DATAMATION 63

December

random access

C Wheaton Smith,
Appl Dev Programs Mgr
I B M Corp
3424 Wilshire Blvd
Los Angeles 5 Calif

BF
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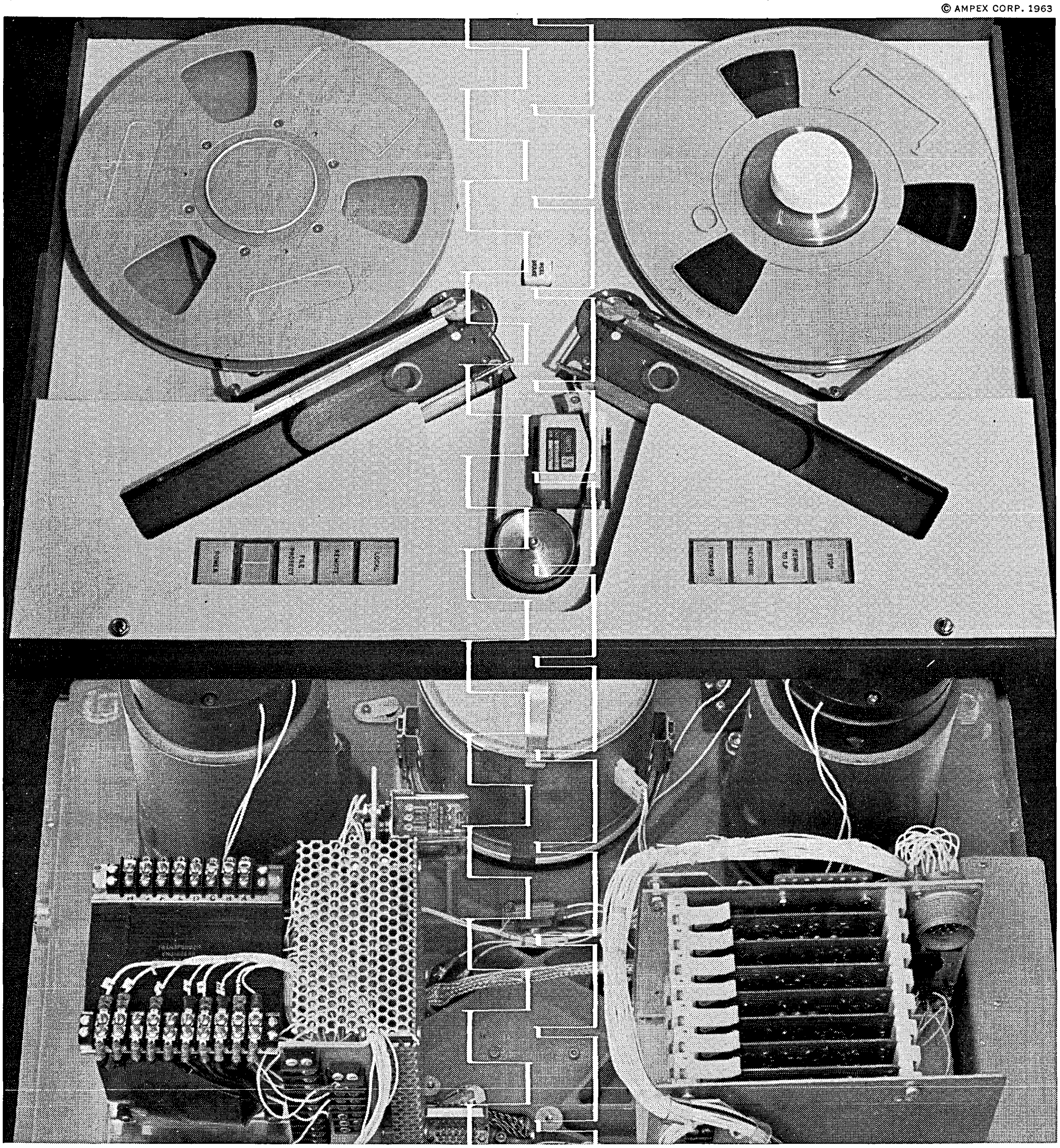
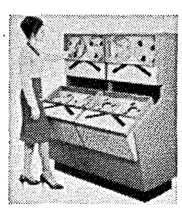


Who has a low-cost tape transport that's all new—top to bottom? AMPEX

Here's a transport that's far in advance of anything in its class—the all new Ampex TM-7. It's a low-cost tape transport designed for less maintenance, less tape wear. And its most advanced feature is the revolutionary single capstan drive system. The new drive system has three major moving parts—a capstan and two reels. As a result, most of the components found in this type transport have been eliminated. Maintenance is far less. And tape wear? Virtually none. The two vacuum chambers keep a uniform tape tension on the capstan. There is nothing to smear the tape; nothing to stretch it. Tapes last and last. Even the old soft-binder tapes can be used with very little wear. The new Ampex TM-7 is completely compatible with IBM tape formats and with other Ampex equipment. It has a packing density of 200 and 556 bpi. A tape speed of 36 ips. A start and stop time of 10 ms with tape distance held within ±10%. Also, Ampex designed a new series of data and control electronics for the TM-7 to provide low-cost tape memory systems. The TM-7211 is a complete memory system enclosed in a 19 inch rack cabinet. And the TM-7212 is a complete shared system with four TM-7 transports in one cabinet. Write to the only company providing recorders, tape and core memory devices for every application: Ampex Corporation, Redwood City, California. Worldwide sales and service.



AMPEX

CIRCLE 1 ON READER CARD

DDP- 24 digital computer introduced March, 1963


$87,000

DDP expanded to 24 bits
Faster arithmetic unit
Comprehensive software

COMPUTER CONTROL COMPANY, INC.

~~17~~ 29 Orders to date* including . . .

Three DDP-24 Computers To EAI For Hydac — 2400

FRAMINGHAM, MASSACHUSETTS — Electronic Associates, Incorporated, Long Branch, New Jersey, has ordered three DDP-24 general purpose digital computers from Computer Control Company, Inc. The three computers were ordered as part of a continuing EAI/3C contract by which 3C supplies the digital portion of EAI's new HYDAC-2400 — the first standard, commercially available analog/digital computer system. The design of the HYDAC-2400 provides for the system to function as a totally integrated unit and also as separate analog and digital computers.

3C Delivers DDP-24 Computer For Gemini Trainer

FRAMINGHAM, MASSACHUSETTS — Computer Control Company, Inc., delivered the first of two DDP-24 Digital Data Processors ordered by McDonnell Aircraft Corporation for use in the Gemini Flight Trainer System.

The DDP-24 will be the basic computer in the system and will provide real-time simulation of the on-board guidance computer through all phases of launch, boost and insertion, orbit, rendezvous and docking, retro and re-entry, and letdown. The com-

NASA Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A DDP-24 Digital Data Processor has been ordered from Computer Control Company, Inc., by NASA for the Goddard Space Flight Center.

The high speed, general purpose computer will be used as a simulator for a world-wide tracking network for manned spacecraft. Data will be utilized in determining vehicle orbits, prediction of landing sites, etc. The DDP-24 is supplied with a compre-

Litton Orders 3C DDP-24 Computer

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Litton Industries for their Communication Sciences Laboratory in Waltham, Massachusetts.

Litton will use the high speed DDP-24 for open-shop scientific and engineering computation. Included as part of the standard DDP-24 contract agreement is a comprehensive software package including FORTRAN II and 3C engineering support services.

Air Force To Get 3C DDP-24

FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by the Air Force Systems command, Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

The Air Force will use the high speed DDP-24 for on-line data format conversion and also off-line for general purpose computation. Included with the DDP-24 is a comprehensive software package

3C DDP-24 Slated For Haskins Lab

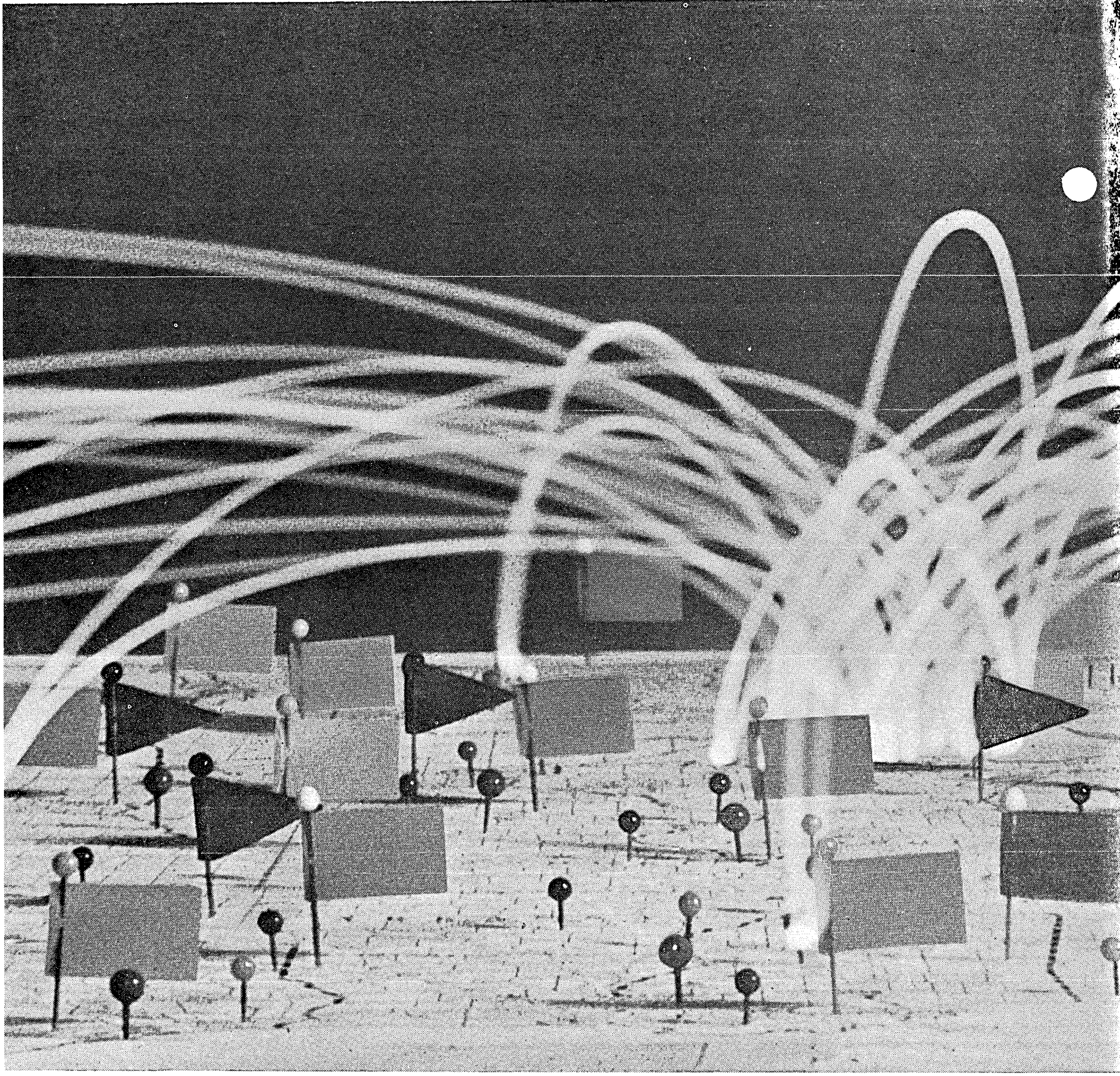
FRAMINGHAM, MASSACHUSETTS — A Computer Control Company DDP-24 general purpose computer has been ordered by Haskins Laboratories, Inc., New York, N. Y. Haskins will use the very high speed, 24-bit word DDP-24 for applications in speech simulation

COMPUTER CONTROL COMPANY, INC.

OLD CONNECTICUT PATH, FRAMINGHAM, MASS • 2217 PURDUE AVE., LOS ANGELES 64, CALIF

* ~~OCTOBER 30, 1963~~ NOV. 19, 1963

CIRCLE 4 ON READER CARD



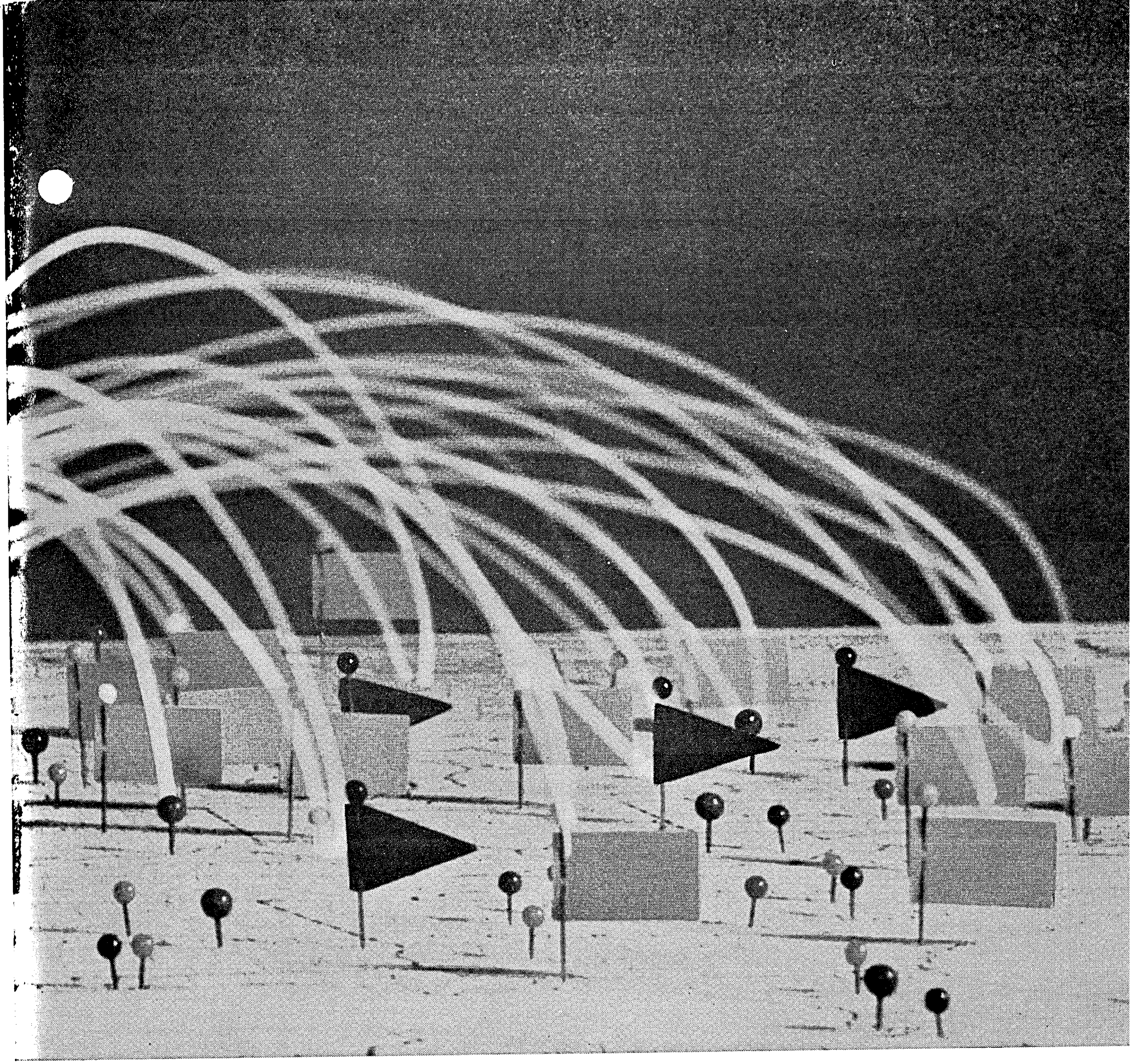
Hot-line for business data – the new IBM 1050 Data

The new IBM 1050 communicates directly with a central computer or with other 1050s over regular communications lines.

It takes punched cards, keyed input, paper tape or edge punched documents...converts to code...transmits 14.8 characters per second. A control unit regulates use of input and output components, provides 2-character address checking, parity checking, longitudinal record checking. The printer used with the 1050 produces a 13-inch line of IBM Selectric® Typewriter quality.

A transmission control unit at the computer sequentially scans up to 112 communications lines, processes high-priority messages immediately.

Write or call any IBM branch office for complete information.

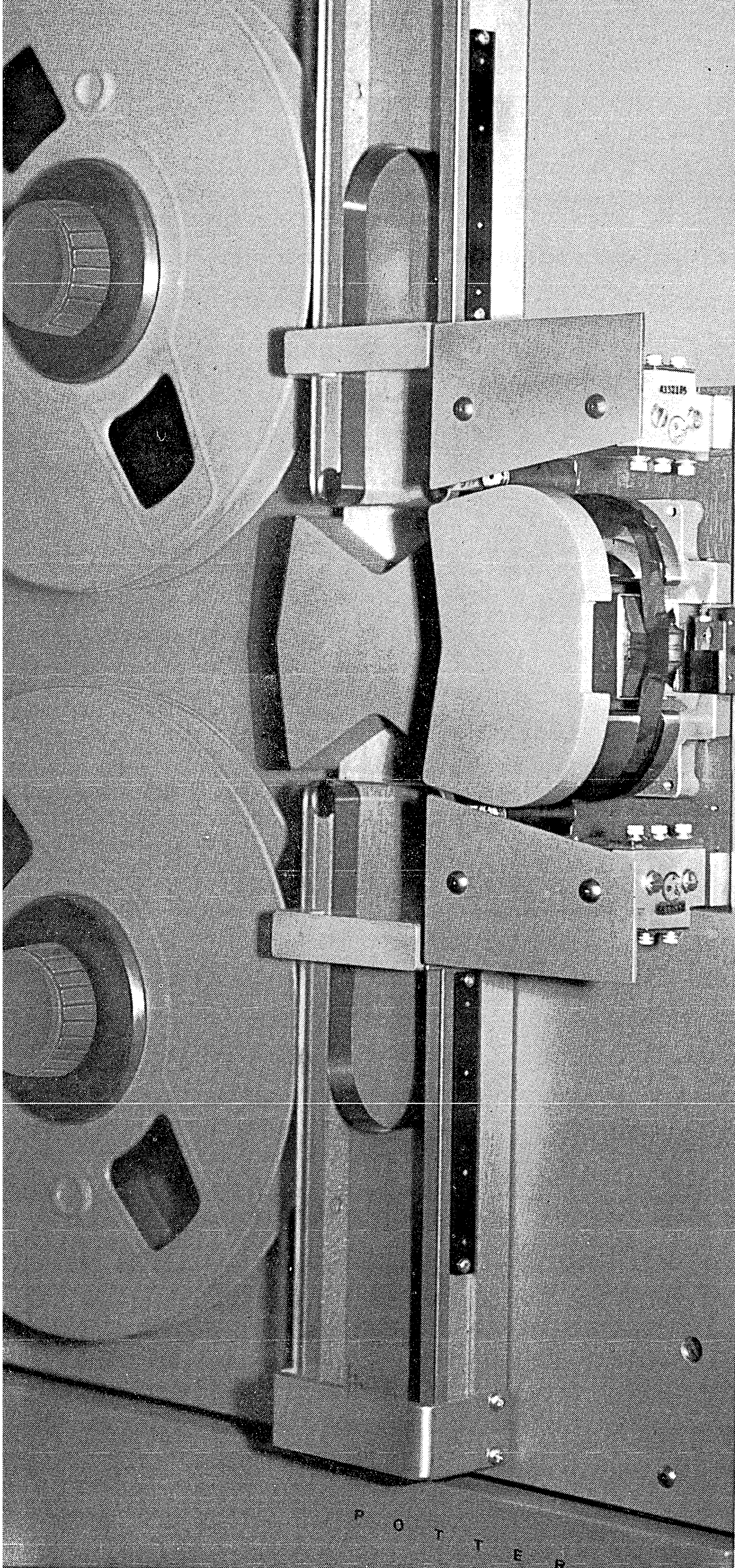


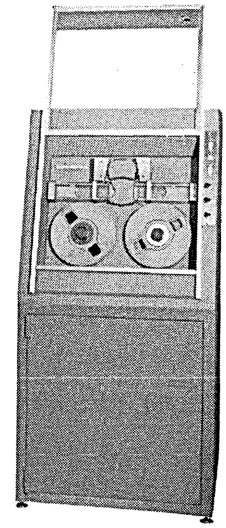
Communications System.

Each 1050 installation may include from one to six input/output devices, including printers, card reader, card punch, paper tape units, keyboard. These easily connected units may be used for local data handling as well as long-distance communication.

IBM®
DATA PROCESSING

CIRCLE 5 ON READER CARD





A very big transport in a 2-foot package

This is Potter's MT-24, a new vacuum column, digital magnetic tape transport which is already proving big in the field. Packed into its mere 24″ height (or length if you prefer to mount it sideways) is all the dependability and performance of tape drives costing over twice as much. Here are the facts:

PERFORMANCE — Read/write tape speeds from 3 to 36 ips, data transfer to 28.8 kc, 200 commands per second. (50 ips and 40 kc performance available in the MT-36 companion unit at very little increase in price!)

RELIABILITY — Use of thoroughly field tested components in combination with new vacuum column construction has resulted in improved transport dependability. Reliability warranted 1 in 10^8 bits read.

COMPATIBILITY — The MT-24 is compatible with IBM's 7330, with packing densities of 200, 556, and 800 bpi. One inch tape and other computer formats are readily accommodated.

ECONOMY — MT-24 (and MT-36) costs less per effective bit transferred than any other transport on the market . . . and with greater operating dependability and data transfer reliability than tape drives costing more than twice as much.

Potter is shipping MT-24's NOW. Delivery within 4 weeks. Want details? Write — Sales Manager.

POTTER
INSTRUMENT CO., INC.
151 Sunnyside Boulevard, Plainview, New York

T.M.

CIRCLE 6 ON READER CARD

DATAMATION

the automatic handling of information

volume 9, number 12

Feature Articles

Departments

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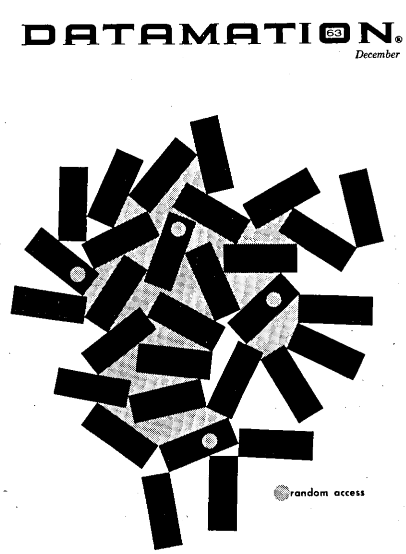

Cover

This month's cover suggests the immediacy of access to data wherever they may be in a random access file. These storage media, increasing in acceptance and sophistication of system utilization, are examined from the hardware, software, and applications standpoints. Cover design is by Art Director Cleve Boutell.

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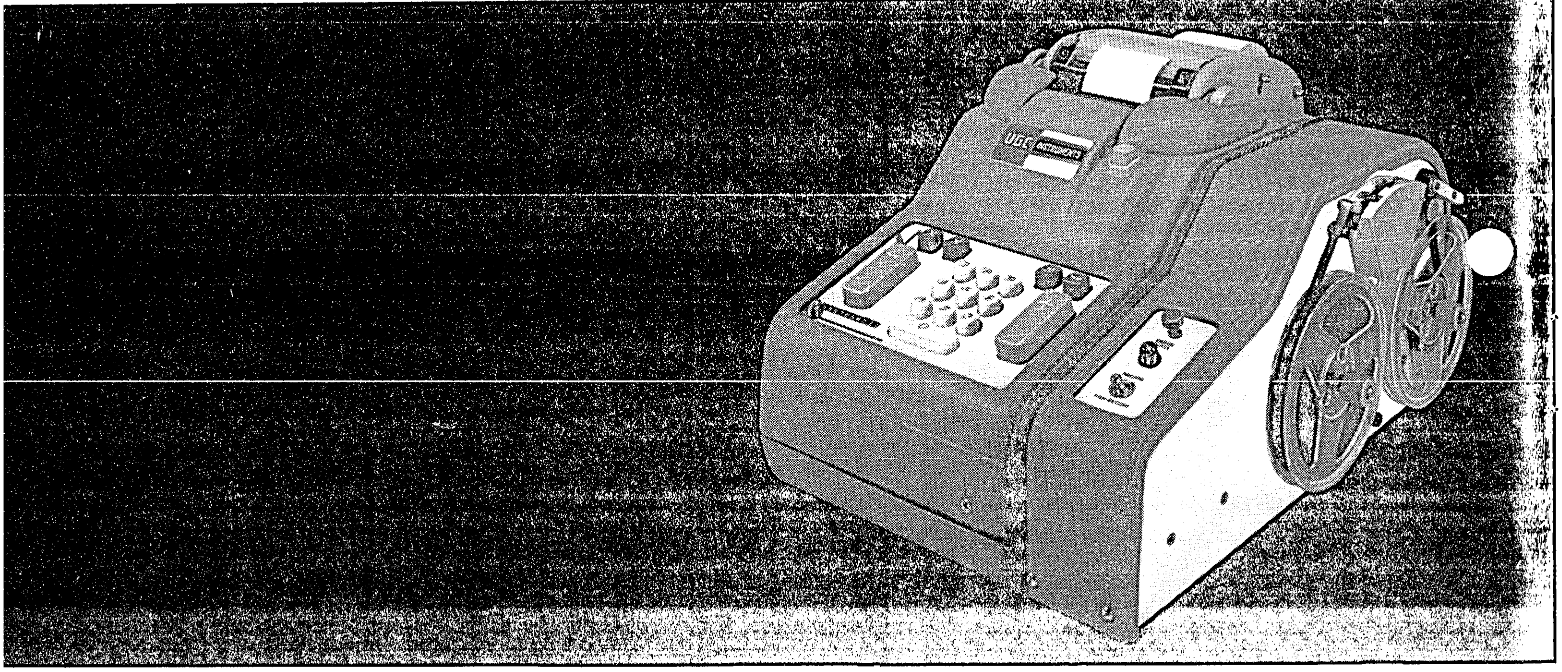
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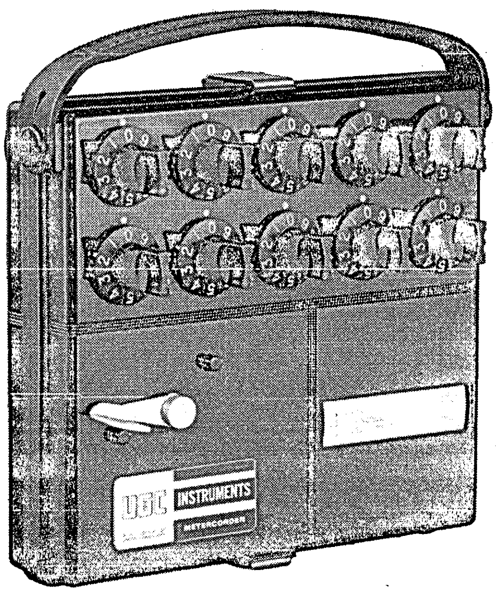
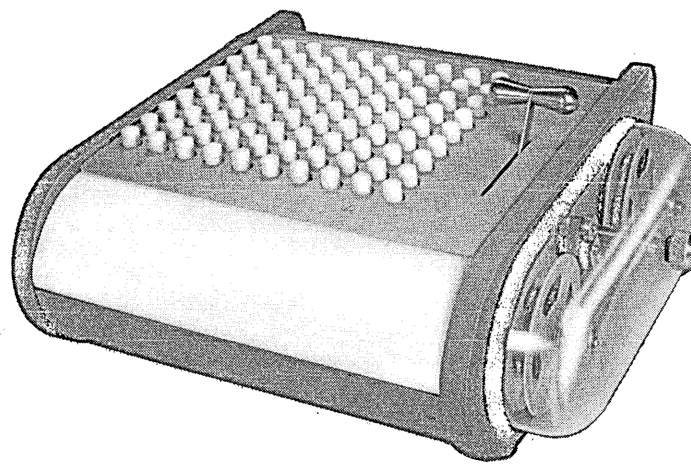
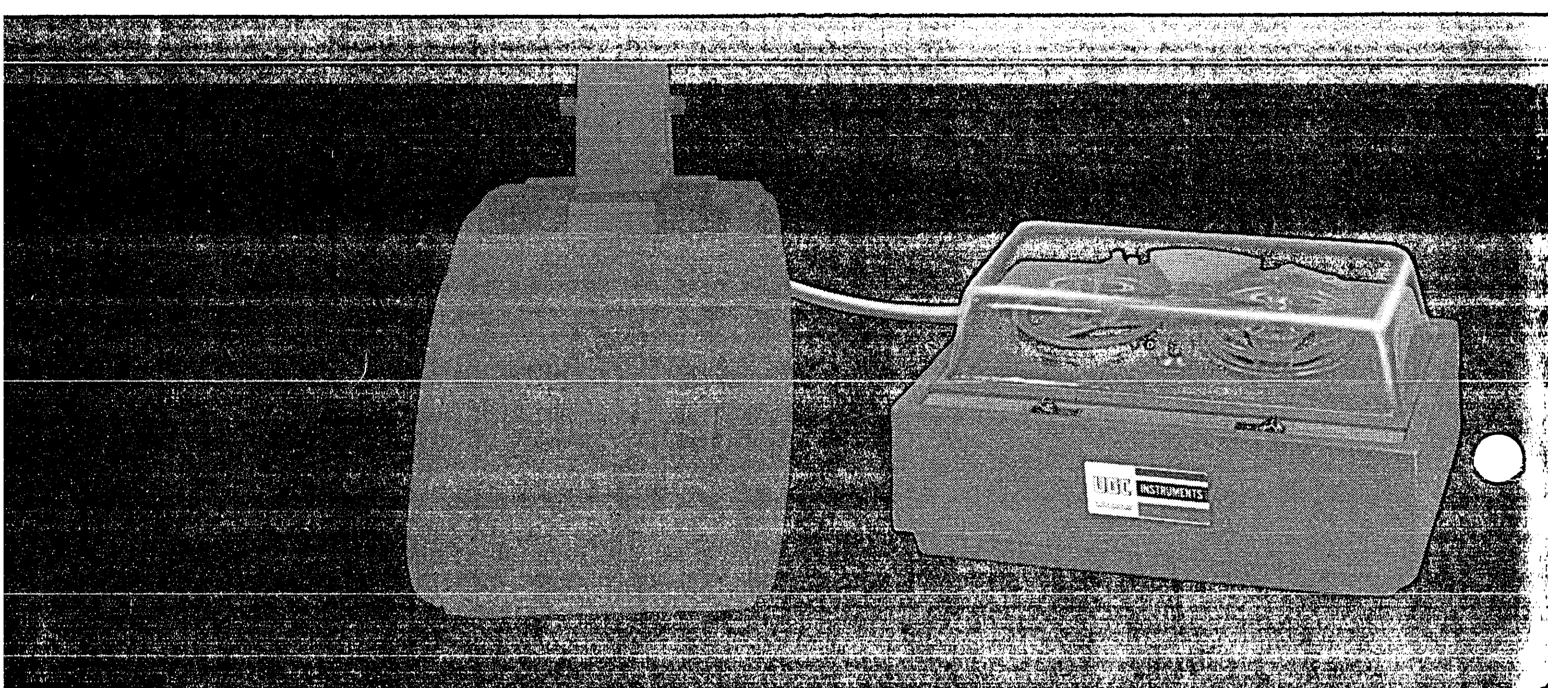

UGC INSTRUMENTS
METERCORDER

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AMCORDER
Magnetic Tape Recording
Adding Machine

METERCORDER
(Far Left)

COUNTERCORDER
Portable Magnetic
Tape Recorders

ADAPTOCORDER
Magnetic Tape
Recording Attachment

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SODA systems magnetic tape recorders save hours in recording, and days in transferring, checking and reproducing digital data for computer processing. □ Wherever document acquisition is performed—in the field, factory or business office—there is a specially designed SODA system to do the job. □ With SODA systems, no further processing is required between the data acquisition and the computer processing center. □ This new concept in data acquisition is faster, more reliable, and considerably less expensive than other data collecting systems. □ For brochure write to UGC Instruments, developer and producer of magnetic tape recording SODA systems.

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CIRCLE 7 ON READER CARD

What makes ASI's 2100 today's outstanding computer buy?

ASI's new 2100 is designed to satisfy both small and medium scale computer needs, combining high operational speed, expanded input/output capabilities and low cost-to-answer ratios in a convenient to use, compact unit. Check just a few of the 2100's features:

MEMORY—2 microsecond total memory cycle time . . . 21 bit word . . . 4096 word core memory expandable in modules of 2,048 words.

ARITHMETIC AND CONTROL—Three index registers . . . double precision hardware . . . fast indirect addressing . . . convenient subroutine access . . . instructions to facilitate floating point operation . . . rapid instruction execution.

Add— 4 usec.
Multiply—30 usec.
Double Add—12 usec.
Unconditional Transfer— 2 usec.

INPUT/OUTPUT—Up to eight complete, buffered, bidirectional input-output channels . . . 500 KC total word input-output rate . . . channels will accept information in 6 to 48 bit fields as specified by the program . . . any channel may be connected to as many as 32 external devices . . . each external device has its own unique interrupt address to which program can be automatically transferred . . . multiple priority interrupts, each with its own order of priority . . . external device operations require program attention for initiation only . . . central processor may communicate directly with external devices without using buffered channels.

SIZE AND POWER REQUIREMENTS—A single upright cabinet includes all electronics power supply and operator control and display panel . . . over-all height 67 inches, depth 25.5 inches, width 72 inches; power consumption is less than 1.8KW . . . standard 110/120 volt 60 cycle AC. No special temperature or humidity controls required.

PERIPHERAL EQUIPMENT—Available with the 2100 is a complete line of proven peripheral equipment . . . high and low density magnetic tape units . . . 800, 200 and 100 cpm card reader . . . 250 and 100 card punches . . . incremental plotter systems . . . 500 character per second paper tape reader . . . 100 character per second paper tape punch . . . input/output typewriter . . . 400 and 200 lpm line printers . . . A-to-D and D-to-A conversion units.

SOFTWARE—A complete package of programs, compilers and routines . . . field tested FORTRAN II . . . symbolic assembler . . . mathematical subroutines . . . available at delivery of 2100 system.

PRICE AND DELIVERY—The prices of the 2100 begin at $87,800 . . . monthly lease price $2,590 . . . first deliveries in December 1963.

For complete descriptive data on ASI's 2100, call or write today.

ASI | 2100

ADVANCED SCIENTIFIC INSTRUMENTS / DIVISION OF ELECTRO MECHANICAL RESEARCH, INC.

8001 Bloomington Freeway, Minneapolis, Minnesota 55420

CIRCLE 8 ON READER CARD

letters

testing aptitude

Sir:

Regarding my article, "Testing Programming Aptitude" (Oct., p. 28), references to Figures 3 and 5 are reversed. This error in the text appears on page 30.

ASCHER OPLER
New York, New York

heretical comments

Sir:

The battle begins. It was inevitable that the rumble of new ideas would be heard inside the temple. And lo! Saint Patrick, patron of Bitland, leader of the people, sallies forth to deal the insurrection a mighty verbal blow ("So You Want to Go On-Line," by Robert L. Patrick, Oct., p. 25).

We adolescents, attempting to evaluate the capabilities of on-line systems in the only honest way they can be evaluated (by trying to build and operate one) are bent, but not broken. We sincerely regret the nervousness we are creating among the Priesthood, but we see a true faith and are groping dimly toward it. We must hurry because "the computer field is beginning to mature." We must find our Grail before the last bug is discovered in SOS or, like a "lake of lava," the "boiling, frothing mass which we know as programming" will "congeal."

True, Mr. Patrick, this bit about on-line processing might be a fad. But then again it might not; just as might have been said about EDP in 1947-8. And where were *you* then? On which side of the fence?

I feel compelled to point out that the confused thinking you so deplore is evident on both sides of the question. To judge a fundamentally different operating philosophy on criteria appropriate to closed shop computer centers is to judge the value of aircraft in war on the basis of hundreds of wars with no aircraft. To pose specific questions:

Have you looked recently at the ratio of compiling and debugging runs to production runs? Or the frequency of very short shots at the machine? Do you suppose that by adding 10 per cent (your figure) to processing time the total problem-solving time (including the hands-dirty programmer's labors) might be reduced? Is it possible that new operating procedures based on conversational capability (e.g., selective feedback vs. laborious memory dumps) or that interpretive acceptance of programs (with the possibility of immediate correction of clerical and format errors) might offset the overhead factor you're so worried about? The only honest answers to these and *many* other questions being asked is, "I don't know." There are some who would like to know, and sacred cows beware.

Space prevents discussion of your concern over reliability and accuracy. Since your concern is based *strictly* on conventional equipment and closed shop procedures, I suspect even you don't attach real concern to it, realizing that the pitfalls you present are easily avoided. One honest test is implied in your article, however, that will blow the top off the whole subject. How many jobs per week are completed on a system designed for on-line processing? What's the cost per job? Is it possible that certain types of applications will be materially more economical when done on-line? That there's room for both operating modes? We're betting so. If we can ever get our system checked out (which is a miserable undertaking under the existing Established systems) we may prove our point.

We are trying something new. If the Established Faith is based on Truth, it will withstand some honest probing. It has been a long time since the last encyclical, Mr. Patrick. In the words of the prophet, "So wut've ya done lately?" (See *Datamation,* Jan. '63, p. 27.)

R. E. NIENBURG H. A. KINSLOW
Mahopac, New York

Author's reply: One pair has stood up and offered testimony. I assume their effort is based on written objectives, a factual published plan, and a sincere concern for what they gain and what it costs. If so, bless them both.

Sir:

I must challenge the conclusion made by Mr. Patrick in the last paragraph of his article. It appears the installation he criticizes has achieved something my customers have wanted me to do for a long time—run 30 hours of work in a 24-hour day. He states that the installation runs 300 jobs per day, each averaging six minutes. Their disc file is tremendous—perhaps feeding negative maintenance into the system. In my opinion, Mr. Patrick's last-paragraph slip is consistent with the soundness of the entire article.

E. D. REILLY
General Electric Co.
Knolls Atomic Power Laboratory
Schenectady, New York

128K vs. 131K

Sir:

There seems to be some confusion in certain quarters on the question: "If you double the size of a 32K memory, is the result a 64K or a 65K memory?" This foolishness has been carried to a new high in your October issue ("The CDC 6600," p. 44) which carries the following absurdity: ". . . memory of 131K . . . in 32 banks of 4K each . . ."

Being reluctant to learn this kind of arithmetic, I would like to urge that we all accept that K= 1,024 has been a fact of computer life for some time now. It is an unfortunate fact that K = 1,000 also remains valid, but I feel that context always makes the meaning clear.

Thus, quadrupling a 10K memory yields a 40K, and quadrupling a 32K memory yields a 128K—which might even be organized in 32 banks of 4K each.

BARRY GORDON
New York, New York

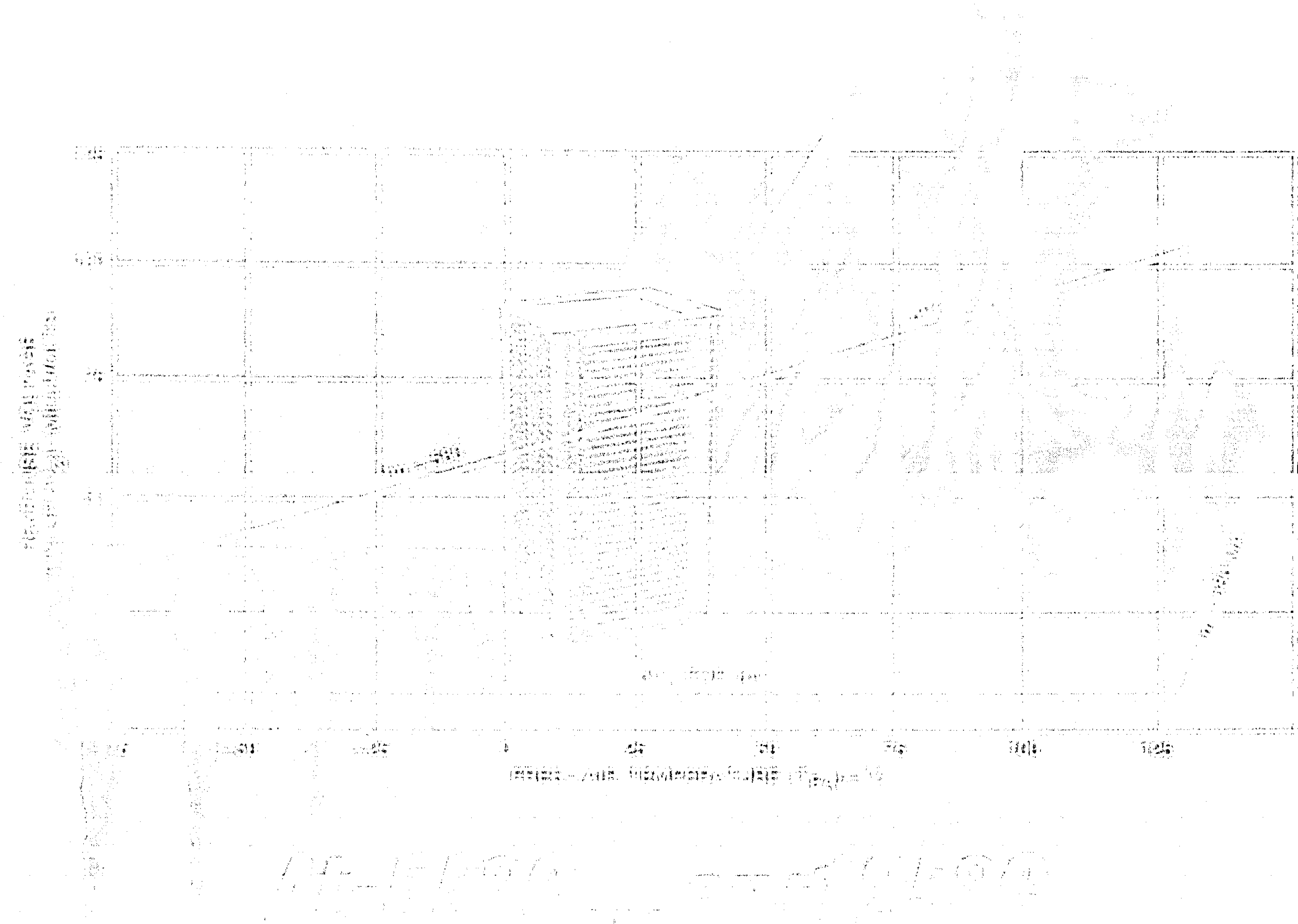
Jeepers, a binary 32K memory has 32,768 positions. Double that and you have 65,536, right? If we called that a 64K array, would everyone understand? Does your wife understand when you address your cute secretary as "Dear"? As long as we understand each other, okay. Henceforth, it's 128K, understood by its context as 131,072 words.

merger-free

Sir:

To clear up any misunderstanding which may be in the minds of some of your readers, Ferranti Electronics, a division of Ferranti-Packard Electric Ltd., is not affected in any way by the recent merger of Ferranti and ICT in England. The Canadian company is autonomous.

H. A. WATTIE
Ferranti Electronics
Toronto, Canada



DATAMATION calendar

● The annual meeting of the American Mathematical Society will be held January 20-24, 1964, in Miami, Fla.

● The Georgia Institute of Technology, Atlanta, Ga., will hold a short course in Methods of Operations Research, Jan. 20-24, 1964.

● The annual IIT Research Institute Computer Symposium, scheduled for Chicago, January 30-31, has been cancelled.

● The Sixth Institute on Information Storage and Retrieval is being sponsored by the American Univ., Washington, D.C., Feb. 10-14, 1964.

● The International Solid State Circuits Conference will be held at the University of Pennsylvania and the Sheraton Hotel in Philadelphia, Pa., February 12-14, 1964. Sponsors are the U of Pa., PGCT and IEEE, Phila. section.

● The winter 1964 meeting of SHARE, the IBM 704/9/90/94/40/44 Users Group, will be held at the Jack Tar Hotel, San Francisco, March 2-6.

● A conference on Industrial Applications of New Technology, conducted by the Georgia Institute of Technology, will be held April 2-3, 1964. Conference sponsors are the Southern Interstate Nuclear Board and Georgia Tech's School of Nuclear Engineering in cooperation with the Atomic Energy Commission and NASA.

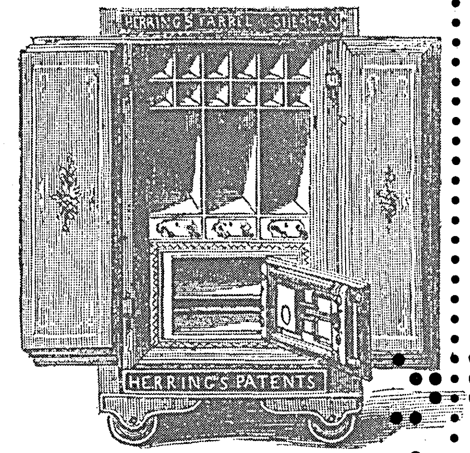
● The 1964 Spring Joint Computer Conference will be held at the Sheraton Park Hotel, Washington, D.C., April 21-23.

● The 1964 annual general meeting of POOL, the organization of users of General Precision computers, will be held May 12-14 at the Palmer House, Chicago, Ill.

● The Systems Engineering Conference and Exposition will be held concurrently at the New York Coliseum, June 8-11, 1964.

● The Fifth Joint Automatic Control Conference, sponsored by the IEEE, will be held at Stanford University, Stanford, Calif., June 24-26, 1964.

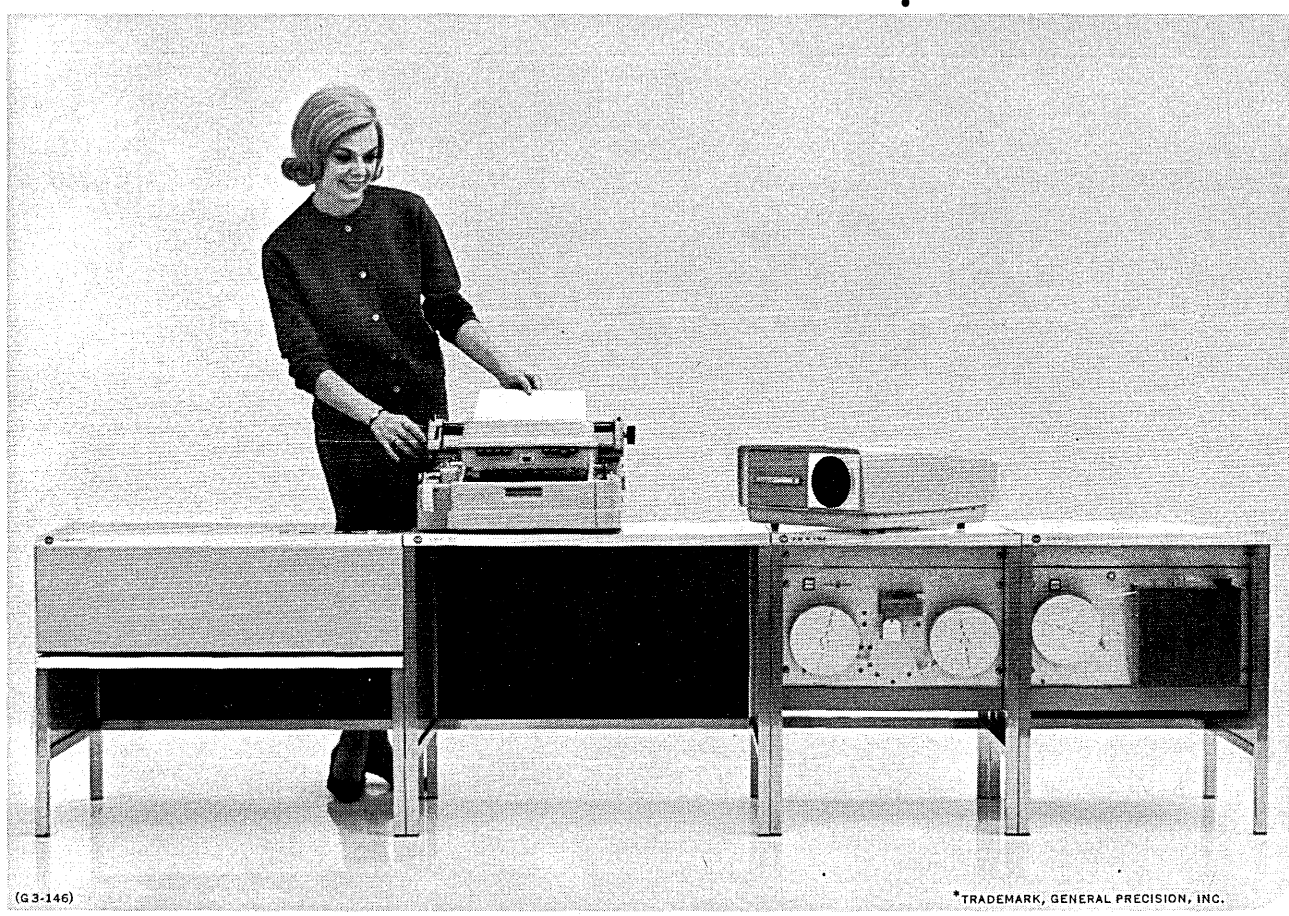
● The Fourth International Analogue Computation Meetings will be held September 14-18, 1964, at the Technical College, Brighton, England. Sponsor is the British Computer Society, under the sponsorship of the International Association for Analogue Computation.



FIRST FULL-CAPABILITY COMPUTER PRICED FROM $16,250

The General Precision LGP 21 Now you can increase the productivity of your scientific or engineering staff with an LGP*21, first full-capability, general-purpose digital computer to sell for a basic price of $16,250. (Add $5250 for special input/output typewriter.) Or lease the LGP 21 under a variety of plans to fit your needs. Use of 500-program library included. Large disc memory: 4096 words of 9 decimal digits each (36,000+ decimal digits). Compact vocabulary: 23 commands covering all arithmetic functions. Adaptable: 32 addresses for program control of input and output equipment. Easy to operate. Completely mobile. Send for full details!

COMMERCIAL COMPUTER DIVISION
GP GENERAL PRECISION
INFORMATION SYSTEMS GROUP
101 W. Alameda Ave., Burbank, Calif.



(G3-146)

*TRADEMARK, GENERAL PRECISION, INC.

CIRCLE 13 ON READER CARD

We're not offering you a cozy little job in a cozy little corner in a great big company

Collins is looking for experienced professionals. We're looking for hardware-oriented men. We're looking for men with theoretical and analytical capabilities, men who know their fields thoroughly and completely. If you are one of these men and you have a Bachelor's or advanced degree in E.E., Math, Physics or Business Administration, you'll be interested in the computer programming and engineering opportunities Collins can offer you.

SENIOR SOFTWARE SYSTEMS SPECIALISTS
(Newport Beach and Dallas)

Broad responsibilities entail development of automatic programming languages and other high level advanced languages for programmed logic computers. Candidates must be creative individuals with several years of programming experience preferably on several computers and who are willing to accept broad responsibilities in the Collins software development program. Responsibilities inherent in these positions demand extraordinary capability built on sound education and diversified experience.

SENIOR APPLICATIONS PROGRAMMERS/COMMUNICATION
(Cedar Rapids and Newport Beach)

Involves programming and program check-out of real time communication-oriented systems. Cedar Rapids position will involve travel.

SENIOR APPLICATIONS PROGRAMMERS/FINANCIAL
(Cedar Rapids and Newport Beach)

Bachelor's degree and several years' experience programming business applications on medium and large scale computers.

SENIOR APPLICATIONS PROGRAMMERS/MANUFACTURING
(Cedar Rapids)

Bachelor or advanced degree in Math, Physics or Engineering. Experience requirements include 3 or more years' scientific programming with exposure to Industrial Engineering, machine shop fabrication, or numerical control of machine tool problems. Experience on equipment such as UNIVAC 490, RCA 501, or IBM 7000 series is desirable. Ability to carry projects from conception through installation is a must.

SOFTWARE DEVELOPMENT PROGRAMMERS
(Dallas and Newport Beach)

Develop software packages for business and scientific computer systems including translators, assemblers, executive and interpretive routines. Will also develop data communications software packages and utility programs for programmed logic computers. Should have Bachelor's or advanced degree in Engineering or Mathematics and at least one year's experience with computer languages and systems.

ENGINEERING COMPUTER PROGRAMMER
(Dallas)

Requires experience in business systems programming as well as scientific programming application. A background with 7070, 7074 and PERT analysis familiarity is desired. Must have Bachelor or advanced degree including statistics or math training and at least 3 years' related work experience.

MANAGER, DATA REDUCTION SOFTWARE DEPARTMENT
(Cedar Rapids)

Involves developing software aids for business data reduction and scientific engineering-type applications; maintaining and improving programming standards and techniques; and to serve as systems design consultant to programmers. Requires B.S. degree in Math, Physics or Engineering with 5 years' related experience. Some business programming experience and management experience preferred.

PROGRAMMING INSTRUCTOR
(Newport Beach)

Involves the teaching of computer programming to customer and company personnel, as well as the development of new programming courses. Requires a degree in Math or a degree in Education and a minor in Math plus 3 years' teaching experience, some of which must be in programming.

APPLICATION ANALYSTS
(Newport Beach and Cedar Rapids)

Involves producing system specifications. Background should include wide experience in the analysis of communication and information processing problems.

APPLICATION PROGRAMMERS
(Newport Beach and Cedar Rapids)

Background and experience should be in business data processing, computer-controlled communication systems or teletype switching. Project includes development of detailed programming specifications and application programs in these areas.

PROJECT MANAGERS
(Cedar Rapids)

Over-all project management of automatic message switching and processing systems. Includes analysis of customer requirements, preparation of plans, specifications and cost estimates, providing technical liaison with customer, maintenance of cost and schedule control, etc. Requires B.S.E.E. or M.S.E.E. plus 2 to 10 years' applicable experience.

OPERATIONS RESEARCH ANALYST
(Cedar Rapids)

Formation of operations research department offers opportunities for candidates who have broad industrial operations research experience. Positions available at all experience levels.

SYSTEMS ENGINEER
(Dallas)

Bachelor's degree and 4 years' experience in computer and communication systems. Analyze customer requirements for large scale real time automatic message switching and processing systems. Prepare and present sales proposals to customers.

LOGIC DESIGNERS
(Cedar Rapids)

Background should include a B.S. degree in Electrical Engineering and 2 to 4 years' experience in logic circuit design.

DIAGNOSTIC PROGRAMMERS
(Cedar Rapids)

Requires a Math or Engineering degree plus 2 to 4 years' experience on large, general purpose computers.

Openings are also available for digital circuit designers and memory systems designers.

For complete information write in confidence to Manager of Professional Employment, Dept. 114.

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CIRCLE 94 ON READER CARD

Until now, there were three ways to break the digital computer speed/cost barrier:

Designation	Add (fixed point)	Multiply (fixed point)	Addressable Memory Size	Price
SDS 910	16 μsec.	248 μsec.	to 16,384 words	$41,000
SDS 920	16 μsec.	32 μsec.	to 16,384 words	$83,000
SDS 9300	1.75 μsec.	7 μsec.	to 32,768 words	$215,000

The new SDS 930 makes four

SDS 930	4 μsec.	8 μsec.	to 32,768 words	$108,000

The SDS 930 is the newest addition to Scientific Data Systems' line of high speed, general purpose computers. It has complete program compatibility with the SDS 910 and 920 (which are now operational in more than seventy-five installations). The 930 instruction list is identical to the 920's. The remarkable 930 speed includes 2 μsec. cycle time and 20 μsec. divide time.

The SDS 930 has one standard and seven optional buffered input/output channels and all I/O channels can operate simultaneously with computation. All SDS 900 Series Computers share these features: all-silicon semi-conductors, buffered input/output, comprehensive software including FORTRAN II and floating point and multi-precision operation. For all the facts about the 930, write...

SDS 930

SCIENTIFIC DATA SYSTEMS 1649 Seventeenth St., Santa Monica, Calif.

CIRCLE 15 ON READER CARD

DATAMATION

BUSINESS & SCIENCE

DIVERSIFICATION, LEASING PAY OFF FOR MCDONNELL

Aerospace firms may do well to note the computing activity at McDonnell Aircraft, which has parlayed a move to diversify into an expansion of capabilities which couldn't be justified by an internal workload.

The St. Louis firm formed the McDonnell Automation Center in March of '60. Since then it's grown from 250 to over 600 people using some $14-million worth of gear, including a leased 7094. Termed a "bold move" by General Manager Bob Harmon, the lease will save $2-million, with the break-even point compared to rental coming after two years (Jan. '65).

Looking for ways to extend its services, MAC is evaluating a new data recording device manufactured by Electric Information, Broomfield, Colo. It's the 303, which uses dial switches and a tape cartridge, which is then removed and put on a model 909 converter for transfer to computer mag tape. The 303 costs $995 right now; the 909 is $1500, or $70/month. MAC's Denver Subsidiary Service bureau, Delcos, Inc., has purchased four 303's (for inventory control) and has one 909.

MORE NEW GEAR FROM GE COMPUTER

Before announcing its new 400 series, GE had been privately previewing a new pair of large-scale scientific computers, the 625, and a faster version, the 635. Said to be in the 3600 class, the new gear is allegedly quite a bit faster than the 7094 and less expensive. Hardware is supposed to be designed and developed cooperatively by GE's Computer Dept. and other GE department computer users. Software specs were also established by internal users, who will develop it as well. Highly modular, the new system offers multiple processors and separate multiple memory modules; one preview attendant called it most impressive. A prototype processor is supposed to be in operation this month.

ADAPSO SPREADS, SPEAKS OUT

One computer organization which isn't afraid to take a stand on legislation and activities affecting it is the Association of Data Processing Service Organizations. Formed in mid-'60, ADAPSO now has 75 members, has added perhaps one third of those in the last year. Now operating out of new quarters in Abington, Pa., ADAPSO is looking for "compatible societies" to share its space. It's also looking for new members -- especially small independent service bureaus (tab and computer) -- from the roughly 600 not yet signed up.

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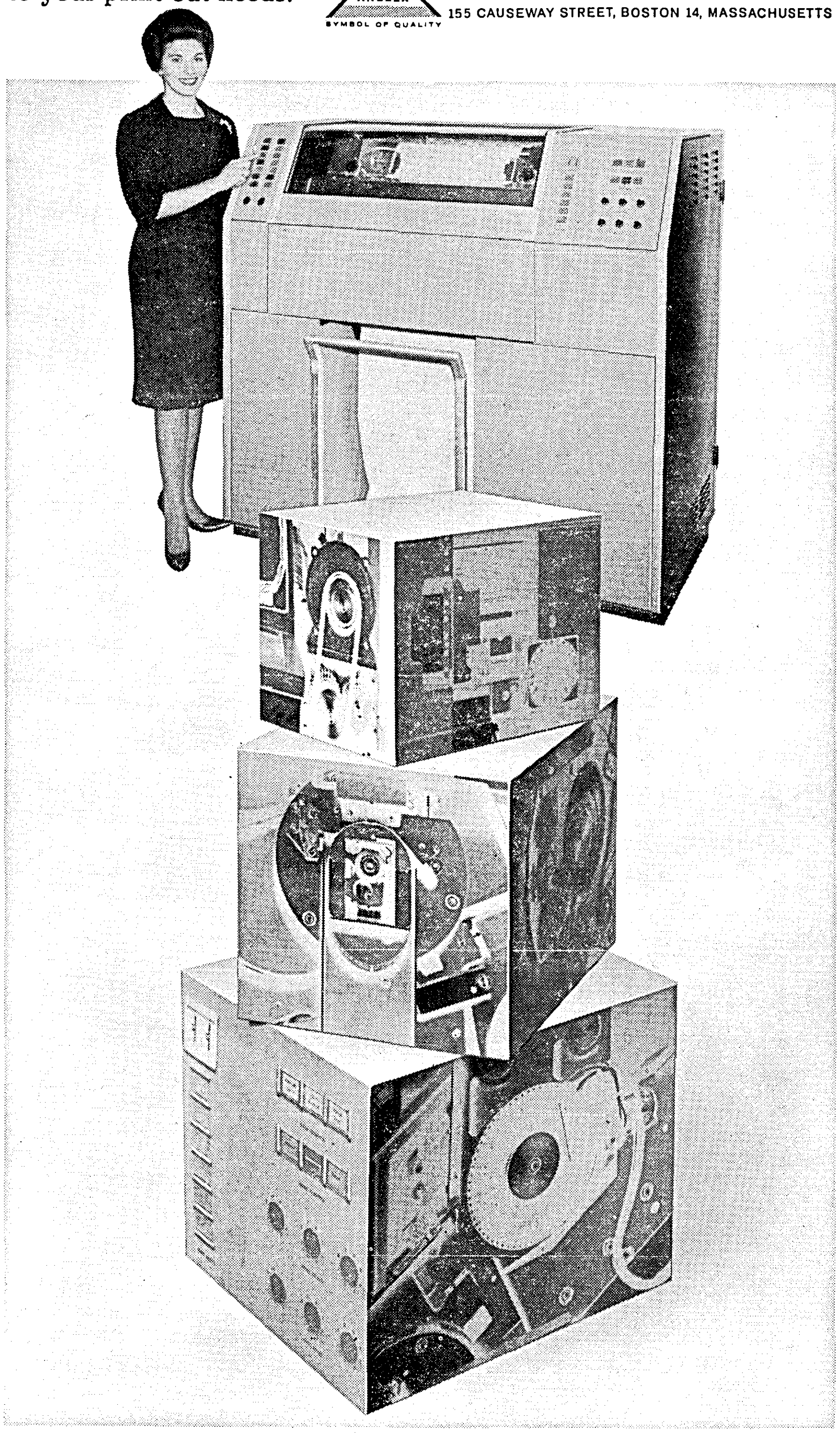

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The Engineering Department operates a computing open shop presently using FORTRAN and SIMSCRIPT with the introduction of other language in the planning phases. In support of this, qualified people are needed to instruct the users in these programming languages. Other challenging opportunities exist in evaluating new hardware configurations and software systems, supporting IBSYS/IBJOB, FORTRAN IV and WAVE, and in applied research in numerical analysis.

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time, programming costs, etc. Filed with ADAPSO headquarters, these will be combined in a composite picture which will allow members to measure themselves against the membership. The association is also working out with Lloyds of London a special group insurance plan, similar to that for accountants' errors and omissions coverage.

On the political front, ADAPSO has urged Senator Douglas to eliminate from a bill a section which suggests the establishment of a federal dp center. Next target: "give-away" dp services by banks.

UNIVAC LEARNS THERE IS A SANTA

Joyous smiles wreathed faces at Univac as their Christmas stocking was filled early with a really big package: a 37-megabuck order for 152 computers for Air Force base-level inventory control around the world. The winning hardware: the 1050 (designed as a satellite) plus Fastrand drum. Interesting aspects of the order: choice of a relatively little used machine, drums over discs, impressive evidence of increasing Univac penetration of the military market.

The fleet deal has other implications: identical machines doing identical jobs gives the AF a single frame of reference for measuring individual installation efficiency. And the size of the order should permit Univac to support their gear more than adequately. With the honors, Univac wins the responsibility of showing Uncle Sam that fleet purchases are smart.

ACM = IEE IN AFIPS

The ACM has won equal representation in AFIPS with the IEEE, which up to now has outweighed ACM 2-1, due to hold-over representation by both IRE and AIEE, which merged to form IEEE. Thus, both ACM and IEEE will have four representatives on the AFIPS board; each will have one vote on the critical question of new members. Coming up for acceptance in April: The American Documentation Institute and Simulation Councils. Neither is likely to make it this time around. The AFIPS board also named Dr. Ed Harder, Westinghouse, Pittsburgh, as Chairman-elect. He is thus eligible to replace current Chairman Don Madden this coming spring.

TEXAS OUTFIT THINKS BIG, PLANS 6600 SERVICE BUREAU

A letter of intent for a Control Data 6600 has been signed by Computer Laboratories of Houston. A subsidiary of Scientific Computers, Inc., Minneapolis (22% of SCI is owned by CDC) which has service centers in Minneapolis and NYC, Computer Labs opened doors in August '61, moved from twin tape 1401's to an 8-tape, 32K core 1604A last May. The company is now investigating the possibilities of customer terminals and communications lines for the 6600, tentatively scheduled for delivery in late '64 or early '65. The goal: a Southwest regional service bureau.

HOPE FOR THE ALSO-RANS: NEW ANELEX DISC PACK

Computer manufacturers hoping to fight the IBM removable disc pack "monopoly" (strengthened by announcement of rental availability of packs by IBM) may get a helping hand from Anelex, which is bringing out its version. Shown privately at the FJCC, the Model 80 claims a 75 msec average positioning time and a maximum capacity of "3.9+ million" characters. To be offered as an EOM item, the Anelex Model 80 will be for purchase only. No prices have been announced, but Anelex promises it will be competitive "with files of this type." Also coming out: the 4800, with 95-million characters and 50-60 msec positioning time.

AIR FORCE IN FOR NAVY AT PMR

Beginning next July, the Air Force will start taking over the Pacific Missile Range from the Navy. Initially, the AF will assume control of the naval missile facility at Point Arguello, including tracking radars, real-time impact prediction computers and range safety functions. In another year, the AF will assume control of down-range sites as well. The Air Force already runs the Atlantic Missile range, where a 3600 is installed. Speculation is that the Air Force will not buy the Univac computers installed and being planned by the Navy, but will go IBM instead. There is no evidence that any of the work now under way to implement the Univac computer-oriented system will be altered to adapt to any AF plans.

FROM PHILCO, BARGAIN BASEMENT RATES, A NEW COMMUNICATIONS SYSTEM

Following up on its promise of pricing restructures after its recent reorganization (see July Datamation, p. 17), Philco has announced its second price cut in a year. Sale price of the 212 main frame with 32K core is down from 2.3 megabucks to $1,650,000; rental drops from $52K to $45K/month. A typical 1000 satellite system with 8K characters, two 90KC tape units, 900 lpm printer, and card read/punch sells for $289,250 (a 40% cut), and rents for 20% less, $8,640. Maintenance costs have also decreased an average of 25%. Not affected: the 210 (no longer in production), and the 211, now in limited production.

Showing some of the legerdemain of its FJCC magician, Philco showed in Las Vegas a previously unannounced message and data switching system, the PCP-150. Announcement was held off until the company won an order for a system from parent Ford Motor, which will probably install it by January '65. The 150 features ASCII 8-bit compatibility, and three sets of transmission rates: 20-180, 300-1600, and 300-2400 over 75-wpm lines.

No prices have been announced, but Philco feels a "normal system" such as that being installed by Ford will run between $15-30K a month.

RUMORS AND RAW RANDOM DATA

Reports are that Dr. J.C.R. Licklider will leave his post at DOD's Advanced Research Projects Agency for a job at IBM...FHA is looking for 1401 & 7074 programmers in the $7-8K salary range. Applications should be sent to J.W. Babcock, Personnel Div., Federal Housing Administration, 811 Vermont Ave. NW, Washington 25, DC. ... Hughes Aircraft/Fullerton is shifting its Computer dept. to a new Data Products Div., is still reportedly in the running for a Japanese tactical air warning command system with its 330 computer. ... A magazine named The New Yorker has named "a magazine called Datamation" in two articles on computers (Oct. 19 & 26). ...Yuck of the Month: NY Times ad for a "Soft Wear Executive."


CONTROL DATA
3600

EDITOR'S READOUT

PRAYER OF A COMPUTER SPECIALIST

On Friday last a gunman assassinated our 35th President. Through our free press the electrifying news was flashed instantly throughout our great land. Gathered with others of similar talent and background we were stunned by the dastardly deed. In our sobriety we started the great down count. The ballistic flight time is about thirty minutes . . . We were in a major population center, surely a prime target area. Had we less than thirty minutes to live?

The thoughts that transpired are worthy of recording. Had the Air Force aide gotten immediately to a phone? Was SAC, at that time airborne? Was the hot line in use? Did the Russian Embassy properly sense the stunned shock and use their own diplomatic channels to say, "Don't anyone move!" Were clouds of SAC bombers appearing on Russian radar scopes? Had our missiles proceeded through the preliminary readiness and were on hold? Were we then re-targeting to adhere to plan even though not all of the first strike forces shone green?

It was noon in Los Angeles. We had only a few minutes to go. We were sitting at a sidewalk cafe and silently watching the traffic pass. The tempo seemed a bit slow, or was that merely due to the raging thoughts in our heads? Was it caused by an international plot, domestic politics, or some deranged nut? Would it escalate? What time was it now?

Thanks to the wisdom of our founding fathers the accession to the Presidency is preprogrammed. With our sound currency there would be no bank panic. Since we are basically peaceloving and law-abiding there would be no riots. With the military admittedly subservient to the civil government we could count on their obedience and discipline as a stabilizing force. Would their training pass this crucial test? Only one mistake could cause it to escalate. Was it already beyond control? Now what time was it?

The traffic was moving slowly now. The luncheon crowds were impeding it. Assuming we were, at that very moment, displaying a controlled show of force; could the Russians control theirs as well? Would one trigger-happy dogface make an error from which they could not recover? GOD, give them training and excellence to match ours.

The time is past. It ha sbeen an hour since the first news. Our President is dead. We have an automatic replacement. Soon they will issue him the Oath. *It didn't escalate!*

We who introduce the military to the developing technology sometimes fail to properly weigh the benefits of stability, training, and discipline. O Lord, bless them for their judgment when our peril was great,

Lord GOD, may your wisdom descend on us as we design our new systems for command and control,

May we control the response and retain such judgment in our computer-based systems,

O GOD, MAY IT NEVER ESCALATE . . .

R.L.P.
11/25/63

FILE MANAGEMENT

by JOHN A. POSTLEY

The task of managing large files is the backbone of many, if not most, of today's computer applications. This file management problem encompasses the areas of file creation and maintenance as well as the mechanized aspects of information retrieval. Very often the entire field is thought of as "information retrieval."

Equipment applicable to this field has recently undergone a substantial increase in capability, variety, and availability. Significantly, this change has occurred in both random access and sequential file equipment. Random access file equipment can be divided into two major types: fixed media equipment, including drums, discs, and tape strips; and removable media equipment, including disc-packs, CRAM, and Magnacard. Sequential file equipment consists primarily of various types of magnetic tape units.

As a result of these improvements in available equipment, the task of determining the "best" equipment for a given application or set of applications has become more difficult. In those cases where it is even possible to identify and describe the problems in which the files will be employed, a number of equipment and problem parameters must be evaluated. Although many special parameters may have to be considered for specialized problems, the more general ones may be listed for reference in appropriate situations.

Equipment parameters are perhaps the more discussed and easier to evaluate. These include the total amount of information which can be stored and, as a special consideration, the total amount of information which can be stored *on-line*. The amount of information which can be retrieved in a single access, and whether this amount is fixed for the equipment or is variable (up to a given maximum), can also be determined. Equipment parameters relating to speed include the peak and average transfer rate of information from file storage to central processor. The time required to access the "next" record is important, as is the average and the maximum time to access a record randomly located. It should be noted that all of these parameters can be meaningfully interpreted both for sequential and random access equipment.

Problem parameters tend to be somewhat more diverse. For different problems, different sets of them may take on varying degrees of importance. The "required" response time is the problem parameter most often considered; both the average and the maximum requirement must be determined and it may be that several different problems to be run on the same equipment reflect several different average and maximum response time requirements.

The volume of transactions in a given period (batch) must also be determined. If batching techniques are used, this may determine the average time to process a transaction. If the file is extremely large and the collation ratio relatively high, then sequential techniques are likely to result in lower average response times than random techniques. Whether or not a given transaction can result in several related or independent accesses to the file can also be an important problem parameter.

The question of indexing is a formidable one, ranging from a simple 1-to-1 relationship between each record and its location, to an un-indexible file or one in which records are identified according to their dynamic content. The amount of retrieval information required by each transaction must be estimated as well as whether and to what degree this amount varies.

Several somewhat "softer" problem parameters which must be investigated include a determination of the system bottlenecks which exist independent of whatever file management technique is used, and an estimate of the relative importance of such functions as selective file maintenance and information retrieval, processing, and output, and the variability of each.

I have attempted to mention only some of the most important equipment and problem parameters which relate to an efficient solution of the file management problem. It would seem obvious that no optimal procedure can ever be devised since it is apparent that some compromise among these requirements must be achieved for each problem or set of problems. The importance of random access equipment vs. sequential equipment is increasing. Although it seems unlikely that random access equipment will ever sweep its adversary from the field, it would be well to consider all reasonable alternatives in the context of each new requirement. Toward that end, this issue of *Datamation* attempts to describe the alternatives presented by several kinds of random access equipment. ■

Mr. Postley is manager of the Advanced Information Systems Dept. of Hughes Dynamics, formerly AIS Inc., for which he was vp and board member. He has been with The RAND Corp. as head of the dp group of the Logistics Dept., with Hughes Aircraft, Northrop, and the UCLA Institute for Numerical Analysis of the National Bureau of Standards.

Author of Computers & People, McGraw-Hill, 1960, he holds a BA in math from UCLA.

INTERCHANGEABLE RANDOM ACCESS DISCS

the IBM 1311

by C. M. HESTER and G. V. HARRIES

The accepted methods of processing data have increased from the basic manual approach to include mechanical processing, data processing in batched form, and random access processing. This is not to say that these methods have been evolutionary, since each of the above systems can function well in specific instances.

Why, then has a need occurred for random access devices? The answer is that many management groups want to continue to get closer and closer to a position where the status of their business can be reflected on an up-to-the-minute basis. Month-end reports often have given way to interim trend reports or analyses, or frequent snapshots of key items.

Dynamic business needs dynamic accounting methods, and for this reason these companies are striving to place their business operation in "real time." A "real time" system is one in which inquiries or transactions are received and processed, and replies or responses are made while the person making the inquiry is still there waiting "on line" with the system.

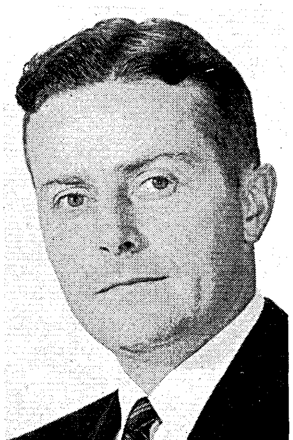
A real-time goal points to more than mere management benefits. In the areas of public utility and banking, it points to better service to their customers. In a real-time system, the person operating a small station or a window can inquire into the entire data processing complex and receive an answer (usually in less than a second). This person operating the terminal can, in fact, then speak for his company. It is a much more effective way of doing business than receiving a personal request at a window station and replying by mail. "Real time" creates a public image of a company's efficiency and its personalized service.

What of the typical user who is making a decision to install new data processing equipment today? It is quite likely that he will consider for the first time the use of random access devices as a means of performing at least a portion of his work. In many instances, the user will find that the large size of his master files and the tremendous volume of activity that occurs against them might make a complete random processing approach unfeasible with present equipment. If he cannot store his data files in a random device where he can get at them at will, then he cannot form a real time system. Recent development trends, however, indicate that this will not be true forever—since capacities of random access devices have increased by at least an order of magnitude in the past five years.

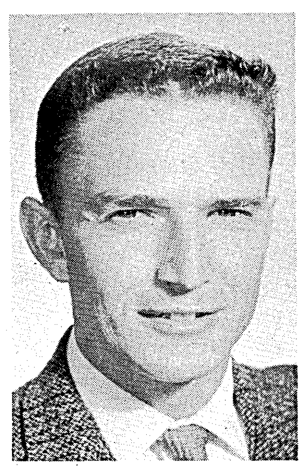
It is possible that the "typical" user has had some experience with tape processing, feels that he must choose between files and tape, and, because of the above circumstances, makes a choice for tape.

It is important to note, however, that although the decision possibly might have been workable, the alternatives were wrong. The user should not consider a system configuration based solely on files *or* tapes. What he should consider, in many cases, is a system which involves both files *and* tapes.

Both tapes and random access devices have advanced in technology and application to a point where they now



Mr. Hester has been responsible for the planning of new random access file products and the introduction of new dp concepts since 1958. He is Manager of Digital Storage Planning, Information Storage Systems, at IBM's San Jose General Products Division Development Lab. In 1950, Hester received a B.S. degree in Business Administration from the U. of Calif.



Manager of Technical Planning, Random Access Memory Programs, at IBM's General Products Division Development Laboratory in San Jose, Calif., Mr. Harries has been responsible for the design engineering of electronic components including the 305 RAMAC file and the 1301 disc storage unit. He received his B.S.E.E. degree from the Univ. of Southern Calif.

can be effectively utilized together on the same system on the same application. Since this is true, the user can begin to utilize random access files on a portion of his work and expect to expand it later.

Previously, it was stated that it is perhaps incorrect to plan an application for data processing by having to choose files *or* tapes. It is likewise improper to plan the application on the basis of its being a sequential *or* random mode of processing. Early tape processing was sequential in nature. The master file was ordered sequentially, and transactions were saved, grouped into batches, and processed against these master files in a sequential manner.

When random access processing was introduced, it became possible to organize the file at random and then process the transactions against this file as they occurred—randomly. What is not commonly realized, however, is that in a great many cases the "random" access file can be made to store the user's data in a *sequential* manner. This fact can change the whole approach to file usage. Organizing the records in a file device sequentially opens up the possibility of utilizing both random and sequential methods of data processing—on the same application. The main processing run of transactions can be sorted and brought to the file in a straight sequential manner, as is done with punched cards or magnetic tape. Inquiries from outside the system can be brought in at once as they occur—singularly or out of sequence. The master file is simply indexed. The incoming interrogation is matched against the index, is told where its particular record is located, and the file moves directly to that access setting for the immediate reading or updating of the desired record. The result is a sequentially batched system with a sensitivity which permits fast response.

File design innovations are making it possible to operate them much faster on sequential processing. One will find that in many cases, when the activity rate in the master file is low, the speed of the random access device in a sequential mode is faster than could be achieved on most tape systems. This happens because the file does not have to read and write *every* record in order to get to the record required for the next transaction. The file merely processes one record by updating it and then jumps sequentially to the next active item without regard to any of the intervening unwanted master records. This concept, called "sequential jumping," allows for greater sequential speed of processing and theoretically could allow a less powerful computing system to be utilized in producing the desired throughput. Sequential jumping was initiated with the "cylinder concept"—which is simply a file design concept that places many reading heads (or stations) at every access position setting. This reduces the number of motions and allows files to achieve a high sequential performance without using a "brute force" approach to pass records faster.

maximizing the cylinder concept

Large amounts of data at one reading position (or cylinder) provide an immediate assist to the problem of storing programs, subroutines, and programming systems residence. These often-referred-to data demand the high data rate and rotation speed of disc files. Programs can start to be read into the processor in milliseconds instead of minutes.

Recent disc storage innovations—such as flexible data formatting (for variable record length), the cylinder concept, disc scan, removable and interchangeable disc packs, and input-output control systems programs—are only a few of the features now available with disc storage units. These features alone, however, do not provide performance. Systems performance comprises a combination of four factors: availability, reliability, flexibility and maintainability. During the past decade, technological advances have been made which permit more effective realization of these factors. The newer files (though larger, faster, and with more function) require less service.

random access for small users

Present trends in engineering and systems planning point toward efficiency not only in material, time and manpower, but also in cost. To meet the needs of the smaller systems area, a development program was initiated to provide a file-oriented, low cost system. The objectives of the program were to bring a workable file capacity with efficient data handling capabilities into a price area which would provide random access processing to smaller businesses.

The IBM 1311 was designed for this lower cost entry. It introduced removable disc packs with a capacity of two or more million characters. If the data file is larger, it can be organized sequentially and blocks of it placed on succeeding disc packs.

Although the 1311, with its removable disc pack, represents a low cost entry into the field of data processing, it is not a crude or non-precise mechanism. The magnetic bits of recording it contains (eight of which go together to comprise a character of data) are recorded so small that there are 1,000 of them in one linear inch. These bits are arranged in rows (or tracks) which are only 0.02-inch apart. This provides a storage density of 50,000 bits (or 6,250 characters per square inch). With all these close tolerances, the disc packs are completely interchangeable, a pack written on a 1311 in Maine can be shipped across country and placed on a completely different file drive in California and be read without any difficulty.

The interchangeability feature required that many new parameters be considered in the design of the recording system. Such parameters as mechnical and electrical tolerances in addition to human factors were considered in the design phases. An access mechanism was designed to position the 10 magnetic heads to the 100 data track positions. An alternative examined was the use of a separate magnetic head for each data track. A head-per-track version of the 1311 would have resulted in the use of 1,000 magnetic heads and created considerable difficulty in the disc removability feature. The net evaluation of the performance and cost factors resulted in the present 1311 configuration which yields the best availability, reliability, flexibility and maintainability consistent with the program objectives.

Devices cannot just fall out of development laboratory engineering programs—if they do, they are likely to have a short life in the field where they are used. This is true because technology seems always to keep advancing. If you "drop out" a product without considerable planning for its technological growth, you may find that you are causing people to go down a "blind alley" in data processing.

That precisely is the underlying reason for file planning. One must assure first that the design allows for future growth in technology and also that concepts are introduced in data organization and handling which can be easily carried forward by the users as they advance to succeeding devices. If the plans are laid correctly, the job of education becomes eased—and the very acceptance of the concept more widely assured.

We are confident that the use of random access devices is destined for growth, and are hopeful that the planning done thus far will make it easier to achieve. ■

CARD RANDOM ACCESS MEMORY

interchangeable decks in random sequential systems

by HERBERT L. GROSS

Random access devices, as we know them today, fall into two categories: the earlier units, in which the recording medium is an integral part of the device itself and cannot be separated from it; and the more recent units which have begun to appear within the past few years, in which the recording medium is removable, replaceable, and interchangeable, like a reel of magnetic tape.

The wide usage of the fixed-medium devices is eloquent testimony to their success in furnishing solutions to many data processing problems. But they have certain inherent limitations that spurred the search for a new class of devices with greater flexibility.

limitations of fixed-file devices

If two or more different jobs are to be done at different times by the processor, but the aggregate of all the files exceeds the capacity of a single storage unit, then two or more complete fixed-file random access units are required to do the day's work, even though perhaps no one of them is needed for more than a few hours a day.

Also, it is difficult to make efficient use of a very powerful batch processing technique that random access devices make available. In this technique, the *selective* abilities of these devices are used, rather than their random abilities.

It is often preferable to sort the input before posting, and then proceed sequentially through the file, reading and writing only those portions of the file where activity occurs. This way of minimizing the number of "seeks" often saves far more time than is spent in sorting, and can yield a very high performance in file processing.

In this kind of operation, it would be most desirable to present the processor with only one section of the file at a time (as with reels of magnetic tape). But the permanent marriage of the recorded information to the recording device prevents this successive replacement of file sections, and demands enough units to hold the entire file—so that again one storage unit (holding the presently active section of the file) is working while all the other storage units are idle.

The sorting itself is a problem, unless magnetic tapes are part of this type of system. Since there is no other way of making the necessary working storage available, sorting can only be done on separate mechanical sorters, even though the processor might have sufficient idle time to do the sorting, and might be capable of doing it at high speed.

It is also very difficult and time-consuming to reorganize a file, to eliminate the excessive "chaining" that is eventually caused by insertions and deletions. Unless magnetic tapes are available, the entire file has to be punched out of the random access memory and then read back in again, at the expense of a great deal of time.

An analogous problem is that of rescue. No magnetic file is immune to a power failure that occurs during a writing operation, nor to fire or other catastrophe, nor to mechanical damage. But in view of the time required to punch out a copy of the entire file for rescue purposes (and in fixed-file devices there is no other way to make a copy without auxiliary magnetic tapes) this operation can economically be performed only at long intervals. Then, in case of file destruction, several weeks'—or even months'—work must be repeated in order to recreate the up-to-date file from the last available copy.

Or some contingency might shut the processor down for a period, without damaging the files. It is then impossible to remove the files from the processor, and take them to a backup installation for processing.

Finally, there are relatively few applications that can be

Director of National Cash Register's product planning for major computer projects, Mr. Gross joined the firm in 1954, at the Electronics Div. in Hawthorne, Calif. He has been at the Dayton, Ohio, headquarters since 1955, as director of training and later manager of customer services in the Data Processing Sales Div. He holds a bachelor's in physics and math from Pennsylvania, and a master's in math and statistics from Michigan.

performed efficiently with random access techniques alone. Some parts of the overall job are best done randomly (or at least selectively), while others are best done by father-son copying. In fact, there are situations in which the same file should ideally be posted randomly at one time and by father-son at another.

In attempting to cope with these problems before the development of replaceable-file random access devices, users were faced with four choices:

They could limit their EDP applications solely to those that were amenable to random access or sequential-selective techniques, and accept the limitations on rescue and backup.

They could install a magnetic tape system and give up random access altogether. If there were any jobs that absolutely required random access, those jobs were simply not done on a computer.

They could install a hybrid system, with both random access units and magnetic tapes, putting up with the fact that one or the other group of peripherals was idle for extended periods.

They could install two complete EDP systems: one random access; one magnetic tape. Even when the work load justified this cost, the complete lack of communication between the systems (except through punched cards or paper tape) sharply limited their ability to achieve a well-integrated system.

In order to eliminate these problems, and relieve the users of these choices, the industry has developed the second generation of random access devices, in which the recorded information can be separated from the recording device.

CRAM is such a second-generation device, and provides the user with a single magnetic file medium, whether his needs be random or sequential.

description of cram

A CRAM unit holds a deck of 256 magnetic cards. These cards are made of the same plastic material as magnetic tape (although considerably thicker) and are coated with the same kind of magnetic oxide material on one side. When the processor program calls for a particular card, that card drops out of the chamber and wraps around a rotating drum, where it is held by air suction (see Fig. 1). The card is now like a magnetic drum, but an unusual drum in which the recording occupies only about two-thirds of the circumference. One-third of each drum-revolution is thus free for updating the information just read, so that it is ready for re-recording during the next revolution. Thus the minimum processing time imposed by CRAM is one-third of a revolution, rather than a full revolution as with other rotating file devices.

When the program has finished with a card, it is returned via the top of the mechanism to the chamber, where it then occupies the outer right-hand position in the deck.

When a card is selected, it is chosen by the selection rods regardless of its location. In fact, the physical sequence of the cards is itself random, since the last-used card is always replaced at the end of the deck.

While the card is on the drum, data may be written or read in any one of seven information tracks during one revolution. No switching time is involved in changing from one track to another on successive revolutions, as the CRAM is provided with individual read-write heads for each track. While information is being recorded by the write head, the read head is performing a simultaneous validity check on the recorded information.

The pattern of tracks on the card is shown in Fig. 2. Each information track holds one block of information, which may contain up to 3,100 alphanumeric characters, or 4,650 numeric digits, or any proportional combination.

One card will hold 21,700 alphanumeric characters, and the deck will store over 5.5 million characters. Since most file information is numeric, these capacities can more pertinently be given as 32,500 digits and 8.3 million digits respectively.

The card drop time (235 milliseconds average) is completely shared with computing; in fact, the drop command may be issued for the next card, prior to the last read or write of the card presently on the drum, giving an effective drop time in continuous operation of 189 milliseconds. When the leading edge of the card approaches the read-write heads (reaches P.E.2 as shown in Fig. 1) the CRAM sends a "demand interrupt" signal to the processor in order to initiate a read or write operation. Reading or writing a full track of information takes 33 milliseconds, with 13 milliseconds available for computation before the beginning of the next revolution. If less than a full track

Fig. 1

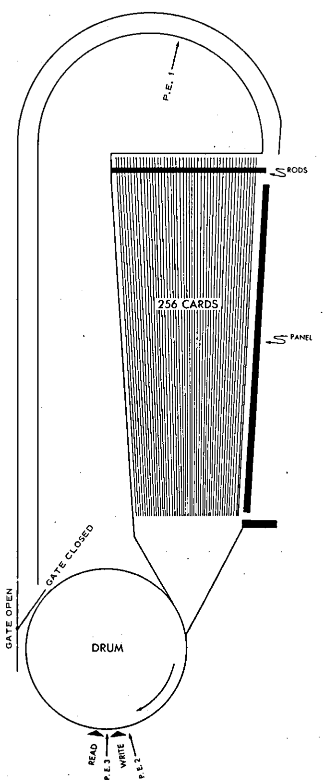
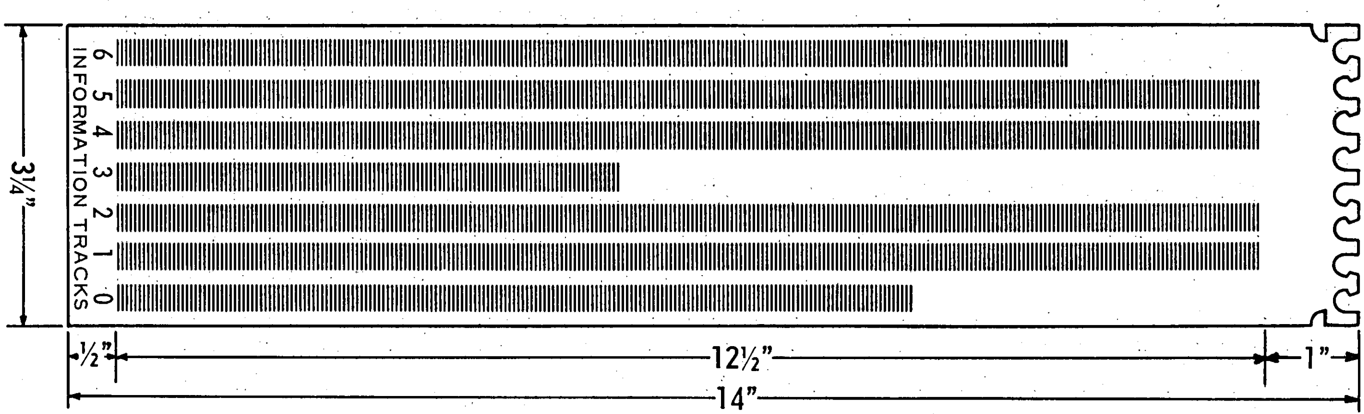


Fig. 2 Tracks on CRAM card.



is recorded, the read/write time is automatically shortened, and the free time is lengthened accordingly.

file processing with cram

When used as a random access device, assuming as worst case that each access is to a different card, CRAM can reply to inquiries (without updating) at the rate of over four per second, and can perform random postings at the rate of over 3½ per second. (This is on the reasonable assumptions that the file records are not over one track long, and that processing can be completed in the available one-third revolution.) With a reasonably random distribution of input transactions, several CRAMs in a system can be programmed to yield throughputs nearly proportional to the number of CRAMs, up to 10 or 12 postings per second.

The power of any random (i.e., selective) access device is greatly augmented by presorting the input, so that any one area of the file is accessed only once for all activity occurring there. CRAM permits the sorting to be performed by the same processor that will do the file posting, without needing additional components (such as magnetic tapes) for working storage during the sort.

A single CRAM can be used to sort a complete file of up to about 4 million digits (proportionately reduced for any alphabetic information). In sorting, the deck of 256 cards is logically divided into "compartment," analogous to individual magnetic tapes. The familiar repetitive merging process is performed, just as with tapes, except that the process is not limited to a two-way merge; the order of merging is as high as the individual processor memory size will accomodate. The same techniques are used in sorting with two or four CRAMs.

Depending on the number of CRAMs used, and the processor's memory size, CRAM sorting times are comparable to those of magnetic tapes in the 30 to 60KC range.

The simplest file posting operation is one in which input transactions are to be posted to a file, and output items created. Fixed-file random access devices require enough units to hold the entire file at one time, and also require external sorting of the transactions if the additional performance given by sequential posting is to be achieved. Magnetic tape systems do not have these drawbacks, but require a minimum of four tape handlers for this job if reasonable performance is to be obtained, and external sorting avoided (while if rewinds are to be shared, six handlers are needed).

The same operation requires two CRAM units, regardless of the size of the file.

A "scratch" deck is mounted on CRAM A, the transactions are read into the processor and stored in a portion of this deck, and then the transactions are sorted by repetitive merging between portions of the deck.

Meanwhile the *first* deck of the file is mounted on CRAM B. As soon as the sort is complete, the processor proceeds through the transactions in sequential order, posting them against the file, and producing output which is stored in the portion of the CRAM A deck that had previously been used for the sorting.

The program alternately accesses the transaction portion of the A-deck to read a track, and the output portion of the deck to write a track. Of course, if nothing further need be done with the output, it would be sent directly to a punch or printer as it was produced, and not stored at all. But CRAM permits the output of one run to be retained within the system for further processing, with no additional file units required.

When the first deck of the file is complete, the program stops while the operator changes decks on CRAM B, just as he would change reels of magnetic tape. Since there is no time spent in rewinding, the system is stopped only for the actual deck-changing time (which is comparable with the time to change a reel of magnetic tape) and it then immediately resumes the posting operation. This procedure continues until all the decks of the file have been posted.

This system is truly modular. About 2.8 million characters (over 4 million digits) can be sorted on one CRAM, but if the quantity of input is greater than this, both CRAMs are used for the sort, while mounting of the first file deck on CRAM B is deferred until after the sort is complete. The sorted transactions are now on CRAM A again. If the total of input plus output is greater than the capacity of one deck, an additional CRAM is made part of the system. If the file is very large, and deck-changing time becomes significant, two file CRAMs can be used, with alternation between them so that the system never stops.

In proceeding sequentially through the file, the program accesses only those cards, and those tracks within a card, where transaction activity occurs. With moderate file activity this selective posting process yields performance equal or superior to that of any conventional magnetic tapes.

The system requirements might, on the other hand, call for the entire file to be read. For example, action might be generated by a flag or by a next-action date stored in a file record. Even though the entire file is read, performance is still very high, since only those tracks whose accounts are active today need be re-written.

At any convenient periodic interval, successive decks of the file are mounted on CRAM A, and successive scratch decks on CRAM B. The entire file is then completely duplicated for rescue purposes at a cost (including deck change time) of less than five minutes per deck. If desired, the file can be re-organized at the same time, in order to eliminate any "chaining" that may have been built up.

The result is that a procedure which would require four to six tapes has been performed with two CRAMs, even though the file may be many times larger than the capacity of one CRAM deck. Even if the second run (the copy) were performed *daily,* the time to pass the entire file twice would be equivalent to the file posting time with magnetic tapes in the 45 to 50KC range.

On the other hand, system considerations (such as extensive expansion and contraction, insertion and deletion of records) might dictate father-son posting, with the direct creation of a new file as the result of the file run. In this case a third CRAM is added: CRAM B then holds each successive deck of the father file, and CRAM C holds each successive deck of the son file. In this application, the CRAM decks are treated exactly like continuous reels of magnetic tape: the successive tracks on successive cards are exactly analogous to the successive blocks on a tape. Now three CRAMs have done the work of a complete tape system.

trading performance for dollars

While one portion of the computing fraternity is seeking higher and higher performance, even at higher cost, a much larger portion is seeking lower and lower cost, even with lower performance. Among members of this majority group, the following procedure is quite common, and performs a complete father/son file posting with only two CRAMs.

When the master file is recorded on CRAM cards, and appropriate small number of the cards in each deck are not used.

When the day's transactions have been sorted, they are distributed—deck by deck—into the unused portion of the file, so that each file deck now contains its own sorted transactions. Then the transaction deck is replaced by a scratch deck.

Now, deck by deck, the file is posted, and the new file is produced on the other CRAM. Output items are stored in the reserved portions of the new file decks.

Obviously, the mounting of each deck of the father file twice, and the multiple card-drops involved in going back and forth between transactions and file records in the same deck, are time-consuming. But the small-volume user of EDP equipment is delighted to find ways of trading off operating time against hardware cost; he still gets his day's work done in a day.

A low-volume user might find that the relatively large block size (3,100 characters) used by CRAM requires more internal processor memory than he otherwise needs to get adequate performance. He can easily reduce his memory requirements by using only a part of the track length for recording, in order to deal with a much smaller block of information at one time. This does, of course, increase the number of decks required to hold his file, but *it does not increase the number of CRAM units.*

It is interesting to note that, under some circumstances, the recording of less than full-length tracks may actually increase system performance in random or sequential-selective operations. The CRAM normally allows 13 milliseconds free for computing between a Read performed during one revolution, and a Write performed during the next revolution. If the computing time required by the amount of activity in a track exceeds 13 ms, the writing takes place during the third revolution.

When a large amount of computation is required, a judicious reduction in the amount of available track-length actually used will reduce the read/write times and increase the available computation time between them, and insure that the majority of postings can be accomplished in two revolutions.

on-line real-time applications

It is coming to be more and more clearly recognized that *any* random access application is a potential on-line real-time application. It is in these areas that CRAM shows the greatest flexibility in using the same device and the same file medium, both for random access applications and for magnetic-tape-like applications.

Among the on-line applications for which CRAM systems are presently being installed are:

- Savings banks and savings & loan associations
- Airline and hotel reservations
- Mortgage service company, with remote inquiry
- Industrial production control
- Consolidated group medical benefits, with remote inquiry

The On-line savings bank application may be taken as typical of many of these jobs. In this system, every teller in every branch of the bank is at all times on-line, through leased telephone lines, to the complete Depositors' File, which is continuously maintained by the computer at a central location. Thus each transaction is posted to the individual depositor's ledger as it occurs, with immediate verification of balances, notification of "holds," and furnishing of accrued interest and other transactions not yet entered in the depositor's passbook.

The bank maintains its Depositors' File in two forms: a skeleton file, which is available to the tellers for their on-line operation during the banking day, and a complete historical file, which is posted at night when the banking offices are closed.

It would be expected that the on-line skeleton file would be recorded on a random-access medium, while the off-line historical file would be recorded on magnetic tape. With CRAM, however, both files are recorded on the same file medium, and both files are posted on the same devices.

During the day, the system requires as many CRAMs as are necessary to contain the entire on-line skeleton file. During the night, *those same CRAMs* are used to post successive decks of the off-line historical file by the father-son method. Then the same CRAMs are used again to perform the bank's other processing jobs, posting the files by either random or sequential techniques, as appropriate to the individual file and the individual application.

mixed cram-tape systems

It is an indication of the flexibility and versatility of CRAM that mixed systems have, in general, been found appropriate only in highly specialized situations. Some of them are:

> All of the processing is performed on CRAM. However, it is required that extremely voluminous historical files must be kept for many years, even though they are infrequently referred to. The cost of magnetic tape for this "dead storage" is lower than the cost of CRAM decks, and one magnetic tape handler is included in the system to record this historical file.
>
> All of the processing is performed on CRAM, but one magnetic tape handler is used for interchange of information with other computers.
>
> All of the processing is performed on a high-performance tape system. However, one or two CRAMs are part of the system to provide random access to a great number of exception-subroutines and rate-tables. Here too a removable-file device is preferable to a fixed-file device, since each of the many files to be processed requires its own subroutines and its own tables; the same CRAMs serve them all.

conclusion

It would appear, from much of the foregoing discussion, that there are no applications for which removable-file random access devices like CRAM are not superior to fixed-file devices, and to magnetic tape. This is not quite so.

There are fixed-file random access units that exceed CRAM in one or another operating parameter—such as, for example, sheer quantity of bulk storage that can be provided. A user whose sole EDP requirements involve random access to a single large file may find a unit of that type preferable.

High-performance magnetic tape, on the other hand, remains preferable for very large sorting jobs, and for extremely large files that are subject to very high activity, in an installation with no requirement for random access or on-line applications.

Card Random Access, however, provides a single practical unit for both random and sequential processing, within an extremely broad performance range. This flexibility, applied to the actual requirements of data processing installations, has repeatedly demonstrated highly efficient operations in the more than 18 months since its first deliveries. ■

EDITORS' NOTE . . .

A lower-cost model of CRAM has recently been announced. Its characteristics are:

6.3 million alphanumeric characters per deck
886 alphanumeric characters per track
Information transfer rate: 28.5KC

RANDOM ACCESS FILE SYSTEM DESIGN

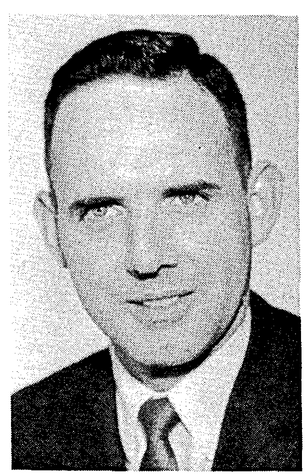
application vs. hardware considerations

by ROBERT J. BUEGLER

The solution of a data-processing problem through the application of random access files must be guided by the basic objective of achieving the optimum design within the limits of justification and stated requirements. Briefly stated, economic system design is achieved by maximum utilization of the minimum amount of equipment with a minimum of programing effort and operating expenses. A full statement and understanding of the problem is a prime requisite to reaching the appropriate solution. The reader may consider such a requirement as obvious, but in the design of a system using random access files, the problem is usually of a dynamic, real-time nature. Underestimating the size of a batch-processing job may lead to longer running times or the necessity for adding equipment. In a real-time, random access problem, an underestimate may result in a system design which is fundamentally inadequate to the job. Additional running time is not permissible, and equipment additions will not necessarily increase the system throughput capacity.

problem area

The amount of data, the size of records to be stored and the reference requirements define, most basically, the magnitude of the problem and, at the same time, narrow the search for file units of appropriate storage capacity and accessibility. For example, a storage requirement for 50,000 records of 50 characters each and a random access rate of 30 per second points in the direction of fixed head drum storage. However, 500,000 records of 50 characters



Mr. Buegler is group head, Systems Engineering Section of The Teleregister Corp., Stamford, Conn. He has developed large-scale dp/communications systems for airlines, and designed simulation, display, inventory control hardware, as well as a system using time multiplex techniques to register dialed inquiries and transmit computer-constructed voice replies. He holds EE degrees from Columbia and MIT.

each, accessed at the rate of three per second, would indicate that a head positioning type of drum or disc could be used. Further investigation of the problem will provide additional parameters permitting the selection of a random access file storage medium which meets all requirements. As will be demonstrated, the file problem area cannot be considered independently from the other portions of the system, and, to some degree, it depends on and influences the system solution.

problem factors

Problem investigation and analysis provide the details which influence the system design and choice of components. Typically, in the selection of a suitable file, items to be examined include:

- Types of records to be filed
- Numbers of record types in each file
- Information fields and their sizes in each record
- Means of referencing each file
- Processing requirements for each file reference
- Maximum rate of access to each file
- Time dependency of records activity in each file
- Response time requirement in reference to each file
- Immediate or deferred return to file of modified record
- Expansion requirements
- Reliability requirements
- Accuracy requirements
- Fallback and data recovery requirements
- Off-line processing requirements for file search, updating, and reorganizing
- Full or restricted system access to files

The following example illustrates a few of the considerations. A file of 50 million characters requires random accessability to records of 20,000 characters at the rate of one per record. In addition, the 20,000-character records are composed of sequentially ordered sub-records of 100 characters each which require an average of 10 accesses for each access to the main record. Allowable processor throughput time is approximately two records. This requirement points in the direction of a large disc file (50 million characters), head positioning time of 200 milliseconds or less with at least 20,000 characters accessable per arm position (perhaps multiple heads per positioner), and a rotational time of 50 milliseconds or less (10 accesses per position). Note that the total access time per reference is approximately 200 plus 10 x 50, or 700 milliseconds. This would be an average 70 per cent load factor on the file, resulting in a waiting time equal to the access time. If a longer access time is permitted, the file reference rate of one per second would lead to a long queue in the processor and the throughput time would exceed two seconds.

problem solution

With detailed answers to the above factors, a workable concept emerges for a method of solution permitting the selection of file units. Having developed for each file the rate of access, method of retrieval, accuracy, etc., it now is possible to calculate for a given file unit:

- The number of records per file unit
- The number of file units required including expansion
- The average time of each access
- The amount of data transferred per access
- The maximum rate of access per file unit and per entire file, including expansion
- The occupancy of each storage unit and entire file
- The number of control units for accessing the file

A wide variety of random access storage devices is available to the system designer, although in specific instances, his area of choice may be limited. The range of access times is from a few milliseconds to times in excess of 500 milliseconds. The range of storage capacities is from a few thousand to tens of millions of characters. In general, fast access is associated with relatively small storage capacities, and slow access is associated with larger stores. Single head per track storage units provide access times related to rotational speed. Multi-track per head storage units include both positioning and latency times in their access. Storage units with positioning mechanisms are inherently less reliable than single head per track storage units but in general are less costly per digit of storage.

Comparison of a few commercially available storage devices is made below to illustrate the relationship among access time, capacity, and cost.

Storage Device	Access Time Milliseconds	Capacity Megabits	Cost Cents/Bit
Drum	5	0.5	1.5
Drum	17	5	0.7
Drum	25	25	0.4
Disc	150	150	0.07

The costs are for the device, itself, and directly associated electronics. No attempt has been made to represent per-bit system cost which must include such factors as dual processor accessibility, fallback provisions, processing time as related to access time, etc. An important system cost factor relates to the type of recording used in the device. High capacity devices are usually not single-bit changeable, requiring the transfer of a large number of bits to read or write data. The lower capacity devices are usually less densely recorded and, dependent upon address structure, a single bit can be read or recorded. This can be of major significance in considerations of transfer time and processor core storage reserved for data surges.

The selection, or tentative selection, of a given storage unit(s) is only the first step and consideration must next be given to incorporating the file(s) into an integrated system. Such factors as reliability, fallback, expansion, programming complexity, maintenance, and operating schedules must be included in this process.

The types of decision which must be made in arriving at a system configuration relate to:

- Single-processor versus multi-processor system
- Single versus multi-level processing
- Single or multiple types of storage devices
- Single or multiple storage units of the same type
- Duplication of equipment and switching arrangements
- Backup files for record recovery and reconstruction
- Provisions for system and file maintenance

In general, an ideal solution with ideal components would be: the use of one processor programmed at a single level of processing, and one type storage unit. The realities of the problem, however, are such that available hardware, both processor and storage, is less than ideal. In fact, there are limitations in speed, accessibility, size, reliability and accuracy. Backup, duplication, and maintenance time must be considered in meeting the problem requirements of reliability and accuracy. Multiple units or operations must be considered where there are limitations of speed, access time, and size. A few general observations in this decision-making process are presented.

The selection of a single processor is preferable to a multi-processor arrangement for carrying the operational load because the switching equipment required in a multi-processor system to provide accessibility to common files can be a costly item.

Single-level processing requires less processor working storage and a lesser programming effort than multi-level processing but, on the other hand, makes less efficient use of the processor. If the problem is such that processor throughput times are storage access limited and a single level of processing cannot handle the maximum transaction rate, then a decision must be made for either multi-processor or multi-level processing.

Single versus multiple types of storage devices may be decided by such factors as time dependency of record activity or relative activity of different types of records together with considerations of multi-processor and multi-level processing. A typical problem of this type might be an airline reservation system. A flight is available for sale as much as one year in advance of departure. However, 70 per cent of the sales on the flight are made in the last seven days before departure. In addition, the flight inventory record is referenced more frequently than are the individual records of the passengers booked on the flight.

As a particular example, if an entire record file were stored in a pair of large, mechanically accessed type of storage units, the rate of access to the file might be such that two processors, each operating at three levels would be required for handling the call rate. If, however, detailed analysis of the file reveals that five per cent of the file is a record type which requires 70 per cent of the accesses, and another five per cent relates to a time period which requires 15 per cent of the accesses, a different solution becomes possible. Consider that the 10 per cent of the file which requires 85 per cent of the activity is placed in fast, multi-head, magnetic drum storage. The remaining 90 per cent of the file which requires 15 per cent of the accesses could remain in the original storage. It would then be possible, with the same processor, to handle the work load with one processor, programmed to operate at one (possibly two) level(s). The elimination of one processor, simplified programming, and simplified switching probably realizes a cost saving against the addition of a second type of storage unit.

The consideration of single versus multiple units in a storage type must be made in the light of such factors as: normal capacity in a given type; safety factors in spreading file over more than one unit; and transfer time and/or recoverability and reconstruction time in the event of full or partial failure. The temporary loss of an entire file through failure of a single storage unit may be tolerable in a system not operating in real time. However, in an on-line system, loss of an entire file can mean complete loss of service until recovery is made. With multiple storage units, the failure of one may not completely disable the operation. Further, recovery or file reconstruction time would be less in a system of smaller multiple storage units than in a system with a single large storage unit.

The general area of file duplication, backup files, and fallback procedures is largely dependent on problem requirements. Full duplication of random access files requires additional accesses and processor time in addition to the cost of duplicate devices but provides for immediate and 100 per cent fallback.

Backup files may be considered generally as magnetic tape images of the random access files, established at some cut-off point in time, supplemented by magnetic tape transaction files of all activity since the cut-off time. In the event of random access file failure, a spare storage unit may be reconstructed at the expense of some delay in regaining access to the random file but at a considerably lower cost than in the case of file duplication.

Provisions for system and file maintenance are largely dependent upon the operational requirements of the system. If the system is not in use around-the-clock, less spare and duplicate equipment is required than for a system in 24-hour operation. A random access unit requiring a weekly service routine must have its file contents transferred to a spare unit if the information is to be continuously available. In 24-hour operation, a spare processor must be available during low-activity periods to conduct file service routines without interfering with operational routines or data.

Similar problems of different magnitudes may follow the same functional solution but the hardware configuration can vary widely. As an example, a passenger reservations system for a small airline may have a system call rate which can be adequately processed with a single computer and with all random access records contained in a magnetic disc file. A larger airline, with the same functional characteristics but a proportionately higher call rate may involve two computers, both high- and medium-speed magnetic drums, and magnetic disc files, in order to provide the necessary accessibility to records.

In large-scale applications, the use of multiple types of storage devices can prove to be a distinct advantage, particularly when considering future expansion. Initially, a system may be well balanced with a combination of drum and disc storage. However, with growth of system activity, the disc storage system may become too heavily loaded and a serious increase in queues and response times results. A solution to this problem might be the addition of another magnetic drum and the transfer of highly active records from the disc to the drum file. This would reduce the throughput time of transactions requiring access to those records and result in an improvement in both processor loading and queuing of transactions.

optimizing the solution

Throughout the process of arriving at a solution, efforts should be made to cut and fit the problem to the hardware available for use. If the processor occupancy or loading is considerably less than the occupancy of the random access files, full advantage has not been taken of a possible reduction in the size of the file. For example, a file may be reduced in size by record compression. This compression is done at the expense of additional processor time and additional instructions in programs in order to decompress retrieved information. However, the compression is partially compensated by the reduced amount of data transferred in the process of retrieval.

In a cross-indexed reference system, the retrieval of a basic record in file is dependent upon prior access to more than one associated reference records. If one of the associated records has a higher probability of reference than the others, the basic record should be stored with that reference record to minimize its retrieval time.

A random access record is often required for fast reference only, and the modified value may not have a requirement for immediate updating in file. Accumulating such modified records for batching of file re-entries may provide the advantage of sharing access times and reducing computer load at the expense of additional working storage in the processor.

These and other similar techniques are the prerequisites to achieving a balanced system design which optimizes performance against cost.

In summary, the successful application of random access files to the requirements of a problem is contingent upon both a full understanding of the problem and a consideration of the interdependence of the files to the other components of the system. ■

an appraisal

RANDOM ACESS STORAGE DEVICES

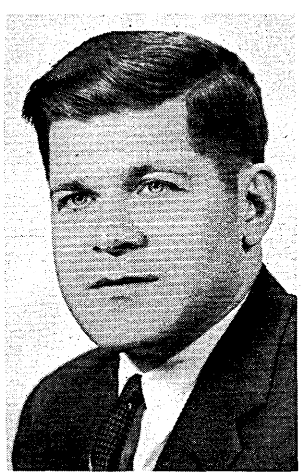
by NORMAN STATLAND & JOHN R. HILLEGASS

In the ideal data processing system, every data record would be instantaneously accessible, making possible a systems concept in which any single transaction would be followed immediately by entries into each affected file. For example, an order request might affect inventory, production scheduling, materials control, billing, dispatching, accounts receivable, credit control, salesman's commission, and other files. Random access storage units make possible an on-line information flow that represents a return to the philosophy of a single data processor. Our forefathers knew this type of business data processing in the form of the solitary bookkeeper, with his green eyeshade and high rolltop desk, who handled all of the firm's paperwork.

As record-keeping functions changed in order to keep pace with increased volume, job specialization, and government requirements, the lone bookkeeper was replaced by departments of people whose function it was to collect, transcribe, post, and evaluate information. Today these departments handle significantly larger volumes and produce more complex reports and analyses. With the arrival of the Information Revolution (i.e., the use of computer systems as management information tools), businessmen and data processing specialists are endeavoring to regain the versatility and centralization of control exemplified by the total systems concept enjoyed over 120 years ago.

types of random access units

Literally defined, "random access" simply refers to the ability to locate any arbitrarily chosen record in a relatively equal amount of time. In normal usage, file storage media are spoken of as either random access or sequential access. Core memory, for instance, is random access memory in the most effective sense since all data is accessible in a matter of microseconds, but the cost per character stored is too high to make core memory practical for on-line storage of large files. On the other hand, magnetic tape, which holds information in serial form, may require that hundreds of feet of tape be read to locate a specific data record. Thus, tape units, by their very nature, are not considered random access units since the time to retrieve



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Mr. Hillegass is a member of the technical staff of Auerbach Corp. and editor of its encyclopedic Standard EDP Reports. He is active in the evaluation of systems and application studies. Awarded a BS in chemical engineering from Lehigh Univ., he was formerly senior staff engineer, programmer, and instructor with the scientific computing facility of Air Products and Chemicals Inc.

any given record is highly variable. Other units commonly classified as random access memories are magnetic drums, magnetic discs, and magnetic tape strips, where each record is readily available after the proper address is selected from an index or directory of record addresses.

Magnetic drum storage offers more storage capacity at less expense than core storage, but involves slower access times. Drum devices consist of a revolving magnetically coated drum with information arranged in tracks around its circumference, allowing read/write heads to pick up and record data as the desired items pass under the heads. Thus, a rotational delay of up to one drum revolution can be incurred in accessing a particular record. Disc file devices can be viewed as a direct adaptation of the magnetic drum storage concept. A disc is a flat surface containing information recorded on concentric circular tracks. Read/write heads are mechanically positioned to a specific location above the revolving disc and then wait for the desired record to pass. Multiple flat surfaces or discs can be mounted on a single shaft to provide larger storage capacity than is commonly found in drums—usually at a significantly lower cost per character stored. Generally, however, the mechanical motion of head positioning, in addition to the rotational delay (or "latency") while waiting for the desired record, makes the disc slower than the drum.

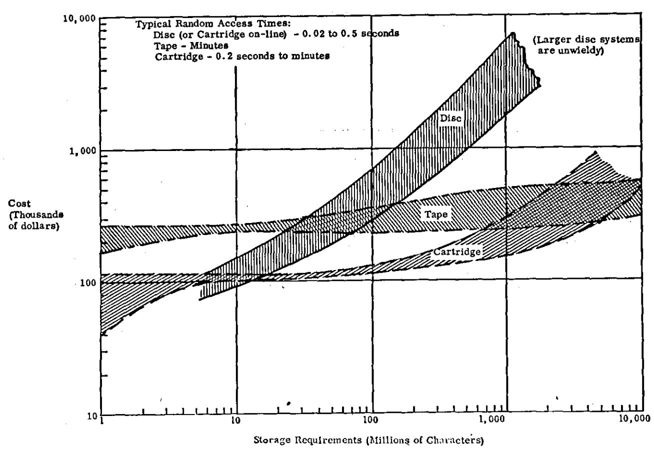
Various other random access devices utilize magnetic tape strips (e.g., the Burroughs Data File which is no longer in production), magnetic cards (NCR's CRAM), and removable "Disc Packs" (the IBM 1311 Disc Storage Unit). Random access devices such as CRAM and the IBM 1311, in which the storage medium can be conveniently removed, stored off-line, and reinserted, are designated "cartridge units" in this article. The relationships of speed, cost, and capacity for various random access units are illustrated in the chart shown in Fig. 1.

the comparison chart

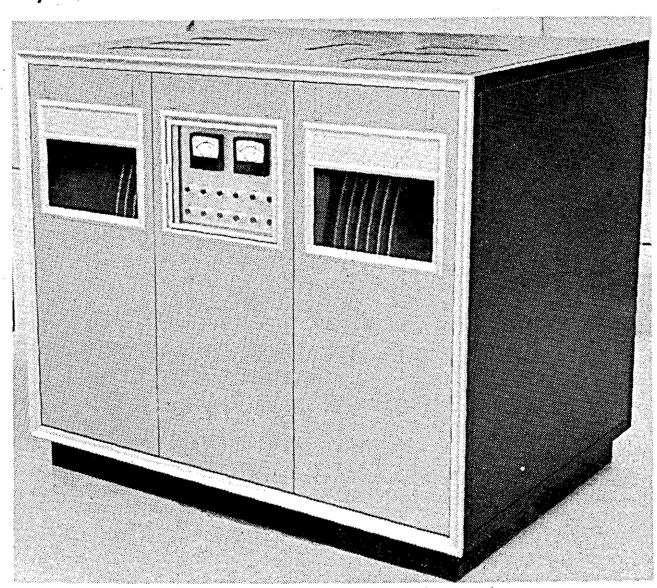
The accompanying comparison chart (Page 44) summarizes the significant characteristics of representative random access storage devices. The entries have been selected to pinpoint specific advantages or disadvantages of each device from a user's point of view.

- Category—The storage devices included in this chart can be grouped into three major categories: Magnetic Disc Files, Cartridge Units (in which the storage medium is conveniently replaceable), and Magnetic Drums.
- Device—Identifies each device by manufacturer, model number, and the name by which it is commonly known.
- Representative Computer System—It is difficult (if not meaningless) to evaluate a random access storage device independently of the computer system to which it is connected. We have selected a single, representative computer system to serve as a basis for all the comparison chart entries for a particular storage device. The capacity and performance characteristics of some storage devices are significantly different when they are associated with other computer systems. The characteristics of the Honeywell 400 and RCA 301 adaptations of the Bryant 4000 Disc File are, in fact, so dissimilar that both versions are shown in the chart.
- Storage Medium—The physical medium upon which data are recorded.
- Storage Capacity—The six entries in this general category define data storage capacity in terms of:
  (1) The number of data discs or drums per physical random access storage unit (often a variable quantity, in which case the range is indicated).
  (2) The number of tracks on each disc surface or drum upon which data can be recorded. (Where a logical track is composed of two or more parallel bit channels which are always read and recorded at the same time, the fact is noted under "Features and Comments").
  (3) The maximum number of alphameric characters that can be recorded on a single track.
  (4) The maximum number of characters that can be read or recorded without any repositioning of the read/write heads (i.e., the volume of a "cylinder" in the Bryant 4000 and the IBM 1301 and 1311, or the total storage capacity in devices which have a fixed read/write head serving each track).
  (5) The maximum number of alphameric characters (usually 6 bits per character) that can be stored in each physical random access storage unit.
  (6) The maximum number of physical units (i.e., cabinet modules) of random access storage that can be connected on-line. This figure is highly dependent upon the particular computer system with which the random access device is to be associated. Maximum on-line capacity for each type of random access storage (with the representative computer system with which it is associated in the chart) can readily be derived by multiplying "Maximum Character Capacity per Physical Unit" by "Maximum Number of Physical Units On-Line."
- Head Positioning Time—For storage devices with movable read/write heads, the time required to reposition

Figure 1



Bryant 4000



these heads is reported in terms of:

(1) The minimum time required to move the heads to the next adjacent track position.

(2) The average time required to position the heads to read a randomly placed record.

(3) The maximum (worst-case) positioning time.

- Average Rotational Delay—The average time (in milliseconds) required for the start of the selected data record to reach the read/write heads after the heads have been properly positioned (usually one-half a revolution in the case of magnetic disc and drum storage devices). The total average "access time" for a randomly placed record is, of course, the sum of "Average Head Positioning Time" and "Average Rotational Delay."
- Peak Data Transfer Rate—The maximum rate at which data is read from or recorded upon the random access storage medium after the desired record has been located, expressed in characters per second. When large blocks of data must be read from or recorded in consecutive storage locations, the overall effective data transfer rate will, in some cases, be significantly lower than the peak rate due to rotational delays between records and/or the need for head repositioning.
- Transfer Load Size—The number of alphameric characters that can be transferred to or from the random access storage device in a single read/write operation. The load size is fixed in some cases and variable in others. Where the minimum increment for a variable-length load is greater than one word, the increment is stated; e.g., "100 to 20,000 by 100."
- Read/Write Checking—The type of checking performed upon the accuracy of data recording and/or reading. The most commonly employed method is to generate and record a parity bit for each character, word, or record, and to check the recorded data for correct parity when it is reread. "Check characters" usually implies a similar but somewhat more powerful system for detecting errors (and, in some cases, correcting them). "Read after write" parity checking or separate (and time-consuming) "write check" operations permit detection of most recording errors at the time of occurrence—a highly desirable feature.
- Representative Cost—To complete the picture, a cost, expressed in dollars per character position (based on purchase cost), is listed for each type of random access storage. This cost is based upon the price of a single physical storage unit of the largest available capacity, together with any control units that are required to connect it to the specific computer system shown in the chart. (The costs of general-purpose computer data channels and multiplexors are *not* included.) It is important to note that the cost per character for a particular type of random access storage may vary significantly when it is associated with a different computer system, or when more or less storage capacity is required.

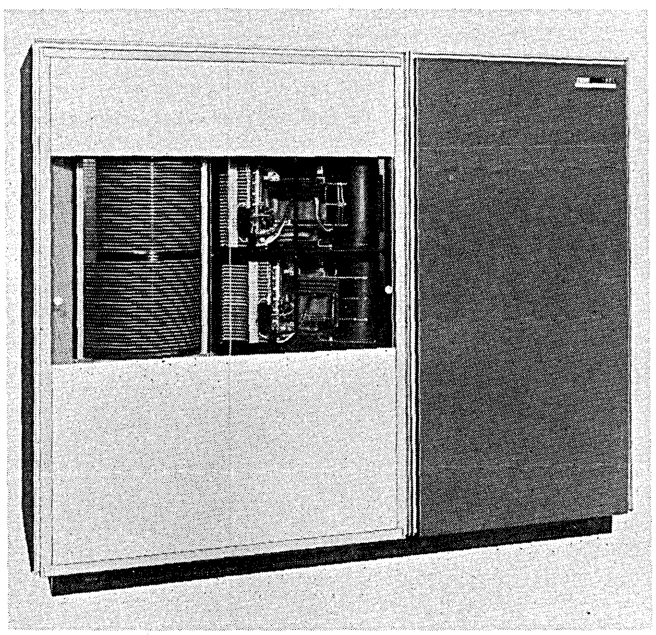
magnetic disc files

The IBM 1405 Disc Storage Unit is representative of "first generation" random access data storage devices. The same basic unit, with less storage capacity, was used in IBM 305 RAMAC systems. A stack of 25 or 50 discs is mounted on a single vertical shaft and served by a single access arm. The arm moves vertically to the selected disc, then horizontally across the disc to the selected band. This extensive mechanical motion leads to average access times of over one-half second.

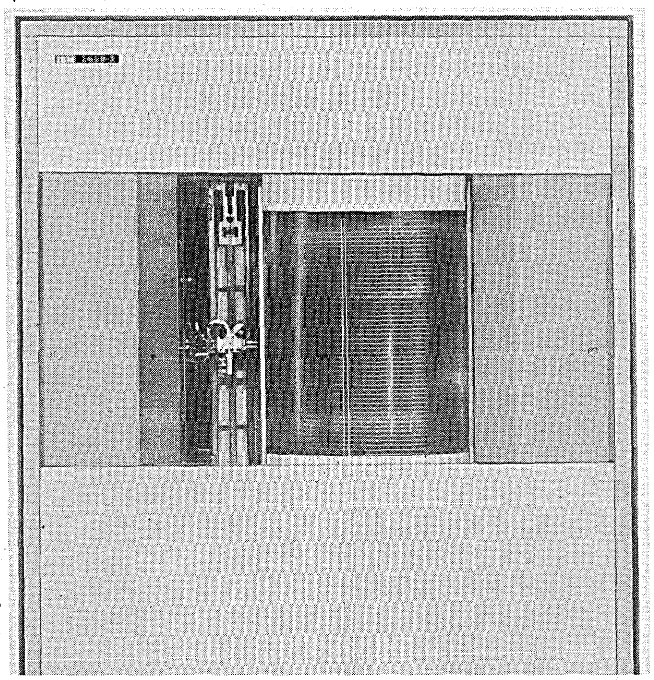
Second generation magnetic disc files are exemplified by the Bryant 4000 (used in Honeywell, RCA, and other computer systems) and the IBM 1301. The key improvement is the use of a "comb" of access arms, one for each disc. All the arms move in unison, and mechanical motion is limited to the plane parallel to the disc faces. The resulting average head positioning times are lower by a factor of four to six than the corresponding time for the earlier IBM 1405. In the IBM 1301, a single read/write head serves all of the 250 data tracks on each disc surface. In the Bryant units, each disc surface is divided into six "zones" of 128 tracks each, with a separate read/write head for each zone.

IBM 1302 Disc Storage, announced in September 1963 for delivery in 1965, is an upgraded version of the IBM 1301. Increases in the number of characters per track and the number of tracks per disc surface will more than

IBM 1301



IBM 1405-2



quadruple the data storage capacity and double the peak data transfer rate, at a significantly lower cost per character stored.

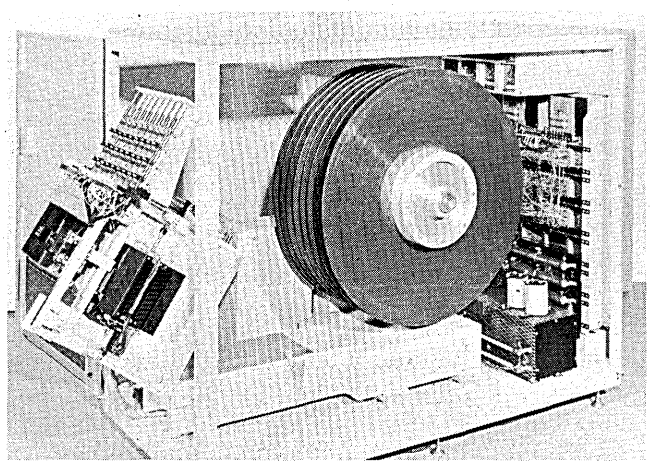
The advent of the comb-like access mechanism has prompted a change in disc file organization concepts. Because all the read/write heads move in unison, they are always at the same track position relative to one another. The data tracks that can be accessed by all the read/write heads at any one position of the access mechanism constitute a "cylinder." The number of cylinders in a disc file is equal to the number of discrete positions of the access mechanism (128 in the Bryant units and 250 in the IBM 1301). Since all of the considerable volume of data in any given cylinder (up to 936,000 characters) can be processed without any head repositioning optimum organization of the user's data files in disc storage can eliminate a sizeable portion of lost time due to access delays when processing sequentially arranged records.

The GE M640A Disc Storage Unit (manufactured by General Electric from a design developed by Telex, Inc., which has since been bought out by Data Products Corp.) represents a subtle but significant departure from the comb-like access mechanism. The GE unit incorporates a separate, individually positioned access arm with eight read/write heads (four per disc face) for each of the 16 data discs. This system permits more flexibility in disc file organization, but only one of the 16 access arms can be repositioned at a time. A two-way (word and record) parity checking scheme makes possible programmed correction of most single-bit read/write errors.

The recently announced Burroughs On-Line Disc File System has a read/write head for each individual data track. This arrangement eliminates all lateral head movement and limits the total access time to the rotational delay time of from 0 to 40 milliseconds—less than one-fifth of the random access time required by the second generation disc files with movable access arms. Significantly, costs per character of storage are competitive in spite of the large number of read/write heads used.

Anelex Corp. has announced a family of three random access disc files. All three models utilize comb-like access mechanisms in which all the read/write heads move in unison. Model 80 utilizes interchangeable cartridges called "disc kits;" each kit contains six discs and can store up to 3,900,000 characters. A constant head positioning time (exclusive of rotational delay time — 12.5 msec) of 75 msec is achieved through the simultaneous operation of seven binary clutches and division of the disc surface into two zones of 100 tracks each. These tracks are accessed by an arm containing two heads (one per zone) per disc surface. The Anelex model 800 accomodates up to eight non-interchangeable discs and stores up to 23 million characters; there are four heads per disc surface, and average head positioning time is 100 msec. Model 4800 employs from eight to 24 discs and stores up to 95 million characters; four heads serve each disc surface, and estimated head positioning time averages 50-65 msec.

Anelex 800



Addressing of record locations on magnetic disc files is usually handled by dividing each track into sequentially numbered sectors. With the notable exception of the IBM 1301 (which features variable sector lengths, defined by the user by means of patterns recorded on a special format disc), each sector has a fixed data capacity. The tracks on each disc surface are usually numbered sequentially, starting at the inner or outer perimeter. Finally, identifying numbers are assigned to each disc or disc surface and to each physical unit of disc storage. The resulting disc record addresses are too long (20 to 30 bits in most cases) to be incorporated directly into the computer instructions that initiate disc file positioning, reading, or writing operations. Instead, the computer instruction usually specifies a location in core memory which, in turn, contains the address of the selected disc record location.

Two major mechanical problems have been encountered in the development of high-performance magnetic disc files: achievement of the desired speed and precision in positioning the read/write heads, and prevention of damaging physical contact between the heads and the recording surface. A variety of complex, ingenious, electromechanical techniques have been employed in the design of the head positioning mechanisms, permitting rapid, dependable performance with data tracks packed as densely as 64 tracks per inch. High recording densities are essential for high data transfer rates and high data capacities, and this demands that the read/write heads be kept within a few ten-thousandths of an inch of the magnetic recording surface. But actual physical contact between the heads and the rapidly revolving surface can be disastrous. Extensive use has been made (in both disc and drum units) of the "flying head" principle, in which the read/write heads "float" on a layer of air generated by the rotational friction of the disc or drum. Some units employ solenoids to retract the heads and prevent physical contact in power-failure situations.

cartridge units

Cartridge units, with their replaceable data storage media, represent an intriguing combination of the random access capabilities of magnetic discs and the essentially unlimited total storage capacity of magnetic tape. In utilizing cartridge units, considerable attention must be devoted to the fact that relatively long delays are incurred whenever cartridges must be inserted by the operator because required records are not available on-line when needed.

The first-generation RCA 361 Data Record File features 128 data discs arranged in a circular cage. Individual discs can be inserted into and removed from the cage by an operator. The cage rotates to position the selected disc where it can be extracted from the cage and placed on a turntable, under the arm containing the read/write heads. This complex (but relatively economical) arrangement leads to average access times of approximately five seconds.

The NCR model 353-1 CRAM (Card Random Access Memory) unit uses flexible magnetic cards as its data storage medium. A cartridge containing 256 cards can be quickly removed, replaced by another cartridge, stored off-line, and reinserted when necessary, in the same manner as a reel of magnetic tape. Each CRAM cartridge can store over 5.5 million alphanumeric characters. One selected card at a time is dropped from the on-line cart-

ridge and wrapped around a revolving drum, after which any or all of the seven 3,100-character data tracks on that card can be read and/or recorded upon. The recording mode is similar to that of many magnetic tape systems: eight-bit channels (six for data) per track, with lateral and longitudinal parity checking and a "read after write" check that detects most recording errors at the time they occur.

NCR has recently announced the model 353-2 CRAM unit for use in its new 315-100 EDP system. The new CRAM model utilizes bit-serial recording (one bit channel per data track). This change results in a higher data capacity per cartridge, a lower data transfer rate, and a lower equipment cost as compared to the model 353-1.

The IBM 1311 Disc Storage Drive (announced in October 1962) combines the comb-like access mechanism of the IBM 1301 with lower on-line storage capacity and a lower price tag, and adds the advantages of cartridge loading. Each "Disc Pack" storage cartridge consists of a stack of six physical discs (of which 10 faces are used for data storage), weighs less than 10 pounds, can be removed from the Drive Unit and replaced by another cartridge in one minute, and can store a maximum of 2,980,000 characters.

One of the key questions concerning cartridge units is their daily performance reliability under normal operating conditions. At this time, virtually no data on mean time between failures statistics is available for these units.

magnetic drums

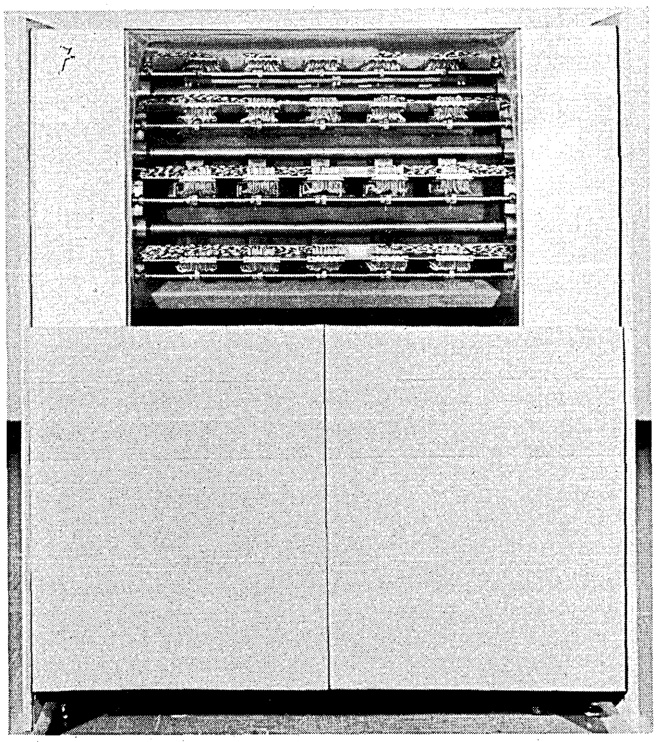
The "conventional" magnetic drum employs a fixed read/write head for each track, so that the only access time factor that must be considered is the rotational delay until the selected record reaches the head (usually an average of one-half a revolution). Two magnetic drums of this type—the IBM 7320 and the Univac FH-880—are shown in the comparison chart. Both are characterized by relatively fast access times and transfer rates, relatively low storage capacities, and relatively high costs per character stored. This type of drum storage is particularly suitable for systems programs, segments of currently operating programs, address directories for larger-volume random access units, and on-line applications where fast response is more important than high storage capacity.

Two Univac drum units employ movable access mechanisms which (as in disc files) decrease the number of read/write heads necessary to serve large volumes of stored data, but increase the access time whenever repositioning of the heads is required. The Randex Drum Unit, used in Solid State 80/90 systems, employs one or two drums in a single physical cabinet. The single access mechanism, with one read/write head per drum, moves horizontally to the selected data track. In concept and overall performance, the Randex Drum is comparable to the IBM 1405 "RAMAC" Unit, even though one employs a drum and the other uses multiple discs.

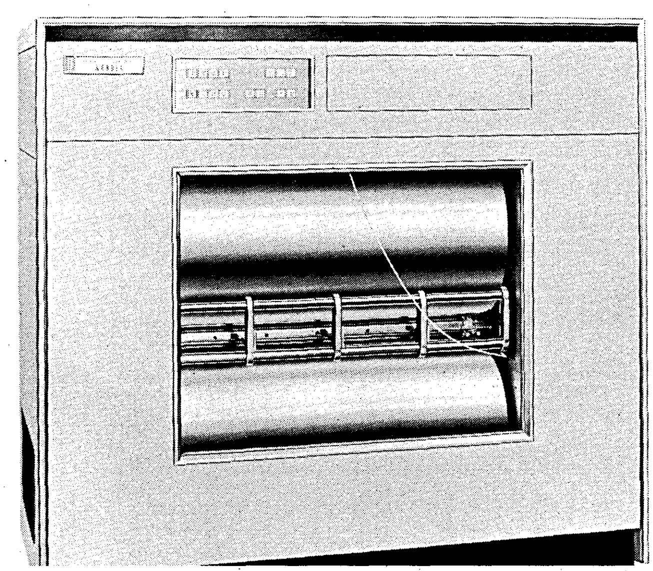
Fastrand Mass Storage, a recent announcement for use in Univac 490 and 1107 systems, also uses a single access

IBM 1311

Univac FH-880



Randex Drum



mechanism to serve the two physical drums in each cabinet. Fastrand, however, employs 32 read/write heads per drum. Each head serves 96 adjacent tracks, and all of the heads move horizontally in unison, resulting in an average head positioning time of only 57 milliseconds. Furthermore, up to 688,128 characters (analogous to a disc file "cylinder") can be accessed at any given position of the access mechanism. A longitudinal data check character is used to detect read/write errors and reconstruct up to 11 bits of missed data.

random or sequential processing?

The business executive usually becomes enthusiastic about the capabilities provided by a random access system that will permit direct inquiry into the file records. Since random access processing can eliminate the time delays involved in sequential batch processing, as used in a punch card or magnetic tape system, one can assume that the files are current and reflect an up-to-date situation. Also, it is possible to use a "one-pass" or integrated applications approach, since related records can either be stored together in one track or rapidly accessed from different parts of a disc or drum file. In a sequential or batch processing system, separate passes of the transaction data may be necessary before the processing cycle can be completed.

Use of random access storage for master files facilitates application of the concept of management by exception. A review of all the existing records can be made at any time, with printouts of only those records that fail to satisfy certain prescribed criteria, indicating the need for attention and action by management. Random access storage units are necessary for on-line business systems operations where diverse types of file data may be needed. On-line business systems, in turn, are a primary medium for effectively producing properly selected information for management.

Another point in favor of random access systems is that by processing transactions as they occur, one can avoid the creation of work scheduling problems within the installation. No longer need reporting for end-of-month closings be delayed two or three days nor weekly reporting cycles all fall on the same production day. These points all favor continued increase in the use of random access processing and on-line systems. On-line applications can be supplemented by those processing tasks that require a "rapid response;" that is, tasks in which the output of results must be forthcoming within a limited period, but immediate on-line action is not required.

An important point to consider when contemplating the use of disc or drum files is the problem of destructive updating of records, whether they are sequentially or randomly arranged in the random access storage unit. Unlike magnetic tapes, where the previous master file tape can be retained as the "father" of the current master file tape reel, the disc or drum surface area containing each master file record is normally erased when the updated record is written back. System concepts using random access equipment must guard against recording errors and assure that sufficient historical information is available to satisfy auditing requirements and permit error recovery. Available safeguards include separate "write check" operations (which verify that the data recorded on the disc or drum are the same as the data in core memory), daily dumping of all master file data on magnetic tape, simultaneous recording of the data on tape and in random access storage, and writing of a journal record of each transaction.

Attempts to record data in tracks containing "bad spots" (imperfections in the magnetic recording medium) must be avoided. In some random access storage devices, this can be accomplished by hardware substitution of a good track for each track found to be bad. Otherwise, the avoidance of bad tracks must be accomplished by programming—usually by means of a directory of disc or drum record addresses which is updated whenever a bad spot is detected.

When random access storage units are used in sequential processing, the principle usually followed is to read a complete track, post the transactions, and write the updated data records on either the same track or another track. Since the largest time component in accessing the data is the head positioning time, it is good practice to read the entire contents of each track. A core storage capacity large enough to permit the use of relatively long blocks of data is desirable, in order to have input, computer processing, and output overlap each other insofar as the simultaneity features of a given computer system will allow.

Random access processing looks less attractive, on the basis of cost per record processed, when the size and daily activity of the file (i.e., the number of master file records that must be accessed and updated) becomes fairly high. In this case, the higher cost of random access storage and the repeated accesses to the disc or drum file increase the relative processing cost as compared to the sorting of the transaction records on magnetic tape and subsequent matching of the corresponding records in the master and transaction files.

To summarize these points, random access systems can be justified by:

- (1) Need for rapid service by users
  - (a) On-line service concept—requests for information can be answered in a matter of seconds.
  - (b) Rapid input to management decision processes can be provided.
  - (c) Data processing can be made available to more people in the organization through use of a data store which is always available and up to date.
- (2) Potential cost reductions
  - (a) Integrated operations make possible, through integrated data processing and "on the spot" information, better decision-making by executives.
  - (b) Data processing scheduling problems and idle time of data processing equipment can be reduced. When peak loads build up, all types of inputs can be batched for random access systems without necessitating subsequent sorting and dispersion runs.

economic considerations

The use of large magnetic drums, magnetic tape strips, and magnetic discs for random access purposes was introduced as early as 1955. However, there have been many limitations on achieving even an approximation of the ideal system using the devices that have been available. These limitations center around three major areas: speed, capacity, and cost. In each of these areas, it is interesting to compare the use of available random access equipment and its natural ally, on-line data processing techniques, with the use of magnetic tape and sequential, batch data processing techniques.

The principal difference between on-line and batched processing is in the method of access to stored data records. In batched systems, access involves sorting the transactions and merging them with or matching them to the sequenced file records. In on-line systems, random access to the file is required. Once the data is in the processor, the same processing must be carried out in both types of systems. The differences between the two methods, therefore, can be determined by comparing the:

- relative speed of access
- relative cost of storage
- overall throughput cost, measured in number of transactions processed per dollar.

relative access times

To study the respective access times of on-line and batched data processing systems necessitates an indirect comparison. Disc or drum access times must be compared to transaction file sorting times, since once the transaction record is matched or merged with the master file record, the processing can be assumed to be identical (if we temporarily neglect variations in file content, which is really a system design consideration).

Most "second generation" disc files (with the exception of the significantly faster Burroughs system) have quoted random access times of 100 to 250 milliseconds, while their drum storage counterparts have access times ranging from five to 100 milliseconds. As a reasonably representative time, let us use 150 milliseconds. As opposed to this, sorting times for representative system configurations of medium scale magnetic tape computer systems average about six minutes per file of 10,000 80-character records, or 36 milliseconds per record.[1]

If we assume that two-thirds of the access time to a random access file medium can be overlapped with computer processing, and that effective transfer rates for disc, drum, and tapes are relatively equal (although this can be disputed), then access times can be compared as in the example below.

	Random Access, On-Line Processing	Tape Sort, Sequential Processing
Total time to locate active master file record:	150 msec.	36 msec.
Time overlapped:	100 msec.	none
Access time actually paid for:	50 msec.	36 msec.

This example is designed solely to illustrate a simple technique for comparing access times for on-line and batched systems. The actual figures can vary greatly with changes in file size, record size, type of random access storage used, computer system configuration, and ratio of access time to central processor time required to process each transaction. As random access times approach or become lower than sort times per transaction, the use of random access storage clearly becomes more desirable for most data processing operations.

relative storage costs

The second consideration involved in comparing on-line and batched data processing systems is the cost of storing the data in the respective auxiliary storage units. Fig. 1 shows the cost of storing data as a function of total storage requirements (basically, master file storage requirements measured in millions of six-bit alphanumeric characters). The indicated ranges are based on actual purchase costs for a wide range of currently available disc, drum, cartridge, and tape units. The purchase costs include all input and output control units necessary to connect the storage units to the central processor, plus the storage media, such as reels of tape or cartridges. (The "disc" category in Fig. 1 includes large-capacity drums.)

The conventional, non-cartridge-loaded disc systems become unwieldy when large storage capacities are required, because a large number of disc units are needed on-line, and maintenance and facility requirements become unreasonable. For storage requirements of up to 100 million characters, the disc file compares favorably with cartridge and tape systems. Perhaps the most striking conclusion is that cartridge systems, when properly used, seem to offer a significant data storage cost advantage over both tape and disc for storage requirements of up to several billion characters.

For extremely large total storage requirements, tape systems are by far the cheapest because of the low cost of a reel of tape and the volume of characters that can be stored on a single reel (up to 20 million characters).

Mixed systems, using both serial and random access storage media, are likely to become the rule in a majority of data processing installations of the future. A combination of discs or drums for smaller files and magnetic tape for the large volume files is indicated by the cost breaks seen on the chart. Files of up to 100 million characters might be stored on discs, and any files larger than this on tape. Usually the more active portions of records are stored on the disc file in order that they may be readily accessible while the less frequently used portions of the records are stored on magnetic tape where they are periodically updated. Combinations of cartridge systems and tape systems would also be feasible for very large data storage requirements.

overall throughput cost

In regard to total response time to process a given transaction and update all affected files, a well-designed on-line system has obvious advantages over a batched system: seconds versus hours or days. But in order to process peak loads without resorting to batching techniques, an on-line system may require significantly greater throughput capacity than a batch system designed to handle the same total workload.

With the currently available hardware, a computer system configuration designed for efficient batch processing will, in nearly all cases, cost less and be able to process more records per day than the corresponding random access configuration of the same computer system. The higher cost of the random access configurations results from the costs of the random access storage units themselves plus the enlarged core storage and on-line inquiry equipment that are usually required for efficient processing.

Therefore, we must conclude that a comparison of direct data processing costs, in terms of number of transactions processed per dollar, will generally show a significant advantage for the batch processing system over an on-line system designed to do the same job. In applications where rapid response and integrated control are necessary or highly desirable, however, the system advantages of on-line processing may far outweigh its higher direct costs.

If you are seriously considering a real-time or rapid response system, you should thoroughly explore this question: Is random access really needed, or can the system requirements be met with less expensive batch processing techniques by producing better reports or by processing magnetic tape files several times daily? A senior management representative of a large, multi-plant, multi-product-line company recently asked the same basic question: "Even if we had all the information available in real-time, would we know what to ask for and what to do with the reports we could get?" ■

[1]*AUERBACH Standard EDP Reports*, Page 11:400.104

CHARACTERISTICS OF RANDOM ACCESS STORAGE DEVICES

CATEGORY		MAGNETIC DISC FILES					
Device		Bryant 4000 (Honeywell 460)	Bryant 4000 (RCA 366)	Burroughs B 472 On-Line Disc System	Data Products 5024 Discfile (CDC 818)	GE M640A Disc Storage Unit	IBM 1301 Disc Storage
Representative Computer System		Honeywell 400	RCA 301	Burroughs B 5000	CDC 1604-A	FE 225	IBM 7074
Storage Medium		Discs	Discs	Discs	Discs	Discs	Discs
Storage Capacity, per Physical Unit	Data Discs or Drums per Physical Unit	3, 6, 12, 18, or 24	6, 12, 18, or 24	4, 8, 12, 16, or 20	16	4, 8, 12, or 16	20 or 40
	Data Tracks per Disc Surface or Drum	768	768	50	256	256	250
	Maximum Characters per Track	4,096	1,600	24,000	5,120	3,072	2,780
	Maximum Characters Accessible Without Head Repositioning	786,432	691,200	Total Capacity	524,288	294,912	222,400
	Maximum Character Capacity per Physical Unit	100,663,296	88,473,600	48,000,000	33,554,432	18,874,368	55,600,000
	Maximum Number of Physical Units On-Line	1	2	20	28	32	5
Head Positioning Time, msec.	Minimum	60	70	0	35	70	50
	Average (Random)	95	105	0	120	199	160
	Maximum	130	150	0	200	305	180
Average Rotational Delay, msec.		33.5	25	20	26	26	17
Peak Data Transfer Rate, Characters per Second		27,500 to 75,000	32,000	100,000	58,800 or 98,000	35,500 or 71,000	90,000
Transfer Load Size, Characters		512	1 to 1,600	96 to 30,240 by 96, 240 to 480	8 to 32,768	192 to 3,072 by 192	1 to 11,200
Read/Write Checking		Parity	Parity	Check Chars., Write Check	Check Chars.	Word & Record Parity, Write Check	Check Chars., Write Check
Representative Cost, Dollars per Character		0.0026	0.0040	0.0053	0.0062	0.0065	0.0041
Features and Comments		All read/write heads (6 per disc surface) move in unison	All read/write heads (6 per disc surface) move in unison	Fixed heads, 1 per track	Individually positionable access arm for each disc	Individually positionable access arm for each disc	Variable record lengths, defined by format disc

*Denotes that an optional feature is required to achieve the indicated figure.

CHARACTERISTICS OF RANDOM ACCESS STORAGE DEVICES

MAGNETIC DISC FILES (cont'd)			CARTRIDGE UNITS			MAGNETIC DRUMS			
IBM 1302 Disc Storage	IBM 1405 Disc Storage	IBM 1311 Disc Storage Drive	NCR 353-1 CRAM Unit	NCR 353-2 CRAM Unit	RCA 361 Data Record File	IBM 7320 Drum Storage	Univac Fastrand Drum	Univac FH-880 Drum	Univac Randex Drum
IBM 7010	IBM 1401	IBM 1401 and 1440	NCR 315	NCR 315-100	RCA 301	IBM 7090	Univac 1107	Univac 1107	Univac SS 80/ 90 Model II
Discs	Discs	Magnetic Discs	Magnetic Cards	Magnetic Cards	Magnetic Discs	Drum	Drum	Drum	Drum
20 or 40	25 or 50	5	One 256-card Cartridge	One 256-card Cartridge	128	1	2	1	1 or 2
500	200	100	7 per card	28 per card	2	400	3,072	128	2,000
5,850	1,000	2,000 or 2,980*	3,100	886	9,000	2,796	10,752	36,864	3,840
936,000	2,000 or 4,000*	20,000 or 29,800*	21,700 (1 card)	24,808 (1 card)	9,000	Total Capacity	688,128	Total Capacity	7,680
234,000,000	20,000,000	2,000,000 or 2,980,000*	5,555,200	6,350,848	4,608,000	1,118,440	66,060,288	4,718,592	15,360,000
5	1	5	16	16	6	5	120	120	10
50	90	75 or 54*	235	235	3,100	0	30	0	125
165	600	250 or 154*	235	235	4,300	0	57	0	333
180	800	392 or 248*	235	235	5,500	0	86	0	540
17	25	20	23	23	2,100	8.6	35	16.7	35
184,000	22,500	77,000	100,000	28,500	2,500	202,800	150,900	368,760	9,280
1 to 234,000	200 or 1,000	100 to 20,000 by 100	2 to 3,100	2 to 886	1 to 9,000	6 to 111,840	6 to 344,064	6 to 393,216	320
Check Chars., Write Check	Parity, Write Check	Parity, Write Check	Two-Way Parity, Read After Write	Two-Way Parity, Read After Write	Parity	Check Chars., Write Check	Parity	Parity, Character Count	Parity
0.0018	0.0030	0.0234 or 0.0163*	0.0068	0.0048	0.0046	0.1520	0.0044	0.0348	0.0091
Two access "combs" serve 250 track positions each; variable record lengths	Single access arm serves all disc (second arm is optional)	Changeable "Disc Pack" cartridges of 5 data discs each	Changeable CRAM cartridges of 256 cards each; 8 bit channels per track	Changeable CRAM cartridges of 256 cards each; 1 bit channel per track	Individually changeable discs in "carousel" arrangement	Fixed heads, 1 per track; variable record lengths	Movable access mechanism has 64 read/write heads	Fixed heads; 6 bit channels per track	Movable access mechanism has 1 head per drum

"Our problem was to get test data into a digital computer without the costs and delays of building black boxes."

"Then we found out General Electric had already built them in its Datanet 60s."

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CIRCLE 22 ON READER CARD

GENERAL ELECTRIC

PROGRAMMER TRAINING: A WORKABLE APPROACH

self-instruction for the 1401 & 7090

by JAMES A. SAXON

The phenomenal growth of the computer industry in the past decade has caused a very serious training problem both for computer manufacturers and for industrial users of computers. The growth of the industry is such that the problem will continue to become more and more acute in spite of the best efforts of manufacturers and users. A small number of educational institutions have become concerned with programmer training and as more and more secondary schools install computers, they will join the training effort. All of this will still not be enough to keep up with the ever growing need for basic training.

The manufacturers are most vitally concerned because their sales depend on the availability of competent people to program their machines. Many industrial firms are involved in full scale training efforts, not because they want to do it, but because they have found it to be an absolutely necessary adjunct to the operation of their businesses. Large industrial and governmental computer users spend tens of thousands of dollars every year in an effort to train a sufficient number of programmers to meet their needs.

Since the need far surpasses the supply, it is obvious that something should be done about the programmer training problem. A number of articles have been written about this subject, but practical solutions or recommendations have not been forthcoming.

In 1961, a large industrial firm, employing hundreds of programmers, decided to attack the problem directly. An experimental study was conducted on the feasibility of utilizing automated training techniques for computer programmers. The study had the following objectives:

1. To eliminate formal training courses and instructors.
2. To allow students to proceed at their own pace.
3. To require no previous training or experience.
4. To permit experienced trainees to skip basics.
5. To eliminate unproductive waiting time between course schedules.
6. To keep failure to a minimum.
7. To provide a means of early qualification of trainees.
8. To be inexpensive.

A self-instructional workbook was developed to teach the fundamentals of programming the IBM 1401 computer. The objective was not to develop expert programmers, but to teach the same basics that were usually taught in a lecture-type classroom course for beginners, keeping in mind the eight points above.

The last two classes taught (29 people) were used as a control group. They were taught in the traditional classroom manner, utilizing lecture and blackboard techniques. Both final test scores and time for completion were compared with an experimental group consisting of the next

An industrial psychologist with a masters from the Univ. of Redlands in Calif., Mr. Saxon is president of Saxon Research Corp., San Diego, Calif., developers of automated training texts for programmers. He is also project director, U.S. Navy Personnel Research Activity, San Diego, and had been engaged in personnel research and systems analysis at Norton and Wright-Patterson AFB, and programmer training with Lockheed in Sunnyvale.

26 people scheduled for the course. The experimental group had no instruction, but simply studied the self-instructional text, each man progressing at his own rate of speed. Without exception, the experimental group scored higher on the identical final test, and time for completion of the course was cut nearly in half. The table below shows the comparative scores.

	Test Score Average	Time for Completion
Control group (classroom)	82.5	60 hours
Experimental group (self instruction)	94.8	36 hours

After a tryout of six months, it was obvious that the training text was accomplishing its objectives; trainees were being turned out faster and better trained, and there were fewer failures. No classroom space was needed, and part time instructors were returned to full productivity.

A cost reduction study (Fig. 1) indicated a sizeable monetary savings per year. This did not include the intangible savings of early qualification for productive work and the elimination of unproductive waiting time between classes.

The following year, a workbook was developed to teach IBM 7090 programming. This proved to be as successful as the 1401, in spite of the fact that the 7090 is a great deal more complex machine.

The technique used in these texts is quite simple. The principal concept is "learning by doing." The trainee can start to study immediately after he is hired; he paces himself instead of attempting to compete with a group which is highly heterogeneous with respect to background knowledge; he retains more knowledge because he must constantly participate by working problems on nearly every page of the book, and he gets immediate reinforcement of the knowledge gained by having the correct answer quickly available.

Before discussing the details of this teaching method, it may be of value to mention briefly the technique of programmed instruction. The terms *programmer* and *program* in this context refer to the development of self-instructional teaching courses in which information is imparted in small, easy to digest bits (called "frames"), each step building on those that came before, developing the topic very gradually so that the student is hardly aware of the increase in difficulty. Such a teaching course is called a *program* and the person who develops it is called a *programmer*.

Programmed texts, at the present time, are of two major varieties: *linear* and *scrambled*. Linear, also called the Skinner technique, refers to teaching in a straight line, one item logically following another from page to page. Scrambled, also called the Crowder method, refers to a technique where each problem may take the student to any one of several pages in the book.

The majority of modern teaching programs are linear in design. Within this framework, there are two types: *horizontally* programmed texts and *vertically* programmed texts.

Horizontally programmed texts are read from the front of the book to the back, across all the pages at one level. After completing the top level, the student goes back to the beginning of the book and reads across the text at the next lower level. This is continued until the entire text is read. This technique involves a great deal of page turning, and restricts the programmer in the amount of space he may use in a single teaching fragment (frame). The advantage is that the correct answer is always found on the next page and is never on the same page with the question.

Vertically programmed texts are read from the top of the page to the bottom. The number of "frames" on a page may vary from one to a dozen. With this technique, a mask is usually used and the student exposes one frame at a time—at the same time exposing the answer to the previous frame.

The art of programmed instruction, although not new, is not too well developed at the present time. A great deal of experimentation is being accomplished, but much is yet to be done. (See "The Computer & Programmed Instruction," by Werner Koppitz, Nov. *Datamation*) One of the accepted techniques today is that the frame (bit of information) should be very small. Training programs that utilize this technique become extremely bulky because it takes many thousands of frames to complete a program on a fairly complex subject. For some subjects and for a certain class of students this technique works very well, but for computer programmer instruction, it was felt that a somewhat different approach would be more practical.

Both workbooks utilize features of both horizontal and vertical programming and avoid some of the problem features of both methods. The technique is vertical, but it

Fig. 1

COST REDUCTION Attainable with Self-Instructional Text (Assuming there will be 100 trainees a year)	
I. COST – CLASSROOM INSTRUCTION	
A. Facilities: Classroom space @ $.64 per student	$ 64.00
B. Instructor: (2 to 1 ratio, preparation to instructon. Duration, 3 weeks @ 2 hrs. a day) @ $4/hr. avg. salary for 5 classes a year	900.00
C. Clerical time: (Approximately 4 hrs. for scheduling, typing, etc.) @ $2.15 hr. for 5 class sessions	43.00
D. Student time: (2 hrs. class and 2 hrs. study each day for 3 weeks) @ $4/hr. per student. Cost for one student $240 times 100 students	24,000.00
TOTAL COST	$25,007.00
II. COST – SELF-INSTRUCTIONAL TEXT (First Year)	
A. Cost of Self-Instructional Text Development	$ 8,950.00
B. Reproducton: (of 100 books)	
(1) 200 plates (Xerox) @ $.80 $160.00	
(2) 20,000 sheets paper @ $.007 $140.00	
(3) 100 loose-leaf binders @ $.20 $20.00	
C. Student time: (approximately ½ classroom time)	$12,000.00
TOTAL COST	$21,270.00
III. SAVINGS	
A. First Year (prorating entire cost of development and plates)	$ 3,737.00
B. Savings each year thereafter	$13,007.00

uses the horizontal method in that the correct answers are not available on the same page and no mask is needed.

Each "frame" is a *lesson* covering an idea or concept susceptible to concise (one or two-page) treatment. The lesson consists of a discussion, extensive examples and a group of free-response problems (Fig. 2). Answers to the questions are on the reverse side of the page containing the questions (Fig. 3). The correct answers are accompanied by "remarks" designed to reinforce the principles covered by the questions.

The lessons are grouped into logical "families" of concepts, called *units*. The unit is concluded with a Unit Quiz, which recapitulates the materials already covered. Frequent tests offer the possibility of many successful attempts on the part of the trainee, serving as an incentive to further effort.

Discussions minimize the use of technical terms and are directed at the beginner. Reference to electro-mechanical theory, "shop-language" and process speeds are avoided. Although the student is initiated with actual machine coding, the texts introduce "software" programming tools as early as possible. Emphasis is placed on symbolic programming and assembly systems as the working language of the programmer.

A primary goal of the text is to develop competent coders capable of following a fairly detailed problem statement. However, basic considerations of problem definition are covered to provide a foundation for developing the insight that marks a skilled computer programmer. The trainee, therefore, is introduced to the technique of stating and flow charting problems preparatory to coding.

Emphasis is placed on the "straight forward" approach as opposed to the more sophisticated techniques that utilize machine characteristics to shorten processing time or to minimize the number of instructions used. It is hoped that these skills will develop through experience and individual initiative after the trainee is on the job.

Discussions with managers of computer installations indicate a keen interest in any new training technique because the problem of programmer training is a constant, never ending requirement for all computer users. The self-instructional workbook is a workable solution to the acute training problem in that a large number of people may be trained in a short period of time at a very moderate cost. ■

Fig. 2

UNIT I — Lesson 3

Word Marks: The IBM 1401 is a **variable word length** computer. This means that a computer **word** may be as long or as short as needed to contain a unit of information. The **word mark** makes **variable word lengths** possible. A **word mark** is not a character in itself, but is associated with the **high-order** (left-most) position of the word. A **word mark** may be shown symbolically by underlining the character with which it is associated. The **word mark** tells the computer that the position so designated is the beginning of a word. When the computer senses another **word mark**, as it scans each character, it recognizes that a new word is beginning and that the previous word has ended.

EXAMPLE:

5	9	2	5	S	E	N	D	I	5	6	H	O	L	D	T
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116

The storage positions shown above contain five computer **words.** The **word marks** in positions 101, 105, 109, 112 and 116, indicate the beginning of each **word.**

PROBLEMS: Write your answers to the following questions in the space provided, referring as necessary to the text. **After** you have written and checked your answers, refer to the correct solutions on the following page. Do not proceed to the next lesson until you fully understand the questions and their correct solutions.

9. 1 2 3 4 3 2 1 0 5 H 2 3 5 S T U V 4 (positions 200 … 217)

Indicate the **high** and **low-order** positions of each word shown in the storage cells above.

9. High Low
(a) ____ ____
(b) ____ ____
(c) ____ ____
(d) ____ ____
(e) ____ ____
(f) ____ ____

10. Symbolically represent the word PRICE in storage positions 501-505, placing the word mark in the proper position.

10.

11. With respect to computer words, the IBM 1401 is a (a) ____ (b) ____ (c) ____ computer.

11.
(a) ________
(b) ________
(c) ________

Fig. 3

UNIT I — Lesson 3

CORRECT ANSWERS

PROBLEMS:			REMARKS
	High	**Low**	
9. (a)	200	202	The word mark always indicates the high order position. The last two words are only one character in length, therefore the single character in each case is both the **high** and **low** order position.
(b)	203	206	
(c)	207	210	
(d)	211	215	
(e)	216	216	
(f)	217	217	
10. P R I C E	501	505	The word mark should be associated with the "P" or high order position.
11. (a) VARIABLE (b) WORD (c) LENGTH			Since a word may be of any length in the IBM 1401, it is called a variable-word length computer.

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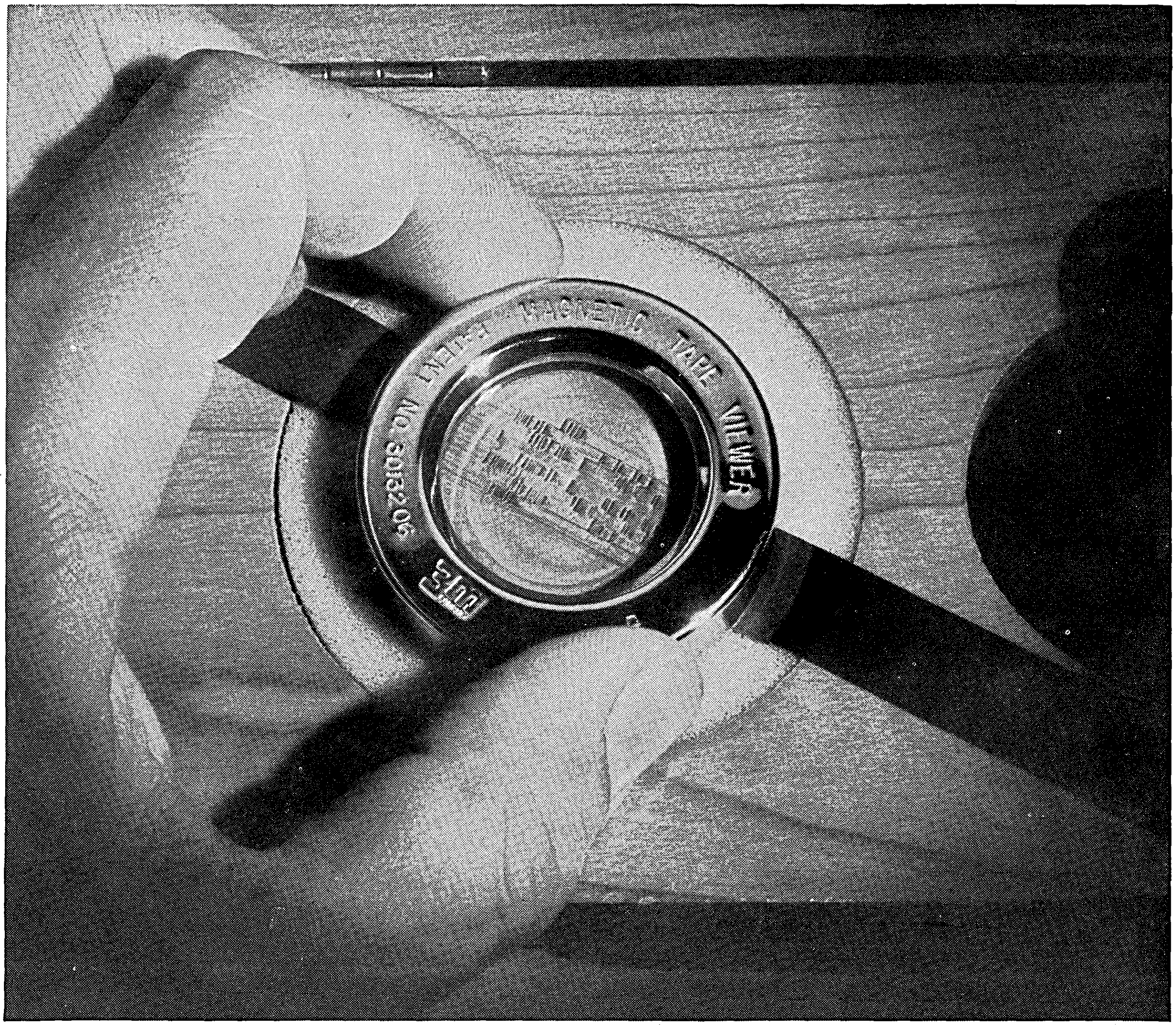

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CIRCLE 23 ON READER CARD

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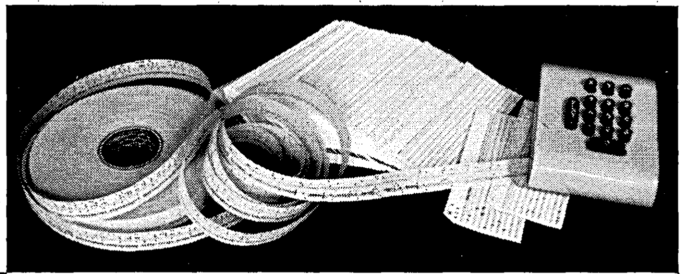
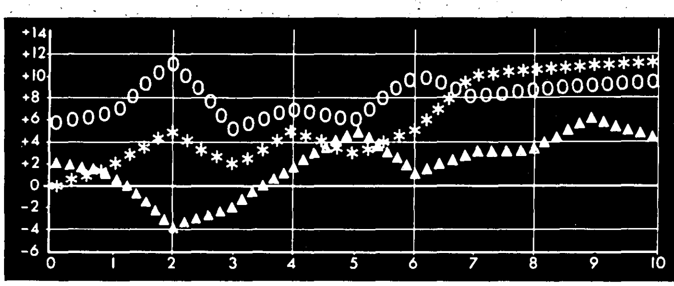
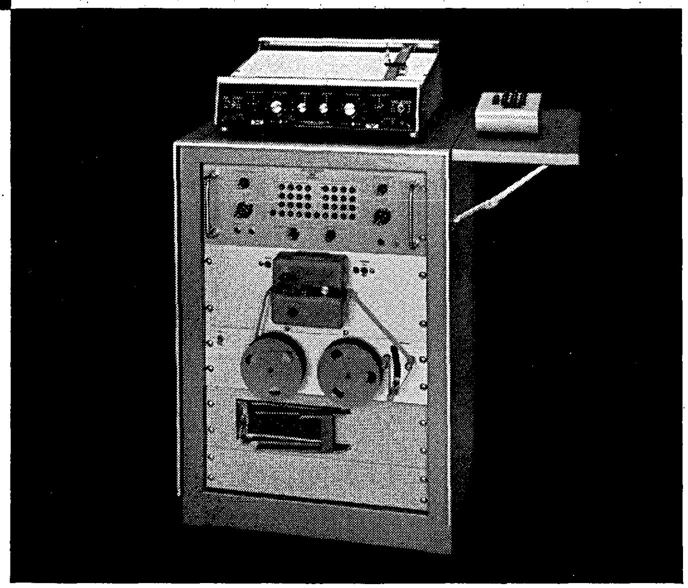




EASY TO READ

WITH THIS



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CIRCLE 24 ON READER CARD

determining unit cost

COSTING PROCESSED DATA

by F. J. DAHLHAUS

It is frequently necessary in a systems design to identify a cost per unit of product. In the case of a data processing application it is the cost per document unit or record handled. A "work sampling" technique has been found ideal for this purpose. The applicability of this technique to data processing systems analysis may first be shown by the definition of Work Sampling, i.e., a collection of observations taken at random intervals for the purpose of time, cost or quantity variables. Thus, it is unnecessary to make the total "exact" counting of all direct and indirect costs to identify the many time, cost or quantity variables.

The first rule in applying this technique would be to determine the percentage of occurrence of a cost condition, or of an observable category, which forms the base for the distribution of the variables within the category. For example, a certain manual and EAM office operation has outputs which are: DD 750's, SF 82's and Shipping Requests. It is required to learn the cost of processing each of these documents.

Exact category definitions must be made for identification of each document in the process. A pencilled note of a telephone conversation relative to a shipment is not a Shipping Request, unless it is a document upon which actions can be taken throughout the chain of procedures.

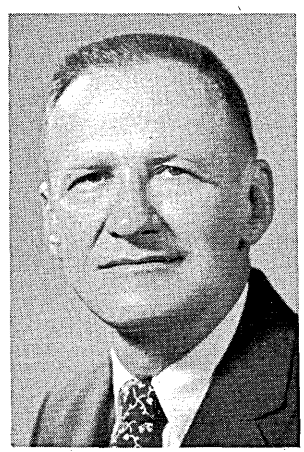
From the category definitions and a schedule of random observations, one can determine the time distribution shown in Table I.

TABLE I

Document	Number of Observations	Proportion of Documents Processed by Work Force
DD 750	502	0.417
SF 82	569	0.471
Shipping Request	131	0.108
Total	1202	0.996

It is now necessary to derive cost values against these functions. There are two approaches available: either hourly charges against the function, or yearly costs of people in the function, depending on what kind of data is most readily available. In either case, care must be exercised that the hour or cost values include both direct and indirect labor, the latter being a total of supervision and services. The hourly charges against the function may be either earned hours or paid hours.

In the case of earned hours, care must be exercised to

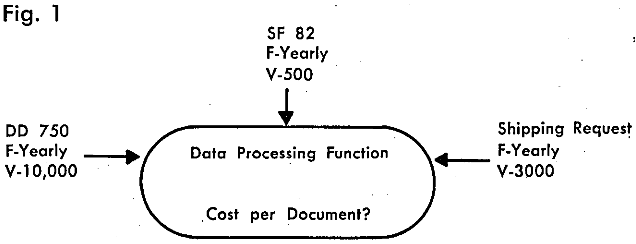


Mr. Dahlhaus is an operations analyst performing special cost and operating studies for the Army Materiel Command in Washington, D.C. He previously was on the staff of the Army Management Engineering Training Agency in Rock Island, Ill., where he was engaged in instruction, course development, and consultation with the Applied Mathematics & Statistics and Automatic Data Processing departments.

adjust the costs upward to allow for payments to individuals not acting in, but paid by, the function. Proper costing requires that vacation and sick leave be charged against the function.

For the sake of illustration, say that yearly cost data is available and that $61,329 was paid out for direct and indirect labor to support the function. Further assume that volumes processed per year are as shown in Fig. 1.

Fig. 1



The total labor cost of the function has been given as $61,329 and the volumes given in Fig. 1 now make it possible to expand Table I into Table II.

The reader will observe that Column 5 of Table II is the kind of data that is collected in the desk audit and flow charting phase of the systems analysis, and is shown on generalized grid charts which summarize item entries of data by document or record. Column 3 is derived from Column 2. Column 4 is generated from Column 3 and the total cost of processing within the function ($61,329, in the example). Column 5 is generated from the flow chart and the data sheets. Column 6 is a ratio of Columns 4 and 5.

For conceptual development, the problem above is deliberately oversimplified. In actual practice, the flow diagramming would generate a structural picture by department, organization and machine processing group, in which the documents are at varying interval frequencies—daily, weekly, monthly, and yearly. Obviously a document produced F-yearly, V-3000 requires less labor and labor cost by a factor of 12 than one of F-monthly, V-3000.

$61,874. The computations would develop in the same manner.

In most office and machine room operations, the document flow occurs in more than one function as specified above so that a more typical picture would be as shown in Fig. 2. Here Department B processes DD 750's, SF 82's and Shipping Requests, as well as a new record, R1, which enters the flow, while Department C processes SF 82's and L2's. A table similar to Table II would be generated for costs in B and C, identifying all documents in the flow. The cost of processing a unit document would then be the sum of the unit costs per document in Departments A, B, and C. The costs shown on a grid chart summary are so determined.

In the above, no loss of technical generality is experienced by considering a combination of clerical, machine room, and computer processes. There is only a problem of definition. Similarly, no attempt is made to explain the work sampling technique, including the conditions necessary for randomness, confidence interval, error allowance, sample size, and training of observers. These aspects are completely explored in the literature, and are well known to industrial engineering and statistical groups in most organizations. (See especially Barnes, Ralph M., *Work Sampling*, New York: John Wiley & Sons, 1957, and Heiland R., and Richardson, W., *Work Sampling*, New York: McGraw-Hill, 1957.)

Fig. 2

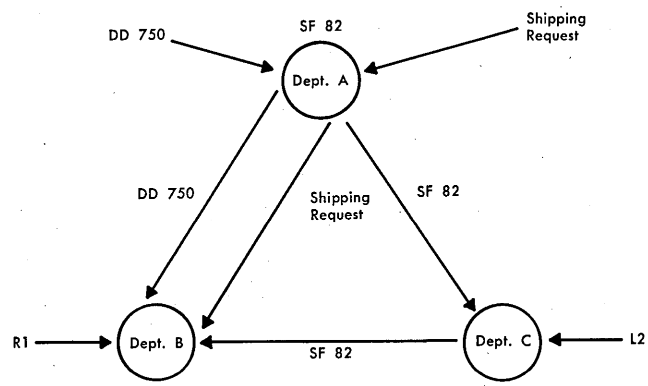


TABLE II

Document Processing Costs—Department A

(1) Document	(2) Number Observed	(3) Proportion of Documents Being Worked	(4) Yearly Cost Relatable to Document (thousand)	(5) Number Documents per Year	(6) Cost per Document
DD 750	502	0.417	$25.6	10,000	$2.56
SF 82	569	0.471	28.9	500	57.80
Shipping Request	131	0.108	6.6	3,000	2.17
Total	1202	0.996	61.1		

In the case in which the F intervals in Fig. 1 are not equal, the Number of Documents per Year (Column 5, Table II) has to be increased by the appropriate factor to convert to total Number of Documents per Year.

If there are other costs such as material and supplies, maintenance, and equipment rental or depreciation, these would be added to the cost of the process within the described functional area. For example, in the problem described, if $510 per year were paid out in rent for equipment, and $35 is the estimated cost of supplies, the total cost figure used to generate Table II would be

The majority problem in generating such data is the mechanical difficulty of keeping track of the unit of measure—documents per year, documents per day, cost per unit, cost per 3000 units, etc. Accurate cost data can be generated at minimum expense by a careful documentation of the flow of records, an identification of the associated costs, and both of these coupled with work sampling. ■

THE GE COMPATIBLES/400

four for business

The second family of computers by General Electric's Computer Dept., termed the Compatibles/400 and comprised of the GE-425, 435, 455 and 465, was announced early this month. The only specs released on the 455 and 465 are two and one usec memory cycle times, respectively, operating on 24-bit words. Both use auxiliary thin-film memories. With each step up through the family, processor performance is said to increase 80 per cent.

Memory access times for the 425 and 435 are 5.1 and 2.7 usec, respectively, and add times for four plus four decimal digits are 15.9 and 8.8 usec. Features common to both systems include a four-character, 24-bit (plus parity) word length; 16, 32, 64, and 128K characters of core; an instruction format of 24 bits binary and a 15-bit address field, and a repertoire of 70 commands. Additional specs: eight I/O channels, automatic program interrupt, and simultaneous read/write/compute. Any word in memory can be treated as an index word for address modification although six fixed index words are also supplied for conventional indexing.

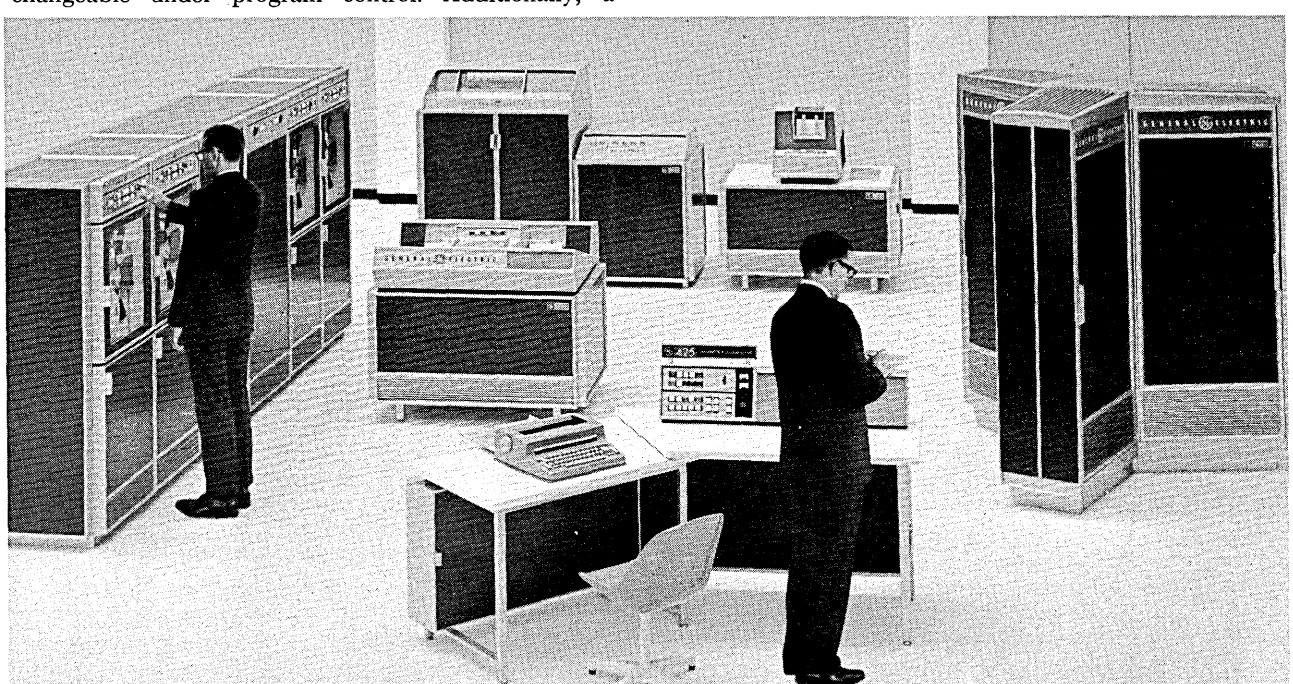
A "relocatable accumulator" speeds data manipulation by taking the accumulator to the data, instead of vice versa. The four plus four digit add time, for instance, is cut by about half. The accumulator is located in memory and is changeable under program control. Additionally, a scatter read/gather write capability places blocks of data in memory and retrieves it in random order, in a program-prescribed pattern, thus eliminating unpacking time.

Software includes COBOL '61 and an assembly program.

Peripheral equipment for the 400 series: a 900 cpm card reader, 100 cpm punch, 1,200 lpm printer, 500 cps paper tape reader and 140 cps punch (for 5, 6, 7, or 8-level tape), 1,200 cpm MICR reader-sorter, and 41 or 83KC mag tape unit. Eight tape drives can be connected to each control unit, which is available in both single and dual-channel models. Also available are the Datanet-30 communications processor and disc files.

Lease prices for the family range from $5,800 to more than $30K, and purchase prices from $275K to 1.5 megabuck. Delivery is in seven months for the 425 and 435; fisrt delivery of the 455 and 465 is scheduled for mid-1965.

Reportedly intended to supplement the firm's 200 series, the 400's have been designed for relatively large scale data processing and data manipulation. Markets include manufacturing and finance firms, the billing end of utility companies, agencies such as Social Security and Internal Revenue. Competitors: the ±1410 hardware. By contrast, the 200's are said to be for, say, the manufacturing firm doing combined data processing and research/engineering computation. ■



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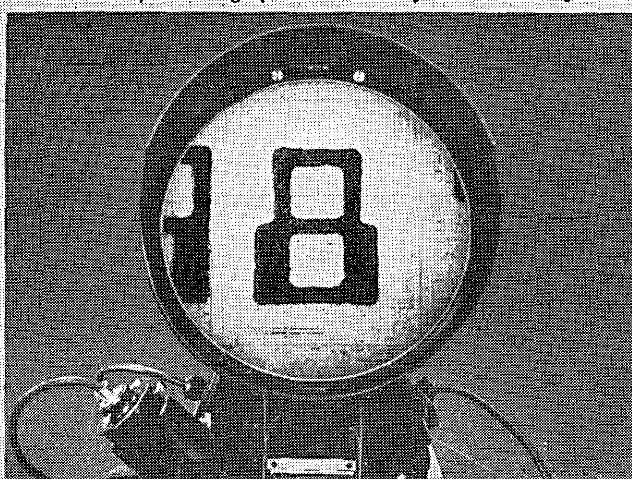

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CIRCLE 26 ON READER CARD

RECENT ACM REGIONAL SYMPOSIUMS

WASHINGTON, D.C.

An overflow crowd of more than 700 preregistrations was reported by the Washington, D.C., chapter of the ACM for its fourth annual one-day technical symposium. Co-sponsor was the Univ. of Maryland, where it was held under the theme, "Information Processing in the Nation's Capital—1963."

Luncheon speaker and Illinois Congressman Roman C. Pucinski said: "It is my hope . . . to help chart through Congress a program which will establish the most efficient method possible for making all scientific data and research quickly available to any scientist in the U.S." Chairman of the House ad hoc subcommittee on a National Research, Data Processing and Information Retrieval Center, Pucinski stated that the goal of his bill (H.R. 1946) to establish a central clearing house of scientific information was not intended to usurp services presently performed by documentation and abstracting groups, but to complement them by making the results of their work available to the total scientific community.

Dr. Alan J. Perlis, president of ACM, discussed in his keynote address the experimental time-sharing system recently developed at Carnegie Tech. Two papers on the retrieval of chemical information, by Ascher Opler of Computer Usage Co. and Ethel C. Marden of National Bureau of Standards, placed strong emphasis on the growing national interest in this area. Other papers were on languages, list processing, automatic indexing and classification of documents, satellite dp, and character recognition.

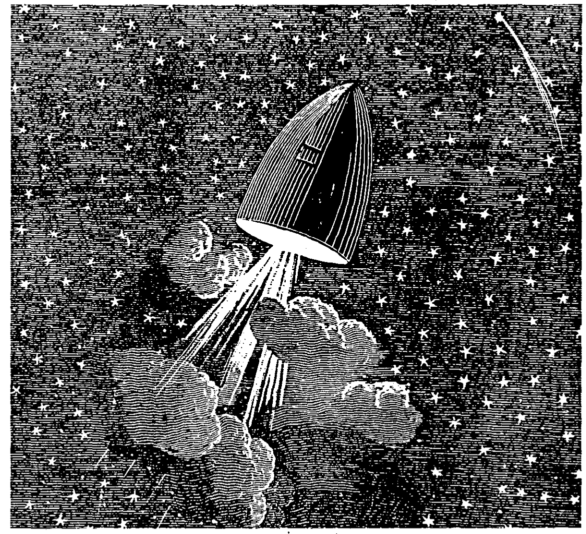
Highlighting the technical sessions was a panel discussion on "Our Resources in Information Processing—Where are the Gaps?" Members discussed resources in terms of today's educational and research facilities and tomorrow's needs, found that human communications in information handling are still uppermost on the list of unsolved problems, and urged more research in the efficient use of present capabilities. Panelists were R. A. Kirsch of the NBS, J. Moshman of CEIR, Perlis, F. Riley of the Post Office Dept., and H. E. Tompkins, Univ. of Maryland. Moderator was W. C. Rheinboldt of Maryland.

An award for service to the chapter was given to Solomon Rosenthal, HQ USAF, chapter head for the past three years.

SOUTHERN CALIFORNIA . . .

Present efforts in the area of computer learning are justified only if the work of computers is useful. "Here, more than anywhere else, will rise a tool for the most good to mankind." This thought by MIT's Oliver Selfridge concluded his luncheon talk at the "Creativity in Computing" technical symposium, the sixth annual in Southern California. Sponsored by five local ACM chapters (Arrowhead, L.A., Orange County, San Fernando Valley, and San Diego), the symposium drew more than 425 to Disneyland Hotel in Anaheim.

Peter Mumford of Ferranti-Electric Inc. discussed on-line interrogation of the time-shared Atlas at Manchester



Univ. Short, high-priority interrogation routines punched on tape have access to parts of the supervisor and scheduler, enabling the operator to question the status of a job or system and to make alterations. Routines enable assignment, for example, of different priorities to programs, suspension and resumption of jobs, and batch compiling to avoid the repetitive calling down of a compiler.

Other papers were on microelectronics, visual input, parts breakdown technique, small computer multiprocessing, sheriff and hospital information systems, and computerized typesetting.

A "flowering" of languages, mostly problem-oriented, as a result of time-sharing was predicted by John C. Shaw of the RAND Corp., one of a panel of four discussing the Impact of On-Line Techniques on Programming and Problem Solving. Others were Glen J. Culler of Space Technology Labs, Jules Schwartz of SDC, and Selfridge. Moderator was Richard Hill of Informatics.

SAN FRANCISCO . . .

The third annual technical symposium sponsored by the San Francisco Bay Area chapter of ACM was held Nov. 1 in San Francisco. Attended by 225, the symposium presented five speakers on the theme of "Problem Formulation, Systems Analysis and Systems Design."

Ascher Opler, Computer Usage Co., differentiated problem-oriented analysis from computer-oriented analysis and reviewed developments aimed at facilitating the former. Among such developments are: the work of Lombardi, of Bosak and of Iverson in formalizing file structure and file transformations; decision table usage; generalized system simulators, nonprocedural language processors; and goal-seeking, heuristic techniques.

O. T. Gatto, RAND Corp., described an automated data system analysis technique known as Autosate. The technique is comprised of three phases: data gathering, translating information specifications into a machine readable form, and preparing analysis reports by computer.

Michael Montalbano, Daniel Teichroew and John P. Seagle discussed work they are doing at Stanford Univ. They emphasized that programming does not solve a problem but mechanizes a procedure. Mechanizing a procedure consists of three stages: formulating a solution procedure in terms of the basic problems to be solved, reformulating the solution procedure in digital terms, and programming the procedure. Both FORTRAN and COBOL are useful only in the third, least costly and least difficult, stage. The Iverson language and decision tables have been tested to see if they will provide the basis for useful formal systems which help in the formulating and reformulating stages.

George Montillon, Procter and Gamble Co., discussed a programming system that performs a variety of analyses rapidly and in more detail than has been possible in the past. The system uses the concept of a data bank and depends heavily on matrix algebra. Examples of its application in advertising and other areas were presented.

Herbert Hellerman, IBM Research, has developed an experimental system which provides a logically powerful method of communicating with a digital computer. The Personalized Array Translator System consists of a subset of the Iverson language in which numeric and Boolean operations on arrays of bit or numeric operands are specified as easily as single operands. An initial system is operational and is implemented by an interpreter program on the IBM 1620. ■

a fable

THE DAY MARKETERS FLIPPED

by BURTON G. MENDELSON

The day dawned gray and flannelly as corporate work days usually do, especially Mondays.

It was a day when, coincidentally, all of the outstanding market research projects in all computer companies and their advertising agencies were received in final report form. In further coincidence, which no one seemed to notice that fateful day, all of these reports suggested negative market acceptance or inadequate market potential, or unfamiliar distribution channels, or inappropriate manufacturing facility . . . confirming the positive recommendation that no action be taken. These recommendations were received by various managements with varying degrees of relief or concern, but all the recommendations were accepted. Management decisions had been finalized.

Every market researcher, statistician, product planner and all contiguous levels of management and subordinates in 3,074 counties and the District of Columbia had been so busy at work on these reports that they had not noticed the blank pages of their calendars ahead. It was with a certain amount of amused relief and laughter on this otherwise normal Monday that they began to plan their week's work without the pressure of an impending deadline on a management report.

Many exclaimed that this was a wonderful opportunity to accomplish the desk and file cleaning so long neglected, and promptly set to work doing this. To the surprise of all concerned, this clean-up job was accomplished by the end of the work day on Monday.

On Tuesday many of these people who never made it a practice to arrive at work on time were found to be sitting at their desks promptly at the beginning of the work day. Many of them probably noticed some of their co-workers for the first time and even conversed with them about the sundry jobs which they had been working on, and sought clues from each other about their next project. The majority found themselves attacking the piles of reading material which had been collecting for many months. Probably due to the unusual intensity of attack, they found that the reading material was dispensed with by the end of Tuesday.

On Wednesday, as a demonstration of their well deserved independence, all our friends came in a little late again. But the old camaraderie was gone and for the most part people avoided each other, and when contact was unavoidable it was usually accompanied by frowns and even some guilty looks.

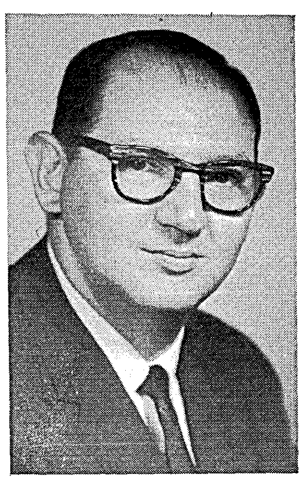
Thursday saw an extension of Wednesday's frowns into active distrust, certain unfounded and misdirected accusations, and the beginning of an air of wonderment which everybody carefully refrained from articulating. The drifting thoughts were periodically dispersed by frantic scouring of follow-up files to see if any projects were left undone. Certain persons of this select group of new product researchers and planners were even found to be making up to managers of established product lines on the sly—a class of people heretofore thought of as untouchables.

Friday, with the reassurance of the pay check, started more brightly. Certainly a factor in this brighter outlook was the monthly management conference luncheon where hundreds of their counterparts from various agencies and companies would gather to hear, once again, the problems and progress to be made in the new products field. Luncheon, at a prominent midtown hotel, started with a little more than the usual number of cocktails.

It was not long before the cloud of uncertainty that had been unvoiced but increasingly obvious to them as individuals engulfed this eminent group as a whole. Near the end of the luncheon, after a short period of silence, it was timidly suggested by one of the conference speakers that perhaps there were NO MORE NEEDS TO CREATE. The conference chairman, rephrasing this (in the form of a question, of course), asked: "Does this mean that the needs of all mankind (and its best friends) have been fulfilled?"

The shock of hearing this expressed by the conference chairman stunned the luncheon guests briefly, but this was a group composed of positive thinkers and doers, and any action, as every executive knows, is better than no action. After a babble of suggestions and counter-suggestions, it was unanimously voted "to recommend to top managements that a long necessary move be made to include in the corporate and agency structures a new department. (This department would, of course, report to the top operating executive or at least to the Marketing Vice President or Director of Marketing—or possibly to the Product Manager—but under no circumstances to the Sales Manager) . . . to be called, of course, OLD PRODUCT PLANNING."

Since the time of this now historical luncheon conference, this move has swept the top 500 and is moving rapidly into the ranks of all corporations and agencies—in complete disregard of the unfortunate coincidence that the title OLD PRODUCT PLANNING was already in use—on the label of a little known eight-year-old straight bourbon. ■



As director of New Product Planning and Market Research for the Communications Div. of Motorola Inc., Chicago, Mr. Mendelson is currently engaged in industrial electronic product planning, and management of the firm's precision instrument and commercial high-speed teleprinter activities. He holds a BS in engineering from Caltech and an MBA in marketing from the Univ. of Chicago.

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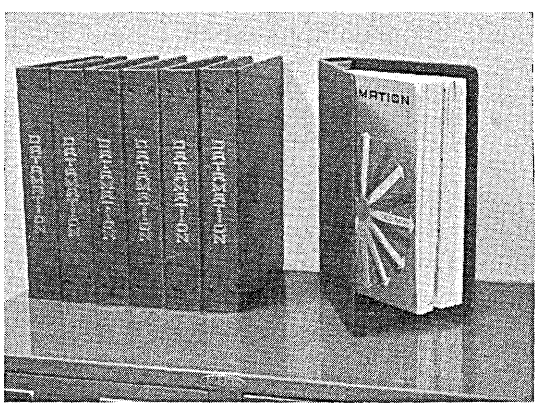

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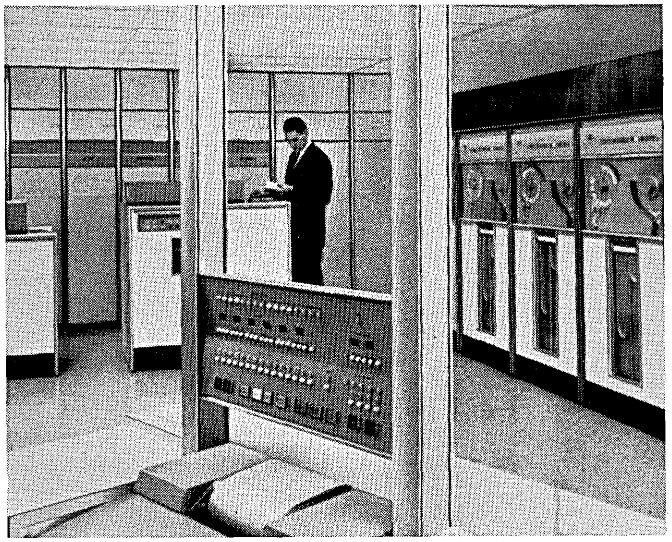

FORTRAN II was fine as far as it went...but FORTRAN IV and this thin-film computer take it farther than first thought possible: cut compiling time up to 90%.

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FORTRAN programming is, of course, not entirely new.

Yet, until now, savings like this in programming time were unheard of. The singular explanation for this advance in the FORTRAN IV system is the very singular UNIVAC® 1107 system, a computer with unique and inherent advantages.

By use of high speed drums and overlapping core and thin-film memories UNIVAC 1107/FORTRAN IV consistently compiles three times faster (even up to nine times faster), and permits execution of object programs up to twice as fast as any competitive system in the field.

Faster compiling, faster testing, faster turn-around, and faster training all result in substantial savings of time and money. Equally important, this unparalleled coordination of hardware and software sets a new standard of capability wherever logical organization, concurrent operations facilities, large memory capacity and vast interrupt provisions are needed. (Seventy-four different interrupt conditions alone are provided in the UNIVAC 1107.)

And if you happen to be working with FORTRAN II, transition to the new system is smooth and orderly. UNIVAC provides a special purpose translator called LIFT which readily converts FORTRAN II to FORTRAN IV.

Can we tell you more...about how to do more in less time?

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CIRCLE 29 ON READER CARD

people IN DATAMATION

■ R. W. Lee, formerly executive vp and general manager, has been appointed president of the Information Systems Group, General Precision Inc., Glendale, Calif. He replaces W. E. Bratton, who has resigned. From 1959-63, he was president of the firm's GPL Div. The Info Systems Group includes the Librascope and Commercial Computer divisions.

■ Robert V. Head, former senior systems engineer with IBM's Systems Research Institute, has joined Security First National Bank, Los Angeles, as vp-Planning & Development Dept. He has also served with GE Computer Dept. as manager of deposit accounting systems.

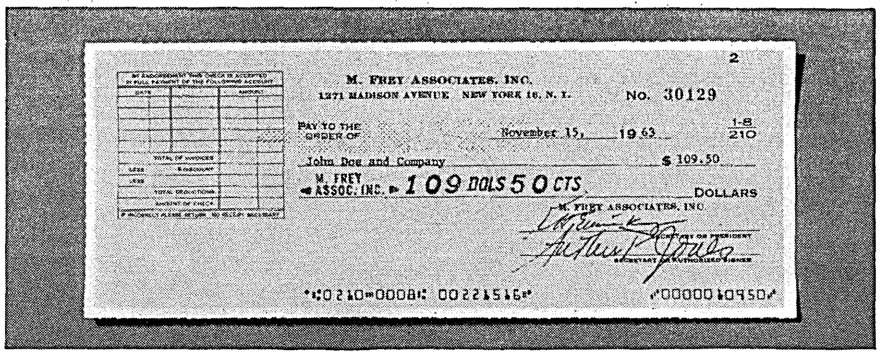
■ E. R. Glaser, formerly manager, Systems Dept., Burroughs Research Div., Paoli, Pa., is joining the MIT faculty, and will be associated with that institution's time sharing development program, Project MAC.

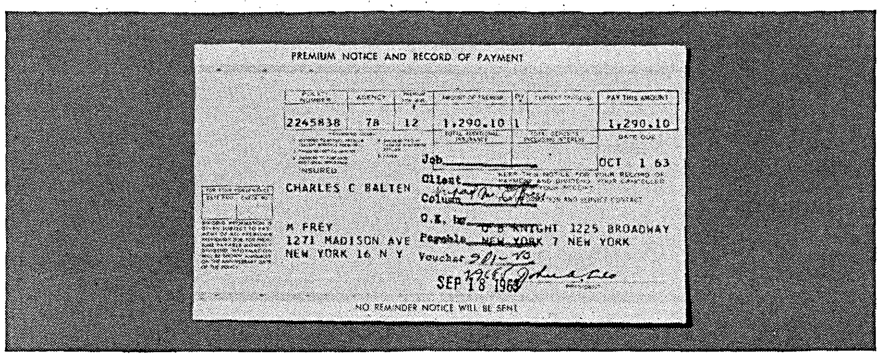
■ R. E. McDonald, Univac general manager in St. Paul, Minn., has been named vp. He remains as chief operating officer of the firm's R&D and production facilities in the Twin Cities.

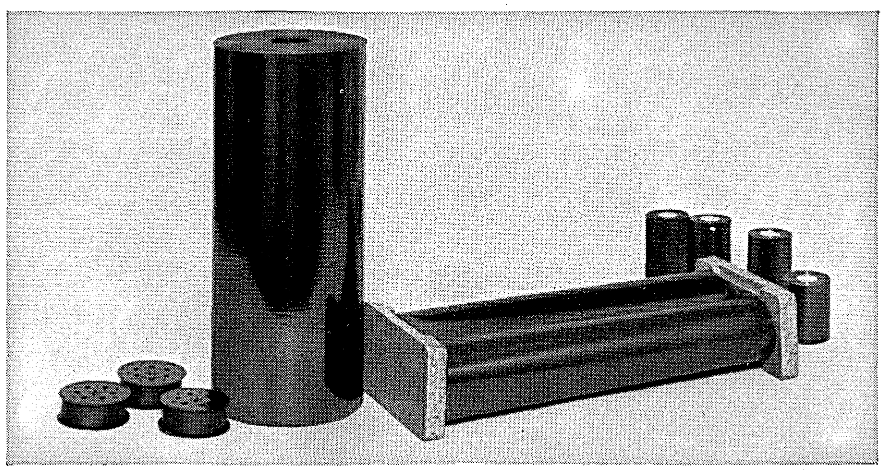
■ Stephen L. Cook has been appointed visiting prof of OR at Case Institute of Technology, Cleveland, Ohio. He is on leave from Richard Thomas & Baldwins Ltd., London, where he is manager of the OR Dept.

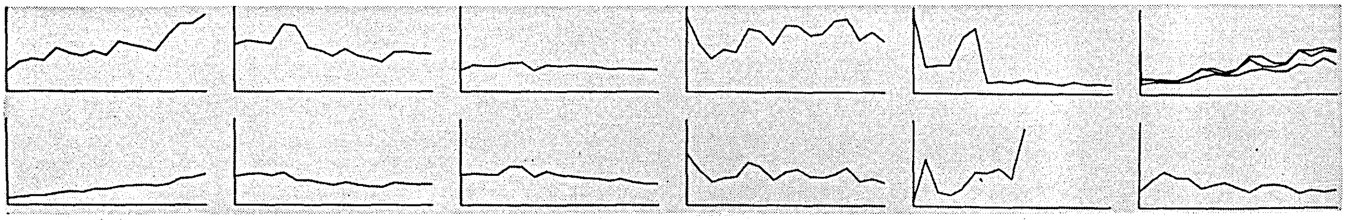
■ James E. Kelley Jr., co-developer of the Critical Path Method, has joined the Information-Management Sciences Div. of Auerbach Corp., Philadelphia. He was formerly vp-mathematical research for Mauchly Assoc.

■ Mack A. Christian Jr. has joined Ashland Oil & Refining Co., Ashland, Ky., as general manager of the newly-formed DP Dept., once a function of accounting. He was formerly with Texaco in Houston, Texas.









1,248 COMPUTERS IN FEDERAL GOVERNMENT

The latest inventory of dp equipment in the federal government shows 1,248 computers operating during fiscal year 1963, and expenditures of 705 megabucks for personnel, hardware, etc., excluding those in classified uses. Computer rental fees account for a third of expenditures by dp units using computers, exceeded by personnel costs (42 per cent). Six per cent went for card equipment rental, and seven per cent for equipment purchase.

As expected, DOD spent most of the 705 megabucks, 63 per cent. The Air Force rang up a 179-megabuck bill, followed by the Army's 133, Navy's 94. Among civilian agencies, the AEC spent 61 megabucks, NASA 39. The report includes a BuBudget projection of 2,100 computers in the federal government by the end of FY '66.

The percentage of purchased computers shows a slight increase over FY '62, up from 17 to 17.7 per cent. If civilian agencies purchase a third of the hardware they acquire during the current fiscal year, as they reportedly intend to, the proportion in those agencies will increase to 30 per cent. The report, *Inventory of ADP Equipment in the Federal Government,* dated Oct. 25, 1963, is available from the Government Printing Office for 40 cents.

AERONUTRONIC MARKETS 1K-WORD, 10 MC MEMORY

A non-destructive readout, 1,024 (48-bit) word BIAX memory with a read cycle time of 100 nanoseconds was demonstrated at the FJCC by Aeronutronic Div. of Philco. First delivery has been made for inclusion in a large-scale military computer.

Of the 100 nanoseconds, 90 is spent in the transmission lines, and only 10 in the array. Word access time is 85 nanoseconds, writing is accomplished in 3.5 usec, and write-read cycle time is 10 usec. An engineering prototype with input address and data buffers, output register, internal timing circuits, and power supplies is priced at $135K. Delivery is in nine months.

RCA INTRODUCES SPECIAL TYPESETTING COMPUTER

Aimed at the medium-sized daily newspaper and larger weeklies is the RCA 30 Newscom, a cut-down 301 with 20K positions of core and the Los Angeles Times typesetting program. It produces justified and hyphenated lines on paper tape for direct feeding to linecasting machines.

Hardware includes the mainframe and paper tape I/O. With 100 cps I/O, rental is $1,985, and price is $99K. This will produce tape at 5.400 column-width lines per hour. Faster paper tape units have speeds of 1,000 cps in/100 out, and 1,000/300 cps. These systems rent for $2,320 and $3,065 respectively, and produce 7,800 and 17,400 lines per hour.

Competitive IBM hardware include 1620 systems which produce 4,000 lines per hour ($1,850 monthly), 12,000 lines using up to 20 paper tape I/O devices (about $2,410 per month), and the same configuration with the 1311 disc file added, producing 12,000 lines per hour. The latter rents for some $3,250.

TULANE & IBM REPORT ON COMPUTER BIOMEDICAL RESEARCH

Tulane University and IBM are entering the second year of a computer biomedical research partnership. Specialists from IBM's Advanced Systems Development Division and the staff of Tulane's Bio-Medical Computing Systems Center reported recently on results of work in medical records research, physiological data handling and X-ray image processing.

The latter work has involved electronic scanning of a 3x3-inch section of an X-ray, which is converted into digital form and stored within the computer. Two digits from 00 through 99 represent ascending degrees of lightness, and are used to prepare a new, clearer image on a cathode ray tube (CRT) for further study by radiologists. The computer-prepared image may lead to more rapid, accurate pinpointing of lesions and other pathology. By this technique X-rays can be enlarged to permit more detailed analysis of a particular segment. Future scanning equipment can also take over the task of locating and measuring lesions.

The team has also developed an experimental technique for analysis of physiological data from electroencephalograms (EEG) and electrocardiograms (ECG). Adapting a speech pattern recognition technique, Dr. R. E. Bonner of IBM has developed a method in which the computer analyzes samples of "normal" EEG and ECG patterns to establish its own definition of normality and rules for recognizing abnormalities.

Established in February 1962 with a five-year NIH grant of $1,674,854, the 17-man Tulane center includes a 40K-core 1410, a 1401, plus peripheral gear. The center is under the direction of Dr. J. W. Sweeney.

MARKETING OF FP 6000 TO BEGIN IN U.S.

The marketing in North America of the first Canadian-designed and built digital computer has been announced by Ferranti Electronics, a division of Ferranti-Packard Electric Ltd., Toronto. Regional sales offices in the U.S. are among plans for the FP 6000, of which eight sales are reported—three to the parent company in England, none in the U.S.

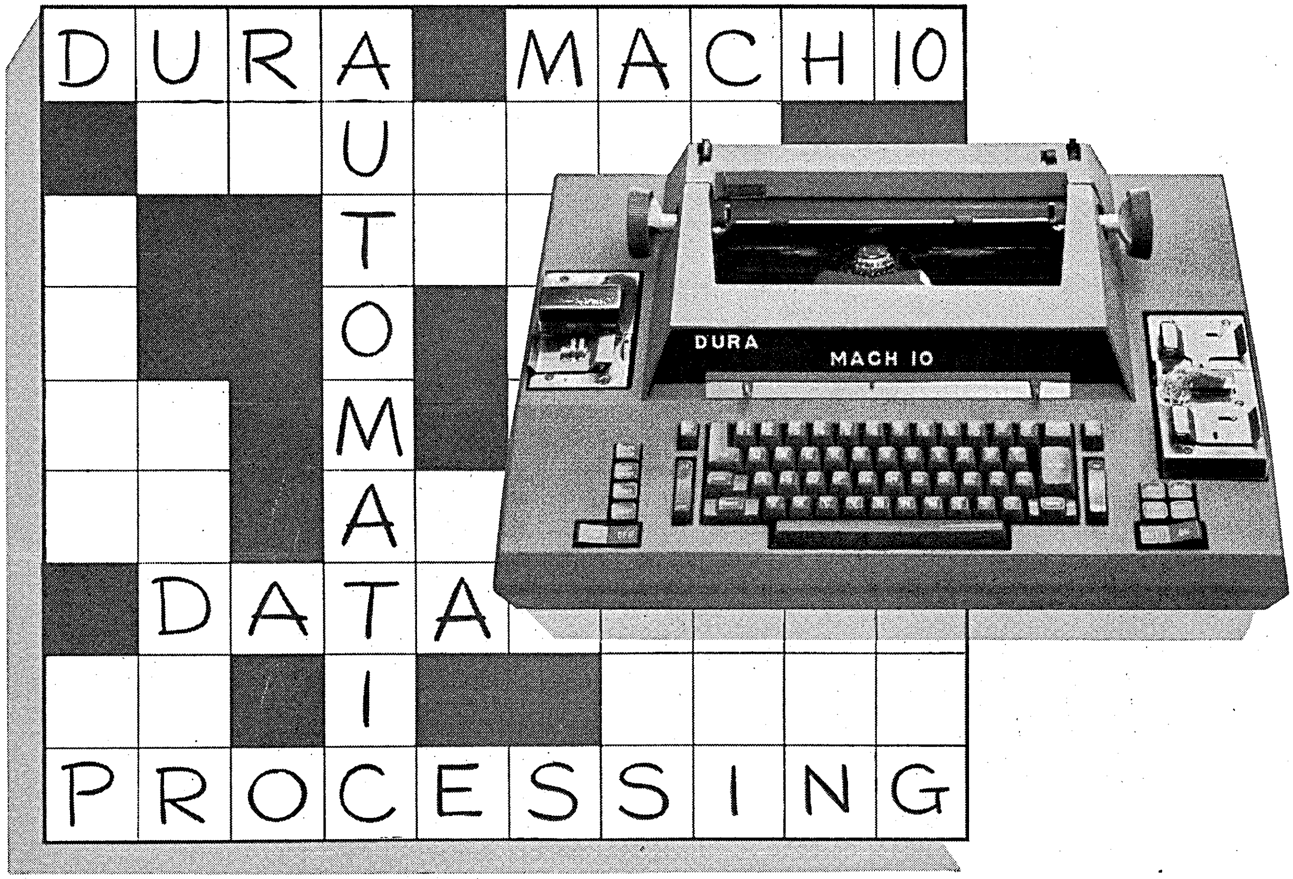
The time-sharing 6000 is a medium-scale, binary computer with 4-32K (24-bit) words of core with a cycle time of two, four, or six usec. Add time is seven usec, multiply 40 usec, and divide 43 usec. Programmed floating point (38-bit) add is 111 usec. Although there is no theoretical limit to the number of programs it can handle at once, the practical limit presently is four.

Among peripheral devices available are 300 and 1,200 lpm printers, 66KC mag tape units, and drum and disc files. Software includes FORTRAN, ALGOL, and Auto-Coder. Typical price is said to be $750K.

IR SYSTEM WITH EAM, COMPUTERS GOES ON-LINE

An information retrieval system with configurations ranging from electronic

ANSWER TO TODAY'S PAPERWORK PUZZLE



The daily mass of paperwork handled in your business amounts to a significant expense. How can you cut paperwork costs and speed up efficiency at the same time? The answer to this paperwork puzzle is the Dura MACH 10, the automatic typewriter that gives you "systems control" over your business data.

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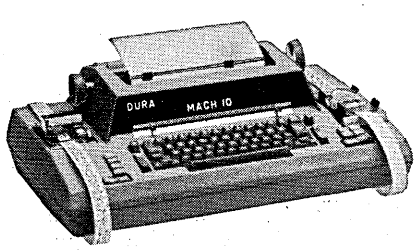

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CIRCLE 34 ON READER CARD

NEWS BRIEFS . . .

accounting machine/punched card equipment to computer/display hardware is operational at various departments of System Development Corp.

SATIRE (semi-automatic technical information retrieval), developed by John Roach of the SAACS Dept. in Paramus, N.J., has a six-second response time to a single question, and can answer, for example, some 100 contract-related questions in five minutes. Microfilmed documents are said to be accessed in 60-90 seconds, from keyboarded interrogation to hardcopy output. A remote subsystem for operation between SDC facilities in Paramus, N.J., and Falls Church, Va., is being planned. Linkage will be by phone lines.

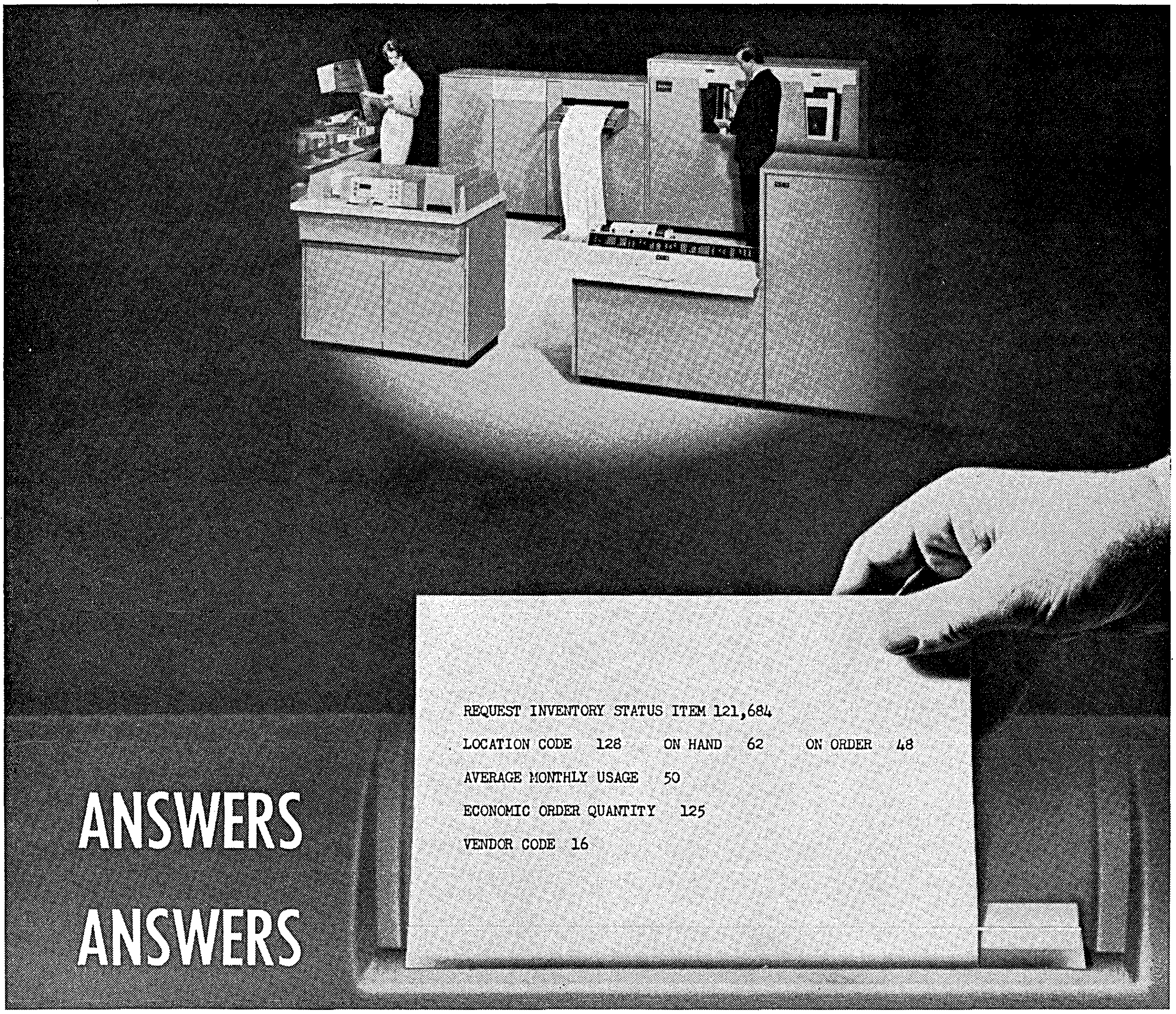
RCA 3301 SOFTWARE TO GO WITH 1ST HARDWARE

Although its FORTRAN IV is not scheduled for delivery until January 1965, the RCA 3301's FORTRAN II, COBOL, and new Operating and Sort/Merge Systems are being readied for shipment with the first hardware delivery, according to the company. The machine is program-compatible with the 301.

The Operating System is an executive which obviates separate programs for the four basic uses of the computer—business, scientific, real-time, and communications computing. The Sort/Merge System uses an oscillating technique in which the computer alternately sorts data on mag tape inputs and merges this data on a master output tape.

● Computer-control operations at three American Oil Co. refineries have been announced. At the Whiting, Ind., facility, an IBM 1710 is central in a closed-loop process control of a 21,000-barrel-per-day Ultraformer. An RW 330 is controlling a 5,000-barrel-per-day alkylation unit in Salt Lake City. An operating-management information system is being readied at Texas City, Texas, using a 1710-1401. The system will scan instrument readings, with less frequent input data entered manually. Hardware expansion for future closed-loop application is said to be possible.

● A 1.8 megabuck, university-wide computation center has been established by the Univ. of Hawaii. Hardware includes an IBM 7040 and 1401 which supplement a 650 being retained for computer education use. Some 80 per cent of machine time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AVERAGE MONTHLY USAGE 50
ECONOMIC ORDER QUANTITY 125
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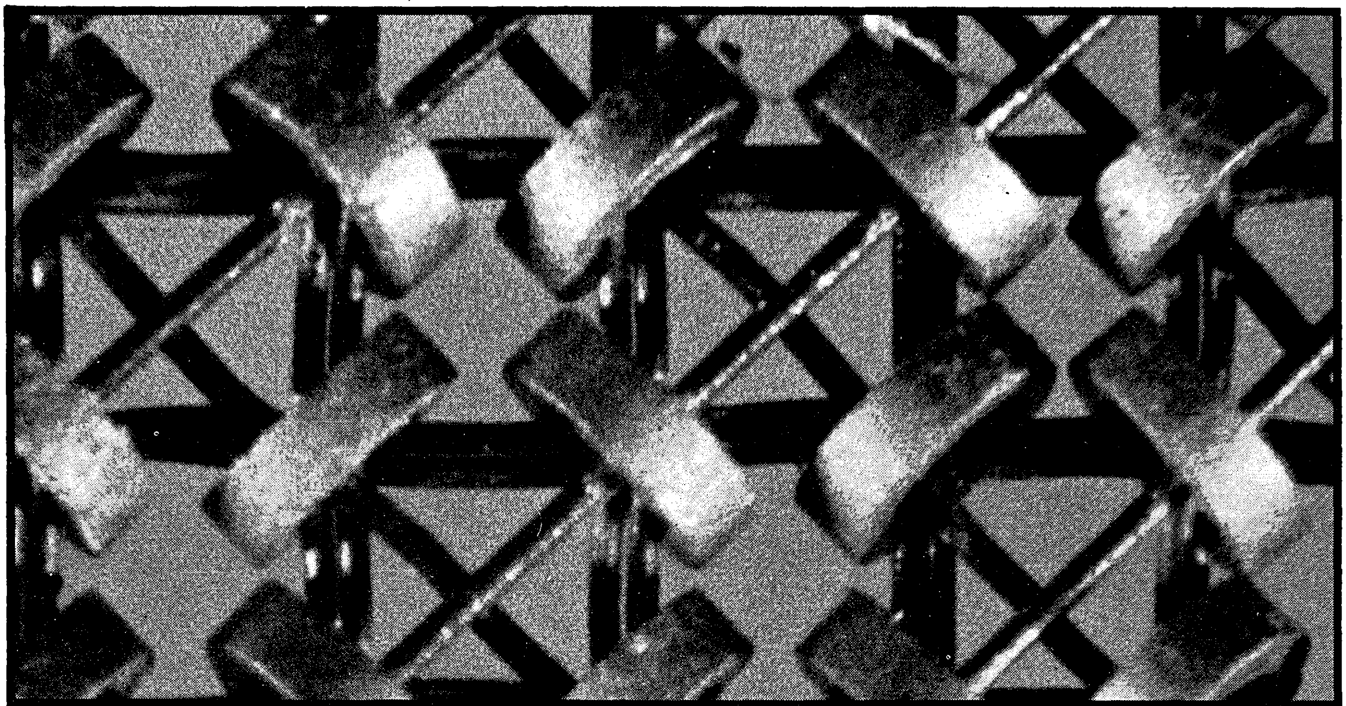
will be for academic research, including an estimated 1,600 hours by the Hawaii Institute of Geophysics in the first year. This is reported to be the second 7040 delivered to a U.S. university. Some of the software is being supplied by the Western Data Processing Center at UCLA. Heading the UH center is Dr. Robert W. Sparks.

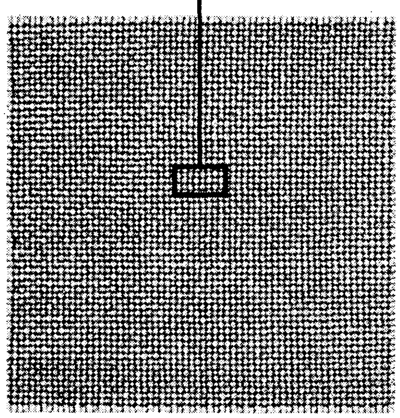
● The first of a three-phase project leading to the development of electronic address-reading hardware has been completed with delivery to the U.S. Post Office Dept. of an engineering model by Philco. An intermediate model is due in 1964, and a prototype reader in 1965. The present scanner, which controls a letter-sorting machine, reads several printed and typewritten faces, and recognizes 50 states and 25 cities. The prototype will be designed to read 500 addresses and direct a sorter machine at the rate of 36,000 envelopes per hour.

● An experimental woven screen memory, demonstrated at the FJCC, has been developed by TRW's Computer Div. Experimental laboratory models of 2,500 and 4,000 bits indicate that planes can be operated in a coincident-current mode with signal-to-noise ratios of greater than 10-l. With improvements, TRW feels the 10-usec cycle time of the lab model can be stepped up to four usec. "Large" planes have been operated at 105°C; small planes have been tested at 195°C. The plane is evidently insensitive to shock, and shows promise of amenability to mass production techniques. Testing and evaluation may pose headaches, however.

● Development of techniques enabling character recognition devices to read blurred or garbled text has been undertaken by RCA Data Systems Center, Bethesda, Md., for the Army Electronics Research and Development Lab, Ft. Monmouth, N.J. Linguistic and statistical characteristics of a language and the local characteristics of the text being generated will be used in a computer-simulated device designed to determine logically what the garbled word should be. Results of the study are said to be applicable to automatic proofreading and word-hyphenation systems.



50 TIMES MAGNIFICATION



5-WIRE COINCIDENT 64 X 64 MATRIX (ACTUAL SIZE)

It takes big minds to think this small

. . . good, sound engineering minds with that added spark of boldness that frequently solves the seemingly unworkable problem. The core memory frame above is a case in point. A 5-wire coincident, 4,096-core matrix less than 2 inches square seemed impossible to make on a production basis. But Fabri-Tek engineers devised special production aids and techniques, and we now produce them in volume.

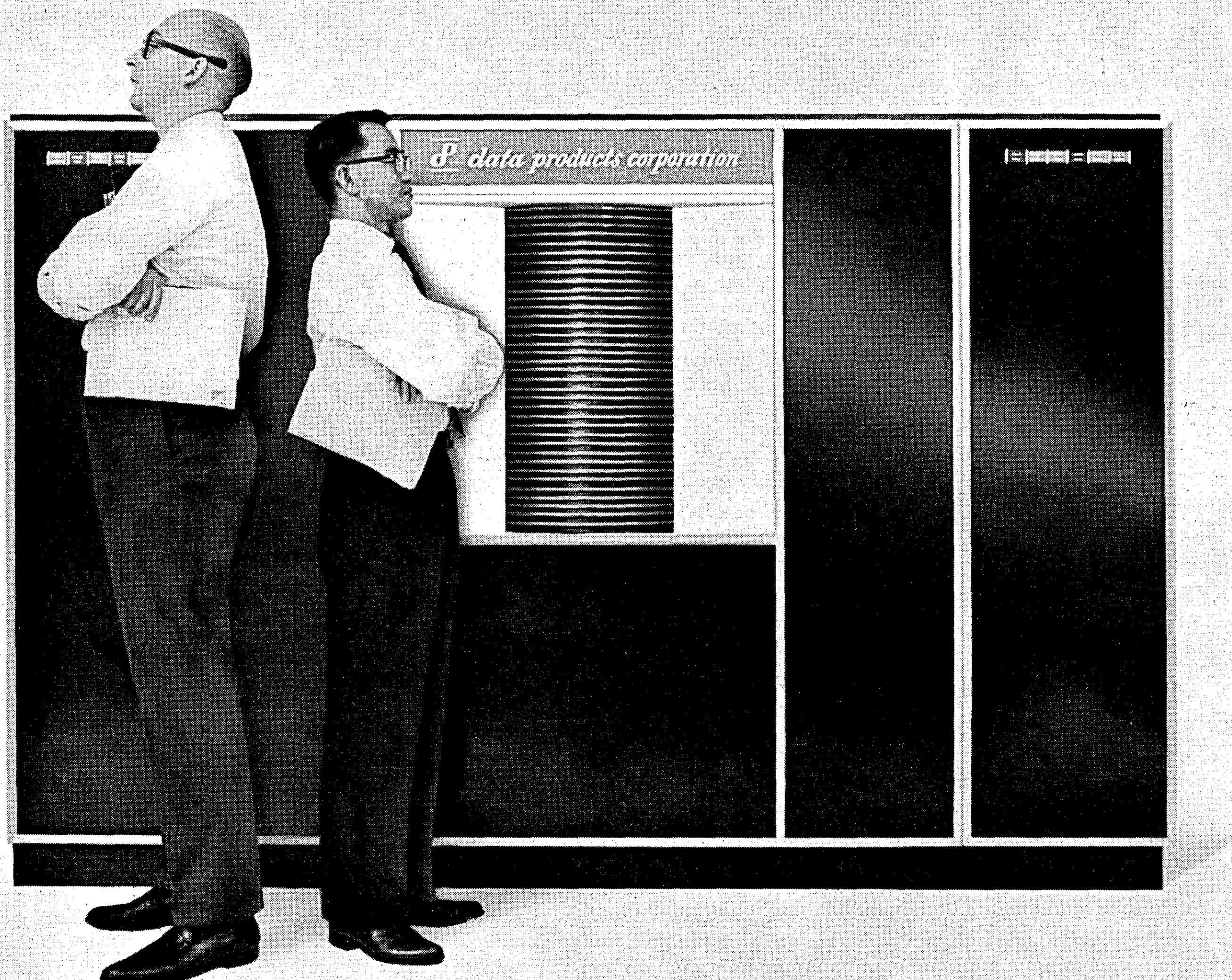
Fabri-Tek engineers fit core memory frames and stacks to your systems. Cores from any quality manufacturer can be used to match your speed and environmental requirements. You get exact electronic and physical fit.

Complete memory systems from Fabri-Tek have been designed with simplified, standard circuits for reliability, ruggedness and easy maintenance. Other features include solderless connections on all inner wiring, test points on printed circuit modules, address and data information indicators, matched input, output and control levels, and optional self-testing features.

New color brochures describe printed circuits, memory frames, memory stacks and complete memory systems. Write today for your free copies. Fabri-Tek, Inc., P. O. Box 8046, Minneapolis 16, Minnesota.

FABRI-TEK®

CIRCLE 36 ON READER CARD



Don't sulk, you both can use it...simultaneously!

Because this *data products* mass random access DISCfILE* has dual accessibility from two separate computers — simultaneously. Because it's designed with a positioner for each disc; and any two selected positioners can be operating, moving to a selected position or transferring data on a channel — simultaneously.

This feature, unique in disc-type data storage equipment, is just one of the many "extras" available in the versatile, reliable DISCfILE. For example, a variety of storage capacities is offered on a compact, modular basis — from 40 million bits and single access through 920 million bits and simultaneous dual access — to provide both flexibility and economy. Choose the DISCfILE according to your immediate needs and then expand the system as your requirements increase.

Reliability? DISCfILE is the industry's most thoroughly "on-line" proven mass random access memory, with several score already installed and more going in every week.

The dp/f-5035 (shown above) offers 460-million bit storage capacity in one 32-disc unit, with 600 bits-per-inch density, a typical access time of 100 ms, with simultaneous dual access — and a reliability factor of but one recoverable error in every billion bits transferred.

DISCfILE can make a significant improvement in your present or contemplated computer system. We can prove it to you — with complete technical data and/or an eye-popping demonstration of a production unit undergoing final system test. Try us out.

data products corporation 8535 Warner Drive/Culver City, California/Phone: 837-4491

*DISCfILE is a trademark of *data products corporation*

NEW FIRMS & mergers in DP

The Control Systems Div. of Daystrom has been acquired by Control Data Corp., Minneapolis. The division, which becomes part of CDC's Industrial Group, produces industrial computer controls and allied gear, including the 636 control computer, which will be continued. Paul G. Miller remains as general manager of the division in LaJolla, Calif.

CEIR has sold an 80 per cent interest in its market research subsidiary, Facts Consolidated, to Economics Research Assoc., Los Angeles. Remaining as head of FC is Dorothy Corey.

The Olivetti firm in Milan, Italy, has created a Numerical Control Systems Div. for the manufacture and sale of such equipment, and also offers its computation centers for the production of control tapes.

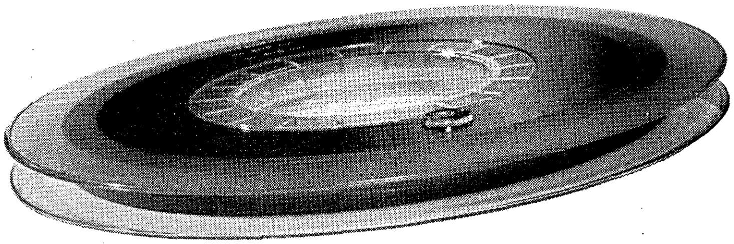
The mail marketing firm of O. E. McIntyre Inc., New York City, has formed a Service Bureau Div. Hardware includes a Univac III and a tape-oriented 1401.

Applied Dynamics International has just been formed as a division of Applied Dynamics, Inc., of Ann Arbor, Mich. Jerome D. Kennedy will serve as president of the new international division, which will be responsible for all company activities outside of the United States.

Klair Systems Inc., producer of "audio-automated" data collection systems, has been acquired by Artisan Metal Works Co., Cleveland, Ohio.

Control Data Corp. has just opened its newest computation center in Great Neck, Long Island, New York. The bureau is equipped with a 1604-A.

Ransom Electronics, manufacturers of digital equipment and modules for industrial, commercial and ground support applications, has recently been established in San Pedro, California.



This is a reel of new, **improved** Computape.

What do we mean by improved?

Longer wear, less static build-up, greater reliability than ever before.

Skeptical? Allow us to make a suggestion:

Test it yourself. Against <u>any other</u> tape.

If that doesn't convince you, you're just plain stubborn.

COMPUTRON INC.
122 CALVARY STREET, WALTHAM, MASSACHUSETTS

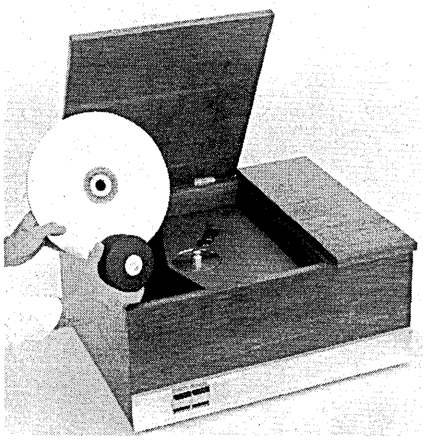
CIRCLE 39 ON READER CARD

DATAMATION

NEW PRODUCTS

interchangeable discs

The Data Disc System features interchangeable 12-inch magnetic discs with a capacity of two megabits each. Average access time is less than 150 milliseconds, and discs reportedly can



be changed in 30 seconds. The unit occupies less than two cubic feet. The system holds 4,000 (64-character) records. Price is $9.5K. DATA DISC INC., 981 Commercial St., Palo Alto, Calif. For information:

CIRCLE 200 ON READER CARD

list processing

CULP I has been designed for use with the IBM 1401. CULP I programs may mix 1401 instructions, list manipulating instructions and list executions. COMPUTER USAGE CO. INC., 655 Madison Ave., New York, N.Y. For information:

CIRCLE 201 ON READER CARD

optical scanner

The 1282 optical reader card punch is for processing credit cards. It reads preprinted information, account numbers imprinted by credit plates, and invoice amounts marked by pencil in an appropriate box. It processes 80- or 51-column cards at 200 cpm. Rental is $1,550 per month, and price is $72K. IBM DATA PROCESSING DIV., 112 E. Post Road, White Plains, N.Y. For information:

CIRCLE 202 ON READER CARD

mag tape

Model D 2020 writes and reads tapes in all three standard compatible formats (800, 556 and 200 bpi). Units run at any single tape speed from three to 45 ips. Prices begin at $9K. DATAMEC CORP., 345 Middlefield Rd., Mountain View, Calif. For information:

CIRCLE 203 ON READER CARD

training slides

This series of PERT training slides can be used in basic familiarization and in advanced courses. Topics covered include selection of the level of detail, development of program matrices, establishing the size of work packages, handling commitments and overhead, and extending controls to production. The set is priced at $78.50. MANAGEMENT PLANNING SYSTEMS CO., 1122 106th Ave., N.E., Bellevue, Wash. For information:

CIRCLE 204 ON READER CARD

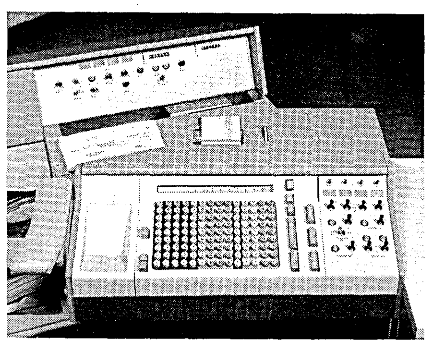
validata 100

This tape-to-tape, point-to-point communications systems is equipped with error detection and automatic correction, and operates at a rate of 10 cps. TELETYPE CORP., 5555 Touhy Avenue, Skokie, Ill. For information:

CIRCLE 205 ON READER CARD

bank encoder

Class 481 magnetic ink character recognition all-field encoder has been designed to prepare documents for bank automation systems. The unit prepares checks, deposit slips and other media for automatic processing



by selectively coding them with magnetic numbers which can be read by machine. Price ranges from $4,900 to $7,000. NATIONAL CASH REGISTER CO., Dayton 9, Ohio. For information:

CIRCLE 206 ON READER CARD

memory

A 28-bit parallel transfer, random access disc file memory has been

NEW PRODUCTS . . .

designed for the Philco 212 system. The memory enables data to be transferred at a rate of 125K words per second from the 250KC zone and 62,500 words a second from the 125KC zone. BRYANT COMPUTER PRODUCTS, 850 Ladd Rd., Walled Lake, Mich. For information:

CIRCLE 207 ON READER CARD

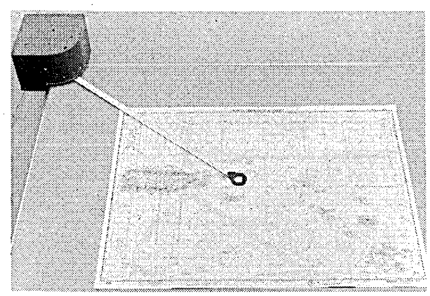
card reader

Model BC124 features a maximum demand feed rate of 800 cpm, serial photoelectric reading of card columns, and the ability to handle 51-, 60-, 66- and 80-column cards. Potential capacity of the unit during an eight-hour day is 384,000 cards. BURROUGHS CORP., 460 Sierra Madre Villa, Pasadena, Calif. For information:

CIRCLE 208 ON READER CARD

electronic tracing

Infotracer is a device for inserting graphic data into data processing and display systems. The Infotracer may be used for entering arbitrary functions into analog computers, extracting data from drawings for use as inputs to computer-controlled metal-working



machines, adding manually-traced data to the plots of x-y recorders and extracting data from terrestrial maps. TEMCO ELECTRONICS DISPLAY SYSTEMS PLANT, P.O. Box 6118, Dallas 22, Texas. For information:

CIRCLE 209 ON READER CARD

tape patches

These perforated patches have been designed for editing and splicing Mylar perforated tapes. The patches are available for 5, 6, 7, and 8 channel tapes. ROBINS DATA DEVICES INC., Flushing, N.Y. For information:

CIRCLE 210 ON READER CARD

upgraded h-1400

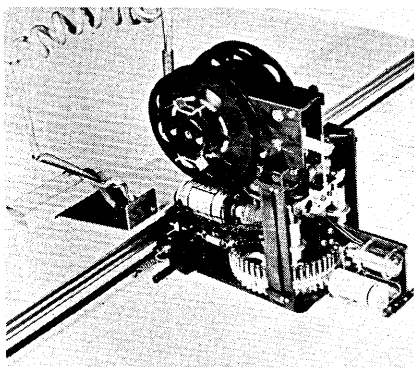
Storage of the H-1400 has been increased to 32K (48-bit) words. Memory cycle time is 13 usec, and three-address add time is 71 usec. In addition to priority interrupt and optional floating point hardware, a maximum 280 communications lines can be linked to the system. Average rental is $16K, and purchase price starts at $500K. HONEYWELL EDP, 60 Walnut St., Wellesley Hills 81, Mass. For information:

CIRCLE 211 ON READER CARD

COMPONENT PRODUCTS

symbol printer accessory

This new line of instruments has been designed to expand the capability of x-y plotters by plotting data as coded symbol point plots. Model 95.154 permits selection of any of 16 characters



and is priced at $1,500. Model 95.164 permits selection of up to 48 characters and is priced at $4,500. ELECTRONIC ASSOCIATES, INC., Long Branch, N.J. For information:

CIRCLE 225 ON READER CARD

phone transmission

The Data-Phone 103-A transmits data serially over regular phone lines at 270 wpm, and has three options on answering operations: no automatic answering (attendant must be present), automatic answering when proper key is depressed, and constant automatic answering. AMERICAN TELEPHONE & TELEGRAPH CO., 195 Broadway, New York, N.Y. For information:

CIRCLE 226 ON READER CARD

digital training computer

The DIGIAC 3010 has been designed as a teaching aid and as an error proving device for OEM logic R & D. The device is priced at $695. DIGITAL ELECTRONICS, INC., 2200 Shames Dr., Westbury, L.I., N.Y. For information:

CIRCLE 227 ON READER CARD

teletone

This selective tone signaling system provides an unlimited number of command or control functions over any single channel communication system. Applications include manual

COMPONENT PRODUCTS . . .

or automatic control of industrial processes, security systems, traffic control and monitoring. TREPAC CORP. OF AMERICA, TELETONE DIV., 30 W. Hamilton Ave., Englewood, N.J. For information:

CIRCLE 228 ON READER CARD

d/a converter

Type 1136-A features a high-speed storage system which permits use with intermittent as well as continuous BCD inputs. The converter operates with four-line BCD inputs or with an accessory matrix cable with 10-line inputs from the 1150-series counters. Conversion rate is up to 10,000 per second. The 1136-A is priced at $650. GENERAL RADIO CO., West Concord, Mass. For information:

CIRCLE 229 ON READER CARD

plotter

The DY-2035A (rack-mounted in two-bay cabinet) and the B (desk-type console) are plotters with a speed of 4 ips and slewing to 20 ips. Accuracy is said to be better than 0.2 per cent of full scale on 11 x 17 inch graph, 0.075 per cent on optional 30 x 30-inch plotter. Both are supplied with FORTRAN II. Prices are $25,500 and $25,950. DYMEC DIV., HEWLETT-PACKARD CO., 395 Page Mill Rd., Palo Alto, Calif. For information:

CIRCLE 230 ON READER CARD

character generator

The KD-5060 accepts digital data and translates it into any alphanumeric character or symbol at up to 320K bits per second. Additionally, it accepts repetitive data signals from core, mag tape, punched tape, or magnetic drum memories of flip-flop registers. INTERNATIONAL TELEPHONE AND TELEGRAPH CORP., 320 Park Ave., New York 22, N.Y. For information:

CIRCLE 231 ON READER CARD

cp

Model 119 paper tape reader can read up to eight-channel paper tape bi-directionally, at a speed of 30 cps. An interrupter switch is supplied to protect the star wheel sensing switches and for self-stepping of the tape. The 119 is priced at $350. OHR-TRONICS INC., 516 5th Ave., New York, N.Y. For information:

CIRCLE 232 ON READER CARD

a-d converter

Type 142 transforms an analog signal to a signed binary number with 10-bit accuracy in a total time of six usec. Conversion accuracy is ±0,15% ±½ least significant bit. DIGITAL EQUIPMENT CORP., Maynard, Mass. For information:

CIRCLE 233 ON READER CARD

NEW LITERATURE

ORGANIZATION GUIDE: A division of the Library of Congress has prepared a report on 449 International Scientific Organizations, a Guide to their Library, Documentation, and Information Services. Priced at $3.25. SUPERINTENDENT OF DOCUMENTS, U. S. GOVT. PRINTING OFFICE, Washington 25, D. C.

TEXTILE APPLICATIONS: Brochure is based on a case history study of a 400 computer installation at a textile manufacturing organization. Quality control, general ledger accounting accounts receivable, management control, billing and payroll using the 400 are discussed. HONEYWELL EDP, 60 Walnut St., Wellesley Hills, Mass. For copy:
CIRCLE 131 ON READER CARD

STUDENT RECORD KEEPING: Describes new data processing applications for accelerating student record-keeping systems. Detailed are the economics of transferring data in punch cards or tape to permanent records or tape via pressure-sensitive labels. ALLEN HOLLANDER CO., INC., 385 Gerard Ave., Bronx, N. Y. For copy:
CIRCLE 132 ON READER CARD

DISC FILES: A, B, and C models of series 4000 disc files are discussed in this brochure which contains information on file organization, addressing, computer interfaces, magnetic heads and the positioning system. Charts and illustrations are included. BRYANT COMPUTER PRODUCTS, 850 Ladd Rd., Walled Lake, Mich. For copy:
CIRCLE 133 ON READER CARD

ELECTRONIC PROJECTS: 28-page catalog describes do-it-yourself kits for building such items as power supplies, magnetic amplifiers and analog computers. H. F. PARKS LABORATORY, Box 1665, Seattle, Wash. For copy:
CIRCLE 134 ON READER CARD

BOOLEAN ALGEBRA: Pocket-sized Guide to Boolean Algebra and Logic Conventions contains a short history of George Boole, basic logic rules, formulae of the DeMorgan theorum, absorption property and canonical form. HARMAN KARDON, DATA SYSTEMS DIV., Plainview, L. I., N. Y. For copy:
CIRCLE 135 ON READER CARD

DIGITAL SYMBOL GENERATOR: Four-page booklet illustrates Type 33 gen-

erator which can automatically translate digital words into symbol format. DIGITAL EQUIPMENT CORP., 146 Main St., Maynard, Mass. For copy:
CIRCLE 136 ON READER CARD

PROGRAMMING PACKAGES: Two programming packages, ADAPT and PRONTO, which enable the 215, 225 and 235 computers to prepare perforated tapes for automatically controlling machine tools are described in a six-page booklet. GENERAL ELECTRIC CO., COMPUTER DEPT., Deer Valley Park, Phoenix, Ariz. For copy:
CIRCLE 137 ON READER CARD

MASS SPECTRUM DIGITIZER: Brochure describes model VR16-MSD, includes specifications based on actual application, operating principles, applications information and a discussion of accuracy. ADAGE, Inc., 292 Main St., Cambridge 42, Mass. For copy:
CIRCLE 138 ON READER CARD

PUBLICATIONS & SERVICES: Lists services, reports to the congress, research bulletins, manpower reports, programs and activities provided by OMAT. U. S. DEPT. OF LABOR, OFFICE OF MANPOWER, AUTOMATION & TRAINING, Washington 25, D. C. For copy:
CIRCLE 139 ON READER CARD

TIME CODE GENERATOR/READER: Illustrated bulletin describes the 858 and includes its areas of application, specifications, theory of operation. ELECTRONIC ENGINEERING CO. OF CALIF., Box 58, Santa Ana, Calif. For copy:
CIRCLE 140 ON READER CARD

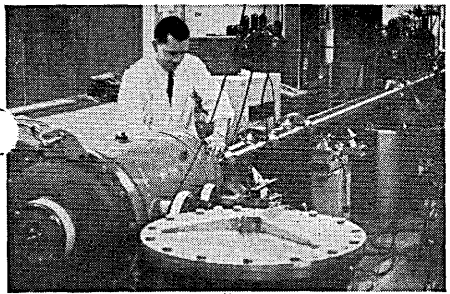
DIGITAL PROGRAM GENERATOR: Six-page catalog features specifications and applications of this company's multichannel pulse digital program generator. COMPUTER CONTROL CO. INC., Old Connecticut Path, Framingham, Mass. For copy:
CIRCLE 141 ON READER CARD

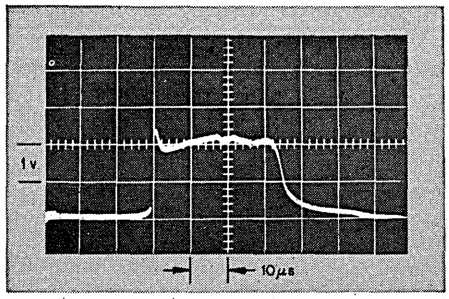
PRICE LIST: User price list covering this company's mag tape designed for use with IBM computers includes tapes used in 200, 556 and 800 bpi applications. AMPEX CORP., MAGNETIC TAPE DIV., 401 Broadway, Redwood City, Calif. For copy:
CIRCLE 142 ON READER CARD

X-Y RECORDERS: Eight-page brochure describes models HR-95 and HR-97 x-y recorders, specifications, and typical performance curves. HOUSTON INSTRUMENT CORP., 4950 Terminal Ave., Bellaire, Tex. For copy:
CIRCLE 143 ON READER CARD

GP DIGITAL COMPUTER: Eight-page brochure describes the 2100 digital computer and lists applications. ELECTRO-MECHANICAL RESEARCH INC., Sarasota, Fla. For copy:
CIRCLE 144 ON READER CARD

ADVERTISERS' INDEX





Super-orbital entry of a space vehicle—one returning to earth from a planet, rather than from an earth-orbiting mission—would result in searing *radiative* heating in addition to the more familiar *convective* type. As a spacecraft nose enters atmosphere, it pushes the thin air aside. A boundary layer is formed next to the skin. Ahead of that is a compressed mass of air; fronting that, a shock wave. The air behind the shock wave becomes incandescent, ionizes, and radiates to the heat shield. Within the boundary layer, friction heats the nose cone by convection.

Lockheed scientists believe that at higher than escape speed a blunt-nosed vehicle may be unable to sustain the radiative heating. Consequently, a return to the previously discarded sharp nose is indicated. Fluid mechanicists are calculating the heat load, determining how rapidly the nose will ablate and how to keep it sharp. Current shock tube tests are providing some clues.

Another research project in Lockheed's Fluid Mechanics Laboratories relates to the flow of buoyant fluids. A typical study program is the determination of how liquid hydrogen, stored in a tank in space, stratifies. This, in turn, determines the level of pressurization required in order to extract all of the fluid. Scientists made a mathematical model of what they think occurs inside the tank. With this as a guide, an actual tank was constructed to obtain measurements and photographs of the flow to verify their theories.

LOOK AT LOCKHEED... AS A CAREER

Consider Lockheed's leadership in space technology. Evaluate its accomplishments—such as the Polaris missile, the Agena vehicle's superb record of space missions. Examine its outstanding advantages—location, advancement policies, creative climate, opportunity for recognition.

Then write for a brochure that gives you a more complete Look at Lockheed. Address: Research & Development Staff, Dept. M-46E, P.O. Box 504, Sunnyvale, California. Lockheed is an equal opportunity employer.

SCIENTISTS & ENGINEERS: In addition to positions relating to fluid mechanics, other important openings exist for specialists in: Inertial guidance • Orbit thermodynamics • Electromagnetics • Mission & trajectory analysis • Gas dynamics • Chemical and nuclear propulsion • Systems engineering

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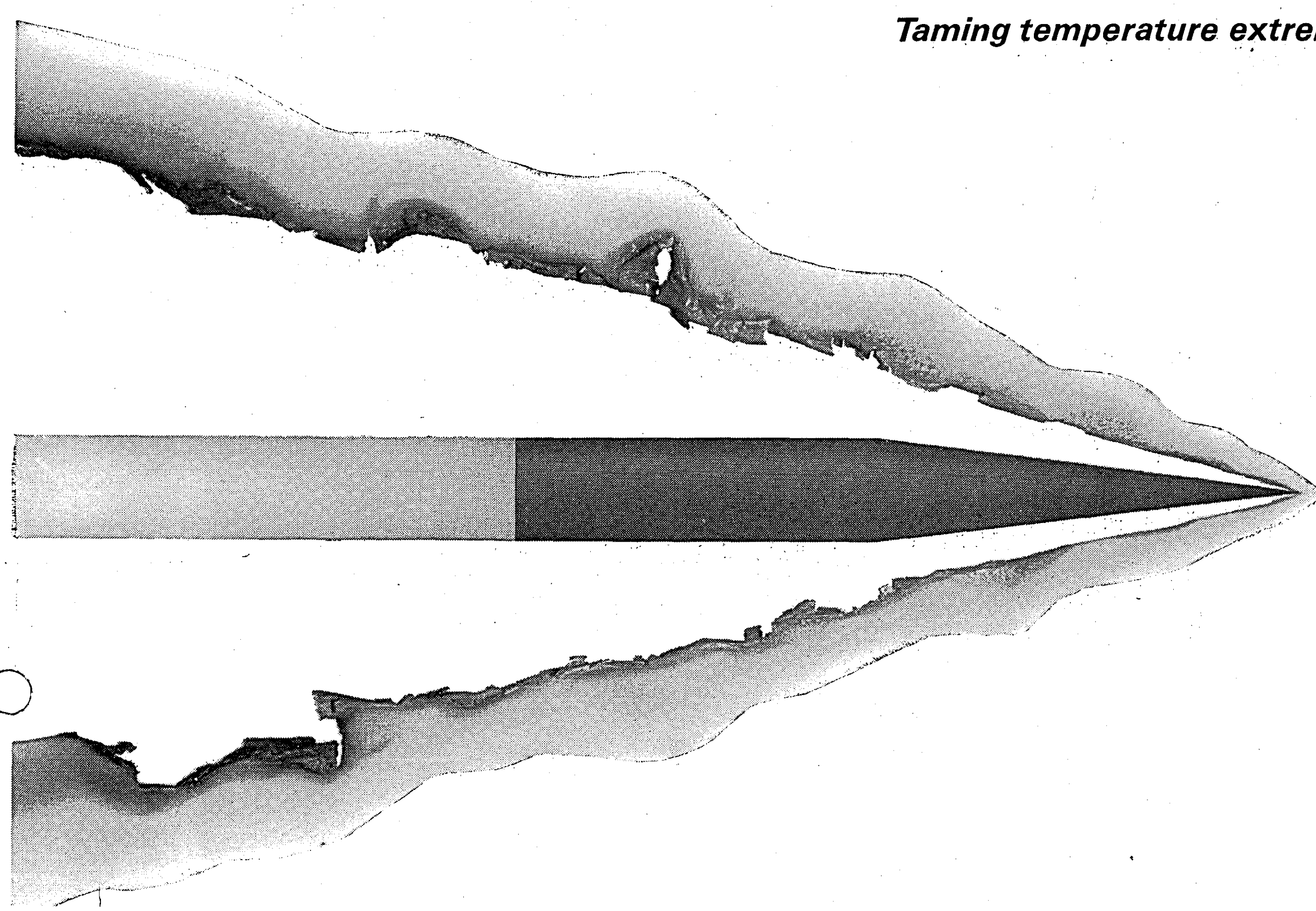
LOOK AT LOCKHEED IN FLUID MECHANICS:

Taming temperature extremes



Someday man will hang his hat on the moon

It may not be the hat pictured here. But it will be close. For man's ancient dream of journeying to the moon is steadily nearing reality.

Bellcomm is busy planning this journey, evaluating systems needed for manned space flight there and back. If qualified, you might like to join the vanguard creating this exciting expedition. There are rewarding openings in the fields of physics, chemistry, engineering, psychology, mathematics, flight mechanics, computing and programming, propulsion, aerodynamics and aeronautical engineering.

Bellcomm welcomes your résumé. Send it to Mr. W. W. Braunwarth, Personnel Director, Bellcomm, Inc., Room 1118T, 1100 17th St., N. W., Washington 6, D. C. Bellcomm, newest company of the Bell System, is an equal opportunity employer.

BELLCOMM, INC.
A Bell Telephone System Company

"We use Computer Audiotape in all phases of our computer operation"

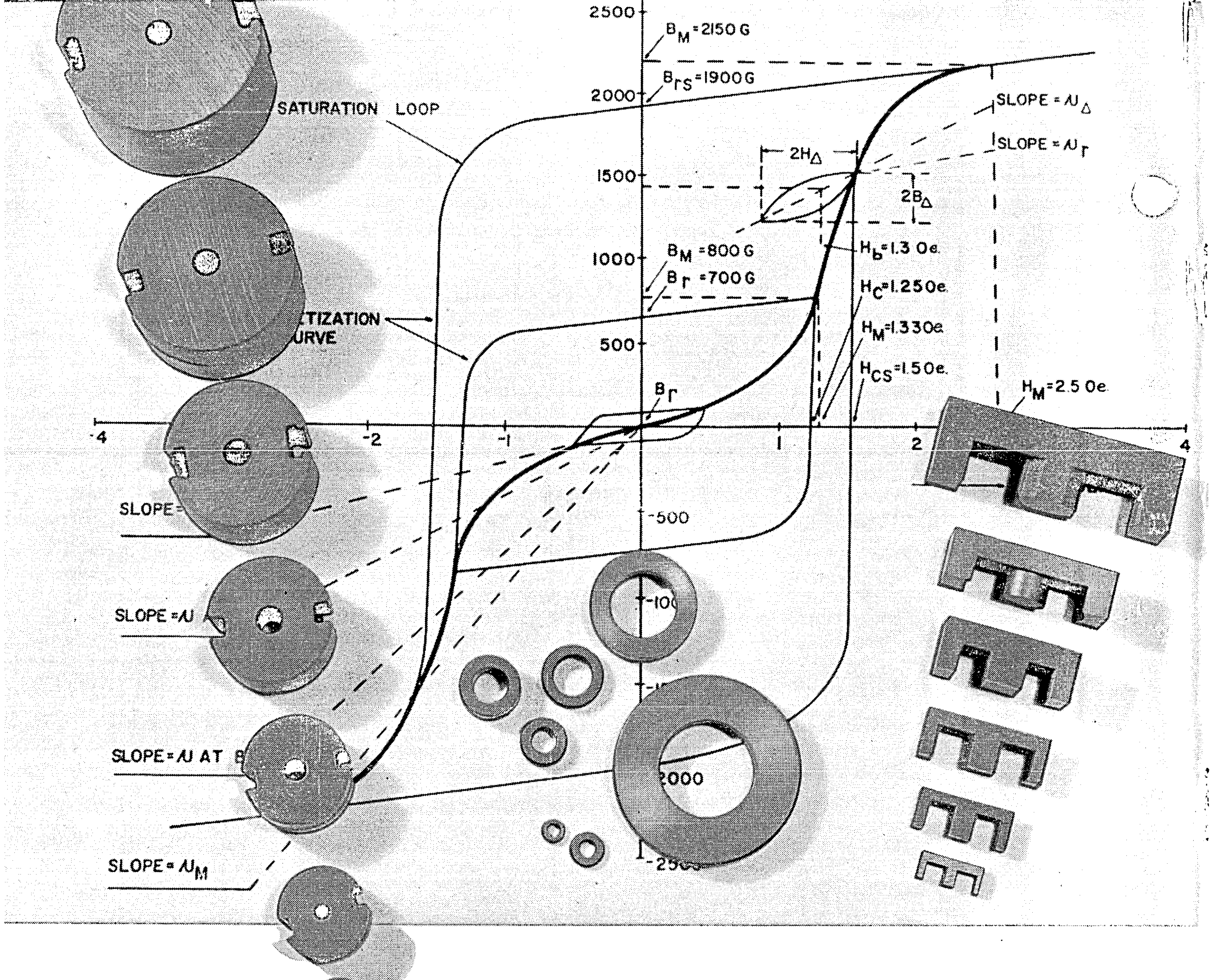
says Mr. Louis L. Hodge, Director of Data Processing Operations for Government Employees Insurance Company, Chevy Chase, Maryland

"GEICO is one of the leading auto insurers in the United States. As a result, our large computer section is used to keep the individual files on almost a million policyholders constantly up to date, as well as to process thousands of claims weekly. Computer Audiotape is active in all phases of these operations. We have purchased close to 1,000 reels in less than a year. We prefer Computer Audiotape for a number of reasons. First—and most important—its quality has been very good. Second, the price is right. And third, the service we get is most satisfactory."

GEICO is just one of the many prominent companies that consistently specify Computer Audiotape. They know that each reel is manufactured with extreme care. They know that each reel is 100% checked to insure that every "bit" reproduces properly. Try Computer Audiotape in your own operation. It's available in a variety of lengths, in bit densities of 200, 556 and 800, in standard and heavy duty types. And consider Audio's new Extra Length Computer Audiotape which offers 50% more tape on the same size reel. Write for complete information to Audio Devices, Dept. BA.

AUDIO DEVICES, INC., 444 Madison Avenue, New York 22, New York

CIRCLE 2 ON READER CARD



BM=2150 G
BrS=1900G
SATURATION LOOP
SLOPE = μΔ
SLOPE = μr
2HΔ
2BΔ
BM =800 G
Br =700G
Hb=1.3 Oe.
Hc=1.25Oe.
HM=1.33Oe.
HCS=1.5Oe.
HM=2.5 Oe.
Br
SLOPE = μ
SLOPE = μM