evaluated. Never is this more true than in the time-sharing systems. I contrast the cost-conscious design rationales used for the direct-couple systems and the cost-free rationales used during the same period by those building time-sharing systems.

Most of our time-sharing systems were designed without a thorough analysis of the problems to be solved, the services to be offered, or the costs to be encountered. Since these are the only systems that we have available to us, the remaining choice is to exercise a moderate degree of caution and select from those available systems the ones which solve problems you actually have.

As indicated in the Stanford study, it is imperative to know your workoad. Further, if the Stanford work were expanded to encompass all of the resources associated with the computer facility (men, machine, time, supplies, etc.), it will then be necessary also to know your present costs. Most of us don't know either our workloads, costs, or have an accurate measure of our current level of performance. This has been lamented several times (4) (13) (18), the most recent time being in the SDC report, which appeals for us to build such a data base.

As the computer field continues to progress, it will be more and more important for us to have this data base which contains measures of how our resources are being applied and what we achieve with each application. New developments are continually appearing on the horizon and we must evaluate every new proposal based on its benefits in solution time, resources used and total cost. Any such evaluation requires present values as a basis for comparison.

In the future, we will hear more and more about data base-oriented systems, teaching machines, and terminals which have graphical capabilities. One wonders whether the developments now taking place in these new areas are preceded by as clear a statement of goals and objectives as the Stanford effort or whether they are merely concerned with the development of function without defining the environment, assuming a workload, and paying attention to cost and performance. ■

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ECONOMICS OF TIME-SHARED COMPUTING SYSTEMS

first of two parts

by WALTER F. BAUER and RICHARD H. HILL

The economic impact of time-shared computer systems is yet to be felt, despite the very great deal of attention recently devoted to such systems. For this reason, perhaps, little writing has been done on the subject of system economics and cost-effectiveness. Some thinking about system economics must have been done, if only by the entrepreneurs of the burgeoning commercial time-sharing systems, but this thinking has yet to find its way into the literature.

This two-part series of articles focuses attention on the economic aspect of time-sharing systems primarily for the benefit of the manager who is faced with decisions involving use of a time-sharing system. The purpose of the series is to help establish criteria for system evaluations, by setting a frame of reference, discussing the fundamental choice (batch vs. time-sharing), and examining cost and pricing factors.

This initial article concentrates on the batch vs. time-sharing choice, technical design and operating experience factors. Part II looks at system design, hardware and software cost considerations, accounting problems and, finally, at the question of pricing.

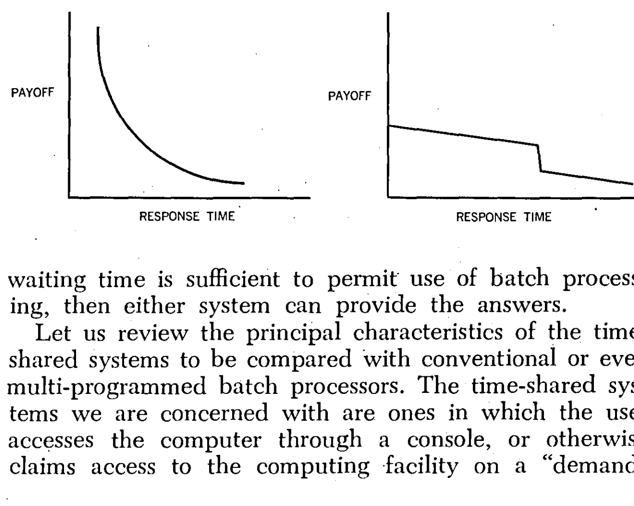
batch vs. time-sharing

For a given environment and a given set of application parameters one can provide a set of powerful arguments which build a strong case for or against the time-shared system, even if it is not possible to prove the general case pro or con. The principles involved can be examined carefully. The parameters and factors can be isolated and their implications understood. In many cases, all factors can be reduced to dollars and comparisons made in terms of two or three quantities representing two or three basic approaches.

In many cases, the user objectives and requirements of the system are such that the time-shared character of the system is, for all practical purposes, mandatory. There is no other way of meeting the requirements. Examples are travel reservation systems, command control systems, and stock quotation systems. These have the common requirement that the user have ready access to the data in the machine; the answers would be of little use if he had to wait the minutes or hours required for batch processing.

However, there are many cases in which a choice does exist. If waiting time is not a factor, or if the allowable

Fig. 1



waiting time is sufficient to permit use of batch processing, then either system can provide the answers.

Let us review the principal characteristics of the time-shared systems to be compared with conventional or even multi-programmed batch processors. The time-shared systems we are concerned with are ones in which the user accesses the computer through a console, or otherwise claims access to the computing facility on a "demand"

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Dr. Bauer is president of Informatics Inc. Before forming the company in 1962, he was manager of the information systems department of the Ramo Wooldridge Div. of TRW. He has been active in the ACM and has served on the governing board of AFIPS. His doctorate in mathematics is from the Univ. of Michigan.

basis. Time-shared systems include the so-called "conversational computing" systems[1] and, in a broad interpretation of the words "time-shared," also message switching applications, process control, real-time missile applications and similar systems. Mainly, however, we are concerned with man/machine interactive systems involving two basic economic factors:

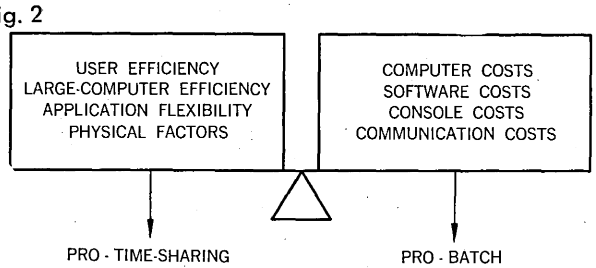
1. Many users share the same hardware, and use it simultaneously.

2. The major factor in the payoff function is the economic utility of response time.

User demand fluctuates rapidly, for it is essentially random. The system adapts to the use but may, sometimes, be idle for short periods, placing on the owner the need to absorb idle time costs.

With respect to the second point, Patrick[2] cites two types of payoff functions as shown in Fig. 1. In the first case, a short response time produces a very great payoff. If the stockbroker can answer a question about stock prices quickly, he has impressed his customer and his chances of making a sale are enhanced. If the payoff function looks like the second diagram of Fig. 1, there is

Fig. 2

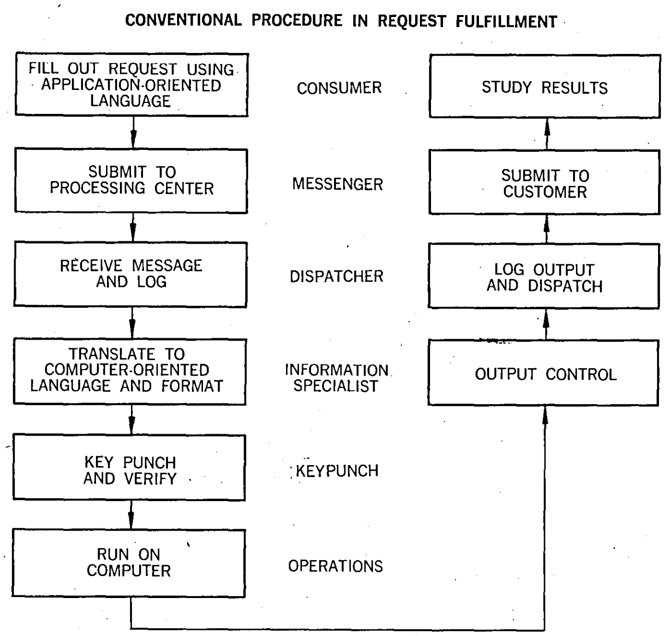


no advantage in a quick response, and one might just as well batch the data requests. If the stockbroker's customer requests a sheaf of Standard and Poor's reports, for example, they might as well be mailed at the end of the day with all the other responses to similar requests.

Inevitably, the choice between time-sharing and batch processing reduces to consideration of specific factors related to user needs. Fig. 2 symbolically displays several factors on opposite sides of a fulcrum, showing that the weights given to each will determine how the scales are tipped. To decide in favor of time-sharing vs. batch implies that efficiency and flexibility factors on the part of the user outweigh the increased costs for computer software, for extra equipment and for communications systems.

The factor of "user efficiency" is most frequently cited as an argument in favor of putting the user directly online. There are few documented studies, but what evidence there is tends to support the argument. One practitioner claimed increases in efficiency of 3:1 to 5:1. Of probable significance, W. B. Moore of Rome Air

Fig. 3



Development Center and Erwin Book of System Development Corp. have independently reported increases in programmer efficiency on the order of 7:1 in coding and debugging program modules. The arguments are plausible when one considers a busy executive's reduction in efficiency if he were forced to use the telephone only certain limited, spaced periods of the day, as opposed to full time access to the instrument.

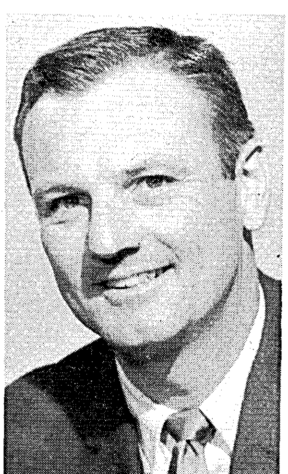
large computer efficiency

A second factor favoring time-sharing systems is that of large computer efficiency. It is a fact that the cost per computer and receiving results. Many people and many processes are involved. Forms must be completed, cards must be punched and verified, and the information must be dispatched correctly, and logged and recorded.

In a time-sharing system, the computer does nearly all of these tasks. In other words, the man at the console can effectively be the "consumer" and he need be the only person in the chain. The input can be in an application-addition on a large machine is lower than the cost per addition on a small computer. The fact that many use the computer simultaneously allows large, centralized computers to be used and, in turn, this "large computer efficiency" advantage accrues. Also, the large computer usually has a more powerful software system supplied with it.

The time-sharing system has the additional advantage of being able to reconfigure itself to appear as an individual small machine to many users, or as a large dedicated system when required. In fact, one user may be using it as a desk calculator, another as a powerful system simulator. Thus, the important advantage of application flexibility is gained by the user—an advantage clearly not available in any given batch processing system.

One of the advantages which is so often overlooked in



Mr. Hill is vice president, programing systems division, at Informatics Inc. A cofounder of the company, he has served on the executive board of SHARE and has been chairman of the San Fernando Valley chapter of the ACM. He has a master's degree in English literature from the Univ. of California at Los Angeles, where he was assistant director of the Western Data Processing Center when it was first formed.

[1] The "remote batch processing" concept deserves special attention, which it receives later in this article.

[2] Robert L. Patrick, "So You Want to Go On-Line," *Datamation*, July, 1964, p. 25.

comparing time-sharing and batch systems is in the process of preparing input to the computer. Whether it is to be prepared for the files of the computer or constitutes a command or request to the computer system, there are significant advantages in inputting the information directly as compared with off-line data preparation. Fig. 3 *(p. 49)* shows the conventional procedure in inputting data to a computer and receiving results. Many people and many processes are involved. Forms must be completed, cards must be punched and verified, and the information must be dispatched correctly, and logged and recorded.

In a time-sharing system, the computer does nearly all of these tasks. In other words, the man at the console can effectively be the "consumer" and he need be the only person in the chain. The input can be in an application-oriented language and the computer can output the results for user consumption. Keypunching by a third party is bypassed.[3] Verification is done by allowing the user to examine his input before it is committed to the computer. The computer, of course, can perform all of the logging and recording operations. The communications system and the remote console take care of routing the information to the user. Furthermore, a properly designed system will result in fewer input errors than a conventional system since, for one thing, there are fewer steps necessary.

Although it is not a quantitative discussion, the authors believe that the analysis of the process as presented in the preceding paragraph constitutes a most powerful and persuasive argument for on-line systems. Furthermore, the input process is one which is common to many applications, and the advantages of on-line systems for these processes are frequently overlooked or not understood. Of course, a similar argument can be made for the output or interrogation process.

operating and implementing experience

Comparing quantitative values such as costs and efficiency factors for batch systems and time-shared systems under comparable conditions is a difficult, almost impossible matter. One simply does not design and fully implement a time-shared system for a given set of requirements and then design and implement a batch system for the same set of requirements. Such controlled experiments and comparative systems are almost out of the question since they are so prohibitive in cost, and are not likely to prove anything for a wide spectrum of computer applications in any event. The best that one can hope for in comparing a batch system with a time-shared system is detailed studies and analyses enhanced by simulation to insure practical handling of all factors.

Experience with current systems in terms of "efficiency" can only be described as inconclusive. A basic problem is concerned with the criteria of efficiency; the load factor on the central processing unit is a commonly used measure, but this may be insufficient in terms of the over-all system objectives. For example, if the objective of the system is to improve programmer productivity by providing on-line debugging, and if the system achieves this objective, then the CPU load factor is immaterial. Present-day time-sharing systems, also, are somewhat experimental in nature and either have been designed to optimize other features than CPU load factor or to meet objectives incompatible with hardware efficiency.

Two factors that seem of major significance in determining the over-all efficiency of the system are:

1. Whether or not the system does background processing in batch mode simultaneously with servicing users on-line.
2. Whether or not the system forces the on-line user to live within the actual hardware limitations of the system.

In the CTSS at MIT in 1965 the following figures were reported to the authors verbally: 60-70% computation, 20-30% swap time (exchange of programs in core and other storage), 5% overhead, the remainder non-overlapped input-output. This system uses most of the computation time for background programs (batch process type). These figures are representative also for SDC's system for the USQ-32 computer. The percentage of computation in these systems falls markedly, however, if the demand is low, or if the number of "interactive users" (number of consoles) becomes high.

Experience to date with virtual memory systems (systems in which the programmer is not constrained by actual memory limits) has not been encouraging. In the IBM 360/67 memory is divided into pages of 4,096 8-bit bytes each, but the user is free to reference one page from another. The referenced page may or may not be in core at the time it is invoked; if it is not available the system finds it and brings it in over a previously loaded page. Cascaded page references can create major problems of efficiency in terms of CPU usage. Levels below 10% are commonly reported. The designers of the IBM 360/67 software, however, believe that major improvements are imminent.

For the moment, at least, it does not appear that time-shared systems can be cost-competitive with batch process systems for the same type of throughput. However, over-all efficiency in terms of human productivity may improve so much that the increased costs yield economically justifiable results in other ways.

Further, the cost of the computer reflects the cost of software and hardware that, in these systems, is high, as will be discussed in Part II. It must be considered, however, that the cost of both hardware and software for time-sharing will be reduced over the next two to three years, tending to narrow the cost gap. It may be that we will not see cost reductions as dramatic as that distinguishing the cost of the first FORTRAN compiler from the most recent, a ten-fold improvement, but some gains will definitely occur. Hardware aids to time-sharing will also improve the cost picture.

design factors and economics

The over-all system design problem is to design the system for maximum usage and efficiency of people and computing equipment in view of the total money spent.

Some of the factors involved in this design are cost of labor, cost of response delay, machine costs, and software system costs. However, the study of system design quickly gravitates to considerations of efficiency of machine usage and system configuration factors, although the various costs mentioned earlier do, of course, figure heavily in examining machine usage and system configuration. Before discussing the problem of system design, it is necessary to fix a number of definitions which will be used in the discussion.

User refers to a person in attendance at the console and registered "in" with the system. *User stations* refers to the number of consoles at which users can sit and make use of the system. The number of stations, obviously, is equal to or greater than the number of users at any given time. *Response time* refers to the time from actuation of a key at a console to the time that a meaningful result occurs as a result of that key actuation. The type of response may vary from simply repeating an alphanumeric character in

[3] Of course, input of large amounts of data will require off-line preparation as with a keypunch.

typewriter fashion or, at the other end of the spectrum, it may refer to the time from program initiation during check-out to the time when meaningful results of that checkout have been obtained and have been displayed or otherwise produced for the user as he waits without engaging in other productive activity. It is important to understand that response time does not normally refer to the time of completion of production runs. *Computer efficiency* refers to that fraction of the computer time (usually processor time) that is used directly in behalf of producing usable results for the user at the console, and includes costs of that computer time.

Computer time can be split into two general types—"direct" and "overhead." Direct computer time refers to the activities in direct support of the user or console operator. Overhead refers to all others. Therefore, determining the contents of a register is a direct usage of the system whereas the system processing required to allow the system to decide which user to turn its attention to next is of the "overhead" type. Other examples of "direct" are any computations performed in program debugging and, of course, any production run.

Using the preceding definitions, a statement of time-sharing system design objectives is as follows: to maximize the number of users within the constraints of staying within a certain maximum response time for all users and maintaining a machine efficiency greater than some minimum. This definition warrants some examination.

"Number of users" can refer either to the average number of active users being currently served by the computer, or it can refer to the number of console stations (users) which are being serviced with sufficient rapidity not to incur any loss of efficiency for the user. There is no great difference between the two, although there might be if user characteristics were markedly different from system to system.

The phrase "response time" bears some scrutiny in the foregoing definition of the problem. It could refer to time delays in production problems. However, in general, the statement of objectives refers to maximizing the number of users who are directly engaged in the system—but also maximizing their effectiveness. When he is on-line, the assumption is made that the user can do no other work, and thus when he is waiting on-line his effectiveness is nil.

The number of users served effectively is a measure of the system throughput or total capacity. If one ignores for the moment the production problems not requiring on-line operation or presence at the console, then this number of users is exactly the measure of throughput and maximizing this number maximizes throughput. Handling of production runs and the system design with respect to optimizing waiting time is discussed below when the topic of schedulers and executive systems is presented.

Optimization of a system is not a simple problem, because the variables involved are not independent. Furthermore, variables like "number of users" and "response time" are random in nature, and what is usually implied is a statement such as "80% of the response times do not exceed 10 seconds."

the scheduling problem

One of the most important design problems in a time-sharing system is the scheduler. The scheduler is the important part of the executive program which decides on a real-time basis how the computer is to service the console station and how it is to carry out the production computation. Therefore, the particular characteristics of the scheduling algorithm which are utilized in time-sharing systems has great implications on the efficiency of the computer and the efficiency of the user. The economic consequences of the scheduler are obvious.

One of the best treatments of the scheduling problem has been provided by Greenberger,[4] who points out that there are conflicting objectives in the design of a scheduling algorithm. On one hand, it is desired that the average response time and the number of users waiting be reduced as much as possible. Another objective is that the scheduling algorithm must recognize customer importance and the urgency of the request. Usually in conflict with the first two objectives, is the desire to serve the users in a fair order, and to limit the length of the wait.

The design of a scheduling algorithm to optimize cost and effectiveness functions is a complex operations research problem. It involves the disciplines of statistics and queueing theory as well as a practical knowledge of the way time-sharing systems are operated and used. However, a point of departure in all of this is a method of measuring the cost of waiting for computed results. Greenberger points out that there are many different ways of relating the rate of accrual of costs and the waiting. The cost rate may be constant with respect to waiting time. It may be a linear and increasing, or it may be a non-linear, complex function. The problem is difficult even with the simplest relationship of costs vs. waiting time. However, with non-linear relationships, the problem rapidly gets extremely difficult. Each customer or each job may have a different cost function. The over-all objective of the scheduler is to minimize the aggregate costs incurred by all customers.

One of the most straightforward ways of scheduling is simply to provide an equal quantum of processing to each user in turn. This is called "round robin" scheduling or "time-slicing." Greenberger points out that the more uncertainty there is with respect to the amount of computation required, the greater the benefits of round robin scheduling compared to a "first come, first served" scheduling algorithm. In the event that the computation time is known *a priori* (which is seldom the case) then the "shortest job next" type of algorithm yields the least total wait. The disadvantage to the "first come, first served" rule is that the person with a very short amount of computation may have to wait as long as the person with a large amount of computation. In between the two extremes of "no knowledge" and "complete knowledge" is the usual situation. The degree to which the computer use is known is the degree to which one should depart from a strict round robin scheduling algorithm.

There is an important modification to the simple round robin scheduling technique which can improve the total system service greatly. This is a scheduler with more than one level of priority. Under this system of scheduling, computing requests which are known, either *a priori* or by machine experience, to be ones which require relatively large amounts of computation are placed in a lower level of priority than those which require short amounts of computation. The greatest improvement in system performance is achieved when the distribution of jobs is continually examined and priority adjustments are made dynamically.

A priori information is also available that can be utilized in the scheduling. Certainly the programmer or user who approaches the console has some idea of how he will use the computer and, in fact, has an idea of how much computer time he will use. This information can be made available to the scheduler, and should be used in the scheduling process. In the following paragraph, a scheduling system is discussed which makes use of this *a priori* information.

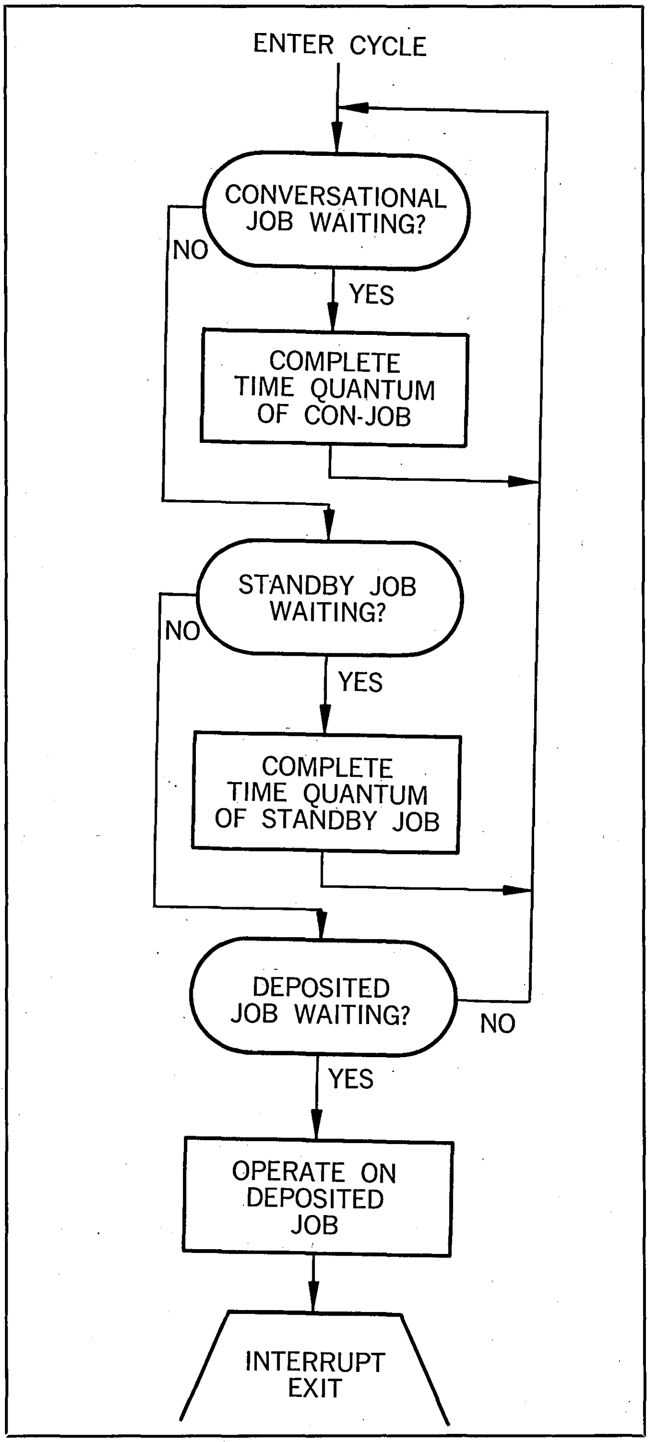
Consider the following approach to a scheduling al-

[4]Martin Greenberger, "The Priority Problem," Project MAC Technical Report (unpublished), MIT, October 1965.

gorithm. Active programs in a time-shared system can be considered to be one of three types: conversational, stand-by, and deposited. There may be additional administrative programs such as those which collect data on the time-shared system itself, programs for bookkeeping or accounting and programs for diagnosing machine operation. These administrative programs could be a fourth (lower) level category or simply "background" programs; that is, programs that are executed whenever there are no higher priority programs demanding service.

Conversational jobs are those in which the programmer or user is giving information to the computer in a way similar to how a supervisor communicates with his staff assistant. He gives the computer instructions or asks the computer questions which require a small amount of computation. A request to retrieve data from a file is an example of such a "job." What characterizes the operation here is that the user expects a response to him which is in the order of seconds; in fact, usually less than five seconds. This means that the time-sharing system must, with high frequency, turn attention to the console, to see whether new information is ready for the computer. Since the amount of processing is small, the amount of attention given, in turn, will be small. In other words, the quantum of processing required at each turn can be small.

Fig. 4



Jobs of the stand-by type are those requests of the computer system which require significantly more computation, but where the response to the user is required within a short time because the user awaits the results at his console. A primary example of this type of operation is the processing of part of a computer program during checkout to determine whether it works correctly. However, this type of operation could be extended to production runs where useful answers are provided, but which require small amounts of computing. Both conversational and stand-by jobs are typically associated with high-priority ("foreground") processing.

The third type is the production run or the deposited type. The job is given to the computer or is deposited with the computer along with certain directions on how it is to be run; that is, the number of parameters involved in the computation and the entry point of the program are provided as inputs. The important point with deposited jobs is that they do not require the person to stand by the console and, in a sense, they are off-line or batch jobs. Deposited jobs may be introduced to the computer in the computer center or from remote terminals.

The scheduler essentially places the conversational jobs in the highest priority; the stand-by jobs in the next highest priority; and the deposited jobs in the lowest priority. Round robin scheduling is done for each of the jobs; however, it is done within the framework of a multi-level priority system. Quanta of computer time for the three types of jobs are determined in advance. For example, the quantum for conversational jobs might be as low as 20 milliseconds; whereas the amount of time given to the stand-by jobs might be as great as 200 milliseconds. The quanta are determined on the basis of whether a meaningful amount of computation can, on the average, be provided with respect to the aims and objectives of that type of job, or the processes which are normally carried out in this type of job.

The scheduling process then is performed as follows: all conversational jobs are first attended to on a round robin basis. Following the completion of one cycle of all of the conversational jobs, the system turns in a round robin fashion to the stand-by jobs. Each stand-by job is given the appropriate amount of attention as determined by the time quantum assigned to that priority level. Any remaining time before attention must again turn to conversational jobs is devoted to processing deposited jobs. Fig. 4 presents a simple flow diagram which explains the process.

Implicit in such a scheduling scheme is the fact that the user is charged according to the time used at the priority level. The system keeps track of each channel or console in terms of the amount of main frame processor time devoted to it over a given period of time. Charges for conversational jobs are at a rate higher than charges at stand-by or deposited priority levels. This scheme would also inhibit the user from registering in at a higher level than his usage would indicate.

This processing scheme is not offered as a serious candidate for a scheduler, but to stimulate thinking on this complex subject. It also illustrates the use of *a priori*

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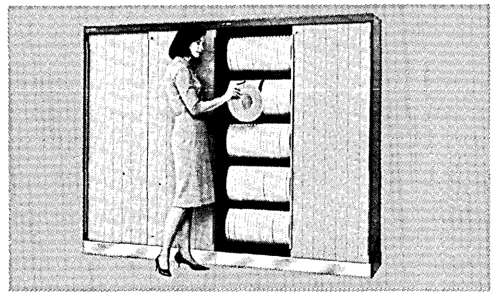

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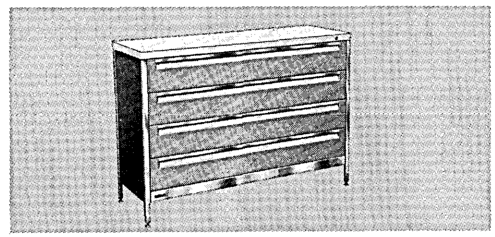

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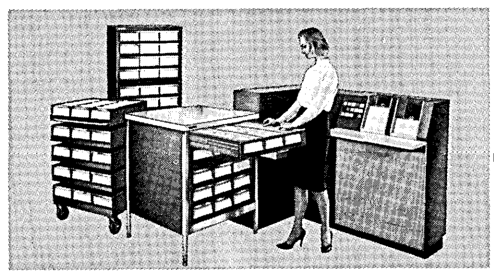

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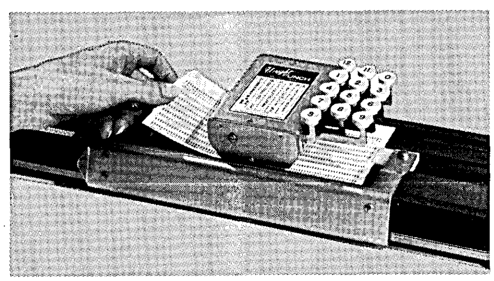

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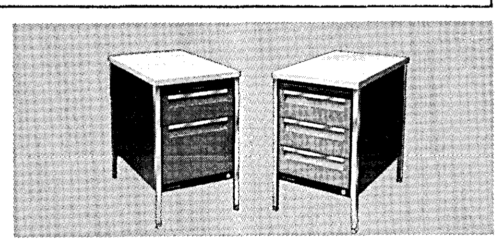

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data on the job which the user can supply to the system to increase scheduling and system-use efficiency. Since the machine must be idle sometimes[5] (assuming that the demand is random) there should always be a supply of lowest priority utility jobs to fill in this otherwise idle time. Examples are auditing, recording and diagnostic jobs. It is appropriate that these non-revenue producing jobs be given the lowest priority.

A final observation on schedulers and scheduling algorithms: there is virtually no limit to the complexity which can be introduced. Complexity introduced in the system is costly and there is the lingering question of whether that cost is outweighed by the accrued savings in increased efficiency for the user and the machine. There is little doubt, however, that schedulers will become increasingly complex since, with increasing improvements in implementation techniques, that complexity will become steadily less costly. (*NEXT MONTH: "Time-Sharing System Computer Configurations and Cost Factors."*) ■

[5] Indeed, in the presence of random demand, no idle time implies intolerably large response times; in fact (mathematically) infinitely long ones.

PROTECTING COMPUTER PROGRAMS

copyrights, patents, trade secrets

by ALLEN W. PUCKETT

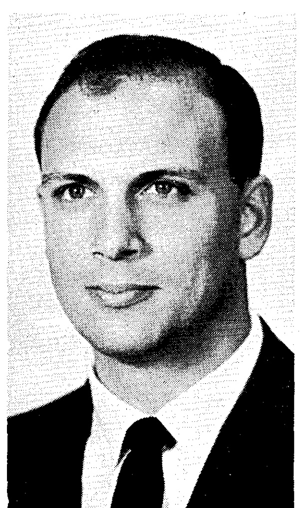
In recent months articles discussing the legal protection of computer programs have proliferated in the edp press. More particularly, much attention has been focused on the legal metaphysics that will determine program copyrightability or patentability, and on the "needs" of programmers and computer users.

In my opinion, under current law a combination of limited copyright protection, trade secret protection, and contractual agreements will be in the best interests of programmers, software companies, and computer-using society. Perhaps best of all would be a statute specifically designed to advance the art of software production. In any case, patents are *not* desirable.

A desirable combination of protections may in fact be obtainable. More important, whether or not it is available probably depends on efforts made by the edp public. Lawmakers and judges are reasonable men. If almost any decision can be accepted without impairing the theoretical integrity of the law, they will strive to reach a "best" answer in terms of its effect on "real" people.

This demands that real people be heard. An informed opinion expressed today can have a significant impact on the law you will be living with for years in the future. Computer software is so economically significant that law defining its status is inevitable. The only question is whether or not that law will be shaped by those who are most affected by it.

To buttress these conclusions, let's examine the law currently governing program protection—not to find "the"



Mr. Puckett is an associate in the San Francisco offices of McKinsey & Co. Inc. He was recently awarded national third prize in the Nathan Burkan Memorial Competition for a paper on the copyright law titled, "The Limits of Copyright and Patent Protection for Computer Programs." He has a BS in business administration from the Univ. of California, Berkeley, and an LL.B from Harvard Law School.

correct answer, but to get a better idea of the ambiguities in current statutes.

current law

One often hears that computer programs should be protected by copyrights or patents so that programmers can earn a fair profit for their work. These considerations are important; but equally, thought must be given to the *purpose* of legal property rights. (This thought should not be reserved for lawmakers only. It can have a crucial effect on the presentations that program producers and program users will want to make to courts or legislatures to ensure that their interests are properly safeguarded by forthcoming judicial decisions or statutes.)

The purpose of copyright and patent statutes is not merely to support authors and inventors. The theory underlying the grant of copyrights and patents is that such grants will benefit the public by stimulating the production of further writings and inventions. Only as far as such stimulation can occur and thereby speed the development of science and the "useful arts" is their grant justified.

Whether or not the grant of patents or copyrights—as we know them today—stimulates the computer art is a complex question. The source of the complexity is that current copyright and patent statutes, with their respective foci on "writings" and "inventions," were not designed to protect creations even remotely akin to computer programs. Given that, it would be astounding if the protection they offered were exactly what is needed. For the same reason, it is very understandable that no one is sure whether or not such protections as do exist can be obtained.

Patent protection is quite different from copyright protection. It is possible, though not probable, that both could apply to programs. Also, most aspects of copyright and patent law are *statutory*, not constitutional. These aspects can therefore be changed by congressional action —and at least with respect to copyright such change is imminent. Finally—though it seems nonsense to those in the field—the treatment given source programs, object programs, cards, and magnetic tape may differ widely. For all of these reasons, the availability of patent and the availability of copyright for program protection are separate questions, which can have different answers.

are programs copyrightable?

Copyrights protect authors from unauthorized *copying* of their *published* writings.[1] Since June of 1964, the Copyright Office has agreed to accept most published programs as copyrightable writings.[2] This acceptance by the Copyright Office is merely an administrative decision that courts *could* find programs copyrightable. But the courts have not yet ruled on the question, and until they do so the prospective "author" should carefully consider case precedents before deciding that copyright law will provide the protection he seeks.

The most obvious objection to copyrighting programs is that they are not "writings" in the legal sense. One commonly raised objection is that punched cards and magnetic tape are parts of a machine that are not intended to be read, and that hence they cannot be registerable writings. The grounds for this objection are a questionable interpretation of an early copyright case involving music rolls for player pianos.[3]

But the most weighty (though the least discussed) grounds for suspecting the copyrightability of programs lies in the well-established judicial distinction between books or "objects of explanation" and inventions or "objects of utility." Loosely, a patent gives an inventor the exclusive right to an art described; a copyright gives an author the exclusive property to a description of art. For instance, a patented engine can be manufactured only with the permission of the patentee, but a technical manual's description of the engine is the exclusive property of the manual's copyright holder.

To quote from the leading case of *Baker v. Selden*, if the "art it teaches cannot be used without employing the methods and diagrams used to illustrate (a) book, or such as are similar to them, such methods and diagrams are to be considered as necessary incidents to the art, and given therewith to the public . . . for the purpose of practical application."[4] In other words, the "methods and diagrams" used to illustrate a book can be objects of utility as well as objects of explanation. If so, their practical use can be prohibited only if they are patentable.

On the basis of this case, courts could easily determine that computer programs are objects of use rather than objects of explanation, and hence that they are not copyrightable subject matter. Perhaps more importantly, even though a program might be copyrighted as a means of "teaching" a new algorithm, the use of that or any other program in order to use the algorithm would almost certainly not be an infringement of the copyright. This argument in particular must give special pause to those who wish to obtain copyrights solely to enhance the salability of their computer programs.[5]

are programs patentable?

The grant of a patent on an *invention* which is *novel, useful*, and *"unobvious"* empowers the inventor to exclude others from making, vending, or using the invention for a term of 17 years.[6] In comparing the powers of patent with those of copyright, note first that the presence or absence of copying is relevant only with respect to the infringement of a copyright. Thus, one who does not copy but instead recreates a patented invention, by his own work and even without knowledge of the previous invention, is as much an infringer of the patent as one who steals the invention outright from specifications supplied by the patent office.

As might be expected, in return for such extensive rights, courts have usually held the prospective patentee to relatively high standards of contribution. Under these standards, courts could decline to uphold patents on computer programs regardless of possible "guidelines" from the patent office describing programs eligible for patents. Such guidelines would, as in the case of the previously mentioned Copyright Office announcement, merely constitute an administrative decision that a court *could* find computer programs to be patentable inventions.

A patent infringer's first line of defense will most reasonably be that a program is not patentable subject matter. That is, a program is not a machine or a "quasi-structural" combination of "means plus function", nor a new method. These categories exhaust the list of potentially patentable inventions.[7]

The category of machines and quasi-structure can be

[1] See 17 USC Secs. 1-14 (1964).

[2] For the most recent statement of the Copyright Office position, see Copyright Office Cir. 31D (Jan. 1965).

[3] White-Smith Music Publishing Co. v. Apollo Co., 209 US 1 (1907).

[4] Baker v. Selden, 101 US 99, 102 (1879).

[5] For a much more detailed and technical treatment of these subjects, see Puckett, "The Limits of Copyright and Patent Protection for Computer Programs", in *ASCAP Copyright Law Symposium No. Sixteen.*

[6] 35 U.S.C. 101 (1964).

[7] See 35 U.S.C. Sec. 100 (1964).

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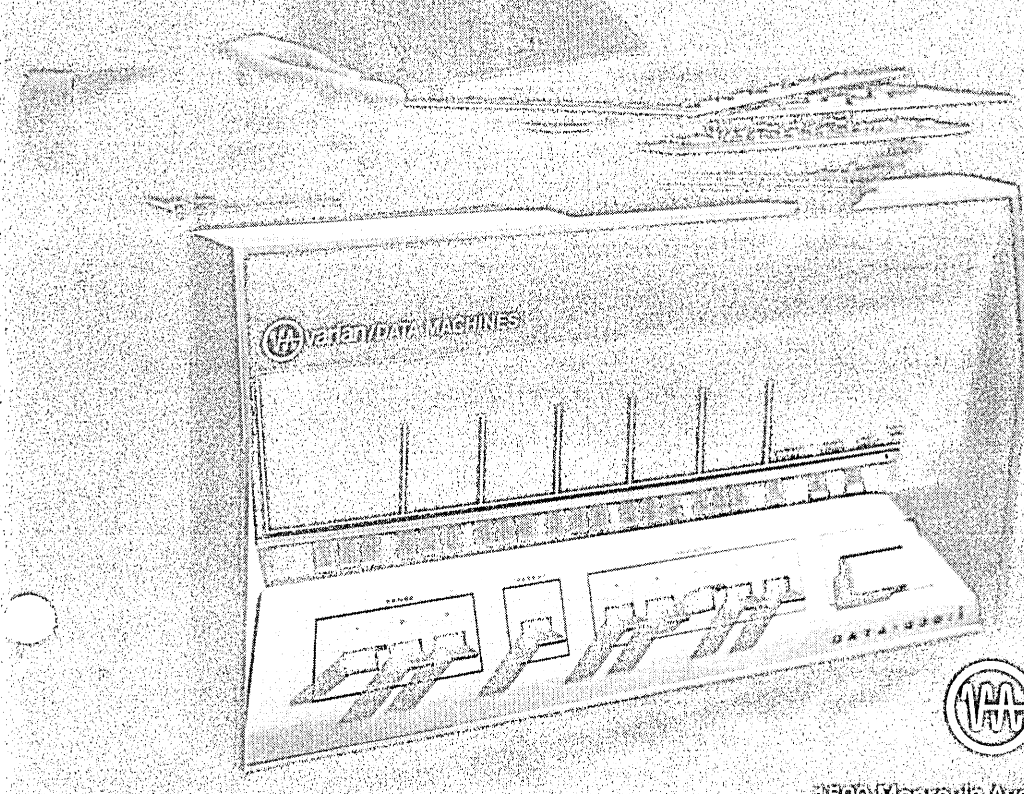

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eliminated with relative ease because the program itself exhibits no physical structure. It has been suggested that a computer plus a program (in the computer memory) is a single problem-solving device and, as such, is a patentable machine. But under the patent law, although a new use for an old machine can justify a "process" or methods patent, the machine itself must be structurally different to sustain a machine patent. Or, "a different adjustment of an old machine will not impart novelty thereto as an apparatus."[8]

If patents are to be obtained on programs, it must be because the programs disclose a new "process" or "method." For instance, it has been suggested that computer programs disclose a "method" of manipulating electrical signals in a useful manner. Program patents would thus cover the use of the object-program-plus-computer signal-manipulating machine (i.e., the programmed computer), but would not cover a flow chart or a source program, since neither of these is a signal manipulating device.

The resourceful litigant has at least two chances to void a patent on a program as a method. The first relies on an old doctrine in the law of patent which attempts to discriminate between "processes" and mere "functions of a machine." The essence of the doctrine is that "a man cannot have a patent for the function or abstract effect of a machine, but only for the machine which produces it."[9] For example, the man who invented an ice cutter that cut square blocks of ice could not patent square blocks of ice or all methods of cutting square blocks of ice, but could only patent his particular cutting machine.[10] Analogously, one could not patent the "method" of manipulating electrical signals. The patent, if any, must reside in the signal-manipulating computer (as a machine).

The second (and more sensible) defense rests on the broad principle of patent law that no patent may be obtained upon an "idea."[11] Several cases further suggest that if calculations, plans, or methods of doing business are the "heart" of a method, the method should not be patentable.[12] It would obviously be no trick at all for a court to find that the "essence" of programs is ideas and plans.

Alternatively, the standards of novelty and "unobviousness" could be involved to dispose of a programmer's claim to invention. For example, if it were conceded that an object-program-plus-computer is a useful signal-transforming method, that method might still be unpatentable because it follows as an "obvious" product of an (unpatentable) source program.

These doctrines are admittedly technical and occasionally quite casuistic. But the point is that there is no simple right answer—only a plethora of gray-shaded ambiguities.

trade secret protection

Statutory copyright and patent protection are not the sole, and perhaps not the most significant, means available to programmers to protect their work products. An important source of protection available to service bureaus and in-house programming groups is the law of unfair competition. This still developing doctrine prohibits the *unfair appropriation* of company trade secrets. Cases in unfair competition are not decided according to rigid rules of law but rather according to the tenets of a more general "equity." There are three rough criteria for trade secrets. First, they must be company-developed rather than one man's ordinary work product. Second, they must be valuable to the business and expensive to develop. Finally, they must be truly secret, and the company will usually bear a heavy burden in demonstrating its efforts to maintain the secrecy.

Each case of unfair competition is decided on its unique merits. Questions considered by a court might include: Was the company careless? Will a man be deprived of his livelihood by an injunction against disclosure? Would the company truly be hurt by the disclosure? Given this search for fairness, a company desiring trade secret protection for a program should decide to maintain the program as a trade secret quite early in its development. The fact that the program is a secret must be carefully communicated to all personnel engaged in the programming project or using the program.

contract protection

The final and perhaps the most obvious means whereby companies or individuals can safeguard the salability of their programs is through the law of contract. Although a contract between vendor and vendee or licensor and licensee cannot be binding on third parties who gain access to the program through the vendee or licensee and without notice of the contractual agreement, a contract can surely provide for appropriately heavy damages to be obtained from the vendee or licensee in the case of such disclosure. This contractual protection should undoubtedly prove the most useful device in meeting the needs of most companies and computer programmers. Contracts can be framed to meet the needs of specific cases. Arrangements for protection can be made without the need for public disclosure of a program.

Why does the limited protection of copyright, used judiciously in combination with trade secret and contractual agreements, provide the best set of protections from the standpoint of the programmer, of the company concerned with protecting software, and of computer-using society? The appeal of trade secret protection is obvious: litigation is decided by the presence or absence of an "unfair" act. There is little opportunity for a company or an individual to institute spurious litigation, or for an apprehended miscreant to plead innocence or surprise.

Similarly, the dawning professionalism of programmers and the rapid obsolescence of programs combine to make contractual agreements an effective means of protecting an economic product. Agreements can be carefully tailored to protect a vendor's security, can be enforced in the courts as readily as a statute, and do not involve needless public disclosure of programs.

The desirability of copyright protection—and the undesirability of patents—are less evident, and must be discussed at further length.

Copyright protection is desirable. That the potential protection offered by copyright is weak, is a major supporting point in favor of allowing program copyrights. In contrast to patent protection, the reproduction of a copyrighted program by a second author (who does not copy the copyrighted program) is permissible. Thus, many potential squabbles and litigious situations are removed. Perhaps more important, under the doctrine of *Baker v. Selden* the use of ideas set forth in copyrighted programs is not restricted to the author of the program. Thus, the author of an analytical technique or of mathematical formulae cannot forbid others to use that formula merely by incorporating it into a computer program.

The importance of these limits on program "protection" emphasizes the attention the computer industry should be

[8] Ex parte Hitchins, 99 U.S.P.Q. 288, 292 (P.O. Board of Appeals 1953). See footnote 5.
[9] Corning v. Borden, 56 US (15 How.) 252, 267-68 (1853).
[10] Wyeth v. Stone, 30 Fed. Cas. 723, 727 (Cas. No. 18, 107) (C.C.D. Mass. 1840).
[11] Burr v. Duryee, 68 U.S. (1 Wall.) 531, 570 (1863).
[12] E.g., Application of Shao Wen Yuan, 38 C.C.P.A. (Patents) 967, 188 F. 2d 377 (1951).

paying to the copyright bill recently passed by the House of Representatives.[13] Should that bill be construed to overturn the *Baker* doctrine, copyright too could become a dangerous weapon—in some ways perhaps more dangerous than patent. Not only would computer programs be copyrightable subject matter, but the owner of the copyright would apparently have complete authority over the reproduction of the program in virtually any manner—even to the point of controlling programs which are in some way identifiably "derivative" from the copyrighted program.[14] For example, it is conceivable that a source language could itself be copyrighted (for instance, as a set of symbols for the expression of logic problems). Many benefits of today's uniform compiler source languages would then be lost. For instance, programming information techniques and personnel can be exchanged between different computer facilities; libraries of old programs and available markets for new routines are relatively large; and perhaps most important, competition among hardware manufacturers is economically feasible. With respect to the latter point, consider the problems of abandoning IBM machinery (to pick a less than random example) if FORTRAN and COBOL could be used only on IBM equipment.

benefits of copyright

But copyright also offers positive benefits to programmers and to the public. The most basic benefit is that anticipated by the authors of the copyright law: It may well serve as a stimulus to greater program production. This is not due to the monopoly rights bestowed by the copyright. Rather, it is due to the status which will be bestowed on programmers by obtaining the copyright. This cannot help but advance the professionalism that programmers are striving to attain. It cannot help but encourage them to exchange ideas and publish their programs in order to receive certified credit for their advances. Ideas *could* be utilized without direct remuneration to the author, but it is probable that the copyright notice will at least impose an ethical restraint on potential pilferers. And even where an idea is taken, the author will be more likely to receive credit for it.

From the copyright notice and registration at least three further benefits may flow. First, the presence of the central registry should facilitate the production of program indices which disclose programs and programmers needed to solve difficult problems. Second, the presence of a programmer's name on a distributed program may tend to encourage centralized updating of those programs. This encouragement again is a function of the ethical influence of the copyright notice, and would have to be encouraged by programming personnel. Third, the presence of registered programs provides a certified resume for the experienced programmer, and thus underpins his technical position and job security.

On the other hand, patents are undesirable. Program patent protection would be so good that it would stifle. Preliminary algorithms which had not been reduced to hard programs and exchanges of general information and techniques would have to be much restricted. The initial innovator would not want to risk later exclusion from the fruits of his thoughts by a later patentee. Research would be discouraged in areas where powerful concerns were known to have developed many computer tools. Wealthier concerns would have a powerful tool for the exclusion of the indigent: the defense of even an unjustified patent suit is quite expensive. In short, the constant refinement of past ideas and the development of new would be greatly impeded.[15]

There would be little stimulus causing the production of new programs to compensate for these indisputable drawbacks. The problem facing most computer users is not stimulating the new and creative use of their machines, but acquiring the necessary programmers to tackle the pedestrian tasks they have already identified. Programmer demand continues to outpace supply to such an extent that the cost of programmers already unbalances organizations' compensation schedules. It is highly unlikely that additional demand pressure could significantly increase the present pace of programmer training. Nor would patent protection foster increased production and sales from independent software groups. Patents are not needed to protect program salability. A programmer's income from his product can be ensured by utilizing trade secret or contract protection. In any case, the problem of program vendors has to date not been protection against unauthorized exposure of their work, but rather finding interested customers.

Some feel that program patents would at least prevent the spread of industry secrecy regarding programs, so that patented programs would be programs that without the patent would never be disclosed to the public in any case. If so, the restrictive effect of the patent is not really a public detriment but instead makes possible a gift to the public which would otherwise not exist. But the thesis that patents prevent the spread of secrecy is today generally disputed. Insofar as a discovered process is not to be generally released, its creator is almost always more likely to use or vend it on a confidential basis than to secure a patent and undertake the burden of policing possible users. In addition, there is already a strong tradition against program secrecy throughout computer-using industry.

special-purpose computers

Finally, it has been suggested that the manufacturers and designers of special purpose computers need protection from equivalently programmed general purpose computers. If patents would protect special purpose computers from infringing programs, then presumably programs could as well be protected against infringement by special purpose computers. If this were so, an even stronger case could be made for protecting programs against infringement by other programs. By this circuitous argument the manufacturers of special purpose computers are claimed to desire patent protection for computer programs. But the only rational reason for building a special purpose computer (rather than programming a general purpose computer in the first place) is to fulfill a specialized need where for reasons of size, initial expense, or operating economy, the general purpose computer would be unusable, uneconomical, or inefficient. In such cases, the inventor of the special purpose computer should be able to obtain a patent for either a machine or for "quasi-structure." And to say that the special purpose computer should be patentable even without unique structure is merely to beg the question of whether or not "theories" should be patentable generally.

Perhaps paradoxically, patents will probably not be used by programmers in any case. The apparent paradox: How can patents be harmful if they are not used? The answer to the paradox is simple: The fear of possible patents can be as restrictive and can have the same consequences as the actual patents themselves. But why will patents not be used? The answer is fourfold. First, patents are expensive. To obtain a patent requires not

[13] S. 597, H.R. 2512, 90th Congress 1st Sess. Secs 101, 106 (1967). This bill will become law if it is passed by the Senate during the current session of Congress.

[14] *Ibid.*, Secs 101, 106

[15] These arguments can be applied to all patent grants, but they are particularly forceful when applied to grants covering computer programs because of the relatively low capital investment required to pursue good programming ideas.

only significant attorney fees but significant lost programmer time—and this when programmer time is the critical commodity we are seeking to make use of.

Second, obtaining patents is time consuming. On the average, from the time an application is submitted to the time a patent is granted requires three years and then the patentee has merely a "license to litigate." Should the patent then be litigated, it is of course possible that effective protection would be even further away. It goes almost without saying that a program is likely to be at least one generation obsolete by then. Third, a program patent is risky. An obvious risk is that large expenditures will have to be made defending the patent. Should the patent be struck down by the courts, the opportunity for other types of protection could well have vanished. For instance, the program would no longer be a "secret" protectable against unfair competition.

Finally, as a practical matter, patents would probably be unenforceable for all but major concerns because of prohibitive litigation expenses and the extreme difficulty of detecting patent infringements. To obtain a patent, an inventor must file a description of the invention with the patent office. A complete copy of that description can be obtained from the patent office in return for a trifling sum. Since creating the program from a detailed description would be inexpensive and since (most importantly) programs would be duplicated for *use* rather than for resale, it would be virtually impossible for a patent holder to track down the clandestine users of a patented program.

what next?

Today's patent and copyright statutes, as interpreted by the courts, are so ambiguous that computer programs do not conveniently fit either within or without their bounds. Decided cases, with a fortifying dose of legal metaphysics, could support new decisions either for or against program protection by copyrights or patents.

Alternatively, program protection could be explicitly provided by a new act of Congress. Such protection could be via an express clause in a new copyright or patent statute—both of which are now being studied—or it could be via a separate enactment with unique provisions.

The opinion of the informed edp public can have a great impact on the resolution of these issues. On the other hand, without this opinion, legal technicians will have no choice but to construct laws by extrapolating from past rules. Decisions *not* to speak out now can be quite significant. The laws which may thus evolve by default will be relatively hard to change, and can pose serious problems for programmers and for computer-using society.

These problems appear to me to be serious enough to merit the immediate attention of high-level management in program-producing and program-using organizations. Especially, serious thought should be given to the long-term effects on organization performance—benefits and detriments of program patentability and copyrightability. Computer systems personnel, while they can supply useful background, cannot be expected to make the broad-gauged evaluation called for here.

The primary responsibility for decisions on program protection rests with the Patent Office and the Senate and House subcommittees on copyright and patent. The chairmen of these committees are Sen. John McClellan (Ark.) and Congressman Robert Kastenmeier (Wisc.). Conclusions will be useful only if they are cogently presented to these decision makers with management's strong endorsement. ■

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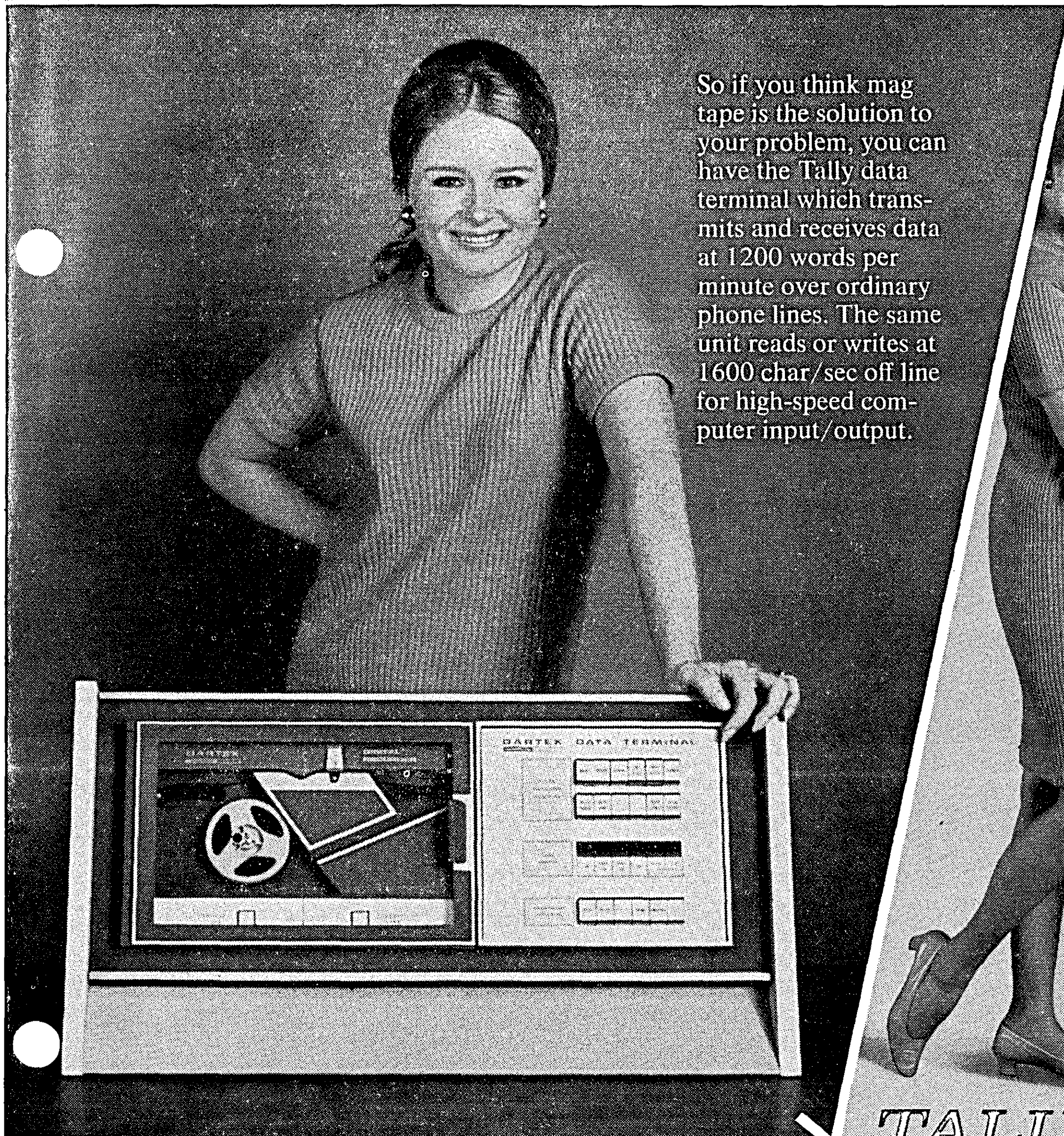

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THE MISSIL SYSTEM

for file management

by EVERETT B. TURNER

During the past decade, many of the advancements in computer hardware and software designs have been directed toward increasing the efficiency of data handling in the giant corporations. While tremendous technological strides have been made, much of this progress is practically meaningless to those companies that fall short of being classified with the giants. These are the companies with the same data processing problems as the giants, but because they are smaller, they have less data to process and the economic environment in which they operate is less complex.

Even so, they need to know—on a daily basis—the physical conditions which describe their operations. They need to process data on availability of raw materials, products made and inventoried, products shipped, and the pattern of distribution. They need to be able to compare actual operations with the requirements set by their corporate plans and they need to determine profitability.

Until recently, the only data-handling tools available for these purposes were those designed with the giants firmly in mind. Smaller companies, with their limited needs, couldn't justify the price. It was too much like having an Olympic-sized pool in your own back yard: so very nice . . . except for initial investment, operating expenses and maintenance costs. In short, as far as the smaller companies were concerned, all the tools for efficient data handling were over-designed.

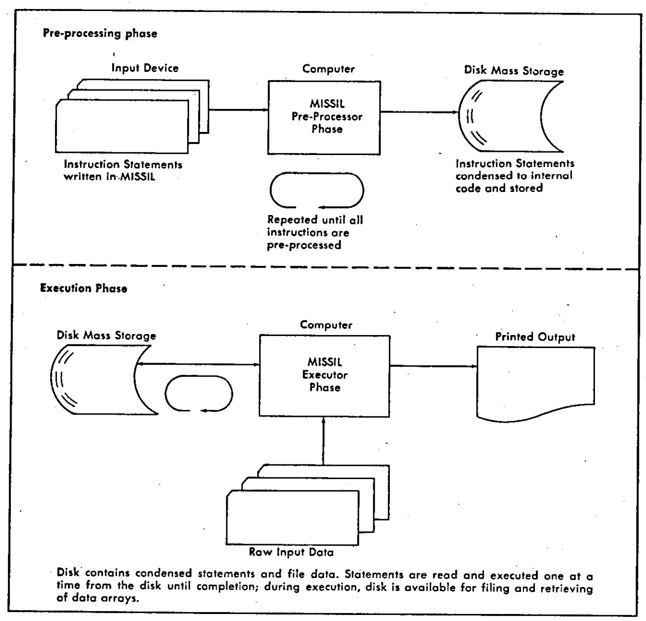
Hardware manufacturers have long recognized this problem. Recently, they also have recognized the marketing opportunities which accompany the problem and they have moved to build new capabilities into their small computers.

The "compact" computer line is here. And now, with the development of MISSIL (Management Information System Symbolic Interpretive Language), so is the language which can make use of the broadest capabilities built into them. MISSIL, designed by Bonner & Moore Associates, Inc., Houston, is tailored specifically to meet the data-handling needs of small computer users. By taking advantage of new capabilities which have been built into small computers—specifically, machines like the IBM 1130/1800 and the GE/PAC 4000 series—MISSIL brings the benefits of a comprehensive management information system within reach of many business and production managements.

The basic design of MISSIL overcomes two major barriers which have severely limited the small computer's usefulness for filing and manipulation of data in preparation and display of information.

First, MISSIL's two-phase, interpretive operation, (illustrated in Fig. 1), overcomes limitations imposed by the

Fig. 1. The MISSIL programming system.



Mr. Turner is manager, marketing division, Bonner & Moore Assoc., Inc. Previously employed by General Electric, where he worked with optimizing techniques common to computer applications, he has a BS in electrical engineering from Texas A&M, and an MS in applied math from Univ. of Houston.

small core storage of the compact computer. In the pre-processing phase, the user writes statements of the source program in MISSIL and feeds them into the computer (via punched cards) while the MISSIL pre-processor is in core. The pre-processor translates the instruction statements to condensed internal code and files the condensed code on disc. At this point, the condensed code is the equivalent of an object program, but requires no core storage. Thus, MISSIL can accommodate a program of essentially any size. When all instruction statements have been translated and filed on disc, the program execution can begin. The executor phase scans the translated program statements and executes them one at a time, in sequence, until all instructions of the program are completed. The use of core storage for arrays and MISSIL subroutines is controlled dynamically during execution. Until changes in the program are necessary, the pre-processing phase need not be re-run and programs may be stored on disc if desired.

Second, MISSIL's design recognizes that those who use small computers are not necessarily familiar with stored logic of their machines and may not be highly skilled in programming techniques. The characteristics of the language are designed to match the thinking of management and the terminology of accountants, production men, and engineers. (A listing of available MISSIL statements appears in Fig. 2.). Thus, MISSIL allows the user to communicate with the computer on his own terms to

Fig. 2. Types of statements.

ARITHMETIC	FORMAT	READ, DATA
ARRAY	FUNCTION	READ, TABULAR
ASSIGN	GET	RETURN
CALL	GO TO	SET
CALL (F)	GO BACK TO	SIGNON
DELETE	IF	SUBROUTINE
ENDSUB	PACK	SWITCH
ERASE	PAGE	WRITE, DATA
FILE	POSITION	

describe the flow of data, the computations, and the control he wishes to take place.

From the conceptual point of view, MISSIL has been some five years in the making. Its ancestral counterpart is Data Reduction Interpreter (DRI), developed by Bonner & Moore in 1962. DRI is a language designed to expand the data-handling capabilities of small machines which do not have auxiliary memory, and has been successfully implemented as a plant management information system on the IBM 1620.

The design of MISSIL was undertaken after hardware vendors started adding new capabilities to their small machines. Bonner & Moore's first approach to the development of MISSIL was to examine the user environment in which the language would operate as a basic tool in a management information system. This study determined that MISSIL would need to be:

1. Workable on compact computers
2. Developed and made available at minimum cost
3. Designed for extensive file handling, storage retrieval capabilities
4. Flexible in its report generating capabilities
5. Kept simple and efficient to use, requiring minimal skills on the part of the programmer
6. Written in a manner which would be understandable (vernacularly) to those who employ it.

After examination of the problem from the user's point of view, it was possible to establish the following design criteria for the language:

1. The language processor resides in core with automatic overlay at all times
2. The program is interpreted statement-by-statement, requiring no core storage for the object program
3. Each statement must be capable of performing as much as possible (indexing control is incorporated in the statement)
4. Recursive use of statements is possible through subroutines
5. Use of core for arrays is controlled dynamically at execution time
6. All data referencing in core is done by searching row and column labels for index.

Obviously, because it is written for use on compact computers, limitations had to be met somewhere. This is the basis for the use of automatic overlays and statement-by-statement interpretation and execution.

Although these design requirements add considerable flexibility and generality of application, they do require some sacrifice in speed. As a comparison, a special-purpose program written in assembly language would run somewhat faster than the same program written, interpreted and executed in MISSIL. This loss in speed, however, is more than acceptable when gains in programming time are considered. MISSIL makes possible the solution of problems which would otherwise be exceedingly time-consuming and difficult from the programming viewpoint.

Another factor which helps override these design requirements is the fact that MISSIL is upward compatible in a language sense with the management information language developed for the IBM 360. This broadens the usefulness for MISSIL for satellite operations of larger corporations where a 360 is used as a central computer.

Comprehensive error detection is another feature built into the MISSIL design. The two-phase operation of the language allows all syntactic errors and many semantic errors to be detected and corrected before execution. At execution time, all execution errors are logged and a maximum error count, determined by the user, will terminate execution.

Additionally, several other functional features make this system simple for the moderately trained operator to use:

Tabular storage of data. The MISSIL user may think of stored arrays as being exactly in the same form and order as in the physical report to be produced, complete with column and row names.

Symbolic addressing. All references to data are symbolic. A specific datum is referenced by giving the array name in which it is stored with row and column call-out identifiers.

Symbolic indexing. Indexing for data arrays can be done simply through the use of special symbols, thus eliminating the need for indexing through "do" loops.

No data ordering required. If data is to be manipulated from two arrays, it need not be either in congruent sets or even in the same sequence in both arrays.

Symbolic name manipulation. Data can be extracted selectively through character manipulation of the symbolic name.

Filing and retrieving by name. Files are stored and retrieved by symbolic name. The MISSIL programmer need not concern himself about sector size, location of data on discs, or the packing of discs for efficient use.

With these operating characteristics, and others, it becomes a simple affair to build a data base, and

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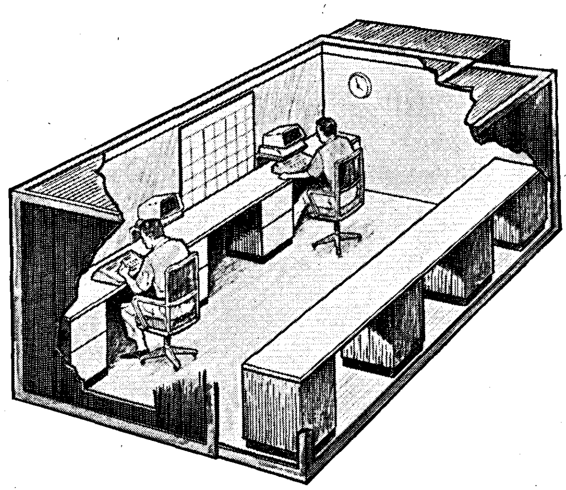

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CIRCLE 23 ON READER CARD

moreover, to maintain and update it. Very powerful but simple commands permit modifications to the stored data. Thus, through use of MISSIL the reduction of raw data, the development of data files, cross checking and verification, and display of timely information is accomplished within a few hours of the moment of request. The MISSIL design also assumes that procedures and flow of information may change on a daily or weekly basis.

Fig. 3.

THIS IS AN EXAMPLE REPORT

METER		READING	CALCULATED VOLUME	PERCENT
FR	001	1000	1010.00	.08
FR	101	100	110.00	.01
FRC	012	10	12.10	.00
FRC	132	1	1.02	.00
FR	102	10	9.50	.00
FR	204	100	110.00	.01
FR	103	1000	1000.00	.08
FR	104	10000	10100.00	.82
TOTAL			12352.62	100.00

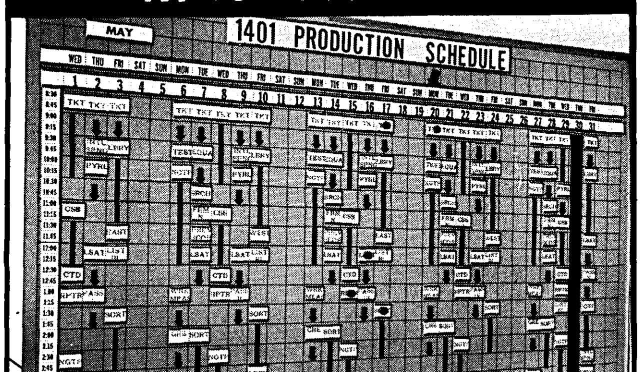
Management wants a variety of reports made available. However, only required information is desired—normally summaries, exception reports and certain on-demand special reports—in time to act upon the information. The data handling facilities of MISSIL provide the tool necessary to generate the needed report writers. Through its simplicity and interpretive ability, the system can be used to develop special report writing capabilities of a continuing nature, and when the period of interest is over, the reports can be terminated. (Sample reports are shown in Fig. 3.)

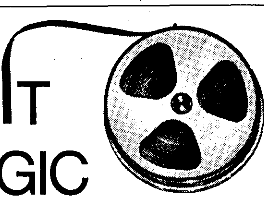
Again, this report writing capability is traced to character manipulation and to symbolic referencing, and the resultant simplicity in programming. This permits a variety of format so that tabular reports may be prepared with a single statement and complex reports wih a minimum number of statements. The reports present the information accumulated from multiple sources. Thus, reports can draw from data and information banks, putting data together in a concise form for evaluation and/or control of the environment.

The new line of compact computers will permit MISSIL communications with linear programming systems made available by vendors. Used together, LP and MISSIL will constitute a software package for matrix assembly, file maintenance, linear programming communication, optimization operations and accounting and analysis.

With these added capabilities, it will be possible for the user to produce management information reports from such sources as operations accounting, analysis and display, inventory projection, decision models, and process-oriented functions such as evaluation and optimization.

A basic version of MISSIL is now operational on the IBM 1130 (8K word core) machine, and an expanded MISSIL, which includes a capability for calling of FORTRAN subroutines, is operating on the IBM 1800. MISSIL for use on the GE/PAC 4000 series machines is dependent on hardware and software availability but should be operational by January, 1968. Expanded MISSIL for use on the 1130 (16K word core) machine also will be available in January, 1968, after the additional core storage is operational. ■





THE NRMA EDP CONFERENCE

The 9th Annual EDP Conference of the National Retail Merchants Assn. held in Washington, D.C., Sept. 26-29, told why, in a period of unprecedented prosperity, the retail store is not raking in its proportionate share of the profits, and where data processing fits into the solution.

The president of NCR, Stanley Laing, keynoted the meeting which was attended by 300 retailers, merchandise vendors, and edp equipment, forms and tag makers.

"Many stores are currently facing what amounts to a crisis in several important areas. Disturbing trends are developing . . ." said Laing. The after-tax return on investment in all department stores for the last five years has averaged 7.6%—"considerably short of realistic requirements for underwriting future growth." After-tax profits as a percentage of net sales have remained relatively stagnant, and the capital turnover in this field, unlike other industries, has not been increased enough to offset the lower profit margins.

Why is this happening? Though the great increase in credit, particularly installment credit, forestalls income and is expensive to operate, it is not a cause of the problem; edp has made a significant contribution in this area.

The real problem is in inventory control and, almost as significant, inefficient use of selling space. In a survey of 27 stores, it was found that efficiency of inventory management has eroded by 9% in the past decade, with the gross margin per dollar of inventory dropping 16%, the inventory turnover dipping 15%. And sales per square foot of selling area dropped 12%. The stores have, he said, failed to apply a "sophisticated return-on-investment approach" to these areas. Much attention has been given to automatic replenishment of staple stock items, fashion merchandise, and "big-ticket" items. But what is needed, he said, is investment control information which breaks down large departments into a number of fine-line classifications or categories—and this must be accurate and timely.

Use of such tools as the NRMA Merchandise Classification Standard and, of course, data processing, has already helped many stores correct inventory imbalances. While there is much discussion and work on on-line real-time systems, Laing noted that the "types of management information systems needed today . . . can be effectively operated on an off-line basis." At the moment there is too much groundwork to be done—such as definition of planning and control concepts—before OLRT and its advantages can be realized, he said.

Many edp people in retail tend to agree with Laing. NCR, however, noted Laing is working hard on developing devices and software for OLRT, because it will provide more accurate data input by monitor transactions, determining taxes, and computing discounts; it will also help enforce store policies and provide immediate data on merchandise availability and customer account status.

System requirements, he said, are two-way communications with central files, system flexibility, complete alphanumeric printing capability for the point-of-sale terminal, new data display techniques, and flexible central control for monitoring remote points.

Laing then went on to show that NCR does indeed have a prototype of the on-line point-of-sale terminal—a modular, all electronic (integrated circuit) system with 10-key and full-keyboard modules, display, thermal printer, and credit card reader.

As of the end of 1966, there were 1,900 computers in 1,300 of the 1,260,000 retail stores and, said Mildred Pass of City Stores, the retail industry is just not ready for OLRT systems. "I believe that we must go through this period with interim systems, getting the automated reports, developing exception reporting, and teaching our merchants and management people how to use them. We must develop the level of accuracy required for OLRT . . . in receiving and marking, in the buyer's office, on the selling floor."

Mrs. Pass noted that accounts receivable must be numbered with straight numeric, checkable digits; checkable classification, SKU (stock-keeping unit), and sales clerk numbers must be established; accounts payable must use the DUNS numbers (Dun and Bradstreet numbers established in cooperation with NRMA for manufacturers) in accounts payable.

The point-of-sale device needed now, she said, is what is available—one which records in paper tape, magnetic tape, or in NOF (optical registers). In 1965, the latest NCR register was the class 53 and 55 optical font unit; stores have found them useable where they had a computer and enough registers were acquired to justify the cost of renting the NOF scanner. NCR now has a new unit, the model 5, which offers more advantages than the 53 and 55, said Mrs. Pass. It has: 11 rows of keys,

three being motorized (vs. two on the other units) providing more ability for selectivity in combining operations and in programming; NOR and paper tape input; faster cycling speed; and greater capability for sequence control. The NOF register produces nearly perfect print, eliminating reject problems when the tape is not scannable.

Mrs. Pass also described the new point-of-sale recorder that Singer Co. will begin testing in its stores in 1968. Produced by Friden (a Singer subsidiary), the 10-key register is all electronic with built-in check-digit verification, and is about the size and price of present registers. Transactions are recorded on a quarter-inch magnetic tape in a cartridge; the tape must be converted into standard half-inch tape (Digitronics is working on a converter). The unit will issue a receipt or mark the sales check, and can be programmed for sequence control and control errors.

She also noted that the Unitote system, which records into a back office data collector onto mag tape, has two advantages—its preprogrammed feature for ease of training, and the ability to verify checkable numbers as they are entered.

GE seems to be developing systems for the retail field. (In addition to the healthy numbers from IBM, NCR, and Honeywell, there were several people from GE's retail group, recently relocated to Paramus, N.J.) Mrs. Pass noted that GE is working on an OLRT point-of-sale device with a 10-key register and is fairly near announcement. IBM, of course, has been working on an on-line unit for six or seven years. While its 1287 optical scanning unit (for handwritten symbols) has been ordered by several retail stores, such as Woodward and Lothrup, Mrs. Pass felt this is not the kind of input device IBM will be able to use for a total system. The "pencil" as input is only good for large ticket, low transaction departments, she thought. Tests with the 1287 have already shown that input accuracy is not great enough.

The necessity of standardizing input data format was discussed in several sessions. The NRMA Classification Standard was issued earlier this year, providing coding for all classes of items sold (i.e. shoes: broken down into baby's, men's, women's, tennis, golf, etc.). But this is only the beginning. Stores have or are developing codes for such categories as color and style. Another standards program is the coding of manufacturers; as mentioned, Dun and Bradstreet, in cooperation with NRMA, has been developing such a system.

Using the DUNS numbers, 101 merchandise manufacturers are now providing stores with pre-ticketed items. Source marking is becoming a vehicle for automatic reordering and, it is claimed, is saving the retailer the expense of ticketing some merchandise himself. In a session on this topic, G. Paul of Catalina described their pre-marking tests with The Broadway stores.

A magnetic tape of each week's sales, tallied from the machine-readable tags, was sent to the Catalina computer system, which automatically issued reorders of items at a predetermined number. The result was that Catalina's business with the stores doubled, and the stores did not experience the usual 50% out-of-stock situation with the firm's goods.

There is somewhat of a controversy over this kind of system since some retailers think pre-marking is a duplication of effort (the vendors cannot premark price and the store must therefore take time to add this and other data) and do not feel automatic reordering is always applicable. (Automatic reordering, however, need not be involved.)

If credit is considered a moneymaker for retailers, it is certainly not without its problems. Each store faces competition from other merchants, from discounters, finance companies, and community and bank credit card operations. And each local credit bureau managed by one or more stores faces competition from the larger more sophisticated computer operations of such national firms as Credit Data Corp. and Hooper Holmes.

In a luncheon speech, American Bankers Assn. automation director Dale Reistad dazzled his audience with a description of the development of ways to pay. There's the check, the guaranteed check, the check permitting the customer to overdraw, the store credit card, the bank credit card, and the coming automatic transfer of funds from the consumer's bank account right at point of sale (this is the promise or threat of the "checkless" society). More immediately exciting is the Money-Back Card, as of September being offered by Dividend Club Inc. This system rewards the consumer for paying cash at certain member hotels, stores, restaurants.

Today many stores will not accept bank cards, but will accept any of the checks listed above, which means they do not gain the formal relationship with the customer which nets them a service charge, the chance to send advertising to him, and the ability to do some analysis of customer buying habits. The Money-Back Card further compounds the problem. If the merchant decides to offer the discount, he still loses the customer-store relationship and gets no service profits.

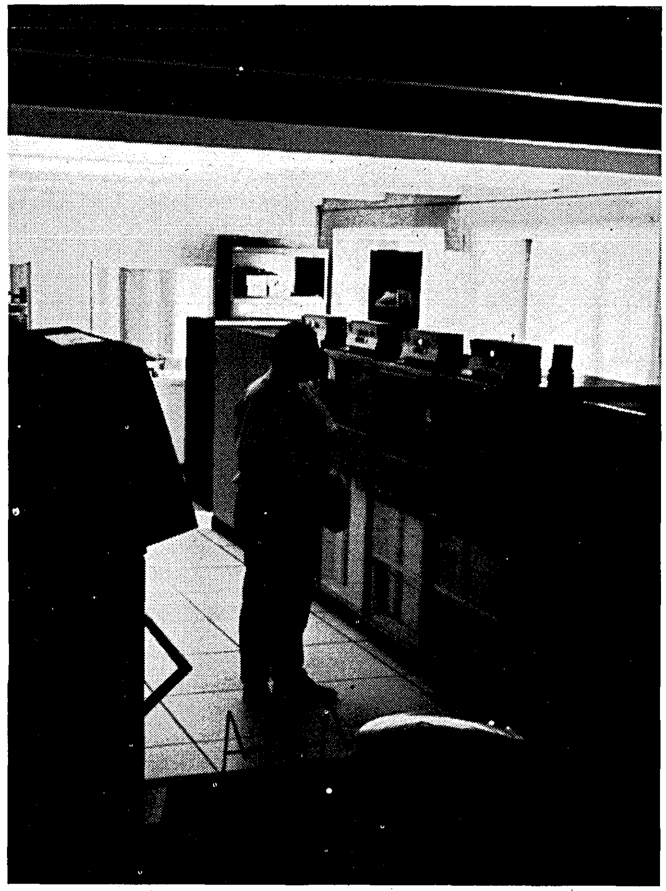
The solution, in short, according to Reistad, is that the banker and the retailer should be friends. And indeed, a committee of the two groups has been formed to discuss the problems. If the retail store adopted the bank card, he said, the banker, for a fee, could supply fund transfer and a sophisticated customer name and address record-keeping system. As for the cash-payment discount, the consumer could receive it through the bank card; the bank would automatically transfer the "computer money" into the merchant's account, or, if the bank paid the discount, it would keep the payment itself for a period, then transfer it. It would seem that the retailer has little choice but to cooperate, since the bankers are bent on the "checkless society" and the two entities will ultimately be bound together by OLRT automation.

There are other forces at play which will change credit granting—namely, the law—noted Joseph Garcia of Federated Department Stores. Much of the "truth-in-lending" legislation will place a cap on service charge rates. In Pennsylvania, a maximum 1.25% service charge is now permitted on revolving accounts that previously had a 1.5% rate. Current legislation in the U.S. House would regulate the manner credit is advertised in the public media, causing a shift in promotional methods and procedures and perhaps an upset in the balance between profits and losses. Medicare raises the question of whether a store should implement exception reporting to help customers account for their purchases of drug items. And there is the issue of invasion of privacy facing credit grantors and bureaus as more central and detailed computer files are developed.

In all their operations, the retail store chain is coming more and more to rely on communications lines to transmit reports and data for processing. NRMA has been exceptionally active in voicing the opinions of its members to the Federal Communications Commission on matters ranging from Telpak, Telpak-sharing, and shared microwave to the coming inquiry on computer/communications and the attendant question of regulation.

Conference attendees, except those from Ma Bell, particularly heralded

How your computer can win when others are losing with an electric power failure.



You're concerned about electrical power failure to your computer. Failure causes data loss, production stoppage, downtime. Our no break power generating unit prevents power failure.

Our unit assures continuous electrical power for your computer system. Not a millisecond pause in generated power when commercial power falters.

The unit isolates the critical part of your computer from electrical power surges. And commercial power sources are full of surges.

The no break unit also provides highly regulated power which sensitive computers demand.

Our people originated the rotating no break system about 4,175 units ago. For 15 years, we've watched others try to match our unit's performance, and, for the most part, fail. It is still the simplest set-up in the field which means it's the most reliable.

Call us and we'll make all our experience available to you. After a few sessions, you'll know almost as much about winning with no break as we do. United States Motors, Area Code 414/ 231-4560 or write to 339 West 20th Avenue, Oshkosh, Wisconsin.

UNITED STATES MOTORS CORPORATION

CIRCLE 37 ON READER CARD

NRMA . . .

the luncheon comments of Bernard Strassburg, FCC Common Carrier Bureau chief, on the pending Microwave Communications Inc. and Carterphone cases. Strassburg indicated that the FCC will probably concur with at least the general recommendations of the bureau on both issues. The Carterphone case put to the test the carrier taboo against foreign attachments on dial-up lines. The bureau recommended that any foreign equipment be allowed, as long as it adhered to technical standards. "Appropriate relaxation of the traditional requirements of the use of foreign attachments would expand the communications equipment market . . . and the growth of the computer services available to the public."

The MCI request was that it be permitted to offer inexpensive microwave services between Chicago and St. Louis, making it a small common carrier. The bureau did not accede to AT&T's protest of cream-skimming, but instead noted that the MCI system would benefit the small business, which cannot afford private or shared-private microwave. In essence, the FCC is smashing any concept that it is an "AT&T subsidiary" and is aiming at decisions to solve the problems posed by digital communications.

NRMA finds the Carterphone recommendations particularly heartening because of the trend in retail industry to install private telephone systems, said the NRMA communications counsel, William Borghesani, Jr. Interconnection between private and dial-up system has been prohibited until this case, and the economic savings to be realized could be great. Shared Telpak is pending before FCC but several attendees said AT&T may itself move to grant it if MCI is permitted to operate.

NRMA does not want regulation of any of the service bureaus—as posed under the computer/communications inquiry, one reason being its potential effect on pricing structures, said Borghesani.

The retailers are also disgruntled with the current Bell System effort to amend state tariffs to do away with manual switchboards in heavy use by the retail industry, in favor of automated switchboards costing three to five times as much. "We have to organize NRMA representatives in each state to voice objections." As in all industries, NRMA is finding that dealing with communications problems on the state level is extremely cumbersome. One attendee noted that for a national system he had to obtain prices on one data set from several hundred phone companies—the range of quotes was $10-50.

In addition to these discussions at the conference, there were many computer manufacturer seminars, sessions on forecasting, auditing requirements, computer evaluation techniques, SMART and MICR. And Western Union got into this meeting too to talk up the computer utility.

The meeting wound up with a trip to Woodward & Lothrup, one of the pioneers in retail edp. They have a few 360/40's, some 1285 optical scanners, disc drives, a 1410—doing accounts payable, accounts receivable, direct mail advertising, expense reports, Retail IMPACT, furniture inventory, sales audit, staple merchandise automatic reorder, unit control. They plan to add 12 IBM 2260 display devices, a voice answer back system, 16 typewriter terminals, two remote printers, and a 1287. Much of the online equipment will be in accounts receivable. They also plan to do customer analysis to help in directing advertising to the proper buyer.

So the retail industry is not standing still. —ANGELINE PANTAGES

Your memory need improvement? Ampex makes cores, planes, stacks, transports and complete memory systems. Check this list for your needs.

a A data system or computer is only as good as its memory, so it pays to get the most reliable memory components and systems. Here are some examples—from a company which is a leader in the development of core and tape memories and has the technology and experience to improve your system's memory—Ampex.

Core Memories

b **START WITH FERRITE CORES...** We offer a full line of ferrite cores ranging in size from 18 to 80 mils (outside diameter). If your application involves a wide temperature range, we can supply you with lithium ferrite cores in 18- to 30-mil sizes. Chart "B" shows typical switching times.

For more information on Ampex cores, circle number 15 on Reader Card.

c **OR WITH ARRAYS OR STACKS...** We have a full line of commercial and military arrays for memory designers, and we're glad to take on design assignments for special stacks and arrays.

Our 2½D stack family has expanded and now includes 18-, 22-, and 30-mil cores. Ruggedized stacks for military applications are designed to satisfy such requirements as MIL-E-5400 and MIL-E-16400 in both 3-wire 3D and 4-wire 3D configurations.

More stack or array info? Circle 16 on Reader Card.

d **OR BUY THE COMPLETE MEMORY!** We design and build all kinds of core memory systems for commercial and military use. They begin with our widely known and used RF series, and range in size up to 20 million bits. Here is a brief view of our core memory line.

RF series is a modular family of reliable memories which offer large ranges of "store" sizes and options. Integrated circuits and "Master Board" construction cut their size and cost, increase reliability. All feature high MTBF, easy maintenance, non-destructive power shutdown.

RF-1, RF-2, RF-3 give you 1.5 microsecond cycle time. Capacities from 512 to 16,384 words, in word lengths from 4 to 72 bits. Each includes power supply. Over 4000 hours MTBF for 4K x 12 RF-1; proportional for RF-2 and RF-3.

New RF-4 memory has faster cycle time of 1 microsecond. Capacity: up to 4K x 20. Available with or without power supply.

RS memory system is a large capacity (up to 32K x 80) 1-microsecond system with a variety of options that let you tailor it to your exact needs.

For more core memory details, circle 17 on Reader Card.

e **MASS MEMORY** consists of 4 modular stacks of 5 megabits each. Cycle time is 2.7 microseconds, but unique 4-way interleafed operation with two-port entry into the four stacks results in *effective cycle time of 675 nanoseconds.*

For more core memory details, circle 17 on Reader Card.

NEW! RG MEMORY

Our brand-newest system, the RG memory packs big capacity into very small size by using integrated circuits throughout. Some features:

- 900 nanosecond full cycle
- modular (16K x 40 max. per 5¼" panel unit), can expand to 32K x 80
- operating temperature 0 to 50°C
- standard TTL positive true logic interface levels
- uses advanced IC's throughout
- low cost yet reliable and simple to maintain
- options: data parity generation and check, built-in tester, indicator panel, zone transfer; many other options

For more core memory details, circle 17 on Reader Card.

Single Capstan Tape Transports

Our tape transports meet all your requirements with data transfer rates up to 120 kHz. All offer at least 2,000 hours MTBF, at least ONE BILLION start/stop operations before replacement parts may be needed in the drive mechanism. All units are interface interchangeable. Write and read IBM compatible 7- or 9-track formats. All contain the Ampex patented single capstan electronic servo control.

f **NEW! TM-16 TRANSPORT** is the newest member of the Ampex single capstan family. It is a direct plug-compatible replacement for any IBM 729 or 2400 series transport. Besides offering higher data reliability at high speeds (60-150 ips), the TM-16 features a number of human design improvements: push-button power window for faster access and easier loading; straight-line threading for operator convenience and faster loading; optional automatic threading; and a modular design that makes maintenance simple.

For additional data circle 18 on Reader Card.

TM-7, -9, -11, -12 transports are the original single capstan transports specifically designed for digital data transfer. Over 1,000 of these Ampex tape drives are now in use around the world.

For complete and up-to-date information on transports, circle 18 on Reader Card.

g **BUFFERED TAPE MEMORIES (BTM SERIES)** incorporate an Ampex single capstan tape memory, an RF core memory and integrated circuit control logic to achieve a highly flexible digital data recording system. A functionally integrated, easy-to-use unit, the BTM buffered tape memory, can accept asynchronous digital data over a wide range of character rates, format the incoming information and record the data in blocked and gapped form on computer-compatible magnetic tape.

For more core memory details, circle 19 on Reader Card.

h **SHARED TAPE MEMORY SYSTEMS** let you save both money and floor space. They time-share the 7- or 9-track data (read/write) electronics between up to four TM-series single capstan tape transports.

TAPE CONTROL UNITS FOR COMPUTERS

The convenience and low cost of digital magnetic tape recording can now be inexpensively obtained for various medium and small size digital computers. By combining an Ampex TM-series single capstan digital tape memory with our Ampex-designed tape control unit (TCU) you have a versatile, compact, low price magnetic tape system. The TCU plugs directly into a computer's input/output interface and decodes standard magnetic tape unit program instructions for tape transport selection and data transfer control.

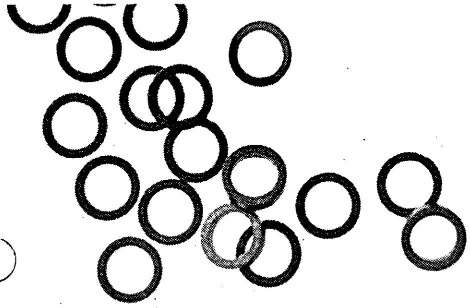
Sound interesting? Circle 19 on Reader Card for tape memory info.

i **HOSTILE ENVIRONMENT DIGITAL TAPE MEMORY SYSTEMS** Our ATM-13 and GTM-14 memories are designed and constructed to take the extremes of pressure, humidity, temperature, shock and vibration found in airborne, shipborne, geophysical and ground mobile applications.

The ATM-13 high performance memory system is IBM-compatible to 75 ips (60 kHz character transfer rate at 800 cpi). Continuous (gapless) to 112.5 ips. Fast start/stop times of 6 milliseconds maximum at 75 ips. Can operate continuously at maximum program rates up to 160 start/stop cycles per second. Environmental Class: MIL-E-5400-G, Class 1A; RFI: MIL-1-6181D; Source Power: MIL-STD-704. Weight: less than 150 lbs.

NEW! GTM-14 memory is IBM-compatible to 45 ips. Continuous (gapless) to 105 ips. Weighs less than 150 pounds. Low power requirements. Will operate on battery power. Capable of operation within the environment of MIL-E-5400, Class 1A.

If you're especially interested in this tough breed of memory, circle 20 on Reader Card.



a

AMPEX

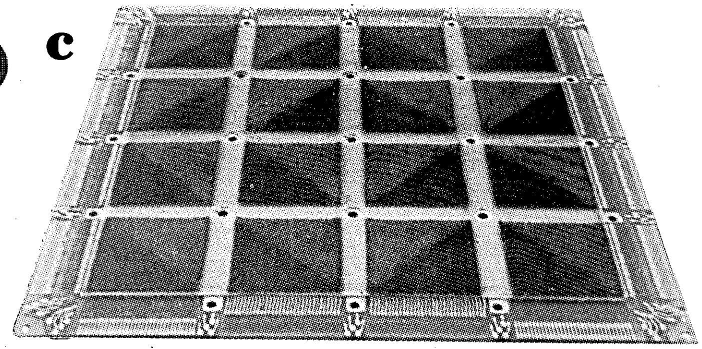
Typical switching times for Ampex Ferrite Cores

b

Core #	*Switching time*
184-06*	175 nanoseconds
204-06*	230 nanoseconds
303-03	360 nanoseconds
304-07*	380 nanoseconds
304-06*	440 nanoseconds
501-10	850 nanoseconds
504-10	1300 nanoseconds
506-15	1500 nanoseconds
802-40	3000 nanoseconds

*Wide temperature range

c



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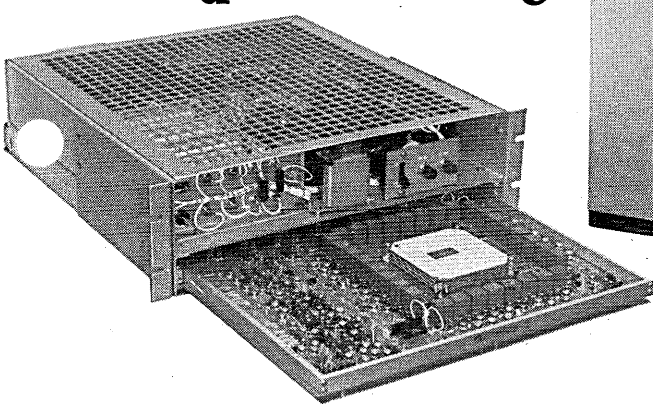

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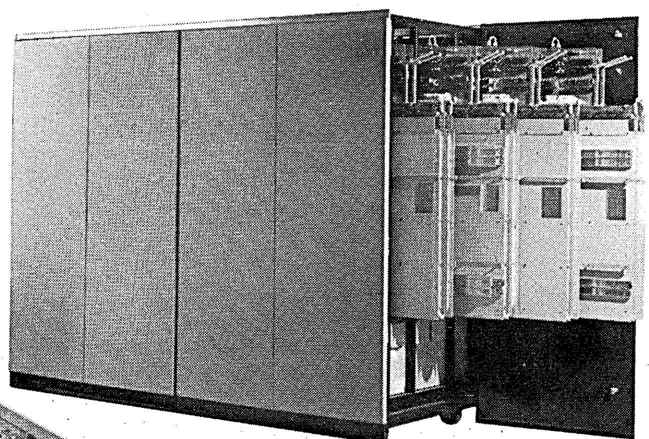

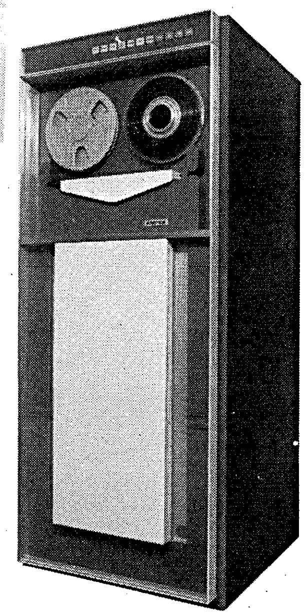

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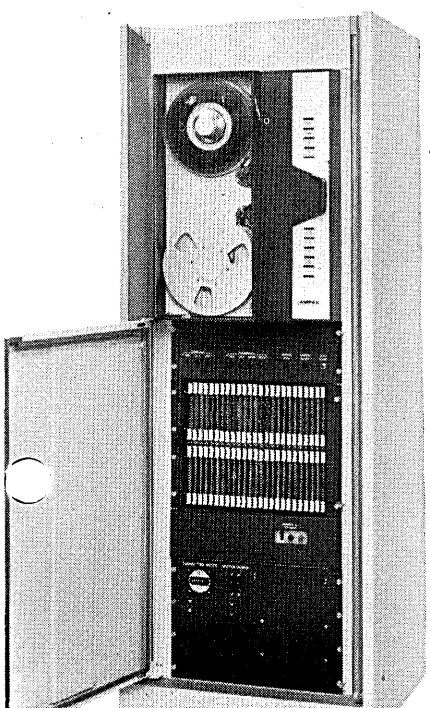

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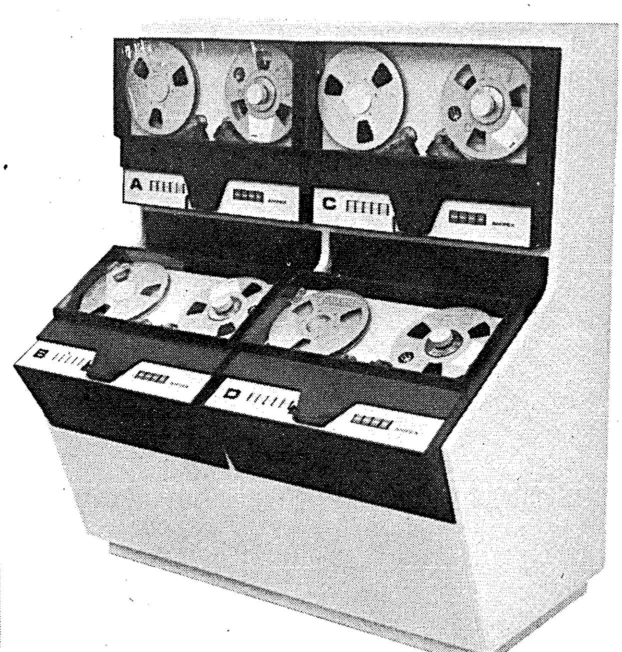

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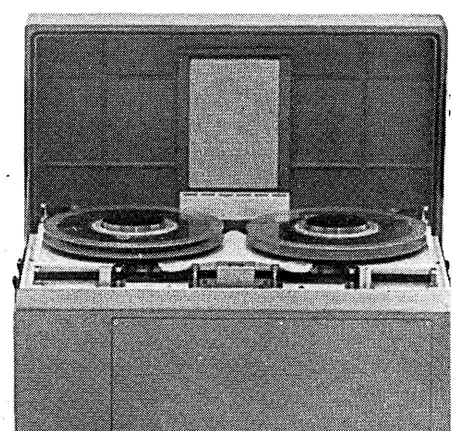
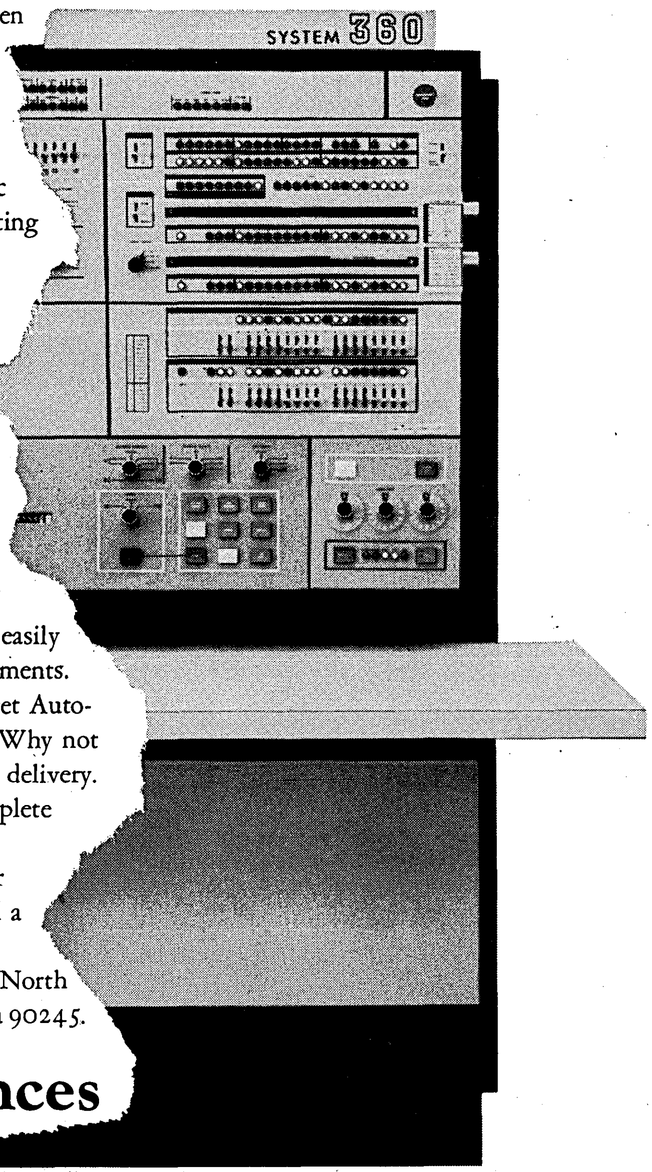


We figured out how to let you get this much more out of your 360.



Through EXODUS II, a low-cost, proven system for converting your 1401 Autocoder or SPS source decks to 360 Assembly Language programs. With EXODUS, the full power of DOS or OS is available and the original program logic is retained. And it works without resorting to compatibility, even during the translation phase. This avoids the high cost of compatibility hardware, for one thing, and its limitation on system expansion for another.

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Also, EXODUS translated programs conserve valuable core. And because of the modular design, the system can be easily modified to take care of unique requirements.

Sooner or later you will want to forget Autocoder and start writing 360 programs. Why not now? EXODUS II is ready for immediate delivery.

Write for our brochure. Read the complete details. Then contact Charles Sullivan, Manager, EXODUS Systems to arrange for a thorough demonstration. (Don't send a deck until after you read the brochure.)

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Computer Sciences Corporation

CIRCLE 41 ON READER CARD

generation 3½?

GE's NEW MONITOR

General Comprehensive Operating Supervisor III (GECOS III) is a new operating system for General Electric's GE-600 series of large-scale computers. It integrates requirements for on-line batch, remote batch, and time-sharing into one system, using a common data base. The problems of employing multiple systems, with incompatible programs and files, no longer need exist for large-scale computer users.

The major design objectives of the new system were:

- The system must be immune to user program errors, whether intentional or unintentional.
- The system must be fully user program compatible with GECOS II.
- The internal system structure must be simplified for ease of extension and modification.
- The system must maximize peripheral utilization.
- The file system must provide file protection and access control in a multiprocessor mode of operation.
- Batch, remote batch, and time-sharing must be integrated for effective concurrent operation.
- The system must operate efficiently under an effective memory discipline.
- Self-measurement and feed-back techniques must be incorporated to provide data for continued development.

The "heart" of GECOS III is a centralized file system of hierarchical, tree-structured design which provides multiprocessor access to a common data base, full file protection, and access control. Full user program compatibility with GECOS II has been retained, but the internal organization and logic flow of the system is completely new. The ease with which the system may be extended and modified has been enhanced greatly.

The processor operates in a dual mode, with the operating executive (GECOS) executing in both "master" and "slave" modes, as required, while user programs execute in "slave" mode only. In master mode operation, the full instruction repertoire may be executed; all memory references are absolute; and full range of memory may be referenced directly. In slave mode operation, memory references are relative to a base address register (BAR) which defines the physical address limits of the executing program; the program cannot access memory locations outside of the BAR setting.

In GECOS III, the memory space required for overlays is minimized and strictly disciplined. A fixed amount of space, called the Slave Service Area (SSA), is dynamically allocated by program for this purpose. Each program in the system has an SSA, and when a program is brought into memory, all system data pertinent to that program is held in the SSA.

I/O requests by the program are queued in tables in the SSA. The SSA also maintains a push-down stack for defining the state of the program, and as system service function overlays are needed, they are loaded into the SSA for execution.

The SSA is adjacent to and below the zero address of each program. The SSA addresses are -1 through -1024 of the program. The BAR setting protects the SSA from user program access. System overlays brought into the SSA reference data within both the user program and the SSA by addresses relative to the BAR setting, making it unnecessary to relocate any code read into the SSA for execution.

Approximately one-half of the SSA is used for overlay execution. In addition, an automatic push-down and pop-up capability for overlays was developed in the SSA. If one overlay executing in the SSA should call another, the first is written on a push-down file associated with the program. When the corresponding exit is made, the SSA is popped up again. Experience has shown that most system service functions can be accomplished within the SSA without incurring the push-down, pop-up overhead.

In addition to solving the space discipline problem, the SSA has proved to be the single most important concept in GECOS III. Since the system data for a program is codified by and adjacent to the program, it is much easier to determine the status of a program or to suspend program execution in order to move it in memory or to swap it out to secondary storage. This association of system data and service function overlays with their programs also results in increased multiprocessor effectiveness by avoiding the memory interface problems which are incurred when such data and subroutines are pooled and under a common memory controller.

file system

Basic to the organization of GECOS III is a file system comprised of a permanent on-line data base, with security protection, and access control. The design of the file system was strongly influenced by considerations of system safety and maintainability. The list-structured physical space definition was discarded, for example, because of the complexity and time required to reconstruct such a base if the list pointers were accidentally destroyed.

Logically, the file system consists of a master catalog which identifies each user known to GECOS. Within the master catalog are pointers to catalogs for every user. The user's catalog may define files, or may in turn name and point to still lower level catalogs. Accounting information for the time-sharing system also is kept in the master catalog.

To identify a file in the system, a string of names is given, beginning with the user name in the master catalog. Each successive name, in turn followed by the file name, defines the file. At any point in this string of catalogs, except for the master catalog, passwords or permissions may be invoked.

Any file or catalog in the file system may be read, written, appended to, or executed. The owner of the file or catalog may specify who may have each of these four types of permissions. In traversing a catalog string, the permissions are checked at each level, and if the interrogator has been denied the permission he seeks, he is not allowed to complete the reference.

When a user asks for a file, he must state what activity he has in mind. Safeguards in the system prohibit a user from asking for one type of permission and then using the file in another manner. The file system allows any number of users to read or execute a file at one time, but will not allow anyone to write or append a file if someone else is referencing it.

For each user in the master catalog, there are entries defining how much space he may use in the file system. The file system will prohibit an attempt to create files exceeding that space limit.

GECOS III provides true device independence. The I/O structure is defined so that user programs reference logical files and need not be concerned with physical device peculiarities. The most important property of these I/O queues is that they allow the adoption of selection strategies which increase the system's I/O throughout. For instance, the drum commonly used as secondary storage informs the processor of its angular position at I/O terminate. The I/O system selects the particular I/O request in the drum queue which will minimize rotational delay. Tests show that throughput may be more than doubled using this technique.

An interesting feature of the I/O design is the "courtesy call," an addition to an I/O request which asks, "As soon as I/O is finished, I'd like the processor again for a brief period, to initiate another I/O request." Any user program I/O request may specify that a courtesy call is to be paid to a given address when the I/O terminates. The operating system interrupts the execution of the program to pay the courtesy call as soon as it has processed the termination of the I/O command. In this way, I/O-bound programs are guaranteed processor time to reinitiate I/O requests as soon as a previous request is finished. Even in a heavily loaded system, I/O is kept running at high speed. The system input and output programs use courtesy calls extensively.

By selecting a new program for execution at each interrupt, I/O-limited programs are kept active and maximum throughput is achieved. When there is a heavy I/O load, the system commutes rather rapidly between the programs that are performing I/O and gets to the "processor burners" (processor-limited programs) only when all the other programs have been serviced. On the other hand, when there is little I/O loading, the system stays for a longer period in each program, with proportionately less overhead.

time-sharing routines

GECOS performs all interrupt processing and dispatching in less than 15% of the processor cycles when the system is heavily loaded, and in about 5% of the cycles when only "processor burners" are in memory.

The GECOS time-sharing system is designed for installations that have a batch commitment and also need time-sharing. The portion of the hardware dedicated to time-sharing is *dynamically* variable, providing an operating spectrum from full time-sharing through full batch processing, according to the requirements of the installation.

The time-sharing executive performs the functions of selecting, allocating, dispatching, and swapping time-sharing user programs. Since the time-sharing executive is treated as a single system program by GECOS, it sub-allocates memory and sub-dispatches the processor to individual time-sharing user programs. In the process of sub-dispatching, the time-sharing executive establishes a new BAR setting around the user program to be executed, insuring the integrity of other user programs in memory.

One of the major integrating factors in the design of the time-sharing system is the use of the GECOS file system. It is through this common file system that user programs in the batch system and in the time-sharing system communicate with each other.

A straight-forward application of this capability allows a large batch job to generate or update a file (perhaps based on inputs from another file entered from time-sharing terminals) and have the updated file available for inquiry by time-sharing users.

An even more interesting capability allows the time-sharing system to generate a job for the batch system. The user program in the batch system may be too large to process conveniently in the time-sharing mode, or may be an existing program for which modification for direct execution in the time-sharing mode is not desirable. An option exists to allow a time-sharing program to wait for the completion of a batch job. In addition, there can be a direct "conversation" between a batch program and a remote terminal.

DONALD J. CAMPBELL
WALTER F. COOK
WILLIAM J. HEFFNER
General Electric Computer Equipment Dept., Phoenix, Ariz.

two more siblings

HONEYWELL ADDS TO 200 SERIES

Honeywell brightened the month of October with announcement of two new computers, a bunch of peripherals, additional software, and a field modification that will allow use of the new DuPont Crolyn high-density mag tape.

The computers are the Models 125 and 1250, to be slipped into the product line just above the 120 and the 1200—which leaves plenty of numbers to spare. This brings the total of Series 200 processors to eight. Reflecting the happy new manufacturer attitude of building first and announcing later, the 125 is being demonstrated at the BEMA show in New York City Oct. 23-27.

The Model 125 has 2.5 usec cycle time, four I/O channels, 4K- to 32K-character main memory capacity, and is said to be 50% faster than the 120 at about a 10% increase in system cost.

The Model 1250 can handle multiprogramming, has a 1.5 usec cycle time, 32K- to 262K-character storage, eight I/O channels, and can handle six simultaneous peripheral operations. Using an expanded version of the Mod 2 operating system—also just announced—the 1250 will take data communications terminals.

Other software announcements include a new assembler, a conversion program to go from the Mod 1 to Mod 2 operating system, and a monitor that permits foreground/background processing with Mod 1 OS.

The peripheral equipment includes two card readers, a low-cost 400 lpm printer, a disc drive, two tape drives, and a control unit for optical character reading.

The Model 223-2 card reader is a 1,050 cpm unit that can be used with all eight processors; the 123-2, fitting the small end of the product line, runs at 600 cpm.

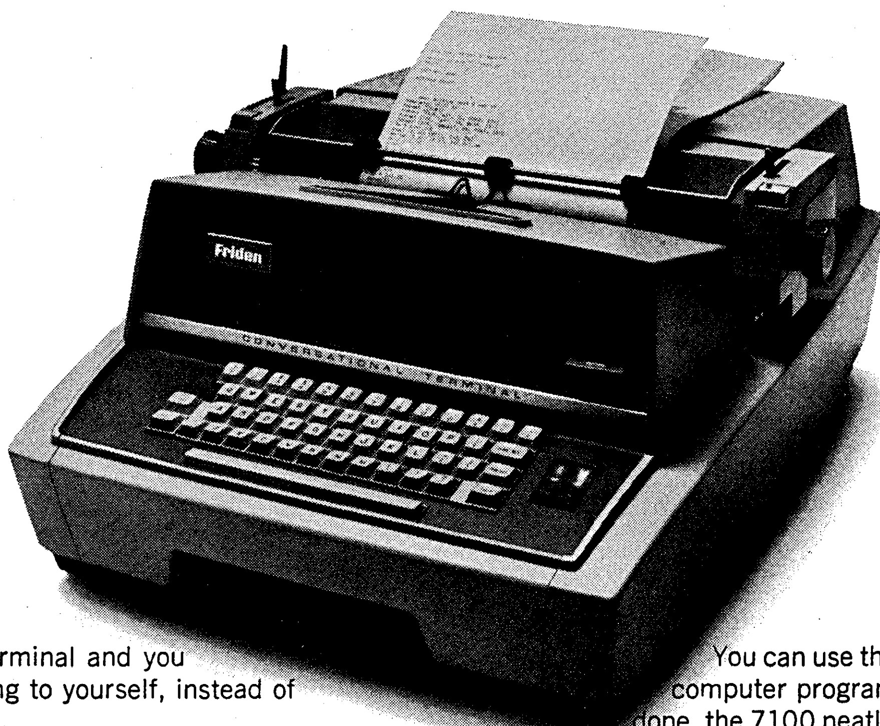
Tape drives added to the line are designed for the 120 and 125 processors and have a 26.7KC transfer rate. Models 204B-11 and -12 now installed can be upgraded in the field to the new -15 and -16, doubling their transfer rates.

Crolyn magnetic tape can be used with the 204B-9 drive if the customer specifies hardware option 054. The standard drive, using conventional tape, has a maximum transfer rate of 96,000 cps at 800 bpi. Adding the option, and using the new high density tape at 1,200 bpi, gives a rate of 140,400 cps.

As for the new processors, prices for the 125 will range from $1,150 to $2,925/month and, for the 1250, from $3,545 to $9,725/month. Deliveries begin this December for the 125 and in July '68 for the 1250. ■

CIRCLE 165 ON READER CARD

Before you buy a terminal to talk to a computer make sure you can talk to the terminal.



Buy the wrong terminal and you may end up talking to yourself, instead of a computer.

The most widely used terminal on the market, for example, was orginally built to send telegrams. So it has a limited number of keys. An awkward keyboard. No lower case letters. And a tiny, telegram-sized carriage.

Maybe that's all you need for "HAVING A WONDERFUL TIME STOP." But it limits you to half the number of characters a sophisticated computer understands (a little like trying to carry on an intelligent conversation with a 4-year old).

Only one terminal now available can begin to match the input-output potential of a modern computer: the new 7100 Conversational Mode Terminal by Friden. The 7100 has the same, easy-to-use keyboard as an electric typewriter. But with one important addition:

The USASCII code!

USASCII puts 128 characters at your command. You can use them to write your own computer programs. And when you're done, the 7100 neatly prints out your program for later use—saving costly computer storage.

Nice? Just the beginning.

The 7100 is the only USASCII terminal with upper and lower case. The only terminal with a 13" writing line. And the only terminal that will reproduce a facsimile of all USASCII codes (except space and carriage return).

It even has a color shift. When you talk to the computer, it prints in red. When the computer talks to you, it prints in black.

The 7100 brings new ease and efficiency to time-sharing, on-line programming, information retrieval, and documentation.

To learn how easily it can let any corner of your company use a central computer, call your nearest Friden office. Or write Friden, Inc., San Leandro, Calif. 94577. Sales and service throughout the world.

Friden
DIVISION OF SINGER
DIVERSIFIED · WORLDWIDE

CIRCLE 42 ON READER CARD

Why not?

—because The Kelly-Springfield Tire Company gets the right tire to the right place at the right time, with a modern communications and data processing system, that's why not. And they sell over 2600 different sizes and types of tires in the U.S., Canada and 66 other countries.

Here's how the system works: at each warehouse Bell System Teletype® machines use master tapes to enter standard information on customers and their purchases, while the variable sale information is typed in manually. The machines make printed orders and by-product tapes containing this information.

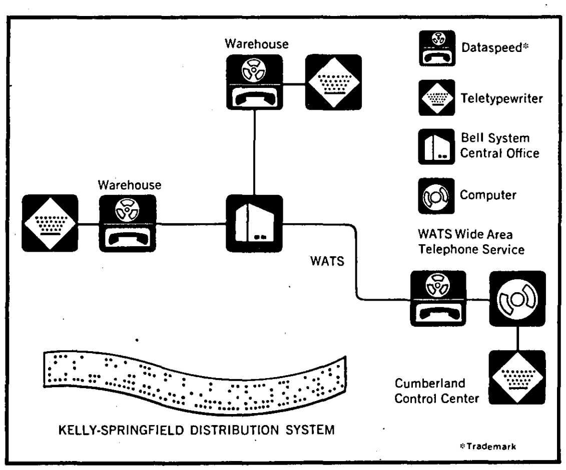
The Cumberland, Maryland, Control Center uses Wide Area Telephone Service to make scheduled calls to the warehouse Dataspeed senders. The punched paper tapes are then transmitted over Dataspeed at 1050 words a minute. Full daily information from the company's giant warehouses, strategically located throughout the country, is transmitted in 16 minutes.

Weekly reports at Cumberland give a complete picture of inventory, sales and orders for every warehouse in the country. A summary of data from each of the 26 warehouses is prepared for factory production scheduling.

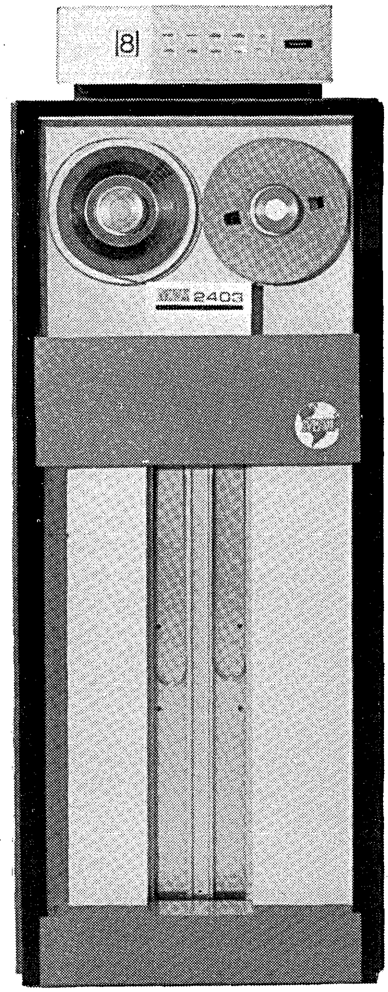
The result: Information flow is faster, more accurate. Customers get the best possible service, everywhere in the Kelly-Springfield marketing world.

For more information, call your Bell Telephone Business Office and ask for a talk with one of our Communications Consultants. And don't hesitate to call us early—because that way we can serve you best.

When you work with data communications, work with the Bell System.



BELL SYSTEM AT&T and Associated Companies



Saves you $6,000 to $24,000
(Doesn't cost a cent for conversion)

The new MAI Magnetic Tape Unit is directly interchangeable with your 729/2401 units—plug for plug, reel for reel. We hook up an MAI unit and it's ready to go to work.

Initial equipment costs for each MAI unit are at least $6,000, and in some cases, as much as $24,000 less than the comparable 729/2401 unit.

So an MAI unit pays for itself in 2-3 years in direct savings over your current rental costs. And then saves you another $5,000 to $10,000 a year. Every year.

A new kind of tape unit. No tape wear and tear from pinch-feed mechanisms on this tape unit. Its *single capstan* drive mechanism handles tape the way it should be handled. Gently.

During operation, the recording surface of the tape touches nothing but the read-write head. And that retracts to eliminate tape wear during loading and rewinding.

A new kind of systems reliability. Because the unit's design is so simple, you improve systems reliability. Read-write reliability equals or exceeds that of your present tape units. Downtime *has* to go down because the MAI unit is so easy to maintain. (It requires no mechanical adjustments, and a minimum number of electrical adjustments.)

So you'll save on an MAI maintenance agreement too. And without worrying about quick service. MAI has branch offices in 45 principal cities from coast to coast.

If you'd like more information, call your local MAI branch office, or write us.

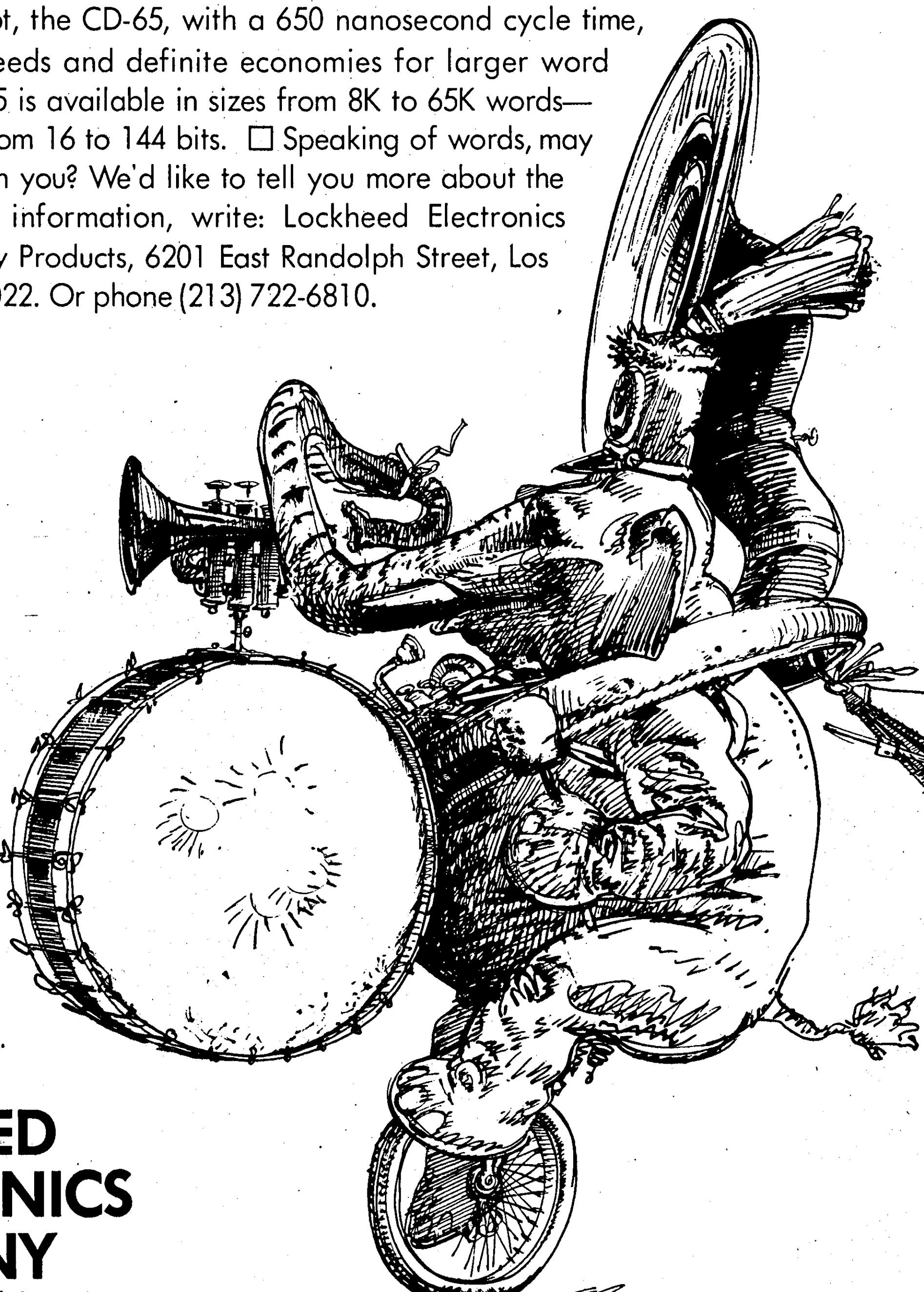
MAI® EQUIPMENT CORPORATION, 300 East 44th Street, New York, N. Y. 10017

CIRCLE 59 ON READER CARD

What does the CD-65 have that all other 2½D memory systems don't?

MORE STRINGENT DESIGN CRITERIA + HIGHER RELIABILITY + GREATER USER VERSATILITY.

The CD-65 is designed with the demanding user in mind. Operating margins in this unit are significantly greater than accepted industry standards. Mechanical packaging of key circuits and magnetics in the CD-65 provides a system organization easily adapted to custom application. All circuits are worst case designed and are verified by customer examination. □ Featuring a newer 2½ D packaging concept, the CD-65, with a 650 nanosecond cycle time, permits faster speeds and definite economies for larger word systems. The CD-65 is available in sizes from 8K to 65K words—each containing from 16 to 144 bits. □ Speaking of words, may we have some with you? We'd like to tell you more about the CD-65. For more information, write: Lockheed Electronics Company, Memory Products, 6201 East Randolph Street, Los Angeles, Calif. 90022. Or phone (213) 722-6810.



LOCKHEED ELECTRONICS COMPANY

A Division of Lockheed Aircraft Corporation

CIRCLE 44 ON READER CARD

news briefs

CARTERPHONE CASE NEAR REVIEW, THEN FCC DECISION

Dp equipment manufacturers eager to lift Ma Bell's ban on foreign attachments received encouragement last month when FCC's Common Carrier Bureau said the initial decision in the Carterphone case construed the issues too narrowly. Public message system customers should be able to use any interconnection device, not just the Carterphone, so long as it doesn't degrade service, the bureau argued.

"Interconnection standards could be established which, if maintained by private systems, would insure proper maintenance of equipment and reliability of performance," the bureau added. Trade associations and equipment firms within the dp industry reportedly are thinking along similar lines, as DATAMATION reported last month; they're developing proposed standards, plus an organization to put them into effect.

The initial decision, which said the foreign attachment ban should be lifted only for the Carterphone, was rendered by hearing examiner Chester Naumowicz Aug. 31. The case is now pending before a review board, which will go over the record, issue its verdict, and then refer the whole matter to the FCC commissioners for a final decision. The Common Carrier Bureau suggested, in its statement, that the review board refer the case immediately.

The bureau statement, issued last month, tried to destroy examiner Naumowicz's contention that the Carterphone case involved only the Carterphone attachment. The bureau cited a 1957 proceeding, involving the Hushaphone attachment, which had required interpretation of the same tariff sections. In that earlier case, the commissioners had concluded that the tariff language affected use of foreign attachments in general, not just a single device.

Furthermore, "the record . . . clearly demonstrates that . . . a case-by-case policy to determine whether . . . a particular attachment . . . should be authorized merely permits the company to perpetuate unreasonable and discriminatory practices," the bureau said.

Naumowicz had alluded to the "inherent unfairness" of a system which gives Bell control over the use of equipment which competes with products made by its subsidiary. The bureau went further: ". . . the telephone company considers it reasonable for police and fire . . . radio systems to be interconnected . . . (even though) there is no (tariff) provision that permits such interconnection." Although some interconnections are allowed in the tariff, the equipment must be provided by the phone company, which, "in its sole discretion . . . could use any kind of device it chose . . . But the customer would not be permitted to do the same thing. By such tariff requirements, the supply of such connecting devices is pre-empted by the telephone companies."

SEC CALLS FOR MORE AUTOMATION

The Securities and Exchange Commission is urging more automation in the securities industry. SEC chairman Manuel F. Cohen, in a speech before a Hartford chapter of investment brokers, noted that "much work remains to be done before the securities industry and its customers—the investors—obtain the full benefits of the well-planned edp equipment. While I do not wish to introduce any note of impatience tonight, it is important to emphasize that this work must proceed at a much faster pace . . . if the securities industry is to maintain the rate of growth that it has achieved in the past two decades."

The markets have already reached volumes of trading not long ago projected for the 70's, he said. The havoc this has wreaked on back office accounting necessitated the early closing of the NYSE several days in August. The exchange has initiated a sharing arrangement through its subsidiary Central Computer Accounting Corp. which will provide back office services to brokers at less cost than manual methods. (The Midwest Stock Exchange pioneered in this kind of operation.) Cohen called for all segments of the industry to cooperate in development of these programs. "We cannot afford to let pride interfere . . ."

The ability of the 900 cpm ticker at the NYSE (adopted only three years ago) to provide price and volume data "has already passed the straining point" and may "already be obsolete." What can replace the ticker that the human eye can follow?

(Ed. note: The NYSE also faces the problem of delivery of its new System 360 equipment. Government priority orders have threatened delays that could put the exchange in the expensive position of ordering interim equipment to handle the volume of trading expected by 1970.)

Another market that is growing and needs help is the Over the Counter market. The National Association of Securities Dealers has long considered the automation of this market and now has Arthur D. Little studying it. This should be completed within two to three months and may result in a computer center to disseminate OTC quotes to brokers via on-line terminals. Later it will facilitate transactions by listing the names of the market-makers in a particular stock. The dealers in this market now obtain quotes and conduct business over the phone. Cohen said the new system, "in addition to providing up-to-the-minute bid and asked prices, could be used to provide high-low, last sale and volume statistics as well as certain facts about the issuer of the security." The actual transaction would probably still be executed over the phone.

Automation of the OTC market brings up several legal and regulatory questions: how to define a market-maker allowed to enter quotes into the system; who will own the OTC system—NASD or outside commercial firm (several companies such as Data Network and Bunker-Ramo bid on such a system in 1965); and further, who will regulate the computer activity itself if the FCC decides that the computer/communications services should be regulated.

The availability of OTC data from a separate facility underlines a growing problem for brokers—the need for several terminals and display devices to obtain all services. The commission, said Cohen, is responsible for seeing that automation is conducted in an orderly manner and in the public interest. "Needless duplication of equipment and a proliferation of non-compatible systems can only operate to the ultimate determent of the industry and the public by burdening the brokerage community with unneeded costs."

Compatibility of equipment is not the only factor. Cohen also pointed to the need for uniform formats in such areas as security identification, a task now being undertaken by the American Bankers Assn. Committee on Uniform Security Identification Procedures. NYSE and AMEX are also developing a uniform order format so that an order placed at any branch

Although computers aren't new to the industry, only now has it been demonstrated how completely computer technology can serve every phase of an airline's organization.

This happened when United Air Lines commissioned UNIVAC to design and build an on-line computerized information system.

It represents the largest such investment the business world has seen thus far. The first to utilize cathode ray tube sets (input/output devices resembling TV monitors) on a nationwide basis.

Over 2800 of these UNISCOPE™ visual communication terminals will link 116 United cities to a centralized complex using three UNIVAC® 1108-II computers.

To the United customer this will mean better service.

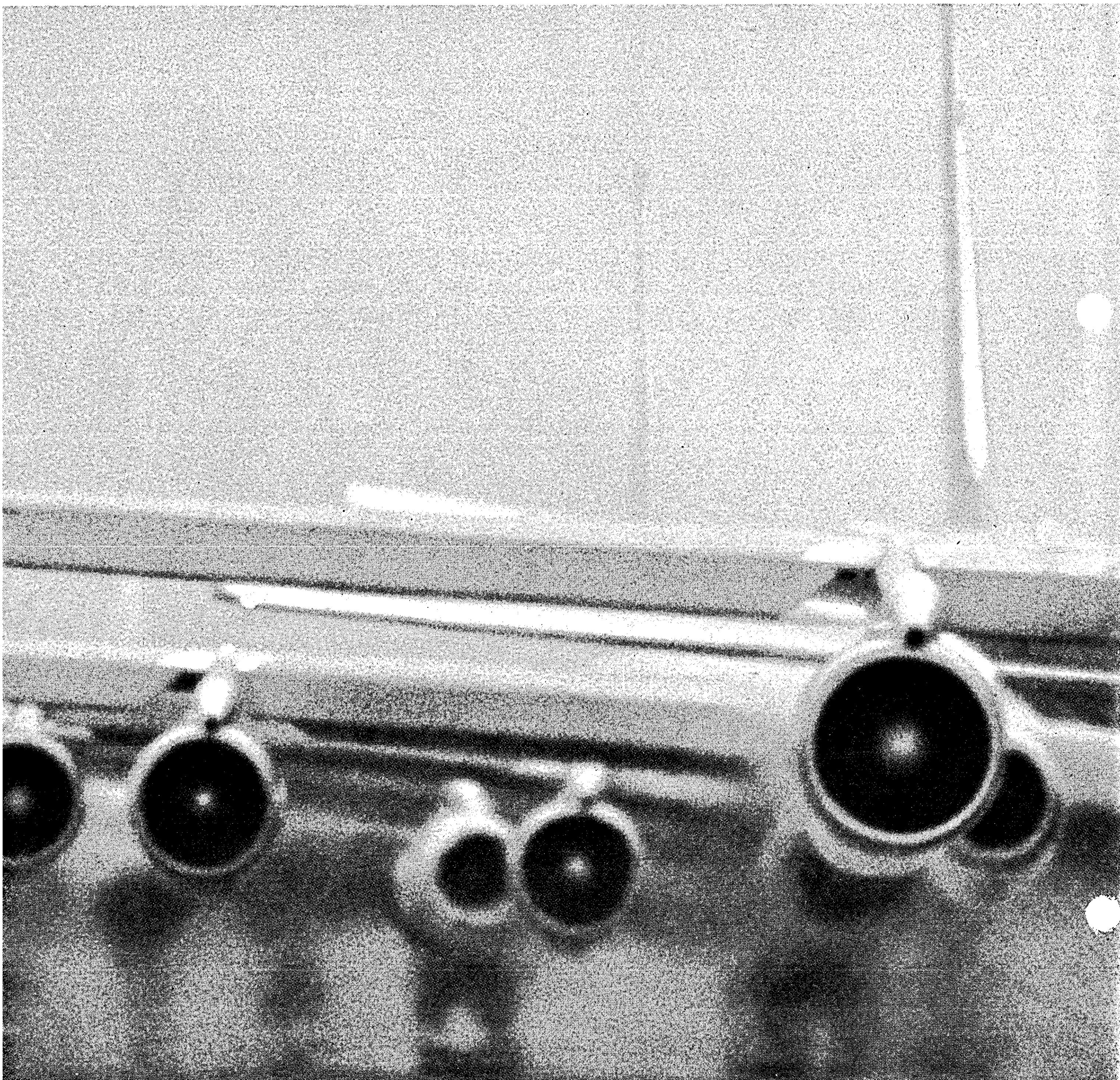
When a United agent queries his set on seat availability he'll get a response in one second.

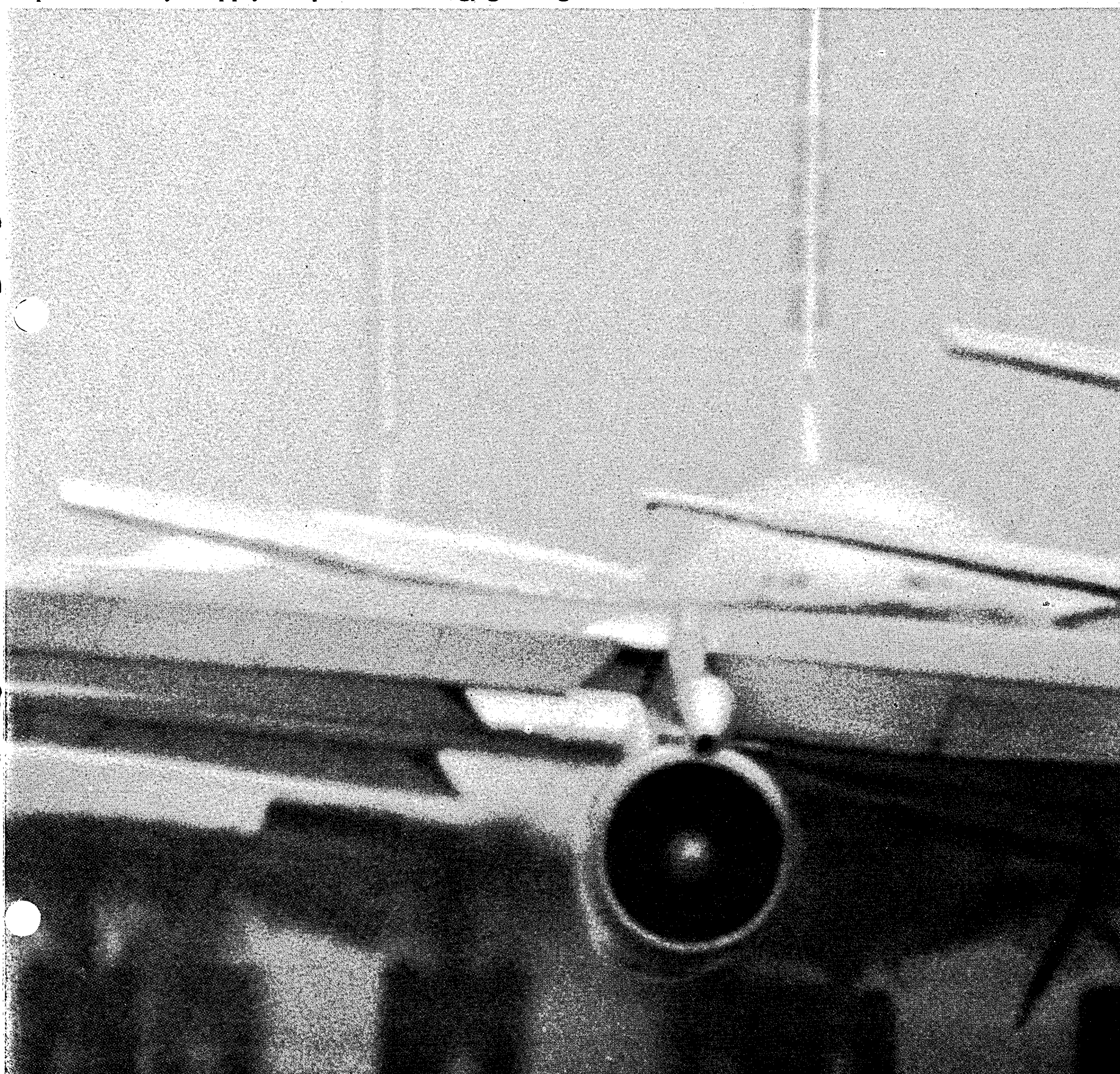
And in that time he'll also get a complete readout on his screen with availabilities for five flights in addition to the one he requested.

Agents at ticket counters and in air freight terminals will have the unique advantage of automatic ticket or airbill printing provided by any one of 700 printer units that are integral to this

Univac

When you grow as fast as the airline industry, you get growing





news briefs

office of a member can be transmitted directly to the floor without physical handling. (Another effort, not noted by Cohen, is standardizing the size and format of the stock certificate itself, hopefully to be used by all markets.)

Personnel trained in the intricacies of both the computer/communications and securities fields is another problem, noted Cohen, who called on the industry to take the necessary steps to meet this shortage. The SEC, itself somewhat of a neophyte in computer use, has been sending key professional and clerical people in its divisions and departments to computer courses.

FINANCIAL ASSOCIATIONS RELEASE TERMINAL SPECS

A joint committee of two large financial associations has released to five computer manufacturers specifications for an on-line teller terminal which they hope will result in better terminals which will cost perhaps 33% less.

The joint committee combined representatives of the U.S. Savings and Loan League and the National Association of Mutual Savings Banks which together represent a total possible market of 33,000 teller and administrative stations by 1974. The goal of the committee: teller terminals in the $5-7K range.

The committee specified as standard performance "a four-second response time under peak-load conditions to at least 50 tellers operating on 35 terminals . . . on one 1200 baud communication line, 90% of the time, with a 98% confidence level." Peak load is defined as a continuing average of 51 transactions per minute over a one-hour period. Maximum response time required is 15 seconds.

In addition to a list of traditional items required of the new terminals, the committee suggested the desirability of the development of control units to service one and two branch locations, with the ability to control a minimum of eight terminals.

Also requested: buffers, and communications which would allow a minimum of 50 teller terminals to be accommodated on one 900-1200 baud communication line, with the ability to drive "at least a 900 baud unconditional line at optimum utilization, and in representative transactions data (exclusive of polling characters) must represent 60% or more of the characters transmitted."

The specifications, which were released in September to Bunker-Ramo, Burroughs, IBM, NCR and RCA, are available from the National Society of Controllers & Financial Officers, 221 N. La Salle St., Chicago 60601. Heading up the joint committee was Bryant W. Cannon of Great Western Financial Corp.

IBM, GENERAL LEARNING WIN BIG T-S STUDY PACT

The race for the educational dp market passed an important milestone recently when IBM and General Learning Corp. won feasibility study contracts from the U. S. Office of Education; the contracts cover a time-shared computer network capable of serving at least 50 schools and 100,000 students. It will be the world's largest, strictly educational t-s system. IBM and GLC were selected from among a total of 39 bidders.

A final system design, probably incorporating the best features of both proposals, is expected to be completed early next year. The value of the project is indicated by one OOE official's statement that "by gaining access to a computer, we believe almost any high school or junior college can improve its educational program and administrative efficiency significantly. The system we're now planning should reveal the kind of hardware and software needed."

The system will serve schools within a 100-mile radius of the cpu. No site has been chosen yet, although several school boards are reportedly eager to become guinea pigs.

Three major applications are planned: compilation, debugging, and running of programs written by high school and junior college students enrolled in dp courses; solution of math and statistics problems, input by students taking such courses as physics and economics; and school administrative chores—e.g., class scheduling, grade reporting, inventory control, and payroll.

IBM's proposal included a 360/50 cpu, linked to I/O units serving 1-4 students each. Data would feed in and out through typewriters. Each administrative terminal would also have a card reader and printer. Each instruction terminal would service about 500 students per week. This system would cost about $16 per student per year, or approximately 1½% of each participating school's budget.

GLC proposed a larger cpu—on the order of a 360/65—together with individual teletypewriter terminals. The cost of this system was estimated at $32 per student per year.

Both plans provide for batch as well as real-time operation. Batch-only terminals, consisting of a reader and printer at each school, were also proposed as an alternative. OOE has asked IBM and GLC for more information on this configuration. "We hope it will be more cost effective," explains an official.

STUDY GROUP WANTS CHANGES IN DOD COMPUTER SELECTION

Several key changes in DOD adp selection and procurement procedures have been recommended by an inter-service study group under the direction of Robert A. Raup, of the Pentagon's data systems policy directorate. Now in semi-final form, the "Raup report" is being studied by the participating military departments and may be changed before being adopted.

The study group turned thumbs down on a single, DOD-wide selection office, but said military departments should have responsibility for evaluating and selecting systems competitively acquired for DOD agencies—e.g., Defense Intelligence Agency, Defense Supply Agency, and Defense Communications Agency. The agency would develop specs and would participate in evaluation selection. It would also have the last word regarding which system was selected; the department, basically, would supply expertise now lacking in the agencies because of their smaller-scale adpe acquisition activity.

The study group recommended rewriting DOD Directives 5100.40 and 4105.55 to:

—stimulate greater use of general purpose, off-the-shelf systems for RDT&E applications and, hopefully, reduce costly system development.

—increase DOD ability to review each service's adp development activity. There is a particular need, the Raup report said, for the office of the Secretary of Defense to review the requirements used to justify acquisition of adp systems.

The task force also said Directive 4630.1 should be changed to give OSD prior approval of all RFPs covering adpe related to telecommunications systems. It recommended striking data processing "services"—e.g., feasibility studies, system design and development, and computer programming—from DOD instruction 4100.33 (which implements BOB Circular A-76), on the grounds that other DOD instructions are adequate.

One reason for establishing the Raup group was a chorus of complaints from vendors regarding the time and expense of answering DOD

Guns, courtesy of Abercrombie & Fitch. For quality reproductions of this photograph, write us at Memorex.

THE TWO GREAT TAPES,

CIRCLE 47 ON READER CARD

LIKE THE TWO GREAT SHOTGUNS, ARE NOT IDENTICAL.

When you buy a Purdey or a Holland, you buy the finest in guns. They cost about forty-five hundred dollars each. They last for generations.

When you buy the two great tapes—ours or the one the computer company makes—you buy the most durable, most reliable computer tape around. Naturally, they cost more. It's not surprising, therefore, that they make pass after pass after pass without a drop-out.

The two great guns are pretty much alike in total performance. But although each is exquisitely crafted to perform unerringly, they are not identical. You'd have to use them both to know exactly what each can do.

It's the same with the two great tapes: they aren't exactly alike, either. In fact, some tape-users insist that our great tape out-performs the other.

Could be.

(Brochures? Specs? Write us at 210 Memorex Park, Santa Clara, California 95050.)

MEMOREX

RFPs. The report provides some comfort, but not much. It says senior adp policy officials should require a vendor response "proportionate to the estimated value of the equipment to be acquired," but they should not overlook the need for "specifications . . . adequate to identify the type, nature, and scope of the data processing workload involved." A study of increasing costs being incurred by suppliers in response to complex RFPs was recommended.

Further standardization of data system specs and bid evaluation procedures is desirable, says the report. It suggests concentrating on these areas: selection criteria and weights, cost evaluation, user participation, workload descriptions included in RFPs, changes in proposals during evaluation, benchmark procedures and purposes, and processing time estimates.

Other recommendations called for wider use of the Army's Qualified Equipment List, and of the related procedure which requires vendors to pre-qualify their equipment; wider use of MITRE's evaluation and selection counsel, now provided only to the Air Force; and greater reliance on simulator programs to verify processing times of adpe offered by vendors. COMET, the simulator used by the Air Force, and the Army's Autotimer program, should be compared and evaluated; "appropriate actions" should then be taken to "provide optimum simulator capabilities to all DOD components."

Another recommendation called for distributing an RFP forecast to qualified suppliers. It would cover expected procurements for one year ahead and be revised quarterly.

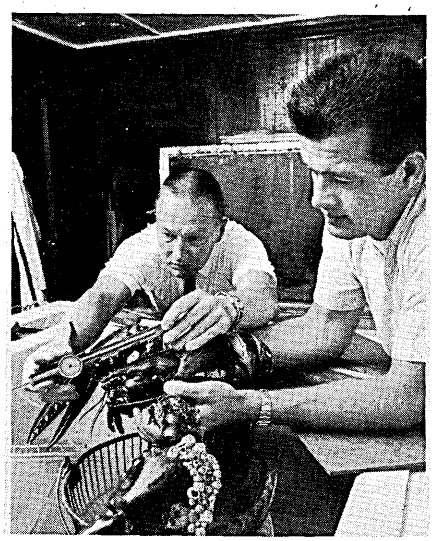
Although the AF Phase II imbroglio wasn't mentioned, it must have been in the minds of study group members when they reported that DOD directives do not provide enough guidance concerning evaluation and selection of adpe to be procured under the Federal Supply Schedule. Areas not covered by the present directives include proposal solicitation, equipment evaluation, announcement and placement of the selection award, and notification to unsuccessful vendors. "The chairman, ASPR committee, should convene a special subcommittee," the Raup report said, "to identify and recommend changes and additions necessary in ASPR to adequately provide for selecting and acquiring adpe under FSS contracts."

GRANDFATHER LOBSTERS THREATENED BY COMPUTER

A computer simulation of the birth-death cycle of the New England lobster has led to the conclusion that the big fellows don't contribute very much to the population—and laws protecting them do little more than reduce the catch.

The model and several computer analyses on the crustacean have been developed, without research funds, by Dr. Saul Saila and John Flowers at the Graduate School of Oceanography at the Univ. of Rhode Island. The model (100 FORTRAN statements) works with such parameters as lobster growth rate, age of maturity, average fertility, frequency of shedding the shell (which affects growth rate), and "fishing mortality" rate. The reason for the two-year "labor of love," said Saila, was to determine the validity of the laws affecting this population and ultimately the simulation will add more knowledge on the lobster and other marine life.

Several conclusions have already come to light. The large lobster isn't a great father because it doesn't mate with the small female and drives the more eligible smaller males away. The simulation showed that only about 4% of the slow-growing females would survive to be the proper size for the big males. On the other hand, the egg-bearing female, which can only mate in one 48-hour period every two years, ought to be protected. Too, the female can be moved to other areas to start lobster colonies. The scientists



worked extensively with a lobster hatchery to observe habits and track movements. Analyses of data obtained by following tagged lobsters showed that lobsters aren't wanderers and have somewhat of a homing instinct.

While the present model, programmed in less than six months, was developed to answer a limited number of questions, Saila intends to develop a program to simulate the life history of the lobster population through a number of generations—one purpose being to more finely determine the maximum and minimum sizes of lobster which the fisherman can harvest without seriously depleting the population. An IBM 360/40 used.

AVIONIC TEST SYSTEM BRIEFINGS HELD BY NAVY, EAI

A series of four one-day briefings, sponsored by the Naval Air Systems Command and the Electronics Industries Association, have been held in Beverly Hills, Chicago, Boston, and Washington D.C., to familiarize representatives of the aircraft and electronics industries with the Versatile Avionic Shop Test VAST system.

The significance of this system to those concerned with computers is that its use by the Navy will lead to certain changes in avionics—communications equipment, navigation and other computers. Some of the probable changes: different test point and modularity requirements; test programs will be the manufacturer's responsibility; the Navy may need software assistance from outside firms; test and peripheral equipment manufacturers will face changed requirements for their products.

The purpose of VAST scheduled for installation aboard aircraft carriers starting in 1970, is to standardize and automate testing procedures to overcome shortages of space and maintenance technicians.

All new Navy avionics equipment, if it requires intermediate or depot level maintenance, is to be compatible with the system.

The VAST concept was developed after three years of study by PRD Electronics, Inc. It consists of devices to apply stimuli and measure responses for up to 85% of existing and projected carrier-based avionics; these units are controlled by a Univac 1218. Through time-sharing, three test stations can be handled by each computer.

The Naval Air Systems Command plans to set up a programming center, where test program design data supplied by the manufacturers will be converted to computer language and their usefulness and accuracy verified.

The Navy believes that installation of the VAST systems will cut shop space needed by 30-50%, reduce the number of technicians by 25%, lower the technical skills required, reduce turnaround time of equipment check-

"Any one of these Dartmouth sophomores... starting from scratch...can do all the calculations in one afternoon that took a year and a half at Los Alamos."

PROFESSOR JOHN G. KEMENY, Chairman, Mathematics Department, Dartmouth College.

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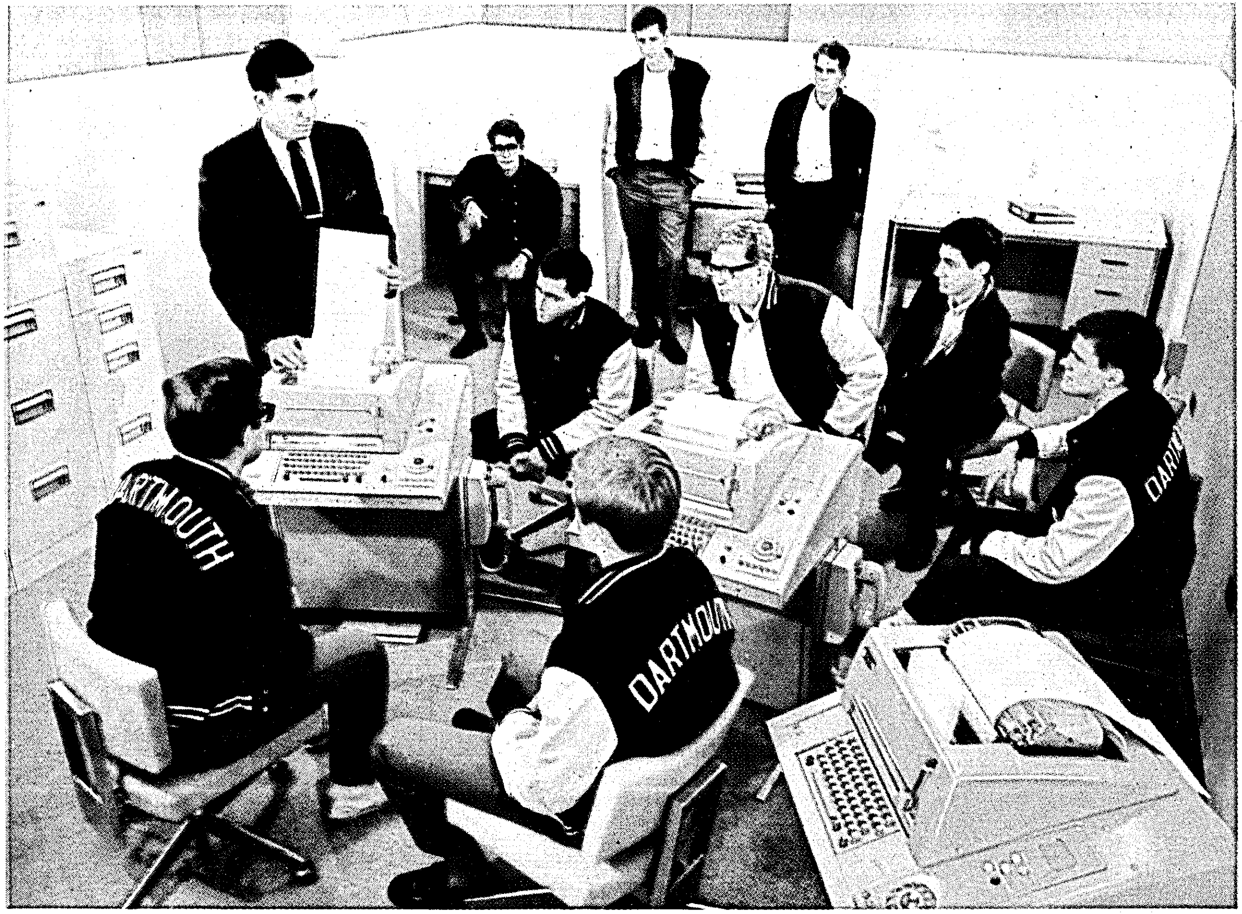

The men of Dartmouth have an incredible advantage over the mathematicians of Los Alamos.

Ask Professor John G. Kemeny. In 1945, he was there.

Today Professor Kemeny and his students and associates at Dartmouth are among the pioneers in bringing to people the useful benefits of the computer.

Five years ago, only knowledgeable people knew how to use the computer.

Dartmouth and General Electric decided to reverse that trend: Take the mystery out of laymen using the computer.

Using a General Electric Time-Sharing computer, Dartmouth developed a new computer language called BASIC. BASIC permits man to speak to the computer via teletypewriter in a language everyone can understand . . . and remember. The English language.

yet the computer is there as a silent partner, multiplying the contributions they are able to make as individuals.

Time Sharing, the powerful combination of General Electric computers and the BASIC language, is one of the landmarks in the age of the computer. Already more than 50,000 people are using GE Time-Sharing service in this country and abroad.

The pioneers at Dartmouth had a vision. That a man and a computer can do more useful work than the sum of what each can do independently.

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The impact is on people — creative people who want to do useful work. Students. Engineers. Scientists. Businessmen. Most of them will never see the computer. Only the teletypewriter. And

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ing, and reduce training requirements and hardware costs.

CHICAGO EDUCATION BOARD EDP OPERATION CRITICIZED

The Chicago Board of Education's data processing bureau has been criticized as overequipped and underused by a management consultant firm.

The firm, Booz, Allen and Hamilton, Inc., said in a report to school superintendent James F. Redmond that the board's edp hardware has been acquired faster than needed and stands idle because the flow of work is poorly planned.

The consultants told Redmond, who took over the bureau much as it is today from past superintendent Benjamin C. Willis, that the equipment is "a conglomerate of systems" rather than a carefully planned one.

The bureau now uses an IBM 7074, a 1401, a 1460, two 1311 disc packs, two 1301 disc files and ten Bunker-Ramo CRT terminals, as well as a Recognition Equipment optical scanner.

The bureau is budgeted for $2,-061,000 this year, but the output of the operation is meager in relation to cost because of high turnover and lack of available qualified employees, the report stated.

The consultant specifically recommended that the board defer the purchase or lease of new equipment until the present hardware is efficiently used, hire additional qualified personnel and draft a sound plan for taking on new work.

The bureau has been growing and has just reached the first plateau in the implementation of its planned total information service, says director of data processing James A. Quinn. Initial master files have been created and maintained for 600,000 students, 25,000 teachers, 14,000 Civil Service personnel, 6,000 supply stock inventory items, the school system's multimillion dollar budget and the financial accounting structure.

Student data is gathered when a student first enters the public school system. This data—name, address, sex, school grade, etc.—is typed on a scanner form, then read and converted to magnetic tape by the optical scanner for 7074 processing. A machine readable status card is then used for updating.

Additions to the master record such as test scores, grades, health and psychological data will be introduced to create a cumulative record system, Quinn says. The consultants say the scoring of standard tests, now farmed out, can be scored by the bureau today at a saving of $100,000 a year.

The consultants also criticized the bureau's use of a second document reader, recently given up. The scanner, rented for $15,145 a month, was idle so much that the cost was $303 rather than the reasonable $45 per hour used, they said.

The bureau also should handle the inventory for the entire school system, the report stated, but at present is only doing inventory for the lunchroom operation.

Booz, Allen and Hamilton also criticized the bureau's handling of payroll. "Systems in the complex area of payroll . . . are not sufficiently reliable and still require an inordinate amount of supplementary clerical handling," the report stated.

"Our staff of 15 programmers wrote the entire software package that converted the second generation 1460 computer into a third generation realtime system," says Quinn. "We also built security checks into the system to insure that only authorized persons have access to any particular information record"

The consultants' report called the edp system "the child of expediency."

A new job handled for the first time this year on the 7074, in conjunction with a 1231-1401, is the scheduling of classes for 150,000 students in 91 Chicago public high schools.

The Chicago board is also introducing data processing curriculum in the high schools. The bureau's education division works with the Department of Curriculum in the development of data processing courses. Quiktran is available from IBM 1050 terminals installed in nine high schools in September.

The Bureau of Data Processing has a staff authorization of 109, half of them in operations (computer, tabulating, keypunch, data control) and the other half in administration, systems, programming and clerical positions.

The consultants reported, however, that turnover is high and the staff so new that management personnel have to oversee the immediate work and are not free for "effective planning and control."

IBM OFFERS NEW VERSION OF OS/360, OTHER SOFTWARE

IBM has announced a new multiprogramming configuration of OS/360, a 20-47% improved FORTRAN H, and five improvements for its Attached Support Processor System.

Release 12 of OS/360 includes Multiprogramming with a Variable number of Tasks, MVT, which permits multiprogramming of 15 separate jobs. Among capabilities MVT provides are faster job turnaround with integrated system I/O, running of multiple jobs and multiple peripherals concurrently, and special exits for abnormal subtask termination (through use of the ATTACH subtask facility). Also available are new operator commands, priority job scheduling, automatic system I/O queuing on direct access storage devices, and multiple classes of output.

The new 360 FORTRAN H version II ran test programs 30-47% faster than the original H. Percentages are based on compile step time less scheduler time. In the tests, 15 programs were run on a mod 65 under OS/360 releases 11 and 12 PCP (Primary Control Program) using the 2301 drum for system residence.

Other improvements are: the version II user can also read and write fixed length records randomly from or to direct access devices; less table space is required for every 100 source cards (18K bytes instead of 35K); additional debugging facility; a storage map providing more information about each symbol in the source program; call-by-name arguments are no longer limited to 25 but governed by the total number of arguments in the program.

The improvements to the 360 ASP system include support of the IBM 2314 for ASP work queue, support of OS/360 control program MFT (Multiprogramming with Fixed number of Tasks) on the support processor, and support to permit use of Synchronous Transmitter Receiver (STR) terminals for remote job processing. These are scheduled for release this month. In May, 1968, IBM will begin support for dual main processors, and release a new job segment scheduler.

DOD PUSHES CONFORMITY TO "TRUTH IN NEGOTIATION" ACT

Prodded by the General Accounting Office, Congress, in 1962, passed the "Truth in Negotiation" act; it says that a contractor, or subcontractor, before being awarded a negotiated, fixed-price contract of over $100K, must certify that his bid is based on accurate, complete, current cost-price data. In 1966, GAO completed a spot check of 242 such contracts; it found "a serious and comprehensive violation of the law" in at least 165 of them, and possible violation in 57

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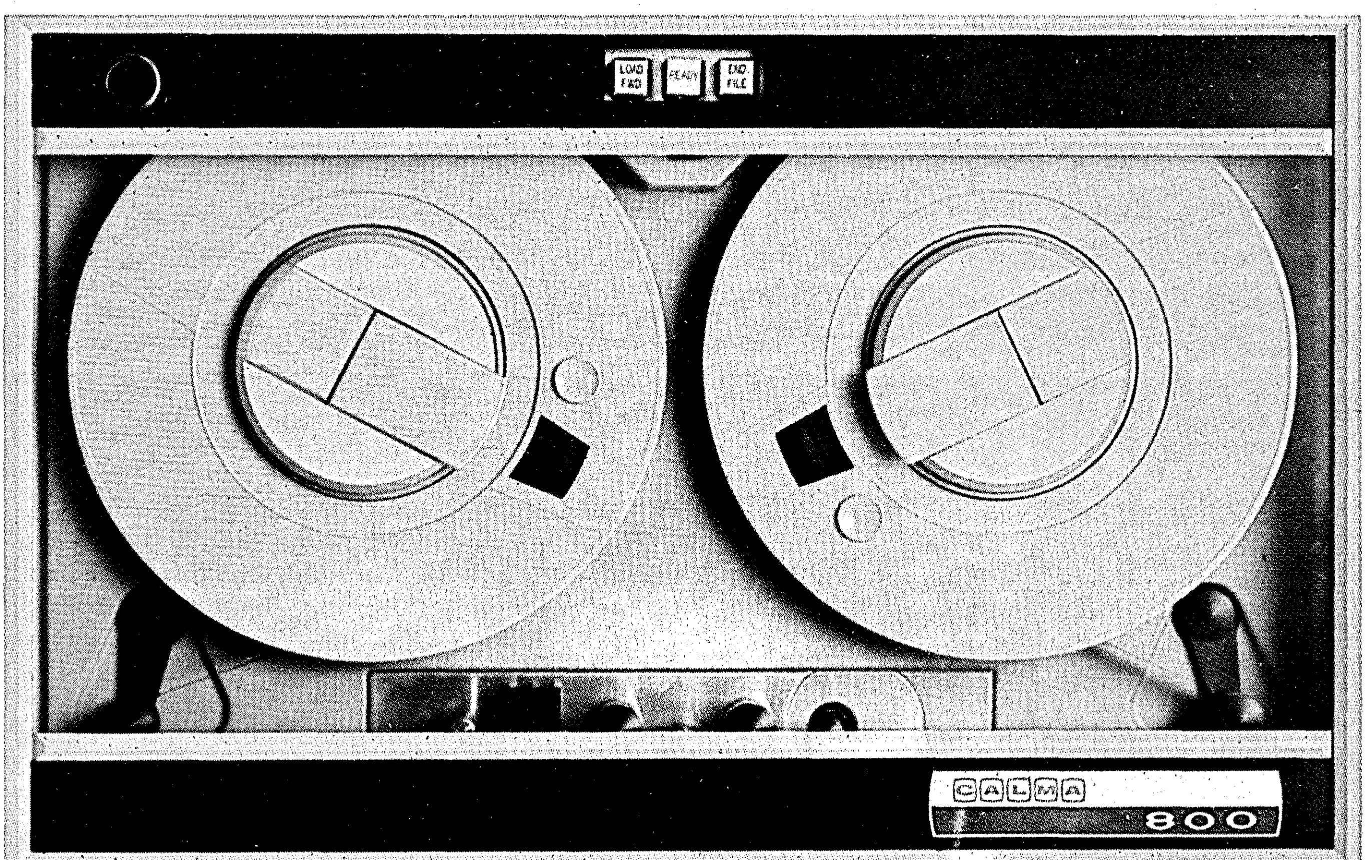

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others. Last Sept. 29, Deputy Defense Secretary Paul H. Nitze, after flak from the Hill, issued a memo aimed at reducing these violations.

The key phrase in the Nitze memo reads: "action shall be taken (by DOD agency heads) to include in all non-competitive firm fixed price contracts involving certified costs or pricing data, a contractual right to have access to the contractor's actual performance records."

The memo's effect on dp suppliers is unclear because no one in the Pentagon apparently has a breakdown of negotiated contracts by type of product. Significantly, however, one of the illustrative examples in the GAO's 1966 report involved an unnamed manufacturer of mag tape recorder-reproducers who, in 1965, sold six units, for $115,758, to an Air Force prime contractor without supplying adequate cost or pricing data.

The main pressure on Nitze has been mounted by Sen. William Proxmire of Wisconsin, chairman of The Joint Economic Committee. Last spring, he headed a subcommittee which looked into compliance with the Truth in Negotiation Act; subsequently, the group issued a report chiding DOD for not giving its auditors power to check contractors' records. GSA, the subcommittee pointed out, had already done as much.

Although DOD has now done likewise, some cynics are suggesting that the effect will be far less than anticipated.

Near the end of his memo, Nitze said "access to a contractor's records shall not be for the purpose of evaluating profit-cost relationships, nor shall any repricing of such contracts be made because the realized profit was greater than was forecast, or because some contingency cited by the contractor in his submission failed to materialize—unless the audit reveals that the cost and pricing data certified by the contractor were, in fact, defective."

PENNSYLVANIA LEGISLATORS WILL GO ON-LINE NEXT YEAR

The Pennsylvania legislature has begun using on-line CRT's to obtain data on all pending bills. Starting with the new session in January, the IBM 360/40-based system, which took 2½ months to program, will be available to all legislators via 25 to 50 model 2260 displays. (Eight displays are now in.)

Using special COBOL programs to obtain high density packing, full texts of more than 3000 bills have been stored on two 2311 disc packs. The bill data is stored in eight different files, such as history and sponsorship, and each full record can be accessed in an average of 14 seconds. A legislator or reporter will be able to get hardcopy printouts from IBM 1053 teleprinters, or will be able to request through the CRT that the records be dumped onto mag tape for later output by a 1403 printer.

The data processing center of the General Assembly is a completely OS/360 shop with a library of 40 COBOL programs. A model 40 is being used to do payroll and other business applications for both the legislative and executive branches. Payroll, using emulated 301 programs, is being run in background along with remote inquiry and updating.

The center's director, Regis Steighner, while not commenting on emulation performance comparison, did note that the 8,000-man payroll job takes 14 minutes on the 40; if run simultaneously with inquiry and update tasks, it takes 16 minutes.

The center is also working on a communications package which will handle both local (1,000 feet) and remote teleprocessing using only the IBM 2848 communications unit, tasks which normally require two separate switching devices.

NEW GROUP FORMED TO PROMOTE DP COOPERATION

In an attempt to achieve cooperation and assistance among the many data processing centers in government agencies, a group called The Federal Automatic Data Processing Council of Northern California and Nevada has been organized. Their impetus was the recommendation for such mutual action as given in the summary to HR 4845, which mentions the advantages of banding together to stimulate the exchange of information and experience, and the possible sharing of

STANDARD FREIGHT CAR DATA SYSTEM ADOPTED

A *real* real-time freight car location system is now possible throughout the railroad industry. And this signifies a potential 10% increase in utilization and efficiency of the 1.8 million car fleet—or the equivalent of 180,000 new cars which would cost $2.7 billion.

After years of testing, the Association of American Railroads has settled on one standard automatic car identification system (ACI) which will be placed at track points and in yards to read and transmit the code number of the cars going by. To Sylvania Electric Products go honors and a potential $20-100 million market. The Sylvania CarTrak System consists of an optical scanning device which can read multi-color coded stripes on cars passing at up to 100 mph. A data conversion/transmission portion of the system will transmit over land lines to a railroad's central computer.

Since a majority of the roads are expected to adopt the system, the market is from 2,000 to 10,000 units. CarTrak has already been used by the Duluth, Mesabi & Iron Range RR, and Pennsylvania RR, which tested this and systems developed by WABCO and ABEX, losing contenders.

ACI is expected to eliminate inaccurate input from waybills and reporting delays, and to help pinpoint the location of one road's car anywhere in the nation. This will not only be done by the data kept in each railroad's computer. AAR has its own central computer system, TRAIN, which is just now beginning to provide car reports and will ultimately serve as a clearinghouse for inter-road information, perhaps on an on-line basis.

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hardware and/or software.

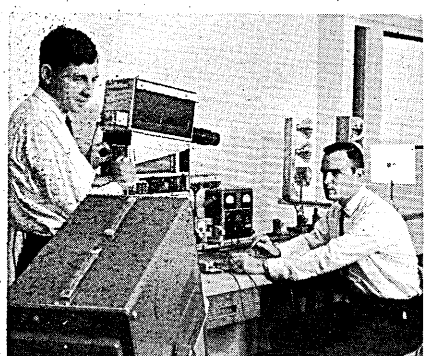
The new organization, which plans to investigate training requirements and conduct an educational program to inform the dp personnel in the member agencies about government policy and future plans, has representatives from all aspects of computer sophistication, ranging from the punched card installation at San Francisco's U.S. Mint, to the large complex at Lawrence Radiation Laboratories. Other members include defense organizations, Forest Service, AEC agencies, immigration offices, Naval Laboratories and Supply Depots, Veterans' Hospitals, Bureau of Public Roads, etc.

Although this is the first group of its kind in the country, interest is strong among government agencies in the Albuquerque, N.M.—Fort Worth, Texas, area.

PREPROCESSOR FOR PATTERN RECOGNITION COMPUTERS

An electro-optical preprocessing system, described at the first annual IEEE Computer Conference, is being used to prepare information in real time for pattern recognition computers at Cornell Aeronautical Laboratory.

The experimental system, subject of a paper by Robert M. Stock and



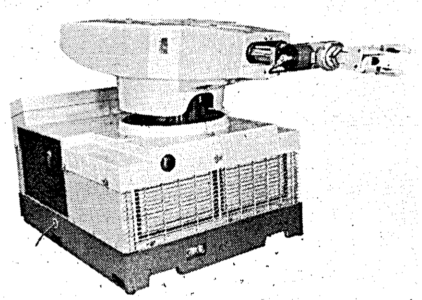
Jerold J. Deener, detects and locates real or photographed objects in white light using standard hardware and optical techniques. Polarized aperture masks, a polarized grating, and a vidicon detector are used and the output of the vidicon is monitored by television and oscilloscope.

Gray scale photographs have also been handled by the preprocessor, with the degree of success depending on the contrast of object edges. The experimental unit is the outcome of research sponsored by the Air Force Avionics Laboratory and may become the key link in a computer pattern input system that could be used for recognition or analysis of pictorial information.

ROBOTS NOW AT WORK IN INDUSTRIAL INSTALLATIONS

Industrial robots are invading the west. At least, their intention to do so was demonstrated at a recent press conference in Los Angeles. Unimation, Inc., a manufacturing company jointly owned by Pullman Co. and Condec Corp., showed off their 4000-lb. giant and announced the opening of west coast sales offices in connection with an affiliate, Consolidated Controls Corp. of El Segundo, Calif.

The robot, disappointingly unanthropoid and designed specifically for



industrial applications, is a one-armed boxy machine with five degrees of movement. It can be programmed to perform tasks requiring up to 200 sequential steps. The 7-foot hydraulically operated arm (with several styles of two-fingered "hands") can pick up an article that weighs up to 75 pounds within an area of 250 cubic feet, and place it down in another location with an accuracy of .050 inch in each dimension. The hydraulic operation permits the unloading of materials into special fluids without short-circuiting the system.

Programming the machine's 80-bit parallel word magnetic tape memory is a process of electronically moving the robot through each of the motions necessary to accomplish a particular job. A remote control unit positions the arm and fingers; as each step is achieved, a "record" button pushed by the programmer places the action in the memory. The memory has four different zones for alternate actions and hand changes on a single job. (For example, while a robot is waiting for material on a conveyor belt, it can be performing another, possibly unrelated, function.)

At present, 65 robots have logged over 200,000 hours in factories; all the major automotive manufacturers have trial installations. Jobs thus mechanized include unloading die casting, operating punch presses, welding operations, unloading lathes, grinders and drill presses.

Asked if any problems with labor unions are expected, Joseph Engelberger, president of Unimation, replied that the only difficulty encountered in the initial installations was: Who will operate the machine? In the first such case, management lost, and the factory workers themselves are "training" the robot. Since the machine was planned for hazardous environments where heat, cold, radiation, odors, noxious gases or heavy loads prevail, any personnel replaced by the robot in the installations now operating have been retrained and placed in better jobs.

Available as an off-the-shelf item (only option is a 10-foot arm instead of the 7-foot arm on the basic unit), the $20,400 machine can be purchased or rented. According to Engelberger, Unimation, in connection with its British sales and production licensee, Guest, Keen & Nettlefolds, will be producing over 40 robots a month by the end of 1968.

● A call for papers has been issued by the SHARE-ACM-IEEE fifth annual Design Automation Workshop to be held in Washington, D.C., July 8-11, 1968. Papers relating to design automation in electronic design, computer aids, process automation, management information and control, and man-machine techniques, should be submitted in summary form to H. Freitag, IBM Watson Research Center, P.O. 218, Yorktown Heights, New York 10598, by December 15, 1967.

● The ACM Special Interest Group on Computer Personnel Research will hold its sixth annual conference in Boston, June, 1968. Papers concerning personnel research, training and development, appraisal, and selection and placement, are being sought. Prospective authors should submit a 300-word summary to A. J. Biamonte, West Virginia Pulp & Paper Co., 299 Park Avenue, New York, N.Y. 10017, by February 1, 1968.

● An opportunity to win a quick 10,000 guilders (about $2750) is offered by the editors of the Maandblad voor Accountancy en Bedryfshuishoudkunde-M.A.B., the Journal of Accountancy and Business Economics published monthly in the Netherlands. The contest, open to anyone or any group, is for design of a management game based on the economic problems of a business firm and suitable for both university and other management training programs. If the game submitted requires the use of a computer, the programming required should be outlined in enough detail

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to make it clear how the processing is to be done. The address for entries and information is Secretariaat M.A.B., c/o Drs. D. G. van Til, Anna van Burenlaan 14, Santpoort-Zuid, Netherlands. Entries must arrive by Sept. 1, 1968.

● A joint study leading towards eventual use of computers throughout the Air Force for improving medical care has been announced by the Electronic Systems Division. Other participants are the Aerospace Medical Division and the MITRE Corp. The procedures being considered include hospital admissions and dispositions, medical records, patient monitoring, ordering of medication, lab tests, and management/financial reporting. Proposed center of the huge system would be the computer center at the Air Force School of Aerospace Medicine at Brooks Air Force Base, Texas. The center would be linked to satellite computers at USAF hospitals around the world.

● A call for papers is out for the 18th Annual National Telemetering Conference, to be held at the Shamrock Hilton, Houston, Texas, April 9-11, 1968. Subjects can be in the broad areas of aerospace, communications, industry, biomedical engineering, and ocean engineering. Deadline is Dec. 7, 1967. Further information on subject matter and format requirements can be had from Lewis Winner, 152 W. 42nd St., New York, N.Y. 10036.

● Acquisition-minded Automatic Data Processing, Inc., "the country's largest independent payroll processor," will enter the scientific and engineering dp service field by buying Research Calculations, Inc., of Newton, Mass. RCI, a 100-man firm, does both commercial and scientific programming and service bureau jobs, using its Honeywell 120 and 200. (A 1200 will replace the 200.) ADP recently also bought service bureau Computer Services of Florida, Inc., and accounts receivable specialist Computing Services, Inc., of New York. The latter two totaled $500K for fiscal '67. These moves could bring ADP, which reported $9 million in '67, well over the 10-megabuck mark next year.

● Europe's first electronic public telephone exchange with stored program control went into the Belgian Telephone Administration in September. The system, 10C, developed by ITT's Bell Telephone Mfg. Co., replaces an electro-mechanical exchange. Among features not available before are automatic transfer of calls, abbreviated dialing, calling-subscriber identification, and availability of touch-tone sets.

● The idea of establishing a center of information on automated hospital communications systems is being studied by the Public Health Service. "If public funds are to be prudently expended in this area, a comprehensive source of information on these systems and the current state of the art is essential," said Surgeon General William H. Stewart. Herner and Co. is studying technical and management requirements for the center under a six-month contract supported by the Division of Hospital and Medical Facilities.

● The Air Force Space and Missile Systems Organization is sponsoring a study to define and evaluate spaceborne computer software. The principal study objective is to develop means for quantitatively measuring the merit of software produced. The AF expects the study to point to improved methods for specifying end-item software quality requirements to contractors, and to use the quality metrics developed during the study to evaluate contractor proposals and measure software performance during acceptance testing. The results of this study, due in June '68, are expected to be readily extendable to other software applications areas. The study is being conducted by the computation and software department of Logicon, Inc., Los Angeles division, under a $50K contract.

● The Association of Data Processing Service Organizations (ADAPSO) has recommended to the Federal Communications Commission that telephone mileage charges be eliminated in order to facilitate computerized data transmission. The organization suggested that line charges be based on time alone, with no regard to distance.

● At the first Latin American Symposium of Scientific and Academic Computation Centers, held at the University of Concepción, Chile, in September, 27 data processing centers from universities, and private and government agencies, formed the Latin American Institute for Information and Computer Sciences. Sergio F. Beltrán of Mexico City was appointed director. This institute will be responsible for coordination, planning, promotion and support of the data processing activities of the organizations represented. LAIICS has also established contacts with similar international bodies such as IFIP, ICC in Rome, and UNESCO. The symposium, sponsored by UNESCO and the Univ. of Concepción, attracted over 100 computer specialists from 15 Latin American countries.

shortlines . . .

The Air Force has adopted JOVIAL (J3) as the standard programming language for command and control operations, and is now sponsoring a study to firm up specifications for the development of compilers and the incorporation of future language improvements . . . Philip R. Bagley, formerly with MIT's Lincoln Labs and the MITRE Corp., has formed Information Engineering, a consulting firm in computer applications, languages and information retrieval, in Philadelphia . . . A $246K contract from ARPA has encouraged System Development Corp. to study human behavior in negotiation and bargaining situations such as occur in international relations. Researching diplomacy, SDC thinkers will use an on-line computer and simulation techniques . . . As the smog comes in on little cat feet, scientists at Hazleton Laboratories in Reston, Virginia, have begun a long-range study of the effects of air pollution, using an IBM 1800 to measure the reactions of monkeys and guinea pigs as they are exposed to contaminants produced by coal-burning power plants. The $2.25 million study, financed by the Electric Research Council, Edison Electric Institute, Bituminous Coal Research, Inc., TVA, and the Los Angeles Dept. of Water and Power, will be concluded in 1971 . . . New York State, California and Michigan have all signed separate lease agreements for the continued use of SCERT (System and Computer Evaluation and Review Technique), the simulation service designed to "pre-select" computer systems, a proprietary program of COMRESS, Inc. . . . The National Science Foundation is sponsoring a third year of the RAND Corp.'s tutelage of linguistic students in computer techniques. Some of the projects being conducted by the pupils on a computer: the formal analysis of the narrative structure of folk tales, a computer program to improve a transformational grammar by random sentence generation, and the investigation of hierarchical ordering of the features of phonological systems.

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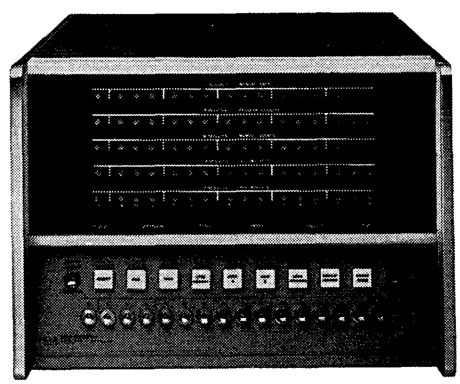
Two computers available—2116A and 2115A—fully software compatible. Start speaking to an HP computer now—with a call to your local HP field engineer or by writing Hewlett-Packard, Palo Alto, California 94304. Europe: 54 Route des Acacias, Geneva.



The 2115A has 16-bit words, 2 μsec cycle time, 4K memory (expandable to 8K) and a $16,500 price including Teleprinter.

HEWLETT *hp* PACKARD

DIGITAL COMPUTERS

06721

CIRCLE 54 ON READER CARD

At last! The computer tape that's not "too good to be true."

Some tapes are. That is, certain of their properties are made "too good." Often at the expense of other, equally important characteristics.

Outstanding tape durability can be gained at the expense of increased head wear; remarkable coating adhesion could mask inherent internal weakness (and result in premature breakdown); "high-powered" magnetic properties may cause the tape to be electrically incompatible with your computer system.

Because magnetic tape properties are frequently interdependent, often conflicting, we make no boasts of specific superiorities for our new Audev K-68 computer tape.

Instead, we deliver a premium tape in which all the critical characteristics have been *balanced* to provide a high initial quality that will not deteriorate with storage or hard use.

What do we mean by balance? Read on.

It's a dirty shame what some "clean" tapes do to your heads.

To begin with, we know what happens when balance is lacking. There is, for example, one computer tape on the market that is excellent in its freedom from dropouts. It makes a remarkable "first-pass" impression. Yet, an imbalance in key properties makes this tape more than 40 times more abrasive than Audev K-68.

One of those key properties is friction, both static and dynamic. And one way to reduce friction is by lubricating the surface of the tape. But this "trick" solution is short-lived and tends to distort start/stop performance.

In Audev K-68, we attacked the problem differently. Carefully combining binder ingredients, processing and surface treatment for proper static and dynamic frictional balance, we've produced a wear-resistant surface that will not break down on high-speed transports.

But, you might ask, couldn't a really hard binder accomplish pretty much the same result? We say...

Don't get stuck by the "sticky tape" test.

Take one of those tough tapes and torture it. No amount of pulling, scratching or stripping off with pressure-sensitive tape will cause the surface to flake or shed oxide.

But this, too, may be an imbalance. What you may not see is a stiffness and brittleness which could make the edges particularly vulnerable to damage.

Audev K-68's balanced cohesive properties prevent coating failure. The binder is hard enough to prevent self-generated dirt caused by abrasion, yet tough enough to keep the edges from deteriorating.

At the same time, K-68's smooth, non-sticky coating provides few anchoring possibilities for ambient dirt or oxide redeposit. And its low resistivity virtually eliminates electrostatic pull on floating dust.

Balance also affects a tape's electrical characteristics.

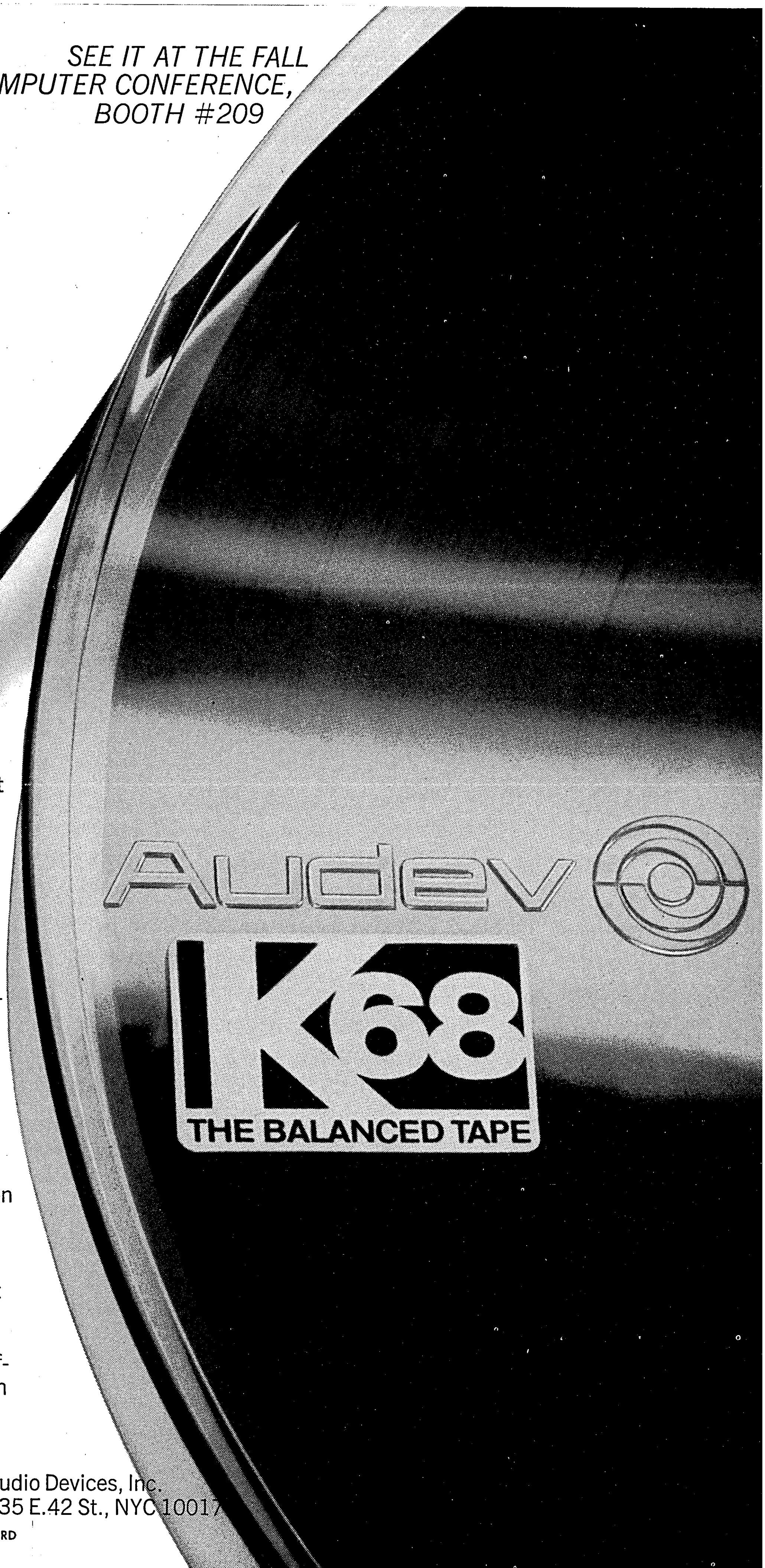
We do our bit for today's high densities.

The higher bit densities of today's computer systems make demands that previously acceptable tapes can no longer meet. Use of a marginal tape in such circumstances often results in a gradual deterioration of quality. Dropouts increase; costly computer time is lost.

Audev K-68 takes these new, stringent conditions into consideration. Its magnetic properties, coating thickness and surface smoothness are balanced for total compatibility with all computer systems and for equal performance at densities from 556 bpi to 3200 fci and beyond.

How? A balanced interplay between low loss magnetics, precise

SEE IT AT THE FALL JOINT COMPUTER CONFERENCE, BOOTH #209



coating thickness and surface smoothness reduces pulse crowding, peak shift and dropout sensitivity without changing output or write current requirements.

K-68's balance also contributes to its environmental stability.

Keep cool. K-68 can take the heat.

Some tapes are as perishable as ripe tomatoes. They react poorly to temperature extremes in storage or transit; they "bruise" easily when moved from transport to transport.

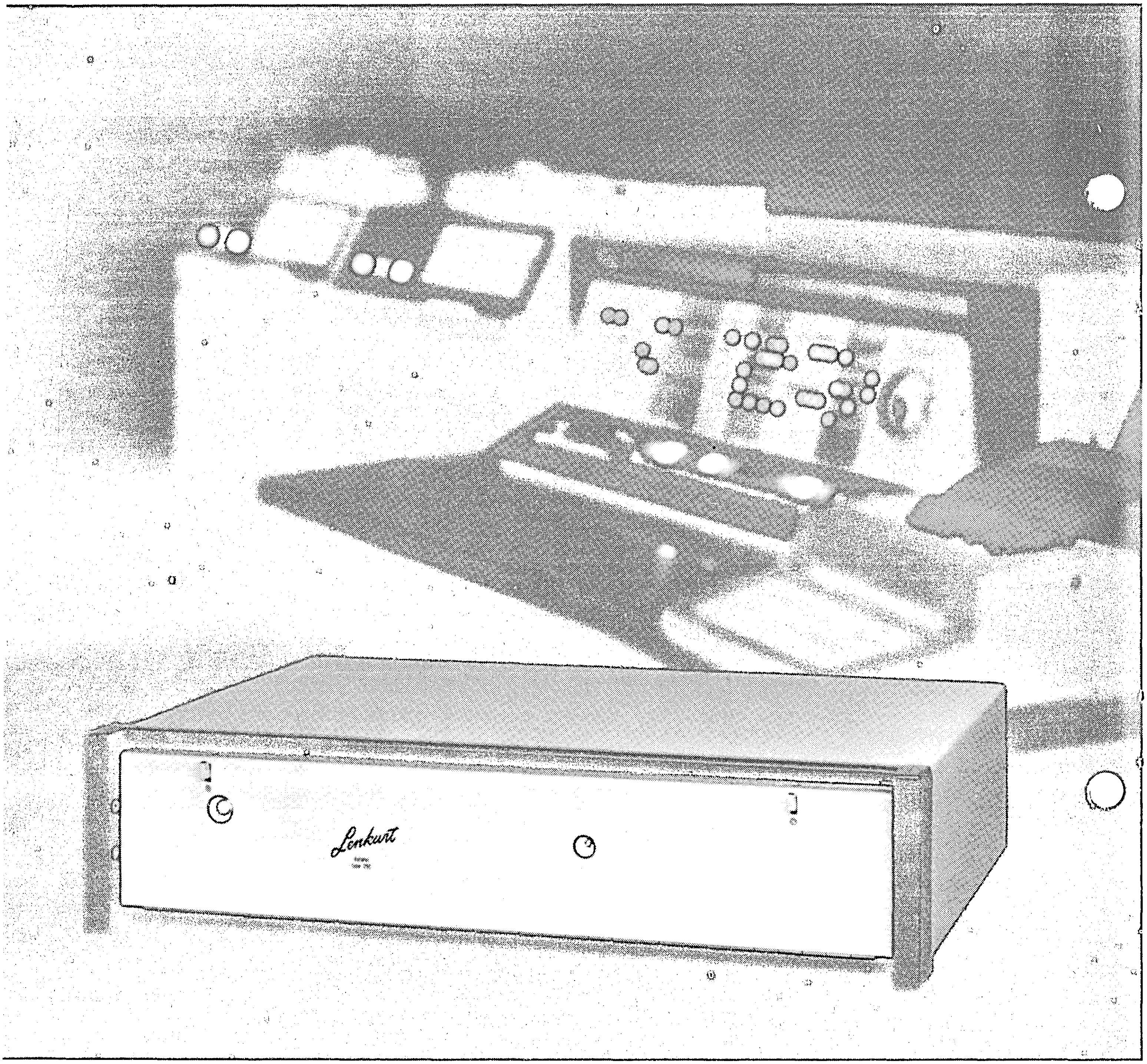
Not Audev K-68. Base and coating properties have been balanced to provide uniform dimensional behavior. Cupping, curling and edge ripples caused by differential expansion or contraction of coating and base have been virtually eliminated.

Nor is Audev K-68 prone to skew-produced, time-displacement errors. Precision slitting, together with the scientifically designed Audev reel—and the low moment-of-inertia of the tape/reel combination—provide smooth tape motion on any transport.

Test a sample reel on your transport. For a change, try a balance, not a compromise.

Audio Devices, Inc.
235 E.42 St., NYC 10017

CIRCLE 43 ON READER CARD



Matchmaker

When it comes to bringing computer installations together, nothing does the job like our 26C Duobinary DATATEL® modem.

Matter of fact, if you have heavy data transmission requirements, you can save hundreds of dollars by buying the 26C.

Recent changes in communications regulations have made it possible for you to buy your own data equipment. The advantages to you are many, especially when the data set you buy is the Lenkurt 26C.

The 26C is fast. Accurate. Transmits data over a telephone channel at speeds from 150 to 2400 b/s. Transmission at 2400 b/s—*double* the maximum binary rate, is obtained by using the remarkable Duobinary process invented at Lenkurt Electric. Equally remarkable is the extremely low error rate. This, and automatic error detection, are bonuses with the 26C.

The 26C uses circuits no more complicated than those found in conventional binary systems. That means high reliability, low cost, and easy maintenance.

Maybe our Matchmaker can make your computers a perfect match.

Lenkurt Electric Co., Inc., Old County Rd., San Carlos, California
I'd like to find out more about the Matchmaker. Please send me your 26C Brochure.

LENKURT ELECTRIC
SUBSIDIARY OF
GENERAL TELEPHONE & ELECTRONICS GT&E

CIRCLE 57 ON READER CARD

washington report

<u>COPYRIGHT REVISION ASKS ROYALTIES ON I/O</u>

The Senate has passed and sent to the House a bill (S2216) establishing a commission to study computerized uses of copyrighted works. Final action is likely this year. The commission would have 25 members, including seven owners and seven users; it would issue a preliminary report in one year, and a final one in three years.

S2216 is aimed at promoting passage of a revised copyright statute. A proposed revision, allowing copyright owners royalties for some computerized uses of their works, is mired in the Senate Judiciary committee. Users oppose this language.

Final Congressional action on copyright revision is likely next year. The big question is whether the disputed language will be excised. The judiciary committee seems amenable, but copyright owners want the present version passed as is, and amended later as necessary. If the owners lose, computer users who input or output copyrighted material without paying royalties will run greater risks of lawsuits. By going to court, owners would impress the study commission.

<u>CAN CARRIERS SELL DP SERVICES?</u>

At press time, the FCC was preparing to tell Western Union whether it could begin SICOM, a new, computerized store-and-forward market quotation service involving shared use of broadband channels. ADAPSO, plus two suppliers of market information — Bunker Ramo and Scantlin Electronics — have objected to SICOM.

FCC's decision will be significant because the case involves a key issue in the computer utility inquiry: whether the carriers should sell dp services. SICOM, as now proposed, doesn't encompass dp per se, but it could easily be modified to do so.

WU's eagerness to have SICOM customers share private broadband channels is strange in view of the company's position in the Telpak sharing case. The SICOM broadband corresponds to a Telpak C or D package. But WU, in comments filed last month, opposed wider sharing of C and D. AT&T agreed. Both carriers said the sharing would have to be unlimited, and in that case would "disrupt" the private line market, lead to higher rates for existing Telpak users, etc. The validity of these contentions will be tested this month, when carrier witnesses are cross-examined by attorneys for user groups.

<u>CAPITOL BRIEFS</u>

Ma Bell was slapped twice last month when: a) the Justice Dept. advised FCC to permit use of any technically-adequate foreign telephone attachment, not just the Carterphone; and b) hearing examiner Herbert Sharfman, seconding an earlier recommendation by the Common Carrier Bureau, advised the commissioners to grant Microwave Communications, Inc., a license to operate a low-cost common carrier voice-record communications system between Chicago and St. Louis. The Justice Dept. statement added that present terminal attachment restrictions "raise substantial questions under the antitrust laws." ... Congressional review of 1970 census questions to weed out those that invade privacy will be proposed by Cong. Cornelius Gallagher in a bill he promises to introduce. A House subcommittee hearing was held on a related bill, introduced by Ohio Cong. J. E. Betts, which would make answers to most census questions voluntary...

The Memorex
630 Series Disc Drive For Your System

2311 COMPATIBILITY

The Memorex 630 Series Disc Drive is fully compatible with IBM 2311 disc drive units. It will read/write Memorex Mark I or IBM 1316 disc packs. A separate read/write head with tunnel erase is provided for each of the ten recording surfaces to assure you of total interchangeability. We can also supply the 630 Series Disc Drive with the exact interface *for your system.*

PERFORMANCE

Total performance of the Memorex 630 Series Disc Drive is unmatched by any other competitive machine. The head load/unload is new—for higher data throughput. The positioner is new—for better access time—the best in the industry. These and other Memorex designed performance features guarantee competitive advantages *for your system.*

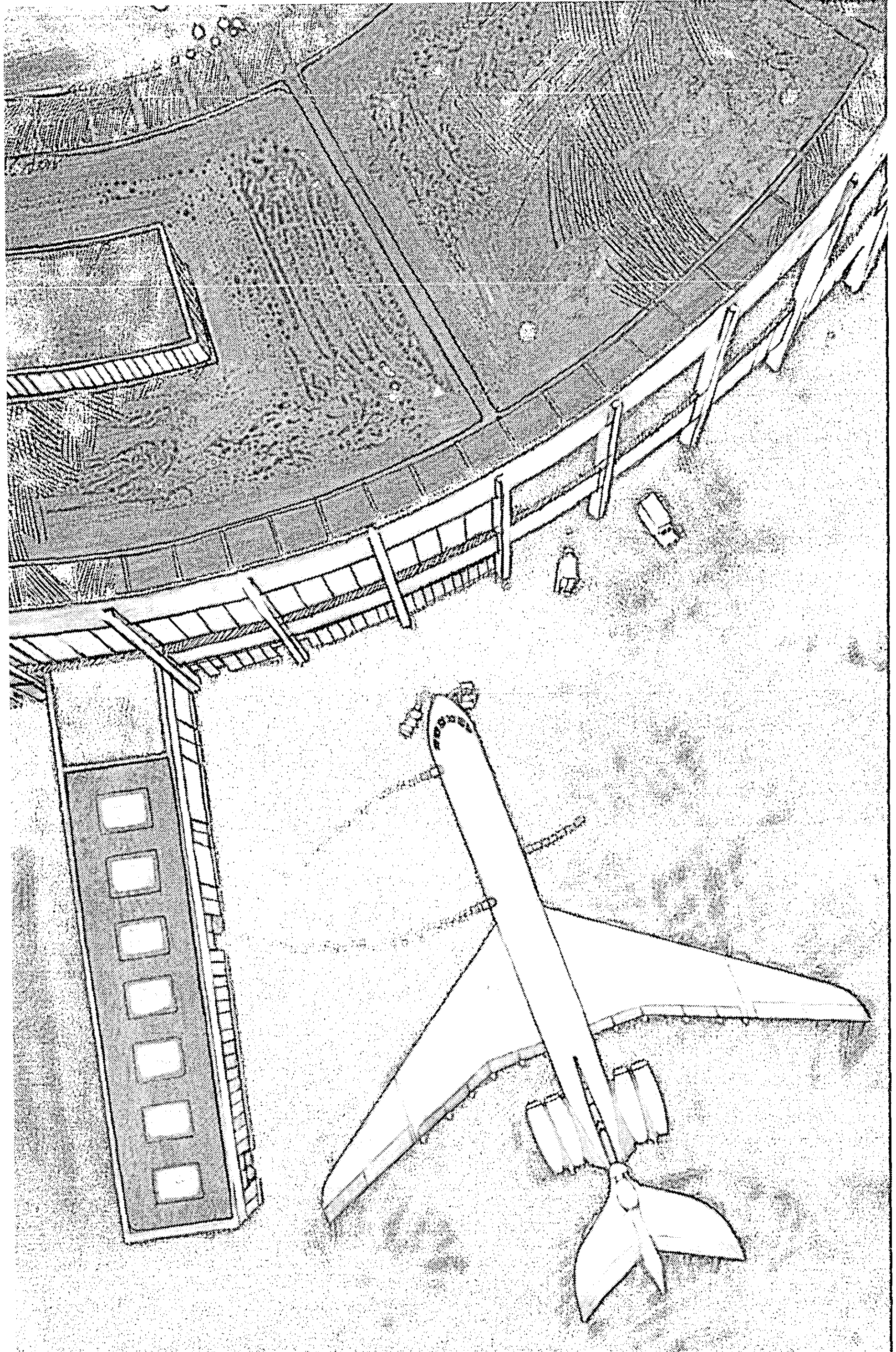
RELIABILITY

The Memorex 630 Series Disc Drive offers superior reliability. Over 75,000 head load/unload operations without error verify reliability and repeatability. The advanced positioning mechanism has fifty fewer moving parts than competitive devices. These and other technical advances guarantee a truly dependable disc drive *for your system.*

For further information about the Memorex 630 Series Disc Drive for your system, contact Peripheral Systems Corporation, 292 Commercial Street, Sunnyvale, California 94086.

Peripheral Systems Corporation
A Subsidiary of Memorex Corporation

SERIES 630



BOAC wants confirmation in print of every passenger reservation made anywhere in the world. Right now.

Easy, when you ask Kleinschmidt.

Kleinschmidt is the language of modern telecommunications.

Home offices talk to division headquarters. Computers talk to production control. And in the case of BOAC, Kleinschmidt data printers in ticket offices provide passengers with fast, convenient flight reservations and confirmation.

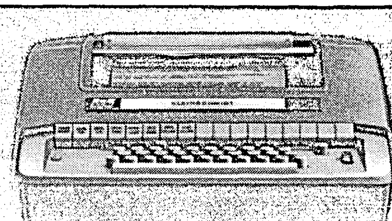
Working in communications systems like BOAC's, the Kleinschmidt 311™ Data Printer "talks" with unbelievable speed and simplicity. It prints-out up to four times as fast as most other teleprinters. Operates with far fewer moving parts and far more reliability. *Outperforms* all competition.

And like other Kleinschmidt data printers, the 311 is compatible with telecommunications equipment of all makes. It can fit directly into the system you now have, or the one you are having designed for you.

Of course, Kleinschmidt is a language most original systems manufacturers already understand.

But we're always glad to repeat the message.

KLEINSCHMIDT
DIVISION OF SCM CORPORATION
DEERFIELD, ILLINOIS 60015 · TELEPHONE: 312 945-1000



SCM®

CIRCLE 76 ON READER CARD

world report

UK UNIVERSITIES UNRAVEL SYSTEMS SNARL

A "new deal" for UK university computing labs has been worked out after a 10-month mediation period by the Computer Board, the policy-making body set up at the beginning of the year to unravel the hotch-potch of the academic, research and educational fields. Suggestions made by the Flowers Committee nearly two years ago have been turned into fiscal budgets and dated plans for curing the bottleneck in universities. Point one is for the idea of regional computing centres to be established in 1971. Although a crash project was carried out for a regional centre at Edinburgh University to relieve a particularly acute problem in Scotland, the two main centres at London and Manchester will wait for their $12 million centres — preferably until a British machine system of worthwhile size is available. As an interim measure, the big concentration of college and research groups around London University have been meted out a CDC 6600 for delivery at the end of '68. It will have satellites at Imperial College, Kings College and London School of Economics. Its basic job will be batch processing.

As an independent measure, units such as Imperial College are making provisional arrangements for development work in conversational time-sharing. Imperial's present appetite is barely whetted with its own 7094; the big nuclear calculations from the physics department, for example, have been flown to Brookhaven and Cern, Geneva (a three time CDC user) for processing.

Proposals have been made for the computing science men at Imperial College to take the third shift on Shell International's twin 1108s in London, for t-s development. Another suggested option being negotiated was to use time on a CDC 6600 at Freeman, Fox, Wilbur Smith and Assoc., one of Europe's big consulting engineering groups.

FUSING CONFUSING AS COMPANIES MARRY

The latest battle in mergers, shaping for a prolonged fight, is a proposed marriage of Associated Electrical Industries (AEI) and General Electric Co. (GEC) — no relation to Phoenix. This will form the greatest electrical and communication complex in Europe if it goes through. Though backed by the government's Industrial Reorganisation Corp., the GEC bid (they sell SDS machines under license) is being fiercely resisted. For the computermen, it adds just one more factor to an already murky scene. Earlier this year, GEC negotiations with Elliott Automation broke down when GEC would not promise to stay out of process engineering, stored-programme telephone exchanges and message switching. AEI has about 10% of the process market with a GE (US) license.

Still an unresolved question is the reported urge to merge English Electric and ICT. The Industrial Reorganisation Corp. is prepared to put up $75 million to oil the wheels of a marriage; finding common ground

(Continued on page 113)

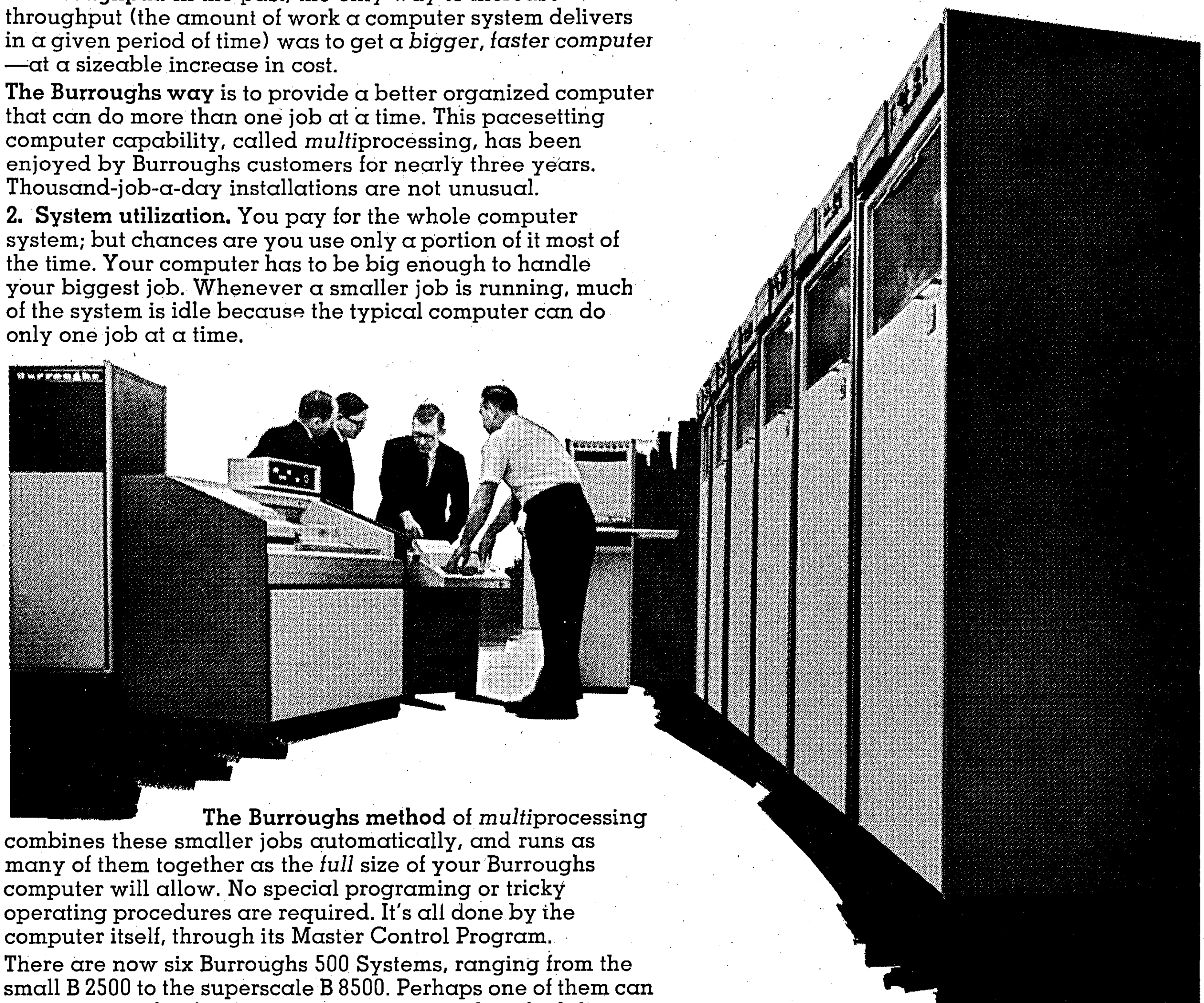
You get more work out of a Burroughs 500 system because more of the computer gets into the work.

That, in a nutshell, is how Burroughs 500 Systems solve two major problems of computer operation: **throughput** and **system utilization.** Their solution means a much higher ratio of performance to price—and a better return on your computer investment.

1. **Throughput.** In the past, the only way to increase throughput (the amount of work a computer system delivers in a given period of time) was to get a *bigger, faster computer* —at a sizeable increase in cost.

The Burroughs way is to provide a better organized computer that can do more than one job at a time. This pacesetting computer capability, called *multi*processing, has been enjoyed by Burroughs customers for nearly three years. Thousand-job-a-day installations are not unusual.

2. **System utilization.** You pay for the whole computer system; but chances are you use only a portion of it most of the time. Your computer has to be big enough to handle your biggest job. Whenever a smaller job is running, much of the system is idle because the typical computer can do only one job at a time.



The Burroughs method of *multi*processing combines these smaller jobs automatically, and runs as many of them together as the *full* size of your Burroughs computer will allow. No special programing or tricky operating procedures are required. It's all done by the computer itself, through its Master Control Program.

There are now six Burroughs 500 Systems, ranging from the small B 2500 to the superscale B 8500. Perhaps one of them can improve your firm's computer operations and profitability. See your Burroughs representative, or write us at Detroit, Michigan 48232.

Burroughs

CIRCLE 60 ON READER CARD

between the two companies is no easy job since they are basically equipment and management incompatible.

BRITAIN MOVES TO COMMERCIAL T-S

In Britain, the change to commercial time-sharing moves apace. First in the field, the Scan stockbroking system of Intinco Ltd., is now part of the monolithic International Data Highways, backed with the seemingly unlimited (nearly $50 million) funds of the International Publishing Corp. The other firm bidding for a system for the stockbroking market is Centre-File. Now owned by Guest, Keen and Nettlefold, the Centre-File operation coughs up $3 million a year in rental to IBM: but so far no income is being received from clients. It switches its first customers on-line this fall, but the viability of the scheme is being reappraised.

The opening of GE's London t-s bureau this summer was quickly followed by the opening of Telcomp, by Time Sharing Ltd., with backing from Bolt, Beranek and Newman in their first serious play for the European field. Telcomp is running on a PDP-1 with an upgrade to PDP-7 on the way.

ICT UNVEILS NEW GIANT

With the increasing demand for big machines, ICT unveiled its latest hardware in the 1900 series in October with the 1906A, a 48-bit word system with a main store of 64K-512K and a 750 nsec cycle time. It is ICT's first i.c. design built on emitted-coupled logic. Priced at $1.5-4.5 million, the 1906A is intended to handle batch and time-shared mixes. New peripherals include a 2 million character drum. Paging techniques first developed for Atlas I have been reinstated, after dropping them for Atlas III. The system is built around three main units: central processor, floating point processor and peripheral processor. Floating point add and subtract times are 0.9 usec; multiply, 2.8 usec; and divide, 7.0 usec. The peripheral processor takes five slow channels, 50K characters-sec; and four fast, 450K characters-sec. There is an option on 30 slow and 16 fast extra channels and two special channels at 1,500K characters.

FOR BURROUGHS: THE SWEET SWELL OF SUCCESS

After its success in the UK banking market (Barclays), Burroughs, transformed overnight from its accountancy-based image to a first-line computer main frame supplier in Europe, is expected to move 8500's to the National Provincial Bank of Westminster. There is also the prospect of the big Burroughs system to be used to rescue an ailing air traffic control system, Linesman-Mediator. The rush to Burroughs is further reflected in about $10 million worth of new business from commercial users for middle-range hardware.

BITS AND PIECES

Univac has a $1.6 million order from Selenia Electronic Assoc., Rome, for two shipboard CP-642B processors. They will be part of an Italian version of Sadoc, automatic systems for direction and combat operation...English Electric has introduced a new 4K-64K process controller, M21-40. Selling from $40K, it has a word length of 16 bits, and a full system addresses 256 I/O devices. Store cycle time is 1 usec; transistor-transistor logic i.c.'s are used for fabrication. ... Two orders totalling $4.5 million have been placed by the Central Electricity Generating Board for computer control in new generating stations.

Precisi

Precision.

An important consideration at Moore—particularly in forms used in scanners. Ink density, paper dimension, 'read' areas, form design, carbons and other specifications must be exact . . . precise . . . for optimum reading results.

Every Moore form for scanner or MICR processing must deliver accuracy, economy, speed—with precision a manufacturing 'must'!

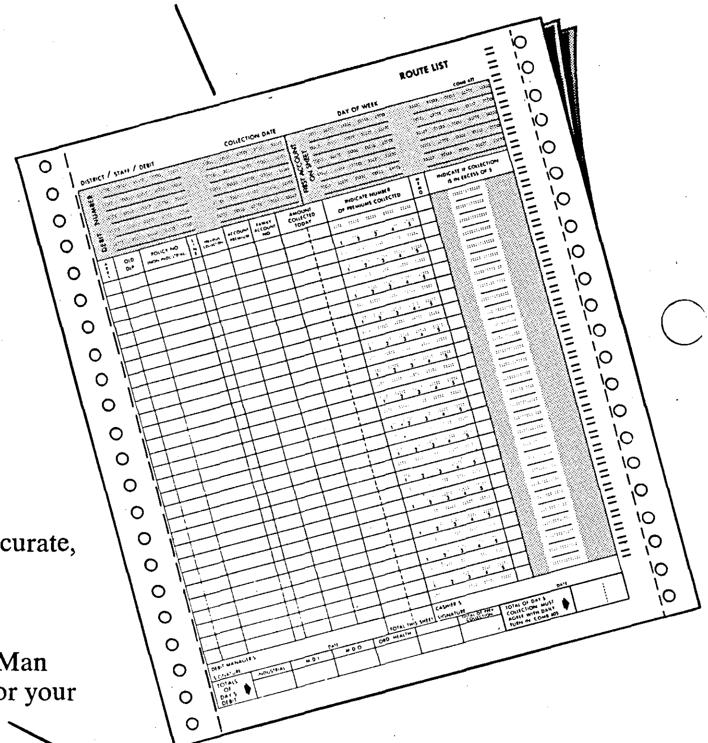
What does such precision require?

Specialized scanning knowledge backed by Moore's constant research. Then specially designed manufacturing equipment—operated by precisionists trained in scanning techniques.

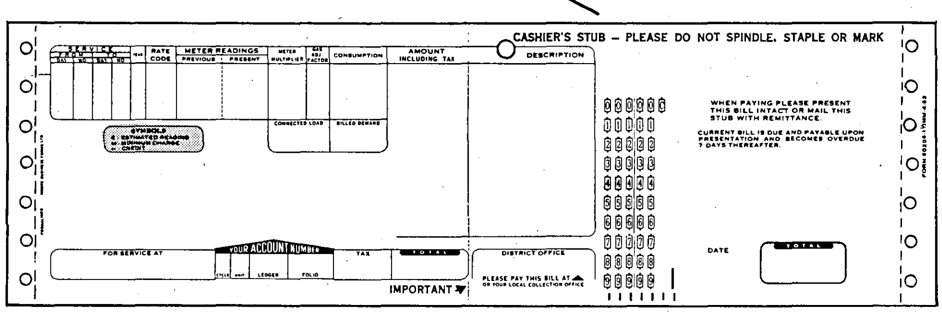
Plus . . . working with OCR equipment manufacturers to meet machine specifications on format and tolerances, inks, and other factors.

Our scanning forms come with Moore's Total Value: Quality materials. Excellent manufacture. Service before and after you buy. Make-good guarantee. Prompt delivery from over 35 plants.

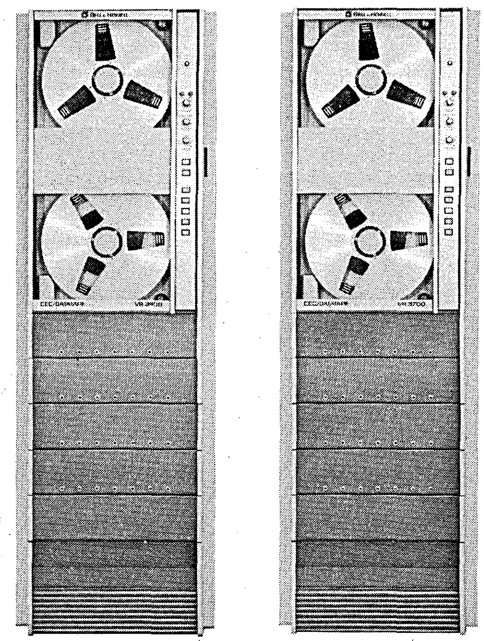
Data Reentry—Moore precision-made OCR forms permit automatic input in scanning operations. Read areas are 'true'—ink density and color response are exact—design meets scanner form specifications. Also—scannable carbons for use in Tab Card sets—with many other Moore forms available to expand your OCR utilization.



Data Entry—Moore MARK READ forms permit accurate, automatic entry of data into processing cycles—with precise reading and minimal rejects. Moore MARK READ forms are made to optimum reflectance response specifications. Ask the Moore Man about MARK READ forms—designed specifically for your system and equipment capabilities.



Should you buy



the new VR-3400? Or the new VR-3700?

Both recorders deliver superb laboratory response. Both are unsurpassed for reliability. Both are sold at a budget price.

Then what's the difference?

The VR-3700 includes state-of-the-art magnetic heads which extend its frequency range to 2.0 MHz. Also available is 500 KHz FM and all have the highest available SNR.

However—should you purchase the VR-3400, and later data handling requirements call for a 2.0 MHz response, you may *convert* it to a VR-3700 by a simple exchange of heads and electronics.

So whichever you choose today, you need have no regrets tomorrow.

Now consider the other advantages offered by *both* recorders:

- Magnetic recording heads guaranteed to exceed 1000 hours. CEC's unique, solid metal pole-tip design has eliminated the inherent deficiencies of lamination and rotary head design.
- Failsafe DC Capstan Drive assures dramatically-improved flutter and TDE performance.
- All-Electric Tension Control. Solid-state amplifiers for improved linear tension control and greater reliability.
- Photo End-of-Tape sensing included in all systems, complete with automatic transfer.
- Automatic 8-speed transport electrically selectable.
- Phase-lock capstan control electronics included for improved speed accuracy.
- Direct electronics phase equalized for best pulse response.

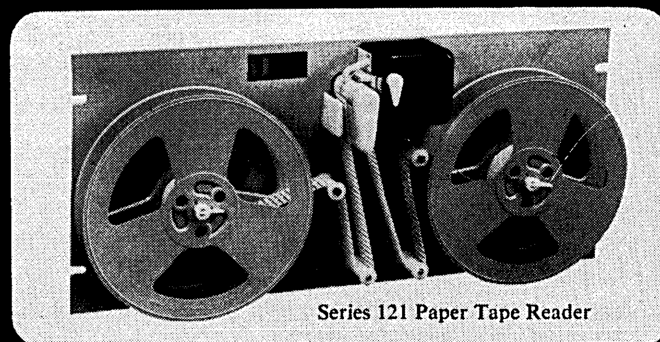
For complete information, call or write Consolidated Electrodynamics, Pasadena, California 91109. A subsidiary of Bell & Howell. Bulletin 3400-X8 and Bulletin 3700-X2.

CEC/DATATAPE PRODUCTS

BELL & HOWELL

CIRCLE 63 ON READER CARD

The Pace Quickens



Series 121 Paper Tape Reader

Ohr-tronics has long preached . . . and practiced dependability, accuracy and economy in tape readers. Now, our newly evolved Series 121, adds speed sufficient to meet any challenge.

Series 121 goes twice as fast as any reader we've ever made . . . and with the same valued reliability! What's more, even though Series 121 reads faster, it works easier. Loading facility has increased with high-lift starwheels and tape holddown arms. Tape is much more expeditiously removed from the Reader head permitting rapid bi-directional tape winding.

Even more to the point . . . though we've greatly raised our speed . . . we've held our price! Series 121 is priced at $550. Other Ohr-tronics values are shown below . . . further vital statistics are no further away than your request.

Series 110, Paper Tape Punch . . . punches standard 5 to 8 channel paper tapes, asynchronously at speeds up to 30 characters per second. Parity switches for error checking . . . tape can be back spaced. Price: $695 with reels; $545 without reels.

Ohr-biter II, Tape Duplicating System...has a highly sophisticated control panel that permits not only straight duplication but skip mode erasure...partial duplication through search mode...keypunch of tape through optional keyboard mode. Price: $1832, complete.

Model 153, Flatbed Reader . . . is designed to be mounted flush on a horizontal surface. Same basic mechanism as 119. Price: $330, complete.

Model 131, Edge-punched Card Reader . . . reads single, handfed edge-punched cards. Price: $415, complete.

Model 124, Flexi-bit Punch . . . punches single hole bits. Price: $89, complete.

Model 112-8 Spooler . . . feeds tape and takes-up 8″ reels when harnessed to reader or punch. Price: $210, complete. 112-5, 5″ reels: $195.

ohr-tronics

305 West Grand Avenue, Montvale, New Jersey 07645

Warranted one full year for parts and labor.

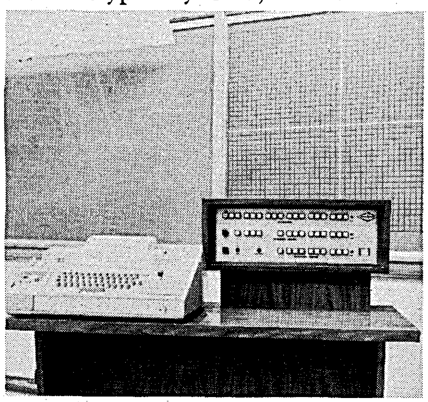
You can depend on Ohr-tronics!

CIRCLE 64 ON READER CARD

new products

classroom computer

The Math-Master ECP-18A classroom computer has a 1,024 18-bit memory, directly addressable in 16 basic instructions. A full set of logical operations complementing "new math" are included. I/O can be accommodated on punched paper tape, typed from the Teletype keyboard, or illustrated



on an elevated display panel. A 20-hour teacher training program is provided with the computer. Software package includes a symbolic assembly language, "Easy-Code Programming," course outlines, teacher-student manuals, programming and operating manuals, and demonstration programs. GAMCO INDUSTRIES, INC., Big Spring, Tex. For information:

CIRCLE 124 ON READER CARD

reader/sorter

The IBM 1259 reader/sorter for MICR banking applications operates on-line with the IBM 360/20, 30, and 40. The 1259, being built by OEM-supplier Lundy Electronic and Systems Inc., reads and sorts checks into 11 pockets at a rate of up to 600/minute. It can also handle deposit slips and other documents that conform to ABA MICR standards. Deliveries begin third quarter 1968 for mod 20 customers, first quarter 1969 for mod 30 and 40 customers. IBM DP DIV. White Plains, N.Y. For information:

CIRCLE 125 ON READER CARD

programming courses

A 24-lesson programming course offers computer runs on a 360 for assignments. The home study course is structured to teach several phases of computer usage: history, time-sharing and systems analysis, as well as 360 BAL, FORTRAN and COBOL programming. COMPUTER USAGE EDUCATION, INC., New York, N.Y. For information:

CIRCLE 126 ON READER CARD

banking computer

The B340 computer system is designed for banks with less than $100 million in assets, and provides application programs for proof and transit, demand deposit accounting, savings and installment loan accounting. The computer includes a 4,800 character cpu; MICR reader/sorter with speeds up to 1,000 items a minute; a 200 cpm card reader; buffered 400 lpm printer; and a three-station tape cluster with transfer rates of 25K cps and a 556 bpi density. BURROUGHS CORP., Detroit, Mich. For information:

CIRCLE 127 ON READER CARD

memory testing system

The PMA-8, utilizing the PDP-8 as a central control element, is a system for production testing and design of computer memory stacks. Tests are input to the computer by paper tape or through a Teletypewriter/tele-

PRODUCT OF THE MONTH

The General Retrieval System for Managers is a generalized file system similar to the KWIC Query system, Informatics' Mark IV, and Applied Data Research's PDQ. Basically an information retrieval system (additional programs and options are necessary for file generation and updating). GRS is designed to allow non-programmers to interrogate a master data base with a series of English statements.

GRS comes with a dictionary of request terms which give the search name and description for each data element in the file. (For example, for Zip Code, the search name is ZIP, and the description is 5 digits – referring to the amount of space available in the record field.) When a manager is preparing a search request form (which will then be keypunched), he can ask for information using these English terms in the dictionary.

The GRS system will also sequence items in a printout, provide some editing capabilities (floating dollar sign, zero suppression, punctuation), and permit accumulations (e.g., net pay, total salaries). Although Mark IV and KWIC provide editing and sequencing, the accumulation feature is unusual, and may be unique with GRS.

The system searches the whole file, pulls out selected records, sorts them, and produces a report. The record formats accommodated by GRS are of fixed length; all items must carefully be accounted for when the data base is established. Using COBOL as a source language, the system is accessed sequentially.

Minimum required configuration is an IBM 32K 360/30 Disc Operating System with reader/punch, printer, disc drive, two disc tape drives (for the data base and select file), sort files on discs.

For $10K, the company, Information Science, Inc., will install and establish one data base (275 fields) including complete documentation and user education. For additional data bases, two options are offered: the user may pay $3K for each additional data base to be established by ISI; for $20K, a generator is available that allows the user company to produce an unlimited amount of files.

Other options include a redefinition of the original base (a major editing job, rather than an update—$250), and another management seminar ($300) besides the one included in the basic cost.

Now available, GRS is supplied with the following services: system flowcharts, program listings, block diagrams, operations instructions, and written instructions on use of all control cards. It can be installed and operating within 30 days of the contract date.

In addition to the basic cost of $10K, ISI offers a lease agreement with option to buy, and a regular lease arrangement of $450/month.

The system is suited for many applications: sales orders, inventory, demand deposits, payroll and personnel. It is now being used in a blood bank with files containing information on rare blood types. INFORMATION SCIENCE, INC., New City, Rockland County, N.Y. For information:

CIRCLE 128 ON READER CARD

0001 0010 0011 0101 0110 0011 0101 1001 1011 0111 0001

0110 0011 0101 1001 1011 0111

Sangamo's New Variable Equalizer conditions lines faster..... keeps every bit of data perfectly in line

0001 0010 0011 0101 0110 0011

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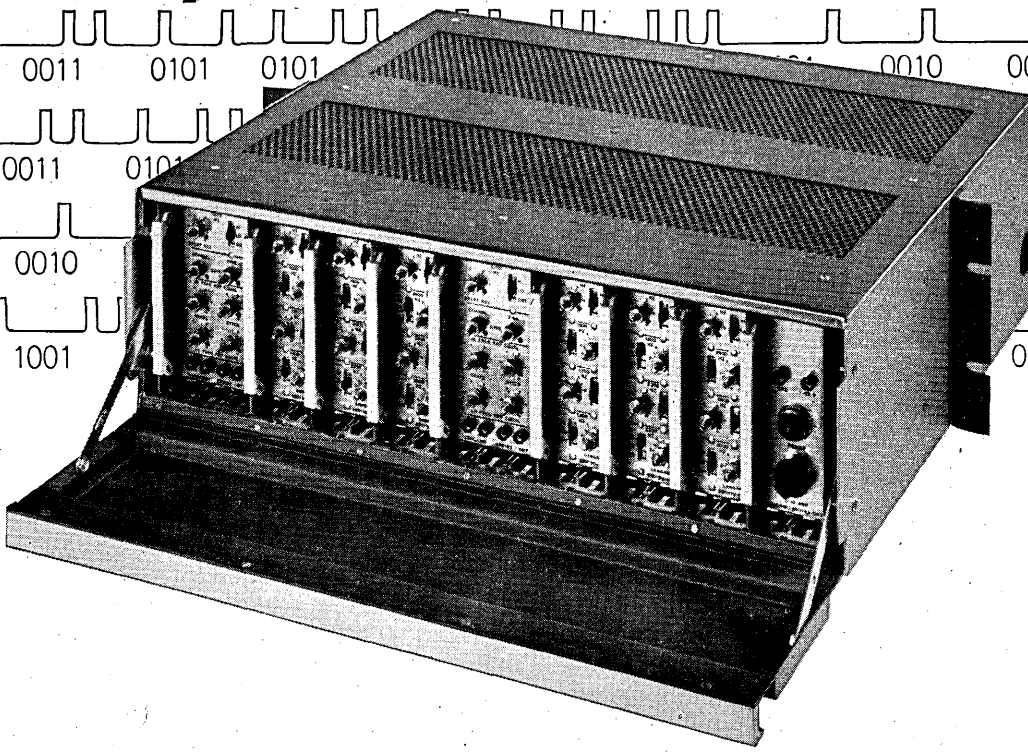


With the increased use of 2400 bits per second and higher data rates, the necessity for equalizing *both* amplitude and phase becomes paramount. The new Sangamo LC-1 line conditioner does both with virtually independent adjustment... permitting faster adjustment with increased accuracy.

How fast? With the LC-1, you can equalize both amplitude and phase of a circuit in less time than phase alone previously required.

Amplitude equalization requires taking five level measurements, setting the two shape controls and the two attenuation compensators. A typical monotonic curve requiring up to 8 db attenuation at 1900 Hz can be amplitude conditioned *in less than 5 minutes.*

Phase equalization is accomplished with 13 individual time delay sections on 200 Hz spacings (option 600 to 3000 Hz or 800 to 3200 Hz). Each section has a 3-position ranging switch to set the vernier time delay control to: 1.28 to 2.28 milliseconds, 0.4 to 1.4 milliseconds, or section bypass. This unique configuration provides fast initial ranging of the equalizer and permits 1 millisecond resolution control for fine tuning. The 13 sections can insert up to 3.5 milliseconds delay at 1900 Hz as related to the delay at the band edges. Minimum time is required to compensate an average line to ±80 microseconds time delay variation through the pass band.

The resonant frequency of each of the 13 sections can be field changed by +67 Hz, +100 Hz, or −67 Hz. When two or three LC-1's are operated in tandem, this subspacing permits placing 26 sections on 100 Hz spacing or 39 sections on 67 Hz spacing, reducing the overall ripple to a minimum while inserting up to 10.5 milliseconds of delay.

The LC-1 is self-contained with optional 24/48 VDC or 117 VAC power supply and occupies only 5¼" of mounting space on a 19" equipment rack.

Write or phone today for Bulletin 5004 and a demonstration at your facility.

Phone 217-544-6411
TRANSITEL DIVISION
Sangamo Electric Co.
Springfield, Illinois 62705

SANGAMO

T67-08

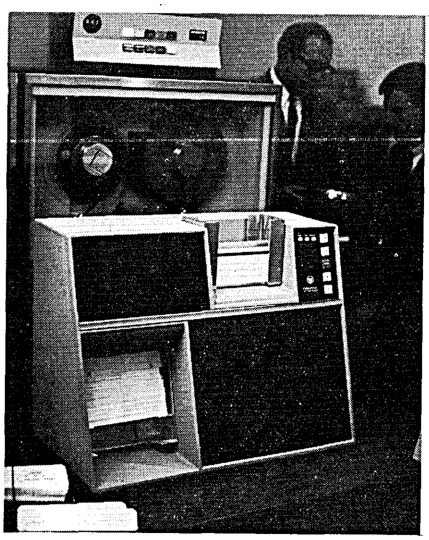
CIRCLE 65 ON READER CARD

printer. Testing parameters are stored in the form of reference tables, and the PMA-8 uses data extracted from these tables to analyze the memory data. When system is not in use, computer and teleprinter are available for general computing. Evaluations performed by test programs include go no-go mode, maximum/minimum parameter search mode, automatic distribution plot analysis mode and shmoo plotting mode. DIGITAL EQUIPMENT CORP., Maynard, Mass. For information:

CIRCLE 129 ON READER CARD

card reader

The series-300 card reader has a rate flexibility of from 50-300 cards a minute and an optional re-read feature which allows the computer to command immediate "re-read" for any card being read. There are five models in the series besides the basic 300 unit. The 305 includes a 1000



card hopper; the 310 has "recirculate" and "reject" off-set functions; 315 is the 310 with the 1,000 card hopper. The model 320 is the basic unit with a "step-column read" capability. Either 51- or 80-column cards can be read. Hopper capacity is 500 cards with a 1000-card modification available. Stacker hold 1,000 cards. OMNITEC CORP., Phoenix, Ariz. For information:

CIRCLE 130 ON READER CARD

mobile teleprinter

The TP-120 teleprinter, using piezoelectric crystals, produces hard copy readout on pressure sensitive paper. The unit takes up ⅓ cu. ft. of space and consumes 5 watts power. MOTOROLA GOVERNMENT ELECTRONICS DIV., Chicago, Ill. For information:

CIRCLE 131 ON READER CARD

digital control system

The LN5000 DDC computer system is for real-time control. The mainframe has a 4,096 (expandable to 65K) word memory with a cycle time of 1 usec. The system also includes I/O assembly package and unspecified peripheral equipment. A manual input console enables an operator to monitor an entire plant; process and control information is displayed on demand, and changes are made through keyboard entries. Available software allows multiprogramming capability. LEEDS & NORTHRUP CO., Philadelphia, Pa. For information:

CIRCLE 132 ON READER CARD

credit card program

A Credit Card Accounting System for the 360 with 32K byte memory and three disc drives or four tapes, provides optional on-line inquiry file that can be used for immediate account status inquiry. This file is recreated each day for all active accounts. Customer statements may be printed or printed-and-punched on 51-column reentry cards. The daily journal can optionally reflect accumulated week-to-date activity, statement-to-date activity, or a full trial balance of the complete file. SOFTWARE RESOURCES CORP., Los Angeles, Calif. For information:

CIRCLE 133 ON READER CARD

communications buffer

The 608E-1000 series of keyboard communications buffers are adaptable to fill any buffer memory requirement for asynchronous input or output character rates of up to 500 KHz; synchronous rates up to 4 MHz. Basic system provides storage of 4,096 8-bit characters expandable to over 128K. Timing and control functions are included. DIGITAL DEVICES, INC., Syosset, N.Y. For information:

CIRCLE 134 ON READER CARD

logic modules

The J series of general purpose, i.c. digital logic modules are for use in systems operating at clock rates up to 5 MHz. Over 20 module configurations are available, including such functions as NANDS, BANDS, inverters, transfer gates, exclusive ORs, 4 x 4 buffers, adders, JK flip-flops, RS flip-flops and a bidirectional counter. SCIENTIFIC DATA SYSTEMS, Santa Monica, Calif. For information:

CIRCLE 135 ON READER CARD

gp computer

The 2115A digital computer has a 4K (16-bit) memory, 2 usec cycle time, and 8 I/O channels (expandable to 40 channels) with automatic priority interrupt. Available software includes an extended USASI Basic FORTRAN compiler, and a new ALGOL compiler which requires 8K core (alternately available on the 2115A). Basic unit includes a Teleprinter. HEWLETT PACKARD, Palo Alto, Calif. For information:

CIRCLE 136 ON READER CARD

time-sharing system

A transmission controller permits from one to 15 teleprinters or IBM 1050/2741 terminals to be connected to an 1130 computer's memory system over telephone lines. Supporting software provides interface with telecommunications equipment. Incoming lines operate concurrently with program execution and all normal 1130 capabilities are maintained. WESTERN TELEMATIC INC., El Monte, Calif. and MORRISSEY ASSOC. INC., New York, N.Y. For information:

CIRCLE 137 ON READER CARD

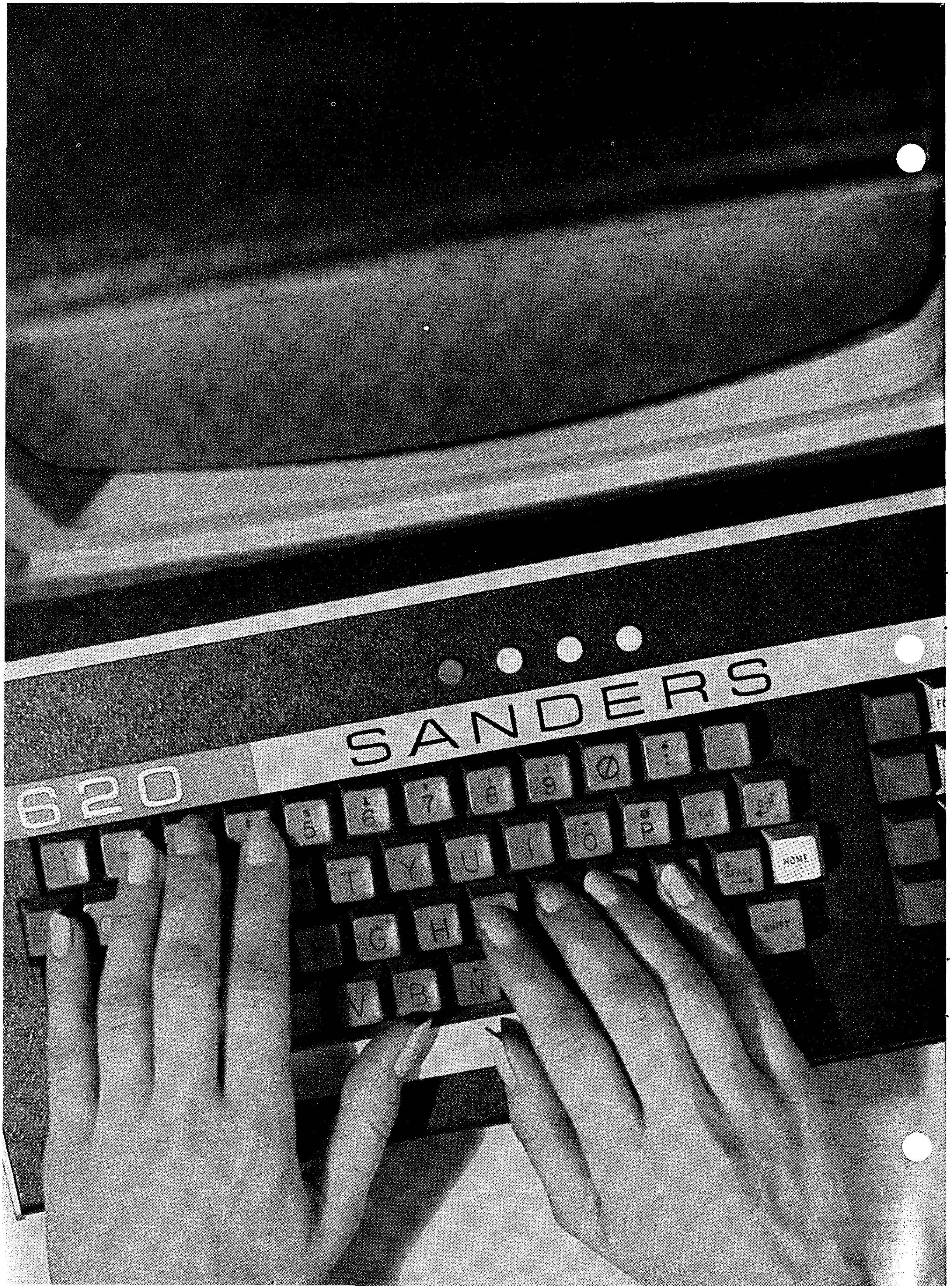
translation program

A machine language conversion system is designed to accept 1400-series object decks and produce 360/20 and /30 assembler source programs. 360 assemblers must have IOCS. System will handle card and tape I/O, indexing, store address-register and external subsense switch. Compatibility of 1400 and 360 storage size and peripheral equipment is required; card operation may be optionally converted to tape system. DATA CENTER, Baltimore, Md. For information:

CIRCLE 138 ON READER CARD

information retrieval system

The PDQ (Program for Descriptor Query) information retrieval system is for use with 360/30 and larger computer systems; the program requires a minimum configuration of one disc pack and 32K memory. It can operate in an on-line inquiry mode or in a batch mode. Using a few natural English commands, PDQ is for per-


620
SANDERS
HOME
SHIFT

Meet the new low-cost Stand Alone Display that doesn't have everything

It's the new Sanders 620 Stand Alone Data Display — a completely self-contained system with all the features you need for remote data retrieval and update but with no costly extras.

It's priced at only $5400 and rents for a low $180 a month, maintenance included.

The 620 System is the first low-cost display terminal to offer these unique advances:

Compact, desk-top design. All I/O, editing, memory, character generation, power supply, and other circuitry contained in a single portable unit. No separate control unit required.

Memory Save feature. A Sanders exclusive that lets you spread 768 characters anywhere in the 2048 spaces on the screen. Blank characters on the screen don't take up spaces in memory.

Fatigue-free operation. Bright, flicker-free, solid stroke characters with size, shape and spacing designed for optimum readability and eye comfort.

Major systems compatibility. Sanders can provide the interface to System/360 via selector or multiplexor channels and to all other major computer systems.

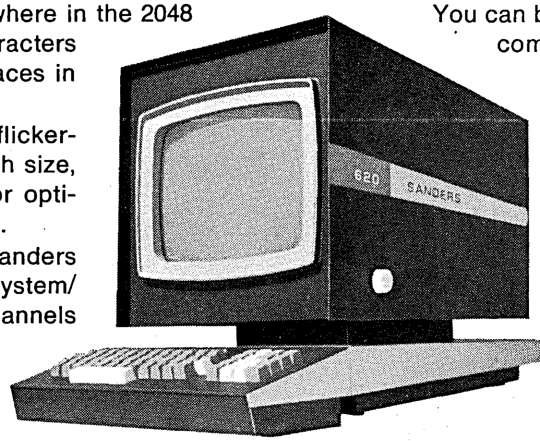
Broad range of options. Lets you tailor the system to exact needs. Hard copy output, format mode, horizontal and vertical tab, conversational mode, cycle left and right (high speed cursor positioning aid), and 2400 bit/second I/O capability.

Sanders 620 Stand Alone and a DATA-PHONE† are all you need in even the remotest location for direct visual access to your central computer.

And for the Data Display that *does* have everything . . . full editing capability, up to 1024 character memory, single or clustered environment, and more . . . see the Sanders 720 System.

You can build a complete data communications complex using 720 and 620 Systems in any combination your situation requires.

We'll be glad to demonstrate either system at your convenience. Call the office nearest you to arrange a date. Or write for literature . . . Sanders Associates, Inc., Data Systems Division, Nashua, New Hampshire 03060. Phone: (603) 883-3321.



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DATA SYSTEMS DIVISION

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*T.M., SANDERS ASSOCIATES, INC. †T.M., AT&T CO. INC.

CIRCLE 66 ON READER CARD

The key word about PDP-10 General Purpose Time-Sharing is Simultaneous

PDP-10 General Purpose Time-Sharing (GPTS) is an advanced software system which can handle multiple unrelated:

- Real-time simulation and control jobs
- Conversational jobs
- Batch-processing jobs

All at once!

For example, a system that's been operating nearly two years interfaces a Digital Equipment Corp. computer with three analog computers forming a hybrid system. The GPTS system is configured to handle the three real-time simulations *simultaneously*.

At the same time the real-time programs are running, individual programmers have direct access to the central processor and its associated peripheral equipment from teletype consoles. From these teletype stations, programmers may write, debug, edit and run their own programs. This feature makes it possible for a user to debug application programs for real-time systems without costly and inconvenient shutdown of the real-time systems.

Using the PDP-10 time-shared batch-processing system, individual users can initiate their own batch stacks or submit jobs to a system background stack which is available to all users. Jobs are placed in the system batch stack through a simple Teletype command. Batch control programs run as ordinary time-shared jobs at the same time as real-time and conversational jobs.

DEC's time-sharing software has been field-proven at numerous installations throughout the world. *True* GPTS is available today with the surprisingly low-priced PDP-10. Why settle for less in your installation?

digital
MODULES · COMPUTERS

DIGITAL EQUIPMENT CORPORATION, Maynard, Massachusetts 01754. Telephone: (617) 897-8821 • Cambridge, Mass. • New Haven • Washington, D. C. • Parsippany, N. J. • Princeton, N. J. • Rochester, N. Y. • Long Island, N. Y. • Philadelphia • Huntsville • Pittsburgh • Chicago • Denver • Ann Arbor • Houston • Albuquerque • Los Angeles • Palo Alto • Seattle • Carleton Place and Toronto, Ont. • Montreal, Quebec • Reading, England • Walkden Manchester, England • Paris, France • Munich and Cologne, Germany • Noordwkerhoot, Holland • Sydney and West Perth, Australia • Modules distributed also through Allied Radio

CIRCLE 67 ON READER CARD

sons with no computer background. While entering data, the user assigns a descriptor to classify or categorize the data. The data may be later retrieved by specifying the descriptors. The data may be in any format and need not be inserted in any sequence. Descriptors are invented by the user; each user may create a private data base with its own descriptor set. APPLIED DATA RESEARCH, Princeton, N.J. For information:

CIRCLE 139 ON READER CARD

military tape recorder

Model DT03E-R military digital tape recorder operates at speeds up to 75" a second, and has a maximum packing density of 800 bpi. Computer-compatible, the unit can use standard IBM reels, and can be supplied with 7-, 8-, or 9-track tape formats. The recorder weighs under 125 pounds, and uses an average of 150 watts of power. TECHNICAL MEASUREMENT CORP., North Haven, Conn. For information:

CIRCLE 140 ON READER CARD

retail terminal

The 1907 batch recording system is a terminal that records business transactions during the day and relays them to a computer by telephone in the evening. The terminal contains a reusable mag tape cartridge which stores retail information; after a day's close of business, the central computer, a 360, collects and processes the information to generate sales, inventory, merchandise, accounting and management reports. IBM DP DIV., White Plains, N.Y. For information:

CIRCLE 141 ON READER CARD

linear programming software

OPTIMA is a mathematical programming system for CDC 6400, 6500 and 6600 computer systems which enables users to mix, compare and combine a number of solutions. Matrix sizes are limited only by the ability to index 250,000 unique variables.

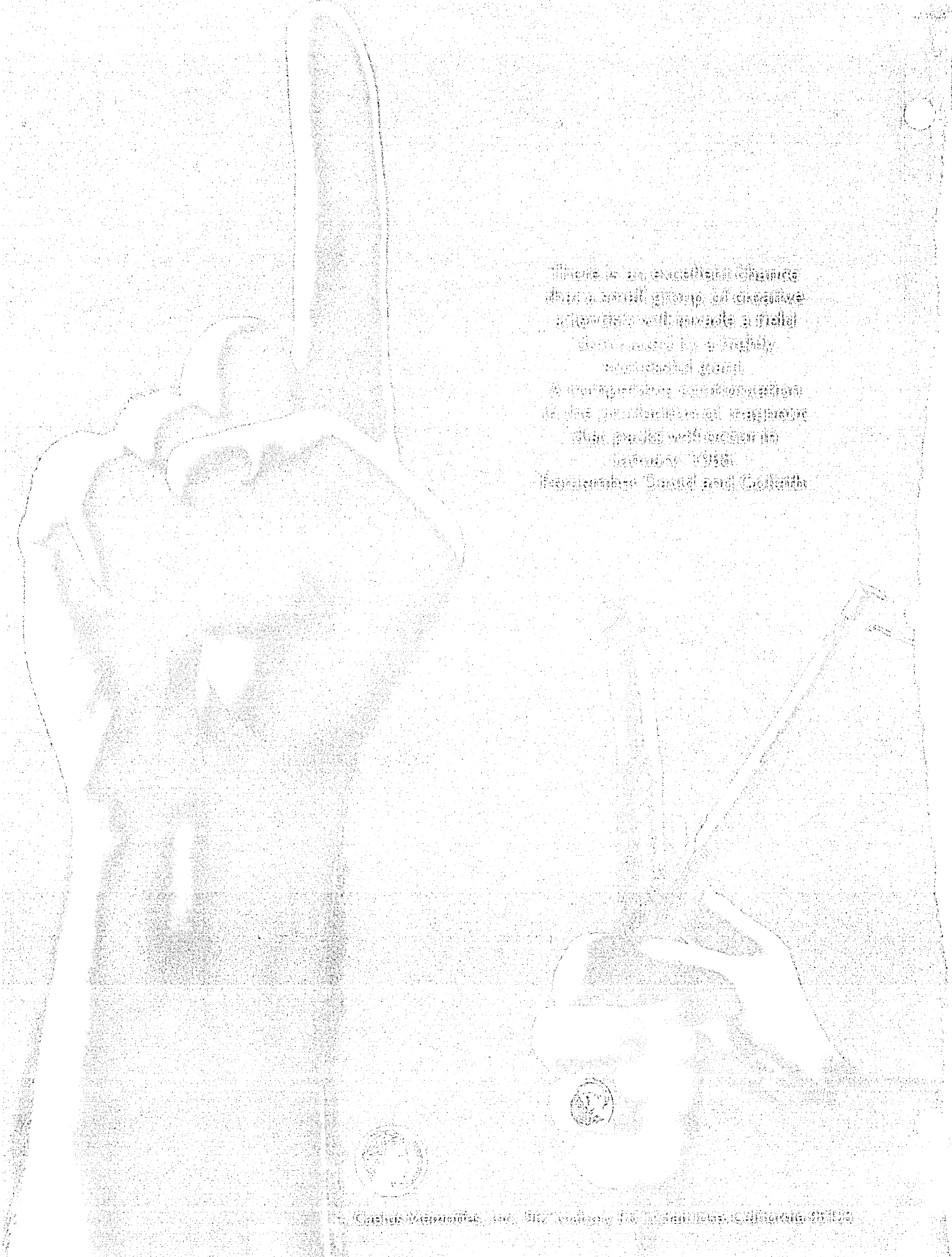
OPTIMA contains a matrix generator language for facilitating manual collection and keypunching of matrix numbers, and a report generator language to specify collection and formatting of reports. Developed by Orchard-Hays & Co., the program will be completed in three versions. Basic 1.0 will be available this winter; 2.0 will be ready first quarter '68; and an advanced system, 3.0, second quarter '68. OPTIMA is not free. CONTROL DATA CORP., Minneapolis, Minn. For information:

CIRCLE 142 ON READER CARD

compact computer

The PDP-8I is a cheaper, faster, more compact, software-compatible, integrated-circuit version of the PDP-8. In fact, it's almost price competitive with the baby of the line, the $10K PDP-8S. Starting at $12,800, the 8I is a parallel, 12-bit, 4K-32K-word fixed length machine with a 1.5 usec cycle time. Add time is 3.0 usec; subtract 6 usec. And with an extended arithmetic option, multiply speed can be 6 usec; divide, 6.5 usec.

8I features not available on its predecessors are prewired interfaces for an extra 4K-word memory, and for peripherals such as high-speed paper tape reader and punch, 100 card/minute punch, incremental plotter, and scope display. A DECdisc and DECtape system software package has also been developed to add to the library handed down from the 8, which includes FORTRAN II (an 8K FORTRAN IV subset to be added), MACRO 8 assem-


There is an excellent chance
that a small group of creative
scientists will invade a field
dominated by a highly
successful giant.
A competitive confrontation
in the production of magnetic
disc packs will occur in
January 1968.
Remember David and Goliath.

bler, PAL III assembly language, tape editor and debugging program, and other routines and programs. Other peripherals available are Teletype (with the basic system), mag drum systems, line printer, a-d and d-a converters. Other features include auto-indexing, microprogrammable instructions, buffered I/O registers, 64 I/O registers, 64 I/O transfer channels, and one I/O bus.

DEC is aiming at both 8 and 8S markets, particularly OEM's (an "attractive quantity discount"), research, process control, and data communications. It is expected that the 8I, which will be mass-produced and may ultimately become an off-shelf item, will sell more than the present number of installations of the 8 and 8S—2,000. DIGITAL EQUIPMENT CORP., Maynard, Mass. For information:

CIRCLE 143 ON READER CARD

card scales

A tab card counter scale for 80- and 90-column cards measures a keypunch operator's production after the cards have been punched. Approximately 99% accurate at its capacity of 1000 cards, sorter time to obtain accurate production counts is eliminated. PELOUZE MANUFACTURING CO., Evanston, Ill. For information:

CIRCLE 144 ON READER CARD

data recording system

A digital data recorder translates output from atomic absorption, ultraviolet and infrared spectrophotometers into digital form; up to three encoders can be used simultaneously. Output can be displayed visually or recorded on paper tape, mag tape or punched cards. Identification data may be introduced and recorded by the setting of 10 parameter switches. BECKMAN INSTRUMENTS, INC., Fullerton, Calif. For information:

CIRCLE 145 ON READER CARD

data modems

Modular, microminiature, digital data modems are available in five models. MC-12/24-1 can transmit and receive data up to 2400 bps in a 3 KHz voice band; it is designed for duplex operation over radio circuits. It can process

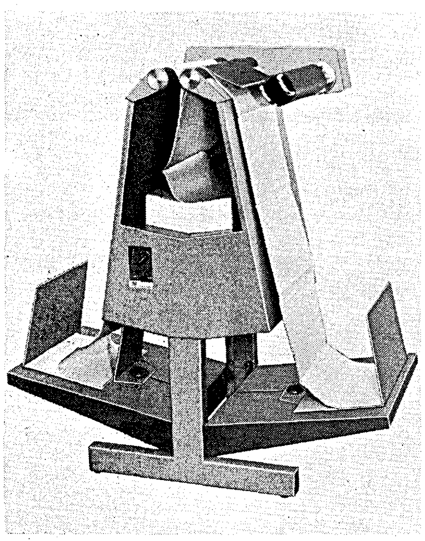
← FOR CAELUS CIRCLE 69 ON READER CARD

data from up to eight sources simultaneously and is compatible with vehicular modems. MC-12/24-2B transmits data over 3 KHz wire line facilities, or cable, carrier, microwave and UHF stations. It can process four data sources at one time, and may be used as an unattended duplex digital relay station. SC-70 is an independent full-duplex test set for back-to-back testing of modems. Error output may be monitored externally or recorded. DVC-QM-37 and DVC-QD-37 transmit and receive binary data over wideband communications systems at rate up to 40 million bps. PHILCO-FORD CORP., Philadelphia, Pa. For information:

CIRCLE 146 ON READER CARD

decollator

The model 283-A decollator has been improved to provide easier operator loading. The unit includes a two-position refold shelf; an additional drop of the web allows the decollator to hold more forms. Also included is a positive storage position for the refold shelf to eliminate damage while open;



the open front design has been restyled to permit easier threading of form webs. Magnetic backstop plates allow location of form depths. Tines of carbon rewind forks have been connected into "U" sections to prevent operator injury. Speed of the decollator is variable, from 50-350 feet per minute; handling paper of 10-110 lb. substance. MOORE BUSINESS FORMS, Niagara Falls, New York. For information:

CIRCLE 147 ON READER CARD

memory system

The ICM-500 memory system can be used as a main memory, or an auxiliary memory, with either standard or custom digital computer systems. It has a 600 nsec cycle time and an access time under 300 nsec. Special units can be ordered with cycle times of 500 nsec. The unit offers capacities from 4,096 to 32,768 words. MTBF for an 8K (28-bit) word unit is over 25,000 hours at 35° C. HONEYWELL COMPUTER CONTROL DIV., Framingham, Mass. For information:

CIRCLE 148 ON READER CARD

electoral strategy game

CONSENSUS is a decision-making, strategic game based on the electoral college system of electing the President of the United States. Each player (candidate) attempts to use his limited supply of campaigning resources to garner the greatest number of votes. Game includes a 14-color playing board illustrating the amount of electoral votes from each state, and economic, regional factors (Voter Interest Groups) that are important in presidential elections. Designed for 2-5 players. Cost: $7.95. SCIENTIFIC GAMES DEVELOPMENT CORP., Box 427, Ann Arbor, Mich. 48107.

control computer

Announcement of the Series 1600 reveals only that the integrated circuit computer is a 16-bit parallel binary system with a 1.8 usec cycle time. The 1600 will be available, but not supported, as a free-standing computer. Instead, it is primarily intended for use as a programmable controller in systems for computer-assisted instruction, large data gathering functions, and manufacturing test and checkout. RCA will use the unit in its graphics and CAI divisions, and as a free-standing automated-test controller for such areas as i.c. and color TV tube production. The 1600 may also be applied as a buffer for communications systems and for back-up to an on-line system when it is in test or repair. And, employing microprogramming techniques, it will be able to serve as a line concentrator, tape converter, disc controller and other "specialty product roles." True to form, it is IBM 360-compatible. Production is scheduled to begin the second half of '68. No delivery or price was announced. RCA EDP, Cherry Hill, N.J. For information:

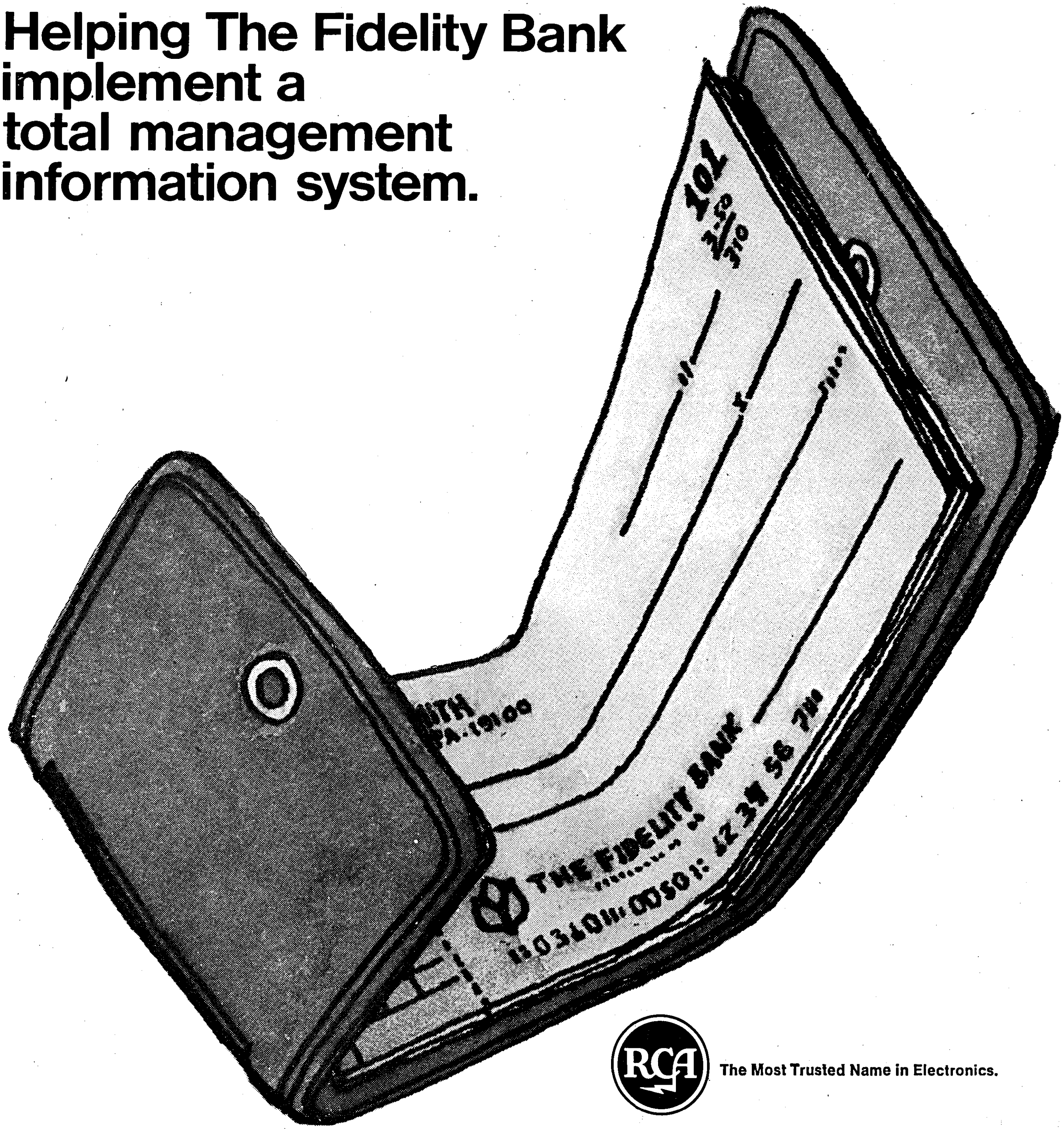
CIRCLE 149 ON READER CARD

What are RCA computers doing in banking?

The Fidelity Bank in Philadelphia is the nation's 43rd largest. Since 1959 it has been using RCA computers to handle internal banking tasks and provide profitable computer services to customers. Because of this success, Fidelity has chosen RCA Spectra 70 computers to build a central information file that will store a complete profile on every customer. Information from this file—accessible in seconds through RCA video data remotes—will permit Fidelity to offer new, better and faster services. This central file will eventually become the data base for a total management information system.

Why did The Fidelity Bank choose Spectra 70? Impressive cost-performance ratios, broad compatibility with other systems, and unique experience in real-time data communications are three basic reasons. For the full story of why The Fidelity Bank, Marine Midland Corporation, Mercantile Trust Co., N. A. and other banks selected Spectra 70, call your nearest RCA EDP office or telephone us at (609) 424-2385. RCA Electronic Data Processing, Camden, N. J. 08101. RCA SPECTRA 70

Helping The Fidelity Bank implement a total management information system.



RCA The Most Trusted Name in Electronics.

CIRCLE 70 ON READER CARD

SCM announces: the "one girl" Typetronic data processing system for small business budgets... is now two to three times faster than any other system!

Now! 300 words per minute with the new *PrintFlo*™ printer. With Typetronic®, SCM introduced a whole new concept in data processing. "Big capability" systems for small business budgets.

250 Per Cent Greater Throughput. Our latest SCM development is the *PrintFlo* 300 printer. With addition of this new printer, Typetronic systems step up working speed to a lightning 30 characters per second. Three hundred words per minute. *Two to three times the speed (and capacity) of any competitive system.*

The new Typetronic configurations, with a 250% greater throughput, afford a performance/cost ratio equalled by no other system in the field.

With More to Come. From the beginning, SCM has been committed to technological leadership in data processing. In the compact systems area, we pioneered the use of magnetic tape in conjunction with tab card input and output.
And more developments are on the way.
Increased versatility. Greater storage capacity.
A different form of information retrieval. Because Typetronic systems are modular, they can grow with the companies that use them. And expand to include important new innovations.
All new ideas you'll be seeing soon.

In the meantime, you can see our *PrintFlo* 300 today.

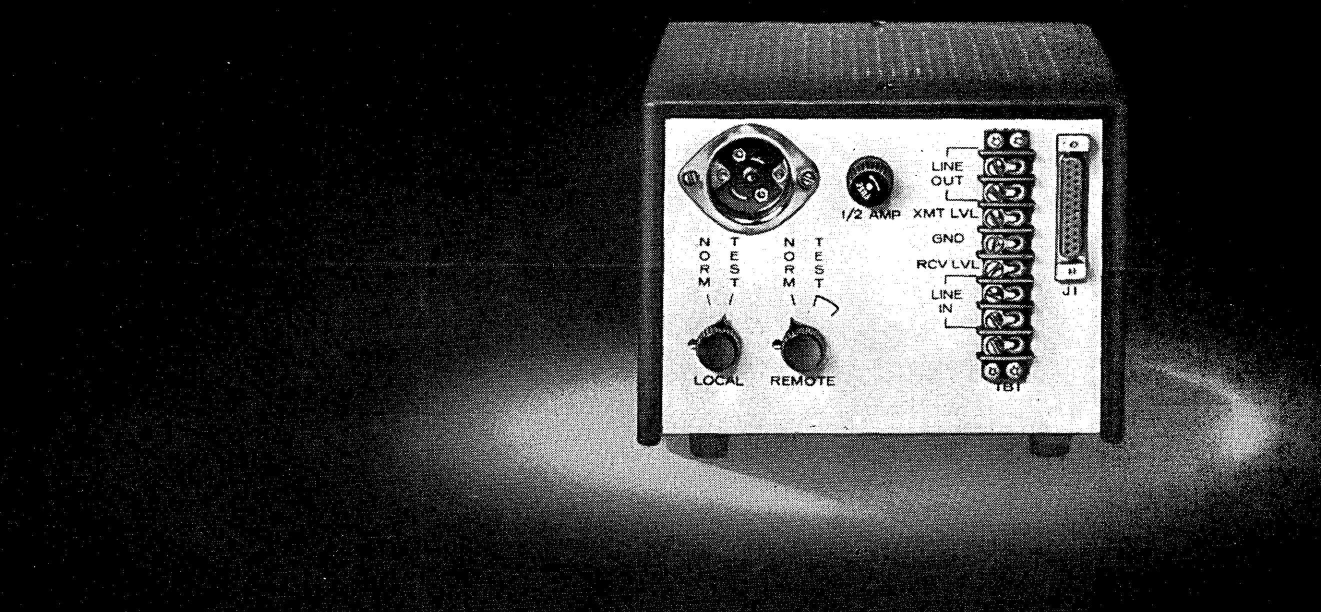
SCM®

DATA PROCESSING SYSTEMS

SCM CORPORATION, 410 Park Avenue, New York, N.Y. 10022
Offices in Canada and major cities throughout the world

CIRCLE 71 ON READER CARD

Are you jacking up DT outlays by leasing high-cost Datasets?



ULTRONIC has the answer . . . *Buy Them!*

Does it make real sense to *lease* Datasets when you can buy them for only $475? Check this price! You'll find that it's *less* than one year's leasing cost.

That's one reason why ULTRONIC DATA PUMPS™ are being used with Burrough's on-line Banking Systems . . . and why close to 2000 units are in operation for stock brokers all over the country.

What's more important is the solid-state reliability that permits DATA PUMPS to transmit or receive up to 1200 bits per second over voice-grade phone lines day after day, with virtually no error or breakdown. If maintenance is required, rapid service is available through the Ultronic nationwide field service group.

Plus factors are the simple controls and ease of operation, carrier control for keying on and off, simplex or full duplex operating modes and remote and local test capability. Light and compact, DATA PUMP weighs only twelve pounds and measures 10¾" x 7" x 5½".

Sound like a good buy? You won't find a better one. If you're on-line now or going on-line, write to us for all the details. Better yet, call us collect.

DATA COMMUNICATION PRODUCTS DIV.
ULTRONIC SYSTEMS CORP.
SUBSIDIARY OF
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MOUNT LAUREL INDUSTRIAL PARK
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MULTIPLEXING SYSTEMS • MAGNETIC TAPE TRANSMISSION TERMINALS • DATA SETS

CIRCLE 72 ON READER CARD

new literature

DP MANAGERS' KIT: Planning kit to aid in planning or reorganization of data processing departments includes: a ruled grid scaled ¼" to the foot upon which the user's floor plan is drawn; pressure sensitive templates, scaled, representing all of the company's edp storage and filing equipment; and scaled templates for all of the major data processing machines, identified with the manufacturer's nomenclatures. Kit comes with instructions for use and suggestions for departmental planning, noting such considerations as lighting, ventilation, and grouping for simultaneous machine operation. TAB PRODUCTS CO., San Francisco, Calif. For copy:
CIRCLE 150 ON READER CARD

MEASURE AIR & WATER QUALITY: Data gathering systems for monitoring both air and water pollutant concentrations concurrently are described in 16-page bulletin. Included are graphic descriptions of "on-site" recording and analog and digital telemetering systems. The advantages and most suitable applications for each system are outlined. The installation of complete data management systems without loss-of-use or obsolescence of existing equipment is also included. THE BRISTOL CO., Waterbury, Conn. For copy:
CIRCLE 151 ON READER CARD

MULTIPROCESSOR DIGITAL COMPUTER SYSTEMS: An analysis has recently been completed of those factors that determine the optimum hardware mix for a given workload and that influence the choice of operating system strategies for a given combination of hardware and workload. Two types of multiprogrammed systems were analyzed: those that terminate jobs in case of memory conflict and those that suspend jobs under these circumstances if there is any possibility that memory can be allocated later. The suspension strategy was found to be superior. 136 pages. Cost: $3; microfiche, $.65. AD-654 384. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

DIGITAL DATA RECORDING: Four-page bulletin describes system for automatically converting instrumental output data into computer language. Bulletin covers basic system operation, data outputs, acceptable output-initiating commands, general functions performed, and includes photographs and ordering information. SCIENTIFIC INSTRUMENTS DIV., BECKMAN INSTRUMENTS, Fullerton, Calif. For copy:
CIRCLE 152 ON READER CARD

COMPUTER EDUCATION: Eight-page report to educators describes the need for computer education at the secondary level and discusses the responsibility of the educator in providing basic computer education and how such a program can be developed. GAMCO INDUSTRIES, INC., Big Spring, Texas. For copy:
CIRCLE 153 ON READER CARD

RANDOM DATA GENERATOR: Technical bulletin describes Model 213 random data generator for data error analysis and pattern sensitivity detection in transmission-medium systems and storage elements. DATAPULSE, INC., Culver City, Calif. For copy:
CIRCLE 154 ON READER CARD

TARIFF INFORMATION STORAGE & RETRIEVAL: A study to determine the feasibility of applying computer technology to the storage and retrieval of tariff information has been completed for the Dept. of Transportation by Battelle Memorial Institute. Phase 1 of the study develops the general logic and formulates algorithms for storing and retrieving tariff data on origin and destination, commodity description, mode, carrier, and related data needed to determine applicable rates. Phase II of the study involves the development of algorithms for accessorial charges, for footnotes, rules and regulations, and for the storage and retrieval of routing data. Cost: $3; microfiche, $.65 for each of

new literature

three parts. Phase I is in two separate volumes: PB-170 590 and PB-170 591; Phase II, PB-175 706. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

COMPILER-COMPILER: 17-page booklet describes the Genesis system, a formalized method for the semi-automatic production of compilers and other systems software. The three sections trace development history, detail technical concepts and summarize the system, giving benefits, performance figures and describing some installations. COMPUTER SCIENCES CORP., El Segundo, Calif. For copy:
CIRCLE 155 ON READER CARD

COMPUTER CONTROL FOR ARC FURNACE: Four-page bulletin outlines how a computer load factor and demand control for arc furnaces cuts electrical costs by taking advantage of utility demand rates. Schematic signal diagram, performance curves, and hypothetical example are included. Brochure also tells how Prodac 50 can monitor and direct other arc furnace functions. COMPUTER SYSTEMS DIV., WESTINGHOUSE ELECTRIC, Pittsburgh, Pa. For copy:
CIRCLE 156 ON READER CARD

MAG TAPE BASICS: 44-page application note presents the fundamentals of magnetic tape recording with special emphasis on analog instrumentation applications. HEWLETT-PACKARD, Palo Alto, Calif. For copy:
CIRCLE 157 ON READER CARD

TIME-SHARING SYSTEM: 20-page brochure describes SDS 940 general purpose time-sharing system with software package designed to simultaneously serve multiple users stationed at remote terminals. The system's time-sharing capability is interactive and conversational; users "converse" with the computer via Teletype equipment. The seven specialized programming services (subsystems) are also described, and existing and potential applications are summarized. SCIENTIFIC DATA SYSTEMS, Santa Monica, Calif. For copy:
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HOSPITAL DP SYSTEMS: Unusual data processing systems installed by three major hospitals are described in 32-page booklet to show how automation speeds hospital procedures. Flow charts are detailed by departments showing input data, processing, equipment used, output data, and interrelationship of each operation. Patient records and specialized internal reports used by hospital employees are shown. MOORE BUSINESS FORMS, INC., Niagara Falls, N.Y. For copy:
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DIGITAL SEISMIC DATA: Article reprint is a current review of how and why digital recording of seismic data is progressing and summarizes the growing use of digital techniques. Basic considerations when selecting a system are discussed, and typical IBM-compatible seismic tape formats are illustrated. Major characteristics of a dozen "field tape" recorders presently available are also listed. POTTER INSTRUMENT COMPANY, INC., Plainview, N.Y. For copy:
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PROCESS COMPUTERS: 52-page booklet on basic concepts of process computers from a programming viewpoint is designed for students and others wishing to acquire an introduction to process computers and programming requirements. GENERAL ELECTRIC PROCESS COMPUTER BUSINESS SECTION, Phoenix, Ariz. For copy:
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ASSOCIATIVE PROCESSING SYSTEM: Report presents a user-oriented system having both algebraic and associative processing capabilities for conventional digital computers. Consists of

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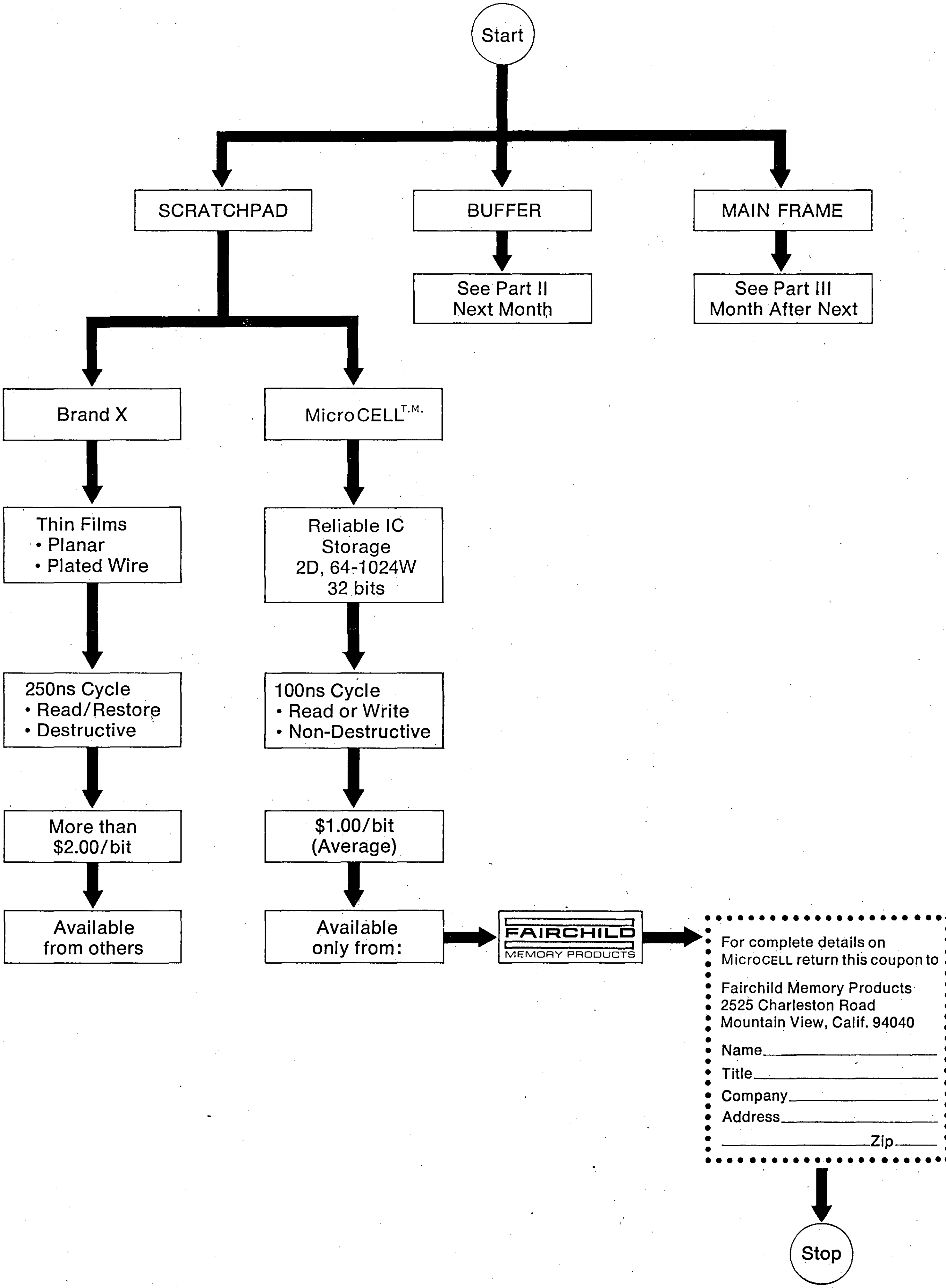

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three sections: 1) describing the high-level programming language for the overall system; 2) outlining the scheme for representing an associative information base; and 3) summarizing the processing routines for associative retrieval requests. 67 pages. Cost: $3; microfiche, $.65. AD-655 810. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

FINANCIAL PLANNING SYSTEM: 13-page report describes consolidated financial planning (CPF) system designed to reduce the cost of preparing long-range operating plans and the length of time required to produce a plan after information becomes available. BONNER & MOORE ASSOC., INC., Houston, Tex. For copy:
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HYBRID ABILITY: Four-color, six-page brochure includes sections on types of components, package configurations, test procedures and manufacturing steps of the company's hybrid circuits. SEMICONDUCTOR DIV., SPERRY RAND CORP., Norwalk, Conn. For copy:
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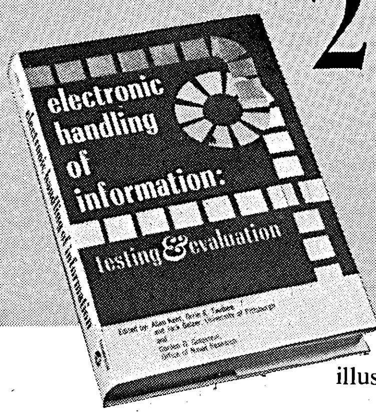

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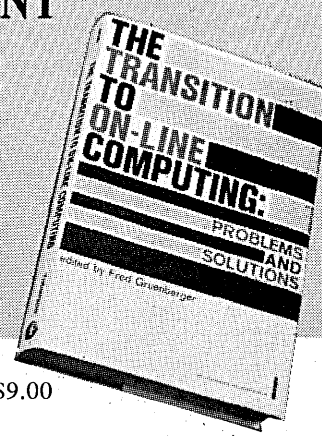

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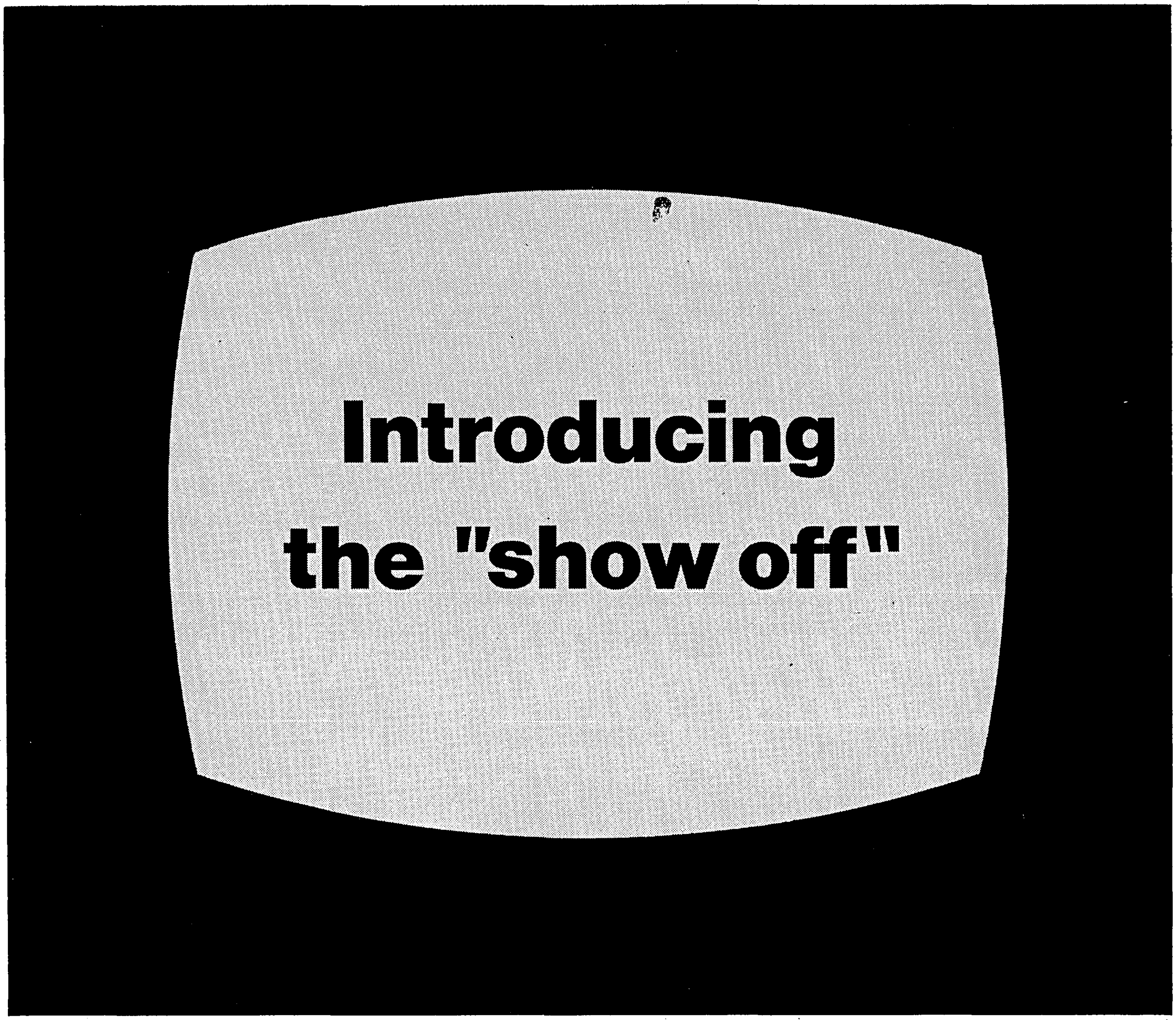

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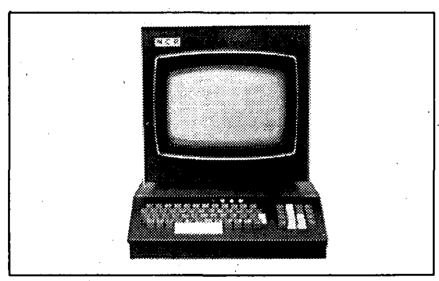

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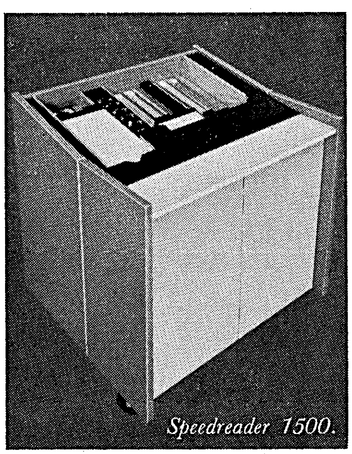
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CIRCLE 313 ON READER CARD

books

***The Copyright Law as it Relates to National Information Systems and National Programs: A Study by the Ad Hoc Task Group on Legal Aspects Involved in National Information Systems,* by the Committee on Scientific and Technical Information, Federal Council for Science and Technology, Washington, D.C. Distributed by the Clearinghouse for Scientific and Technical Information, Springfield, Va. $3.00 copy; $ .65, microfiche. 58 pp.**

Until recently, the typical reader of this publication probably equated the word *copyright* with *patent* and said "Can I use one of these methods to protect the software I've just written?" Or else he thought about the problem of patenting hardware and the battles which manufacturers have undertaken to determine patent validity. But probably the hottest issue in the copyright field right now is between the right of the author to protection and the right of the researcher to information, with a computer used as the interface mechanism.

For a dozen years, Congress has been trying to revise the Copyright Act of 1909; last spring, the House managed to pass a bill and send it on to the Senate. The original discussions of copyright reform gave only passing thought to possible copyright infringements arising from putting copyrighted materials into machine readable form, manipulating them with electronic equipment and outputting them in whole or in part, perhaps hundreds of miles away.

From a few voices crying in the wilderness three years ago (such as Reed Lawlor's article "Copyright Aspects of Computer Usage," in the October, 1964 issue of *Communications of the ACM*), the published interest is now reaching tidal wave proportions.

The document being reviewed, a 58-page basic study and 15-page summary, does a good job of reporting on the current problems in this area. The concern of the authors is, of course, the Federal Government's desire for the establishment of useful data in machine readable form. But the presentation is surprisingly well-balanced, particularly in regard to the factual background. The task group pinpoints its position and the problems:

> . . . the scientific, technical and economic progress and the international competitive position of the United States depends on the ready access to information as well as its effective use. As the means of disseminating information develops through technological progress, we must be assured that legal procedures, which may be necessary today in balancing the interests of the copyright owners in compensation [competition?] with those of the users, continue to keep pace with the technological advance in the use of published information.

The report outlines three particular problem areas: (1) ready access to copyrighted material, (2) whether the conversion of copyrighted material into machine readable form is an infringement of copyright, and (3) the proper scope of exemptions for non-profit users. The efficient use of the computer's information retrieval ability clearly contemplates that vast masses of data will be needed, and some of it will probably be copyrighted. If the user has to worry about copyright problems, the data base will either not include copyrighted material, or the user will be forced to devote research time to the administrative problem of obtaining permission to use the material.

The task group states that "potential users of the information systems are not adverse to paying, but wish to be guaranteed the right to use the material that they are willing to pay for." This statement suggests the possible solution of mandatory licensing by statute, or the establishment of a voluntary clearing house. The former provides a means of reasonable compensation even when the copyright proprietor cannot be immediately located (and the new statute proposes a copyright period of 50 years), but involves the difficulty of defining what writing must be licensed, who can use the material and how much the royalty should be. The voluntary clearing house may have some anti-trust problems and there may be some authors who do not wish to join. Both require administrative machinery.

The second problem—whether putting copyrighted material into machine readable form is an infringement of the copyright—is really, as noted by the task group, a subdivision of "at what point in the process of putting information into the system, manipulating it, and recovering it should compensation be charged?" Section 106 of the House Bill made it clear that such input was an infringe-

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ment and that this was the Congressional intent. The House Committee report stated that, unless the fair use doctrine were applicable,

> . . . The following computer uses could be infringements of copyright under Section 106: reproduction of the work . . . in any tangible form . . . for input into an information storage and retrieval system; reproduction of the work or substantial parts of it, in copies as the "printout" or output of the computer; preparation for input of an index and abstract of the work so complete and detailed that it would be considered a "derivative work," computer transmission or display of a visual image of a work to one or more members of the public.

This position, favored by the publishers, is based on the arguments (1) it is difficult to determine what use

will be made of the material once it is in the computer, (2) whether payment at the time of output will be due may depend on the status of the user, and (3) the accounting required for payment on each use will be a substantial cost in addition to the copyright payment. The arguments against making input an infringement are (1) currently much of copyright material fed into the system will emerge in the form of reproduction, (2) using computers to operate directly on the copyrighted material in the data base does not necessarily replace a sale of the material, and (3) certain people, particularly in the educational process, are entitled to use copyrighted material without payment of a royalty, so why should they have to pay initially.

Both sides agree that the doctrine of fair use should stilll continue. This doctrine, developed by the courts through decisions of copyright cases, is well summarized in the basic report and has been codified in the proposed statute as follows:

> The fair use of a copyrighted work . . . for purposes such as criticism, comment, news reporting, teaching, scholarship, or research, is not an infringement of copyright. In determining whether the use made of a work in any particular case is a fair use, the factors to be considered shall include: (1) the purpose and character of the use; (2) the nature of the copyrighted work; (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and (4) the effect of the use upon the potential market for or value of the copyrighted work.

This doctrine of fair use has been suggested by one group of lawyers as a possible solution to the input-output problem; they have suggested the law state:

> To the extent the copyrighted material is recorded in computer readable form, and is used to generate and disseminate information in a manner which would be considered fair use if an automatic information processing system were not involved, such recording and use shall be deemed to be a fair use.

But other lawyers, depending upon their economic orientation, favor royalties on input or royalties dependent on the type of output and the type of user of the output.

The type of user leads to the third problem area—that of exemptions for non-profit uses. It is here that the most noise has been raised. The present copyright law does provide certain exemptions in that the copyright owner has exclusive rights in the performance of non-dramatic literary or musical works only when such performances are public and for profit. Under Section 110 of the proposed law, the not-for-profit exemption has been changed somewhat to require performance and face-to-face teaching in classrooms of non-profit education institutions, or non-profit teaching transmission (classroom TV) and the like. The COSATI task group finds these exemptions are narrower than the present law. The University Communications Council (EDUCOM) finds that "the relevant exemptions provided in S597 [the Senate Bill] are not adequate and would seriously hamper educational development in this country." In testimony last spring, this group termed the bill "pernicious" because it did not give computer assisted instruction systems the same privileges (DATAMATION, April, 1967). The publishers reply, "These educators in their professional zeal have disregarded the fact that their argument might be applied with equal force to other professions, such as medicine, public health, nursing and social work—all of which certainly are of basic importance to the public welfare."

In fact, the battle gets rather vituperative. Spokesmen for EDUCOM have written:

> The copyright industries—the "publishers" in the broad sense —seem to have gotten along rather well under the long-standing statutory arrangements granting traditional exemptions. Nevertheless, the publishers have insisted throughout the evolution of the Revision Bill on erasing these exemptions.
>
> Sometimes this insistence has been so strident as to disregard the plain fact that the publishers are themselves the beneficiaries of like preferences, whether these take the form of postal subsidies, appear in the guise of public funds appropriated directly or indirectly for the purchase or licensing of copyrighted works, or take the shape of the copyight status which confers on them the basic monopoly.
>
> When the revision effort began, the register of copyrights advised that the traditional exemptions be continued. But, amid a great welter of propaganda, the register has gradually swung around. The result is that the Revision Bill abandons the old line and substitutes particularistic exemptions of narrower scope. As we shall see in more detail, the cutting down of the traditional exemptions operates with special strictness and with serious effect on schools and libraries desiring to use the advanced technology represented by the computer.

And a publisher has replied:

> . . . for several months EDUCOM officials have declined invitations to meet with book industry representatives for discussions of common-interest problems, including uses of copyrighted materials. To the publishers' standing invitation, EDUCOM representatives have only replied that they are not yet ready to talk. Nevertheless, they have been ready to talk, and indeed they have talked a great deal, to other educators, to congressmen, and to many government officials in the Executive departments. How can one account for their uncooperative attitude toward publishers?
>
> We publishers can, of course, only guess at the answer to this

question. Those of us who have followed closely the development of the EDUCOM concept do guess that EDUCOM officials must clearly feel that it is much too early for them to be able to talk confidently about their prospective operating policies and practices. To my own way of thinking, their reticence at this time goes far to prove the House committee's contention that the techniques and economics of computerized educational systems are not yet so fully developed and known as to provide a firm basis on which to apply copyright principles.

The COSATI task group proposes interim solutions for the three problems. It would insure ready access for non-profit users by exempting input into non-profit systems from any copyright liability for an interim period; it would postpone the input-output problem by providing a moratorium on payment of copyright royalties at the input stages; and it would improve non-profit exemptions by carrying forward the current scholastic exemption. This position will find favor with the educators and the scientists; it probably will not find favor with the publishers who are already upset by the demands of federal organizations such as the Educational Research Information Center (which has asked permission to avoid copyright in such broad terms that it could distribute complete copies of books without limitation to anybody); nor do the publishers feel that organizations such as the National Geographic Society, RAND and SDC should be considered non-profit.

Another recommendation of the COSATI group is the establishment of a commission to study the problems of copyright laws as applied to computers and to information systems. S2216, filed by Senator McClellan in August, proposes to create the "National Commission on New Technological Uses of Copyrighted Works" which would consist of the Librarian of Congress, two Senators, two Congressmen, seven representatives of copyright owners, seven representatives of users and four representatives of the public. The Commission would file a preliminary report in one year and a final report in three years on "the reproduction and use of copyrighted works of authorship (1) in automatic systems capable of storing, processing, retrieving, and transferring information, and (2) by various

forms of machinery reproduction."

While the bill does not include COSATI's moratorium, the establishment of such a commission seems a logical means of giving each faction an opportunity to be heard and to submit its views on these questions without the necessity of confining their remarks to the provisions of a bill under consideration by Congress. It is unfortunate that this problem did not receive more attention in the preceding dozen years when the Copyright Office was attempting to hammer out a general revision. But it may be for the best that this aspect of copyright reform has not yet been resolved. The march of technology, particularly in the OCR and CRT areas, is such that a solution of the copyright-computer interface should be a mature enactment of Congress and not a last minute program patch.

—ROBERT P. BIGELOW

book briefs

(For further information on the books listed below, please write directly to the publishing company.)

Time-Sharing Data Processing Systems, James R. Ziegler. Prentice-Hall, Englewood Cliffs, N. J. 1967. 299 pages. $10.50.

A general introduction, definition, and discussion of the applications and techniques of time-sharing. Discussion of a hypothetical installation is included to show how hardware and software problems could be handled.

people

■ G. Hobart Reinier is the new director of the Chicago police data systems division. He replaces Richard Golden, who is now assistant to George Gorgol, head of the city's newly formed data processing control section.

■ Robert D. Beals, formerly a vice president of American Express Co., has been named president of Computicket Corp., a subsidiary of Computer Sciences Corp. He will direct the marketing and operation of the national computer-based system for the sale of sports and theater tickets.

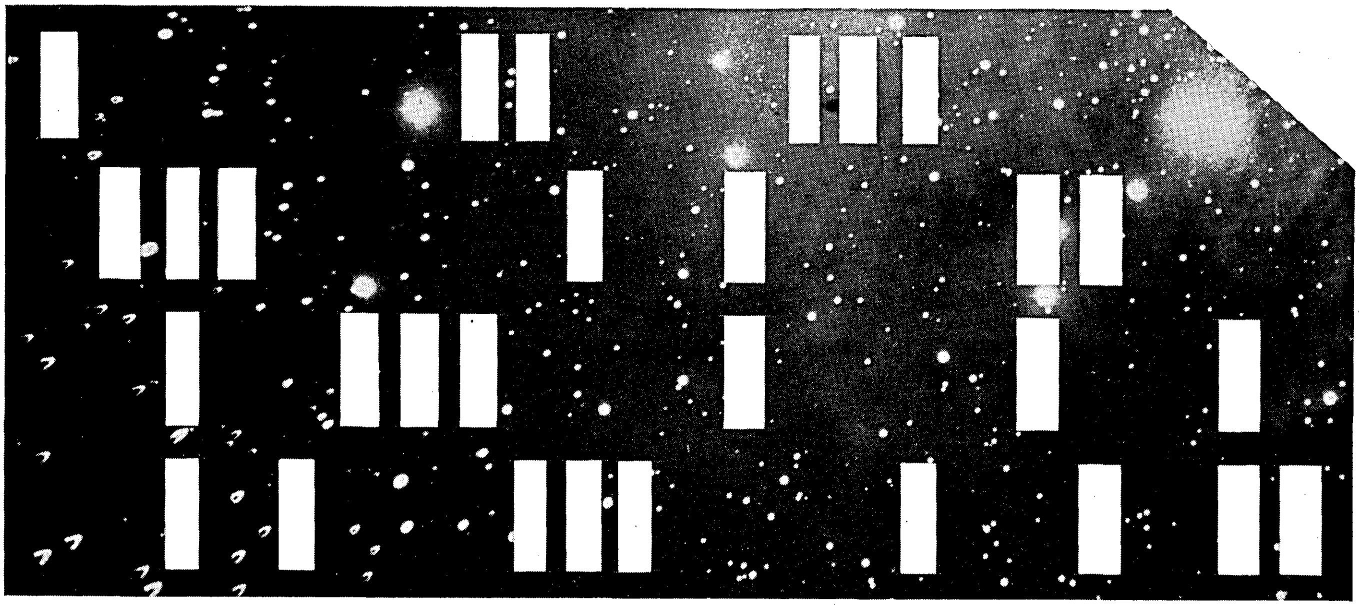
■ John C. Vose has been named head of the data processing section of Leeds & Northrup Co., Philadelphia. He has been with the company since 1957, most recently as section head of corporate systems design.

■ Leon Davidson will leave Union Carbide at the end of this month to become an independent consultant in White Plains, N.Y.

■ Louis B. Horwitz has been appointed vice president of the time-sharing division of Scientific Data Systems, Los Angeles. He will manage the marketing, development, and manufacture of the SDS 940 time-sharing computer system and the operation of the company's time-sharing service center. Horwitz had been with Beckman Instruments for ten years prior to joining SDS.

■ Michael G. Goudge is the newly appointed president of Computer Sciences Canada, Ltd., Ottawa, where he will direct the firm's marketing and administrative activities throughout the country, with emphasis on the expansion of eastern Canadian operations.

■ General Electric's Aerospace and Defense Group, New York, has announced the appointment of H. Brainard Fancher as manager of its advanced systems and requirements operation. He will have worldwide responsibilities for managing the expanding engineering efforts associated with designing and planning advanced defense electronics systems and will direct systems engineering and marketing of the company's Defense Electronics Div. products. William R. Smart succeeds Fancher as general manager of Bull-General Electric in Paris.



PLAY YOUR CARDS RIGHT.

JPL's SYSTEMS DIVISION NEEDS PROGRAMMERS

This Division is responsible for mission analysis design, planning and conducting flight operations in support of Lab projects, and for overall system analysis and design of the Deep Space Network.

This is the "lifeline" of space missions, from mission study to trajectory design and analysis, orbit determination, in-flight control, programming and data processing.

The Systems Division integrates the activities of JPL engineers in various disciplines into a team effort. It's nice work... and you can get it.

IF... COMPUTER PROGRAMMING RESEARCH is your long suit, then this is for you:

Be responsible for telemetry data recovery by computer techniques, utilizing data pattern recognition procedures which lead to adaptive programs for telemetry data decommutation and identification, data editing and suppression, and information retrieval. Included is investigation of special application compiler methods for generation of object decommutation and identification programs. Also involves program reliability studies in the areas of program testing, validation methods, rapid recovery or reinitialization in the event of program failure, and program operation in a degraded state.

AND IF... TRAJECTORY PROGRAMMING is a good deal for you, here's the score:

Be responsible for the development of computer programs for precision trajectory computation and analysis and interplanetary orbit determination. Should be skilled in the development of high precision planetary ephemerides and trajectory-oriented languages. Experience in celestial mechanics desirable.

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To: Mr. Wallace Peterson, Supervisor, Employment
JET PROPULSION LABORATORY
4800 Oak Grove Drive, Pasadena, Calif. 91103
Attention: Professional Staffing Dept. 579

I am presently employed as a programmer. I guess I could just "stand pat," but I'm interested in new ways of advancing my career.

To be specific, my present position is: (title and responsibilities) ______

My educational background is: (highest degree, major, year obtained, school, etc.) ______

I am experienced or interested in the following areas: ______

With my qualifications and experience, a bright future with JPL is in the cards for me. Please contact me to arrange an interview date.

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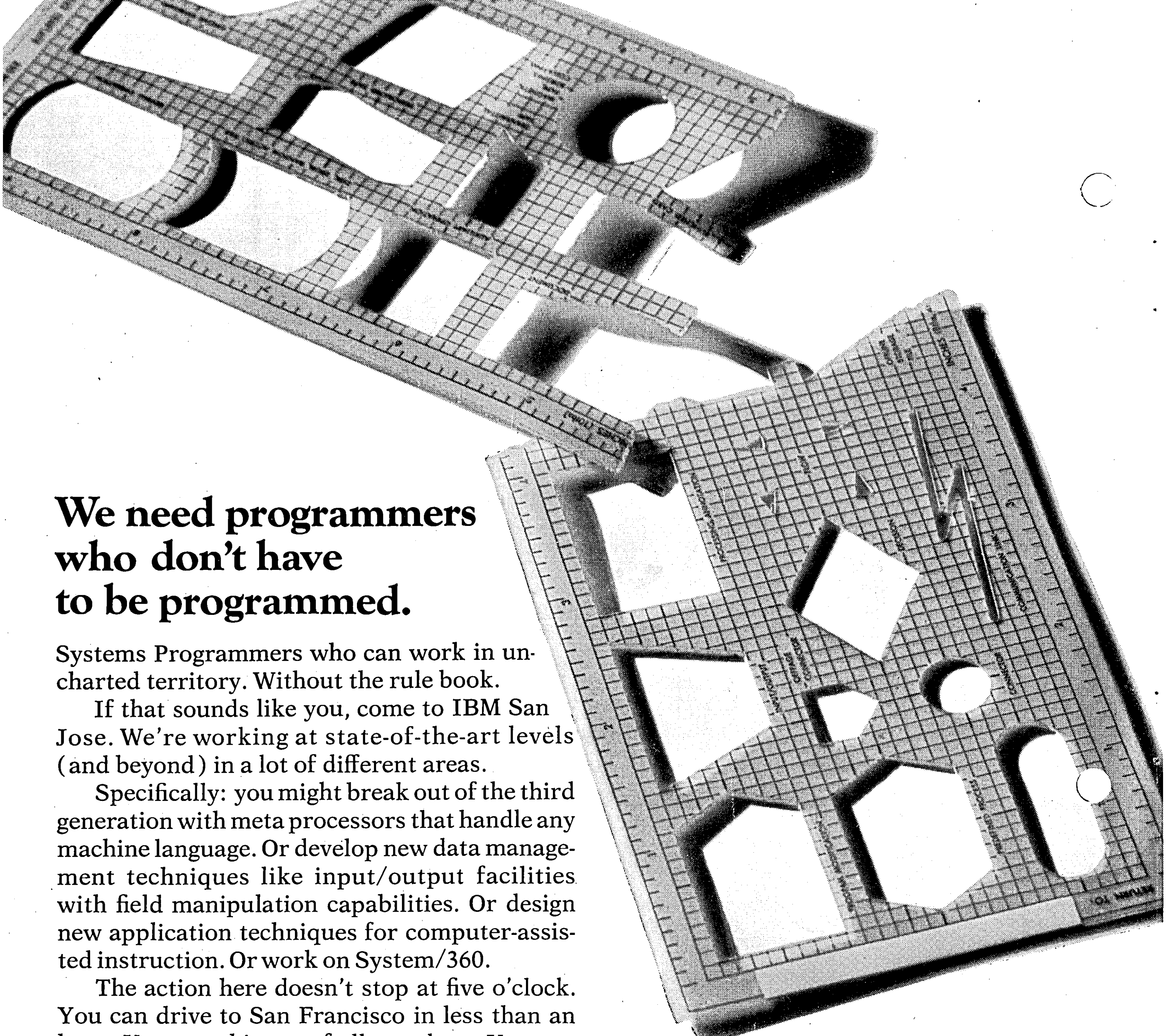

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The action here doesn't stop at five o'clock. You can drive to San Francisco in less than an hour. You can ski or surf all year long. You can get your Master's through our Tuition Refund Program.

There's a lot more to tell, so please write. To qualify you should have an imaginative approach to programming, a B.S., and at least one year of significant programming experience. Send a resume or outline of your experience to Engineering and Scientific Employment, IBM Corporation, Dept. UC9-L, Monterey and Cottle Roads, San Jose, California 95114. An Equal Opportunity Employer. IBM

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Four young men with detail experience in conversion of second generation commercial batch processing system to third generation; as well as experience in real time system development for 360/40 using PL/1, QTAM, OS, interested as a team in a challenging assignment. Reply box #11-1.

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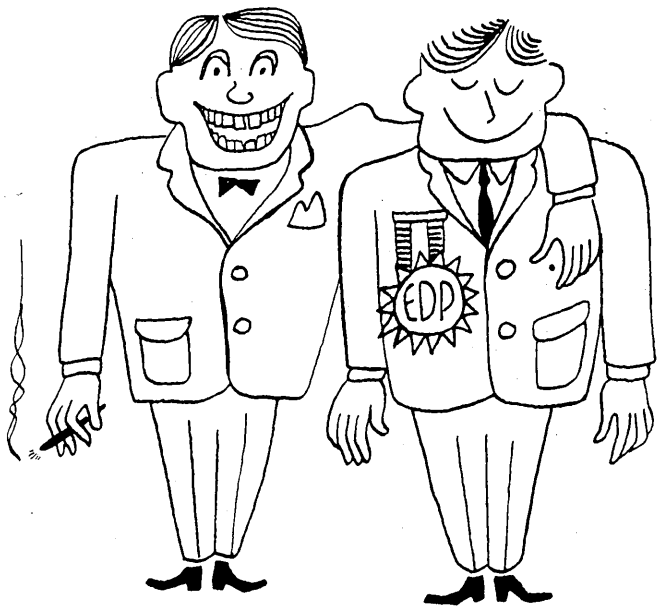
DIRECTOR OF DATA PROCESSING EDUCATIONAL PROGRAMS

Requires independent initiative and ingenuity to devise or improve educational methods and to meet program objectives. Broad knowledge of educational training methods and practices, familiarity with data processing methods, and several years of related experience is required. Speaking and writing ability is also desirable. Salary open, depending on experience and qualifications. Pleasant working conditions in new office near large city. Send resume and picture to Box #11-2.



IF YOU'RE EDP PEOPLE, YOU'RE A HERO TO US!

And right now, we need a lot of heroes! We are one of the nation's largest casualty insurance companies . . . and consequently we operate one of the nation's largest EDP centers in our Chicago home offices. Since the department is growing constantly in both capacity and importance, we are in urgent need of experienced EDP personnel.

First, we need a *Data Processing Planning Group Leader*. Reporting directly to the assistant manager, he will direct operations of a group of analysts who prepare computer programs. Starting salary to $15,000 depending upon background. An executive position offering really outstanding security plus a superior benefits program. Degree preferred but not essential. Approximately four years experience in EDP planning is a requirement.

Second, we are looking for a *Senior Analyst specializing in software*. This expert must know his equipment and be able to analyze it, provide and service software, determine and administer new systems training, as well as perform special research projects in the DP department. Starting salary to $13,000, depending upon experience; limited only by his own capabilities. Excellent potential for quick advancement with complete stability, including a fine broad spectrum of benefits.

Third, we have urgent demand for a *Senior Data Processing Analyst* in the DP Planning department. Prefer degree, but equivalent business experience qualifies. Will prepare original analyses and instructions for a DP system involving a series of stored program procedures. As a project leader, will coordinate and supervise analysts assigned to the project. Starting salary to $12,000. Must have a minimum of three years' EDP experience. From this excellent position, the right man will move up rapidly.

If you are looking for maximum job security, together with a unique benefits package, send your resume in complete confidence to:

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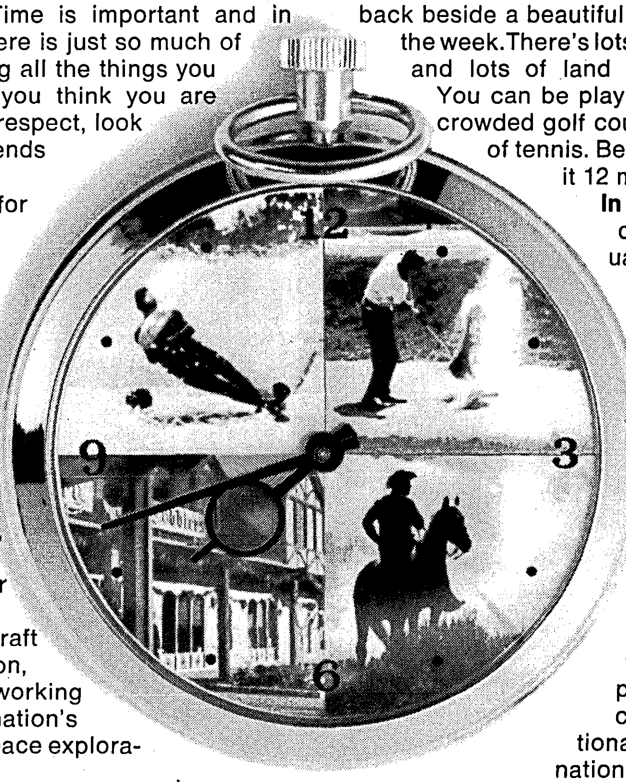
If you are an engineer, programmer or scientist who wants to make the most of his time, here's how.



Let's face it! Time is important and in each lifetime there is just so much of it to spend doing all the things you want to do. If you think you are cheated in this respect, look at the big dividends waiting for you when you work for Lockheed Electronics Company and live in a resort environment just 23 miles from Houston, Texas. Tempus Fugit!

In 5 minutes ...You can get from your home, town house, or apartment to our facilities at the Manned Spacecraft Center in Houston, where you'll be working on some of the nation's most exciting space exploration programs.

You can be sailing and water skiing in the beautiful waters of Lake Nassau.

You and the kids can catch shrimp or crabs from the dock virtually at your front door or if fishing is your cup of tea then why not try the bass fishing? Lunkers of five pounds and up are not uncommon.

Your children can attend some of the finest schools in the nation. In 1966, nearly 10% of the high school seniors in the local district were semi-finalists in the National Merit Scholarship tests, compared to a national average of six-tenths of one percent.

In 10 minutes . . . You can be dining at some of the finest restaurants in the country. Try the bay oysters, shrimp creole or crab gumbo and you'll see what we mean.

You and your family can be riding horseback beside a beautiful bay on any day of the week. There's lots of horses in Texas and lots of land to ride them on. You can be playing golf on an uncrowded golf course or enjoy a set of tennis. Best of all you can do it 12 months of the year.

In 30 minutes . . . You can be taking graduate or other educational courses at any one of the 11 near-by colleges and universities under Lockheed's generous tuition refund plan. You can attend year round sporting events at the famous Houston Astrodome, the theatre, the ballet, the symphony or 1001 other cultural and recreational activities that the nation's six largest city is famous for.

In sixty minutes...You can explore old forts that played a prominent part in our history or hunt antiques in small towns that haven't changed much since Texas was the Lone Star Republic.

You can enjoy some of the best duck, geese, quail, turkey and dove shooting in the country.

If it's time you moved your career ahead and if it's time that you and your family lived a lot, then consider a career today with Lockheed Electronics Company in Houston, Texas. It's a company you can bank on!

Rush your resume to Mr. Dean Pearson, Lockheed Electronics Company, 16811 El Camino Real, Houston, Texas. Or call him collect at (713) 488-0080.

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CIRCLE 323 ON READER CARD

say IBM will have to develop a new line of computers to cut this Gordian Knot.

Haddad, in his letter to X3, advocated moving "immediately forward...to obtain (separate) magnetic tape standards for the storing and processing of data." The implications are vague, but may bode trouble for standards folk and users alike.

ROUND & ROUND GOES UP & UP

The disc business continues its heady spiral. Memorex, which began "aggressive" marketing of its IBM 2311-compatible packs in mid-August, says it's got over 1000 units out in the field with nary an operation complaint from perhaps 2-300 customers. They hope to reach $2 million/month in shipments soon, will have a new plant in Santa Clara, Calif., running in January. Delivery is usually 30 days.

Meanwhile, Mac Panel, North Carolina tape and disc maker, is also making strides, has perhaps 300 units out. Their new disc plant, which will produce "several thousand" units a month, is scheduled to be running full blast in January also, hopefully will allow Mac to maintain 30-day delivery. Both companies will undoubtedly bring out 2314-compatible packs.

A NEW PEAK, MAYBE, BUT NO SPECS YET

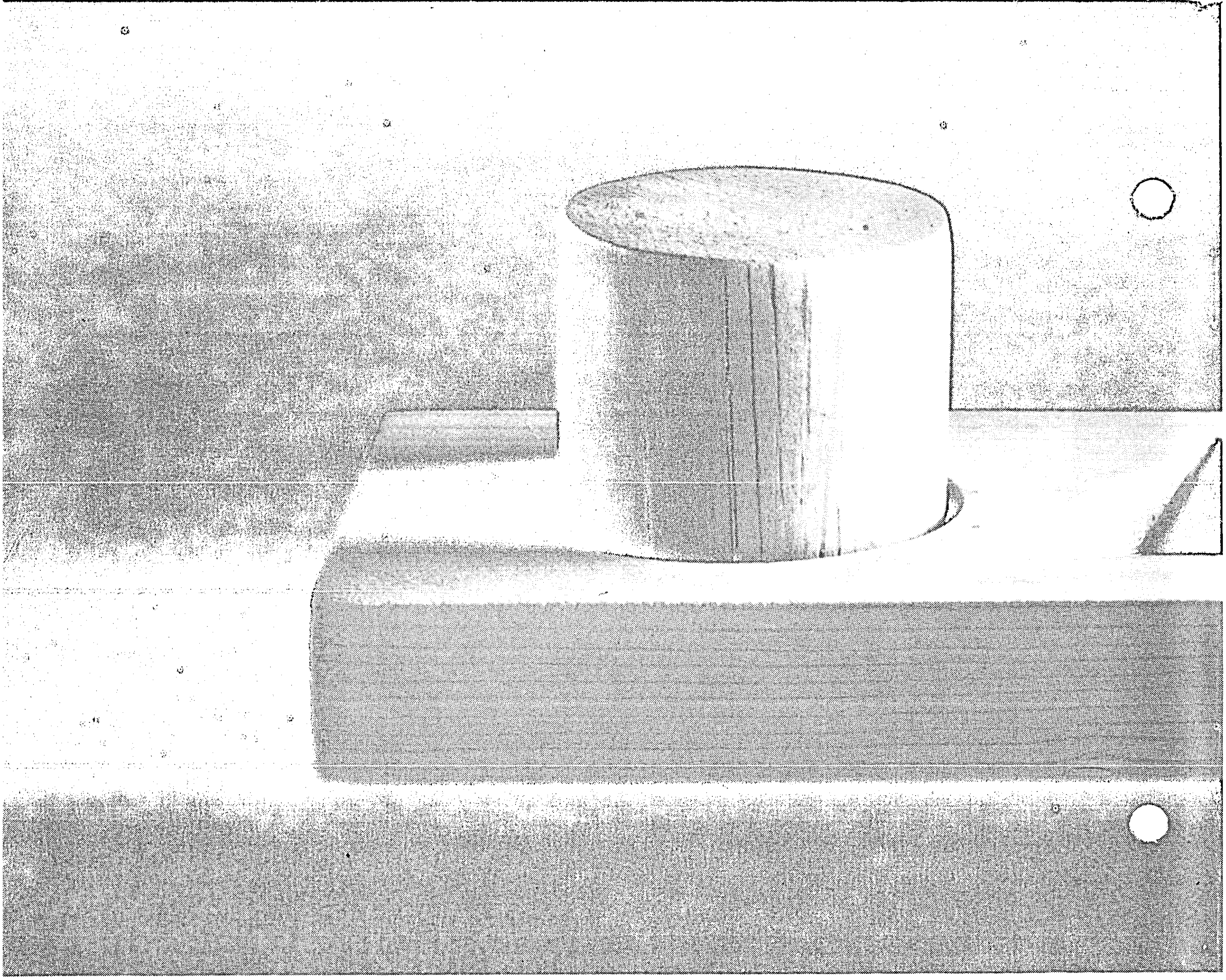
Dragonologists—China watchers—are still trying to assess the announcement out of Peking last month of China's newest digital computer. Built by the Institute of Computer Technology (claimed by one Dragonologist in a recent interview to be dormant) and described as "a large-size, transistorized, general-purpose, digital computer," it is hailed as "...a new peak scaled by the Chinese people in their efforts to achieve and surpass the advanced levels of world science and technology."

Preliminary analysis of the Peking announcement indicates the new machine is in test stage. Primary applications will undoubtedly stress defense: space flight, rocketry and nuclear science.

The designer, Tschien Sue-Sen, did work at MIT and Caltech, was a protege of Von Karman, is the author of a book, Engineering Cybernetics.

RUMORS AND RAW RANDOM DATA

One report says all those 360/30, /40 and /50's now installed are spending 80% of their time, on the average, in emulation mode. ... RCA is said to be coming out with a 120KC tape drive; meanwhile, users complain at lack of high-speed rewind on 30 and 60KC units. ... We hear CDC's extended Fortran will be delayed until Dec. or Jan. and Scope 3.1 will probably take until Dec. ... IBM is now offering the 360/50 hardware modification developed by Allen-Babcock Computing. Called the "T-S hardware assistance" feature, it rents for $1400/month...Little, Costello Co. has acquired contracts of most of the firms formerly represented by mfr.-rep firm Costello & Co., Fabri-Tek subsidiary. Pres. Will Little will operate out of L.A. with offices in Palo Alto & Dallas. ... ADAPSO will not ask the FCC to eliminate toll charges for data communications. ... Likeliest contenders for P-BAMS, forthcoming Corps of Engineers procurement calling for 48 installations, are GE and IBM, which now split the Corps' current computer inventory. IBM will probably propose an 1130-360/50 or /65 mix; GE is pushing the 225-400. GE may have the edge: the 225 can handle tape; the 1130 can't. ... Lee Johnson, former top Univac gov't marketeer, is now director of Computer Network Corp., D.C. t-s firm which plans to put the first of two B5500's on line this month.



Programmers, you have a real choice at RCA

RCA SERVICE COMPANY has a wide variety of openings in both business and scientific programming. Business assignments include management information systems, random access applications, and information retrieval systems among others. And, you'll have the opportunity to train on third generation computer systems. We believe that programmers should have frequent change of job assignments to keep them stimulated.

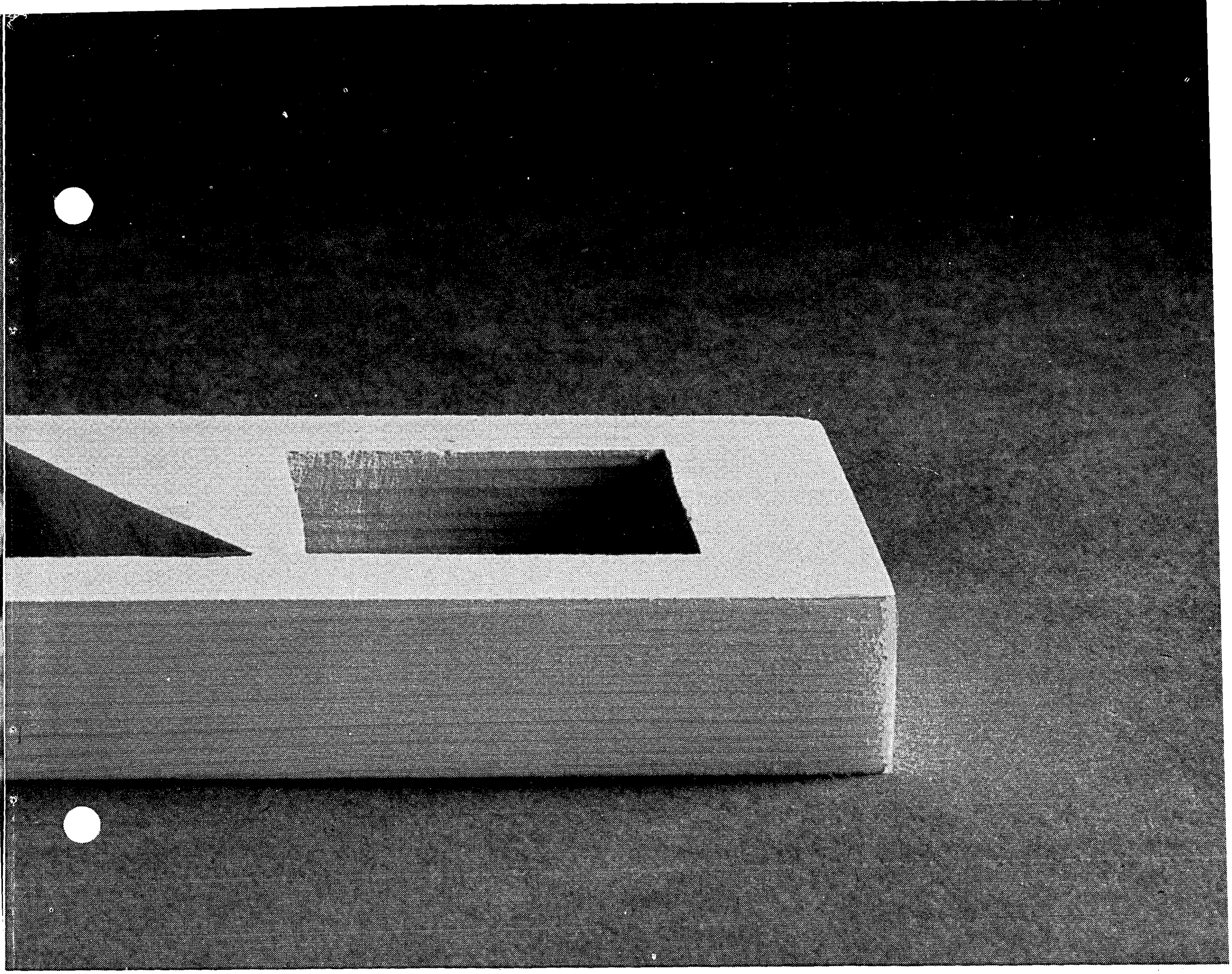
Openings in scientific programming vary widely. We ask for experience in either real-time or communications programming, or scientific applications on medium to large scale computers.

Openings are in locations throughout the United States and overseas assignments.

RCA GRAPHIC SYSTEMS DIVISION is busy adding the speed of electronics to typesetting.

It is all part of the information explosion. In the past ten years, book sales have tripled; newspaper and magazine circulation is up, and publishers are

The Most Trusted Name in Electronics



looking for new ways to keep information up to date.

At this division we've combined computers with new electronic typesetters that can set the text for an entire newspaper page in less than two minutes. Together, they do the complete job: store and recall manuscripts, size and lay out pages, and set the type.

These assignments require exceptional programmers who combine experience and competence with imagination.

It isn't easy, but it's fascinating; requiring bold creative effort in return for personal recognition and reward.

Openings are at all levels for those with a minimum of two years programming experience. Location is Princeton, New Jersey.

RCA ELECTRONIC DATA PROCESSING is in a period of unprecedented growth as a direct result of the success of the SPECTRA 70 product line, a true third generation computer system. Here EDP professionals can find unmatched opportunities for career development.

Systems Programming projects include time sharing, executive systems, random access, compilers, utility systems, information retrieval and other areas. Some of the career opportunities in business programming include special industry applications, management information systems and field systems support. Engineers, product planners, and program planners are needed for developmental projects for advanced equipment and systems.

These positions are in Cherry Hill, New Jersey. Openings also exist for equipment salesmen and systems representatives in sales offices throughout the United States.

To find out more about these major areas of programming at RCA, write to: Mr. T. Beckett, Radio Corporation of America, Bldg. 2-2, Camden, New Jersey 08102.

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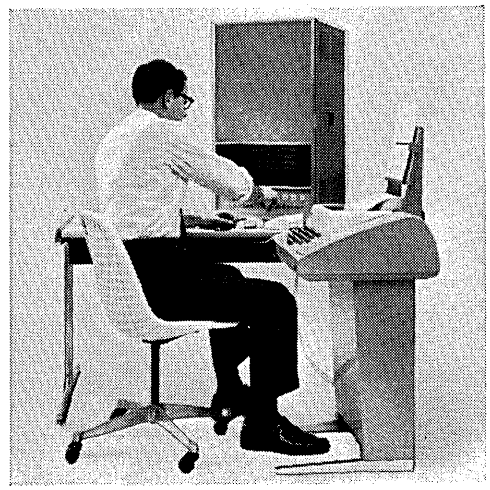

To the computer specialist who figures he'd show 'em how, if he ever got the chance:

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Now Hewlett-Packard's in the computer business... with a series of versatile, small, high-speed digital computers, so flexible, so well packaged that they're begging to go to work on the applications that only you can find... and sell. We've got the products. We invite you to apply your computer engineering expertise either to advancing our line of computers and software or to marketing them. The choice is yours.

Hewlett-Packard computers have been developed to give the working engineer a direct problem-solving interface with the electronic instruments manufactured by HP, letting him assemble his own computer-controlled instrumentation systems. They're designed to be equally effective as free-standing general-purpose problem solvers. And there's a wealth of experience behind these computers—developed and manufactured by a dynamic company that's spent 25 successful years in the measurement and data-handling business.

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We think our computer is going to revolutionize the measurement and data-handling business. Sound interesting? Write Ray L. Wilbur, 1501 Page Mill Road, Palo Alto, California 94304. An equal opportunity employer.

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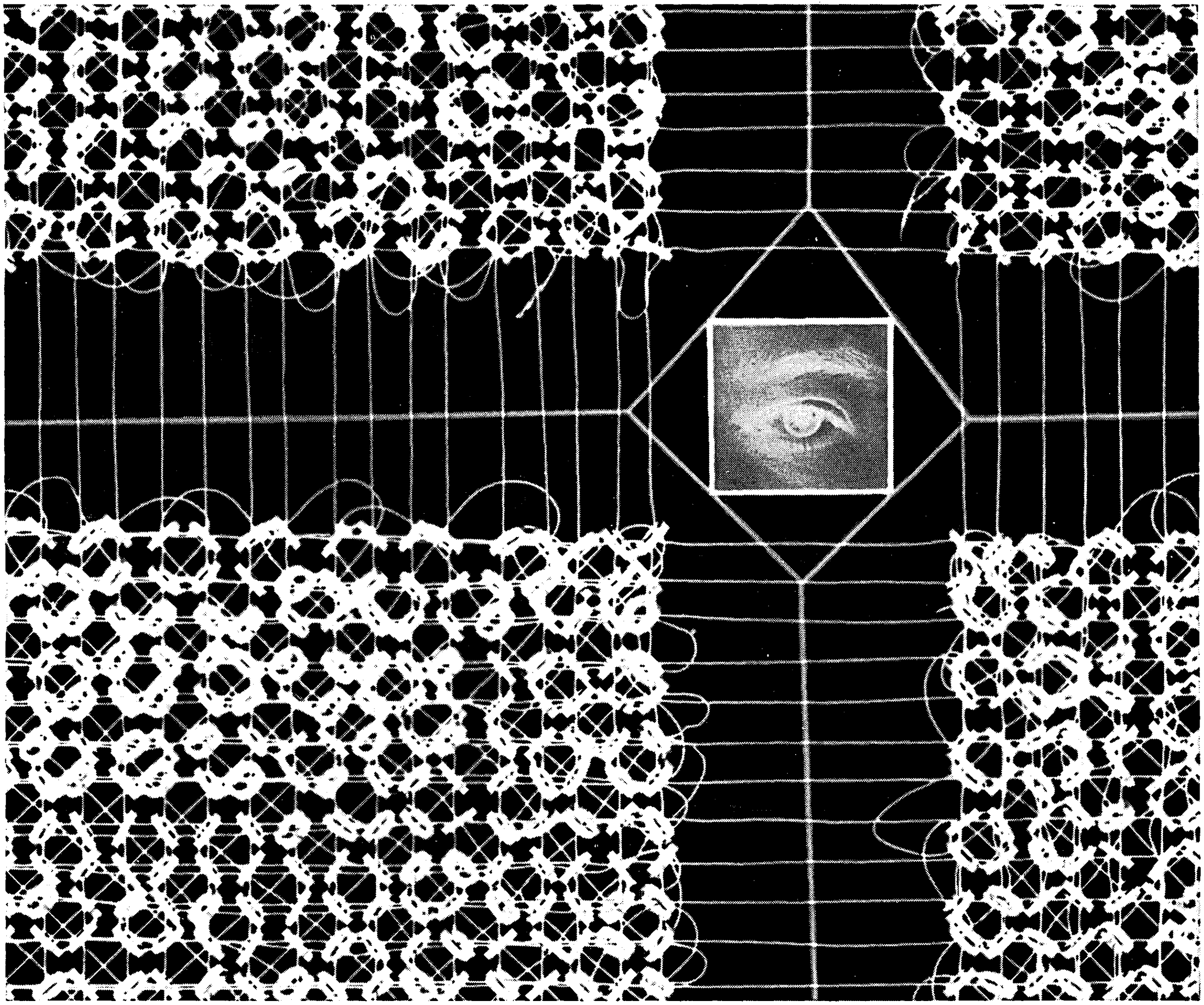

Lockheed information systems hold the answer to a challenging career

At Lockheed, the young and vital field of Information has created the industry's broadest range of outstanding opportunities. Scientific computing, satellite tracking, real-time data processing, hospital, educational, business, and governmental administrative information systems offer a unique opportunity for a varied and fulfilling career.

To accomplish its highly diversified assignments Lockheed maintains a centralized data processing facility —one of the largest computer centers in the country.

Scientific computing at Lockheed plays many important and varied roles in Flight Mechanics, Trajectories, Thermodynamics, Electronics, Propulsion, Structures, Flight Technology, Hydrodynamics, Navigation Guidance and Control, and other vital fields.

In other areas of activity, Lockheed has developed a revolutionary process for handling patients' records to free doctors and nurses to perform their primary duties. Lockheed also leads the way in state-wide information systems such as the one planned for the State of Alaska.

In addition, the planning and control of all U.S. Air Force orbiting missions is conducted at the Satellite Test Center, which also maintains one of the world's largest and most powerful real-time computing facilities with assignments ranging from simple ballistic missile shots to highly complex, classified satellite missions.

Engineers and scientists are invited to write Professional Placement Manager, Lockheed Missiles & Space Company, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

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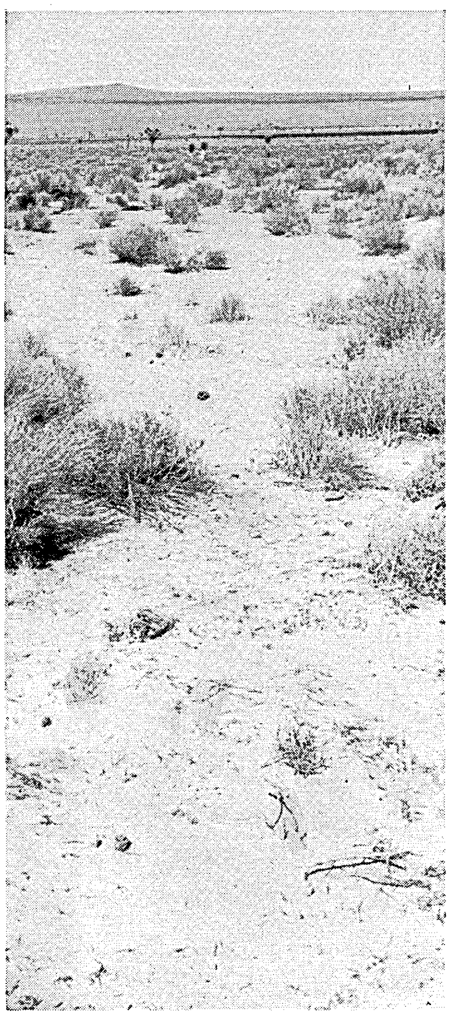

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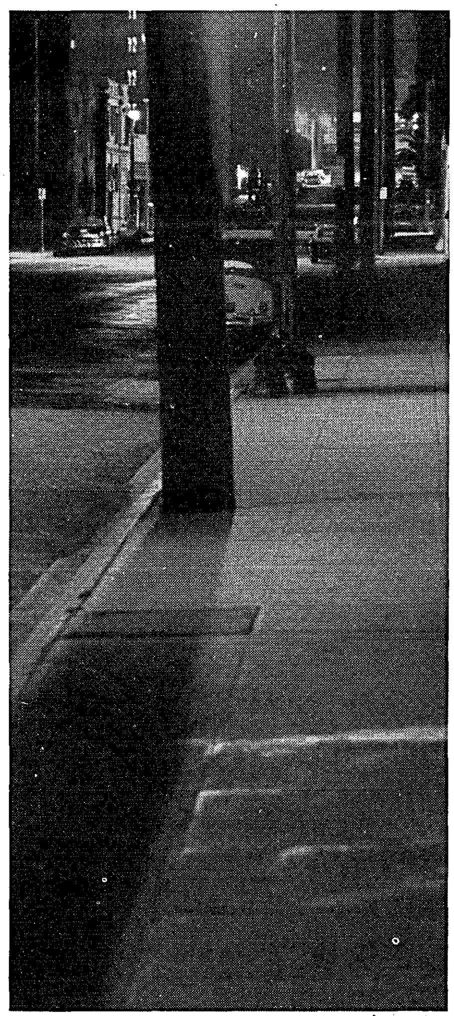

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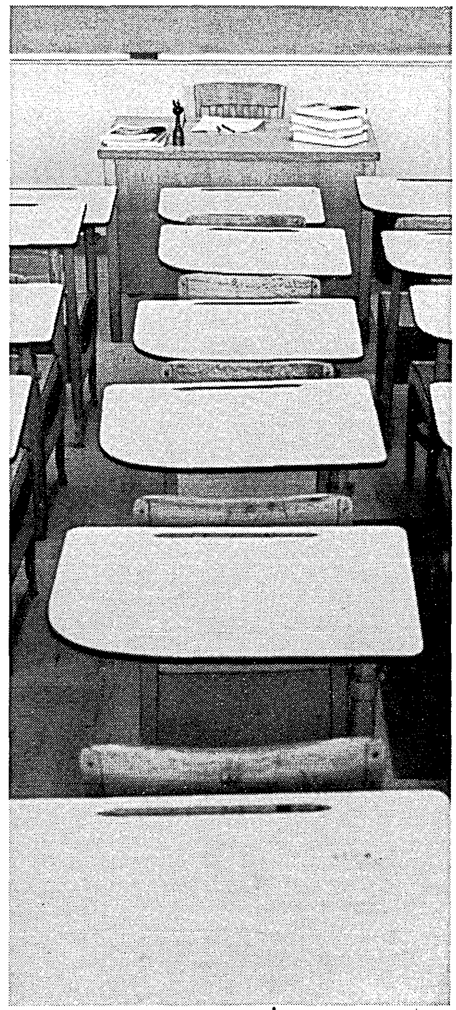

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You'll do well at Autonetics. More important, you'll do good.

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CIRCLE 337 ON READER CARD

the forum

The Forum is offered for readers who want to express their opinion on any aspect of information processing. Your contributions are invited.

THE REAL EFFECTS OF STANDARDIZATION

There is currently out for letter ballot a proposed American COBOL Standard. In all probability this means that shortly there will be a COBOL Standard. Because U. S. standardization is a voluntary activity, at first glance it may appear that the passage of any standard has little effect at the grass roots level. My purpose in this discussion is to dispel such a belief as the height of naïveté and belonging, at best, to those shallow practitioners of the black art of electronic punched card accounting.

Standardization is a necessary pursuit within the information processing field. It superimposes a certain discipline, no matter how slight, on a normally uncontrollable activity, e.g., the development of a high level programming language. It fosters greater understanding of the subject, campaigns for its widespread acceptance and establishes the starting point for serious and continuing refinement of the result. It suffers from two communicable diseases—lethargy among its proponents and indifference among its audiences.

The technical autonomy with which almost all computer installations operate is fantastic. Installation personnel are motivated to ever-increasing goals of technical accomplishment by their managements and satisfied by plaudits of technical achievement by their vendors. Their world is finite and meaningful; they are secure in the belief that they are on the right track. But we must accept change as progress and recognize that second generation pursuits have been overtaken by third generation accomplishments. Ignorance of, or indifference to, technical standardization activities is yet another manifestation of this same type of complacency.

It is evident that my major point is that standardization does in fact affect every single installation regardless of its size, shape and machine allegiance. Perhaps you may consider the critical path of effect to be too circuitous, too indirect and too dissipating because of its length. Let us trace a probable route for the COBOL standard.

Step 1—Passed as an American Standard.

Step 2—Accepted by the government as a Federal Standard.

Step 3—Implemented by computer manufacturers interested in federal business (all).

Step 4—Distributed as product line software by all manufacturers.

At this point each user's installation is forced to determine the differences between his current COBOL and the new standard in order to evaluate the benefits of the change. I submit that such an evaluation performed, in essence, would have a significant after-the-fact effect on each computer installation.

If the major premise is that standardization does indeed cause significant action to be taken, then the minor premise is that each must be aware of and support standardization activities. Perhaps this is a perfect example of not being able to afford to do so and not being able to afford *not* to do so. People have said to me, "We plan to use COBOL for an application not normally associated with its use. Do you think this attempt is ridiculous?" What is ridiculous is that these same people make no attempt to influence the scope of the language through participation in some aspect of COBOL development or standardization. If those functions required by new applications are not added to the language, the jobs of innovative, conscientious programmers and analysts will continue to grow with unnecessary complexity. And the excuse often presented by these same myopic interrogators that nothing can get accomplished by a committee must be disallowed—at least until they try and fail.

Others have stated how difficult it is to get funding for their participation. But how much does it cost to read documents and to communicate by mail? How expensive is it to establish a review procedure through users' groups and even to have active participation by a user group representative underwritten by the computer manufacturer? For example, what computer manufacturer would really fail to sponsor a genuine user group activity organized for the specific purpose of insuring adequate consideration of his product line within a national standardization activity? They send their own people, so why not send their users—who might even be more effective? And how does one measure the cost of a few days' effort each month against the benefits of a standard precisely responsive to an installation's needs?

No one knows how many people squeeze their sustenance from the genteel art of programming. We do know, however, how few participate in drafting new developments and formulating industry standards. Yet which of us are able to conduct our technical lives without using a product or subject of some standardization activity? In a recent issue of *Communications of the ACM* a tally was offered of the extent of ACM participation in USA Standards Institute's committees. Discounting the 16 members who participate only at the X3 level (administrative), the total ACM membership participation in USASI is 86. Considering the ACM membership at approximately 16,000, the .005% participation seems to be severely disproportionate. (USASI puts no size limit on either talent or committees.) No doubt other technical organizations are similarly represented. Nevertheless, each proposal which becomes a USASI Standard represents every member of the technical community. Less than 200 years ago we fought a war because of taxation without representation. Standards passed without your awareness present the same insufferable consequence. We need another revolution—this time against lethargy, against indifference and against complacency. Join the fight and help stamp out academic exercises. A bas ennui!

—HOWARD BROMBERG

MAC tape and the 140% Hero.

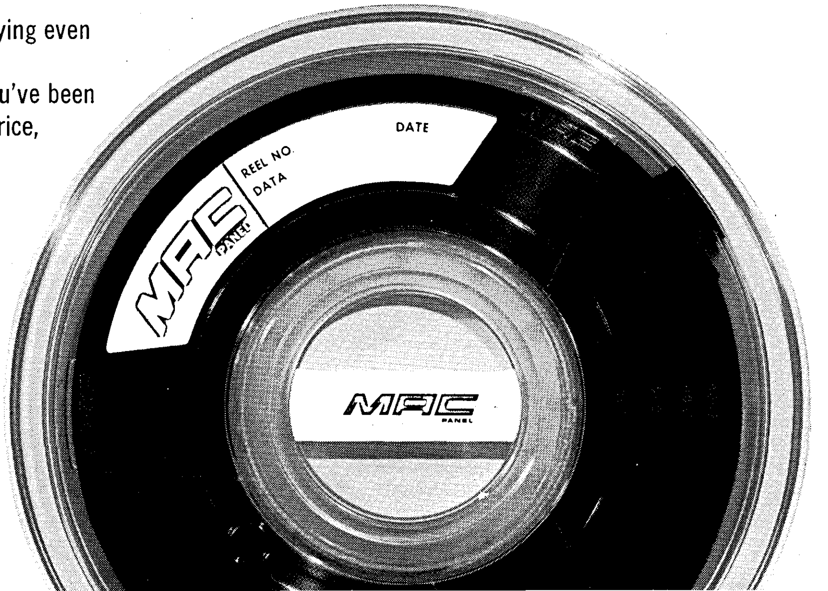
Are you spending 140% of what you have to spend to buy premium quality, heavy duty, error free tape? Maybe you're about to become a 140% Hero. Read on.

There is no finer tape on the market than MAC Tape. Yet you can pay as much as 140% of the MAC price—and not buy better. How come? We don't know.

MAC Tape is neither easy nor inexpensive to make. We use only the finest raw materials—and they cost more. We grind our coating formulation longer than anybody—and that costs more. We put it on with an expensive rotogravure process, rather than less exact methods—and that costs more. We even wash the finished tape in washers of our own design, to remove the last, smallest surface impurities—and that costs more. Why do we do these things the hard way? Because it's the only way we know to turn out reel after reel of tape that's up to your standards—and ours.

There are cheaper ways to make magnetic tape, but not better ones. We figured out how much it costs to do it our way, added a small profit, and that's our price.

We're not trying to kid you with unsupported superlative claims, nor with contrived, mnemonic names. If you have been paying even 101% of the MAC price, you can save money without sacrificing quality. If you've been paying as much as 140% of the MAC price, think of what you can save. Either way, you can be a Hero; the size of your Hero button won't change, the size of your savings will. Write MAC Panel Company, Box 5027, High Point, N. C. 27262 and join the Happy Heroes —a club for clear thinking savers.



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We've got it made—literally. All the combinations you see here and hundreds of variations on our FX-12 and FX-14 core memory systems have been in mass production. They're available on dependable delivery schedules. We can ship tomorrow morning if you like.

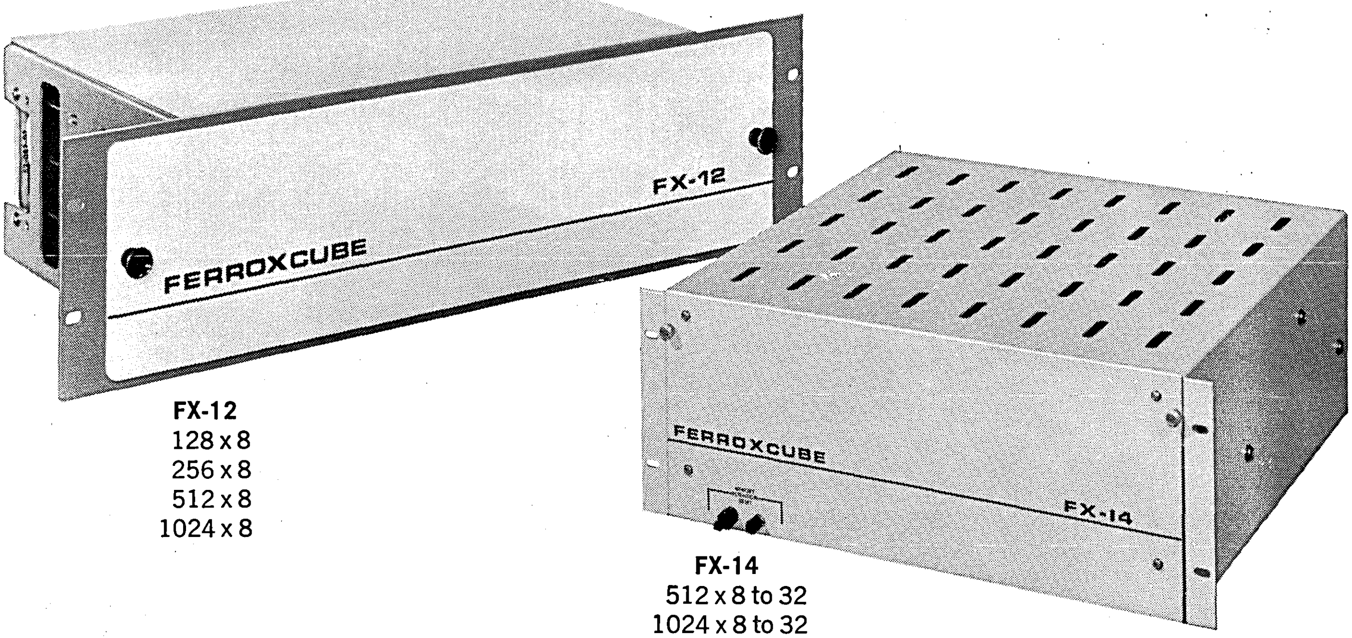
You've got it made because these are core memories with all the advantages of core storage over electromechanical techniques: speed, random access, non-dissipative, non-volatile... to name a few. And, because they're mass produced, reliability is higher than core storage systems built on a onesy-twosy basis.

You've even got it made on cost. Remember, all the engineering is done. You specify; we produce and ship. That alone narrows the cost between Ferroxcube core memories and less versatile types. Example: you can buy a Ferroxcube 1024 x 8 FX-12 system complete with stack electronics and timing for $1,990.

But that's not all. With so many models to choose from, interfacing is flexible: buy what you need to interface with what you have and save some more money.

For details on all this performance and economy, write for Bulletin MS670, "Ferroxcube Catalog-Standard Coincident-Current Memory Systems." It describes 513 ready-to-go models—with prices. Not so incidentally, we're the only manufacturer to publish a price list on memory systems. Reason: production experience; we know our costs in advance. You will too.

Ferroxcube
Systems Division Englewood, Colorado



FX-12
128 x 8
256 x 8
512 x 8
1024 x 8

FX-14
512 x 8 to 32
1024 x 8 to 32
2048 x 8 to 32
4096 x 8 to 32
8192 x 8 to 16
16,384 x 4 to 8

See us at the FJCC—Anaheim, Booth No. 104

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CIRCLE 3 ON READER CARD