DATAMATION® 66

July

ELECTROMECHANICAL MASS STORAGE

Our optical reader can do anything your keypunch operators do.

(Well, almost.)

It can't come back from a two-week vacation with a third degree sunburn. Or get sick. Or go to the little girls' room. But it *can* read. And gobble data at the rate of 2400 typewritten characters a second. And compute while it reads. And reduce errors from a keypunch operator's one in a thousand to an efficient one in a *hundred* thousand.

Our machine can read upper and lower case characters in intermixed, standard type fonts. It can handle intermixed sizes and weights of paper, including carbon-backed sheets.

An ordinary computer program tells our reader what to do . . . to add, subtract, edit, check, or verify as it reads. This lets you forget format restrictions, leading and trailing zeros, skipped fields, and fixed record lengths. And our reader will not obsolete any of your present hardware because it speaks the same output language as your computer.

Our Electronic Retina Computing Reader can replace all—or almost all—of your keypunch operators. Right now, our Electronic Retina Computing Reader is saving companies like United Air Lines hundreds of dollars every day.

If you have a volume input application, it can do the same for you. Tell us your problem and we'll tell you how.

CIRCLE 4 ON READER CARD

RECOGNITION EQUIPMENT Incorporated

U. S. Headquarters: Dallas, Texas 214-823-8194

Offices in principal U. S. cities and Frankfurt, London, Milan, Paris and Stockholm

Your revised 1966 Reference Guide to CEC Analog and Digital Magnetic Tape Recorders and Accessories

This guide includes the important new advances achieved by the DR-3000 Recorder

Type VR-3600 – The dean of recorders, and the ultimate choice for the most demanding pre- and post-detection and general purpose use.

■ 400 cps to 1.5 mc direct frequency response; and dc to 500 kc FM frequency response.

■ Bi-directional capability including reverse automatic phase equalizers – available on special order.

■ 7- or 14-channel systems available as standard.

■ Available in"Universal" machine configurations for compatibility with lower bandwidth CEC recorders by switch selection.

■ Accessories include monitor meters for display of bias, input and output signals, RFI certification to MIL-1-6181D.

Type VR-3800 – This data recorder offers the basic advantages of the VR-3600 at a modest price. Often referred to as the "work horse" of midband recorders.

■ 300 cps to 300 kc direct frequency response; dc to 40 kc FM frequency response with high-accuracy FM system.

■ Six speeds to 60 ips, instantly switchable.

■ All-metal-front-surface recording heads – reduce cleaning to a minimum; reduce tape and head wear.

■ 7- or 14-channel systems available as standard.

■ Direct system fully amplitude- and phase-equalized.

Type VR-2600 – Recognized as the finest, most versatile performer in its class.

■ Available with any combination of four types of recording/reproducing electronics and configurations (direct, FM, PDM, PCM).

■ All solid-state electronics, pushbutton controlled for operation without readjustment at six (6) tape speeds.

■ 600 kc direct, 80 kc FM, IRIG PDM, and 1000 bit-per-inch PCM capabilities.

■ 7- and 14-track analog systems as well as 16-track PCM systems available as standard. Accessories include edge track voice recording/reproducing, shuttle control and monitoring equipment, including both meter and oscilloscope presentation.

Type VR-3300 – Unmatched for applications where ruggedness and mobility must be combined with outstanding performance.

■ 100 cps to 300 kc direct frequency response; dc to 20 kc FM frequency response.

■ Dual capstan drive system provides closed-loop speed and tension control equal to standard laboratory systems.

■ Interchangeable record and reproduce electronics and heads with CEC's Type VR-2800 laboratory recorder/reproducer and VL-2810 continuous loop recorder/reproducer.

■ Six-speed record/reproduce system.

Type VR-2800 – A highly reliable wideband system for use in laboratory environments with direct and FM electronics.

■ Six-speed record/reproduce operation.

□ 100 cps to 300 kc direct system and dc to 20 kc FM system.

■ Up to 7 or 14 channels on ½″ or 1″ tape respectively on 14″ reels provide extended record time. 32-channel, 1″ systems also available on special order.

■ Uses all-metal-front-surface magnetic heads, as do all CEC recorders, for long life and minimum tape wear.

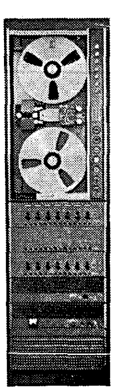
Type PR-3300 – Designed for mobility at a modest cost.

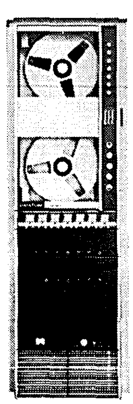
■ High-quality mobile magnetic tape recorder/reproducer for standard 100 kilocycle work.

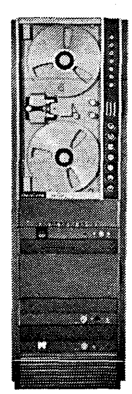
■ 7- or 14-channel systems on ½″ and 1″ tape respectively; 10½″ diameter reels.

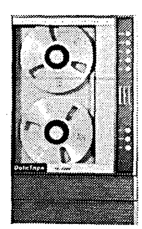
■ Handles information via direct, FM or PDM techniques in any combination. Like the VR-3300, this unit can be operated from ac or dc power sources using its accessory precision frequency power supply.

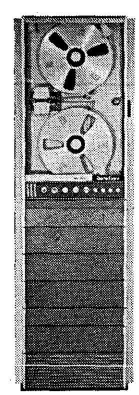
■ Interchangeable electronics with CEC's GR-2800 and GL-2810 magnetic tape recorder/reproducer systems.

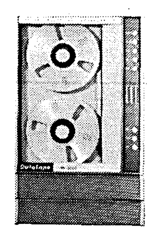

VR-3600


VR-3800


VR-2600


VR-3300


VR-2800


PR-3300

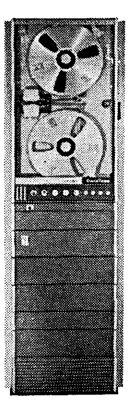
	VR-3600	VR-3800	VR-2600	VR-3300	VR-2800	PR-3300	GR-2800	GL-2810	VL-2810	DR-3000
TAPE SPEEDS	6 speeds to 120 ips	6 speeds to 60 ips	7 speeds to 120 ips (in two ranges)	6 speeds to 60 ips	6 speeds to 60 ips	6 speeds to 60 ips	6 speeds to 60 ips	6 speeds to 60 ips	6 speeds to 60 ips	From 37½ to 112½ ips
DIRECT FREQUENCY RESPONSE	400 cps—1.5 mc	300 cps—300 kc	300 cps—600 kc	100 cps—300 kc	100 cps—300 kc	dc—100 kc	100 cps—100 kc	100 cps—100 kc	100 cps—300 kc	
FM FREQUENCY RESPONSE	dc—500 kc	dc—40 kc	dc—80 kc	dc—20 kc	dc—20 kc	dc—10 kc	dc—10 kc	dc—20 kc	dc—20 kc	
CHANNELS	up to 14	up to 14	up to 14	up to 14	up to 14	up to 14	up to 14	up to 14	up to 32	up to 9
RECORDING METHODS	Direct, FM	Direct, FM	Direct, FM, PDM, PCM	Direct, FM, PDM	Direct, FM, PDM	Direct, FM, PDM	Direct, FM, PDM	Direct, FM, PDM	Direct, FM, PDM	up to 800 bpi NRZ
ELECTRONICS	Solid-State	Solid-State	Solid-State	Solid-State	Solid-State	Solid-State	Solid-State	Solid-State	Solid-State	Solid-State

Type GR-2800 — Commonly selected for general lab use in both industrial and military applications because of its operating economy, long life and reliability.

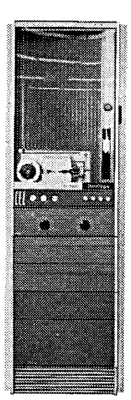
- General purpose laboratory recorder/reproducer system accommodating data in direct, FM or PDM recorded format in the frequency range from dc to 100 kc.
- Utilizes all solid-state electronics.
- 7- or 14-channel operation on ½″ and 1″ tape respectively, with reel diameters to 14″.
- Closed-loop capstan drive system.
- Precision capstan drive electronics and tape speed control servo provide tape speed accuracies to within ±0.02% of recorded speed.

Types GL-2810 & VL-2810—Specifically designed for data reduction or data monitoring and storage where machine workload is heavy.

- Accommodate tape loop runs from 2 to 75 feet at six tape speeds from 1⅞ to 60 ips.
- GL-2810 handles data in the range from dc to 10 kc via FM techniques, and from 100 cps to 100 kc employing direct techniques; GL-2810 handles dc to 20 kc FM and 100 cps to 300 kc via direct.
- Utilizes ½″ tape for up to 7 channels, or 1″ tape for up to 14 channels, using IRIG geometry.
- Accessories include selective erase equipment providing erasure of any combination of 7 to 14 tracks, without removal of the tape loop from the machine. Bulk erase equipment also available.



GR-2800



GL-2810

Type DR-3000 — This "universal" recorder offers unequalled versatility and performance — at the lowest cost of any comparable digital tape system. Additional recent advances have placed the DR-3000 in such a position as to virtually eliminate competition.

New Advantages:

- Standard choice of 3 tape speeds, 37½, 75 and 112½ ips, for complete IBM compatibility. (Previous top, 75 ips.) Other speeds to 112½ ips, on special order.
- Simplified logistics and minimum spare parts requirements through interchangeability of parts for both low, medium and high-speed systems.
- Mechanical head azimuth adjustment and individual forward and reverse static skew adjustments on read and write amplifiers reduce system static skew to less than 0.25 microseconds.

Original Advantages:

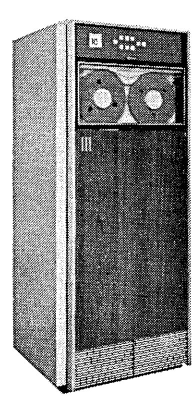
7- or 9-channel formats including 200, 556, and 800 bpi recording densities or 1600 bpi phase-encoding density on special order.

Rigid performance specifications provide guaranteed machine-to-machine compatibility.

Straight line tape loading requires no threading. Easiest of all to load, entire operation takes less than 10 seconds.

Compact, rugged design with unique tape buffering provides the only high-speed system mountable in a 19″ or 24″ rack.

Dual capstans with special self-adjusting actuators assure positive and gentle tape drive; eliminate tape slippage. And air bearings virtually eliminate tape friction.



DR-3000

CEC's DataTape® Accessories

The Monitor Oscilloscope is used with tape recorder/reproducers, or any multichannel instrumentation system to provide visual display of electrical signals ranging in frequency from dc to 3,000,000 cps. Unique features of this unit include up to 500 kc sweep rate and modular construction.

The Type TD-2903 Automatic Tape Degausser is designed to erase data signals from magnetic tape wound on reels up to 14″ in diameter and tape widths from ½″ to 2″. A reel of 1″-wide instrumentation tape recorded at saturation level is erased to a nominal 90 db below normal level.

The Dynamic Tape Tension Gage permits accurate tension measurements directly while the recorder is in operation . . . helps keep your recorder in proper operating condition through routine maintenance adjustment.

For complete information on any CEC Tape Recorder/Reproducer, write or call CEC for Bulletins in Kit 9009-X1.

CEC

Data Instruments Division

CONSOLIDATED ELECTRODYNAMICS

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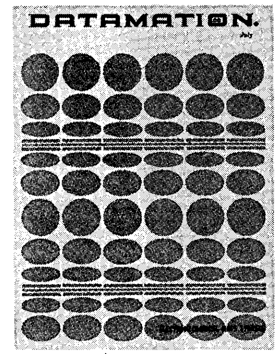
CIRCLE 5 ON READER CARD



july
1966

volume 12 number 7

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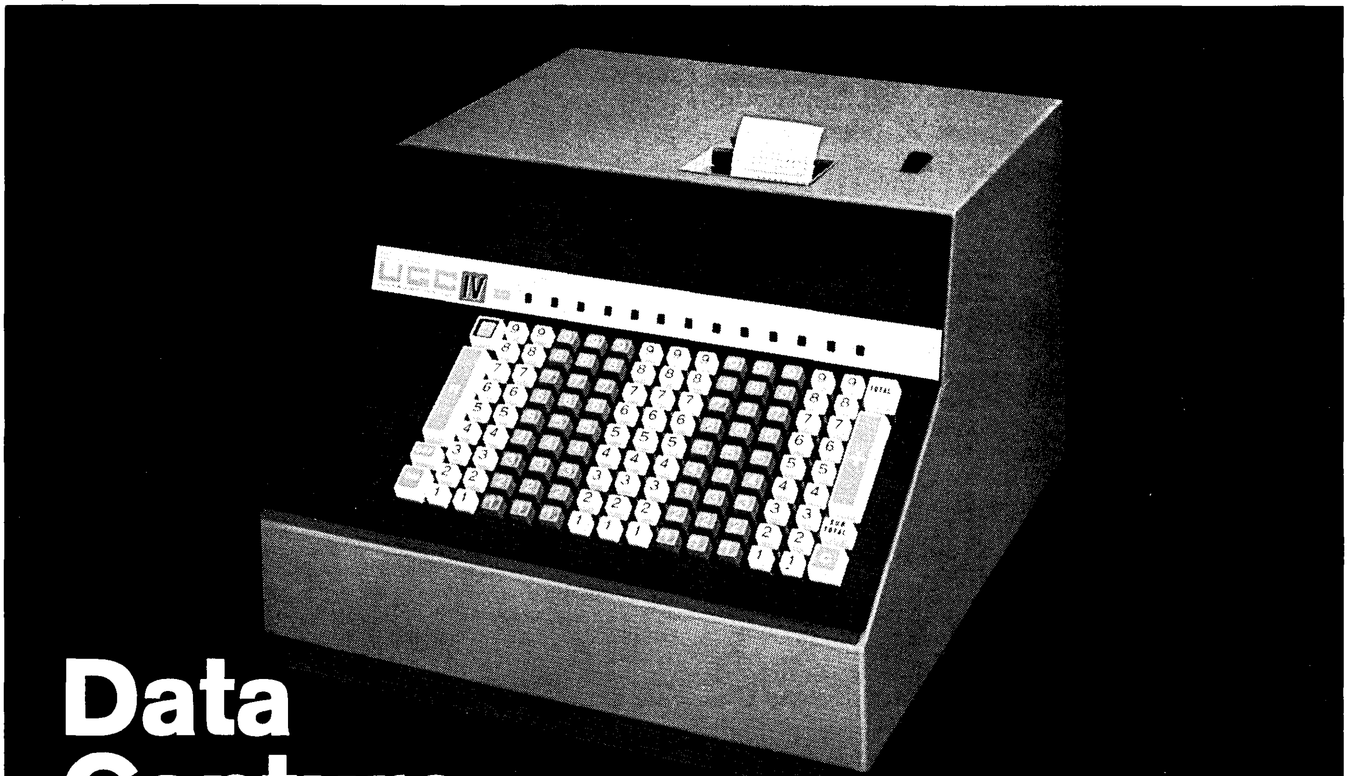


Data Capture Breakthrough

for users with 50 or more source data locations

Series IV

Data Recording/ Computer Input System

Rents for as little as

$49⁰⁰

per month per recording location

Price includes:

1. Standard Model SERIES IV full bank recorder, leased in quantities of 50 or more on three year basis
2. Off-line SERIES IV Converter/ Receiver which writes IBM compatible ½" magnetic tape
3. Maintenance Contract and installation charges

SERIES IV now makes true Source Data Acquisition an economic reality by providing reliable, easy-to-operate source data recorders at an attractively low per-station cost . . . and high speed magnetic tape computer input as the end product of the system.

SERIES IV is designed for the user with requirements for data capture at multiple source locations. The system is magnetic tape oriented—including data recorders which write ¼" magnetic tape and hard copy . . . and off-line ¼" to ½" magnetic tape receiver/converter units.

Additionally, SERIES IV offers data transmission capability at speeds of 60 cps on standard Data Phone subsets. Prices per recording station equipped with data Recorder, Transmitter, and Receiver (with ½" tape output) run as low as $91.00 per month in quantities of 50 or more.

Hardware flexibility is built in the Data Recording Unit. It can be customized to the application. A wide variety of options and keyboard configurations offer maximum systems flexibility. Standard features of the basic Recorder are: Error-free cartridge loading ¼" tape deck ☐ 10-Column full bank keyboard and hard copy listing ☐ Manual Clear ☐ Automatic keyboard clear after recording ☐ End-of-file and Void function keys ☐ Machine lock-up at end of tape or power failure.

For a few extra dollars the following customizing optional features can be added: Upper and Lower Accumulators for debit and credit entry and batch totals ☐ Accumulator Display ☐ Accumulation by selected field ☐ Supervisory keyboard enforcing ☐ Battery powered operation for applications requiring semi-portability ☐ Motorized columns in data field ☐ Choice of keyboard field from 3 to 13 columns ☐ Data check with Record Quality Assurance circuitry.

Full information and price quotation for Recorders tailored to your application can be obtained by sending the coupon below. Light weight, portable magnetic recorders are also available.

For Immediate Information, Clip and Mail:

UGC INSTRUMENTS, INC., 5610 Parkersburg Drive, Houston, Texas 77036
or Call SU 2-3030

NAME__________ TITLE__________

COMPANY:__________

ADDRESS__________ CITY__________ PHONE__________

Interested in:

☐ SERIES IV Full Bank Recorders Shown Above
Number of Recording Units______

☐ Data Transmission
Number of Transmitters______

☐ Portable Alpha-Numeric Recorders
Number of Units______

☐ Development Contract for Special Recorders Utilizing ¼" Mag Tape Medium

☐ Have Systems Engineer Call for Appointment

☐ Send Literature Only

CIRCLE 7 ON READER CARD

Heads!

You don't pick precision magnetic tape this way, but we have the feeling that some people do.

"How can you lose," we've heard it muttered, "one leading brand is as good as another."

Well, like the song says, "it ain't necessarily so."

Take Computape users. They would rather be safe than sorry. And they've found that, for long, reliable, error-free performance, Computape is about the safest tape going.

Has to be. Not a reel of tape leaves the plant that hasn't been checked and re-checked dozens of times for perfect quality and uniformity. And of course, each reel has been meticulously produced to meet the individual specifications of the equipment on which it will be used.

Nothing is completely sure in this life, but when you can come this close with Computape, why tempt fate with some other brand?

A PRODUCT OF COMPUTRON INC.
122 CALVARY ST., WALTHAM, MASS. 02154

CIRCLE 8 ON READER CARD

DATAMATION

july 1966

volume 12 number 7

datamation departments

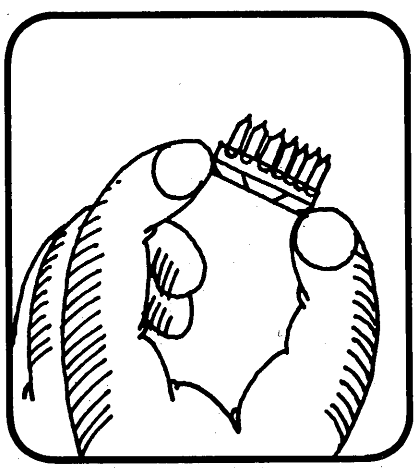
automatic information processing for business industry & science

Announcing the Burroughs B 6500

A new electronic data processing system with software that is ready right now

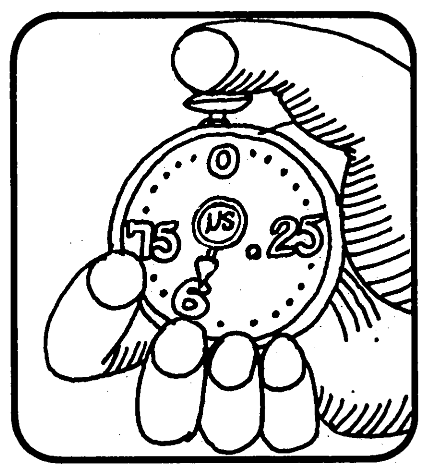
The B 6500 will have the kind of multiprocessing ability, dynamic modularity and high through-put per dollar proved in use by the B 5500.

In the B 6500, all these advantages are greatly enhanced by new hardware technology. The result: A system which is ideally suited to engineering/ scientific jobs or business applications or a combination of both. A highly advanced time-sharing system which completely obsoletes the rigid time allocations for on-site vs. remote-site work. With the B 6500, numerous jobs—all completely different—can be multiprocessed at the same time, regardless of origin. And all, of course, under full software control.



High speed monolithic integrated circuits

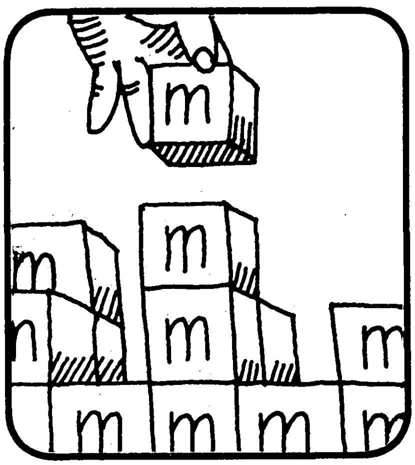
The clock rate of the B 6500 is 5 megacycles—an extremely fast speed made possible by the system's monolithic integrated circuitry.



Fast memory speed with thin film

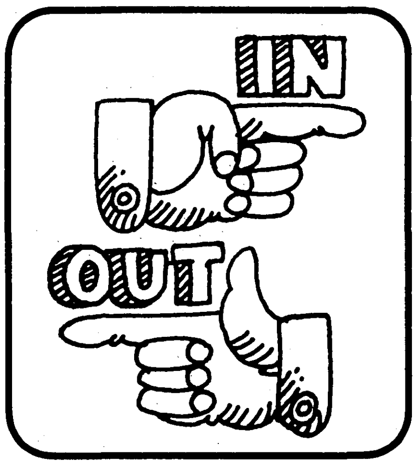
The memory cycle time of the B 6500 is 600 billionths of a second—so fast that it cannot be equalled except by giant systems at a giant cost.

Consider our accelerating success with the unique B 5500 – or better still, see it demonstrated. Now, for requirements that extend beyond this already powerful computer, the new B 6500 implements that same proven software and internal organization by 5 times the processor speed, 7 times the memory speed, up to 3 times the memory capacity, and twice the I/O capability.



Large memory capacity

The B 6500 provides up to 106,496 words of thin film memory. This extensive capacity is available in functionally independent banks.



Input/Output Multiplexor

This is a device which provides up to eight high speed input/output operations simultaneous with each other and one or both processors.

We can't show you the hardware today. But we *can* demonstrate the internal organization and proven software: A comprehensive operating system that schedules and controls many jobs at once. Simultaneous COBOL, ALGOL and Fortran compilations. Even a mixture of batch and random access processing plus time-sharing.

Your local Burroughs representative will be glad to arrange such a demonstration or to discuss other Burroughs 500 Systems. Or write us at Detroit, Michigan 48232.

Burroughs Corporation

CIRCLE 9 ON READER CARD

From the original painting by Neil Boyle

SATURN

Saturn S-IVB responds to the instructions of STOL (Saturn Test-Oriented Language), conceived, designed, implemented, and documented by a Douglas Aircraft Company/Planning Research Corporation multidisciplined team. The sponsoring agency was NASA's Marshall Space Flight Center. One of the reasons for STOL's swift evolvement was that the software capability at Planning Research is supported by independent and superior knowledge of computer hardware engineering.

Planning Research system synthesis is complete. It begins with analysis and design – and ends with final checkout of *any* computer system. Applied, it saves time or money or both. Write for a complimentary copy of *Computer Systems Analysis and Programming.* Address Dr. Alexander Wylly, Vice President for Computer Sciences.

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calendar

DATE	TITLE	LOCATION	SPONSORS
July 17-22	Meeting: Programmed Production	Minneapolis	Forest Products Research Society
July 25-29	Course: 8800 Operation	Computing Center Princeton, N.J.	Electronic Associates, Inc.
July 25-Aug. 5	Course: Control Systems Technology	Los Angeles	Univ. of Calif. Extension
July 26-28	Course: Programming Problem. $195.	Jack Tar Hotel San Francisco	Computer Usage Education, Inc.
Aug. 1-5	Course: Digital Computation. $200.	Computing Center Princeton, N.J.	Electronic Associates, Inc.
Aug. 1-19	Course: 8400 Programming	Computing Center Princeton, N.J.	EAI
Aug. 8-12	Course: Urban & Regional Information Systems	Los Angeles	Univ. of Calif. Extension
Aug. 9-11	Course: IBM S/360 Software. $195.	Sheraton Eastland Portland, Maine	Computer Usage Education, Inc.
Aug. 11-13	Conference on DP	Seattle, Wash.	Northwest Computing Assn.
Aug. 18-19	Course: Symbolic Control	Chicago, Ill.	IIT Research Institute
Aug. 22-24	Symposium on Information Systems	Battelle Institute Columbus, O.	Battelle Institute Ohio State Univ. Office of Naval Research
Aug. 22-26	Course: 680 Operation. $200.	Computing Center Princeton, N.J.	Electronic Assoc., Inc.
Aug. 22-Sept. 2	Course: Control Theory. $275.	Columbus, O.	Ohio State Univ. Engineering Dept.
Aug. 22-Sept. 2	Course: 680 Maintenance	Computing Center Princeton, N.J.	Electronic Assoc., Inc.
Aug. 23-26	Convention and Exhibition	Los Angeles	Western Electronic Show and Convention
Aug. 23-25	Course: Time-Sharing. $195.	Jack Tar Hotel San Francisco	Computer Usage Education, Inc.
Aug. 29-Sept. 2	Course: Control Engineering. $185.	Berkeley, Calif.	Univ. of California Engineering Extension
Aug. 29-Sept. 2	Course: Basic APT	Chicago, Ill.	IIT Research Institute
Sept. 12-16	Course: Militran Language. $200.	Willard Hotel Washington, D.C.	Gulton Systems Research Group, Inc.
Sept. 12-Dec. 19	Course: Operations Research. $85.	Los Angeles San Francisco Fullerton, Calif. San Diego	Univ. of Calif. Extension Offices

letters

sessions & censures

Sir:

The SJCC in Boston was well administered; however, the technical sessions at which papers published in the proceedings were read, were a complete waste of time. The reason one goes to the sessions is to obtain insight into the areas being discussed or to learn new techniques being applied in some areas—*not* to hear papers which he has in his hand being read (word for word in some cases).

It's like the professor who wrote the text for the course and then lectured from his book. We knew he had something worthwhile to say, but couldn't he at least use different words?

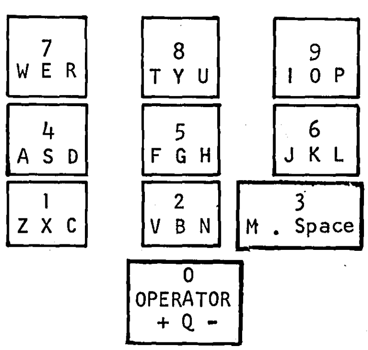
KENNETH E. SHOSTACK
Everett, Massachusetts

pushbutton phone

Sir:

In "A Pushbutton Telephone for Alphanumeric Input," by Leon Davidson (April, p. 27), the author states correctly that an astronomically large number of different 12-button alphanumeric layouts may be conceived . . . Since man is a creature of habit, and since we already have two standard keyboards with which almost everyone is familiar (the standard 10-digit adding machine and the

Fig. 1



standard typewriter keyboards), why not consider the enclosed layout, (Fig. 1) as a third preliminary choice?

RALPH R. DUNHOWER
San Francisco, California

Author replies: The proposal that the telephone dial digits be laid out exactly as in the standard 10-digit office-machine keyboard is well taken. If only two electrical connections are then reversed inside the button-dial mechanism, such a phone would be fully compatible with the present pushbutton phones for dialing and input purposes, and both types could be in simultaneous use on the same systems. I understand that an ASA committee is looking into this digit arrangement with the industries involved.

As for the proposal about arranging the letters to resemble the typewriter keyboard, however, there are at least two points against this. The major defect is that our existing touch-typing skills would not in fact carry over to this layout, since touch-typing is a muscular-memory skill and different finger patterns would have to be learned for any arrangement on 10 buttons instead of 44 keys. Moreover, the two-hand operation of standard touch-typing would not be either convenient or desirable in the telephone situation, since the 10-key format is spaced out for one-hand usage, not for two.

where credit's due

Sir:

The Editor's Readout (April, p. 21) on the SHARE meeting omitted the session chairman's name.

Philip Dorn, manager of the SHARE PL/I project, in bringing this group of speakers together, undertook an effort only slightly less than that required for arranging an international summit conference. The smoothness with which the presentations proceeded attests to his success, and I believe some mention of his achievement is required.

HERB VAN BRINK
Manager, SHARE FORTRAN *Project*
New York City

litter letter

Sir:

The "Information Implosion" (April FORUM, p. 184) by Robert V. Head beyond a doubt proves the old adage that we now know more and more about less and less, and now it is faster and faster—and we have the paperwork paperwork as proof.

J. ROBERT MAXEY
Indianapolis, Indiana

dialogue in graphics

Sir:

I am afraid Ivan Sutherland's informative article on computer graphics (May, p. 22) might be used as a justification for the on-line KLUDGTRAN programmers to pass their problems to the user instead of solving them. He discusses the use of dialogue to help communicate the user's concept of the drawing structure to the system. This may be a good approach, but it can easily lead to the technique of having the user choose most of the program branches on-line before he can get his work done.

I believe a trial and error method with simple learning would be a better technique than dialogue. The program would look for a different or more generalized structure when the user is dissatisfied with the results. The method would yield a smoother operation and provide more user satisfaction, especially in the early phases of development when a dialogue method would be asking the wrong questions and would not be programmed to handle the right answers. The user would provide structure information by indicating when the system has made a wrong or insufficiently generalized decision. The programmers would not have to make value judgments nor describe their structure algorithms in English suitable for dialogue.

The on-line procedure to handle the structure problem of identifying the group of drawing units the user has in mind could be as follows: the user points his pen and requests the appropriate action (possibly identification only). The system indicates the units briefly via some modulation technique and performs the action. The user then indicates if the response was correct, insufficiently inclusive, or incorrect. If he makes progress and arrives at the desired result, the system can tell him if he didn't make use of the general principles in use, such as "point to the left-most item in a row." If a procedure is supplied to allow the user to specify the type of structure for an operation, some effort can be saved. An inexperienced user would not be required to know what they are since the system can tell him when he missed a shortcut.

STEPHEN W. CLOSS
Poughkeepsie, New York

Author replies: A well-designed man-machine system should make communication as fast and easy as possible. Mr. Closs has correctly pointed out that a computer could respond to an ambiguous command by making a guess at what was intended. By doing the most likely action, the computer in effect asks, "Is *this* what you wanted?" The man can say "yes" by going ahead. This is a fine form of dialogue for use in simple situations where the computer can usually make a correct guess. It is not good if it is hard to correct a wrong guess. Systems which use guessing must provide for further dialogue in case the guess is wrong.

A well-designed man-machine system should have the ability to teach, and Mr. Closs has correctly pointed out that the machine should instruct the man so as to make him more fluent in the language they use. Faced with a command which he cannot understand, the computer should tell exactly what else is needed or show examples of well-formed commands. Too many of today's computer programs merely print out "error" without helping the user to fix it.

English is a poor language for man-machine dialogue. Today's typewriter-based man-machine systems generally use conventional languages based on the traditional algebraic programming languages. Drawing systems generally use a language composed of stylus motions and pictorial responses such as the pointing and flashing described by Mr. Closs. A "question" posed by the computer can take the form of blinking boxes. The man may "answer" by pointing to one of them. Dialogue can and should exist without English.

A well-designed man-machine system should be capable of accepting instruction. By this I mean the man should be able to define the meaning of new commands, thus molding the system to his own particular needs. In a very limited sense the computer has "learned" to serve the man better.

Unfortunately, computer learning in a more general sense is very difficult to program. We don't know how to make computer programs which can generalize from experience. It will be very hard to make a program which will recognize "progress" and tell its user which general principle he failed to use. Programs that respond to ambiguous commands by guessing reflect the value judgments of the people who made them. It will be very difficult to make a program which will improve its guesses by recognizing the pattern of its errors. Nevertheless, I agree with Mr. Closs that progress toward these goals is worthwhile.

computers & schools

Sir:

By accepting a view of the "school of tomorrow" as something resembling what schools are like today ("The Computer and the School of Tomorrow," May, p. 41), the best that Rogers and Cook can suggest is a solution to certain organizational problems, missing the point that the existence of computers may encourage enough of a change in what we mean by "school" to make their proposal irrelevant. They are correct, of course, in saying that "The mere avoidance of routine paperwork . . . is hardly to be regarded as an advance in education." However, besides not really taking this point very seriously themselves, the authors show an insensitivity to most of the basic educational issues relating to the use of computers in schools. There are a number of present educational practices, for example, which they seem to accept on face value but which in fact do not stem from any carefully formulated educational theory; they are expedients which may now be re-examined in light of today's computer technology.

Within the area of student evaluation, to pick a case at random, there are at least three developments tied directly to computer capability which may significantly change the way we evaluate school performance but which are substantially ignored by the authors' proposal. The first of these involves the vanishing distinction between instruction and evaluation within the context of programmed instruction and therefore within most of the present work of C.A.I. A question not always simple to answer is, "When does an item teach and when does it test?" As the two functions become more and more interdependent it becomes reasonable to re-explore the purposes and forms of evaluation.

An extension of this idea leads naturally to the notion of monitoring student performance, not only to determine the next step or branch to take in his instruction, but perhaps more importantly to provide him with a picture of the path he has followed through some instructional set—a sort of meta-evaluation of the student interacting with the substance of a discipline.

A third interesting possibility concerns that old expedient called the "grade." Simply stated, the point here is that the power of the computer to deal in a systematic way with natural language makes it feasible to explore replacing the grade with an English statement regarding student progress so that not only can we get away from unidimensionality, which leads to such things as "ranking," but so that we can bring the richness of natural language to bear on what we say about children.

That Rogers and Cook ignore these and other basic issues such as whether or not the classroom or even the school building itself will in the future become vestigial because of computers—and the fact that they, instead, treat such trivial questions as whom one might hire as part-time employees in the school's machine center for the afternoon shift—is indefensible at the very least. I think these difficulties arise mostly because they ask themselves an unimaginative question. Their concern seems to be to use what they know at the moment about teaching children to facilitate the application of computers to education. What they should be concerned with is the question of how the computer can be used to enhance our knowledge of the process of education.

ALLAN B. ELLIS
Graduate School of Education
Harvard University
Cambridge, Massachusetts

Mr. Rogers replies: Mr. Ellis' comments are well taken. I do not think we "ignored" the issues he raises, however. Our acceptance of some current educational practices — such as the presence of a teacher in the classroom—was to show how CAI could function even within such a framework. With regard to student evaluation, the CAI system we described clearly could not work until the significant changes in this area referred to by Ellis have occurred. We tried to indicate the crucial role played by the computer monitoring of student performance, not only for the selection of individual lesson material, but, of course, for its effect upon the instructional program design itself. The present use of the computer to enhance our knowledge of the educational process is a necessary condition of its future use in the process itself.

huddled warm bodies

Sir:

Your mention of the CUC scientific sub office in Washington (May, p. 19) leaves a somewhat misleading impression . . . Our move was designed to concentrate the talents presently available in our Washington office, and not concentrate all CUC "scientific programming talent in one place." In fact, each of our 10 operating offices is currently engaged in varying degrees, in scientific programming.

CARL H. REYNOLDS
President
Computer Usage Development Corp.
Mount Kisco, New York

computing text

Sir:

Your World Report (May, P. 87) references a new IBM (U.K.) publication, "Management Standards for Data Processing," which is actually a 1963 book by D. H. Brandon referenced in the IBM publication. The latter is called "System/360 Data Processing Standards."

F. J. ASH
Brandon Applied Systems Inc.
New York, New York

Datamation welcomes your correspondence concerning articles or items appearing in this magazine. Letters should be double spaced . . . and the briefer the better. We reserve the right to edit letters submitted to us.

Now Cheaper by the Billion.

Introducing the Bryant Series 4000-2A real time mass memory system. It can store 3.8 billion bits. The largest single unit disc file capacity in the world. And by far the lowest costing random access system available today. All data is on-line, available within an average of 100 milliseconds. A basic cabinet offers modular growth to capacity. Environmental control reduces maintenance to a minimum. Dual access option offers increased throughput. The 2A joins 190 Series 4000 files operating all over the world. Deliveries begin in November, 1966. But don't wait till then. Call your nearby Bryant Application Engineer now or write: 850 Ladd Road, Walled Lake, Michigan 48088.

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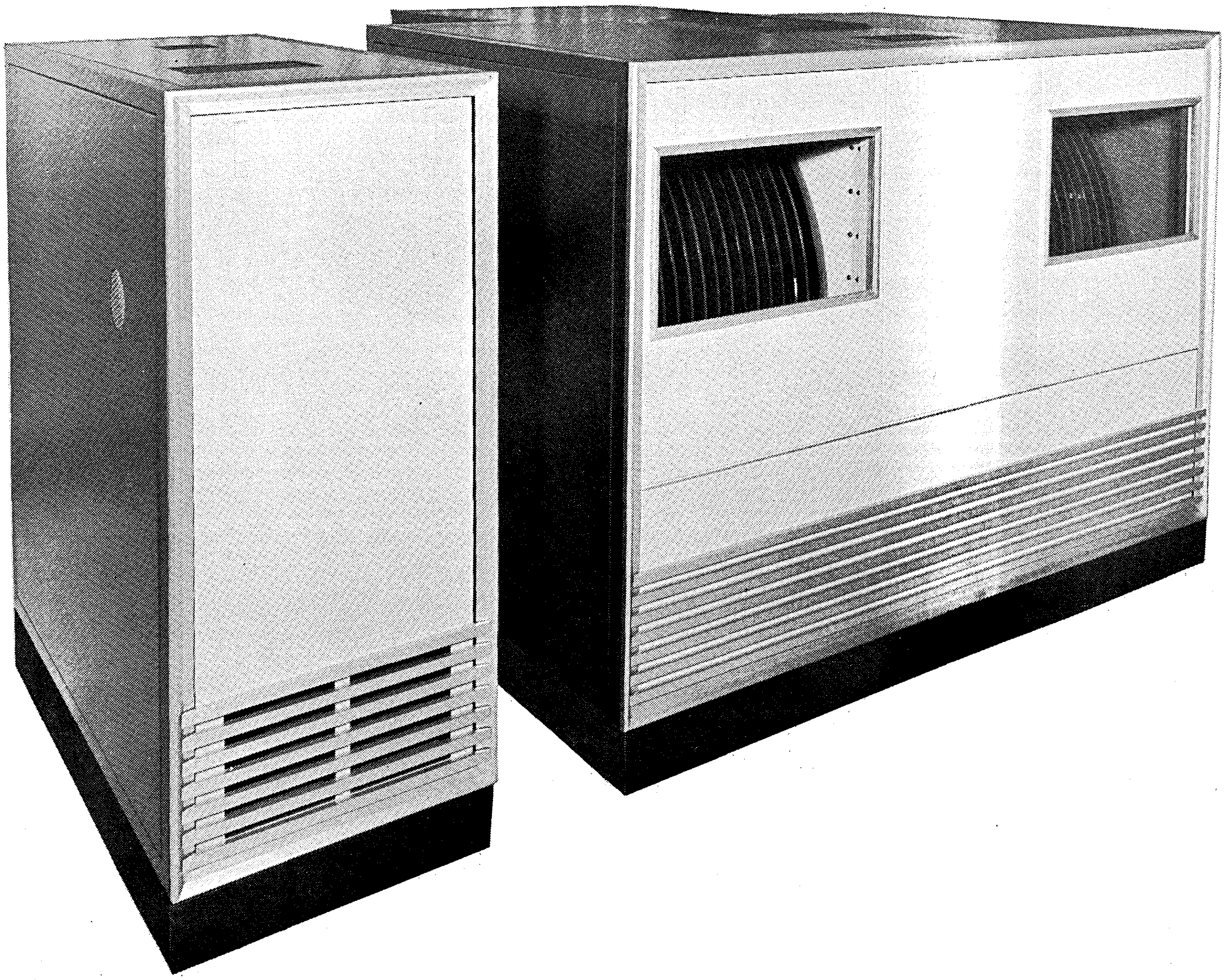
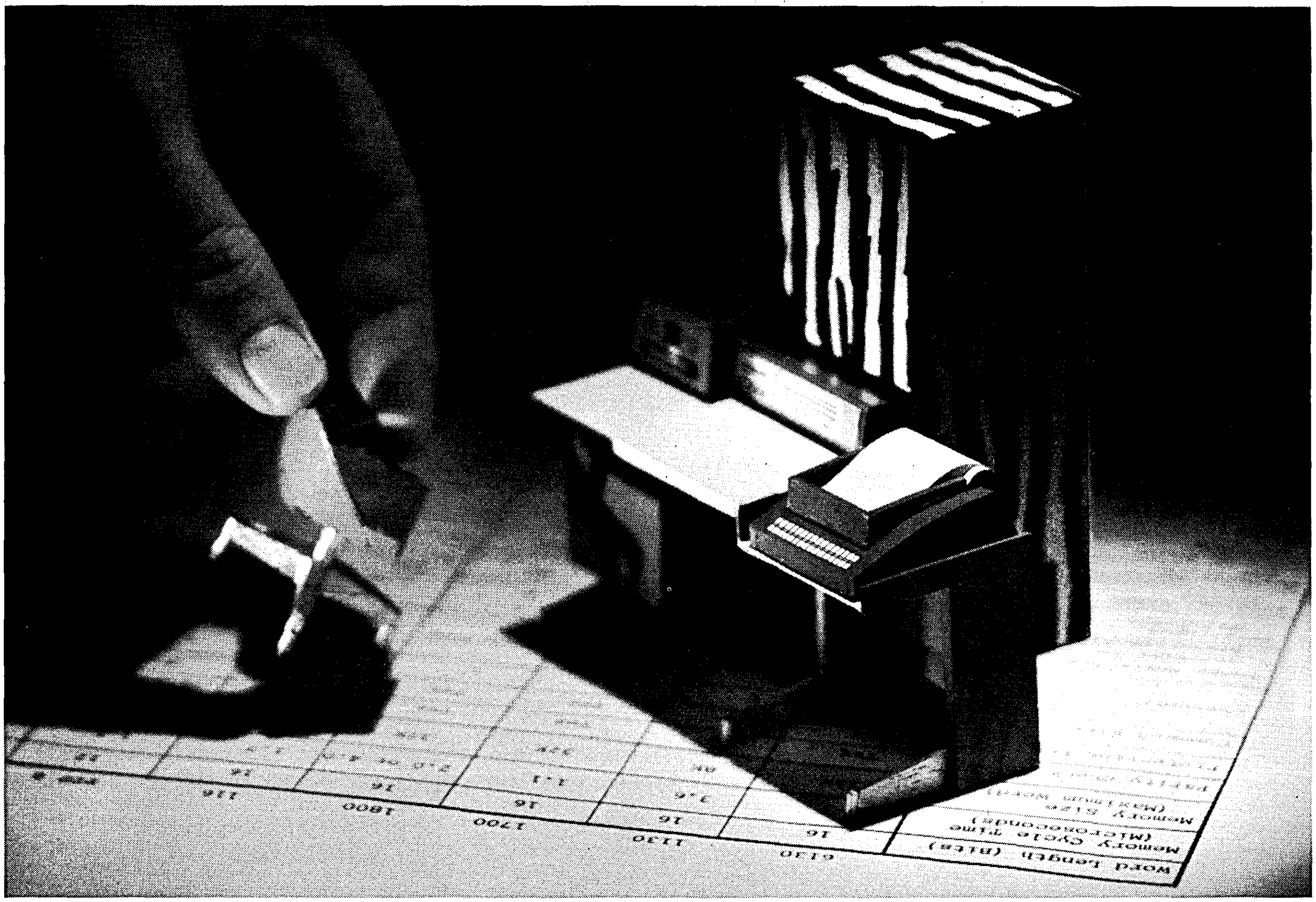


CIRCLE 14 ON READER CARD

ASI invites you to compare its new ADVANCE 6130



...with the other "compacts"—1700, 1800, 1130, 116.

Not really a "paper tiger" any longer, the 6130 is less paper and more hardware. So if these other machine numbers are familiar to you and you aren't expecting delivery of any one of them in the next few months, hold everything and investigate the 6130. The 6130 has been designed to offer more capability at the same cost than any of the other machines listed. In fact, we've got a comparison chart proving just that.

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ASI COMPUTER DIVISION EMR

8001 Bloomington Freeway, Minneapolis, Minn. 55420

look ahead

MERGER OFF, BUY ON,
PEOPLE OUT, PROFITS IN

There's plenty of behind-the-scenes action at CEIR lately. The company has ended merger talks with Western Union, plans to acquire an L.A. 185-man data reduction firm (Associated Aero Sciences), perhaps as consolation for a futile bid to acquire Politz, which went to CSC. The top man at CEIR's American Research Bureau has stepped aside, and Jack Moshman has left, together with Drs. Richard Tauber and Walter Simonson, implying a decreasing emphasis on fancy programming services. The company's top technical man, Moshman was there 9½ years. He's taking over as head of management sciences for EBS Management Consultants, Inc., will operate out of Washington, D.C.

The service bureau franchise operation is moving slowly: nine have signed so far, giving CEIR 14 centers in all. But the firm wound up its best quarter ever this month, with earnings about six times the previous six months, added another 1½ megabucks by selling its last 20% share in CEIR U.K. The stock is selling at eight times earnings.

NO. 2 UNIVAC TRIES HARDER --
AND TRIUMPHS

NASA's recent $30 million award to Univac (passing over CDC and GE) means that five 1108 II systems will replace 39 computers and 48 remotes at the Marshall Space Flight Center in Huntsville and Michoud/Slidell, La. The configurations, to be phased in by late 1968, will include a total of seven 65K-word core memory banks, 5.5 begacharacters of mass storage, and 60 remote terminals. Applications span scientific, commercial and remote batch processing, data acquisition, and process control -- multiprogrammed and/or multiprocessed in all combinations. Univac, solidly number 2 government computer supplier, has also won a Weather Bureau order for an 1108 to supplement CDC 6600 activity.

NEW COPYRIGHT BILL
MOVING ALONG

A new copyright bill that in its present form would have definite effects on the computer industry is slated to be reported out by a House Judiciary subcommittee this month. The draft legislation would prohibit the input of copyrighted material into a computer without permission of the copyright holder. Thus, the storing of full texts of such material in an information retrieval system without permission would be illegal.

The bill, which won't be enacted until next year, does extend copyright protection to computer programs. About 50 such programs have been registered so far, including 30 in the last year. It also allows federal contractors to copyright programs they develop for the government (although royalties can't be collected from Uncle Sam). Final legislation probably will include both of these provisions; neither is controversial.

Whether computer program developers will be able to use copyrighted material without paying a royalty is likely to depend on how the courts interpret the

(Continued from page 17)

"fair use" doctrine. If the programmer lifts only a small portion of a copyrighted work, he probably won't have to pay, provided the copyright holder's potential market isn't reduced. Greater use will, in most cases, have to be paid for.

But section 109 of the draft bill represents an important exception. It allows any amount of copyrighted material to be used, royalty-free, for teaching in the classroom. Suppliers of computerized instruction programs are obvious beneficiaries of this provision; however, it isn't likely to remain in the bill. Publishers' groups have squawked loudly about what they consider a serious loss of potential revenue, and, as a subcommittee staffer puts it, "the message has come through."

DEFINING AN EXCEPTIONAL CIRCUMSTANCE

One giant question faces the FCC in its ruling that Comsat customers must operate through common carriers except in "unique and exceptional circumstances." What are these circumstances? The FCC has told the cc's to reduce their satellite channel rates to "reflect the economies" satellites afford, but the carriers can go just so far and still protect their other services, particularly cables. Given this, will the government decide certain projects -- such as medical information networks -- are vital enough to allow them to bypass the cc's, taking advantage of lower tariffs from Comsat?

Observers also note another possible "circumstance": the IBM-Comsat (sans carrier) bid to operate a system for gathering and processing weather satellite reports for the Dept. of Commerce. In addition to saving the carriers from the multitude of firms moving to work directly with Comsat as "authorized users," the ruling gives a boost to the faltering stock activity at AT&T, affected by the FCC investigation. It also seems to bar Comsat from its hotly contested proposal to add service for Puerto Rico and the Virgin Islands.

SMALLER MACHINES FOR BIGGER MARKETS

Digital Equipment Corp., heady from the success of their PDP-8 -- 500 orders so far -- will soon announce a 4K-word (12-bit) system for under $10K. Program-compatible with and a redesign of the 8, the PDP-8S is slower, has fewer options, and uses a serial arithmetic unit. DEC expects 1000 sales the first year, marketing initially at an "attractive discount" to OEM for use in such areas as scientific research and process control. Basic system comes with Teletype; memory is expandable to 32K. Delivery will be under three months.

In the offing this year are new 36-bit (a la PDP-6) and 18-bit machines. Cost cuts and additions of new peripherals and software, i.e., Fortran for an 8K system, are planned for the PDP-8 "family."

Meanwhile, a new company in Needick, Mass., called Business Information Technology -- or, steady now, BIT -- is busy working on a low-cost, desktop machine that might compete with the PDP-8S. Potter Instruments has a controlling interest in this six-month-old firm.

CASHING IN ON CREDIT

The war for control of credit information is getting hot. Combatants include banks, credit bureaus, a common carrier and a manufacturer. An early battle is shaping up in New York City, where three firms --

(Continued on page 105)

editor's readout

FOR WANT OF A POLICY . . .

Ed Feigenbaum is upset.

You might say the soft-spoken director of the Stanford University Computation Center is downright unhappy. And with good reason. He's watching valuable computers at his university sit idle, while students are unable to use them.

The problem arises from a hassle over who is supposed to foot the bill for instructional use of computers at institutions supported by federal funds. The Bureau of the Budget stated its position in Circular A-21, a document designed to establish "the basis for a uniform approach to determining the costs applicable to research and development performed by educational institutions under grants from and contracts with the Federal Government."

The key statement (p. 37, section 2 b) says in essence that the charges to the government shall be no greater than those charged for other work, including "usage by the institution for internal purposes." And *that*, of course, means unsupported faculty research as well as instructional use. The BOB position—which might be stated, "We shouldn't be charged more than other users; education is the university's responsibility, not ours"—seems reasonable.

But Feigenbaum feels that what is on the surface a rational accounting procedure is stifling computer education. "We are wasting an important national resource at an enormous rate," he says. "The lost computer time is unrecoverable. It is gone forever." He points out that the computer is there, whether it's being used or not. The additional costs to run student problems—some punched cards and some paper—are nominal. In the vacuum created by the absence of a national computer education policy, auditing principles have *become* policy. He asks, "Do we *really* want our universities' computers to sit idle one third of the time?

Part of the problem seems to stem from a government inability to recognize the varying values of different levels of service. On the other hand, it's not clear that the universities have done much to establish accounting principles which could lead to such distinctions.

There appear to be three possible solutions. One is a continuation of present practice: let the universities find the dollars to support instructional use of computers. Another is to establish clearly defined levels of service with varying rates, an indirect subsidization which would ease the universities' financial bind. Or the government can develop a national computer education policy and establish a new fund to pay for student use.

Several interested parties—including the Committee on Governmental Relations of the National Association of College and University Business Officers, and a panel of the President's Science Advisory Committee—have been studying the problem,* now being pondered by government procurement officials.

We hope they come up with a satisfactory solution. Two vital resources—students and computers—are involved. And we hope that the final solution is based on a policy which recognizes the importance of these two resources to our national welfare . . . and not merely on narrow, if necessary, accounting procedures.

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* *The PSAC committee is investigating the broader question of computers in universities, also studied by a special committee of the National Research Council of the National Academy of Sciences, which has published a 176-page report. Entitled "Digital Computer Needs in Universities and Colleges" (Publication 1233), it is available from the NAS/NRC Printing and Publishing Office, 2101 Constitution Ave., N.W., Washington, D.C. 20418. The cost: $4.50.*

available now

A REVIEW OF ELECTROMECHANICAL MASS STORAGE

by JOHN S. CRAVER

This article and supplementary charts are presented to show the variety of on-line electromechanical random access storage devices now available to the system designer and to supply details of design and performance characteristics that will aid him in the selection of a product appropriate to his needs. There are also a variety of non-electromechanical random access storage devices available, such as large core arrays and plated wire memories. They have not been covered in this article. At this time, their higher cost per bit has limited their use to those applications where microsecond access times are required. The design trends in the mass storage field are presented as an aid to understanding the potential of each of the various devices; the number and types available are changing so rapidly that it is necessary to have an understanding of their operation in order to evaluate new devices as they become available.

Three types of electromechanical devices have emerged as separate entities in the random access mass storage field. These are the head-per-track systems, the moving arm systems, and the removable media systems. The head-per-track systems provide access times ranging from a minimum of 2½ ms to a maximum of 70 ms and storage capacities up to 400 million bits; the moving arm fixed media systems provide ranges of access times from 30 ms to 400 ms and storage capacities up to 8 billion bits; and the removable media systems provide ranges of access times from 25 ms to 1500 ms and on-line storage capacities up to 34 billion bits. Because of their ability to store inactive data off-line, the total data capacity of the removable media systems, like that of magnetic tape systems, is virtually unlimited.

head-per-track systems

The head-per-track systems take the form of discs or drums which have one or more read/record heads for each track of information. Information is accessed by electronically switching a selected track to a read amplifier and reading the data in serial mode. Switching time, e.g. track access time, is on the order of several microseconds and access time or latency will depend upon the position of the data in the track relative to the read head at the time the track is selected. Access time may vary from less than a millisecond to the number of milliseconds taken for a complete rotation of the disc or drum.

Average access time for randomly occurring data is therefore one half of revolution time. In some systems, more than one track is read in parallel, resulting in increased data rates but no change in data accessing times. Accessing times may be increased by providing more than one head per track, spaced so that only a partial revolution is necessary for the data to reach a read head, or by increasing the rotational speed of the disc or drum so that less time is taken for the data to reach a read head. Multiple heads per track usually cost more than increases in rotational speed and they are not commonly employed.

Increases in rotational speed are limited by transfer rate of the output electronics, material strength of the disc or drum, balancing of the disc or drum, and power available

Mr. Craver is a senior consultant with Hobbs Associates, Inc., Corona Del Mar, Calif. He has been a member of the senior staff at Informatics, manager of the Philco computer office for the Houston Manned Spacecraft Center, and regional manager of product planning for Univac. He holds a BS from Lehigh Univ. and an MBA from the Wharton School of the Univ. of Pennsylvania.

to rotate the system. In general, if higher accessing speeds are desired, the diameter of the recording media is reduced so that it can be revolved at a higher speed without producing strains in the disc, excessive wear, or a requirement for excessive amounts of power: Reducing the diameter results in shortening of the track length; thus a greater number of tracks and heads are needed to store a given amount of data. In head-per-track systems there is a direct relationship in access time and cost per bit for a given systems design.

Cost. The cost per bit of a head-per-track disc system can be substantially reduced by increasing the recording bit density. For example, a head-per-track disc system with 1000 tracks and 8-bit parallel output requires 8 read and 8 write amplifiers, 1000 read/write heads, switching circuits to connect selected heads to the read/write amplifiers, and the magnetic discs with their rotating mechanism. If the disc provides an effective track circumference of 40 inches and data is recorded at a bit density of 500 bits per inch, each track would have a capacity of 20,000 bits and the system would have a capacity of 20 million bits. If the bit density is increased to 1000 bits per inch, the system capacity doubles to 40 million bits.

Such an increase in bit density will result in an increase in the output frequency of the system unless the rotational speed of the system is reduced. Improved design of the read/write head, better head flying techniques, and higher frequency output circuits may be needed to increase bit density; however, increasing bit densities allows a substantial increase in the storage capacity of the system without a corresponding increase in cost, since no additional recording surface or read/write heads are required. To the designer of a mass storage system, increasing bit density is a highly desirable approach to lowering the cost per bit of data storage since a doubling of recording density and output frequency allows him to obtain twice the storage capacity with a minimal increase in system cost.

*Design Trends.*The present trend in head-per-track storage systems for mass storage applications is to design systems that require 30-40 milliseconds maximum access time and to increase bit packing densities to 1000 or more bits per inch.

moving arm mass storage

Moving arm mass storage systems include both disc files and drums. They are similar to the head-per-track systems except that data is accessed by physically positioning a read/write head above the selected track rather than electronically switching to a head that is permanently positioned above the track. Since moving arm disc and drum systems require a much smaller number of read/write heads than do the head-per-track systems, they do not require the elaborate electronic switching matrix necessary to connect the appropriate head to the read/write electronics. Instead, the moving arm systems require a precise mechanical positioning device to move the read/write head to an assigned track. This device must include the control electronics which allow it to accept the computer-supplied address for track positioning.

Moving arm mass storage systems are an attempt to achieve a lower cost per bit trade-off between cost and access time. The substantial reduction in number of read/write heads required by this type of system allows a lower cost per bit. The cost per bit of a moving arm random access storage unit can be lowered not only by increasing bit density but also by increasing track density as neither requires an increase in the number of read/write heads. If bit density is not increased, the total capacity of the file may be doubled by adding one bit or one position more resolution to the arm positioning mechanism, still retaining the same storage media, the same drive systems, the same amount of read/write electronics and, for that matter, the same speed of read/write electronics.

Access Time. Access time of moving arm disc systems is substantially greater than that of head-per-track systems because it includes both the rotational latency of the system and the time necessary to move the head over the appropriate track. Rotational latency—the average time required for data to reach a prepositioned head—for moving arm and head-per-track systems is essentially the same because discs and drums of similar size are used. In all modern moving arm systems, at least one head is used for each disc surface so that no inter-disc travel time is required. Many systems, such as the Bryant 4000 series, use multiple heads per disc surface so that the arm need not be moved the full number of tracks to access data. In these systems, all tracks which are positioned under the read/write heads at an arm position may be accessed within one revolution of the media as if they were head-per-track systems. Maximum head positioning time varies from 50 to 400 milliseconds, depending on the design of the equipment.

The designer of a moving arm disc system can take advantage of increased bit densities to increase file capacity, without adding more heads as he can in a head-per-track system; however, he may also increase file capacity without adding heads, by increasing track density. This is done by writing narrower tracks and writing them closer together. Adding one binary positioner to the arm position selector of a moving arm disc system and decreasing the width in which the track is written will double the storage capacity without any increase in bit density, number of discs that must be rotated, or change in the transfer rate of the data. Doubling of both track density and bit density allow a fourfold increase in the storage capacity of the system at relatively little increase in cost.

Design Trends. The design trend in moving arm disc file systems is to take advantage of increased track density and increased bit density to reduce the cost of the system and to allow smaller rotational elements that can be accessed more readily by a single head, e.g. a greater number of heads for the same number of tracks. Thus, the trend in the more modern moving arm systems is to provide both a lower cost and a faster access time. Access times of some moving arm mass storage systems are being reduced so that their maximum access time is approaching the maximum access time of some of the large head-per-track systems.

Multiple Positioning Systems. Some systems use more than one head positioning device. One is positioned to the track from which data is being read while the others are moving to tracks from which data will next be needed. In some cases, such as the Data Products DiscFiles, these positioners allow accessing of data only from a different disc than that from which data is being read while in others, such as the Bryant PhD 340, all data may be accessed by all accessing mechanisms.

removable media systems

The removable media system is a relatively new device in the field of mass storage and takes a variety of forms, including the single-disc pack, the multiple-disc pack, cartridges of tape loops, and cartridges of magnetic cards. Maximum access time for a removable media system varies widely depending upon the number of movements that must be made to access data, and whether they are made in parallel or sequentially. The small single-disc storage units and multiple-disc storage units require two sequential accessing movements—rotational latency and head positioning time—while some of the large magnetic

COMPARISON OF HEAD-PER-TRACK RANDOM ACCESS STORAGE UNITS

Head-per-track systems on this chart are arranged in ascending order of maximum storage capacity in order to show the range of equipment available. Where prices appear, they are for purchase of a single unit without read, write, or select electronics.

COMPANY	MODEL No.	CAPACITY OF UNIT MILL. BITS	DISC OR DRUM & DIAM.	AVG. ACCESS AT MAX. SPEED	No. OF SURFACES	No. OF DATA TRACKS	No. OF DATA BITS PER TRACK	RECORD DENSITY BPI	TRACK DENSITY TPI	PRICE— NO ELECTRONICS
Librascope	L321	0.33	10" disc	8.0ms	1	45	7500	500	20	NA
Magne-Head	71-64	0.52	7" disc	8.5ms	1	64	8192	532	40	$ 3,000
Magne-Head	4-64	0.6	4" drum	2.5ms	1	64	9420	750	33	7,000
Magne-Head	71-128	0.66	7" disc	8.5ms	2	128	5200	500	40	4,000
Librascope	L322	0.67	10" disc	8.0ms	2	90	7500	500	20	NA
Magne-Head	91-64	0.74	9" disc	8.5ms	1	64	11,500	533	32	4,000
Bryant	5064	0.803	5" drum	2.5ms	1	64	12,560	800	28	NA
Magne-Head	111-64	0.95	11" disc	8.5ms	1	64	14,895	533	32	5,000
Magne-Head	91-128	1.13	9" disc	8.5ms	2	128	8800	533	32	5,000
Magne-Head	131-64	1.16	13" disc	8.5ms	1	64	18,200	533	40	6,000
Librascope	L110	1.18	10" disc	8.0ms	1	72	16,384	1000	40	NA
Bryant	75064	1.2	7.5" drum	5.0ms	1	64	18,840	800	28	NA
Magne-Head	4-128	1.2	4" drum	2.5ms	1	128	9420	750	33	10,000
Vermont Res.	102A	1.28	10" drum	2.5ms	1	64	20,000	637	NA	NA
Magne-Head	72-256	1.33	2-7" discs	8.5ms	4	256	5200	500	40	6,000
Magne-Head	111-128	1.56	11" disc	8.5ms	2	128	12,200	533	32	6,000
Bryant	5128	1.6	5" drum	2.5ms	1	128	12,560	800	28	NA
Vermont Res.	152A	1.92	15" drum	5.0ms	1	64	30,000	637	NA	NA
Magne-Head	131-128	2.05	13" disc	8.5ms	2	128	16,000	548	40	7,000
Magne-Head	92-256	2.25	2-9" discs	8.5ms	4	256	8800	533	32	7,000
Librascope	L210	2.36	10" disc	8.0ms	2	144	16,384	1000	40	NA
Bryant	75128	2.4	7.5" drum	6.2ms	1	128	18,840	800	28	NA
Vermont Res.	104A	2.56	10" drum	5.0ms	1	128	20,000	637	NA	NA
Vermont Res.	202A	2.56	20" drum	8.3ms	1	64	40,000	637	NA	NA
Magne-Head	9-128	2.7	9" drum	5.0ms	1	128	21,195	750	40	8,000
Magne-Head	112-256	3.12	2-11" discs	8.5ms	4	256	12,200	533	32	8,000
Bryant	5256	3.2	5" drum	3.7ms	1	256	12,560	800	28	NA
Bryant	10128	3.2	10" drum	6.2ms	1	128	25,120	800	28	NA
BMA	MS112	3.58	12" disc	16.7ms	2	128	15,600	1200	30	7,000
Magne-Head	12-128	3.6	12" drum	8.5ms	1	128	28,260	750	40	11,000
Vermont Res.	154A	3.84	15" drum	8.3ms	1	128	30,000	637	NA	NA
DDC	7301-1	3.84	disc	8.5ms	2	128	30,000	1000	50	NA
Librascope	L114	4.04	14" disc	7.0ms	1	112	36,000	1500	50	NA
Magne-Head	132-256	4.10	2-13" discs	8.5ms	4	256	16,000	548	40	9,000
Univac	FH330	4.72	drum	8.5ms	1	256	18,432	NA	NA	NA
Bryant	75256	4.8	7.5" drum	6.2ms	1	256	18,840	800	28	NA
Vermont Res.	108A	5.12	10" drum	8.3ms	1	256	20,000	637	NA	NA
Vermont Res.	204A	5.12	20" drum	8.3ms	1	128	40,000	637	NA	NA

COMPANY	MODEL No.	CAPACITY OF UNIT MILL. BITS	DISC OR DRUM & DIAM.	AVG. ACCESS AT MAX. SPEED	No. OF SURFACES	No. OF DATA TRACKS	No. OF DATA BITS PER TRACK	RECORD DENSITY BPI	TRACK DENSITY TPI	PRICE— NO ELECTRONICS
Magne-Head	9-256	5.4	9″ drum	5ms	1	256	21,195	750	40	12,000
Bryant	185128	5.8	18.5″ drum	8.3ms	1	128	46,472	800	28	NA
Librascope	L116	6.0	16″ disc	8.0ms	1	128	47,000	1500	63	NA
Data Disc	F6	6.0	12″ disc	16.7ms	2	64	NA	3333	33	6,450
Bryant	10256	6.4	10″ drum	8.3ms	1	256	25,120	800	28	NA
IBM	7320	6.98	12″ drum	8.6ms	1	400	16,648	NA	NA	NA
BMA	MS212	7.15	2-12″ discs	16.7ms	4	256	15,600	1200	30	9,000
Magne-Head	12-256	7.2	12″ drum	8.5ms	1	256	28,260	750	40	14,000
Vermont Res.	158A	7.68	15″ drum	8.3ms	1	256	30,000	637	NA	NA
DDC	7301-2	7.68	2-discs	8.5ms	4	256	30,000	1000	50	NA
Univac	FH432	7.86	drum	4.25ms	1	432	NA	870	NA	NA
Magne-Head	134-512	8.19	4-13″ discs	8.5ms	8	512	16,000	548	40	13,000
Librascope	L214	8.64	14″ disc	7.0ms	2	240	36,000	1500	50	NA
Bryant	10384	9.65	10″ drum	8.3ms	1	384	25,120	800	28	NA
Vermont Res.	116A	10.24	10″ drum	8.3ms	1	512	20,000	637	NA	NA
Vermont Res.	208A	10.24	20″ drum	8.3ms	1	256	40,000	637	NA	NA
BMA	MS312	10.726	3-12″ discs	16.7ms	6	384	15,600	1200	30	$13,000
Magne-Head	18-256	10.9	18″ drum	16.6ms	1	256	42,390	750	50	20,000
DDC	7302-3	11.52	3-discs	8.5ms	6	384	30,000	1000	50	NA
Bryant	185256	11.8	18.5″ drum	16.7ms	1	256	46,472	800	28	NA
Librascope	L216	12.0	16″ disc	8.0ms	2	256	47,000	1500	63	NA
Bryant	10512	12.9	10″ drum	8.3ms	1	512	25,120	800	28	NA
Librascope	L314	13.2	2-14″ discs	7.0ms	3	368	36,000	1500	50	NA
BMA	MS412	14.3	4-12″ discs	16.7ms	8	512	15,600	1200	30	17,000
Magne-Head	12-512	14.5	12″ drum	8.5ms	1	512	28,260	750	40	22,000
Vermont Res.	166A	15.36	15″ drum	8.3ms	1	512	30,000	637	NA	NA
DDC	7302-4	15.36	4-discs	8.5ms	8	512	30,000	1000	50	NA
Librascope	L124	15.4	24″ disc	17.0ms	1	240	64,000	1500	50	NA
Bryant	185384	17.8	18.5″ drum	16.7ms	1	384	46,472	800	28	NA
Librascope	L414	17.9	2-14″ discs	7.0ms	4	496	36,000	1500	50	NA
Librascope	L316	18.0	2-16″ discs	8.0ms	3	384	47,000	1500	63	NA
Vermont Res.	132A	20.48	10″ drum	8.3ms	1	1024	20,000	637	NA	NA
Vermont Res.	216A	20.48	20″ drum	16.7ms	1	512	40,000	637	NA	NA
Magne-Head	18-512	21.7	18″ drum	16.6ms	1	512	42,390	750	50	27,000
Bryant	185512	23.7	18.5″ drum	16.7ms	1	512	46,472	800	28	NA
Librascope	L416	24.0	2-16″ discs	8.0ms	4	512	47,000	1500	63	NA
Univac	FH880	28.31	24″ drum	17.0ms	1	768	36,912	518	30	NA
Vermont Res.	182A	30.72	15″ drum	16.7ms	1	1024	30,000	637	NA	NA
Librascope	L224	31.7	24″ disc	17.0ms	2	496	64,000	1500	50	NA
Librascope	L1800	32.26	4-16.5″ discs	13.0ms	8	1152	28,000	900	48	NA
IBM	2301	32.76	11″ drum	8.6ms	1	800	NA	1250	80	NA
Vermont Res.	232A	40.96	20″ drum	16.7ms	1	1024	40,000	637	NA	NA
Magne-Head	18-1024	43.4	18″ drum	16.6ms	1	1024	42,390	750	50	40,000
Bryant	1851024	47.59	18.5″ drum	16.7ms	1	1024	46,472	800	28	NA
Librascope	L324	48.2	2-24″ discs	17.0ms	3	752	64,000	1500	50	NA
Librascope	L138	50.0	38″ disc	34.0ms	1	512	98,000	1300	83	NA
Librascope	L424	64.5	2-24″ discs	17.0ms	4	1008	64,000	1500	50	NA
Burroughs	B475	57.6	4-28″ discs	20.0ms	8	1200	73,920	1045	33	NA
Univac	1782	75.5	24″ drum	17.0ms	1	1536	49,152	691	NA	NA
Librascope	L3800	190.0	6-38″ discs	17.0ms	12	4096	46,600	710	48	NA
Librascope	L4800	409.0	6-48″ discs	35.0ms	12	5184	79,000	900	48	NA

card systems require as many as five accessing movements, some sequentially and some in parallel.

The design trend in removable media systems, like other moving arm systems, is to increase both bit density and track density; however, these increases are used primarily to provide larger capacity rather than to reduce access time. Most cartridge loaded mass storage media are used in business data processing and other non-real time applications where accessing time is not of prime importance since data requests can be ordered or queued.

Parallel Access. When high access speed is required from a multiple disc pack system, it may be obtained by allowing the simultaneous access of different pieces of data from more than one disc pack. This overlapping can reduce the effective access time to the rotational latency of a single disc pack, when data is simultaneously being accessed in several packs, as rotational time used to read the data becomes less than the average arm positioning time. Most removable media systems have only one positioning system per file, so it is usually necessary that the next piece of data be located in a different file if it is to be accessed while other data is being read.

File Reconstruction. The removable media systems have a number of advantages for some business data processing applications. Removable media storage allows use of the grandfather-father-son approach to data storage that has long been used in magnetic tape systems. With this approach, the previous file is saved together with current file inputs so that the previous file may be updated with the current inputs should a file be lost or destroyed. Saving the previous file is difficult if the storage media is not removable. Thus the removable media system lends itself to this type of application while allowing the advantage of random file access.

The removable media file also has advantages when a data processing system is used for a variety of applications because it is possible to store both the programming and the data for each application on separate removable units. By doing this, substantially less on-line storage is required than would be required if all programs and associated data for all applications had to be stored in a non-removable system.

*System Failure.*The removable media system also reduces the problem of storage unit failure. When a fixed on-line data storage system is used, the full system may be put out of operation if there is mechanical difficulty with the file. This can only be prevented by maintaining a duplicate file on-line on another mechanical unit. With the removable media system, it is possible to remove the media from the disabled unit and transfer it to a usable unit with little lost time if more than one accessing unit is available.

Design Trends. The design trends in the removable media field have been to increase bit density, increase track density, and in particular to increase the number of accessing units to allow simultaneity of access between different units so that the effective access time may be reduced to as little as the media latency time through the use of queued data requests and program look aheads.

hardware selection

Selection of an optimum mass storage device must depend not only on a knowledge of the functions and economics of available mass storage media but also on a thorough understanding of the structure of the data to be stored and the manner in which that data is entered into and called up from storage. No generalized comparison of mass storage devices or mass storage techniques, no matter how cleverly conceived, can take these into account. The information presented in this article and the accompanying charts is intended to familiarize the reader with the characteristics of commercially available equipment but does not replace detailed study and analysis of the data structure and the system.

Prior to selecting a random access mass storage system it is necessary to specify the maximum number bits, bytes, characters or words of data to be stored, the length of block in which they will be accessed, a transfer rate at which they are desired by the system, and an average or maximum access time in which they are needed.

Amount of Storage Needed. Maximum capacity of an on-line random access storage system, can be measured in bits, bytes, characters or words. Specification of maximum capacity should include the amount of data storage required for worst-case situations and an allowance for future expansion of the file to accommodate increases in number of items in the data base and increases of the amount of data stored per item.

The allowance for expansion need not be as great when modular systems are used that allow the addition of more storage units at a later date, or when removable media systems are used that allow rapid changes in the on-line data store.

The unit of data storage used will vary with the controller and its computer interface. As the storage media is binary in nature and each bit is stored as a separate entity, any storage unit can be used to store any type of digital data. Whether the output is bit serial, or bit parallel, binary, or decimal by byte, or by character will depend upon data organization provided by the controller to interface with a particular computer.

In order to simplify comparisons in the accompanying charts, the bit is used as the basic amount of storage in comparing mass storage devices. Effects of the controller on data organization are omitted, since they vary with the computer system to which the storage device is attached.

Block Length. Block length of stored data is primarily a function of the computer and its interface with the data storage system rather than a function of the storage device. Greater efficiency of data transfer is obtained with large block transfers than with small block transfers, since less time is spent in searching for the next piece of data. This is particularly important with mass storage systems that utilize moving arm techniques because they require longer delays between reading units of data than do head-per-track systems. Since block length is a function of the computer system and its organization, it should be specified as a function of the computer interface rather than as a function of the data storage device.

Transfer Rate. Transfer rate of rotating mass storage devices is a function of the recording density, i.e. bits per inch, the speed at which the recording media is moved, i.e. inches per second, or revolutions per second times the effective circumference, and the number of tracks which are read in parallel.

In actual practice, transfer rate must be limited by the slower of two rates: the peak data transfer speed of the mass storage unit or the peak data transfer speed of the computer system to which it is connected. The designer of a mass storage unit may use the same basic mechanism to provide more than one transfer rate by changing the recording density, changing the rotational speed, or reading more than one head in parallel. To avoid system dependency, transfer rates used in this article are in million bits per second seen at the read head when the media is operating at the rotational speed necessary to provide the indicated average rotational delay.

Access Time. Average access time will vary with the data storage device, its data accessing techniques and whether

COMPARISON OF MAGNETIC CARD RANDOM ACCESS STORAGE SYSTEMS

COMPANY	MODEL No.	CARD SIZE (inches)	CARDS PER CARTRIDGE	TRACKS PER CARD	REC. DENS. BPI	TRACK LENGTH (bits)	CARTRIDGE CAPACITY (mill. bits)	CARTRIDGES/ UNIT	UNIT CAPACITY (mill. bits)	AVG. TIME TO ACCESS (ms) NEW TRACK	NEW STRIP	NEW CARTRIDGE	PRICE
Honeywell	251	NA	512	32	NA	6,000	94.8	1	94.8	16.7	95	—	$29,250
Honeywell	252	NA	512	128	NA	6,000	380.0	1	380.0	16.7	150	—	50,625
Honeywell	253	NA	512	128	NA	6,000	380.0	5	1,902.0	16.7	NA	225	100,125
IBM	2321	12⅞x2¼	200	100	1780	18,000	360.0	10	3,600.0	95	175	387	136,500
NCR	353-1	14x3¼	256	7	260	3,100	38.9	1	38.9	24	235	—	38,000
NCR	353-2	14x3¼	128	56	700	7,840	56.2	1	56.2	24	235	—	30,600
NCR	353-3	14x3¼	256	56	700	7,840	112.4	1	112.4	24	235	—	35,500
RCA	3488-1	16x4½	256	128	700	9,100	298.3	8	2,387.0	20	385	385	135,000
RCA	3488-2	16x4½	256	128	700	9,100	298.3	16	4,774.0	20	460	460	200,000
RCA	568-11	16x4½	256	128	1400	17,112	561.0	8	4,488.0	20	385	385	145,000

COMPARISON OF REMOVABLE MEDIA RANDOM ACCESS STORAGE UNITS

COMPANY	MODEL No.	DISC OR DRUM & DIAM.	SURFACES PER CARTRIDGE	TRACKS PER SURFACE	UNIT CAPACITY MILL BITS	CART. ON UNIT	REC. DENS. BPI	TRACK DENS. TPI	TRACKS PER ARM POS.	No. OF BITS W/O HEAD MOVE.	HEAD POS. TIME (MS) MIN.	AVG.	MAX.	AVG. ROT. DELAY (MS)	PRICE WITH ELECT.
Anelex	80	14" Disc	12	100	24	1	707	50	12	240,000	NA	NA	100	12.5	NA
	81	14" Disc	12	200	60	1	960	100	12	312,000	NA	100	NA	16.7	NA
CDC	852	14" Disc	10	100	20.9	1	988	50	10	140,000	30	85	145	20	NA
	853	14" Disc	10	100	24.5	1	1105	50	10	245,560	30	85	145	12.5	NA
	854	14" Disc	10	200	49.2	1	1105	100	10	245,560	30	85	145	12.5	NA
Data Disc	M4	12" Disc	1	128	4.	½	2500	40	1	49,998	1	338	790	25	$7,775
GE	DSS120	12" Disc	1	128	4.7	½	NA	NA	1	NA	105	420	NA	26	NA
	DSU150	16" Disc	2	320	47.16	1	3200	80	8	589,000	30	65	90	26	20,000
IBM	1311-1	14 Disc	10	100	20.3	1	1020	50	10	160,000	54	250	400	20	17,610
	2310 A1	14" Disc	2	100	11	1	1080	100	2	40,960	1	338	790	20	13,500
	2310 A2	14" Disc	2	100	22	2	1080	100	4	81,820	NA	500	1500	20	21,375
	2310 A3	14" Disc	2	100	33	3	1080	100	6	122,780	NA	500	1500	20	29,950
	2311	14" Disc	10	200	58.4	1	1110	100	10	290,000	25	75	135	12.5	26,300
	2314	14" Disc	18	200	1,656	8 spare	NA	100	18	8,280,576	25	75	135	12.5	252,000
Potter	4550 TLM	30" Tape	8	112	50.2	2	1020	56	32/ctr	1,792,000	45	71	85	25	19,000

COMPARISON OF FIXED MEDIA MOVING ARM RANDOM ACCESS STORAGE UNITS

COMPANY	MODEL No.	DISC OR DRUM & DIAM.	TRACKS PER SURFACE	SURFACES	REC. DENS. BPI	TRACK DENS. TPI	SIMULT. MULT. ACCESS	TRACKS PER ARM POSITION	HEAD POS. TIME MILLISECONDS MIN.	AVG.	MAX.	AVG. ROT. DELAY (MS)	UNIT CAPACITY MILL BITS	PRICE WITH ELECTS.	PRICE NO ELECTS.
Control Data	813	26" Disc	192	64	1070	50	No	4	20	65	110	26 ms	604	NA	NA
	814	26" Disc	192	128	1070	50	2	4	20	65	110	26 ms	1208	NA	NA
	808	26" Disc	192	128	850	50	2	6	20	65	110	26 ms	791	NA	NA
Data Products	5022	31" Disc	256	32	600	26.7	No	8	110	180	250	26 ms	222	$55,500	$28,600
	5025	31" Disc	256	32	600	26.7	Yes	8	55	90	250	26 ms	222	69,200	28,600
	5045	31" Disc	256	64	1000	26.7	Yes	8	50	85	250	26 ms	875	99,800	51,800
	5042	31" Disc	256	32	1000	26.7	Yes	8	50	85	250	26 ms	438	79,800	28,600
	5042S	31" Disc	256	32	1000	26.7	No	8	100	170	250	26 ms	438	70,400	28,600
	5045S	31" Disc	256	64	1000	26.7	No	8	100	170	250	26 ms	875	90,400	51,800
	5065	31" Disc	512	64	1000	53.4	Yes	8	50	85	250	26 ms	1750	119,800	63,800
	5085	31" Disc	512	64	2000	53.4	Yes	8	50	85	250	26 ms	3500	143,600	77,800
Bryant 4000	Model 2-B	39" Disc	768	26	600	64	opt.	162	30	95	140	25 ms	854	NA	84,920
	Model 2-C	39" Disc	768	50	600	64	opt.	306	30	105	165	25 ms	1643	NA	122,600
	Model 2A-B	39" Disc	1536	28	800	128	opt.	162	30	95	140	25 ms	1643	NA	98,000
	Model 2A-C	39" Disc	1536	52	800	128	opt.	306	30	105	165	25 ms	3800	NA	140,000
	2600-2 Module	26" Disc	768	68	1500	128	opt.	204	NA	NA	120	17 ms	4100	NA	117,000*
	2600-6 Module	26" Disc	768	204	1500	128	opt.	612	NA	NA	160	17 ms	12,500	NA	160,000*
IBM	2302-1	Disc	500	40	1060	100	2	40	50	165	180	17 ms	702	252,000	None
	2302-2	Disc	500	80	1060	100	4	40	50	165	180	17 ms	1404	355,000	None
	2302-3	Disc	500	50	1060	100	2	46	50	165	180	17 ms	896	252,000	None
	2302-4	Disc	500	100	1060	100	4	46	50	165	180	17 ms	1794	355,500	None
Univac	Fastrand IA	24" Drum	6140	1	1000	53	No	64	30	92	154	34 ms	3892	160,000	NA
	II	24" Drum	12,480	1	1000	106	No	64	39	92	154	34 ms	7784	184,000	NA
	Modular Fastrand	Drum		1	1000	53	No	16	NA	NA	NA	17 ms	64	27,000	NA
Bryant	PhD 170	20" Drum	2752	1	1000	64	opt.	43	30	42	55	17 ms	173	NA	35,000
	340	20" Drum	5504	1	1000	128	opt.	43	30	42	55	17 ms	346	NA	41,000

*Tentative Prices.

the controller can accept queued requests. Effective access time will vary with the structure of the data base used, its degree of randomness, and the randomness of requests. In non-real-time data processing systems, non-random data frequently occurs as a result of the assignment of sequential identification numbers, times, dates, or quantities. This may cause a tendency for clumping or grouping of data which reduces effective access time below the theoretical average access time listed by the manufacturer of a storage device.

Real-Time Applications. In some real-time applications, the use of sequenced numbers creates the same non-random situation. However, the designer of real-time systems must consider the worst-case situation and use maximum access times rather than an average in order to assure that a process cycle will always be completed without overlapping the next cycle.

In the accompanying charts comparing mass storage equipment, it is not practical to include these systems considerations as there are many kinds of data base and systems considerations vary accordingly. Access times used are those furnished by equipment manufacturers.

The factors determining access time will vary with the nature of the storage system, the number of levels through which data is searched and whether the search occurs in different levels sequentially or in parallel. These range from the single-level access systems, such as the head-per-track discs in which the track containing the data is directly accessed, to the multiple-level access system such as the IBM Data Cell in which the data cell drive must be addressed, the data cell positioned to a sub-cell position, the data strip selected and transferred to the read station, and the read/write head selected.

Head-Per-Track Storage. In a head-per-track data storage system, one that searches for data at one level, the minimum access time is zero as the desired character may be the next one being read. The average access time is one-half drum or disc revolution as this is the statistical average required to locate a random piece of data if a random series of addresses is received. The maximum access time is one revolution of the disc or drum system, because all data is exposed to all heads during that time period (usually head switching time requires only several microseconds and is disregarded because it does not appreciably alter access time in a head-per-track system). From a realistic standpoint, the average access time is seldom the effective access time because a truly random series of addresses is seldom received.

Moving Arm Storage. Calculation of meaningful access times for a moving arm system is considerably more difficult than for a head-per-track system. All moving arm systems require the rotational time necessary to locate the data, as do head-per-track systems. However, they also require an interval to position the head over the correct track, and confirm that the head has been correctly positioned.

In a moving arm disc system, the minimum latency time can be zero, as it is in a head-per-track system, if it is assumed that the head is positioned over the correct track and that the data is ready to pass under the head. Maximum access time in a moving arm disc file is the length of time necessary to move the arm the maximum distance or maximum number of tracks plus the maximum latency or rotational time. About the only reasonable definition that can be used for average access time is that it falls somewhere between these extremes. Most manufacturers consider the average access time of a moving arm disc system to be composed of the average latency, as described, plus the average arm positioning time; however, there is no accepted definition of average arm positioning time. Depending upon the manufacturer, it can be:

One half of the maximum arm positioning time.

One half of the total time it takes the arm to travel one track and the time it takes the arm to travel the maximum number of tracks.

The actual time that it takes the arm to travel one half of the tracks. (The arm must accelerate to a speed and decelerate from a speed. Therefore, the rate of movement of the arm across the tracks is not uniform. Thus the time taken to position 50 tracks is not necessarily one half the time taken to position 100 tracks).

These definitions of average arm positioning times are used only to indicate some of the variations that exist. The term may mean almost anything between the minimum and maximum arm positioning times, depending upon the manufacturer's definition. Further, in most cases the file is not used in a manner in which average positioning time is truly important. Typically, a larger file is used than is required for the immediate data storage needs, either because of the requirements of some other application of the same file or because of extra capacity to allow for expansion. In either case, the data tends to be in one area of the file, thus reducing the actual average arm positioning time to something other than that required to access the full file. Further, in non-real-time data processing, the most common application of moving arm disc files, there is a strong tendency for the data requests to group as a natural result of some numbering system or as a result of some data ordering because of previous processing such as batching or sorting. Some systems are designed so that data requests are queued and data is furnished not in the order requested but rather in a sequence corresponding to the order in the file. In effect, such systems derandomize even random data in order to reduce access time.

A realistic access time is even more difficult to obtain for multiple level accessing systems such as the RCA models and IBM Data Cell; or for systems with multiple positioning mechanisms such as the Bryant PhD Drum and the IBM 2314.

In the IBM Data Cell, accessing time may vary from 95 ms—to access another track in the same strip—to 600 ms to access a new strip in a different cell. Only one head positioning and read mechanism is available and requests cannot be overlapped.

On the other hand, the IBM 2314 multiple disc pack system has eight separate head positioning mechanisms so that it is possible to pre-position one read mechanism while data is being read from another. This overlapping can reduce effective data access time to less than arm movement time in many applications.

mass storage characteristics

The accompanying tables of mass storage characteristics are intended to show the operating characteristics of available head-per-track, moving arm, and removable media mass storage systems.

Since many computer manufacturers purchase mass storage units from peripheral equipment manufacturers, the same devices may be sold by a number of different manufacturers. In order to avoid excessive repetition, mass storage units are listed under the name and model number of the original manufacturer.

Information in these tables has been obtained from literature and contacts with the equipment manufacturer, and wherever possible confirmed before publication. However, it must be kept in mind that there are many variations of the same basic equipment and that the rapid advances of mass storage technology cause frequent changes in the manufacturers' specifications. ■

you can't be too careful

INSURANCE FOR DATA PROCESSING

by HAIG G. NEVILLE

The vast capacity to function as a central information processor, funneling and concentrating the work of former multiple manual and perhaps far-flung processing units at far greater speed and efficiency, is the computer's most obvious advantage. It is also its greatest source of vulnerability. Just as the proper functioning of the human body depends on the central nervous system, the firm that bases its operation on computer processing is vulnerable to disruption of staggering proportions should damage or destruction strike the computer system.

The purpose of this article is to summarize the kinds of possible damage and examine what can be done to minimize and transfer the consequences. In addition, the area of liability arising out of errors and omissions in the processing of data for others on a shared time or service bureau basis will be discussed.

what is the risk?

The major sources of risk for the user of a computer system are damage or destruction of the equipment itself and the loss of records and media which are the basis of the processing function. Since most firms lease their equipment, they are under the impression that major sources of damage to the computer are assumed by the manufacturer under the terms of the lease. Heavy reliance on the lease wording is not a generally recommended attitude since the high cost of the equipment makes it most probable that recovery will be sought if it can be determined that the damage to the equipment was caused by the lessee's negligence.

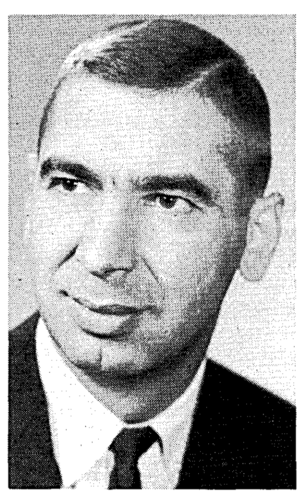
Important differences in the terms of leases require a searching analysis of how far the computer manufacturer's assumption of liability extends. If the lease contains a clause absolving the user of most liability for damage or destruction to the equipment except that arising out of his negligence, it may be well to determine whether the user is required to bear the burden of disproving his negligence. Consideration must also be given to the common law liability of negligence and, if no reference in the lease is made to this point, relief from this liability cannot be found unless it is spelled out. Furthermore, both equipment and records of the data processing system are susceptible to many more types of damage and with far greater consequences than ordinary equipment maintained in business offices.

The clerical and paper work function is an example. Once committed to the data processing system, damage to the system or the media records can be disastrous, since the personnel, skills, equipment and facilities formerly used in the manual operation are no longer available. Yet the schedule of accounts receivable, production schedule, inventory control, accounts payable, and payroll must be met.

Imagine the consequences, for instance, if a fire had destroyed your data processing system last night. You would be faced with the realization that the task of system development, programming, debugging, and conversion of records which took years to complete must all be redone almost overnight. The cost of this reconstruction can be sufficiently staggering to be almost insurmountable. Yet this is precisely what could happen if the matter of fire prevention, safe storage of records and programs, and adequate insurance has been neglected.

The loss potential to data processing systems can be of major proportions even though the fire or other peril is relatively minor and controlled. Temperature and humidity control are critical factors in a computer room and variations will cause system malfunctions. For example, a small but intense fire was ignited by a welder's torch in the air conditioning system which served the machine room of a large eastern bank. The refrigerant was released and the destructive acid compounds contained in the halogenated refrigerant spread into the machine area. Not only was there a total loss of a memory drum and other equipment in the room, but the information stored was irretrievably lost. Substantial damage has been caused to magnetic tapes and records by the action of smoke particles, steam generated by water used to extinguish a fire, water itself and temperatures in excess of 140°F.

One final area of risk arises from "time sharing" and the



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processing of work for others. Professional firms, banks and consultants—such as accountants and engineers—are exposed to liability claims arising out of (a) their use of edp equipment resulting in output errors, (b) erroneous programming of a client's system while acting in a consulting capacity. Acknowledgement of these loss possibilities cannot fail to reveal the importance of adequate backup facilities and proper attention to loss prevention. In connection with these problems, consideration must be given to: (1) loss of the equipment, whether leased or owned outright, (2) the additional expense of reconstruction of media and records, (3) the extra expense incurred to return to a normal operation, and (4) the loss sustained by the interruption of business. In addition, for firms engaged in processing work for others on their system, liability arising out of errors and omissions cannot be overlooked.

adequate disaster plan essential

The first step in a disaster plan is to protect, in an attempt to eliminate the risk of loss. The protection of essential records is vital in order to continue operations. These records can be categorized as:

1. Vital records—irreplaceable, original documents necessary to maintain solvency or to restore production sales.
2. Important records—expensive to reproduce in terms of time and money.
3. Useful records—loss of which would cause inconvenience, but could be readily replaced.

In most cases, duplication is the most satisfactory solution to record reconstruction. The duplicates should be stored safely in a vault remote from the plant or office.

Even with the implementation of the above procedures, however, problems arise with respect to (a) random access storage and (b) current batched working data. Random access storage is even more vulnerable to a minor mishap in the computer room, further emphasizing the importance of the above procedure on a continuing basis. Current records in constant use, such as sales slips and accounts receivable, require special attention since the information is only as current as the last batch delivered to storage.

Protection of the equipment and records is the user's responsibility. Sufficient literature has been published by the National Fire Protection Association, manufacturers of fire protection devices, and computer manufacturers that space will not be devoted here to the significant factors involved in the construction of a model computer installation.

importance of backup arrangements

Once a particular function has been committed to a computer system, an uninterrupted flow of processing is vital to the normal operation of the business. Preparation for continued operations under emergency conditions should include:

1. Reciprocal arrangements for the exchange of facilities with another user in the event of an emergency.
2. Plans for transportation of personnel, data and records to these facilities.
3. Built-in program check points and restart procedures to facilitate rapid resumption of normal operations.
4. Rehearsal under simulated disaster conditions to eliminate unforeseen difficulties.

Conventional forms of insurance are not generally broad enough to cover the computer room operation in the areas discussed. As pointed out records, media, and the equipment are susceptible to a broad spectrum of risks not generally provided for under standard insurance policies.

The recent development of special data processing insurance attempts to fill these gaps and falls into four main categories:

1. Damage to the property including the system, equipment and records.
2. Extra expenses involved in securing temporary facilities and reconstructing data and records under critical conditions.
3. Loss of earnings caused by the interruption of business.
4. Liability arising from error in output and omissions in doing work for others.

equipment, data and records

One of the major advantages of the newly designed data processing insurance is that it covers on an "all risk" basis. "All risk" means that only a few types of loss are excepted—such as wear, tear and deterioration, war and nuclear attack. This is in contrast to the conventional fire and extended coverage policies covering a limited number of named perils such as fire, wind, smoke, explosion, etc. It is evident that from the standpoint of a computer user, fire and extended coverage is generally inadequate since the computer system is subject to loss from a far greater variety of perils than are provided for under these policies.

As mentioned earlier, a very important point to keep in mind when leasing equipment is that the fact that the manufacturer has insurance on his equipment does not automatically free the user of liability. The high cost of the equipment provides an incentive to the lessor's insurers to exercise their subrogation (recovery) rights and they are not likely to feel bound by the manufacturer's good intentions.

'A "waiver of subrogation" can be negotiated between the user and the manufacturer's insurer to avoid any attempt at recovery as described above. In addition, provision can be made under the data processing policy to protect the user from losses not assumed by the manufacturer by a "difference in conditions" clause.

Perhaps the greatest area of vulnerability for a computer system is the loss and destruction of media. It is generally accepted that the costs of programming—including the phases of systems analysis, coding and debugging—can equal or exceed the value of the equipment itself. The loss of the "concentration of values" represented in the information contained on the reels of tape, punched cards, punched paper tape, and other media can develop into a substantial risk.

The damage and destruction by fire to the three computers in the Pentagon Air Force Statistical Division Offices reached nearly 7 million dollars. No estimate was made of the loss of destroyed records contained in the over 7,000 reels of magnetic tape which went up in smoke. At a cost of $40 per reel for the raw tape, this comes to $280,000. But the information on each tape was worth millions of dollars. The time and effort to create a tape reflects years of program time, processing and editing. The real loss was conceivably as much as $30,000,000.

It should be noted here that fire and extended coverage policies exclude coverage for "accounts and manuscripts" except for the actual cost of the raw material plus the nominal expenses of transcription or copying. It is evident therefore that the fire and extended coverage approach for attacking this problem of information is entirely unacceptable. Similarly, the coverage afforded by the conventional valuable papers and records policy leaves a question as to whether or not it is intended to cover electronic storage records. Since this policy was developed at a time when most records were documents readable by the human eye, it is questionable whether the clause would include such storage media as tape, drums and discs.

In contrast to these conventional forms, the coverage afforded under the media and record section of the specially designed data processing policy affords coverage on an "all risk" basis to "active data processing media." This expression can leave no question as to its meaning and therefore it is much more acceptable than the wording of the previously discussed form.

The coverage includes agreement to replace the damaged media with other media of like kind and quality. It is therefore a condition of this policy that the insured keep a duplicate copy of each master program and instruction tape in a fireproof safe or vault with a combination lock located at a remote place rated as a separate fire risk. In the absence of this condition, the inability of the insured to replace the damaged media with media of like kind and quality would render the policy inoperative and there would be no recovery. Therefore, the condition is a reasonable one and a further demonstration of how prudent business practices facilitate rapid recovery in the event of a loss.

determination of values

The determination of media values is probably one of the most perplexing tasks that an insurance manager may face. It requires the close cooperation of the data processing unit and a complete analysis of the operation in order to arrive at realistic values. Every operation must be analyzed to determine its value in terms of programming costs, present operational value, and the possibility of any "backup" in the event that the program is lost or destroyed. Examination of the updating of programs must be made in order to determine the cost of revising stored previous generation programs to comply with the damaged or destroyed active tapes. And since this is a very important area a great deal of patience and assistance will be required in order to make a meaningful determination of values for media.

In the event of a disaster, great pains and effort would be expended to expedite the work elsewhere on other equipment without regard to the expenses involved. It is highly important to the continued operation of the business that payroll, inventory, order processing and manufacturing continue uninterrupted. Therefore, many expenses are likely to be incurred immediately after a loss and during the period of restoration and reconstruction in order to maintain a continued flow of operations.

Coverage for these expenditures is provided under the special data processing policies with an "all risk rider" designed specifically to allow for the susceptibility of edp systems to perils other than fire and allied risks. Each account is rated individually. The rate for insuring the equipment, media, records and extra expenses is based on the fire and extended coverage rate, plus a loading to take care of the additional perils. This loading will vary from 10 to 15 cents per $100 of coverage. The premium for a major oil company that purchased this coverage subject to a large deductible came to $4,000 annually for $4,000,000 of coverage.

loss arising from interruption

Most firms recognize that a fire can cause far greater loss to the business than just the physical destruction of property. Therefore, they carry business interruption insurance to cover the loss of earnings during the period of recovery. This is generally written on a "named peril" policy similar to fire and extended coverage. In recognition of the need for a broader form of protection in computer operations, "all risk" business interruption insurance has been developed. It is designed to provide for the loss of income when the operation is interrupted because of damage to equipment or active data processing media. The premium for this coverage is determined by charging a fraction of the fire and extended coverage rate plus a "load" for the "all risk" perils.

errors and omissions liability

In the past few years, firms using computers to perform data processing services for others have shown considerable interest in errors and omissions coverage because of the liability of the data center. The following examples illustrate some of the consequences:

A service bureau was employed for the purpose of collating the market data in a research study. In analyzing the data, the research firm came to a number of market conclusions which were the basis for the client to open regional warehouses. Due to an error in the statistical tabulations of the service bureau, the conclusions reached by the research firm were unsound. As a result, the client firm became bankrupt. The client firm brought suit against the research firm and the data processing service bureau, seeking compensation for opening the warehouses in the wrong geographic areas.

Banks are very much in the service bureau business, processing checks for other banks and offering payroll and accounting services for business. The bank assumes the responsibility for maintaining up-to-date payroll records, issuing the payroll, and preparing necessary accounting and government reports. An error in the system could involve a bank in a substantial liability if the erroneous information was delivered to a client who suffered damages by relying on it.

It is a service bureau's function to prepare all the financial records such as payroll, insurance deductions, pension deductions, social security and related records. An error in the program or instruction tape is not limited to the immediate serious consequences, but can conceivably result in a union dispute, a strike, down-time, and loss of sales for the client firm.

coverage available

The recently developed coverage for liability arising from errors and omissions in doing work for others is designed to fill the need for protection outlined in the above examples. The form covers the insured's legal liability for damages on account of any claim caused by a negligent act, error or omission, arising out of the performance of a data processing service for others. Rates are based on receipts derived from doing work for others and vary from 14 cents per $100 of annual receipts for a limit of $50,000 liability to 60 cents for a $1,000,000 limit. Underwriters will normally insist on a deductible, usually not less than $5,000 per claim.

In this area of errors and omissions coverage one must keep in mind that the coverage is designed for the liability to others arising from errors and omissions on the computing system. It does not apply to internal loss or damage from programming error or the spoiling of a deck of cards by erroneous punching.

This area of liability of a data center is still uncertain. Data centers themselves are not at all sure of the limits of their liability. However, close examination of the risks involved—from the standpoint of the physical risk to the computers, the media, extra expense, source documents and valuable papers, accounts receivable, and the errors and omissions liability, together with a study of the coverages presently being offered on the market and yet to be developed—can help an insurance manager take an intelligent approach to properly managing and coordinating his insurance program. ■

FORMULA MANIPULATION COMPILER

derivatives, applications and factors

by JEAN E. SAMMET

Throughout the history of using computers for scientific calculations, the attitude and practice has been to emphasize that computers are good for doing arithmetic, but that they are not useful for doing "pure" mathematics or even algebra. In fact, the motivation for the first computers was to develop ballistic firing tables—an extremely numerical process. As a result of the influence of the digital computer on numerical analysis, many analytic techniques in mathematics have been forgotten or ignored over the past 10 to 15 years. The time is long overdue when this trend can and should be reversed.

The historical picture is perhaps not quite as black as has been indicated above. It is greatly to the credit of Messrs. Kahramanian and Nolan that they both wrote programs to do formal differentiation on a computer as early as 1953.[1] They appear to be the first to use a computer to do what can reasonably be called formal mathematics—e.g., to find the derivative of x^2 is $2x$. After 1953 there was a long (by computing standards) hiatus in time before any significant amount of work began to appear in this area again. Small things were done around 1959 and 1960, but the next most significant developments were LISP, ALGY, ALPAK, FORMAC, and Formula ALGOL.[1]

The casual reader, or somebody who is not too well acquainted with this field, may legitimately question the need for programming systems of this kind. However, there are numerous instances in which problems exist requiring weeks or months of manipulation of algebraic and trigonometric expressions. Furthermore, this work is just as prone to human error as are numerical computations. Because of the types of problems illustrated by formal differentiation of complicated expressions, generation of series involving hundreds of terms, analytic solution of linear and differential equations, etc., there was felt to be a need for a general purpose practical system.

objectives of formac

FORMAC was developed as an experimental system, to determine whether it was possible to provide a general purpose capability that would be useful for a wide class of problems. The primary objective was a practical sys-

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[1] At the request of the editor, specific bibliographic references other than the major ones on FORMAC are omitted. They appear, however, in: Sammet, J.E., "An Annotated Descriptor Based Bibliography on the Use of Computers for Non-Numerical Mathematics," *Computing Reviews*, July-August 1966. A description of these and other systems will appear in: Sammet, J. E., "Survey of Formula Manipulation," *Communications of the ACM*, August 1966.

tem, rather than a more mathematically elegant but potentially less useful system.

In trying to develop the basic concepts for the type of system desired, it was necessary to consider the type of work for which people would want to use this system. An investigation of some problems immediately showed that people wanted to do not only analytical work, but numerical work as well. In other words, the very tedious algebraic manipulation that was required in the solution of problems in physics, engineering, etc., were often—although not always—a prelude to, or intermingled with some numerical evaluations. For example, in network analysis engineers often want to take the derivative of a very complicated expression, and then evaluate the result for sets of numerical parameters.

There are other cases in which the coefficient of a particular term in an expression has significance from its algebraic form rather than from the numeric value. As a simple example, if we wish to consider the following equation as a quadratic in x: $x^2+y^2+2x+2yx+2y+1=0$ we soon find out by applying the normal quadratic formula that the discriminant is zero, and as a result this quadratic in x has a double root—namely, $x = y+1$. Note that this is quite independent of the value of y, either algebraically or numerically. Thus if y itself is something considerably more complicated, then the result of having a double root would still be the same.

As indicated above, there is a need for the ability to do numeric computations along with the non-numeric capabilities being provided. Furthermore, there are cases in which people wish to iterate on expressions; for example, there are many formulas in physics which look like very simple iterations but rapidly become very tedious. In addition to the need for numeric capability, and some type of repetition or loop control, there is obviously a need to get the expressions into and out of the computer—in other words, input/output capability. These factors lead one to the inescapable conclusion that a formula manipulation capability should be an inherent part of a numerical compiler, and FORTRAN was the obvious and logical choice because of its widespread use. Thus, it was felt that the user would obtain the most practical system if the additional capabilities he was receiving were an integral part of a compiler which he normally used for solving his numeric mathematical problems. It was therefore decided that this additional capability would be added to FORTRAN, and since FORTRAN IV and IBSYS were the major new developments at the time the work on FORMAC started, it was decided to add the FORMAC capability to FORTRAN IV and have the entire system run under IBSYS-IBJOB on the 7090/94. Every attempt was made to emphasize the fact that although this was a major conceptual addition to existing capabilities, it could still be handled in the normal operational way rather than as something completely separate and different.

Because of the current importance of time-sharing and man-machine interaction systems, it seems worthwhile to make some comments about this subject in connection with the original objectives of FORMAC.

There are some analytical problems for which terminals are absolutely essential, and others for which they are relatively useless. At the time that work on FORMAC started, in August 1962, time-sharing was not as well developed as it is today; furthermore any crystal ball rightly predicted that terminals were not going to be as widespread in 1964 and '65 as a normal computer configuration. Since the objective of the project was to determine the feasibility and general usefulness of a system of this kind, it was essential to make the system independent of special equipment. Thus, although it is clear that there are problems that cannot effectively be solved in a batch system, it was decided not to tackle two major problems at once.

Experience has borne out this decision, in the sense that there are many more people using FORMAC now than could possibly have used it had it been designed for a man-machine interaction system. This is not to negate the value of the latter; on the contrary, a subset of FORMAC was made to run under MIT's CTSS on a line-by-line basis (i.e., not stored program basis). Although this particular version was not designed for practical use, it has proven to be very convenient in testing and running small programs.

basic formac concept

In order to understand what is meant by the FORMAC capability, the basic concepts of FORMAC and FORTRAN must be distinguished from each other. In the latter, a compiler produces a set of instructions which operate at object time to produce a number. In FORMAC, the object time routines produce a string of specially coded symbols which represent expressions such as A+ B**2. This difference is most easily shown by an example:

Assume that we have the equation $y = x^2 + \frac{3\,x\,m}{z}$

In FORTRAN, we would expect to assign *numbers* to x, m, and z, and compute the value of y. In FORMAC we would expect to assign *expressions* to x, m, and z, and "compute" the new expression y. The FORTRAN program

```
X = 4
Z = 6
M = 2
Y = X**2 + 3*X*M/Z
```

causes Y to be assigned the value 20, after the execution of these statements. The FORMAC program

```
LET X = A + B
LET Z = A - B
      M = 2
LET Y = X**2 + 3*X*M/Z
```

causes Y to be assigned as the name of the expression (A+B)**2 + 6*(A+B)/(A−B). Note that the only difference between the appearance of the FORTRAN and FORMAC programs is the use of the key word LET before the FORMAC statements, and the ability to permit X to be an expression instead of a number.

uses of formac

Before proceeding with a discussion of the capabilities available in FORMAC, it is worth indicating just a few of the variety of applications in which it has been successfully used.[2] Although most of these applications are naturally oriented towards scientific and engineering applications, the fourth example is expected to have significant implications in economic modelling and studies in population growth and prediction.

1. A program to generate two coefficient time series occurring in the law of position for Keplerian motion was written. The results of this problem provide for a more accurate prediction of the position of an artificial satellite than has been previously possible using a non-naive numerical technique. For that matter, the series apply to the gravitational motion of any secondary body around a primary body.

2. A program capable of calculating various quantities of interest in tensor calculus has calculated Christoffel symbols of the first and second kind for 12 basic orthog-

[2] These were done by a variety of people in different organizations. Further information on some of these and on some other applications is given in various references by the people involved, and in the following article describing several of these applications and others: Tobey, R. G., "Eliminating Monotonous Mathematics with FORMAC", IBM, Systems Development Division, TR 00.1365, November 1965. (Submitted for publication.)

onal co-ordinate systems. In addition, given the Cartesian components as functions of the curvilinear set, the components of the metric tensor themselves may be calculated.

3. Study the state of stress and deformation under static and dynamic loads of an inflatable shell in the form of a rectangular plate. The governing equations are solved by iteration of the matrix for the equations and assumed power series solutions for the dependent variables.

4. A general algorithm for non-linear maximum likelihood estimation of a set of equations in observed variables with respect to given parameters was developed. The FORMAC program accepts as input the symbolic system of equations and numerical data (i.e., the observations) and produces the values of the parameters which correspond to the best maximum likelihood approximations to the observed data.

5. A use of FORMAC with Kirchoff's derivation of Lagrange's equation to find the equation of a mass in a moving co-ordinate system from a fixed co-ordinate system. FORMAC was used to calculate partial derivatives with respect to velocity, angular velocity, time and displacement. The program can also input rotation and translation data, and determine the location of the body.

6. FORMAC has been used to develop a set of general purpose programs. For example, one has as input, a set of differential equations, plus initial conditions plus error criteria; the routine will integrate the equations numerically to give as accurate a solution as specified when possible. Another program has an input, sets of differential equations, auxiliary conditions, functions to be used in approximating a solution. A solution which is as accurate as possible (in the least squares sense) at a specific set of points is determined. Being used for experimental mathematical work, these routines have application in any area of physics or engineering in which differential equations are used.

formac language

The language[3] may be thought of as being composed of the following elements: (1) the operators, (2) the executable statements, and (3) the declarative statements.

In addition to the four basic arithmetic operators and the exponentiation (**), the following six operators were chosen to correspond to FORTRAN operators: FMCSIN, FMCCOS, FMCLOG, FMCEXP, FMCATN, FMCHTN. There are four others which are unique to the FORMAC capability. The most interesting and important of these is the differentiation operator whose general format is as follows: FMCDIF $(f, v_1, m_1, v_2, m_2, \ldots, v_n, m_n)$ where f is the expression to be differentiated, and the pairs v_i, m_i indicate the variable and order of differentiation; the latter can be omitted if it is 1. It is simple to use, as shown by the following example: if we want to take the first derivative of the expression $7x^3 \sin x^2$ with respect to x, we simply write:

```
LET Y = FMCDIF (7*X**3 * SIN (X**2), X)
```

and the result will be $21x^2 \sin x^2 + 14x^4 \cos x^2$ or (in computer notation)

```
X**2.0*SIN(X**2.0)*21.0+X**4.0*COS(X**2.0)*14.0
```

(The constants appear at the right because of the standard internal form that is used; there is a command, namely ORDER, which can be used to change this standard form for output).

We can take partial derivatives in the following way. To take the second derivative with respect to x followed by the third derivative with respect to y of the expression $4x^2 \sin y^3$, we simply write:

```
LET Z = FMCDIF (4*X**2 * SIN(Y**3), X,2,Y,3)
```

and obtain the result (in computer form)

```
Y**3.0*SIN(Y**3.0)*(-432.0)+Y**6.0*COS(Y**3.0)*
(-216.0)+COS(Y**3.0)*48.0
```

The remaining three operators are combinatorial (FMCOMB), factorial (FMCFAC), and double factorial (FMCDFC). These are probably familiar to most people, except for the last one which is the same as the factorial except that the count goes down by 2 instead of by 1. It was essential to introduce these operators because many problems in formal mathematics involve factorials and combinatorials and there needed to be a formal way of representing $n!$

A complete list of executable commands is given in Table I. To introduce some of these and to show how they can be intermingled with FORTRAN statements, let us consider the following general problem. Suppose we wish to find the roots of a quadratic equation when the coefficients may be either expressions or numbers. A FORMAC program to do this is shown in Fig. 1A, (p. 39). As indicated in the comments there, the program was written to handle just three cases. It could easily be generalized to handle any number of cases by writing the solution to the quadratic as a subroutine and then having the main program read in expressions at object time, which can be done using the ALGCON command.

The SYMARG and ATOMIC statements in the program are needed, respectively, for flagging the start of the program and declaring that certain variables never represent anything but themselves. These statements are based on this particular implementation, and do not have much logical significance for the general formula manipulation capability.

The equations to be solved are assumed to be written

Table I: FORMAC Executable Statements

Statements yielding FORMAC variables		
LET	—	construct specified expressions.
SUBST	—	replace variables with expressions or other variables.
EXPAND	—	remove parentheses.
COEFF	—	obtain coefficient of variable or variable raised to a power.
PART	—	separate expressions into terms, factors, exponents, arguments of functions, etc.
Statements yielding FORTRAN variables		
EVAL	—	evaluate expression for numerical values of the variables.
MATCH	—	compare two expressions for equivalence or identity.
FIND	—	determine dependence relations or existence of variables.
CENSUS	—	count words, terms, or factors.
Miscellaneous statements		
BCDCON	—	convert to BCD form from internal form.
ALGCON	—	convert to internal form from BCD form.
ORDER	—	specify sequencing of variables within expressions.
AUTSIM	—	control arithmetic done during automatic simplification.
ERASE	—	eliminate expressions no longer needed.
FMCDMP	—	symbolic dump.
Plus all FORTRAN statements		

[3] Further information on the language including many small and large examples is given in increasing amounts of detail in:
Sammet, J. E.; and Bond, E. R., "Introduction to FORMAC," *IEEE Transactions on Electronic Computers,* Vol. EC-13, Number 4, August 1964.
Bond, E.; Auslander, M.; Grisoff, S.; Kenney, R.; Myszewski, M.; Sammet, J.; Tobey, R.; and Zilles, S., "FORMAC — An Experimental FORmula MAnipulation Compiler," *Proceedings of the ACM National Conference,* August 1964.
FORMAC (Operating and User's Preliminary Reference Manual), IBM Program Information Department, Hawthorne, N.Y., No. 7090 R2IBM 0016, August 1965.

as an expression equal to zero, and this expression is assigned a name through the "LET CASE (I) =" statements. This is similar to the regular assignment statement in FORTRAN except that the word LET is used to indicate a FORMAC command. The first step in the process of solving the quadratic is to remove all parentheses so that the coefficients of the powers of the variable can be determined. This is done by the use of the EXPAND command followed by the three COEFF commands; the latter permits

Fig. 1A

```
INPUT TO FORMAC PREPROCESSOR
      $IBFMC QUDTST  NODECK
      C        THIS PROGRAM FINDS THE ROOTS OF A QUADRATIC EQUATION WHERE
      C        THE COEFFICIENTS CAN BE EXPRESSIONS OR NUMBERS
      C        ALTHOUGH THIS WAS SET UP TO RUN ONLY 3 CASES IT COULD OBVIOUSLY
      C        BE GENERALIZED BY USING A SUBROUTINE AND READING EXPRESSIONS
      C        IN AT OBJECT TIME
            SYMARG
             ATOMIC X,Y,K
             DIMENSION CASE (3), X1(3),X2(3)
             LET CASE(1) = X**2 + 2*X*(Y+1)+ (Y+1)**2
             LET CASE(2) = 2 + X**2 - 4*X
             LET CASE (3) = 3*X**2 + K*(X+X**2+1) + 4
             N= 3
             DO 88 I = 1, N
             LET RVEXPR = EXPAND CASE (I)
      C              REMOVE PARENTHESES
             LET A = COEFF RVEXPR,X**2
             LET B = COEFF RVEXPR,X
             LET C = COEFF RVEXPR, X**0
      C                THE EXPANSIONS IN THE NEXT THREE STATEMENTS ARE
      C                DONE BECAUSE THE PARENTHESES MUST BE REMOVED TO
      C                PERMIT  MAXIMUM COLLAPSING OF EXPRESSIONS
             LET DISCRM = EXPAND B**2 - 4*A*C
             LET X1(I) = EXPAND (-B + DISCRM**(1/2))/(2*A)
             LET X2(I) = EXPAND ( -B - DISCRM**(1/2))/(2*A)
       88    CONTINUE
             FMCDMP
              STOP
              END
```

Fig. 1B

```
FMCDMP CALLED FROM STATEMENT NUMBER     32    IN DECK 'QUDTST'

THIS IS A FORMAC DUMP OF ROUTINE   'QUDTST'

 FORTRAN VALUES
    ADDRES SYMBOL      SUBSCRIPTS       TYPE     VALUE

     03025 I                          INTG-NUMB             3

 FORMAC VARIABLES
    ADDRES SYMBOL      SUBSCRIPTS       TYPE     VALUE                  EXPRESSION

     03031 A                          REAL-LET   040000253336    K+3.0$
     03033 B                          REAL-LET   040000253377    K$
     03035 C                          REAL-LET   040000253421    K+4.0$
     03040 CASE          1            REAL-LET   140000253200    X*(Y+1.0)*2.0+X**2.0+(Y+1.0)**2.0$
     03041 CASE          2            REAL-LET   140000253230    X*(-4.0)+X**2.0+2.0$
     03042 CASE          3            REAL-LET   140000253246    K*(X+X**2.0+1.0)+X**2.0*3.0+4.0$
     03044 DISCRM                     REAL-LET   040000253354    K*(-28.0)+K**2.0*(-3.0)-48.0$
     03046 K                          INTG-ATOM  000000100000
     03050 RVEXPR                     REAL-LET   040000253335    K+K*X+K*X**2.0+X**2.0*3.0+4.0$
     03052 X                          REAL-ATOM  040000100000
     03055 X1            1            REAL-LET   140000253423    -Y-1.0$
     03056 X1            2            REAL-LET   140000253401    3.41421355$
     03057 X1            3            REAL-LET   140000253312    K*(K+3.0)**(-1.0)*(-5.0E-1)+(K+3.0)**(-1.0)*(K*(-28.0)+K**
                                                                 2.0*(-3.0)-48.0)**5.0E-1*5.0E-1$
     03062 X2            1            REAL-LET   140000253454    -Y-1.0$
     03063 X2            2            REAL-LET   140000253276    5.85786447E-1$
     03064 X2            3            REAL-LET   140000253457    K*(K+3.0)**(-1.0)*(-5.0E-1)+(K+3.0)**(-1.0)*(K*(-28.0)+K**
                                                                 2.0*(-3.0)-48.0)**5.0E-1*(-5.0E-1)$

     03066 Y                          REAL-ATOM  040000100000
```

you to find the coefficient of a variable in an expression. (It is worth noting that it is easy to use information from the COEFF command to make sure that the equation is really *quadratic*—i.e., not linear or cubic or some higher power. This was omitted in order to make the program short). Once having found the coefficients, the two roots are simply defined; the variable DISCRM is introduced simply to reduce the writing; it could be eliminated and the two "LET X(I)" statements could contain the full formula.

The results of the program, shown in Fig. 1B, were obtained using the FMCDMP command, which causes all variables in the FORMAC part of the program to be printed in a specific format. A word about the overall format may help in understanding it. FMCDMP has become a powerful debugging tool as well as a means of output; some of its features may have a wider applicability than just in FORMAC.

The top part of the printout gives the value and type of variable for all FORTRAN variables which are in FORMAC statements. The list of FORMAC variables is shown in alphabetical order, with subscripts where relevant. The TYPE column simply indicates whether the variable is floating point integer, and whether it is "ATOMIC" (meaning it represents only itself) or "LET" (meaning it names an expression). The VALUE column contains information from the internal Symbol Table and is of use only to people who understand the internal workings of the system and are trying to find obscure bugs. The final column contains the actual expression for the variable named. As indicated earlier, the sequence within the expression is based on the standard ordering used internally. The $ is used to indicate the end of the expressions. Because of the limitations of high speed printers, we use the same notation as for input, obviously much less natural than standard mathematical notation. However, only a little practice is needed to develop facility in reading the expressions in the form shown; in fact, people have quite successfully worked from output where a single expression takes many pages.

description of other commands

Having seen a few of the commands illustrated above, we can now put the entire list of executable commands into their appropriate groups with some perspective on them. The executable commands fall into three categories: (1) those commands whose results are definitely FORMAC variables, (2) those commands whose results are FORTRAN variables, and (3) miscellaneous. This list is shown in Table I and is in addition to the regular FORTRAN statements.

We have already seen illustrations of the LET, EXPAND and COEFF commands. Two other capabilities which are needed are the ability to replace a single variable by an expression or another variable, and the ability to "pull apart" an expression, in order to examine its component parts. The former is done by the SUBST commands, and the latter by the PART command. For example, if the expression is actually X*(Y + SIN(Z)), successive applications of the PART command would yield each variable (X, Y, Z) and operator (*, +, SIN) and the fact that Z was the argument of the sine.

Of the four commands yielding FORTRAN values, the

EVAL and MATCH commands are the most general in concept and applicability. The EVAL permits the user to evaluate an expression for a set of specified numeric values; the result is a numeric FORTRAN variable which can now be used in any FORTRAN statement. It is important to notice that there is a significant distinction between the results of SUBST and EVAL. Even when the former uses only numerical quantities, it yields a result which is in an internal form understandable only to the FORMAC part of the system. In fact, the EVAL was implemented by using SUBST and then converting the resultant number to the appropriate FORTRAN notation internally.

The MATCH command is used to determine when expressions are the same, where the user can specify whether "the same" is to mean the expressions are *identical*, or are merely *equivalent*. Thus, $x\ (y + z)$ is equivalent to $xy + xz$, but is certainly not identical to it. In both cases, the result is a FORTRAN logical variable.

After very long and complicated manipulations, it may not be at all possible to know what variables are still present, and the FIND command supplies that information as a FORTRAN logical variable after suitable examination of the expression.

The CENSUS command is used to count numbers of terms and factors in a particular expression. This number is often used in setting up loops. One may wish, for example, to do something to each term of an expression; it is possible to allow the system to count the number of terms and use that as the final parameter in a DO statement.

There are no separate input/output statements in FORMAC. The ALGON and BCDCON are used in conjunction with the FORTRAN READ and WRITE, respectively, to convert to and from BCD and the FORMAC internal representation of expressions. We have also seen the FMCDMP used for output in the example. The ORDER command is provided to give the user a certain amount of control over the form of the output. Because of the wish to make the internal manipulations as efficient as possible, all expressions are put into a standard form, which will differ significantly from the way in which the user might expect to have them come out. For example, the actual result of expanding (A + B)**3 is A**2*B*3+A*B**2*3+A**3+B**3, whereas one would normally expect—and probably prefer—A**3+3*A**2*B+3*A*B**2+B**3. (Ideally one would have $A^3 + 3A^2B + 3AB^2 + B^3$, but this is many orders of magnitude more difficult). Appropriate use of the ORDER command will permit the user to achieve the second alternative.

It is unfortunately characteristic of these kinds of problems that they run out of space very easily; the user is allowed to remove the expressions that are no longer needed by using the ERASE command, and thus make this space available for other expressions.

The last of the miscellaneous commands is AUTSIM, which is connected with, but not identical to, the Automatic Simplification capability in FORMAC. This is a fairly significant facet of the system, and deserves separate discussion.

automatic simplification

One of the most difficult conceptual problems in any system for manipulating mathematical expressions is the question of simplification. The latter is a term which does not lend itself to easy definition, even by example. For example, is $ab + ac$ simpler than $a(b+c)$? Almost every person to whom this question is posed either shrugs his shoulders or says, "I don't know" or "it depends." The crux of the matter is really in the last answer; depending on the use that one wants to make of the expression, and the steps which are to follow it, the form of the expression may be more or less simplified with or without parentheses. It was decided very early in the definition of FORMAC that no system could possibly determine which of two equivalent forms were simpler. Therefore it was decided to do automatically those things which it was felt most people would want, and which were needed for efficiency in the system, but to allow the user control over the rest. Thus there is a routine called Automatic Simplification which operates automatically after each executable command, and which is considered an inherent part of this system.[4]

This routine does "appropriate things" with ones and zeroes, combines like terms and factors, and does a few other things. By "appropriate things" with ones and zeroes, we mean that the routine does such things as changing $a+0$ to a, $1a$ to a, a^0 to 1, etc. The routine also does such things as combining $2x+3y-4x$ into $-2x+3y$ while x^3y^4/xy^7 *becomes* x^2/y^3 and $x(y+1)^5/(y+1)^2$ becomes $x(y+1)^3$. If the expression is $(a^2+2ab+b^2)/(a+b)$, the routine will do nothing with it, since it does not contain an automatic factoring capability. The user—as stated before—does not need to request this type of simplification to be done; it is done for him automatically. The control that he is able to exert in terms of applying the distributive law, and the converse which permits a simple kind of factoring, is through the EXPAND and COEFF commands. Thus, any time the user wishes to remove parentheses from an expression, he need merely use the EXPAND command. It is probably clear to anybody who thinks about the problem for a moment that general factoring is as difficult as the problem of performing general integration; no attempt was made to provide either of these difficult and non-elementary capabilities within the first version of FORMAC. A limited form of factoring is provided through the COEFF command, which permits people to find the coefficient of a single variable or powers of the variable. Through the use of the COEFF command and some loops, one can factor a given expression with regard to powers to the single variable.

Returning now to the specific AUTSIM command, it does not turn on or off the Automatic Simplification routine; it simply controls the amount of arithmetic which is done during the automatic simplification process. The user decides whether to evaluate all, some, or none of the operators factorial, combinatorial, sin, cos, etc., when they have numeric operands. Thus the user decides whether to leave FMCFAC (4) as it is or replace it by 24.

rational arithmetic

One of the interesting features of FORMAC is its ability to permit mixed modes of expressions, and more significantly, rational arithmetic. By rational arithmetic, we simply mean that if we add the fractions $(a/b) + (c/d)$ we obtain $(ad + bc)/bd$ where the numbers are now reduced to the lowest terms. Thus ¾ + ½ will yield 5/4 as a result. Users of FORTRAN will recall that if one adds 1/3 + ⅓, the result in fixed point arithmetic is zero, while if done in floating point, the result is naturally .666. . .7. Unfortunately, for the vast majority of problems that are done in a formula manipulation system, neither of these alternatives is tolerable. The former gives the wrong answers and the latter gives answers which may be correct

[4] This is described in detail in Tobey, R. G.; Bobrow, R. J.; and Zilles, S.N., "Automatic Simplification in FORMAC," *Proceedings of the FJCC*, November 1965.

but are certainly not understandable. For that reason, if all the quantities in an expression—both variables (through declarations) and constants—are fixed point, the calculation performed by the Automatic Simplification routine will be done in precise arithmetic, using rational numbers where necessary. Some people have actually used FORMAC primaril to obtain the capability of doing the rational arithmetic.

declarations

There are four specific declarations, in addition to the normal FORTRAN declarations; two of these meet a general functional need, and two are required primarily because of the current method of implementation. Probably the most interesting in the first category is the DEPEND, which permits the user to declare if one variable depends on another. The reason for needing this is that if we want to take the derivative of an expression of the form $x^2 + y^2$ where y is a function of x, we need to know that in some way y depends on x. In other words, we want to be able to say that y is a function of x without being concerned about what the functional relationship really is. In such a situation, dy/dx will really exist, even though it cannot be given an actual expression value. Thus if we write DEPEND (Y/X) and then write

LET Z = FMCDIF (X**2 + Y**2, X, 1)

the result will be

X*2 + FMCDIF (*Y, *2)

thus in normal mathematical notation, if $y = f(x)$, then

$$\frac{d(x^2 + y^2)}{dx} = 2x + 2y\frac{dy}{dx}$$

The other declaration that has real substantive meaning is the PARAM. This permits the user to specify pairs to be used with either SUBST, and/or EVAL, and be able to cross reference them as is done with the format statement in FORTRAN.

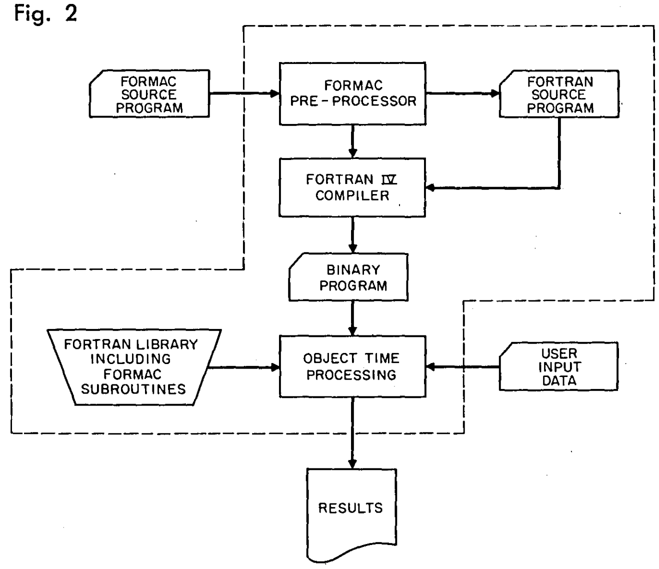
The ATOMIC and SYMARG declarations were introduced primarily to ease the implementation, and are illustrated in the example shown.

implementation

Since the primary interest of the reader is assumed to be in the FORMAC capability, only a very brief description of some of the more important facets of the implementation will be described. In the initial planning of the system, there were several possibilities considered. One was to write an entire system from scratch, in which case the FORTRAN portion would probably have been a subset of FORTRAN IV; another possibility was to modify the FORTRAN IV compiler, and a third possibility was to try to write a preprocessor which could convert FORMAC statements to FORTRAN statements and then have this processed by the FORTRAN compiler. It eventually became an important design objective that the entire system should run under the 7090/94 IBSYS-IBJOB without any special treatment, other than by having the tape containing FORMAC and using the appropriate control cards. This objective was achieved, and the system does run currently under IBSYS-IBJOB, Version 13. The method used was to write a preprocessor; the entire system flow is shown in Fig. 2. The syntax of the FORMAC statements was deliberately chosen so that the preprocessor would not have to examine anything but actual FORMAC statements and a few FORTRAN statements which were essential for the processing.

Unlike a normal FORTRAN compiler, a series of interpretive subroutines to execute the FORMAC statements must be available at object time. The reason for this is that expressions are changing dynamically, and it is impossible to compile executable code for an expression whose form is not known at compile time. For example, if one wished to compile code to expand the expression $(a+b)^3$, one would need to know what specific form a and b had. This information is not available until object time, because a and b may themselves be the names of other more complicated expressions which are not known until execution time, and furthermore would depend on a particular flow through the program. For that reason, the object time routines actually are executed interpretively upon an expression.

Fig. 2



This does not really cost extra time in the sense that one normally thinks of interpretation, because the process of scanning the expression is the major activity, and this must be done in any case. As was stated earlier, each object time routine is followed by the execution of the automatic simplification routine which goes through and "cleans up" the expression that has just been created. It is interesting to note that there are many expressions that fit in core after—but not before—they are simplified. Thus, although the automatic simplification routine takes time and space, it saves more space, and the latter is definitely at a premium in systems of this kind.

conclusion

In some sense, FORMAC is attempting to reverse some of the directions of technical activity in mathematics over the past 10 to 15 years. Prior to use of digital computers, very few people knew anything about numerical analysis; now it is an area of major activity and is used even in some cases where it is undesirable but is the only method available. Although we have not yet gotten to the point where nobody knows anything about analytic techniques, we are rapidly approaching that sorry state; furthermore, many people are spending a great deal of time doing work by hand that could be done better on a computer. It is hoped that FORMAC and other systems of its kind will help to reverse this trend. To further that objective (and as a result of many requests), although FORMAC was originally intended only as an experimental system, it was made available as a Type 3 (experimental) system; its identification number is FORMAC 7090 R2 IBM 0016.

As with all systems of this kind, a great many people participated in the development of the initial version. The contributions of E. R. Bond and R. C. Tobey were of paramount importance, and the work of M. Auslander, R. J. Evey, R. Kenney, M. Myszewski, and S. Zilles merits specific mention. ■

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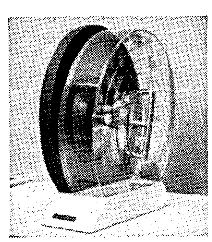

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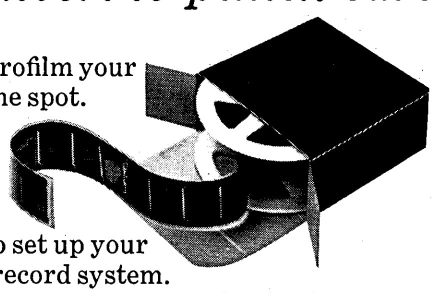


DATA PROCESSING—1890 style

The following letter was written by a resident of Bellerose, New York, to Thomas J. Watson, Jr., chairman of the board of IBM.

Dear Mr. Watson:

Perhaps you won't mind hearing a little about the past from an ex-operator of your equipment, so you can see if there has been any progress.

I was a temporary Government employee during the census of 1890 and operated a Hollerith sorter-tabulator in the Census office on 9th Street between E and F, Washington, D.C. This was the Inter-Ocean Building, so-called because the Atlantic Building was on one side and the Pacific Building on the other. It had long been condemned as unsafe but that seemed to worry no one.

Herman Hollerith used to visit the premises frequently. I remember him as very tall and dark. Mechanics were there frequently too, to get ailing machines back in operation and loafing employees back at work. The trouble was usually that somebody had extracted the mercury from one of the little cups with an eye-dropper and squirted it into a spittoon, just to get some un-needed rest. Really hard work in a government office was then, as now, somewhat scarce.

My immediate superior was a Mr. Shaw* and it was a saying in the office that "Shaw does nothing and Springer helps him." This was not true, of course. Much of the time I didn't help him at all. It was there I saw the girl to whom I was eventually married for 53 years and I spent more time trying to overcome the stiff formalities of those times and get acquainted with her than I did operating one of your un-glamorous sorting machines.

Shaw was a remarkable man. With a drink or two, he could add three columns of figures simultaneously and get the right answer faster than any machine before or since. If he could have been kept in just the right amount of liquor, Hollerith's machines might now be no more of a memory than the Inter-Ocean Building, (and what would you be doing now?). But electricity proved to be a more dependable computer fuel than alcohol, in the long run, and today's Chinese-like characters in magnetic ink spell out, to me, a sad epitaph for the sometime-sober Shaws of yesterday.

I understand your equipment is somewhat different today. Then, the blank cards were inserted into a punch board, the punch moved about, and pushed down by hand to make a round hole in the desired position. Cards were inserted into the sorter-tabulator one at a time. The count would be registered in visible dials and a bin opened automatically to receive the card. This was a tedious process and, when nobody was looking, I used to pile up identical cards by sighting through the holes, count them and drop them into their bin, then manipulate the dials manually. The division head, Col. Dawson,* noted for his profuse and virulent cussing, saw this one day. His quotable comment was, "This is like hanging out the wash without washing it." I answered, "Yes, but this wash is at least clean." However, the Colonel's blue blazes ended the practice, despite its obvious advantages.

Working conditions may have improved elsewhere but it would be hard to match ours even now. Hours were from 9:00 to 4:00 with half an hour for lunch. I could get home in time for a couple of tennis games before dinner. (Who needed golf then?) We survived the hot Washington summers without air conditioning by closing early every time one of the girls managed to faint.

The salaries of those days may sound funny now but they covered the then known necessities and some of the then available luxuries. I started at $50 per month but soon qualified for $60 by taking an examination in which I received an especially favorable comment by writing a glowing description of Springfield, Illinois (without ever having been there).

And so, Mr. Watson, if all this hasn't interested you at all, it has at least amused me to recount some of my long-gone experiences and pass them along to a man of the modern age. Thanks for listening anyway (if you got this far).

Sincerely yours,
CHARLES A. SPRINGER

*Not his real name. After all, he may be still alive. Who knows?

COMPUTER EXPERIENCE AT THE CENSUS

176 years later

by Charles B. Lawrence, Jr.

Census data processing experience dates back to 1790 when the first census of the United States was taken under requirements written into the Constitution. Thomas Jefferson directed the collection of data by U.S. marshals whose travel on horseback and use of quills to record information was in the approved mode of the time. There was little if any mechanization or standardization of procedures or even of forms in arriving at a total count of 3,929,214 persons in that first U.S. census. A number of attempts to improve the methods of collecting and tabulating census information were made during the next hundred years but the first quantum leap in data processing took place when Herman Hollerith, a former Census employee, acted on suggestions made by the Chief of Census Vital Statistics, Dr. John S. Billings, and wedded punch cards and data processing in the 1890 census.[1]

Since then the Census tradition of innovation and continuous improvement in data-processing techniques and equipment has been internationally recognized. The Census machine shop—or laboratory, as it is now called—was established just 60 years ago by an appropriation from Congress to undertake experimental work in developing tabulation machinery. An impressive record of inventions and equipment improvements has resulted from the perceptive attention that the laboratory's engineers have given to the studies, suggestions and comments of census program managers, equipment operators, systems analysts, and others.

Included in the record are many mechanical devices for machine tabulation systems—such as keypunch machines, unit counters, multi-column sorters, and tabulators, and numerous modifications of equipment to permit special processing. In recent years, as the Census has become computer-oriented, it has tended to assign its highest hardware development priorities to electronic devices. However, the processing of reports from millions of respondents has required intensive research and development activity in both mechanical and electronic equipment. Such activity, conducted in close coordination with the National Bureau of Standards, has produced many special and general purpose devices designed to improve data processing quality and productivity at the Census while also reducing unit costs. Among the more recent Census-produced equipments are: FOSDIC (Film Optical Sensing Device for Input to Computers); map area computer; systems to automate microfilming including automatic page turners for widely varying document formats and sizes; information storage and retrieval systems; continuous form copying machine, and others.

While the Census is now rapidly expanding its computer applications and scanning capacities for the preparation of inputs to the computers, it also uses and for some time will continue to use and to improve, where it is economical, various kinds of mechanical equipment. Many such improvements have been aimed at making transcribed information more suitable for computer input. String punching and continuous multiple-program punching on differently

Mr. Lawrence is director of international statistics programs, Bureau of the Census, as of April, 1966. Before that, he was assistant director for operations and responsible for data processing there. He holds AB and AM degrees from Columbia Univ. and is presently taking courses at American Univ.

[1] Leon E. Truesdell, "The Development of Punch Card Tabulation in the Bureau of the Census, 1890-1940", U.S. Government Printing Office, 1965

formated cards, for example, may significantly reduce punching costs but their prime goal is to facilitate creation of computer records that can be edited more effectively.

census work volume

Workload is a factor in all management and production problems and is a major reason for Census interest in computers. In general the Census has three kinds of projects: periodic censuses, current programs, and reimbursable projects for other federal and non-federal sponsors.

Periodic Censuses, of which there are now ten, are taken either every 5 or 10 years, in years ending with 0, 2, 3, 4, 7, 8 and 9. Some changes in this schedule to improve spacing will shift the economic censuses from years ending in 3 and 8 to years ending in 2 and 7. The population enumerated also varies from census to census, with the latest counts being roughly 180 million in the population census, 55 million in the housing census, 3.5 million establishments in the economic census, nearly that many farms in the agriculture census, etc.

Current Programs include the monthly foreign trade statistics and the annual, quarterly, monthly, and weekly surveys of different economic and demographic areas that depend on sample information from mail questionnaires and from the approximately 1000 enumerators that work from Census regional offices. These programs publish about 1200 reports each year.

Reimbursable Projects have been growing in number and size over the years. Their volume as measured by their total costs now approximates the annual Census appropriation for salaries and expenses. Such projects may involve either, or both, the collection or processing of data. They include over 400 special population censuses per year undertaken for state or local governments, the collection and tabulation for the Department of Labor of the monthly statistics on unemployment, many other well-known statistical programs, and literally hundreds of single-time projects.

Growth in population and economic activity directly affect Census workloads and so do the fluctuating requirements of the major periodic censuses which must be planned in advance in order to compress computer processing time. Except during major population and housing censuses, the Census Bureau is likely to have no more than 5000 employees on its staff. During major censuses, however, employment can move up in a matter of days to nearly 200,000 and then drop off as a quickly as enumerators finish their assignments, and as data processing and publication are completed.

computers at the census

In the precomputer period, the Census was using over a thousand general and special punchcard processing machines efficiently; but the necessary intermixture of manual and mechanical methods generated a constant concern for census target dates and required highly complex coordinating and management mechanisms. Even today, however, the Census uses mechanical equipment to tabulate many of its small single-time projects and in doing so saves both programing time and elapsed time.

In the middle and late 1940's the Census and the National Bureau of Standards working together studied the new war-born scientific computer, the Eniac, then being built for the Army by the University of Pennsylvania and sought to determine what possibilities there might be of adapting electronic principles to data processing. As a result Univac I was designed and built by the Census by two members of the faculty of the University of Pennsylvania, Dr. John Mauchly and Mr. J. Presper Eckert, under a contract awarded in 1948 to fulfill the performance specifications developed cooperatively by the Census and National Bureau of Standards.

There were effectively no electronic data processing experts to test that first adp system when it was placed in operation in April, 1951. In fact testing it for acceptance was a problem of no small dimensions. No proven programs were availabe for such a purpose and the Census record indicates that the volume of useful work accomplished during Univac I's breaking-in period was far below the computer's capabilities. The Census staff, often disappointed but never discouraged, learned that many failures were not necessarily machine failures and that although Univac I had weaknesses it also had a surprising capacity and accuracy. Salvage programs and other techniques were developed, and used successfully to increase the volume of useful work. A steady increase in computer productivity was noted, and unit operating costs gradually fell into line. With a generous measure of high quality executive, professional and technical attention, the trend toward lower production costs was established and is continuing at this time through third generation computers.

The first assignments to Univac I, while only peripherally related to any of the major censuses, excited great interest and raised both hopes and doubts about the possibilities of a "computer revolution." The economic censuses of 1954 constituted a major test. Unquestionably the internal operations of that first commercially available electronic computer for data processing were far faster than those of any prior processing equipment. The unique mercury tank memory and machine implemented programs of instructions opened possibilities far beyond those of any punch-card technique, and the introduction of magnetic computer tape drives overcame to some extent the slow input of the scientific computers then in use. Univac's initial Uniprinter output, however, was slow and unreliable in its performance. When high-speed printers became available, they were substituted for the older Univac Uniprinter and greatly accelerated the preparation of output for human consumption. All in all, what was produced in those early not-so-long-ago days was regarded as a tremendously significant achievement with great promise. Although the Census staff more than once felt its faith, persistence, and learning capacity severely challenged, the over-all results were gratifying.

As workloads have increased and as programs have been transferred from mechanical to electronic equipment, the Census has purchased, leased, or rented time on a succession of computers. Following its 1951 acquisition of Univac I, it purchased a second Univac I in 1955 and then two Univac 1105's in 1958. It contributed to the purchase of two additional Univac 1105's at the University of North Carolina and at the Armour Research Foundation in Chicago in 1959 as a means of reserving time on those computers during the 1960 Censuses of Population and Housing. An additional Univac 1105 was leased and installed in 1962 and used for two and one-half years. Two IBM 1401's were also procured in 1962; one, with Univac tape drives permitting conversion between IBM and Univac tapes, was purchased; and the other, a card machine, was leased. In 1963 two Univac 1107 systems were purchased and installed, bringing the Census computer inventory to eleven at that time. In addition to these, the Census had and still has contractual arrangements with other computer centers to rent time on their computers when needed during peak periods. By now, of course, Univac I has been retired to the Smithsonian Institution.

Somewhere in the neighborhood of 600,000 computer hours, measured in terms equivalent to Univac I operations, have been used by the Census since 1951. Expressed in terms of Univac 1105 time Census usage approximates 300,000 computer hours. Annual computer usage in the Census in 1966 is 25 times higher than it was during the first full year of operation of Univac I. It is now above the 50,000 hour per year level, measured in terms of Univac 1105 equivalent time. In the next 10 years, another 50% increase in Census computer requirements may result from currently foreseeable workloads. The as yet unforeseeable workloads will not be estimated here.

modernization of census computer systems

In keeping with its experience, that perfection is perfection and data processing is data processing and never the twain shall meet, the Census believes that any operation can be improved. Evaluations of equipment needs are, therefore, made periodically. Out of these analyses of processing requirements and of advances in the state of the data processing arts, have come some guidelines for selecting, replacing, and modernizing computing systems. Some of these stated informally indicate that:

1. The Census does not intend to rely on one computer, however large or powerful, to process all of its work. The economic and political importance of issuing certain reports on regular fixed time schedules requires that alternative processing devices be available in cases of equipment failure or of conflicting priorities.
2. Major computing systems are selected for use over periods of at least 10 years. However, major systems reviews are conducted every 5 years and computing systems are selected and installed for roughly half the computing workload, thereby avoiding a complete changeover at any one time. This leapfrog approach has provided a two-system operation, with each system having a life expectancy of about 10 years.
3. Compatibility between operating systems becomes increasingly important. As program and data files accumulate, compatibility must be considered in the selection of any new system. Selection of a new system that is not compatible with the most recent Census system is to be considered only if there is clear evidence that the measurable expense and time of converting computer programs from one system to another and of training computer-related personnel will be fully recoverable from the advantages of the new noncompatible system.
4. Arrangements for use of accessible back-up computing activities at other installations are preferred to the amassing of total inhouse systems capacity adequate to handle all peak loads with the extra continuing expense that such capacity would involve.
5. Systems capacity should be based on a 3-shift, 5-day week, leaving weekends for emergency situations, special priority projects, uneven work schedules, and growth is to be considered in determining the capacity and the timing of acquisition of a new computing system recognizing that requirements always tend to reach capacity at rates accelerated beyond anticipations.

The question of whether to purchase or rent computers was given an early answer by the Census. Following a management and accounting practice established during the operation of its machine tabulation system, the Census has charged every minute of equipment time directly to using projects. Repeated analysis of these charges have shown that, at its levels of operation, the Census has saved $15 million by purchasing rather than leasing its electronic computing equipment.

Top level attention in Census operations has been directed toward equipment maintenance. From the days of its first computer, the Census started training its own computer maintenance engineers and technicians. Notable difficulties were experienced initially in meeting higher outside wage scales for trained computer personnel, and not all trainees stayed with the Census; but gradually a permanent and highly successful Census electronic computer maintenance force was established—a force which, if not unique in federal civilian agencies, is at least not widely duplicated.

In comparison with contract maintenance, the Census has by now realized savings of $6.5 million in its out-of-pocket maintenance programs. Rigorously enforced, regularly scheduled equipment maintenance has benefited Census production and regularized high priority dates. It will remain a factor in Census planning and operations.

peripheral equipment

FOSDIC. To avoid dependence on slow manual mechanical punch-card techniques in preparing computer input, the Census together with the National Bureau of Standards studied various devices and possibilities during the 1950's and then developed FOSDIC (Film Optical Sensing Device for Input to Computers). Four production models were built later in the Census laboratory for the 1960 Censuses of Population and Housing.

The FOSDIC system uses a questionnaire in any size up to 14 x 20 inches with a capacity of 13,000 positions for the marking of answers. Microfilm copies of the questionnaires are scanned by FOSDIC, which transfers their information to magnetic tape. Internally FOSDIC, operating under program control, passes an electron beam from a cathode ray tube through the clear spot answers in a negative film image to a photo cell. FOSDIC circuitry then identifies and encodes the answers and records the appropriate characters on magnetic tape.

In the 1960 censuses, 25 microfilm cameras and four FOSDIC's were used to read questionnaires with their records for 180 million persons and 55 million housing units. The cameras, operating on two shifts to photograph questionnaires, produced approximately 950 miles of microfilm which the FOSDIC's, working on three shifts, scanned at rates equivalent to 1000 punch cards per minute—a volume that a punch-card operator might be expected to produce in a day. The combined camera-FOSDIC system employed less than 100 camera and machine operators, maintenance engineers, camera loaders, quality controllers, and record clerks for a total of about 28,000 man-days to prepare the magnetic tape for the 1960 censuses. In the 1950 census, which had 30 million fewer persons and 10 million fewer housing units, 200,000 man-days were required for card punching, with a peak of 3,000 operators.

Although punch-card techniques greatly extended Census ability to cross-tabulate information and to produce more valuable statistics, the close time schedule for reporting the apportionment counts required by the Constitution never permitted the substitution of punch-card techniques for the time-honored methods of progressively summarizing hand tallies form the field. Not until 1960 were the apportionment counts produced by other than manual methods. Then the FOSDIC computer complex made history and gave testimony to the speed of electronic data processing by not only producing and reporting apportionment counts on schedule but also producing a great many other statistics at the same time.

FOSDIC developments since the 1960 censuses have been centered on expanded memory with capacity for testing and organizing data, storing programs internally, and achieving higher-density recording of output on magnetic tape.

Improvements in tape handling mechanisms and the use of solid state components to increase reliability and reduce maintenance requirements have also been incorporated. Hopefully these developments will result in a threefold increase in FOSDIC's throughput and a similar boost in the computer input speed of FOSDIC tapes.

Optical Character Recognition. FOSDIC has also been used to read certain high-speed printer symbols uniquely identifying respondents, and facilitating Census mail check-in and follow-up procedures. Some experimentation with handwritten characters has also been undertaken, but FOSDIC at present is essentially a position reader rather than a character recognition device. The Census, however, is also interested in high-speed optical recognition of typewritten alphabetic and numeric characters in a variety of type fonts. It has undertaken studies of several different types of scanners and now has formally requested proposals from industry for a document-reading system to handle customs declarations for foreign trade statistics. It is expected that a contract to meet Census requirements can be written and that another line of experience profitable to the government can be opened.

Automation of Microfilming. In microfilming the 1960 censuses, in preparation for FOSDIC scanning, camera operators manually turned the questionnaires to be photographed. Since then automation of microfilming has been achieved for certain projects and has clearly indicated the possibilities for broader development not only for the handling of one-sided or double-sided single sheets, but also for book-type schedules where automatic page turning can reduce personnel requirements, operating time, operator error, and project costs. A prototype automatic page turner has now been developed and is being tested for use in the 1970 Censuses of Population and Housing.

High-Speed Printing and Microfilm Output. In contrast to the popular flashing-light cartoon conception of computer output, the data processing function of computers produces a veritable Everest of output. The Census has four off-line high-speed printers and four on-line printers that produce millions of lines of printing each week. Part of this is accounted for in mailing lists, reporting forms, and double-pass statistical tables in a completed format ready for photography and offset reproduction. Much of the rest consists of reference-file material, program printouts, memory dumps, and statistical tables for unpublished data which need not be reproduced in printed form. As might be expected, with faster computers the volume has shown no inclination to diminish. However, an alternative to high-speed printing for reference and intermediate-use files is the conversion of information from magnetic tape to alphanumeric form on microfilm, a process that the Census is finding to be not only cheaper but also faster than high-speed printing. It has been serving Census purposes effectively in recent months. As Census experience grows, further advantage will more than likely be taken of what seems to be a very efficient process.

Map Area Computer. To compute population density both population counts and area measurements are needed but only the population estimates have been regularly updated for the United States. The areas of the thousands of political jurisdictions of the United States, although continually changing, have not been reported since 1940 when an expenditure of approximately a half-million dollars was required to make them available. Current measurements using the same or similar methods would now cost two or three times as much. To produce these data at one-fifth their earlier costs, the Census has developed a new device for measuring areas of maps. The device, known as the Map Area Computer, applies sampling methods and electronic techniques to measure the surface of any thin insulating material that has been cut to the desired shape. The computer eliminates the need for hand recording and manual manipulation of figures that have characterized past area measurement processes. The computer uses the latest decennial census maps available.

Data Transmission. The time schedules of major censuses have exerted accordion-like pressures for expansion and contraction of Bureau personnel. As a result, data processing activities of the Census Bureau are not concentrated in one location. The Jeffersonville, Indiana, Census Operations Office, for example, acts as a document receipt and data preparation office for most censuses. Prior to the 1963 Economic Censuses, cards punched there were flown to Washington for input to the centrally located computer system. However, under current practices, information from approximately 35 million cards has been transferred automatically at night by an IBM data transmission system (1013/7702) across some 500 miles of leased telephone wire from a card reader in Jeffersonville to a magnetic tape terminal in Washington. Cost reductions accompanying the change from manual to automatic data transmission have been matched by improved reliability and simpler control procedures. The Census need no longer contend with the problems of fog bound airports and of retrieving punch-cards from Boston because they couldn't be landed in Washington.

software and operating problems

Compatibility. The Census is now preparing to replace its two remaining Univac 1105's and to obtain equipment compatible with the 1107 systems. It has learned that in the type of work involved in Census operations (as distinguished from mathematical computations), increasing computer memory capacity and internal speed does not in itself guarantee a corresponding increase in productivity and may not offset the heavy cost attached to the conversion of programs from one system to another. It has also learned that operating noncompatible systems is not the most effective way to encourage a programming staff to reach the highest peaks of efficiency. Programming for the Univac I was done in machine language; the 1105's employed a USE compiler but could neither accept Univac I programs nor have their own programs run on the 1107's that now use Sleuth, an assembly language, and also FORTRAN IV and Cobol.

The current systems and programming staff of the Census totals 125. It uses FORTRAN IV on the Univac 1107 systems for many projects, especially when shorter elapsed programming time and lower project costs are possible; but, the use of assembly languages has been favored on major programs where computer operations have heavily out-balanced programming costs. There is still hope, of course, for a breakthrough in computerized program preparation from decision tables. For some time the Census has been devoting continuous attention to that possibility. However, it is not yet a substitute for compatibility of equipment, especially when the magnetic tape library holds 100,000 reels of data tapes, and the program file holds another 5 to 10 thousand reels.

Many census tapes are used repeatedly in high-priority programs reporting on U.S. exports and imports, unemployment, population estimates, housing vacancies, industrial production, construction activity, wholesale and retail sales, accounts receivable, etc. In fact, some 20,000 reels are regularly out of the tape library in staging areas being prepared for computer use, on tape trucks in transit to or from computers, on tape drives or machine racks, at FOSDIC, data transmission or conversion stations, or on off-line high speed printers, tape-to-microfilm devices, or other processing locations. Considering this volume, unless and until an efficient, standard, automatic technique is perfected to convert programs from one system to another, the cost in time, dollars, headaches, and production delays would make conversion difficult to justify either operationally or economically. The Census has already converted its processing techniques from punch cards to computers, and from Univac I to Univac 1105. It is now completing the conversion of its active Univac 1105 programs to the Univac 1107 system. It has attempted to develop standard conversion programs and has met with some success in relatively restricted applications; however, large-scale applications do not appear to be economical. Therefore, the acquisition of a new computing system incapable of accepting already written regularly used Bureau programs would present the Bureau with major cost and operating problems. The rewriting of any significant portion of the Bureau's basic file of programs to permit their operation on a new system would require funds and programming resources in quantities that are not now available to the Census and that would be difficult to justify if they were available.

Standard Languages. Unfortunately, standard languages have not been as available for use as one might think they should be. Their applicability has been limited by the absence of translators operationally effective on the earlier Univacs. The Univac 1107 system now has such software and for certain types of jobs, Census programmers are regularly using FORTRAN IV and COBOL especially modified to improve their input characteristics. Census policy promotes the use of standard languages for the programming of many types of runs.

Programming. There are few areas in data processing that can compete with programming in the presentation either of problems that are crying for solution or of contributions that are integrating electronic computing into more effective management and production systems. Since it ordered its first computer, the Census has studied programming in many different ways; i.e., as an instructional language or series of languages, as an art to be refined, as a tool for sharpening work objectives and relating specifications to acceptable outputs and costs, as a critical problem area in which communication between subject matter specialists and programmers needs continuing attention, as a work activity to be measured, as a means of packaging routines and subroutines, as a challenge to supervisory practices, as an elusive but highly important element in systems costs, as a decision making process to be automated, and as an area in whch computer science can be either advanced or retarded.

Increasingly efficient programming has lowered computing costs. However, during the initial periods of computer experience, the costs of operating the computer, if fully loaded with programming costs, were competitive with those of previous techniques more in outlook than in actuality. Writing the first programs involved the trial and error learning of how to program, how to test and debug programs, how to make or to avoid making error-prone corrections, how to develop logic in extra-logical if not illogical detail, how to reduce the level of detail by transferring to the computer the task of translating simplified and standardized instructions into their logical equivalents in complex electronic patterns, and how, above all, to keep preparatory time within reasonable limits in order to be able to produce at all. Today, although the preparation of new programs in new subject areas is by no means a routine operation, the elapsed time required to develop programs has been greatly reduced. Even so, the costs of this programming process and of the necessary and unavoidable errors that are a part of it are a significant factor in data processing costs.

In 1961, for the purpose of reducing programming time and costs, the Census established an organizational unit within its Data Processing Systems Division to undertake basic and applied research in programming techniques. New ways of relating specifications to computer processes and of computerizing programming itself, from decision tables for example, are being developed and are offering real promise. The task of documenting them and of getting wider acceptance and use of them by other programmers is a problem; however, the Census training program is incorporating them into its courses, as they become available.

Over the years, there has been a steady increase in programming productivity. When more than one computer system is in use and when programming requirements vary widely between new programs and program maintenance, between simple and complex programs and between programs with clearly defined specifications and others needing systems attention, general measures of productivity are not as useful to supervisors as are job oriented measures. However, there is interest in general trends, especially when they show a decreasing ratio of programming hours to computer hours, which they are doing in the Census.

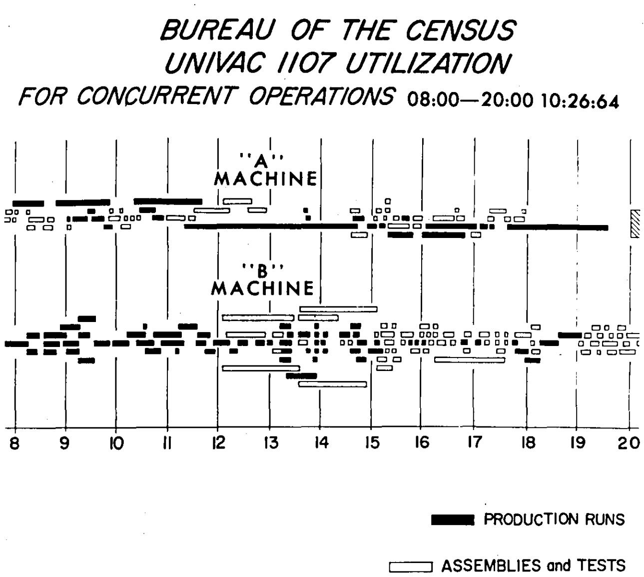
Editing. The substitution of computer editing for the manual editing of questionnaires is one of Census' unsung achievements—one that has had a broad beneficial impact on the quality, timing, and costs of data processing. The statement that statistics are not better than the raw data from which they are compiled might well be extended to indicate that statistics can be worse than the data from which they were compiled, because the condition of raw data can deteriorate during processing. Highly repetitive manual operations of coding, editing, and correcting have been shown to introduce errors into data, sometimes in excess of the errors they have sought to correct. The computer, however, thrives on repetitiveness, and once a program has been written and debugged, the computer follows it faithfully, tirelessly and productively. The review of questionnaire returns for internal consistency, conformance to stated tolerances, and the need for imputing missing information, are examples of tasks requiring routine comparisons and decisions. Such decisions have been structured over time, have been programmed individually for many projects, and are now regularly made in the computer to the advantage of the data collected. Following pretested specifications, the computer can make corrections and appropriate imputations. All such computer decisions, or a selection of any of them, can be printed out in a before-and-after diary record for technical review.

A simple edit procedure now used in the foreign trade exports program might serve as an example: three factors—weight, quantity, and value—can be compared for consistency. If weight has been reported in hundred-weight instead of tons, the computer, using a paired comparison routine, can identify the discrepancy and correct it. The computer can also undertake the self-generating updating of historically based imputation ratios, or it can flag an abnormal amount of imputation for a commodity and recommend new ratios.

Concurrent Operations. To its considerable advantage, the Census has exploited the capacity of the 1107 to process programs concurrently or in parallel within the computer. An effective executive routine permits the computer to select work, assign facilities and components, and perform a complex mix of work proceeding through the computer in separate concurrent sequences of operation. Much of the set-up time (tape changing, console inquiry and response, etc.) and the peripheral operation time (tape reading and writing, card reading, printing, etc.) that otherwise would be lost as far as central processor use is concerned, is usable by other programs in the mix in other stages of their operations. The computer does not seek as in a serial-type operation to complete one run before initiating, performing or completing work on other runs. On the contrary, instructions within programs, during concurrent processing, are executed in accordance with the availability of central processor time and of assigned program priorities. Fig. 1 illustrates graphically the relations between Census program runs and elapsed time. During one period shortly before 1400 o'clock, the graph shows that nine runs were being processed concurrently.

Requirements of programs for central processor time differ a good deal. Certain types of production programs use substantially all of the available time of the 1107 central processor. Others, if run concurrently, may use no more elapsed time for the mix than would be required for one program operating alone. Because internal computer speeds are so high, many runs are short. It takes, for example, 45 seconds to develop the tally matrix showing the personal characteristics of age, race, sex, and household relationship of persons enumerated in a standard-type special census of a city of 50 to 100 thousand population. For the aggregate of Census 1107 computer work, the average run requires only 90 seconds of central

Fig. 1



NOTE: EACH CONTINUOUS LINE SEGMENT EQUALS ONE COMPUTER RUN

processor time. The average mix of work, as it is now being presented to the computer, uses only about one-third of available central processor time.

A typical report prepared by the 1107 on its own activity (Table 1) illustrates this point.

It is clear that for Census work, faster, larger, more powerful central processors do not increase throughput as much as one might expect. Although FOSDIC has cut down the input preparatory time and substituted fast magnetic tape for the slower input of punch cards, there remain the still cumbersome manual and mechanical monitoring and operating procedures conducted at the computer. These need to be systematized, and probably can be. The results of a systems analysis indicate that there are promising possibilities for increasing the effectiveness of Univac 1107 for Census work. One of these is the addition of mass storage devices to hold frequently used programs and reference files that now constitute input/output problems on magnetic tape. Another is the increasing use of the computer itself to perform organizing, checking, reporting, labeling and other support functions presently handled as manual phases of computer operations.

Improvements such as these may well constitute the next round in the Census modernization program plus an augmenting of the two existing 1107 systems with a third compatible system needed to handle the higher workloads projected for 1968 through 1971. During that time, the economic, agriculture, populations, and housing censuses will all be on the computers along with the current programs.

Table 1

TABLE IV

UNIVAC 1107 ACTIVITY REPORT
WEEK BEGINNING 11/21/65

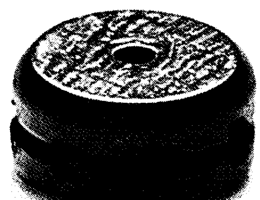
	TOTAL NUMBER	TOTAL CENTRAL PROC TIME H: M: S	1107A NUMBER	1107A CENTRAL PROC TIME H: M: S	11 NUMBER
CONCURRENT OPERATIONS:					
TOTAL.............	2857	93:43:23	1122	53:20:58	1735
TESTING............	1598	23:41:52	188	3:30:46	1410
TESTS............	306	8:12:42	18	1:34:17	288
ASSEMBLIES........	512	6:31:43	45	1:09:39	467
MAINTENANCE.......	-	-	-	-	-
OTHER(C/T'ETC)....	780	8:57:27	125	46:50	655
PRODUCTION.........	1259	70:01:31	934	49:50:12	325
SORTS & MERGES....	273	17:07:50	206	12:00:46	67
TAPE CONV.........	205	5:11:13	145	3:19:58	60
PERIPH OPER.......	5	35	2	3	3
OTHER PDN RUNS....	776	47:41:53	581	34:29:25	195

	TOTAL NUMBER	TOTAL CLOCK TIME H: M	1107A NUMBER	1107A CLOCK TIME H: M	1 NUMBER
ALL OPERATIONS:					
CONCURRENT OPER.....	2857	263:37	1122	127:07	1735
RATIO - CLOCK TIME/ CENT PROC TIME....		2.8		2.4	
SERIAL OPER.........	7	2:31	7	2:31	
RESEARCH & TRNG.....		13:57		13:57	
SCHEDULED MAINT.....		33:23		14:00	
EMERGENCY MAINT.		25		25	
IDLE TIME...........		7		-	
SYS INTERRUPTION....		-		-	
OFF TIME............		22:00		10:00	

Documentation. Magnetic tapes must be clearly identified and their contents and format so described that current or future users can use them effectively. Because the Census sells tapes to many users of statistics (always fully protecting the confidential nature of individual reports), the requirements for documentation are even more detailed than they might otherwise be. The preparation of such documentation is not a small problem in a busy shop. Both management and programmers must be convinced that it is a necessary part of the programming system, and that it is essential to the continuity of operations and to the maintenance or conversion of programs in an organization where the original programmers may not always be available, or even if available may not recall all the details of decisions that they made together with others. Early outside users of Census tapes made their views about the need for detailed documentation quite clear to the Census which now builds into its program and project cost estimates provision for appropriate tape documentation.

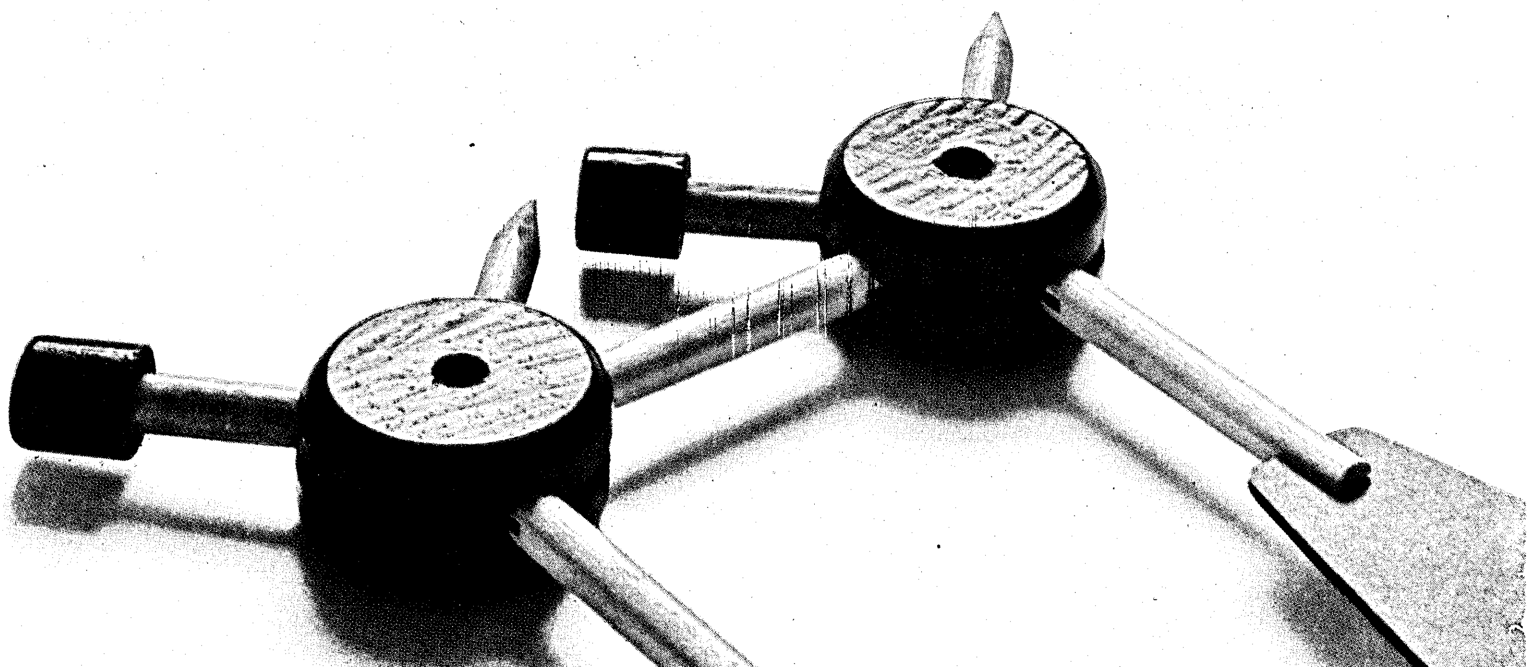
The Census maintains one of the largest and most active data banks of national and local area data from which demographic and economic data tapes and punch cards may be purchased. It also provides reimbursable data processing services to those who would prefer to specify what they want from Census tapes and have Census produce the tables for them. Effective with 1964 issues, the Census Catalog is divided in two parts: (1) Publications,

Sperry Rand Univac announces the interlinking computers.



Start with any one, and simply build on it as your computer needs grow.

Introducing the Univac® 9300: The first high-speed tape system the small computer user can afford.



The 9300 brings you from punched-card data processing to a magnetic tape computer in one small inexpensive step.

It can read, write, and compute at the same time.

It can run one or two peripheral tape programs and the main program at the same time.

It gives you reliability, efficiency, and a time saving of up to 50%. And far faster management control. Plus the opportunity to grow smoothly, without disturbing your business in the process.

The 9300 is powerful. It starts with two tape drives, and can be expanded to sixteen. Its effective tape read or write speed is 34,160 characters per second. This can be doubled by adding another control unit.

But the 9300 does more. It brings you complete UNIVAC software support: Tape assembler. Sort/merge. Report Program Generator. Fortran IV. Cobol. Control Stream Operations for unscheduled batch processing. Et cetera.

In other words, the opportunity to benefit from every major advance since UNIVAC invented the first electronic computer in 1946.

And, the 9300 is just a small step away from the next higher model in the series.

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And announcing some things to come:

The UNIVAC 9200 and 9300 are here right now.

But you might also like to know about some things we're working on for delivery in the very near future.

Like our UNIVAC 9500, which will combine real-time with batch processing and scientific capabilities never before available in a medium-scale computer. The 9500 will be able to serve even a large organization's entire data processing needs. Watch for it.

And watch for the other computers in our 9000 series. They will be as advanced in their class as the 9200, 9300, and 9500 are in theirs.

One thing more before you go.

UNIVAC has been the technological leader in the electronic computer business since we started it. We believe the computers in the 9000 series will help to demonstrate this fact. We'd like to discuss them with you. Call us.

Perhaps we can help you grow.

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and (2) Unpublished Materials. Part 2 identifies machine-readable data in the form of computer tapes and punch-cards, and also lists tally sheets and other unpublished special tabulations.

census systems development

The Census, as a major federal statistical agency for the collection and reporting of general purpose social and economic information, has had extensive experience in the processing of large volumes of data, with and without computers. It is appropriate, therefore, to ask, "What special lesson has been learned from this experience?" One answer concerns the computer's role in achieving objectives. The Census has learned that success in data processing depends less on a computer's characteristics than it does on the understanding and readiness of computer users to organize and plan in new terms.

With their higher electronic speeds, computers doing the same work as the mechanical equipment they replace can show faster output, but their performance records are not always more economical. It is possible to take another approach to computer utilization, by programming to take better advantage of internal processing capabilities, and in doing so to produce more valuable products, better controlled in quality at substantially lower unit costs. However, if computers are viewed as parts of a new system to be planned from start to finish, their relative contributions to the content, quality, timeliness and usability of results can be significantly greater at lower costs. A total systems approach to planning evaluates objectives, resources and results as well as methods, equipment and alternatives. It requires, in the statistical area, attention not only to an individual program, but also to the program's relations to the public, which both supplies and uses Census data, and to other programs and developments competing for support. It involves not only the use of computers, but also the continued expansion of the use of sampling which has itself caused a revolution in data collection.

Operating under congressional authorization or directives, the Census undertakes only specifically identified programs. All proposed new projects are reviewed by the Secretary of Commerce, the Bureau of the Budget, with its Office of Statistical Standards, and appropriate congressional committees; and the costs, results and needs for continuation of every project are regularly re-evaluated. In its planning and review processes, the Census interacts with an extensive network of ad hoc and continuing advisory committees representing public and private users and producers of statistics including officials of local, state, and national agencies, scientists, educators, professionals, businessmen, publishers, and others. From their points of view, the committees advise the Census on the nation's current and potential needs and uses for social and economic data. They discuss with the Census the content and priorities of programs and make recommendations on statistical methods, timing, standards, research and development, respondent attitudes, sampling, quality control, processing techniques, costs, etc. New ideas, alternative approaches, and improved formulations of statistical objectives and programs are the products of these studies and reviews.

Internally the Census is organized under a director, a deputy director and five assistant directors whose responsibilities follow functional lines; i.e., economic fields, demographic fields, operations, research and development, and administration including the field collection of data. Individual censuses receive individual appropriations, and are individually controlled and accounted for with Census staff assigned exclusively to them for the temporary periods of their operations. Continuing statistical programs are directed from permanently staffed subject-matter divisions.

The planning or replanning of a census, major survey or current program is developed through the establishment of a temporary systems team in which Census divisions participate. A systems team may report to an assistant director, to the deputy director, or to the entire executive staff composed of the director, deputy director, assistant directors, and the director of international statistics programs. Following approval of plans for a census or program, a division chief or program manager, reporting to an assistant director, is appointed to carry it through to completion. As program sponsor, he purchases the services he requires from regular census organization units which furnish, in response to his technical specifications, specific job estimates and time schedules. The sponsor maintains full technical direction, approves estimates and time schedules, evaluates progress, quality and actual costs and reviews and approves the final report for publication. He assembles necessary staff for his analytical, procedural and control responsibilities, sometimes from the systems team that outlined the activity and from other sources. While there is a permanent Census Bureau staff for supporting services, individual censuses are staffed as terminable projects on which the executive spotlight is turned in planning, operation and evaluation. For a major census or special activity, a coordinator, reporting to an assistant director, may also be appointed to analyze workflow, identify difficulties, or impediments at or between decision points, and report progress with recommendations.

Under this system, the Census computers are operated by specialists whose constant objectives are to improve productivity and quality levels. In this, they have been highly successful. During periods when workloads exceed computer capacity, contracts with other centers are activated. The Census maintains liaison with such centers and is aware of their capabilities. To say that this arrangement solves all computer priority problems would not be accurate, but it prevents unforeseeable and unmanageable work backlogs from developing and avoids the expense of installing and maintaining excess computer capacity.

computerized systems

The design and development of integrated statistical reporting systems in economic and demographic areas has long been a major objective of the Census. The computer, while only a partial answer to that need, has directly or indirectly affected all other Census processes and has required their continual re-evaluation, not so much in terms of their individual efficiencies as in terms of their possible contributions to a more effectively integrated system. Some examples will serve to illustrate the point.

Current Industry Reporting—Semi-automated. The Census in a series of surveys has collected reports on a sample basis, some monthly, quarterly, semiannually or annually, from manufacturers in 100 different industries. These surveys were designed at different times in response to specific data needs of their industries. Originating before the computer, they were processed on a variety of adding machines, calculators, accounting machines, and punch cards.

The Census was unwilling to transfer processing, survey by survey, from traditional methods to computer programs. Such a plan could have been more costly than the old methods. Instead, a systems team studied the whole operation from the printing of the form and the collec-

A bank statement in Japan, inventory records in Colombia, insurance billing in Australia...

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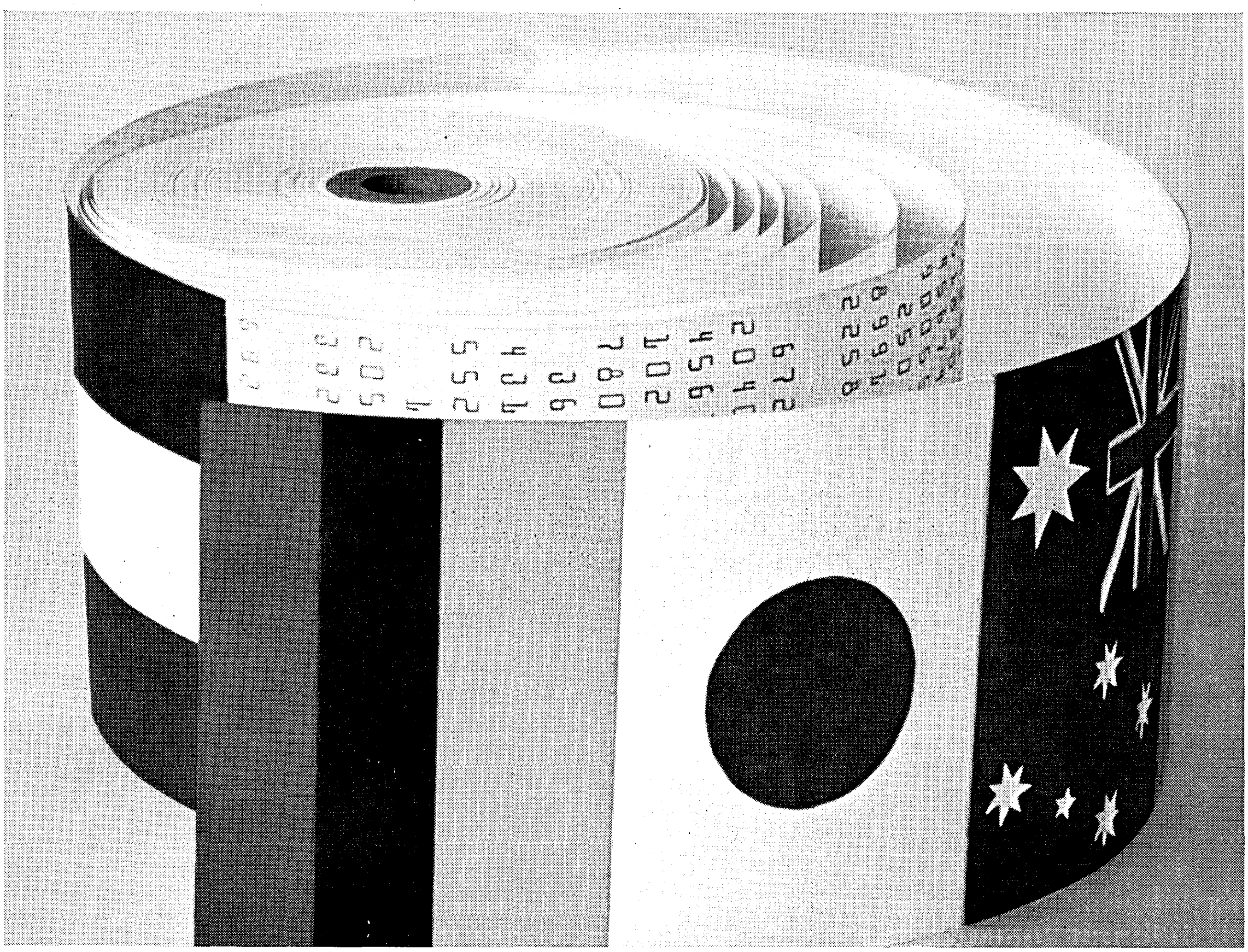

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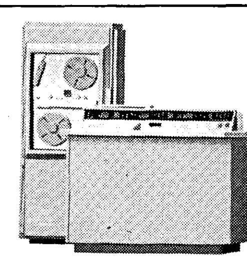

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CIRCLE 27 ON READER CARD

tion of data, to the printing of the results and their use by the public.

The team was jointly chaired by an industry specialist and a systems analyst who drew in appropriate representation from other disciplines including statistics, computer programming, economics, psychology, and operations research. Its plan has already reduced costs, replaced traditional forms with forms prepared by the computer individually for each respondent, introduced automated editing procedures, and computerized reports ready for offset reproduction. As the system progresses, the Census may find it possible to feed back to an interested respondent, ratios computed for his own business establishment along with similar ratios computed on area or national bases. Such feedback of useful analytical information for the respondent's particular kind of business may make reporting seem less burdensome to respondents.

Coordinated Use of Machine-Readable Data. In another development, flowing from Census' continuing search for alternatives, the Economic Censuses have substituted machine-readable information from Social Security Administration and Internal Revenue Service files for information traditionally collected directly by the Census from over a million small businesses. Such data are needed for the economic analyses that are now required in the development and application of public and private policies and practices. Continuing efforts to expand capacities for interagency transfers of information in machine-readable form for statistical purposes may lift other reporting burdens from the public and hold down data collection costs.

Mailing Lists and Automated Check-in for Follow-up. With the advent of the computer, census mailing lists were re-examined. Previous listing techniques were replaced with computer listings that were built up from IRS and SSA machine-readable records which also provide notice of business births and deaths. The computerized address listings of the economic censuses also include a set of symbols uniquely identifying each respondent. When census forms carring these symbols were returned by respondents in the 1963 Economic Census, they were microfilmed for scanning by FOSDIC, which transferred the symbolic identification to magnetic computer tape. The computer then eliminated from the nonrespondents list the names of those who had responded. This rapid current check-in system minimized the costly and irksome sending of follow-up requests to businessmen who had already responded. It also reduced the volume of mail requiring special attention.

An experimental extension of the trend toward increasingly integrated reporting systems in census economic areas was the computerization of census news stories. Data on 1963 retail trade, for example, were tabulated by county. The computer then selected certain key figures, compared them with the 1958 Economic Censuses and wrote separate news stories for each county. The stories highlighted the increases or decreases in the volume of sales, employment, and number of establishments in a county. These stories, individually addressed by the computer to the newspapers, T.V., and radio stations serving each county, resulted in local news media reporting more information about the results of the 1963 Economic Censuses than about any previous economic census.

19th Decennial Census. Self-enumeration in population surveys using FOSDIC-style questionnaires and computer-controlled mail distribution and follow-up techniques has been studied intensively. Experimental censuses in Huntington, Long Island; Louisville, Kentucky; and Cleveland, Ohio have tested both FOSDIC self-enumeration forms and computer-controlled mailing techniques with promising results. Timing, coverage, quality of responses, costs and other factors are being evaluated with the planning problems of the 1970 Census in mind.

Geographic Coding. The further development of computerized geographic coding of addresses is being coordinated with the refinement of computer-controlled mailing techniques. Using an address reference file, the computer can assign codes not only for standard political jurisdictions but also for census tracts, blocks, block faces, longitude and latitude coordinates, and other areas or points. This new flexibility makes possible, at a cost of course, tabulations for areas not delineated prior to the collection of data. Looking ahead at our rapidly changing urban areas, such a facility could make historical data available to match new data and provide measures of change geared to current rather than past social, economic or political geographic patterns.

Administrative Systems. Not until after its major reporting systems were programmed and operating on the computer did the Census Bureau turn its attention to the computerization of administrative systems in personnel, pay roll, accounting, budgeting, progress reporting, etc. Now Census computerized systems operating in these areas, especially those using FOSDIC, are being studied by other agencies with similar problems. Notable amongst these administrative systems are SPARTAN—System for Personnel Automatic Records, Transactions and Notices, and PROP—Performance Review for Operating Programs. Descriptions of these are available from the Census. They represent the Census Bureau's approach to the development of a fully integrated management information and control system using the computer in processing not only progress reporting and personnel records and actions but also a whole series of applications in budget preparation, financial control, payroll preparation, management planning, and the automation of required reports to other agencies. The objective is to capture, combine, measure, evaluate and report all data necessary for the operation of a complex organization. That full objective is still to be attained, but it is attainable.

man-machine relations

The Census staff learned years ago that a tool is not a system and that possession of equipment whether mechanical or electronic does not guarantee production. In that sense, it is perhaps self-evident that there is no "computer revolution," and that there never has been nor ever will be one. Computers never revolt! It's people, with their changing insights, goals, attitudes, skills, and values, who make revolutions. They create the tools they use. It is their vision that limits or expands the possibilities for change. Tremendous unused physical resources have been at man's hand throughout all history waiting for him to see their possibilities for use. The essence of revolution is neither in tools nor in resources, but in what man thinks and does. This is especially true in an age when discovery by chance has been replaced by the methodologies of planned invention. The revolution in technology stems from man's innovative attitudes toward reducing the sphere of the unknown, from his readiness to adopt new ideas and practices, and from his still feeble efforts to control his natural and cultural environment. Man designed the computer and now is creating revolutionary uses for it in management, science, communication and production. The Census Bureau became involved at an early date in this revolutionary think-do-systemize process and is still seeking to further it and reap benefits from it. ■

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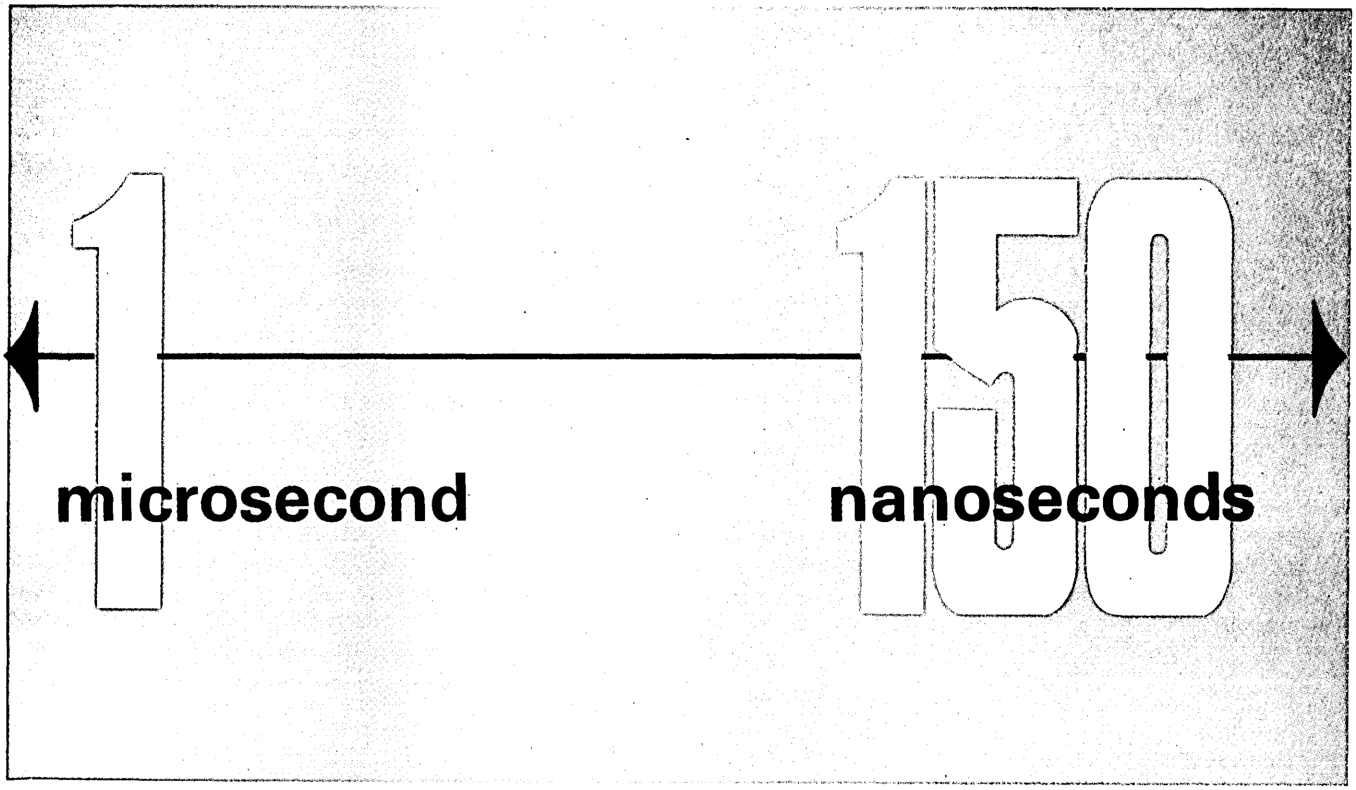

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GENERAL PURPOSE DISPLAY SYSTEM

by ALFRED H. VORHAUS

The display is an element essential to any effective dialogue between the computer and its user. Much of the value of the computer depends on its ability to provide responses on cathode ray tubes and printout devices and to provide these responses in most any form—tables, lists, bar graphs, line graphs, maps, geometric figures, and so forth. Further, a display in any of these formats is successful only when the data portrayed are structured to highlight the user's interest. This means that the computer's data base must be available for the user to arrange items of information in any relationship he prefers; or, if the data base does not contain desired information, the user should be able to add it without elaborate rearrangement and yet with confidence that he can recall this new information to reflect any useful relationship with the information of the original data base.

Research on this family of user-oriented programs and systems is going on in SDC's Research and Technology Div. Specifically, the Data Base Systems Staff in this division is conducting research and operating an experimental program to create a display system that will provide the kind of flexible, on-line, interactive operation necessary for a significant user-computer dialogue.

Called General Purpose Display System (GPDS), it is a research project concerned with building and investigating the capabilities of an operating display system using the technique of on-line process building. On-line process building refers to a method for constructing display formats by a question-and-answer dialogue between the computer and its user. The computer presents a message in English, asking the user what he wants to do; the user responds by typing an answer on a keyboard device or selecting a response from multiple choices with the use of a light-pen on a cathode ray tube or, in some cases, indicating a location or drawing a line with a stylus on a RAND Graphic Input Tablet (GIT). The computer will then interpret the user's response and ask another question to prompt the user along the next step of the process. When the user has finished the process he wanted to build—a table, graph, map, etc.—he can end the questioning and store the process he has constructed. In the future he or any other user can recall this process by referring to a designated code name. The process can be used intact or can serve as the starting point for a modified or more complex version.

Each user can thus collect a repertoire of processes, or formats, that suits his special purposes. Used effectively, with skill and experience, this technique of on-line process

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Head of the Data Base Systems Staff in System Development Corp.'s Technology Directorate, Mr. Vorhaus is responsible for developing computer-based systems that can store, manipulate, organize, retrieve, and display large amounts of data at the direction of on-line, nonprogrammer users. He joined SDC in '57, has been involved with programming efforts in air defense and satellite control projects, and became involved with LUCID and GPDS in '64 when appointed to head the Data Base Display Project.

building will enable the user to format the data base or information store he uses to near perfection.

GPDS is one of two major projects undertaken by the Data Base Systems Staff for the Advanced Research Projects Agency of the Dept. of Defense. The other major project, LUCID (Language Used to Communicate Information System Design), is a general purpose data base management system that allows the user flexibility in specifying, loading and accessing his data base. Information stores that operate with GPDS are written in LUCID.

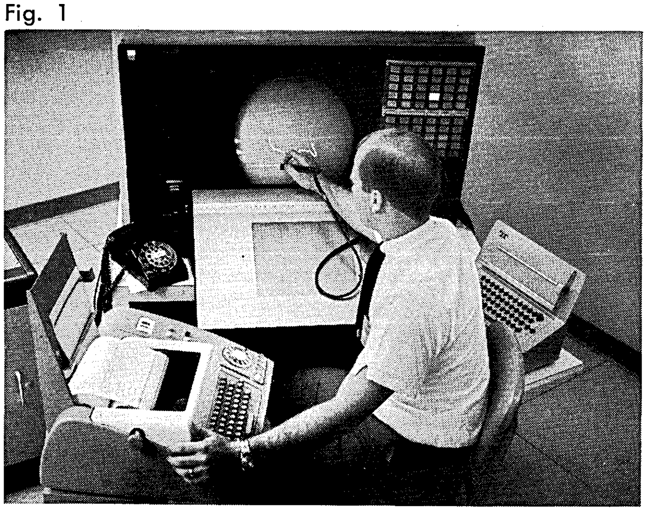
GPDS is presently designed to work on the AN/ESQ-32 computer at SDC and operates under time-sharing, a system that opens the Q-32 to as many as 35 simultaneous users who operate on-line—that is, who interact with the computer directly through teletype, keyboard consoles or other communication devices. Each time-sharing participant can manipulate his own data base, and the computer handles each special problem simultaneously—or so it seems to the user.

The chief significance of GPDS is the fact that it frees the computer user from a single format prepared by a programming specialist (or several separate and expensive programmed formats). He can construct his own formats, as many as he wants and in the way he wants them, as he himself sits at the console.

The specific advantages of the system are its user orientation through the convenient method of process building and the use of computer queries in a structured, restricted, natural-English form; its data base compatibility—that is, the fact that items from the computer's information store can be included in the user's response to a question, and this information will be called up and included in the process being developed; and its versatility with input-output devices—under GPDS the user can communicate with the computer using any available device, including keyboards, light-pens or the RAND GIT. Output, or computer messages, can be presented on cathode ray tube display consoles or teletypes.

In the present GPDS five devices provide communication between the user and the system (Fig. 1). A display console with a 10 x 10-inch cathode ray tube (CRT) display area and a light-pen are the user's principal communication channel in normal operation. As many as 2,048 symbols can be displayed in four character sizes. The CRT also has a line-drawing capability with a limit of 1,024 positions per axis.

Fig. 1



A model 33 Teletype is used to start the GPDS and can be used as an input-output device after start. At any time it can provide a convenient printed record of the user's actions or the system's responses. A switch panel or "button box," with 60 pushbuttons that illuminate when selected, provides a convenient way to refer to and execute the basic control functions of the system.

A RAND GIT provides a 10 x 10-inch writing surface that is a direct spatial analogue of the CRT display device. Using a stylus, the user can communicate graphic information, lines or figures, directly to the computer. When the user holds the stylus at any point on the tablet, the corresponding point appears on the CRT display as a spot of light (Fig. 2). The tablet can be used to insert almost any kind of graphic data into a process. In the figure, the

Fig. 2

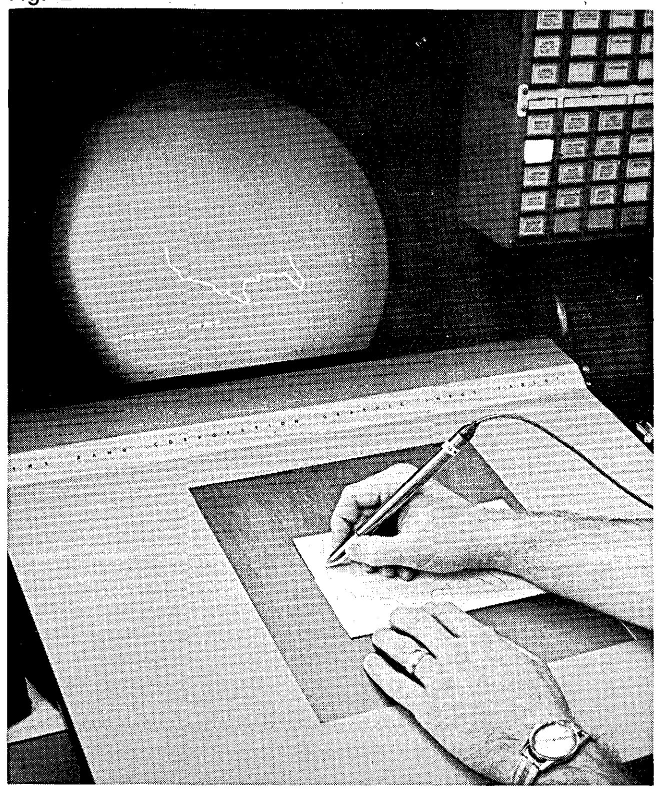
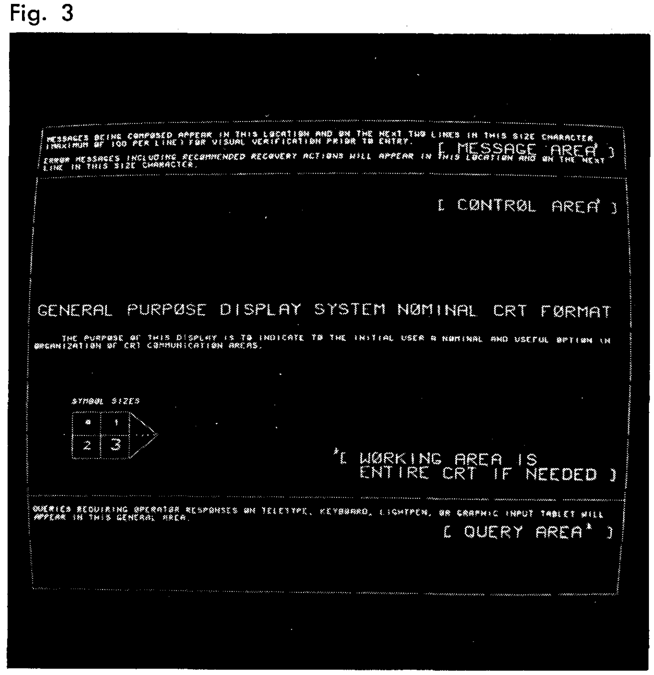


Fig. 3



user is shown tracing a map on the tablet. It is displayed on the CRT and entered in the system.

Finally, a keyboard can be used to type messages to the system. It can be used with the CRT to satisfy most requirements for providing information to the system if no hard copy record of the user's actions is required.

When GPDS is activated, a nominal CRT display appears on the scope (Fig. 3). This display provides a simple explanation of the way data will appear, indicating the area where messages being composed will show up for verification, and where error messages and recommended recovery actions, queries and so forth will appear.

The system design for simplicity of user operation is characterized by the arrangement of the switch panel (Fig. 4). Basic control functions for operating the program are arranged in six columns with unmistakable identification for each column.

Fig. 4

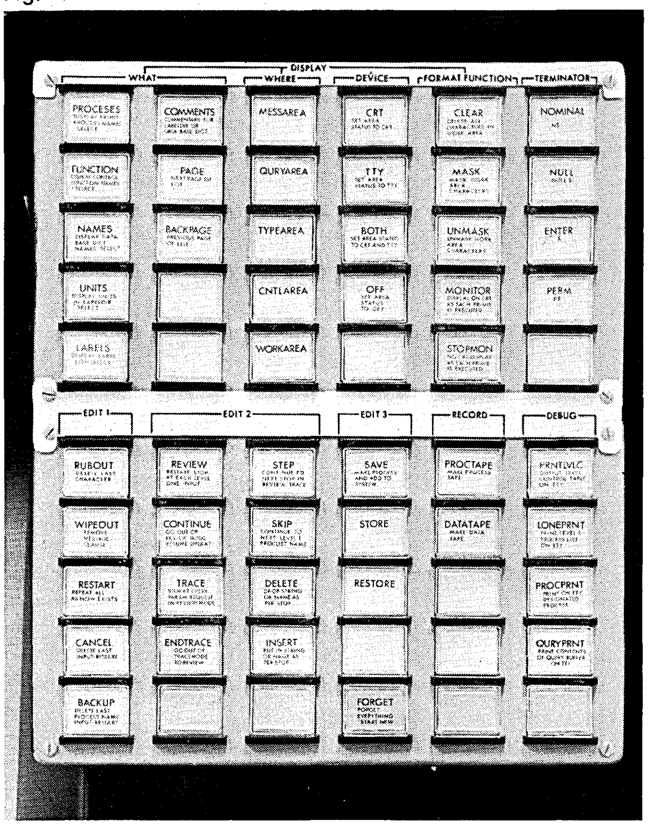
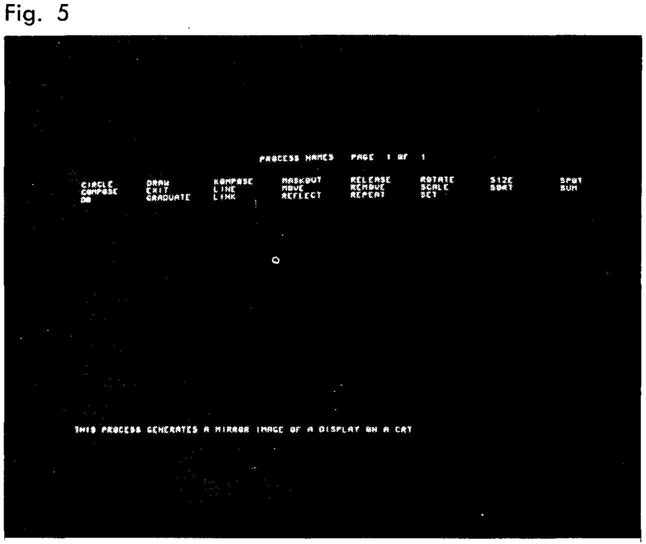


Fig. 5



By pushing the PROCESS button, the user can call to the display scope the list of processes that have been constructed to date and are available to users. If he should be uncertain about any of these or if he is a new user, he may push the COMMENTS button, then light-pen any process name, and the scope will offer a short description of that process. In this case, the user has light-penned REFLECT and the description appears in the lower left of the CRT (Fig. 5).

In like manner, the user can call up the control functions, and by light-pen action receive a short definition of each. For convenience, the user may request a list of units of measure available in the system. By light-penning, he can identify as degrees, inches, etc., any figures he will use. It is also possible, using GPDS, to convert from one unit of measure to another.

A very simple example of manipulating a display through process building involves rotating a rectangle. Using the basic process, LINE, a more advanced process, RECTANGLE, is easily possible. LINE asks the user to indicate vectors between two points; by calling LINE four times and indicating the sides of a rectangle, the figure is formed. Once the rectangle is completed the user can light-pen the basic process, ROTATE, and queries will appear requiring that he indicate the point of rotation and the number of times the figure is to rotate (Figs. 6 and 7).

The process list contains the term, SCALE. If the user light-pens this term he will be asked to indicate the axes

Fig. 6

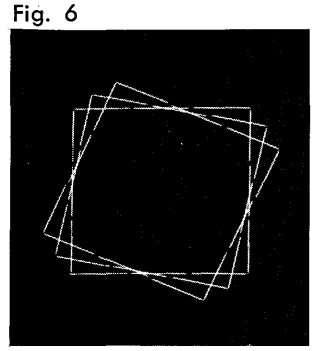
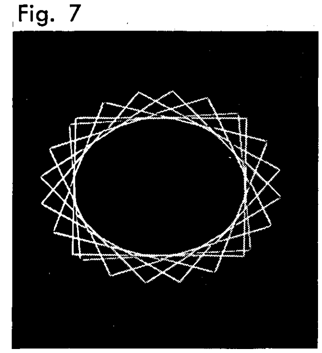


Fig. 7



to be scaled and the proportions he desires. If the user indicates the horizontal and vertical axes of the rotated rectangle and asks for a proportion of 3 to 1, the result is this elongated version (Fig. 8).

By indicating ROTATE once more and responding to a query to supply the angle of rotation, the user can tilt this figure. He then light-pens the desired unit and types "°45" on the teletype. The result is the figure tilted 45 degrees, as the user requested (Fig. 9).

A pie chart will provide an example of a figure useful

Fig. 8

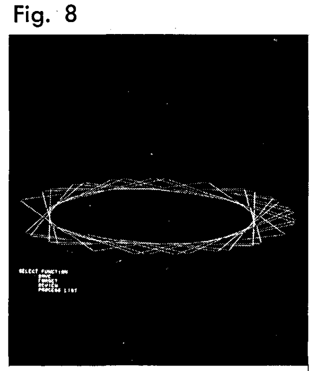
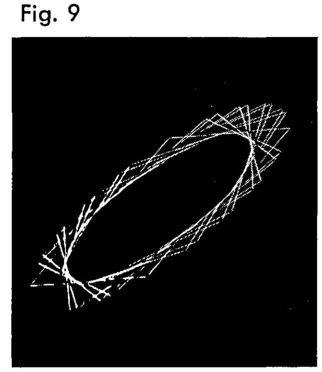


Fig. 9



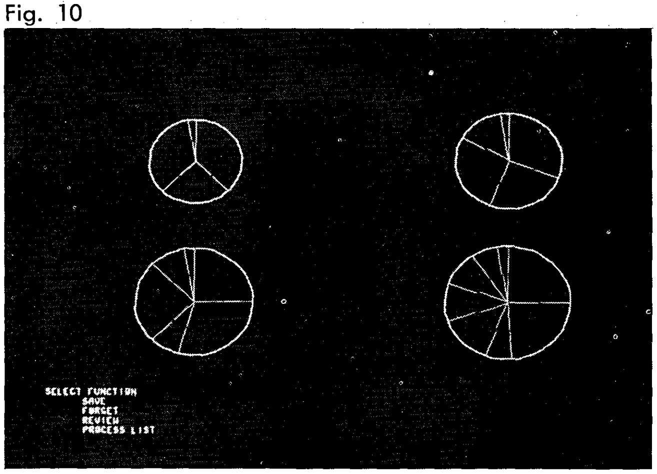
for illustrating information from a data base. This example demonstrates the construction of four pie charts using mathematical values. Once the process has been entered into the user's repertoire, he can substitute values drawn from any data base. A primitive process, CIRCLE, enables the user to present circles on the scope at points he indicates. Previously the user had asked for the location of pie charts. He now responds with the coordinates—by typing them out, light-penning the scope or pointing the stylus on the RAND GIT.

The user in this case enters a query to control the size of the circles by supplying the length of the radii. Then he enters a query asking for the number of segments in each chart. Again, he provides the numerical values. The next query asks for the angles from the vertical for segments; the numerical values provided appear in the upper left of the CRT.

The response, providing angles for the segments, completes the cycle necessary to build the pie charts, and the computer starts to work building them on the CRT (Fig. 10).

When the pie charts are completed on the scope the program provides the instruction shown in the lower left. The user may save the process, do away with it, review

Fig. 10



it once more, or call for the process lists and continue building. In this instance the user wishes to save the process—that is, add it to his repertoire. Therefore, he light-pens SAVE. This brings a query to the scope asking that he name the process. The arbitrary name he has chosen is INCOMEPI. He types this name on the keyboard and it appears in the upper left of the scope.

When this name is entered, another query appears asking for a commentary to describe the new process. The commentary selected is "This process builds four pie charts with various divisions."

Now the term INCOMEPI is entered in the list of processes in alphabetical order, and if the user light-pens this term he will receive the commentary describing it.

In the course of his work with the computer, the user may wish to make this a more elaborate process or use it as the starting point for something new. He can do this by recalling the process and adding new queries that change or expand the original.

Having developed this process, the user can now apply it to his data base. For example, suppose he is interested in circles that show the proportion of a given corporate income for each year from 1961 through 1964. When the query "supply lengths of radii—one for each pie chart" appears, the user can respond, CORPORATE INCOME FOR (YEAR EQ 1961 + A)/100000 ' DOLLARS.

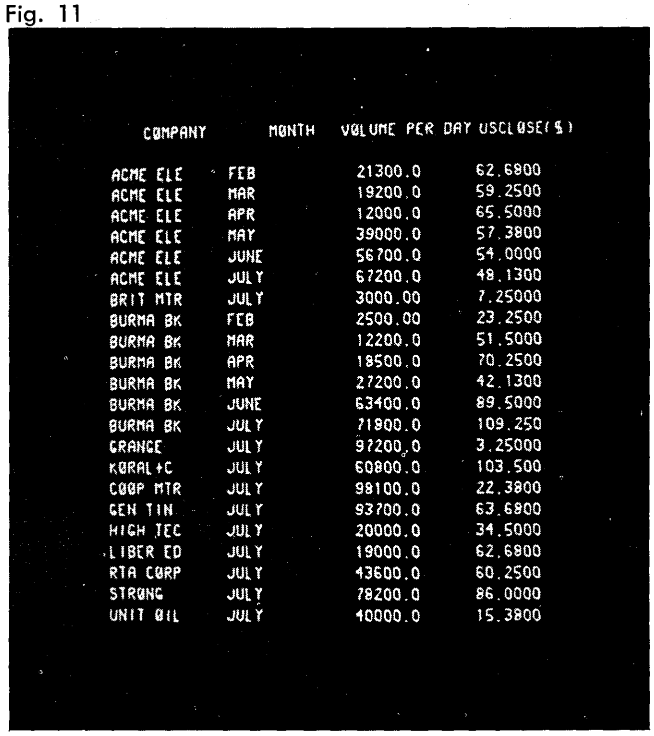
The following query asks for the number of segments in each chart. Referring to his data base, the user can ask for a number of segments equal to the number of customers who have provided income to the corporation in each year—1961 through 1964. Then, when the query "supply angles from the vertical for segments" appears, the user's response requires segments proportionate to the amount of income provided by each customer. He keys in CUSTOMER CONTRIBUTION FOR (YEAR EQ 1961 + A) ' CORPORATE INCOME FOR (YEAR EQ 1961 + A) '360' DEGREES.

The result will be pie charts, like those in Fig. 10, illustrating proportionate income by year with a breakdown of customer contribution.

It is evident that the user's ability to select and build graphic presentations well tailored to his data base and purposes will improve as his experience grows.

An example of a process arbitrarily named TAB4COL will illustrate further the capability of GPDS to manipulate a data base. This display (Fig. 11) presents a sample data base structured as a four-column table. The

Fig. 11



COMPANY	MONTH	VOLUME PER DAY	USCLOSE($)
ACME ELE	FEB	21300.0	62.6800
ACME ELE	MAR	19200.0	59.2500
ACME ELE	APR	12000.0	65.5000
ACME ELE	MAY	39000.0	57.3800
ACME ELE	JUNE	56700.0	54.0000
ACME ELE	JULY	67200.0	48.1300
BRIT MTR	JULY	3000.00	7.25000
BURMA BK	FEB	2500.00	23.2500
BURMA BK	MAR	12200.0	51.5000
BURMA BK	APR	18500.0	70.2500
BURMA BK	MAY	27200.0	42.1300
BURMA BK	JUNE	63400.0	89.5000
BURMA BK	JULY	71800.0	109.250
GRANGE	JULY	97200.0	3.25000
KORAL+C	JULY	60800.0	103.500
COOP MTR	JULY	98100.0	22.3800
GEN TIN	JULY	93700.0	63.6800
HIGH TEC	JULY	20000.0	34.5000
LIBER ED	JULY	19000.0	62.6800
RTA CORP	JULY	43600.0	60.2500
STRONG	JULY	78200.0	86.0000
UNIT OIL	JULY	40000.0	15.3800

items of information are fictitious stock exchange figures representing some companies on the exchange, the month in which their performance was measured, the volume of shares traded, and their U.S. closing averages.

The sample process, TAB4COL, was constructed using a few of the primitive processes: SET was used to establish control items for arranging or formatting the data and to establish storage for the data to be displayed in the columns; COMPOSE was used to accept and display the column headings and to display the data in the columns; DO and REPEAT controlled the iteration necessary to display all data entries; and EXIT was used to end the process when all columns requested had been displayed. Once the process has been built in this way, TAB4COL can be used to call up many combinations from this data base or to structure new and different data. TAB4COL appears on the process list and a short description is available to the user.

As an example, suppose the user wants a table showing only the performance for July of those companies with a volume over 50,000 shares in that month. The user can light-pen the process TAB4COL and the dialogue begins. The computer first asks the user to supply the number of columns he wants. After responding with "three," a query appears asking for the heading of the first column; the user types COMPANY and the column heading appears on the scope.

Then a query appears asking the user to supply data for the column. The user's response refers to his data base—he asks for the names of companies with a volume over 50,000 shares in July. The computer searches the data base and presents the data for the first column on the scope. When this is done, a new query asks for the heading of the second column. The user responds VOLUME PER DAY.

Then the query asking for data to fill the second column appears and, again referring to his data base, the user requests the volume in July for each company with over 50,000 shares traded. The computer fills out the second column and the query asking for the third column heading appears. The process for displaying the third and final column is like the others. The query is in the lower left and the response in the upper left (Fig. 12).

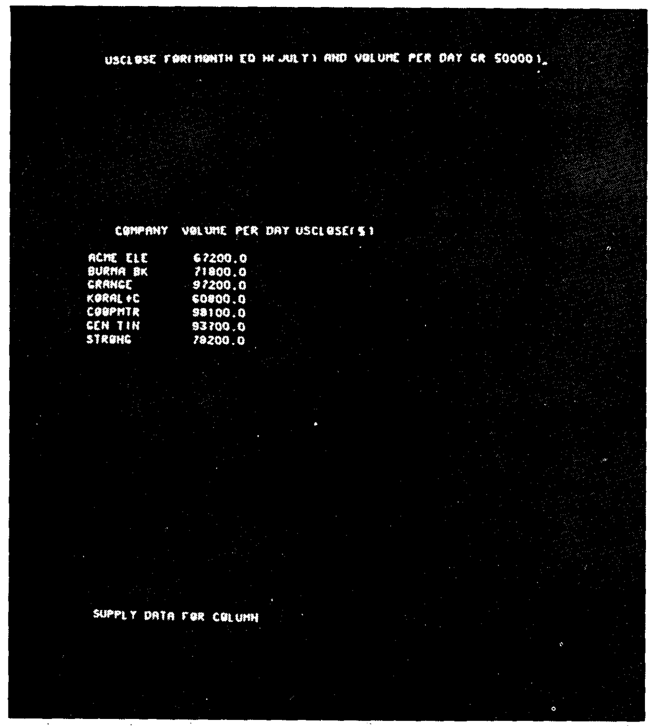
The computer displays on the scope the U. S. closing averages for the companies specified.

The examples offered have presented simple displays and have formatted small stores of information. Using GPDS, displays of almost unlimited complexity can be developed with the method of process building, and a data base of enormous volume can be manipulated. In the course of the experimental program, the full capabilities of the system have not yet been tapped.

The General Purpose Display System operates with a program of 63,000 instructions, including non-real-time utility elements. It uses about 47,000 words of memory in the Q-32 which has a 64,000-word memory capacity. GPDS accommodates a unique time-sharing feature within the system itself. The SDC Time-Sharing System on the Q-32 operates in 16,000 words of memory. GPDS uses 17,000 words of memory for an interpreter that handles the communication between the user and the system; the other 30,000 words handle a control program that actually time-shares certain basic procedures, peripheral programs and other control functions.

The present system is certainly experimental. While it includes some intolerable features, the Data Base Systems Staff has begun a second version that will operate under time-sharing in SDC's planned IBM 360/67. There is every

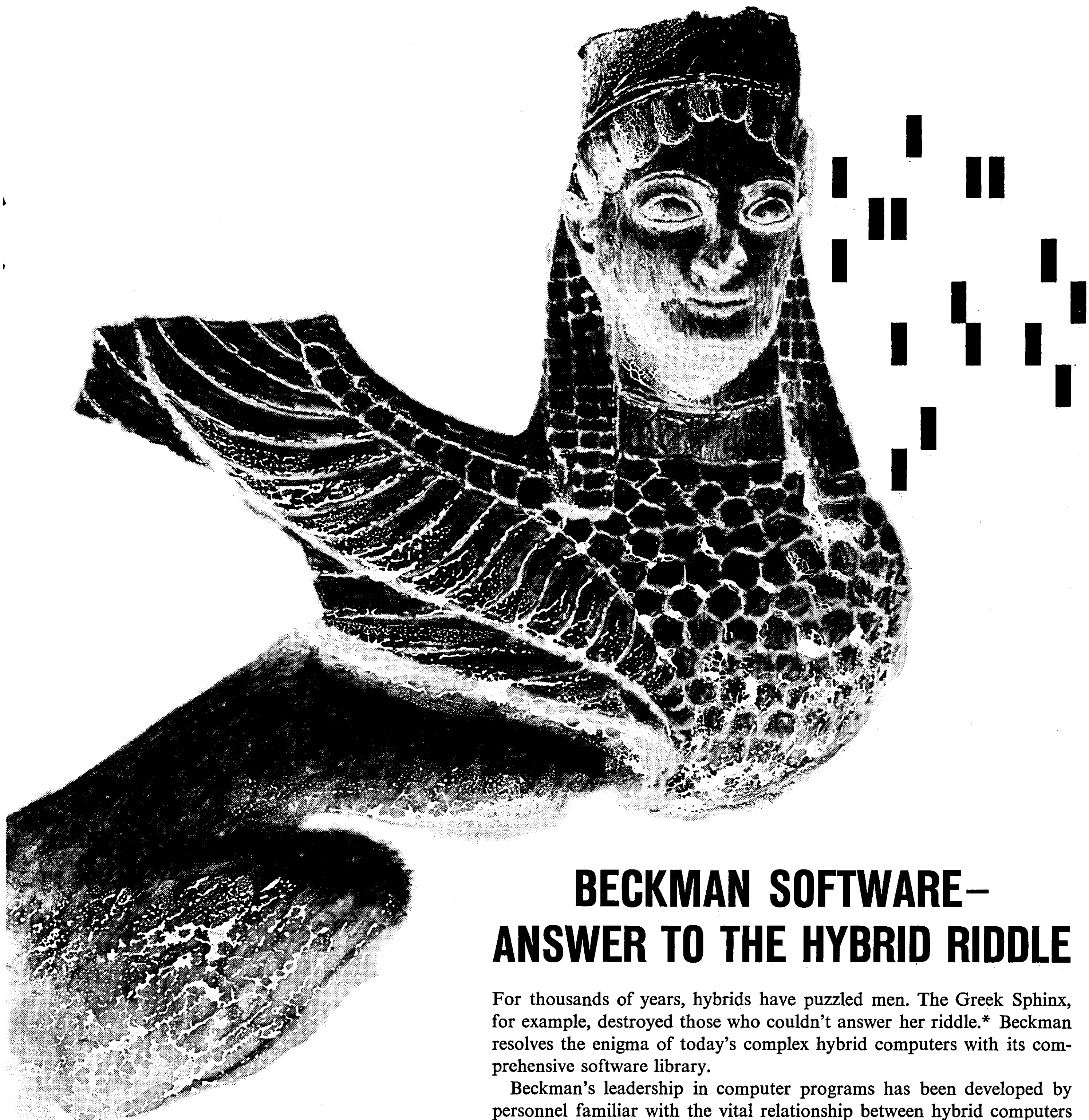
Fig. 12



reason to believe that this new version will be a fully operational, well human-engineered system. Many capabilities of GPDS, of course, are operational now—the graphics functions, for example. Among the major shortcomings to be overcome is the slow response time that results from the fact that the system is fully interpretive. All steps in the process-building methods must be performed each time a process is used. This is obviously unsatisfactory. A number of possible solutions are being examined for the system that will operate on the 360. One promising approach is a technique for building a compiler under control of GPDS to compile and store values and, thus, avoid the need for them to be interpreted.

Another drawback in the present system is that a number of functions are performed in the main programming system and the central computer that should be handled by peripheral equipment. Hardware is available and this condition is certain to be improved.

It is obvious, at this point, that GPDS is a significant development in the attempt to bring about more user involvement in computer programs and systems. The system promises flexibility in the presentation of complex displays to format information from a large data base. ■



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For thousands of years, hybrids have puzzled men. The Greek Sphinx, for example, destroyed those who couldn't answer her riddle.* Beckman resolves the enigma of today's complex hybrid computers with its comprehensive software library.

Beckman's leadership in computer programs has been developed by personnel familiar with the vital relationship between hybrid computers and software. With Beckman systems you receive complete field-proven program packages providing ease of man-machine communication.

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Let Beckman software answer your hybrid riddle. A detailed description of our programs is available. Write for our new brochure, "To Harness a Hybrid".

** What walks on four legs in the morning, on two at noon, and on three in the evening?*

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CIRCLE 31 ON READER CARD

probably not

ARE SMALL FREE-STANDING COMPUTERS REALLY HERE TO STAY?

by MARTIN B. SOLOMON, JR.

A great deal of confusion presently exists on such subjects as the economics of computers and time-sharing. A large misconception continues to plague the computer industry: that small computers are more economical than large computers *for many types of jobs* and becoming increasingly a better price performer than large machines. In addition, several other claims are often made favoring the small machines. Most of these claims are simply old wives' tales. The data at hand show exactly the opposite.

A recent article (Gruenberger, April '66 DATAMATION) is a typical example of some of the erroneous conclusions presently reached in such analysis.

Grosch's law, conceived in the 1940's, claims that a computer's power is roughly equivalent to its cost squared; that is, if one computer rents for $1000 per month and another for $10,000 per month, the second will be about 100 times as powerful. Empirical results have always shown Grosch's law to hold, notwithstanding some claims to the contrary. At least two studies bear this out. The first was done by Kenneth Knight[1] in his doctoral dissertation at Carnegie Tech where he analyzed 225 computers in three different time periods: 1953-54, 1959, and 1962. Knight cleverly and carefully computed power ratios among almost all known American computers taking into account such factors as core size, instruction mixes for scientific and commerical jobs, instruction speeds, and input-output considerations. The result of his analysis upheld Grosch's law quite closely in all cases.

The second study was performed by the author.[2] It was more limited in scope in an attempt to eliminate some of the many variables inherent in such a study. Only the IBM 360 line was studied, thereby excluding the portion of rental resulting from software, the effect of memory size, I/O differences, etc. Included in the analysis were scientific, semi-scientific and commercial type kernels. Each kernel was "costed" for several different models of the 360.[3]

All three cost functions indicate that the System/360 roughly follows Grosch's law.

What confuses some analysis is the fact that small computers have, over the years, increased in power relative to cost. What is often unnoticed is that large computers, too, have been gaining—at an even greater pace. This must be true if Grosch's law remains in balance. So it is not true that the price performance ratio of small machines is increasing faster than that of large machines.

Arguments, other than economic, are made for the small machine. To quote Gruenberger, these are reliability, safety, speed, security.

1. **Reliability.** The argument is often made that "if the central processor or the data links break down, then 100 consoles are down, all at once. On the other hand, 100 free-standing machines are hardly likely to be out of commission."[4] While the quote is obviously a truism, its relevance is questionable. All computers will be subject to failure for many years to come but a large computer might afford features no small machine could justify. Duality in processors and especially in input-output equipment, auxiliary power sources, automatic failure detection and recovery, 24-hour customer engineers on the spot, more elaborate spare parts inventories, and possibly more reliable components are some such features. The real question is whether each user receives more trouble-free service and less down time, not will a system *ever* fail. Failure is a part of the computer business. It must be expected. But it might well be minimized and handled better on large machines.

2. **Safety.** Again the advantage of a large machine seems obvious. I would much rather trust real-time monitoring to a large dual computer than a small stand-alone machine, wouldn't you?

3. **Speed.** Gruenberger states that "The ratio of speeds

Mr. Solomon is assistant director of the Univ. of Kentucky computing facility and a faculty member in the college of business and economics. He has an MBA from the Univ. of Kentucky.

[1] Kenneth E. Knight, *A Fast Sort of Country* (Unpublished Ph.D. dissertation, Pittsburgh, Carnegie Institute of Technology, 1964).
[2] Martin B. Solomon, Jr., "Economies of Scale and the IBM System/360," (forthcoming in Communications of ACM).
[3] Models 30, 40, 50, 65, and 75.
[4] Gruenberger, Ibid.

WHY IN THE WORLD DID EAI ADD THE 8400 TO THE LIST?

IF YOU KNOW SCIENTIFIC SIMULATION,
YOU'LL UNDERSTAND OUR ANSWER.
THE NECESSARY COMBINATION OF SPEED,
CAPACITY AND MODERATE COST...
OF ON-LINE CONTROL AND INTERACTIVE
SOFTWARE...SIMPLY DO NOT EXIST
ANYWHERE ELSE IN THE MARKET TODAY.

We didn't want a computer that could do everything. We wanted a system a scientist could do everything with.

Simulation, experimental design studies, engineering model building—these are computer-aided creative processes. They place great demands on the designer and the computer that assists him. The EAI 8400 and its simulation software is the first computer a designer can really consider a partner. He can talk to it, ask questions about his simulation model, demand the highest performance. He can require that all his own mistakes be found and forgiven, with error-free behavior on the part of the computer.
The creative design engineer—the man who has devised a mathematical model of a new design and wants to experiment with it —needs to be close to the machine at run-time. He needs to modify the program and data during the run. He can't afford to be hampered by operating details such as octal conversions and symbol searches. He needs the simplicity—and the sophistication—of the 8400.

SM Service Mark of Electronic Associates, Inc.

The prime focus for the 8400 system is man: the design engineer, the experimentalist, the simulation engineer. The system was designed to respond to his needs in every way. This concept of usability calls for an economy of means and effort to yield a high throughput.

It starts with the problem of how to give a powerful, expensive complex machine to one person — aid him as he searches for an undefined number of answers through a trial-and-error process and still provide computer services for others. Moreover — provide this usability and an economical cost/performance ratio.

Scientific laboratory computation is not all creative and experimental. There will always be a significant amount of straight processing — assemblies, FORTRAN compilations, data sorting, report generation. The 8400 was designed to do these jobs while fully meeting the requirements of the simulation engineer.

The 8400 multiprogrammed system provides real interactive control and conversation for the designer. It lets him have as much think time as he wants. Batch processing goes on as background work, soaking up all the machine time he doesn't use. In fact, he is unaware that it is taking place.

Why is the EAI 8400 the best digital computer for simulation? Look at features like these:

High Operational Speed

The EAI 8400 has the speed performance of some giant machines that cost 4 to 5 times as much. As for machines in its own price class, the 8400 is 1½ times as fast!

First there is raw speed—minimum execution times for each machine function. Memory access: 1.75 µsec. Typical floating point multiplication of two 32-bit data words: 7.35 µsec. That's fast.

Then there is the speed-up due to shorter sequences for doing a given job. This comes from the very large set of instructions and options. One group of floating-point instructions automatically performs mode conversions between fixed and floating-point numbers with no additional time penalty. Sixty-three decision commands reduce tests to one or at most two steps. There's direct addressing of every bit in core. Indexing with the accumulator, as well as 6 other high-speed registers. And most valuable of all, a 56-bit push-down store (the SAVE register) which will accept the contents of all the arithmetic registers just prior to any arithmetic instruction at a cost measured in nanoseconds! All these are important hardware features that mean speed.

But for real-time simulation something more is needed. The entire software system must be designed for very short computer response time. The 8400 FORTRAN generates code that speeds the execution of entire programs. The object code is optimized for minimum execution time—just as well as a top programmer could do it for a large, complex program. For tough problems, such as a hybrid computer program where tight coding is needed, assembly code may be freely intermixed with FORTRAN statements.

The 8400 Monitor system has a master scheduler and priority interrupt handler which direct the multiprogram schedule in the computer. But for quickest response, the monitor permits the user to assign a priority above the multiprogram priority list.

Finally, to help the programmer design for real-time constraints, the compiler and assembler both contain pseudo-operations for estimating and adjusting the execution time of segments of code by as little as several microseconds.

On-Line Access To The Model

The EAI 8400 brings the design engineer close to his program—that is, to his model—not just close to the computer itself. He need not be concerned with machine operating details, yet he still has direct access in symbolic fashion to many details of his program. To do this, the 8400 has the hardware features for interactive control: mass memory devices, remote typewriter stations and CRT display systems with the latest options of light pens, vector mode, and special operating features.

Above all, the entire software system is geared to the interactive mode of operation. This includes the IOCS, the multiprogramming schedules of the monitor, the language processors, and the special conversational-mode systems HYTRAN℠ and SPECTRE. The HYTRAN Operations Interpreter is a JOSS-based mathematical processor with numerous extensions to provide control of the linkage and analog computer in a hybrid system. The SPECTRE on-line assembly system, based on DDT, is a full symbolic assembler. In fact, it is a disassembler—which means it will create a symbolic listing from a program in core. SPECTRE permits you to modify a program in core, assemble and insert new code segments, run a trace, and execute a program section to a breakpoint.

Economic Computer Utilization Through Multiprogramming

It is obviously inefficient to tie up such a powerful system for fast, short runs. Yet it is necessary for the user to sit and think between runs. How is this conflict overcome?

Only by multiprogramming. Only with a monitor designed for this kind of interaction. Only with a system that can assign the full resources of the computer to a single user for a short period, and can respond at any time to real-time interrupts and still do batch processing on a queue of jobs. Only with the 8400.

This multi-user mode takes several forms. In a hybrid system the 8400 is usually assigned one top priority job (the hybrid programs) to which it applies full power whenever and for however long it is needed. Other interactive processes have next priority. And the job queue is the "background" that uses the remainder of the system time.

Thus, the 8400 gives you high run-time speeds . . . effective, rapid, on-line interaction of the investigator with his model . . . and economic utilization of the system with no charge for "think time." This, we believe, is exactly what the man interested in simulation and scientific computation is looking for in a digital computer system.

Our goal is more than just to manufacture computers... It's problem-solving through simulation.

The EAI 8400 Digital Computing System is an expression of this aim.

Electronic Associates is in the computer business because we believe in simulation.

You've known us for a long time as the leader in analog simulation. We are now the only company that's strong in all three: analog, hybrid and digital computer systems.

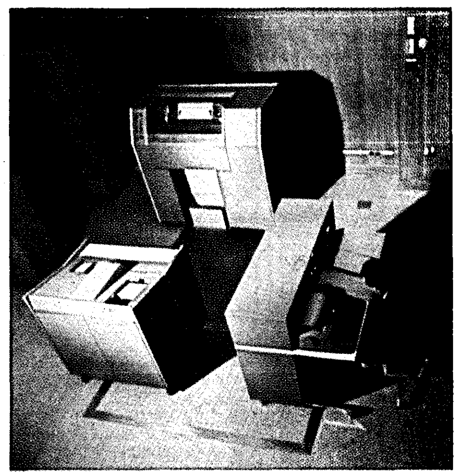
We have grown in the three disciplines as we sought to improve the art of simulation. The culmination in digital systems is the 8400. And this system is designed for use in a powerful new hybrid, the EAI 8900.

We have lived and breathed simulation for 14 years, working with thousands of design people through all the trials, errors, headaches and successes of innumerable simulations.

This experience is embodied in both the hardware and software of the 8400.

The rapid acceptance of this medium-scale system marks it as the most popular digital computer ever designed for simulation, and several are already in full operation here and abroad.

We and the 8400 speak a problem-oriented language. If you're not sure of how to handle your particular scientific simulation requirements, come in and talk to us at one of our five computation centers. We'd like to help you discover the power of computer-aided design.



Write For Brochure

What you've read is only part of the story. For the rest, let us send you the detailed technical description of the EAI 8400 design. We've given deep thought to the rationale of every detail. You'll see "reason why" for everything we've put into the EAI 8400. You'll understand why it's being called the "hottest" digital computer on the market today—and "the computer that has everything." Send to Dept. 302 for your copy today.

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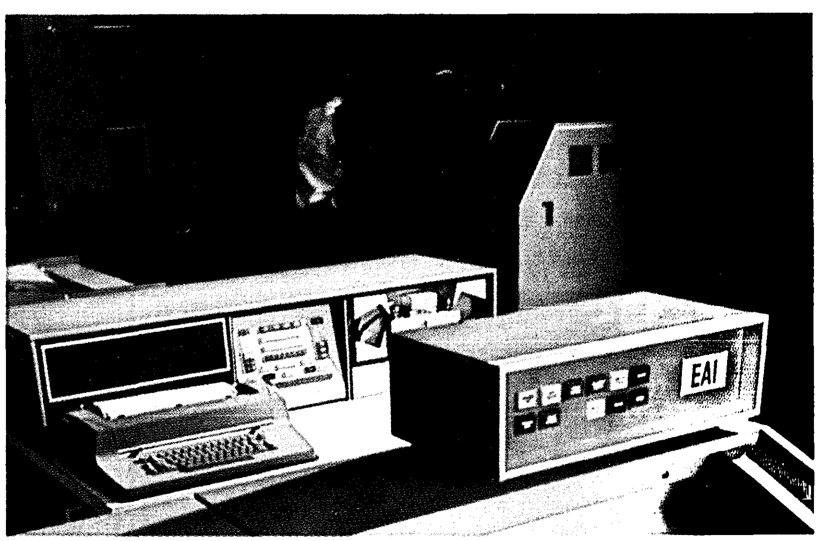

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West Long Branch, New Jersey

of the large machines to small ones is now of the order of 3 or 4 to 1. . . . I conjecture that the ratio of speeds (large to small machines) will tend toward 1:1. . ."

The 360 Model 30 has an add time of 39 microseconds. The Model 92 has an add time of about .1 microsecond. This is a ratio of 390 to 1. If we compare small specialized computers, the ratio is much smaller, but the comparison becomes multidimensional. Again, there appears to be no evidence to support Gruenberger's hypothesis.

4. **Security.** It is often said that small machines offer greater protection against unauthorized access to classified information. I seriously doubt that this is true. Larger, more powerful machines can perform scrambling and unscrambling techniques that one might not afford on small machines. A more centralized system of data storage, control and security may be possible with larger machines and more time can be devoted to the problem if fewer but more highly specialized people concentrate effort on the problem. In 100 different, small installations, a great deal of scattered effort is devoted to solving the security problem. In a large, central system, this may not be the case. Of course we must be careful not to necessarily confuse large machines with large organizations although the former often implies the latter.

Some of the controversy is over *communication links* and not computers themselves. Reliability, safety, and cost are all affected by these links, if such exist. It is important to point out that large systems can justify themselves *in the absence of remote computing.* Terminal operation is not a necessary condition for a large, or even time-shared, computer. But the reliability of a system is constrained by the least reliable component, and it is true that most present communication links were not designed for data transmission and have not been as dependable as we want them. But the past market has been so small that little attention was devoted to the problem. Now the demand for such services is rapidly increasing and the quality of product must necessarily increase in responding to that demand.

In summary, small computers will be around for a long time but not because they are cheaper, or better, or safer. They offer, in some cases, convenience, status, independent assignment of priorities, and some specialized facilities not yet well-implemented on large computers. But when it comes to general-purpose computing, the economies of scale are swinging increasingly in the direction of large machines. Computers offer such large economies that the large-scale computer utility seems imminent. ■

THE UNIVAC 9200 AND 9300

low end of a new family

The first of a new breed of computers from the Univac Div. of Sperry Rand Corp. was announced late last month. The 9000 series starts with the small-scale 9200, a card-oriented system for users upgrading from tab gear. A step above it is the 9300, and a medium-scale 9500 system is promised soon. The program-compatible family uses monolithic integrated circuits and a plated-wire main memory. The latter operates in a non-destructive readout mode, obviating the rewrite cycle after each read cycle. Easier to fabricate than cores, wire memories are said to cost "a good deal less."

The 9200 has a cycle time of 1.2 usec, and memory capacity from 8-16K (8-bit-plus-parity) bytes. Each byte can store two numeric digits or one character. It has 16 registers, eight for arithmetic and eight for I/O functions, and performs over 10,000 additions/second. Processing is overlapped with card I/O. Software includes an operating system, assembler, report generator, reproducer gang-punch program, and Mathpac routines for scientific calculations. (Included in the latter is floating point.) Prices range from $39,340 to $98,685, and rentals from $1,040 to $2,420. Deliveries begin in 12 months.

The larger 9300 has 8-32K bytes of memory and a cycle time of 600 nanoseconds. It performs 20,000 additions/second, has 16 registers, and performs processing overlapped with card I/O and tape reading or writing. Optional is simultaneous tape read, write and compute.

A card and tape system, the 9300 accommodates up to 16 tape drives; the 34KB units permit read or write operations at speeds up to 68,000 cps. Or place a 1001 Card Controller on-line and the system will process more than 2,000 cpm from as many as four separate inputs. The operating system enables the concurrent processing of one or two peripheral programs simultaneously with a main processor program. Other software include FORTRAN IV, COBOL, and an assembler. Prices range from $62,610 (card system) to $348,380 (maximum tape system). And comparable rentals are $1,675 and $9,310. Deliveries begin in September '67.

Peripherals include the 1001 which, with a 9200 or 9300, permits card file merging and selection with processing. Off-line, it collates, sorts, edits and proves. The 9200 also has a 250-lpm printer (with a 63-character type bar). With a 48-character type bar, it prints alphabetic lines at 250 lpm and numeric lines at 500 lpm. The standard 96 print positions can be expanded to 120 or 132.

The printer for the 9300 runs at 600 lpm with a 63-character type bar. All-numeric printing with a 16-character bar is at 1,200 lpm. The standard model has 120 print positions, expandable to 132. The tape drive, a Uniservo Vic, handles 9-track tapes recorded at 800 bytes/inch. Transfer rates range from 34,160 all-alpha to 69,320 all-numeric characters per second. ■

role of small machines

COMPUTER CHARACTERISTICS

by ROGER T. BAUST*

The pace of hardware introduction has declined rather dramatically during the first half of 1966 as compared to the two previous years. This issue of the *Quarterly* lists only three new computers, and in the April issue none was added. Four other machines, the ASI 6130, Burroughs B6500, and the Univac 9200/9300, were recently announced and will be included in the October issue. By the time this article appears, though, several other new machines may have been unveiled. This compares to 45 general-purpose computers announced in 1964 and 35 in 1965.

The trend toward computer families has submerged some interesting aspects of small individual computers. At the bottom of an extensive series of machines, the small computer is often marketed as the first step in the growth of a new installation. In this case, the emphasis on upward compatibility is easily understandable. However, many small computer installations have no requirement for upward compatibility in that they are used in special-purpose systems or applications. These small computers are priced quite differently than small general-purpose data processing systems and require some explanation to prevent misunderstanding.

The low-cost special-purpose computer usually has a small word size, 12 to 18 bits, thus facing the designers with the problem of large memory addressability with a small address field. While ingenious techniques involving indirect addressing have been developed to overcome this problem, they often require the programmer to resort to inefficient and core-devouring ways of effectively using the addressing scheme. Limited word size also implies limited accuracy, which for some forms of computation necessitates double-precision techniques, further increasing the storage requirements. The additional instruction executions needed to perform a given task are usually offset by a very high instruction execution rate.

"Getting what you pay for" is characteristic of these small machines, often requiring the customer to choose from as many as 100 optional extras, all at additional cost, to make them functional. Like the auto industry, the basic model price bears little resemblance to the actual purchase price. This is really a blessing in disguise, since many applications of such machines do not require full-scale computational or input-output power and hence do not suffer that cost penalty of unused capability. A basic computer may have only a 4K memory with a Teletypewriter for input-output. The $30,000 purchase price of the basic machine could jump to $100,000 for an 8K machine, high-speed punched paper tape equipment, and a pair of slow-speed magnetic tape drives.

Time-sharing may well reverse the current role of the small computer from being competitive to being complementary. The use of small computers in time-sharing, which Fred Gruenberger described in the April issue of DATAMATION as the "best of both worlds," may present the small computer with a bright new future. Linked to a large-scale time-shared system, they can, even in their stripped-down version, serve as data collectors, display processors and extensions to the central processor's computing power. In this capacity, the limited capability of the small machine may well be the most economical solution to come of the perplexing problems that confront the time-sharing world today. ■

* Mr. Baust is editor of "Computer Characteristics Quarterly," published by Charles W. Adams Associates, 575 Technology Square, Cambridge, Mass. 02139. The publication is available from that firm for $10 a year. Adams Associates also holds the copyright to this tabulation.

SECTION I

	Monthly Rental Typical Range	*First Delivery* Month and Year	*Processor Speed* Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	*Internal Storage* Capacity in Thousand Words	Word Size	*Magnetic Tape* Thousands of Characters per Second	Buffering	Read Forward and Reverse	*Disc Storage* Capacity per Unit	Access Time in Milliseconds	Thousands of Characters per Second	*Drum Storage* Capacity per Unit	Access Time in Milliseconds	Thousands of Characters per Second	*Peripheral Devices* Cards per Minute In—Out	Paper Tape Characters per Second In—Out	Printer Lines per Minute	Off-line Equipment	*Other Features* Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Memory Protection	Byte. Manipulation	Console Typewriter	*Software* Algebraic Compiler	Business Compiler
SCIENTIFIC DATA SIGMA 7	$15,000 (5.6-20)	10/66	2.0^{C}	1.2	$4\text{-}131^{E}$	32b	15-60	MR WC	√	—	—	—	$1.5M^{L}$	17.5	90	800^{M} 300	300 120	1000 800	—	√	224^{S}	√	$√^{U}$	√	√	√	$√^{Y}$	$√^{Z}$
BURROUGHS B3500	$7,200 (4.8-20)	5/67	32^{C}	1^{D}	10-500	$1a^{F}$	9-72	MR WC	√	10 M	20	240	—	—	—	1400^{M} 300	1000 100	1040	—	√	3^{S}	√	√	√	√	√	√	√
BURROUGHS B2500	$5,000 (4.2-12.3)	1/67	64^{C}	2^{D}	10-60	$1a^{F}$	9-72	MR WC	√	10 M	20	240	—	—	—	1400^{M} 300	1000 100	1040	—	√	3^{S}	√	√	√	√	√	√	√

SCIENTIFIC DATA SIGMA 7: C. Includes indexing and mapping and assumes memory overlap. E. Up to 32 additional 16-word blocks of fast memory with 60 nanosecond read and 90 nanosecond write. 6 microseconds needed to save one block and bring the next into use. L. Access time can be reduced by scheduling algorithm. This disc is listed under drum storage because its function is similar to that of a drum in there is no lateral head movement. M. 400 cpm reader also available. P. 132 print positions. S. 7 in each register block with up to 32 blocks available. U. Optional. Y. FORTRAN IV with first delivery; PL/1 in 3rd quarter of 1967. Z. PL/1. Note. This system uses memory mapping which allows dynamic hardware relocation and has other features oriented to multi-processing and time-sharing.

BURROUGHS B3500: C. Add time assumes two five-digit numbers. D. Per two bytes. F. Eight-bit characters or bytes. M. MICR sorter-readers are available and can also be used off-line. S. When system is multiprogrammed, each program has the use of three index registers.

BURROUGHS B2500: C, D, F, M, S. See Burroughs B3500.

ABA NATIONAL AUTOMATION CONFERENCE

If it was a bit windier than usual in Chicago June 6-8, it *could* have been due to the presence of some 1500 bank automaters discussing such airy topics as the checkless society, an automated nationwide credit information system, central files, etc.

The panel on "Computer Utilities—What? When? Where?", chaired by W. Putnam Livingston of Bankers Trust Co., was one of the best. The topic was *really* a financial information utility, but before that can come about, said Livingston, two prerequisites are a standard information format (requiring a "prodigious effort") and the use of numbers instead of names. Computer Sciences' Bob Head equated the utility with a national credit system, which he equated, in turn, with the checkless society, something he feels can be a reality in 5-10 years. The big question: who will control the utility?

Clarke Newlin, dp manager of the Associated Credit Bureaus of America, said that the credit bureaus will operate a nationwide credit information system for credit granters. He mentioned the first step toward such a possibility: a cooperative effort of IBM, the Credit Bureau of Houston and ACB which will result in a computerized credit bureau in Houston in early '67. It will be followed by another in Dallas.

James V. Vergari, vp and general counsel of the Federal Reserve Bank of Philadelphia, says the check is a payment device, not a credit instrument, and he raised several basic questions which must be answered before the checkless society checks in. Among them: What will replace the check? What will be the role of demand deposit? What do we do about float? (Yeah, cries Mr. Average Consumer).

Another panel on a national credit information system posed visionaries versus look-before-you-leapers. Harold B. Hassinger, First National Bank of Boston, took a look at the requirements of compatible, machine-readable information and a central file accessible without human intervention. He predicted a universal ID number soon. And he cited the rapid emergence of three credit information systems—Credit Data Corp., Hooper-Holmes, and Credit Intercommunications—who have been asked by major New York City banks to submit proposals for an automated credit exchange.

Charles Block, Chase Manhattan, claims that more research into the checkless society is required before it is haphazardly pursued. (See Letters, May, p. 11.) Questions posed by Block: Is the check now obsolete? (No.) Can banks handle required check volumes? (Yes.) What do the customers want? (Let's study the various functions of checks.) What will be the effect on banks? (Hmm.) He noted the various means available to reduce the number of checks (bank payment of bills, one-check payrolls, credit cards), pointed out that at his bank individuals write only 35% of the checks the bank handles. "The future is not inevitable," he said.

Dick Sprague, of Touche, Ross, Bailey & Smart, spelled out a beautifully intricate automatic credit system called SAVE (System for Automatic Value Exchange), which ties together consumer, retailer, banks, computers and terminals.

A panel on the computerized central information file emphasized the problems to be faced by PIP (Personal Identification Project) in consumer identification. Bernard J. Ellis, ABA's PIP coordinator, touched on the relative merits of social security numbers, birth numbers (a la Sweden's system), voice recognition, and —of all things—names. Walter E. Trabbold, comptroller of the Bank of Delaware, described the pioneering his bank has been doing in central file development in cooperation with IBM and AT&T. George B. Chaffin, representing the Worcester County National Bank in Massachusetts, said his bank has devised a coding technique that achieves a high degree of accuracy in file retrieval attempts using name as the identifier.

A status report and preview of banking automation by Dale Reistad and Robert K. Wilmouth, chairman of the ABA automation committee, revealed some interesting facts. Of what Reistad says were 5000 computers installed in the U.S. in '65, 300 went to banks. And he noted one teensy step toward the checkless society—something that 52% of the banks surveyed by the ABA think unlikely to happen —the application for a patent for a cheap "money key."

The survey also reveals that 81% of the banks answering accept the extension of computer services as fact or coming in time. The respondees reckon it will be 10 years before plain folks like you and me pay our bills by phone, but 17% of the banks say OLRT is an accepted fact, while 33% think it's coming eventually, and 14% don't believe it will ever happen.

On the standards front, ABA has helped to persuade the Post Office to change over from 51-column to 66-column postal money order form; accepted a standard designation for securities; and has established a PIP committee to investigate the "desirability and feasibility of establishing a uniform system of personal (credit) identification in the United States."

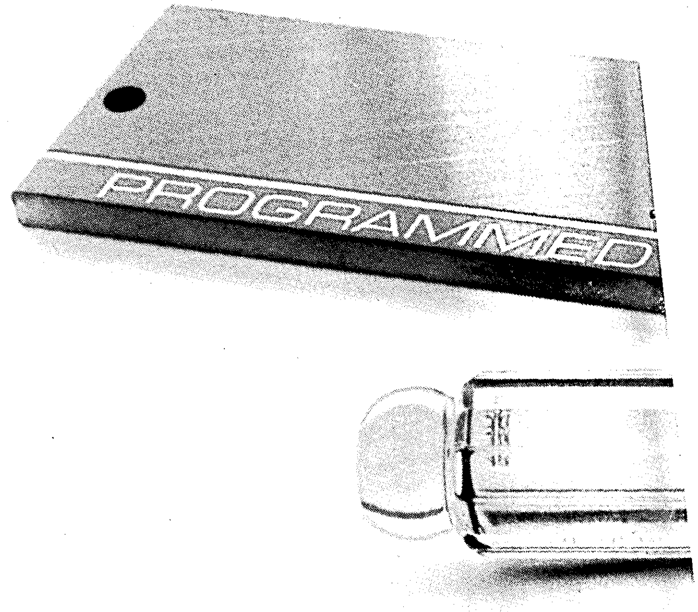
software for sale

One panel on software evaluation, sale and exchange featured a debate on whether the ABA should set up a centrally administered and controlled computer library, or simply act as a central clearing house for software. The audience voted in favor of the clearinghouse, 84 to 10. The debate was more than academic: a "SWAP" room at the conference had listed 540 programs as either available or wanted, and heavy preliminary interest in the programs was reported, although it's difficult to tell how many deals will come from the program, only recently established by ABA. Payroll, with 22 entries, led the list of program packages wanted, evidence that Computer Sciences Corporation was on the right track in announcing the availability of such a package for the 360/30 at the conference.

There were few surprises or eyeopeners at the exhibits, where 29 firms offered their wares and services in 69 booths. GE showed its PR-21 printer, which prints its own COC-5 optical font at 1200 lpm, and a document sorter with COC-5 and MICR reading ability. Both NCR and Cummins-Chicago Corp. showed units incorporating the Mohawk Data Sciences keyboard-to-mag-tape-unit. NCR showed how checks rejected by a sorter could be read onto the Mohawk tape; C-C used it to capture data being read from perforated payment coupons.

It was, in general, a good conference, well organized and well attended. Bank automation is evidently here to stay.

—ROBERT B. FOREST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Los Angeles, August 23-26
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An operating PDP-9 will be at WESCON in L. A. on August 23, and New York and Boston immediately thereafter. The PDP-9 is a new, high speed, low cost, medium size general purpose computer.

If you're thinking of buying a CDC 1700, or an IBM 1800, or any other 16 to 24 bit computer, then wait.

Think on this. When the PDP-1 was introduced, it was the world's first computer for less than $100,000. When the PDP-8 was introduced, it was the world's first computer for less than $20,000.

The PDP-9 is bigger than the PDP-8. But price and performance are in our blood. The PDP-9 is worth its wait in gold.

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COMPUTERS · MODULES

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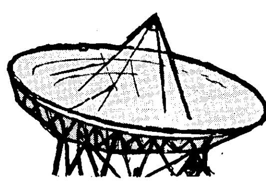
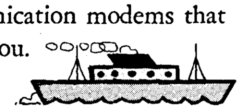
CIRCLE 36 ON READER CARD

If you have data to communicate, why not talk to the world's most experienced data communicator?



Data to communicate?

We have an expression about our data communication modems that will interest you.



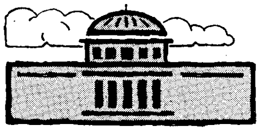
It's "optimum combination of factors."

Best technique (Kineplex). Reasonable cost. Minimum dimensions. Minimum power requirements. Ease of operation.

It's experience that makes such a combination possible.

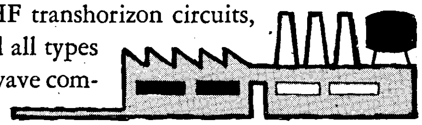
Collins began its continuing research program in data transmission systems shortly after World War II, when the need for more efficient high speed systems of this type became evident.

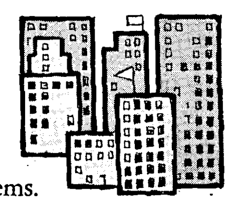
That program has produced many of the landmarks along the industrys' state-of-the-art path.



One of the program's major achievements was the development of Kineplex, a Collins modem technology which is now universally accepted as that which provides minimum error rate with maximum transmission rate per unit of bandwidth.

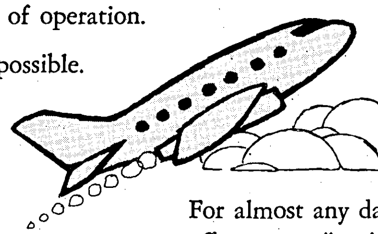
Our field experience with Kineplex has been extensive. Collins modems are used in Atlantic and Pacific transoceanic long range HF circuits, VHF transhorizon circuits, VLF radio circuits, and all types of wireline and microwave communication networks.





Collins modems are serving in tactical and strategic operations for the military, in defense and business applications for the government, in tracking operations in the nation's space effort, and in large and small industrial communication systems.

They also are used in secure voice and teletype systems to transmit encrypted digitized signals.



Collins modems are available in airborne, rack, and cabinet configurations, and in a wide range of data rates — from very slow to extremely high speeds.

For almost any data transmission problem, Collins is able to offer you an "optimum combination of factors."

For information on specific equipment or applications, call or write to: Data Marketing Department, Collins Radio Company, 19700 Jamboree Road, Newport Beach, California. Phone: (714) 833-0600.

COLLINS RADIO COMPANY • COMMUNICATION / COMPUTATION / CONTROL

COLLINS

WORLD HEADQUARTERS / DALLAS, TEXAS

CIRCLE 33 ON READER CARD

news briefs

STONY BROOK CONFERENCE ON ADVANCES IN COMPUTING

A swat at irresponsibility in the software community and a panel's "close look at time-sharing" were the major happenings at the recent Second Stony Brook Conference on Advances in Computing.

Dr. Herbert Grosch, of GE, speaking to 500 attendees at the one-day meeting, criticized all involved—manufacturers' programmers, users, universities—for forcing manufacturers to produce software systems which are not widely needed and which affect the price of all hardware. We are at the end of the second and the beginning of the third generation, he said, and have the opportunity to stop and consider wasteful practices. "Is it necessary that the user have his programming system done by all the manufacturers he might buy from?"

Universities have more power than their 40-percent-discounted equipment entitles them to, Grosch said. Their continuing domination of professional organizations, which are supposed to circumvent "individual greed," has "encouraged a proliferation of unused dialects in the software universe." Grosch also called for the disbanding of SHARE, just to make his point that user groups are also not fulfilling their role—which is to put pressure on the manufacturer before a system comes into being, not to discuss its details afterward. Government dp leaders are readying to put the squeeze on the software industry, he noted, referring to the standardization effort, and it deserves it.

The time-sharing panel discussed applications for the technique and debated time-sharing versus hierarchical systems. A major criticism, coming from the floor, concerned the many systems being planned for putting "pipsqueak data" on-line and acting as no more than electronic calculators. The panel pointed out several important on-going projects, in particular on the on-line escalation, or expansion, of languages. Gilbert McCann described Caltech's pioneering work on such a system, which is operated by an IBM 360/50 and uses a file shared with a 7040/94 system.

Some of the time-sharing issues becoming evident from experience, as listed by J.C.R. Licklider of IBM, include speech output, on-line programming and debugging, and command languages of the operator-operand sort. Sharing is also a means to implement graphic man-machine interaction, on-line public files, on-line CRT-aided programming, user-oriented languages more sophisticated than the operator-operand sort, management information systems, and computer-assisted instruction.

Should all the user's dp functions be put on one system? Dr. Saul Rosen noted that Purdue's experience has shown that time-sharing can cater without great trouble only to a well-matched set of problems. A hierarchical arrangement of computers was thought to be preferable for meeting varied needs. For example, light pen control might best be handled by a peripheral computer. Neither system arrangement is inexpensive but, the panel noted, "if you have to ask the cost, you can't afford it."

The panel warned against thinking manufacturers would do a better job on time-sharing software than they did on batch-processing, or that big new systems will be more reliable than—or even as reliable as—the old systems.

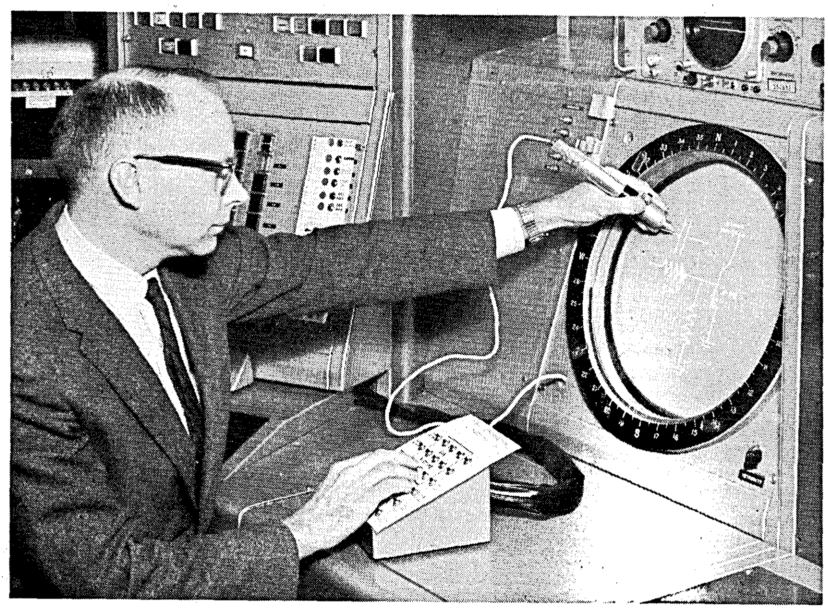
HONEYWELL ABSORPTION OF 3C UNDER WAY

The implications of the Honeywell buy of Computer Control Corp. are slowly becoming evident. First, a Computer Group, headed by vice president Walter Finke, has been formed to encompass the Honeywell EDP division and 3C, now called the Computer Control Division. Further, the Honeywell process control activity now is in Computer Control's bailiwick and is called the Control Systems department. Formerly this activity was handled by the Industrial Products division in Ft. Washington, Pa.

Honeywell maintains that 3C will keep what it came with—in personnel, plants, sales offices, and product line.

NBS MAGIC USED FOR ON-LINE MAN/MACHINE RESEARCH

A Machine for Automatic Graphics Interface to a Computer (MAGIC) has been developed by the National Bureau of Standards, with support from the National Aeronautics and Space Administration. Directed at facilitating two-way communication with computers and the operation of remote inquiry stations, MAGIC senses pictorial material drawn on its screen and stores drawings in its memory for later recall. The multi-section console includes CRT, keyboard for input, built-in and accessory control panels, and a secondary passive display. MAGIC operates on the principle that a curve can be represented as a series of points along a connected path on the display area. It's now connected to a MOBIDIC B twin computer and peripheral devices.



Have you ordered an IBM/360?

Have you also ordered, or considered, a digital plotter to produce computer data in graphic form?

A picture is still worth ten thousand words – or stacks of printed listings.

Let CalComp show you how volumes of computer output can be reduced to meaningful charts and graphs – automatically, accurately, and completely annotated.

CalComp Plotters are compatible with the IBM/360 and other advanced digital computers... and with the computer you now use.

Call "Marketing" for details.

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CIRCLE 40 ON READER CARD

But as a division it is expected to double its sales within the next three years. Based on the last six-month report, this would mean annual revenue of almost $60 million. Heading up the CC division as vice president and general manager is Benjamin Kessel, formerly president of 3C; his EDP division counterpart is C. W. Spangler, sitting in Finke's former spot.

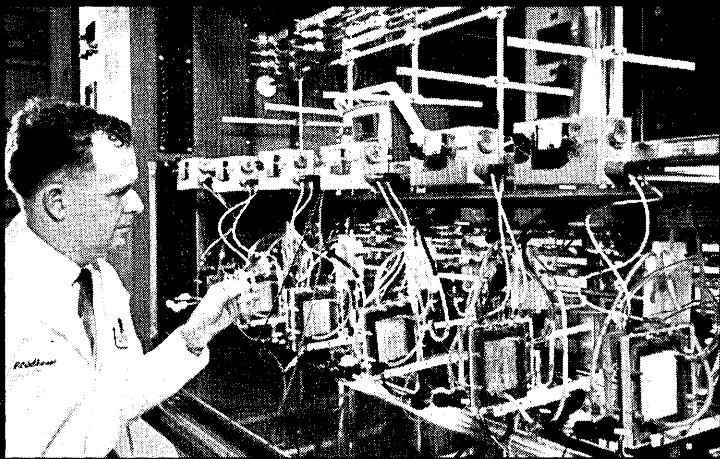
The Control Systems department, managed by R.W. Moe, is expected to come out with new process control systems, aided in the area of direct digital control by 3C know-how. The H-20 process control system now produced will continue to use the 21 processor in most instances, although, where preferable, processors which came with the 3C line will be substituted. (Most 3C computers have been sold to systems builders in areas like process control.) All sales personnel in the industrial division who were involved with process control computers will be shifted to this department, which will continue to be located in Ft. Washington.

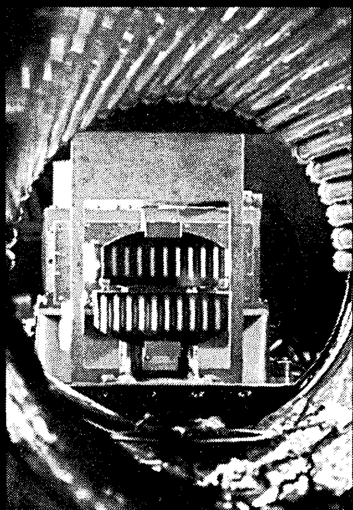
NEW YORK ACM CHAPTER HASHES OVER ON-LINE USE

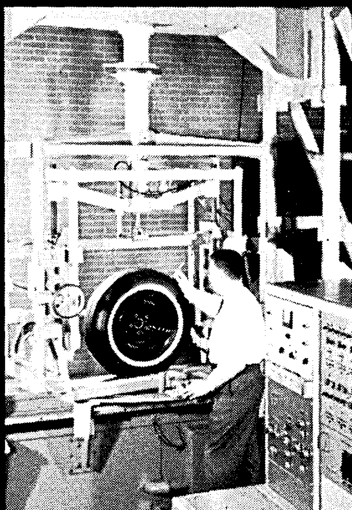
"By 1970 nearly all systems will be of the on-line real-time variety." "Would you believe 10 per cent?"

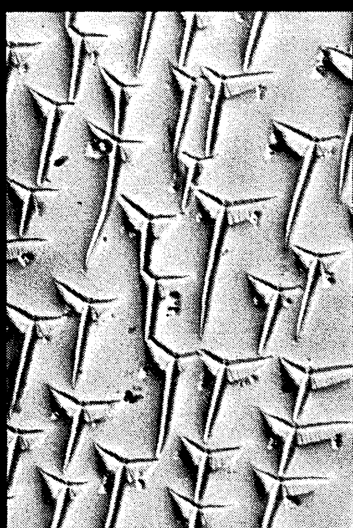
A debate on the immediate future of on-line real-time systems (OLRT) was the preoccupation of a recent New York City ACM chapter meeting. Richard Sprague of Touche, Ross, Bailey & Smart reasserted his prediction made in 1960 that most systems would be on-line by 1970 because of the economic and systems needs that persist: for centralization, for integration of functions, for faster response time, for bringing data processing to the user at his location, for placing large files on-line, to solve the problems created by batch processing, for smaller firms, etc.

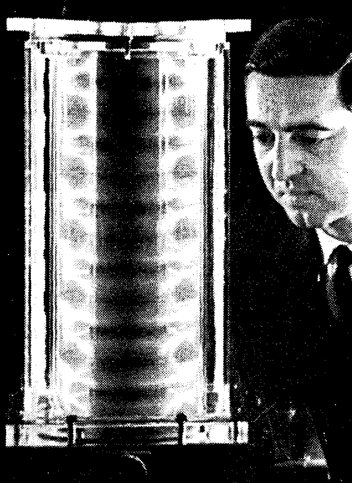
The antagonist on the panel, consultant Richard Brandon, saw little hope for such rapid OLRT development (maybe 20 per cent "eventually") and relegated "management information systems" to the growing dp list of myths. He and consultant John Morrissey noted that the deterrents are: the lack of qualified systems people, the complexity of real-time software, and the lack of a workable general-purpose system. Brandon felt that any OLRT systems planned for operation by 1970 must be in the first stages of implementation now. Most present installations are small, he said, and their managers are not sophisticated enough to tackle OLRT.

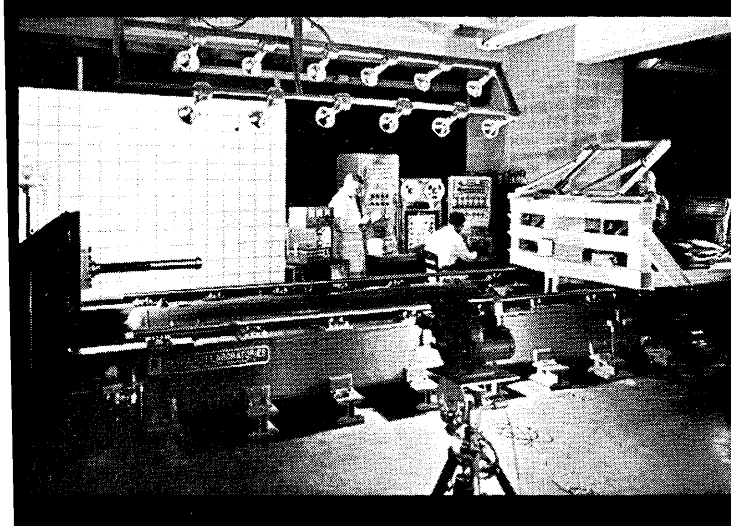












Our anniversary pictures came out fine, but we're still not completely happy with them.

We're in a reminiscing mood.

Just ten years ago the General Motors Technical Center was formally dedicated, became our new home. It's an inspiring campus for contemplation . . . and accomplishment.

What have we been doing this past decade? Research ranging from adhesion to x-ray diffraction—covering crystals, corrosion, computers, energy conversion . . . magnetics, polymers, reliability, stress . . .

Some specific accomplishments in three broad areas:

■ Research on combustion reactions, vehicle emissions, emission controls, and smog chemistry. We found that one-third of the automotive hydrocarbons in the atmosphere came from crankcase vents. So we shut them off. We've developed a system for effectively decreasing the exhaust hydrocarbons too. And we've discovered which hydrocarbons are the worst offenders in smog formation.

■ Traffic dynamics, vehicle handling, and driver aids. We've developed mathematical descriptions of road traffic situations, pinned down many interrelationships between car, road, and driver. Our mathematical models also describe vehicle ride, vibration, and directional control. And we've explored automatic highways and car-road communications systems as new approaches to safe, efficient travel.

■ Engines. Our gas turbines now have good fuel economy, excellent engine braking, and very low hydrocarbon emissions. The quiet GMR Stirling engine is extremely efficient, with a closed cycle taking heat from almost anywhere.

We like our anniversary pictures. But they tell such a small part of our whole story.

GM

General Motors Research Laboratories
Warren, Michigan 48090

Research on fuel cell electrodes.
Long path infrared study of smog photochemistry; study of tire behavior.
Electron micrograph of iron whisker surface; basic study of fluid mechanics.
Research on human injury tolerance.

news briefs

Manufacturers surely won't have the software developed in five years that the unsophisticated can use.

Sprague countered, noting first that the proliferation of utilities will put more users on-line without the corresponding increase in the demand for computer people. "We will eventually see a non-linear relationship between people and systems." As for a general-purpose system, he pointed to the KEYDATA commercial time-sharing operation as surely a "beginning" in this area.

Henry Staehling of Western Union opined that the software would solve itself—meaning both that manufacturers would provide it and that it is not that different from batch-processing software. The real problem not being dealt with is specialized I/O terminals, he said. Staehling also thought "real-time is a fact because IBM says it is." Morrissey argued IBM was not about to be an innovator in this area, when they've "already got a good thing going."

THREE DAYS IN AUGUST: THE ACM CONFERENCE

The 21st Annual National Conference of the Association for Computing Machinery is scheduled for Aug. 30-Sept. 1 at the Ambassador Hotel in Los Angeles. General chairman for the event this year is David F. Weinberg, TRW Systems.

The opening day sessions will hear a keynote address by Russell G. McFall, president of Western Union. First-day sessions will discuss the data base dilemma, numerical analysis, simulation and file management. On Wednesday, Aug. 31, sessions will include business data processing; engineering, medical and scientific applications; historical development of programming languages; and social responsibilities of the computer professional and the industry. On Thursday, panels will review time-sharing, computer program patents and information retrieval.

Companies planning to utilize the conference for recruiting purposes are being asked by the ACM to register with the committee and pay a $1000 fee.

UNIVAC, IBM GET AIRLINE ORDERS

Three more airlines have announced their orders for new computers: Scandinavian Airlines, Air France (both Univac) and Braniff (IBM). SAS, by May, 1967, will install two 494 systems; Air France will have two 1108 multi-processors in operation by 1968 and will complete expansion by 1977. Braniff has ordered two 360/65's to be in operation by the end of 1968.

The 1108's at Air France, Paris, will each have two 65K-word memory banks; auxiliary store will be 10 memory drums with a 327-megacharacter total capacity. Initially, 516 CRT agent sets (Raytheon design) will be located in 19 European cities, by 1977, 1105 units will be located worldwide. The SAS-Copenhagen configuration will have a 1005 slave computer, eight FH-432 drums (12.6 megacharacters total), and three Fastrand II drums (400 megacharacters). In Dallas, Braniff's 262K-byte 65's will have two 2314 disc files totalling 414 megacharacters. About 400 IBM 2915 CRT agent sets will be located in 34 U.S. cities.

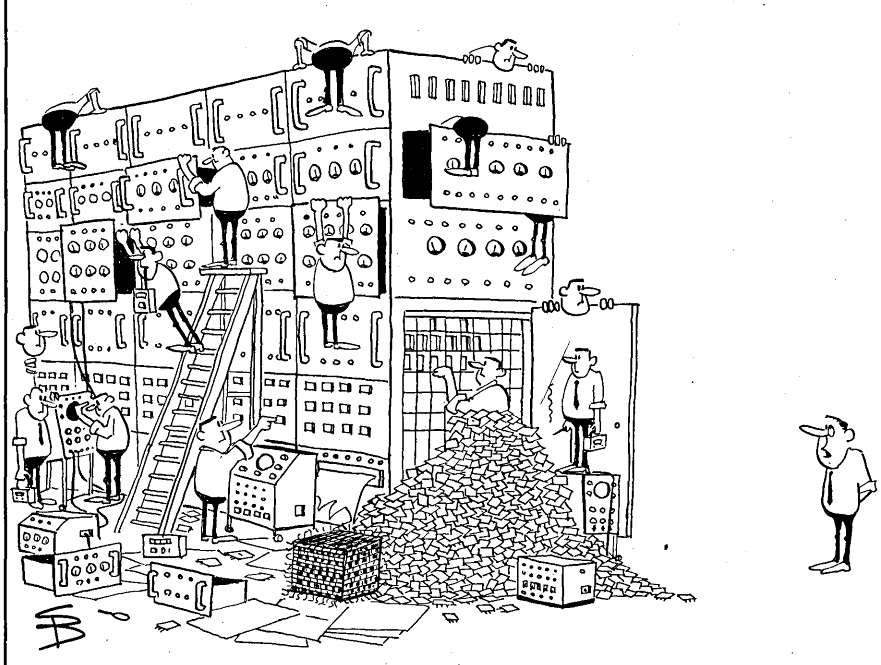
In addition to the above airlines, Univac has installations or orders at Eastern, Northwest Orient, BEA, Reuben Donnelley's interline reservations service (all 490 series), United (1108's), and SITA (European interline reservations service, 418's). IBM has 7000 series equipment at Pan American, American and Delta, and 360 models in or on order at Eastern, Continental, Western, Frontier, BOAC, Alitalia, and Qantas.

CDC SCORES OVER IBM IN $20 MILLION NASA ORDER

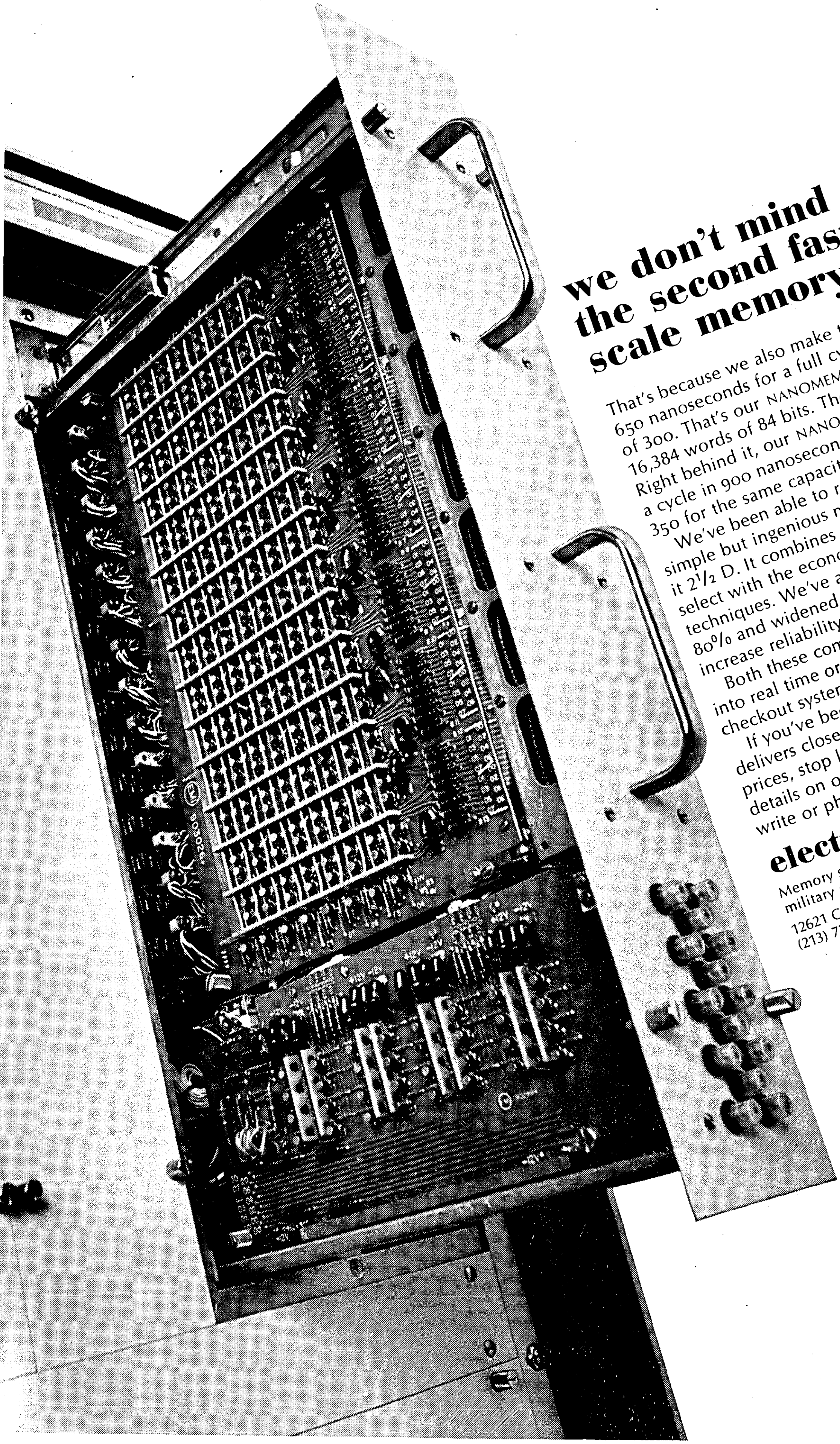
Control Data broke through with their first success in the big-machine market with NASA, beating out IBM to furnish a large-scale computer complex for Langley Research center.

The equipment, which includes two 6600's and a 6400, will cost about $20 million under a fixed-price contract awarded after competitive negotiations. It will be mated with analog machines and used for such simulation projects as rendezvous and docking in earth and lunar orbits, landing on the moon, and control of planned supersonic aircraft. CDC says the big system is to meet Langley's requirements for six years.

● Recognition Equipment has set up an international division to push the Electronic Retina Computing Reader in Europe. With headquarters in Germany, the division will also operate through subsidiaries in England, France, Italy and Sweden. First European installation of the computer-controlled optical reader has been made at the Swedish Postal Bank in Stockholm and there is a market for this type of multifont reader in many other European countries with similar postal banks. The company now has seven of their about-$600K machines in and orders for another dozen, including a recent one from American Express for three units. They plan on moving the Dallas plant into a new facility this September, designed to double present production capacity to two systems a month.



"Trouble?"



we don't mind making the second fastest large scale memory system.

That's because we also make the fastest. How fast? 650 nanoseconds for a full cycle with an access time of 300. That's our NANOMEMORY(TM) 650. It handles up to 16,384 words of 84 bits. They don't come any faster.

Right behind it, our NANOMEMORY 900 completes a cycle in 900 nanoseconds with an access time of 350 for the same capacity.

We've been able to reach these speeds by using a simple but ingenious magnetic organization. We call it 2½ D. It combines the speed potential of linear select with the economy of coincident current techniques. We've also reduced stack connections by 80% and widened operating margins to increase reliability.

Both these compact memory systems fit perfectly into real time or high speed computers and checkout systems.

If you've been looking for a memory system that delivers close to thin film speeds at magnetic core prices, stop looking. We've got two. For complete details on our NANOMEMORY 650 or 900, write or phone

electronic memories

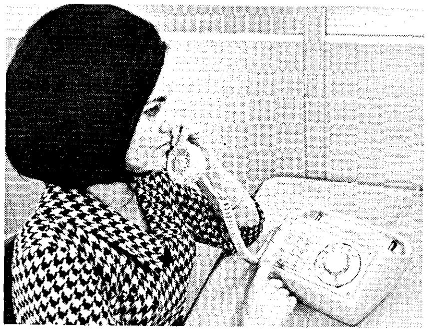
Memory systems, stacks and cores for commercial, military and space applications
12621 Chadron Avenue, Hawthorne, California
(213) 772-5201

CIRCLE 53 ON READER CARD

new products

telephone i/o

Called a data retrieval subset, this phone has both a conventional rotary dial and 12 pushbuttons. The rotary dial is used to call the computer through the central office switching



equipment, and questions to the computer are addressed through the touch-tone-type buttons. Answers, of course, must be in the form of a voice response. GENERAL TELEPHONE & ELECTRONICS CORP., New York, N.Y. For information:

CIRCLE 150 ON READER CARD

crt symbol producers

The model 401 is a series of stroke writers that produce symbols for CRT displays at up to 4 usec per symbol. With a patented function-generation technique, an unlimited character style and repertoire are said to be possible. Cards can be custom-built to produce virtually any shape of symbol, figure or character that can be made up of 20 or fewer straight line segments. The basic series has a 64-character repertoire (28 special symbols as specified and 36 gothic alphanumerics conforming to Mil-C-18012A. This is expandable to 128 characters. TASKER INSTRUMENTS CORP., Van Nuys, Calif. For information:

CIRCLE 151 ON READER CARD

gp computer

The SCC 655 is a small-scale machine with 4-32K (24-bit) words of core. Cycle time is 1.75 usec, add time is 3.5 usec, and multiply time is 24.5 usec. Features include hardware multiply/divide, hardware index register, two to 64 priority interrupt channels, and memory protect feature. Software includes FORTRAN and an assembler. SCIENTIFIC CONTROL CORP., Dallas, Texas. For information:

CIRCLE 152 ON READER CARD

image storage/retrieval

The model 1350 stores filmed images which, when accessed, produce aperture cards in 3-6 seconds. System capacity is 504,000 images, and up to 1,000 requests/hour can be made. Input and output is by aperture card, but the stored image is on a chip of film just like the original. The chip, however, also has an oxide stripe to hold identifying information. Images can be requested by an on-line computer, a card reader, or the system's printer-keyboard, but then a computer is still needed to find the address of the image desired. Handily, a 360 would fill this bill. In the on-line mode, a remote user could get the computer to find the address and do the accessing. IBM DP DIV., White Plains, N.Y. For information:

CIRCLE 153 ON READER CARD

half-page printer

Completely interfaced for use with small-scale computers (PDP-8, SDS 92, DDP 116 and H20), 32-column printer operates at 2400 numeric lines/minute or 1200 lpm alphanumeric. Either programmed transfer or program interrupt transfer operation is afforded. Interfaces for other processors also available. DI/AN CONTROLS INC., Boston, Mass. For information:

CIRCLE 154 ON READER CARD

communications/control system

The C-8500 has applications in multi-speed communications control, business and scientific computation, and real-time control. Heart of the unit is the 8560 computer group, a processor with either a 16K (8-bit byte) core memory with a 3-usec cycle time or from one to four 64K-byte 2-usec units. The latter has an access time (four bytes plus parity) of 750 nanoseconds. Internal coding can be ASCII or EBCDIC, and operations can be on a byte, half-word, full word, and double words. Add time is 4.5 usec, and multiply/divide time is 24 usec. Other features: multi-level indirect address-

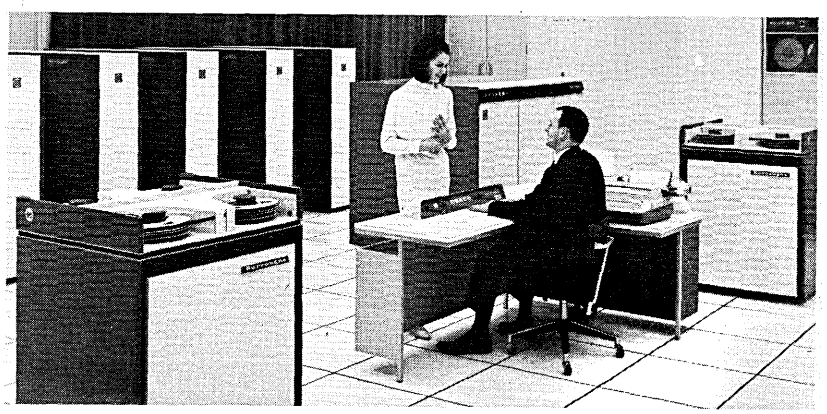
PRODUCT OF THE MONTH

The large-scale B6500 computer is a step above the B5500, with which it is compatible, but smaller than the B8500, with which it is not. Like the latter, the 6500 has a thin-film main memory. It is expandable from 16,384 to 106,496 (48-bit) words. Using monolithic circuits throughout, the processor clock rate is 5 MC, memory cycle time is 600 nanoseconds, and the access time is 300 nsec. Execution time for an add is 400 nsec, the average floating point multiply time is 6.4 usec, and the divide time is 11.2 usec.

Designed for multiprogrammed (time-sharing) operation under control of the MCP operating system, the 6500 can also be hooked up in a dual-processor configuration. Features include dynamic storage allocation and priority interrupts. Unlike current paging schemes, program segments are handled in variable size "pages." The system's secondary storage is a head/track disc file with a 20-msec average access time.

Software, which is already running on B5500's (announced and first delivered in '64), include the operating system MCP, ALGOL, FORTRAN and COBOL. Prices begin at $1 million ($22K/month) and deliveries are scheduled to start in the first quarter of 1968. BURROUGHS CORP., Detroit, Mich. For information:

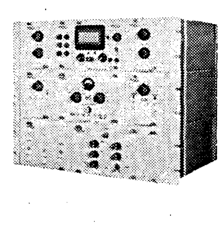
CIRCLE 155 ON READER CARD



ARE YOU GAGGING TODAY'S COMPUTERS WITH YESTERDAY'S COMMUNICATIONS

You probably are if you limit your data transmission rate to 200 cards or lines per minute, the average data transmission at 2400 bits per second. But you can take the gag off by boosting your data transmission throughput more than 80 per cent with the Rixon Sebit-48M modem which transmits at 4800 bps. You still use telephone voice circuits. You cut in half the time required to do such jobs as payroll transmission. You can add new functions to your system with the extra off-line time gained from the higher transmission rate. You often save labor costs and line charges, too. The Sebit-48M interfaces with all systems and complies with FCC regulations. Rixon equipment has removed gags from military and commercial systems around the world. It can do the same for you. Write or call Rixon and let us show you how.

Technical brief: *The Sebit-48M operates at 4800 bits per second over standard alternate voice/data lines as specified in FCC Tariff 237.*



RIXON ELECTRONICS, INC.
2120 Industrial Parkway/Silver Spring, Maryland 20904

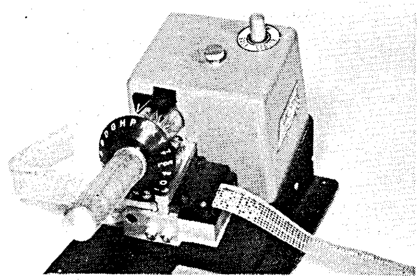
CIRCLE 46 ON READER CARD

ing, three hardware index registers, and FORTRAN IV. System I/O, servicing character-at-a-time peripherals and sensing/monitor devices, is by a multiplex communication loop, using a time division multiplex technique. Loop rate is 1.2-million bits/second. Data can also be transferred within a multiprocessor system on a full record basis. In this mode, blocks of data transferred at up to 640,000 bytes/second. COLLINS RADIO CO., Dallas, Texas, For information:

CIRCLE 156 ON READER CARD

paper tape punch

Manual device operates on paper or Mylar EIA 1-inch, 8-track tapes. Applications include punching of new



N/C tapes and correcting errors on tapes. Unit weighs 11 pounds. ELECTRO TECH, Minneapolis, Minn. For information:

CIRCLE 157 ON READER CARD

display recorder

The model 1311 has a 16-inch CRT that displays up to 2,048 alphanumerics that can be placed at any of 1024 x 1024 locations, a lightpen that can detect a character or a point on a plotted curve, and a 35-mm microfilm recorder. The latter, replaceable with a 16-mm unit, records at 6 frames/second. Designed for use with small and medium-scale computers, the 1311 has an optional line generator. Software is supplied. STRAZA INDUSTRIES, El Cajon, Calif. For information:

CIRCLE 158 ON READER CARD

off-line media conversion

Models MCS-2500 and 1800 convert both cards and paper tape to mag tape. They read paper tape at 1,000 cps, but card reading speeds are 1500 and 800 cpm, respectively. Both use the TM-7 tape drive, a card reader with separate control buffer console, and paper tape reader with self-contained buffer electronics. Tape densities are 200, 556, and 800 bpi, ASCII compatible. The system reads cards of 51, 80 or 90 columns, and tapes of 5 to 8 levels. AMPEX CORP., Redwood City, Calif. For information:

CIRCLE 159 ON READER CARD

communications systems

Simulcom is said to be the first communications system that allows up to 20 stations on a Teletype network leg to operate simultaneously over one voice grade circuit. (Under other systems, although several stations may use one line, only one station can transmit at a time.) Simulcom, which uses a new concept in character multiplexing techniques, requires that each station have a local control unit, two data sets (Ultronic's Data Pumps), and one or more Teletype units. A central control unit is placed in the main office for traffic monitoring. A switching computer can be used with the system to route messages between stations in different legs of a Teletype network. Cost of Simulcom for a 20-station network is $2,200/month. Initially, it will be used by brokers for transmission of stock transactions. ULTRONIC SYSTEMS CORP., New York, NY.. For information:

CIRCLE 160 ON READER CARD

logic cards

A family of digital cards, including programmable units, are drawn from the firm's SMS (standard modular system) used in 1400's. The programmable cards have a "program cap strip" that enable breadboard designs to be altered. Other cards include dual gated flip-flops, flip-flops with emitter follower outputs, oscillators, variable delays, single shots, integrators, etc. Delivery is within 30 days. IBM DATA PROCESSING GROUP, White Plains, N.Y. For information:

CIRCLE 161 ON READER CARD

miniature computer

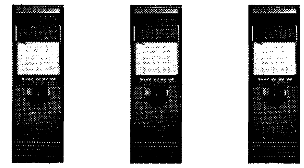
The model 5360 is an IC computer that meets Mil-E-5400 Class I and II requirements. It has 8K words of core with a 6-usec cycle time, weighs 30 pounds, occupies 0.6 cubic foot, and consumes 105 watts. Delivered to the MIT Instrumentation Lab as part of a flight inspection positioning system under FAA development, it will assist in evaluating FAA radio navigation systems by comparing positional information from such sources as TACAN, VOR, and ILS against that from an inertial platform. CONTROL DATA CORP., Minneapolis, Minn. For information:

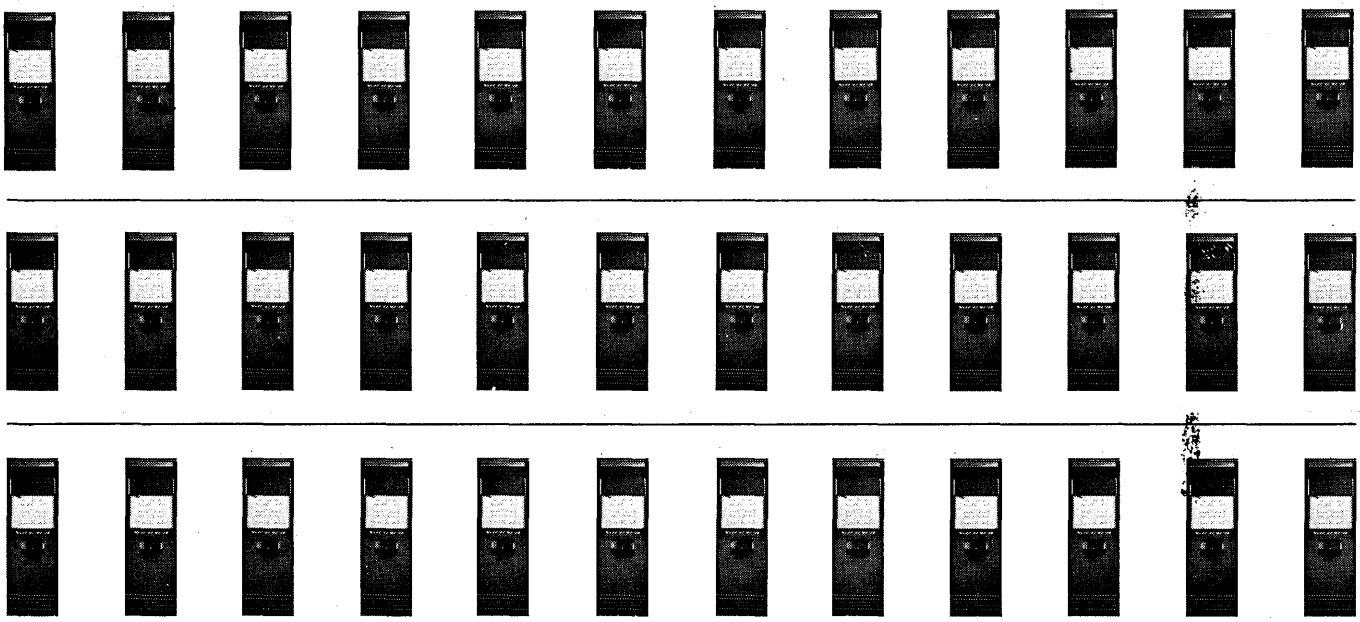
CIRCLE 162 ON READER CARD

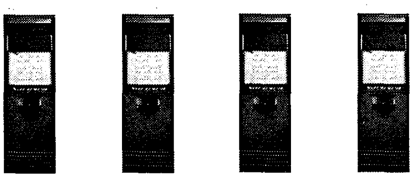
desk-size computer

The model WSS-10 consists of the model WS-02 scientific calculator, as well as data storage registers, storage for 512 program steps, punched card and patch board programmers—mounted in a desk. In addition to 72

These DATA/620's







have been hired!

to do the following jobs:

- Shipboard Telemetry Data Acquisition and Processing
- Real-Time Digital Data Compression Studies
- Digital Computer Maintenance Education
- Digital Computer Technology Education
- Point of Sale Data Acquisition and Display
- Automatic Checkout of Launch Vehicles
- Aqueduct Control System
- Business Data Conversion
- Character Recognition
- Polymer Chemistry Research
- Biomedical Research
- High-Energy Physics Research
- Wind Tunnel Data Acquisition
- Isochronous Cyclotron Data Processing
- Time-shared Engineering Calculations
- Portable Aerial Survey Data Processing
- Aircraft Test Data Acquisition and Processing
- Sonar Data Reduction
- Oil Well Drilling Optimization
- Optical Scanning
- Communication Concentration and Switching

The new Data/620 is a remarkably versatile computer adaptable to a wide variety of system, real time, and data handling applications, with such features as 16 or 18 bit words—over 100 machine commands—1.8 usec GP core memories—up to 64 I/O devices—software including FORTRAN, Assembler, Aid and Maintain.

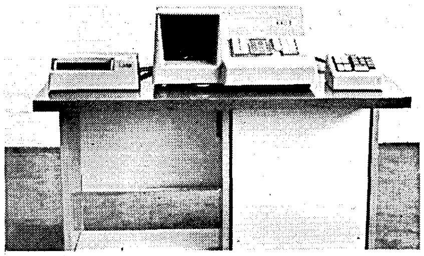
If you have a computer requirement, ask about the computer that really does the job, and costs $28,800—the DATA/620. We have an interesting fact filled 36-page brochure, yours for the asking. Write to:

DATA MACHINES

1590 Monrovia Avenue, Newport Beach, California • Telephone (714) 646-9371 TWX (714) 642-1364

Division of DECISION Control, Inc.

CIRCLE 47 ON READER CARD



decimal digits stored in arithmetic registers, 648 digits of storage are available. PRODUCTS DIV., WYLE LABORATORIES, Los Angeles, Calif. For information:

CIRCLE 163 ON READER CARD

upgraded computer

The GE-115 model II has a cycle time of 6.5 usec, down from 8 usec, 8-16K words of core, and is now being offered as a free-standing computer. Formerly, it has been available only as a remote terminal to large processors. Deliveries begin in April '67. GENERAL ELECTRIC CO., Phoenix, Ariz. For information:

CIRCLE 164 ON READER CARD

facsimile transmission

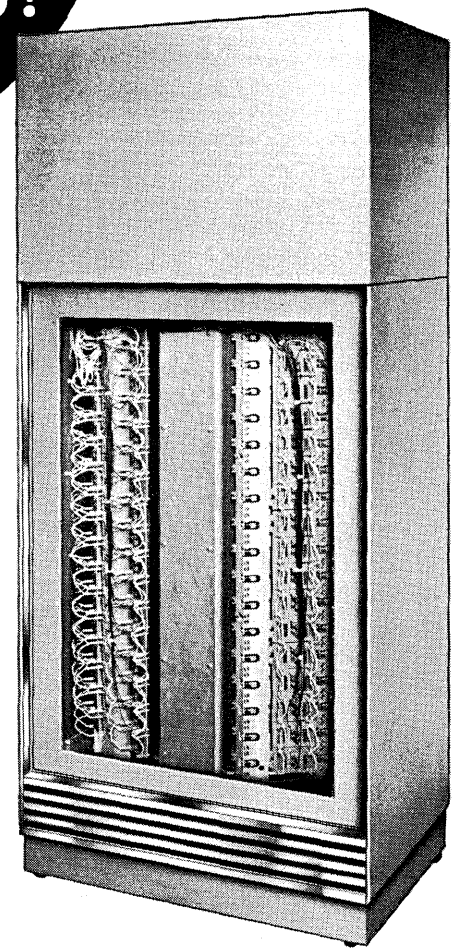
The 4 Dispatch facsimile communications system, with a 3½-inch scanning area which allows short-burst message transmission, is designed for office use. The roll-around console accepts 11-inch-wide documents and transmits via telephone lines to in-house or remote terminals, which can operate unattended. Optional features are push-button internal voice/facsimile switching, dataset, voice communications, and dictating equipment. ALDEN ELECTRONIC AND IMPULSE RECORDING EQUIPMENT CO. INC. Westboro, Mass. For information:

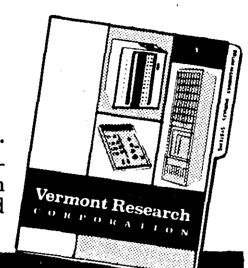
CIRCLE 165 ON READER CARD

modified mainframes

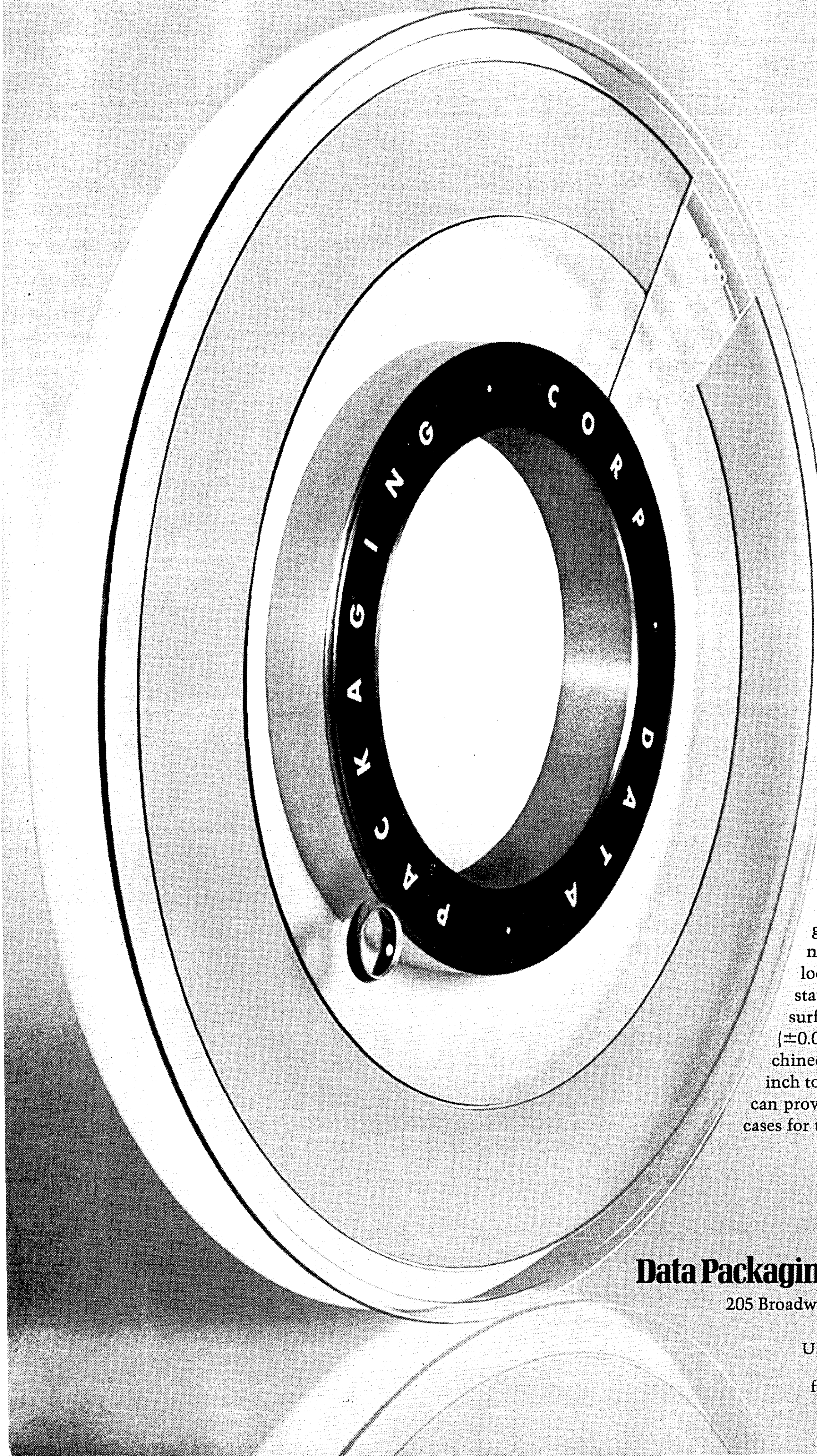
The A versions of the SEL 810 (16-bit) and 840 (24-bit) computers feature an I/O configuration permitting the operator to communicate with up to 64 external units. Both offer optional time-sharing features: program protect, variable base register, I/O instructions trap, and stall alarm. Standard features include a hardware index register, manual program stop, multilevel indirect addressing, two priority interrupt levels, and four sense switches. In addition, the 840A offers an optional extended arithmetic unit. Both systems have a 1.75-usec cycle time and core storage up to 32K words. Delivery is 90 days. SYSTEMS ENGINEERING LABORATORIES, INC., Ft. Lauderdale, Fla. for information:

CIRCLE 166 ON READER CARD





Vermont Research
CORPORATION



Be choosey.

The best reels for computer tape have aluminum hubs and winding surfaces. The best way to get them is to ask for them. / This is why you should. / Aluminum winding surfaces don't compress under tape pressure, don't explode when the pressure is gone, don't distort after any number of winds. / Flanges locked to the hub are parallel, stay parallel. / Hub and winding surface are machined concentric (±0.001 inch tolerance), faces machined flat and parallel (±0.001 inch tolerance). / Every tape supplier can provide Data Packaging reels and cases for the choosey ones. Be choosey.

Data Packaging Reels and Cases

205 Broadway, Cambridge, Massachusetts

U.S.A. patent numbers are 3229928 and D202831. Other U.S.A. and foreign patents issued or pending.

CIRCLE 50 ON READER CARD

new literature

LAMINATED PLASTIC FLOOR TILE: Four-page brochure illustrates Perma-Kleen floor tile for elevated floors. It requires no waxing, sealing or polishing and is an electrical insulator and will not indent from heavy equipment. Comparative data on various types of floor covering is provided and samples of five mist and abstract patterns are shown. GENERAL ELECTRIC CO., La Grange, Ill. For copy:

CIRCLE 130 ON READER CARD

TELEMETRY: 12-page periodical, "The EMR Telemeter," is published quarterly and intended to provide information to those who have recently entered the field as well as the experienced engineer. Early issues have covered basic telemetering techniques and some of the more recent advances in data communications. ELECTRO-MECHANICAL RESEARCH INC., Sarasota, Fla. For copy:

CIRCLE 131 ON READER CARD

COBOL INFORMATION: Bulletin produced by the COBOL task group of ASA's subcommittee X3.4 on common programming languages, supersedes previous releases. Bulletin number 8 is a working document containing language specifications for the proposed American Standard on COBOL, including elements of several functional modules, e.g., mass storage, sort, report writer, table handling, segmentation. Copies of 52-page document are available by writing on company letterhead. CIB EDITOR, DP GROUP, BEMA, 235 E. 52 St., N.Y. 10017.

STANDARDIZATION OF TYPEWRITER FONTS FOR AUTOMATIC READING: 53-page report is based on investigation and evaluation of existing typewriter fonts and includes an evaluation of a type font developed by ASA Subcommittee X3.1 on character recognition. Investigations were by computer-programmed assessment of each font using a technique developed partly under Air Force contract and under General Precision's Link Group-sponsored character recognition efforts. Order No. AD-630 471. Cost $3. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

ADVANCED GP COMPUTER ORGANIZATIONS: 82-page report states that to achieve maximum system performance from highly parallel computer organizations, new solution models and programming techniques must be developed. Three areas were investigated—applications, programming, and machine organization. Volume 1, Stock No. AD-631 870. Cost: $3; microfiche, $.75. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

LP SOFTWARE: Linear programming software system for the H-200 series is described in 31-page fact sheet. Among the items covered are application, agendum command options, report writer, matrix generator, running times, data input, monitoring features, solving simultaneous linear equations. HAVERLY SYSTEMS INC., Denville, N.J. For copy:

CIRCLE 132 ON READER CARD

NUMERICAL INDICATOR TUBES: Fact sheet describes types B-5440 and B-5441, low-cost, cold cathode tubes which measure 0.75″ wide and 1.8″ high when seated for minimal instrument-panel packaging density. Character size is 0.6″, giving a viewing distance of 30 feet. BURROUGHS CORP., ELECTRONIC COMPO-

NENTS DIV., Plainfield, N.J. For copy:
CIRCLE 133 ON READER CARD

TAPE REELS: Information on tape reels for instrumentation, computer, video and audio recording, detailing design philosophy of the reel, industry specifications and the care and handling of the reel is available in 14-page fact sheet. AMPEX CORP., Redwood City, Calif. For copy:
CIRCLE 134 ON READER CARD

TAPE PUNCHES AND READERS: 20-page brochure covers features and specifications on company line of tape punches and readers. Products are available for original equipment manufacturers and users of punched paper tape for dp and other applications. Brochure has index for quick reference. ROYTRON DIV., ROYAL TYPEWRITER CO., INC., Hartford, Conn. For copy:
CIRCLE 135 ON READER CARD

MICRO FORMS: Information and samples of aperture cards generated directly from 16mm or 35mm roll film is supplied. Return of original rolls intact and uncut is possible as well as 8½ by 11 Xerox print-out from roll film, microfiche and aperture cards with selectivity of image. PROFESSIONAL SERVICE CO., Brick Town, N.J. For copy:
CIRCLE 136 ON READER CARD

LINEAR PROGRAMMING: 16-page brochure describes applications and benefits and cites experiences within the construction industry, flour and feedmix companies, lumber firms and primary metals field, food processing and the oil industry. GE INFORMATION SYSTEMS MARKETING OPERATION, Phoenix, Ariz. For copy:
CIRCLE 137 ON READER CARD

SOLVING ENGINEERING PROBLEMS: Ten application notes cover problems solved on the PDS 1020, including RLC circuit impedance and phase angle, least squares curve fit, RC filter response, Chebishev filter response, numerical solution of a first order differential equation, RC filter step response, Butterworth filter attenuation curve, Gaussian error curve and RL circuit analysis. Each application note contains a definition of the problem, flow chart and a step-by-step solution sheet. PACIFIC DATA SYSTEMS, Santa Ana, Calif. For copy:
CIRCLE 138 ON READER CARD

Union Carbide's SYSTEM/360 checked in Wednesday, started work Thursday...

Union Carbide got their first IBM SYSTEM/360 at 11:00 a.m., June 23, 1965.

It arrived at their Tonawanda complex in pieces: a Model 40 central processing unit, a printer, three tape drives and lots of other blue boxes.

By noon the next day, it was ready.

Dr. S. L. Wang, Manager of the Computing Center, was impressed by the installation speed. Especially since it was the first SYSTEM/360 to be installed for industrial use in the East.

Within a week, SYSTEM/360 was helping to solve all kinds of engineering and scientific problems ... problems in cryogenics, problems in deep-sea pressure calculations, problems in air separation column design, problems in space vehicle insulations for Union Carbide's Linde Division, a major producer of industrial gases and cryogenic products.

Union Carbide credits the efficiency and flexibility of SYSTEM/360's ASSEMBLER language for the rapid conversion.

With it, they wrote a simulator program so that programs for their old computer could run on SYSTEM/360 six and seven times faster than before.

IBM held seminars to help Linde engineers learn to program their own problems in FORTRAN, the language used for engineering problem-solving. Initially, 115 engineers attended. They found out how easy SYSTEM/360 is to use.

Now they get answers fast.

Their next SYSTEM/360 will take care of commercial problems now handled by another system and also allow more engineers to solve problems.

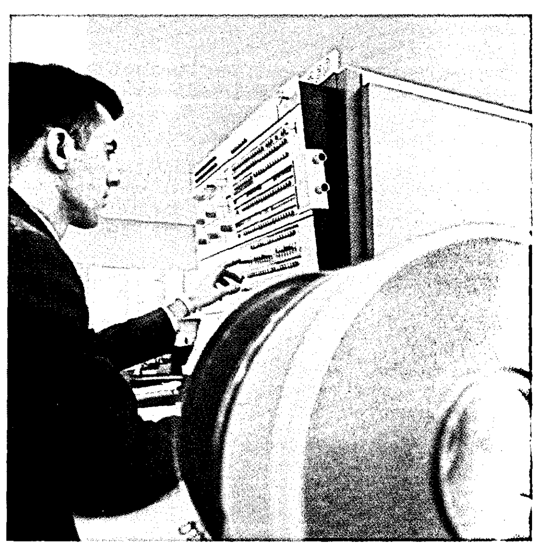
Union Carbide will be getting additional SYSTEM/360's.

A lot of other companies like SYSTEM/360, too. They like its performance, speed and versatility.

We have a hunch you will too.

IBM.

got results Friday.

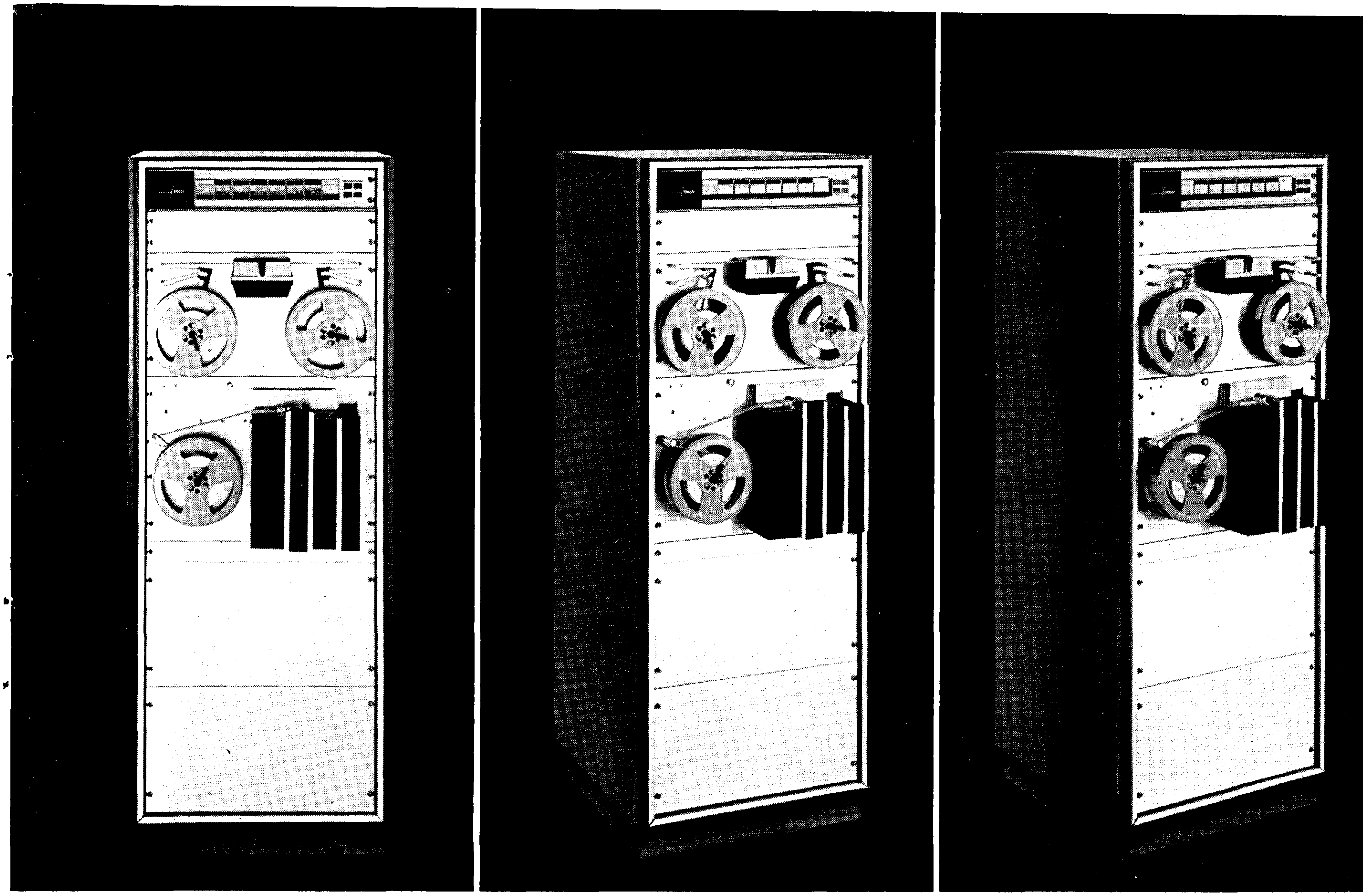


"Is it good business to have your D. P.* do the strip?"

No one should have to pay for a strip like this. It's that useless paper strip that comes between every one of your continuous tabulating cards. Thousands of these paper parasites choke your wastebaskets and litter your floor. You don't need medial waste strips. Neither do Formscards, the continuous tab cards that are all business, with just a clean perforation between them. Without medial strips to clutter up the works, Formscards take up less space, cost less to ship and speed up data processing operations. You'll also throw half your wastebaskets into the wastebasket because there's no mountain of trash piling up each day. Formscards don't put on a show. They just get the job done . . . quickly and economically. So why put up with the strip in your office? Let Formscards take it off for you! Forms, Inc., Willow Grove, Pa. Phone: OLdfield 9-4000 Area Code 215.

*Data Processing Personnel

CIRCLE 10 ON READER CARD



Moving data fast is half the battle. The other half is moving it without mistakes.

Now you can get error free data from here to there (or there to here) at 1200 words per minute.

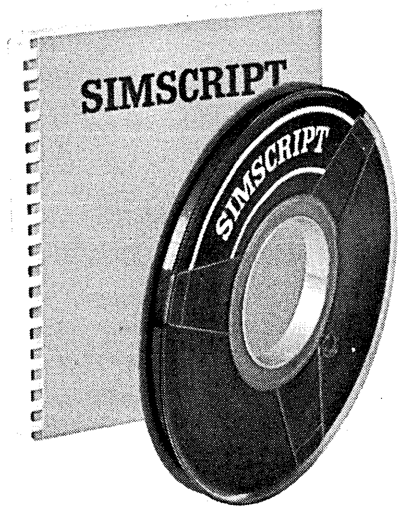
The new Tally Business Communications System 311 Send/Receive Terminal is the most versatile perforated tape station ever offered and the only one which detects and deletes errors. Use the System 311 for transmitting and receiving data over ordinary dial up telephone lines at 120 characters per second and for off-line tape duplication and editing in its spare time.

The compact System 311 can be operated unattended. Thus, a central data processing center can automatically handle data messages during off-peak/evening hours and still have data processed and retransmitted by the next morning. Easy loading is a key feature. In 30 seconds or less, you can load a new roll of tape.

Now, for the first time, you don't pay extra for error-free data. So if you have data communications problems, we think it will be well worth your while to take a look at the Tally 311—the machine that transmits clean, error-free perforated tape. For full details, please address Robert Olson, Tally Corporation, 1310 Mercer Street, Seattle, Washington 98109. Phone: (206) MA 4-0760. TWX: (910) 444-2039. In the U. K. and Europe, address H. Ulijohn, Tally Europe Ltd., Radnor House, 1272 London Road, London, S.W. 16, England. Phone: POLlards 9199.

TALLY®

CIRCLE 51 ON READER CARD



There.

Digitek's new generation SIMSCRIPT compiler has been delivered on time to General Electric for the GE-625 and GE-635 computer systems. Check: use in both batch and conversational environments / double precision, complex and logical arithmetic / binary input output / 1500 statements a minute compile speed / 24K instructions / 8K max phase size / high object code efficiency / gets and puts compiled open / good diagnostics at compile and object times / debugging aids / compiles direct to binary / uses FORTRAN IV loader and library / warranted for two years / bargain.

DIGITEK CORPORATION

6151 WEST CENTURY BOULEVARD, LOS ANGELES, CALIFORNIA 90045, (213) 670-9040

CIRCLE 52 ON READER CARD

LARGE-SCALE HARDWARE, NATIONALISM TOP THE NEWS

June saw the European computer scene hassling over problems which have become the tough chestnuts on the eastern side of the Atlantic. Difficulties over the $300-million Nato air defence system, Nadge, still held the prior place of interest. As foreshadowed in last month's World Report, one of the three competing consortia, headed by ITT, bowed out, leaving the field to Westinghouse and Hughes. A former member of the ITT club, Elliott Automation, has joined up with Hughes in a group that already includes Marconi, Thomson-Houston (France), Telefunken, Selenia, and Hollandse Signaalaparaten. Hughes is believed to have made the lower of the two bids now being examined by the Nadge Management Office.

Second of the perennial problems to be aired has come with a decision by Germany to buy only locally-made machines for central government departments, even against more competitive offers from foreign companies. Germany's Minister for Economics says that this is not meant as a discouragement to foreigners to compete in the general market, but as a stimulus from the federal administration to boost manufacturing and research in the computer industry to achieve a better competitiveness. Registered resident manufacturing groups, such as IBM Germany which produces 90% of the country's output, are understood to be eligible for government contracts, although systems imported from other IBM plants would be excluded.

The third of the posers to be resurrected is whether or not Europe can afford really giant machine development without international cooperation. ICT is giving the problem a re-examination and is discussing the subject informally with the U.K. government departments who would provide the major custom. A decision is important to ICT, now in the throes of firming up specs for its next generation.

IN AUSTRALIA, G.E. REAPS WHILE OTHERS WORRY

General Electric has been awarded the Australian contract most sought after for several years. It's a GE 615 system estimated at $2 million for the Dept. of Social Services in Sydney — perhaps to be duplexed in Melbourne...The government, with some $25-million invested in computers, is concerned about the shortage of trained dp personnel. Universities are accused of turning out students "too scientific oriented." This follows a similar gripe against the Australian Computer Conference (see June, p. 109)...Sir Leon Bagrit, chairman of Elliot-Automation, came Down Under to predict computers at same prices as U.S. autos.

HEAVY COMPUTERIZATION SLATED FOR OCEAN LINER

The Cunard steamship company, which operates the liners Queen Mary and Queen Elizabeth, is planning a full dp system as well as automated engine control for its new $75-million vessel, the Q4, under construction in Scotland. The ship is a 58,000 tonner, and Cunard expects the $2-million control and dp system to handle

(Continued on page 103)

(Continued from page 101)

clerical chores, victualling and inventory records, engine control and navigation. (The present Queens have crews of 1200, with about 1000 of them in the catering and clerical departments.) Equipment is expected to be supplied by Ferranti's computer division, which has installed most of the shipborne military systems for the Royal Navy.

BIG SPENDER SHELL OIL PREPARES HUGE ORDER

One of the biggest plums of the year is expected to go to Univac with multiple 1108's and 9000 series satellites to the Shell Oil group. Shell is the largest international industrial complex managed outside the U.S., with companies in Holland, France, Germany and the U.K. The group plans a series of mammoth real-time integrated dp nets. The first major contract is to be placed from the London office. Throughout the group there is a mixed bag of 50 to 60 existing IBM, Univac and other installations. The decision on the latest real-time project is being made at corporate headquarters in The Hague, and will influence proposals for all members of the group.

Shell's new research laboratories at Amsterdam have also placed the largest hybrid order outside the States. Worth $1,250,000, it has gone to Redifon-Astrodata for two Ci 5000's hooked up to a Sigma 7. This is also the first reported SDS sale for a Sigma 7 in Europe. Originally the Ci 5000's were specified to be linked to a 360/44. IBM ducked out because its European software groups were too busy with dp work to give time to writing a special purpose hybrid-linkage operating system.

FROM RUSSIA WITH BURROUGHS

A delegation from Russia's Ministry of Automation and Institute of Electronic Control Machines, Moscow, flew to London for a demonstration by Burroughs of on-line banking and to examine their large disc file. Burroughs said the party was specifically interested in character recognition and encoding machines used in British banks. In Poland, English Electric held a special conference on automation in generating stations and steel mills in conjunction with their display at that Poznan Fair.

BITS & PIECES

Britain's General Electric Co. (not related to the U.S. firm) is expected to announce a $4.5-million contract for a single industrial control and management system based on computers made under license from Scientific Data Systems...Hallstra Pulp and Paper Mills, Hallvstavick, Sweden have ordered an AEI CON-PAC 4040 process control system...NCR data centres have been opened in the Philippines and Auckland, New Zealand. A large on-line banking system based on 315's is also to be delivered to Hong Kong... Standard Telephones and Cables (an ITT subsidiary) is introducing an ADX 6300 into Eire's Shannon Airport for message switching of communications traffic from North Atlantic air routes...London-based consultants John Hoskyns are offering a fixed price programming service for ICT 1900, IBM 360 and Honeywell 200 machines. The company says it is possible because of new standards and test packages devised by its own research group.

(Continued from page 19)

Credit Intercommunication Corp. (still in the planning stage), Credit Data Corp., and Hooper-Holmes -- will bid on a computerized credit info system for major banks. Proposals are due in the fall.

CIC says it will be "allied with" Western Union, which is evidently developing the system for free. In return, CIC will use WU's hardware and lines to massage its files. CIC will sell credit info to (and buy it from) subscribers. The company has its eye too on other credit granters: small loan companies, retail, etc., and eventually would like to use WU's network to link credit files in different areas.

After three years' work, Hooper-Holmes has 6 million records on a Honeywell 200 for credit card, oil, financial, and other firms -- plans six regional computer centers (where and what equipment undecided) starting next year.

Credit Data, too, has a similar-sized file on a 1410 in Los Angeles, plus unautomated systems in San Francisco and Detroit. In southern California, banks and subscriber-merchants can get information in 90 seconds with a local (toll-free) call.

WILL THESE BE THE GOOD OLD DAYS?

You think software is bad now? Just wait, says computer pro Ascher Opler. It's going to get even more complex. And he cites such esoteric terms as virtual memory, re-entrant code, and microprogrammed logic of read-only memories to get the point across. On the other hand, many of the tasks now absorbing computer systems programmers may be taken over by hardware. Such people may soon find themselves helping design machine innards. The changes may catch a lot of old-timers with their technology down.

RUMORS AND RAW RANDOM DATA

Dan McCracken, author of nine programming language books and invaluable Datamation advisor, is leaving the industry to study for the ministry. ... IBM withdrew a 360/67 from a bid recently, giving rise to rumors that machine is being withdrawn. It's hard to believe; they're said to have 150-200 orders for them. ... Union Carbide is beefing up its computer planning dept., has recently added Dick Utman, Sherman Blumenthal, and Leon Davidson. ... Prof. Saul Rosen is leaving Purdue for State University of NY where he'll teach computer sciences and act as a computer center associate. ... A new GE data center with a 645 is reportedly planned for Long Island. ... Internal problems, not the time-sharing technology, are keeping San Francisco-based Tieline off the air for a while. Scheduled to offer franchises for computerized classified ads with CRT's and an RCA 3301 (see Oct. '65, p. 17), the firm hopes to re-form in a few months and carry on. ... Under development at General Telephone Co. of California is a multi-access system with 500-600 on-line terminals getting a 15-second response time. CPU may be a dual 360/65. ... Some commercial firms are grumbling because IBM won't "encourage" them to order the new 1500 computer-assisted instruction system. With a "selective announcement" policy -- a practice some say isn't kosher under the consent decree -- 1500's are being offered to organizations in education and research. ... Although IBM would seem to have enough to keep them busy just now, rumors are circulating of a smaller time-sharing system. ... Latest chuckle button on insiders' lapels: "Would you believe PL/II?"

computer oriented sessions

WESCON '66

The Western Electronic Show and Convention—with tents, trumpets and sideshows—convenes in Los Angeles August 23-26. Exhibitions and company-sponsored seminars will be presented at Hollywood Park and in the Sports Arena; technical sessions will be held in the meeting rooms of the Biltmore Hotel. In addition to the 27 regular sessions, consisting of 110 individual papers, there will be two days of invitational sessions and three concurrent special symposia.

Two overview invitational sessions of interest to computerdom: "Information Management: A Technology Amplifier," Wed., Aug. 24, 2:00-4:30, Biltmore Ballroom. Headed by chairman Robert M. Hayes, UCLA, the session will discuss available hardware for storage and retrieval and plans for technical society information exchange. "On-Line Computing," Thurs., Aug. 25, 2:00-4:30, Biltmore Ballroom; Richard H. Wilcox, Office of Naval Research, chairman. Papers will cover education techniques, uncommon applications, and command and control.

Of the regular sessions:

Session 1, "Circuit Engineering by Digital Computation," Tues., Aug. 23, Biltmore Bowl, 9:30-noon. Topics will include a program for linear systems analysis, and computer design of servosystems.

Session 9: "Advanced Spaceborne Computer Concepts," Tues., Aug 23, 2:00-4:30, Biltmore Galleria. Highlights will be papers on multiprocessing organizations, associative memories for space applications, systems approaches to the voice insertion of data.

Session 16, "Electronic Systems for Urban Rapid Transportation," Thurs., Aug. 25, 9:30-noon, Biltmore Ballroom. Discussion will center on computer control of transit cars and automatic revenue control.

Session 21: "High Availability Computer Systems," Fri., Aug 26, 9:30-noon, Biltmore Ballroom. Papers will stress systems effectiveness and reliability.

The Sports Arena exhibits will include sections on computers, communication and detection, air and space control systems, and automatic controls.

GOVERNMENT PUTS THE SQUEEZE ON CONTRACTORS' DP COSTS

A long-heralded change in Armed Services Procurement Regulations, covering contractor-furnished dp equipment, is scheduled to be adopted Sept. 1. The amendment provides that if a contractor's annual leasing costs at a single profit center exceed $500,000, and if DOD is billed for more than 50% of this amount, directly or indirectly under a cost reimbursement-type contract, then the contractor must show that leasing is more economical than purchasing. Otherwise, the government will pay an "ownership fee" based on a pro-rated share of the purchase cost. Smaller contracts — costing the government $250,000 or less per profit center — are covered by another part of the new ASPR; it applies additional criteria to the "rule of reasonableness" which has allowed DOD contract officers considerable latitude in approving lease charges until now.

DEVELOPMENT OF SOFTWARE EVALUATION TESTS BEGIN

The ASPR change was one of several topics covered last month by federal ADPE managers at the hearing of a House subcommittee headed by Rep. Robert Nix of Pennsylvania. Harold Seidman, BOB's assistant director for management and organization, reported that his agency is: a) placing "high priority" on development of software evaluation tests; b) planning to consolidate small-lot dp procurements in the hope of securing quantity discounts; and c) reviewing the present practice of asking for single-price bids, covering hardware, programming, training, and technical services. Purpose of the latter study is to determine whether separate price quotes would save the government money.

From another source, we learn that NBS is developing a Fortran evaluation test based on the X3.9 standard ASA approved last March. By fiscal '68 procurement time, a yardstick for Federal Supply Service contracts is expected.

This software improvement effort may run into trouble, though. When Lloyd Dunkle, assistant FSS commissioner, appeared before the Nix subcommittee, he wondered how responsibility for poor program performance would be assigned if the hardware and software came from different sources. Al Bishop, DOD's dp management staff director, added that "we would certainly not want to be panicked into (separate prices) until we have all the economics in hand. We would like to stay the way we are for the moment."

FEDERAL COMPUTER CENSUS SHOWS IBM POSITION DOWN

Two years ago, IBM accounted for 65% of the computers in use by the federal government; today, the comparable figure is about 35%, according to the ADPE inventory report for fiscal '66, scheduled for release this month. This was revealed in the testimony of Harold Seidman (see above). Others say IBM's share is closer to 33%; Univac 19%; CDC 10%; NCR 6%; Burroughs 5%, and all others 27%. Univac, Burroughs and CDC have benefited most from IBM's relative eclipse.

As of June 30, '66, the government was using 2,620 computers, 98% more than three years ago. More than 50% of the inventory is now government-owned, versus 21% in '63, the latest report states. And annual expenditures during this period rose $400 million, to $1,038 million.

CANADIAN COMPUTER CONFERENCE

The majestic Canadian Rockies witnessed the coming of age of computing in Canada with the convening of the 5th National Conference of the Computer Society of Canada at the Banff Springs Hotel. The computerites of the country north of the world's longest undefended border have always taken an active part in conferences in the U.S.; now, for the first time, nearly half of the papers of a Canadian meeting were delivered by Americans, and a significant portion of the over 500 registrants were from outside the country, including some representation from Australia, Scotland and the USSR.

The Computer Society of Canada, previously known as The Computing and Data Processing Society of Canada—with rumblings of a second name change (to the Information Processing Society of Canada?)—is the official Canadian representative to the International Federation for Information Processing (IFIP). Its 1,000 members include scientists, engineers, programmers, salesmen, managers with a wide range of interests. Since the last report on computing in Canada[1] the number of computers has increased by 50% in a little over a year[2] and must be well over the 1,000 mark by now.

The conference theme, "Computers and You, the User," was reflected in two panel discussions—on social implications and on big business—and in a large number of papers on industrial applications. The tone was set in his keynote speech by Dr. R. M. Fano, director of Project MAC. Discussing the relationship between the time-shared computer system and the community of users, he said the confidence of the user is vital, and his interest and privacy must be protected. Even in the scientific community, he said, there are a few chiselers and panderers who attempt to get into the operating system to forge their time records and resort to violence.

The panel discussion, "Social Implications of Computers and the Social Responsibility of Computer Specialists", moderated by the reviewer, generally agreed that we indeed have a responsibility. Although the session, attended by about 300 people since there were no other sessions competing with it, did not get into enough specifics or proposals for action, it did provoke a lively discussion and even controversy, thanks to the provocative barbs of Dr. H.R.J. Grosch of GE-Tempo. Dr. H. H. Saunderson, president of the University of Manitoba, extended the wag's definition of a University: a number of buildings and people connected by a steam-line and a computer. He called on social scientists with an acquaintance of computers to give serious study to the changes we are creating. And the Reverend Canon M. K. H. M. Creal made an impassioned plea for us to apply our technology to those things which improve the quality of human life. He considered it unthinkable for us to remain unaware of the effect our work has on society.

The panel of businessmen on "Computing and Big Business in the Next Five Years," moderated by Dr. H. S. Gellman, could not make up its mind on how time-sharing will help the executive of tomorrow. No one claimed to have—or even know of—a total integrated automatic management system, but an overall gain in control of the business was reported, due to the reduction in the information time-lag.

The 48 papers selected by the program chairman, Dr. B. A. Hodson, included many interesting applications, such as a data processing system for experimental seismic arrays for moni-

[1] *Datamation*, May 1965, p. 38.

[2] Census of Computers in Canada, Special Supplementary Issue, *Quarterly Bulletin*, Computer Society of Canada, June 1965.

toring a comprehensive test-ban treaty; computer-based statistical techniques for oil and natural gas exploration; Monte Carlo simulation for improved forest fire control; a Critical Path planning method for EXPO '67, the world exhibition to be held in Montreal during Canada's centennial year; computerized research in psychiatric service facilities, and Massachusetts General Hospital's time-sharing system (see Dec. '65, p. 29). Software papers included algebraic manipulators (FORMAC and ALGEM), generalized file structures, and a system for generating problem-oriented languages.

The president's address by Prof. J. W. Graham called for more educational facilities directed to the practical application of computers. Providing one approach to this problem was a paper outlining the Southern Alberta Institute of Technology's computer curriculum. This paper, by R. H. Jewison of the institute, was followed by another approach: an emphasis on algorithmic procedures over programming languages. This was by Dr. T. E. Hull of the Univ. of Toronto.

Some recent survey results of the Computer Personnel Research Group, of Johns Hopkins Univ., were reported by its chairman, Dr. R. A. Dickman. It appears that the proportion of programmers with college degrees is not significantly higher than the proportion of the general population with degrees. For a change of pace, one paper explored the use of computers in the visual arts, while still another looked at the intellectual implications of computing.

The five western sections of the computing society, led by general conference chairman K. R. Marble, provided a warm, ebullient western hospitality. There was a western dinner complete with dancing girls (and a skit in which a sick patient was connected to a sicker computer attended to by an even sicker doctor); a Klondike night, gambling casino and all; and a formal international dinner with a slick presentation by a NORAD team—which caused a few members of the audience to walk out. All this plus a number of receptions (under the circumstances, I lost count), and the beautiful mountain setting added up to a conference hard to beat.

—LESLIE MEZEI
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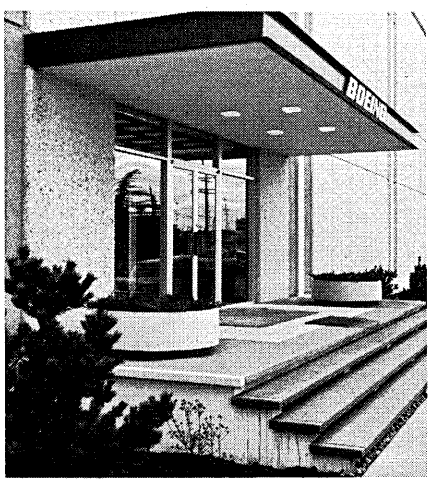
Computer Research Engineers—Assignments involve supporting planetary and missile system efforts by application of logic design optimization procedures, adaptive techniques, Boolean analysis, and hybrid functions. Duties involve performing research, conducting studies, and directing development of unique special purpose and advanced general purpose computers. Duties also include the development of special logic circuit designs and the utilization of integrated microcircuits required for advanced and unique computer implementation.

Data Processing and Display Engineers—Responsibilities include analyzing overall systems objectives and defining



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requirements for communications, display and advanced data processing sub-systems and resolving difficult system integration problems employing microelectronic techniques. Additional duties include the simulation of complex systems by hybrid equipment, and the development of new processing and display techniques relating to sensors, instrumentation, communications, guidance and control. Positions are also available in advanced memory and display research.

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people

■ Samuel Levine, vice president, Bunker-Ramo Corp., has been elected chairman, computer group of the Institute of Electrical and Electronic Engineering.

■ Paul H. Rosenthal has been appointed a senior member of the advisory staff of Computer Sciences Corp., El Segundo, Calif. He was formerly with Univac as manager of generalized applications.

■ Mark E. Moore has been named business systems designer, Baxter Laboratories, Inc., Morton Grove, Ill.

■ John R. Opel has been elected a vice president of the IBM Corp., Armonk, N.Y. He is an assistant executive for plans and controls in the data processing group.

■ Warren L. Schwenker, after 38 years with Remington Rand, has formed a new company, Computer Consultants, in Cincinnati, Ohio.

■ Eugene Gralla has been named director, data systems planning, Trans World Airlines. He was formerly head of information systems design and control, Office Naval Material.

■ Francis A. Rowe is the new director of management information systems at Sperry Rand's Univac division in Blue Bell, Pa.

■ Dr. Judea Pearl has been appointed director, advanced memory devices, Electronic Memories Inc., Hawthorne, Calif. He was previously a member of the technical staff at RCA's Sarnoff Research Center.

■ Roy E. Stone has been promoted to director, systems and data processing, Mead Johnson & Co., Evansville, Ind.

■ Anthony G. Oettinger, professor of applied mathematics, Harvard Univ., has been elected president of the Assn. for Computing Machinery. Bernard A. Galler, Univ. of Michigan, was elected vice president, and Donn B. Parker, Control Data Corp., secretary.

■ E. Mark Sheldon, former manager of instruction, has been named director of Control Data Institute, Minneapolis, Minn.

■ Leslie Mezei, formerly at York Univ., has been appointed associate professor in the Dept. of Computer Science, Univ. of Toronto.

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Programming the IBM System/360, by Computer Usage Company, John Wiley & Sons, 1966.

This book has 21 chapters: Introduction to System/360, Assembly Language, Addressing, Branching, Indexing and Looping, External Linkage, Internal Linkage to Subroutines, Program Layout and Organization, Binary Arithmetic, Floating Point Arithmetic, Decimal Arithmetic, Arithmetic Conversions, Bit Manipulation, Editing Output, PSW and Interrupts, Input-Output (Hardware Oriented), and Input-Output (User Oriented). Six appendices supplement the body of the text, making the book a self-contained reference guide for S/360 programmers; the six appendices are: Instruction Formats by Mnemonic, Machine Instruction Mnemonic Codes, Character Codes, EBCDIC and ASCII-8 Charts, Hexadecimal-Decimal Conversion Table, and Detailed Information on Typical Input/Output Device Responses. An index completes this well-organized and highly useful book.

Twenty staff members of Computer Usage Company collaborated on this book, under the general editorship of Ascher Opler. Mr. Opler is to be commended for coordinating the efforts of 20 authors to produce a book with excellent continuity and uniformity of approach.

Mr. Opler states in the preface: "Although directed to experienced programmers, the book may also be used to learn programming." This is claiming too much. The level at which the topics are discussed is beyond the grasp of readers with no prior experience in programming and may present difficulties for readers experienced only in higher-order language programming. Such topics as are discussed in the chapter on table look-up are difficult for the beginning programmer to grasp at the flow chart level, let alone at the assembly language level.

As Mr. Opler states, the book is both a reference book and a textbook, but, in this reviewer's judgment, a textbook only for experienced programmers. For the novice programmer, with sufficient guidance, it can serve as a supplemental reference book.

The book discusses System/360 assembly language programming without reference to any particular member of the family of 360 computers or to any particular software system. This generality of approach is admirable. Beyond this, the authors provide insight into some of the better 360 programming techniques. Such techniques as methods of loading and maintaining base registers, setting up subroutine linkages, utilizing sets of instructions to form multi-way switches, performing a binary search, manipulating bits and bytes, and so forth, are discussed in terms of efficiency of operation and ease of coding. Each chapter presents hints on effective coding techniques related to the topic.

It is certainly refreshing to see that Computer Usage Company has made an effort to share with the entire computing community the knowledge gained in the initial struggle that is inevitable in using new hardware. With the guidance provided by this book, new 360 programmers can avoid pitfalls encountered by Computer Usage Company's programmers, who were among the earliest users of the 360. The chapter on program layout and organization is a typical example of such guidance.

Each chapter is well-written, each provides adequate examples (with few typographical errors), and each provides sufficient continuity so that continual reference need not be made to preceding chapters. The least satisfactory chapter is that on addressing. The author states that the subject (i.e., base-plus-displacement addressing) causes trouble to new System/360 programmers. Unfortunately, the author's discussion does not tend to simplify the problem.

In summary, this book is "must" reading for experienced assembly language programmers new to the 360. It may be profitably studied by higher-order language programmers who wish to become familiar with the 360 assembly language. For training novice programmers, it may well serve as a teacher's guide but not as a student text. Because of its continuing utility for reference, this book deserves a place in the 360 programmer's personal library.

—PATRICIA L. EDDY

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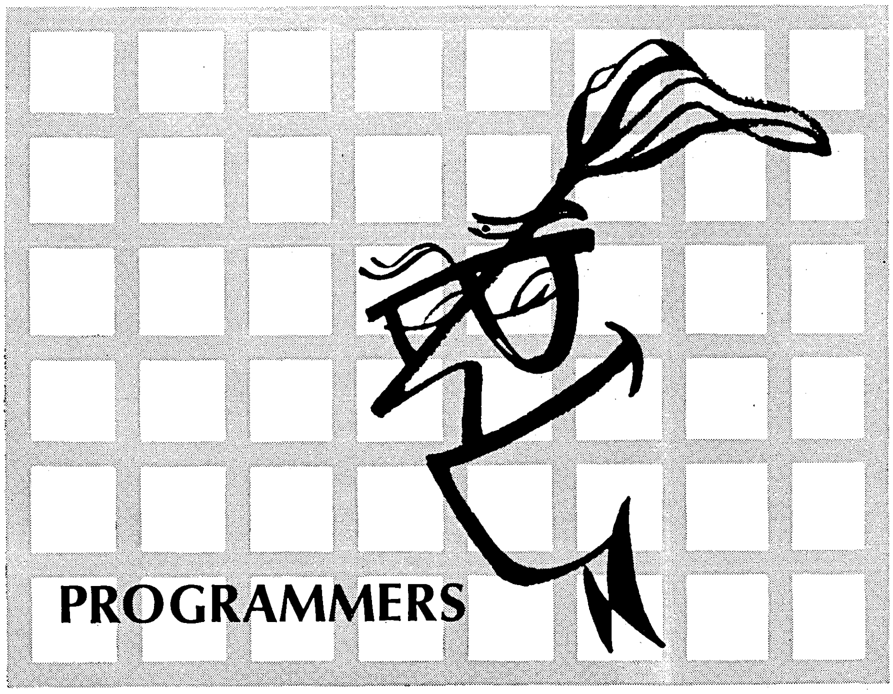

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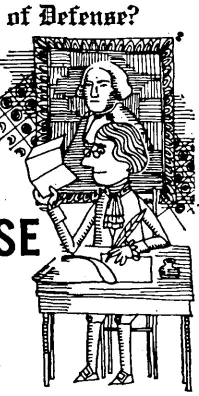

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the forum

The Forum is offered for readers who want to express their opinion on any aspect of information processing. Your contributions are invited.

STANDARDS: A SNAPSHOT SUBJECT TO CHANGE

Much has been said recently in public and the press about standards for information processing. Ideas, hypotheses and theories have been sought to provide a basis for such standardization. Appeals have been made to logic, the "natural laws" and other more occult meta-authorities. I feel it is time to clarify some misconceptions which have been spread concerning the development of standards for the soft side of information processing.

To begin with, the term "standard" is itself a semantic trap. It connotes stability, provability and ultimate authority. These attributes do not necessarily obtain. The word "standard" may be applied to at least three types of things:

- *Physical Constants,* such as π, Avogadro's number, atomic or molecular frequency, etc. The only possible arguments about these are as to methods and accuracy of measurement. A body of theory exists to refine this accuracy through improvements in methodology.
- *Negotiated Conventions,* such as languages (COBOL), symbology, codes, formats, etc. These (American standards) are arrived at through negotiations and compromise, and ostensibly reflect the consensus of those substantially concerned with the subject matter.
- *Required Specifications* (usually, but not necessarily, based on convention) such as federal specs or mil specs which must be satisfied if awards are to be made for contracts.

One notes that in the first instance there is little emotion, since the theories have a sound base in the physical sciences and are provable. In the second instance the convention represents a norm agreed upon as highly desirable (at a certain point in time). Finally, the specification is dictated so that uniformity (compatibility) can be achieved and *compliance measured.*

Standards in the field of information processing are in the main either Negotiated Convention or Required Specification. The need for these conventions rests on and is in direct proportion to the amount of information interchange anticipated or desired. Thus, it is wise to look to the causal factors in assessing the need.

It is true the researcher needs powerful and sophisticated tools for programming language investigations. He also needs the flexibility and freedom seldom found in being conventional.

However, the majority of users of information processing devices need stability (temporal and arbitrary) to conduct the business that pays for research.

Those of us engaged in the development of programming language standards are, then, searching for a compromise between a highly sophisticated, flexible meta-language and languages that are simple (for wide understanding) and stable (for continuity). The solution should be broadly useful and based not only on the state of the art, but also on the state of the use. This kind of effort must draw on the various facets of formalized, logical hypotheses and seat-of-the-pants intuition. Because the standards are based on demonstrated consensus which reflects need, there can be no theory that will lead to standards. Certainly, any theory for the abstraction of the conceptual basis of programming language would be helpful in the objective evaluation of candidate languages, but not the sole criterion.

The uncertainty and difficulty in arriving at lasting statements of the solution to variable needs has led to the development of two classes of conventions or standards. These are "fundamental" standards which form the lattice for the design of systems and "secondary" standards which, utilizing the fundamental standards, extend the range and sophistication of the conventions in a particular specialty or application.

Examples of fundamental standards include:

ASCII
Signalling speeds for data transmission
Physical properties and dimensions for media (tape, cards)

Secondary standards include:

Printing Subsets of the ASCII graphics
APT
Recording techniques for media (tape, cards)
Formats for data transmission

Thus, the body of convention rests on basic agreements about the characteristics (or desirable parameters) of various aspects of information processing systems. As the needs of users change and the sophistication of systems design increases, the secondary (and perhaps primary) standards must be reviewed for adequacy. This will lead to the reaffirming, modifying or discarding of these standards. In other words, these standards, hopefully supported on a theoretical basis, are the best statement of the custom of the IP world at a particular point in time, and are and should be subject to constant questioning and scrutiny to remain timely, comprehensive and responsive to the emerging art of information processing. —V. E. HENRIQUES

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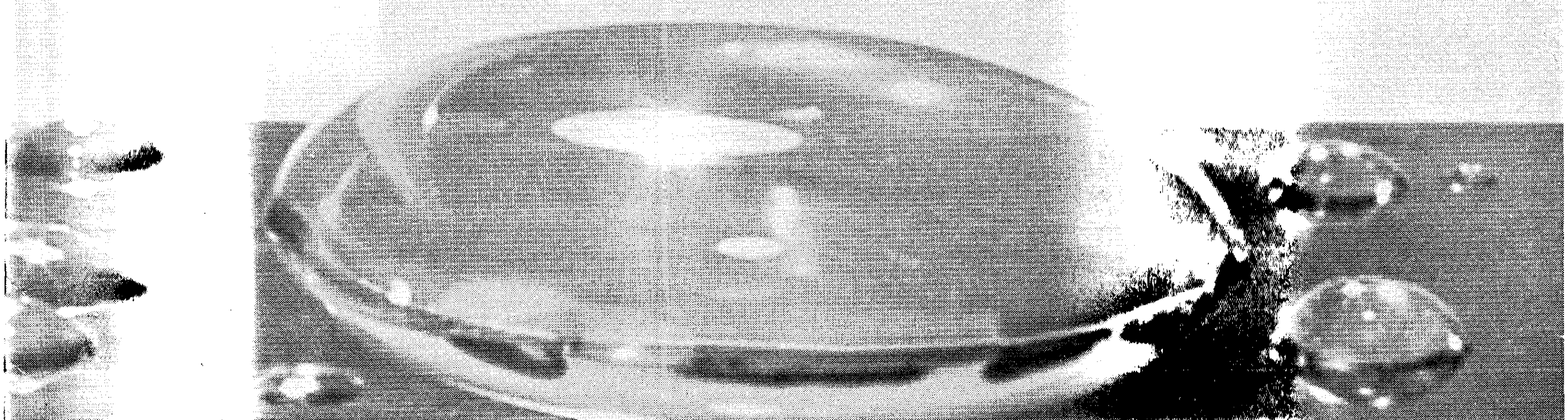

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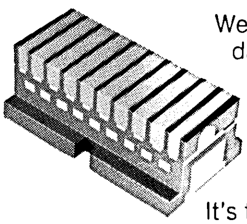

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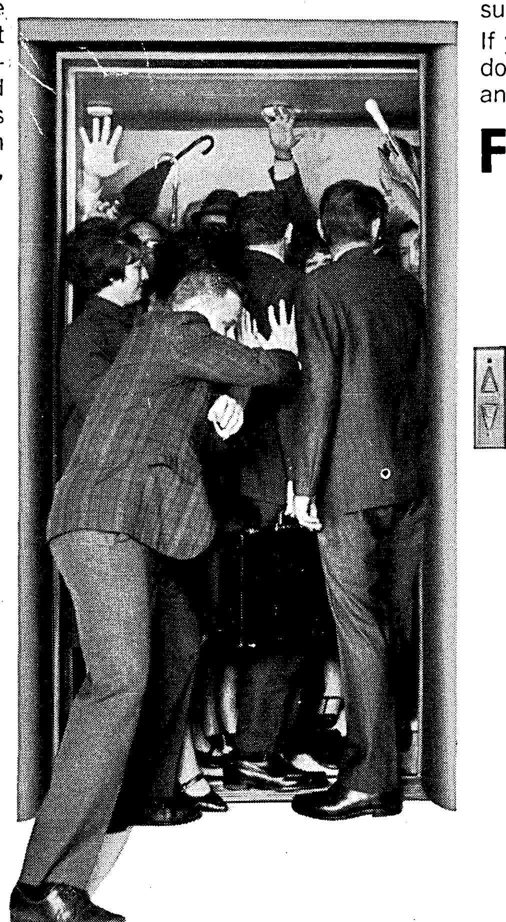

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