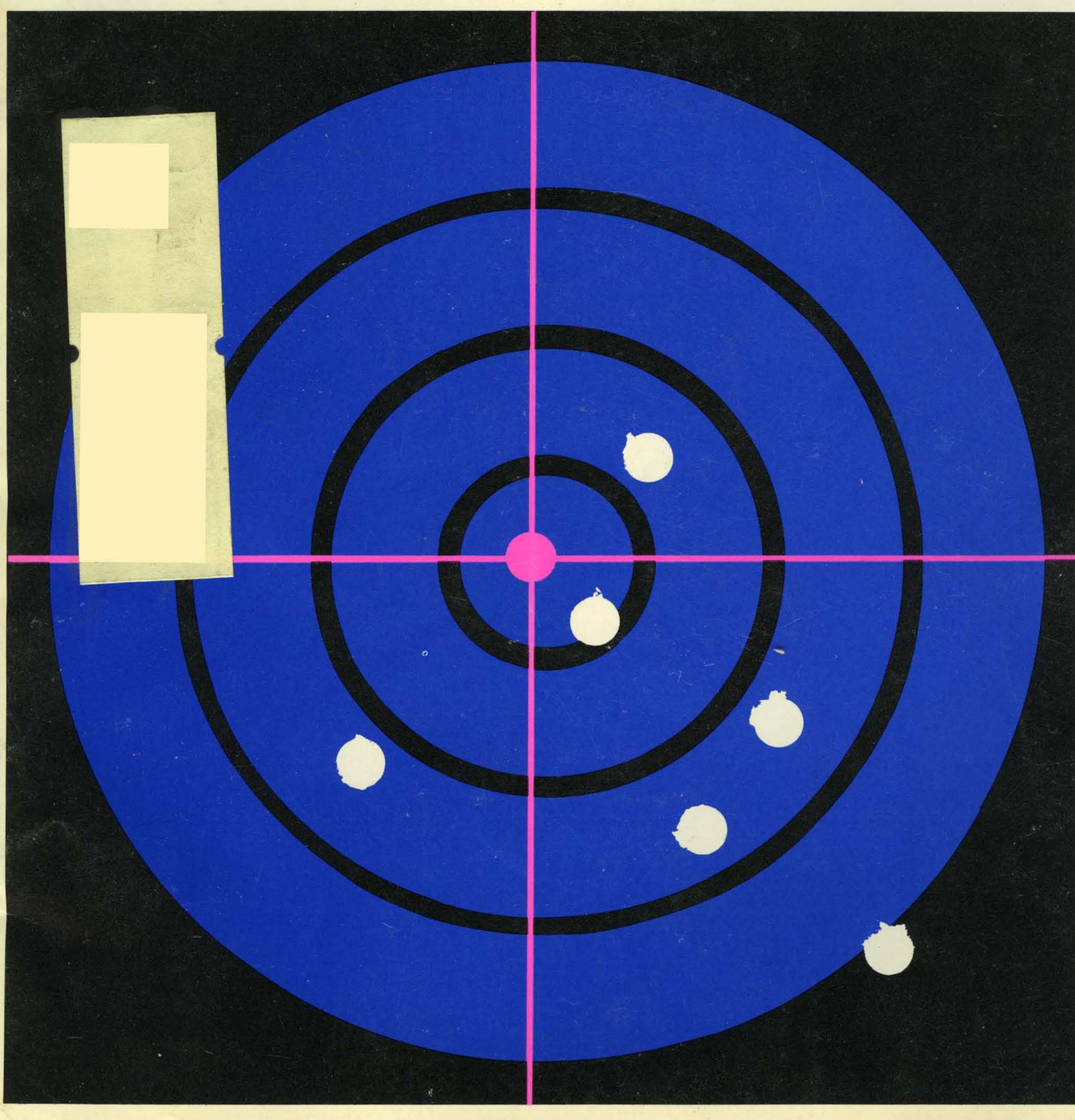
DATAMATION®

67

February



computer selection

There are three things to remember about Sigma 5.

First, it is multi-use, like its big brother Sigma 7. It does foreground real-time control, background general-purpose computation, and high-speed input/output. Simultaneously.

Second, Sigma 5's central processor is so powerful and sophisticated that it works even more efficiently with $500,000 worth of memory, peripherals and options than it does in its basic $90,000 configuration.

Third, Sigma 5 grows without fuss. Everything is modular—memory, input/output processors, peripherals, central processor options, software. Each upward transition is simple and logical until you reach Sigma 5's limit. Then if you want to keep on growing, just substitute a Sigma 7 CPU and behold! You have a Sigma 7 time-sharing system.

Two computers aren't better than one.

It no longer makes economic sense to have different computers for different kinds of jobs.

Sigma 5 will control your plant, do your scientific and engineering computation, and look after your accounting and inventory. All at once.

Nobody will have to stand in line. Everyone will be protected against loss or interference. Sigma 5 can deal with foreground real-time interrupts in 6 microseconds without losing control of any of its other jobs, yet every background user will get his answers faster than he needs them.

Nobody loves a lazy computer.

If your Sigma 5 ever has an idle microsecond it will be your fault.

Sigma 5 doesn't stop computing to wait for input/output. It doesn't reserve idle capacity to take care of on-line peaks.

Instead it dynamically and very rapidly shifts from one task to another in order to keep all its power working all the time. Input/output is managed independently by one built-in and five optional I/O processors, with up to 160 automatic I/O channels.

The bigger the better.

One reason why Sigma 5 gets more efficient as it grows larger is that when memory modules are added interleave and overlap occur. This not only increases the effective speed of the central processor but raises input/output capability too.

Sigma 5 won't wait for software.

Sigma 5 is program-compatible with Sigma 7. The software for both has already been developed and is being delivered now with Sigma 7's.

So you won't have problems with new and untried software. And you won't have to wait either.

Sigma 5 software is modular like the hardware. As your Sigma 5 grows the software grows too, in natural, simple, logical steps.

Software for Sigma 5 includes Basic Control Monitor, Batch Processing Monitor, three ASA-compatible FORTRAN IV compilers including a high-efficiency version, Symbol Assembler, Meta-Symbol Extended Assembler, SDS COBOL 65, Sort/Merge, and a library of mathematical, business and utility routines.

All Sigma 5 software is multi-use.

Here are some numbers.

Basic memory cycle time of 850 nanoseconds is reduced as overlapping of memory occurs.

32 memory sizes, from 4,096 to 131,072 words.

Memory uses 32-bit words, is addressable and alterable by 8-bit bytes, halfwords, words, and doublewords.

16 general purpose registers, expandable to 256. All memory is directly addressable without base registers.

8 automatic I/O channels in CPU, plus 5 optional I/O processors, either multiplexor IOP's (300,000 bytes/sec.) or selector IOP's (30 million bits/sec.) in any desired combination.

224 levels of priority interrupt. Priorities automatically recognized without program intervention.

How soon?

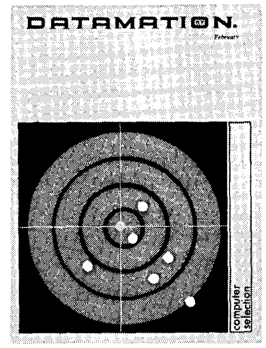
Order now and you'll get your Sigma 5 (with software) in August.

You can order the exact configuration that fits your needs. Or if you have budget problems, order what you can afford now and plan to add modules as more funds become available.

Growing with Sigma 5 is almost painless. All you feel is a slight twinge in the pocketbook.

SDS
Scientific Data Systems, Santa Monica, California

CIRCLE 5 ON READER CARD



february
1967
volume 13 number 2

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DATAMATION

1967

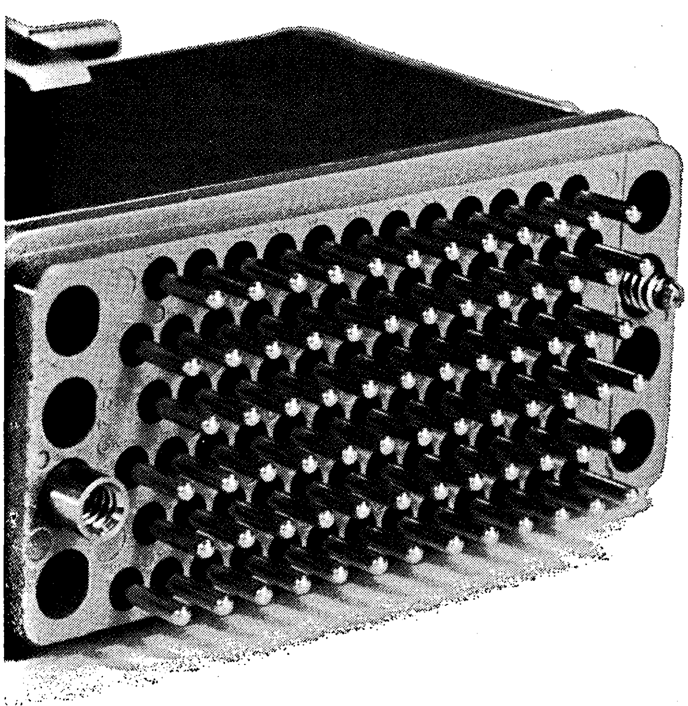
volume 13 number 2

automatic information processing for business industry science

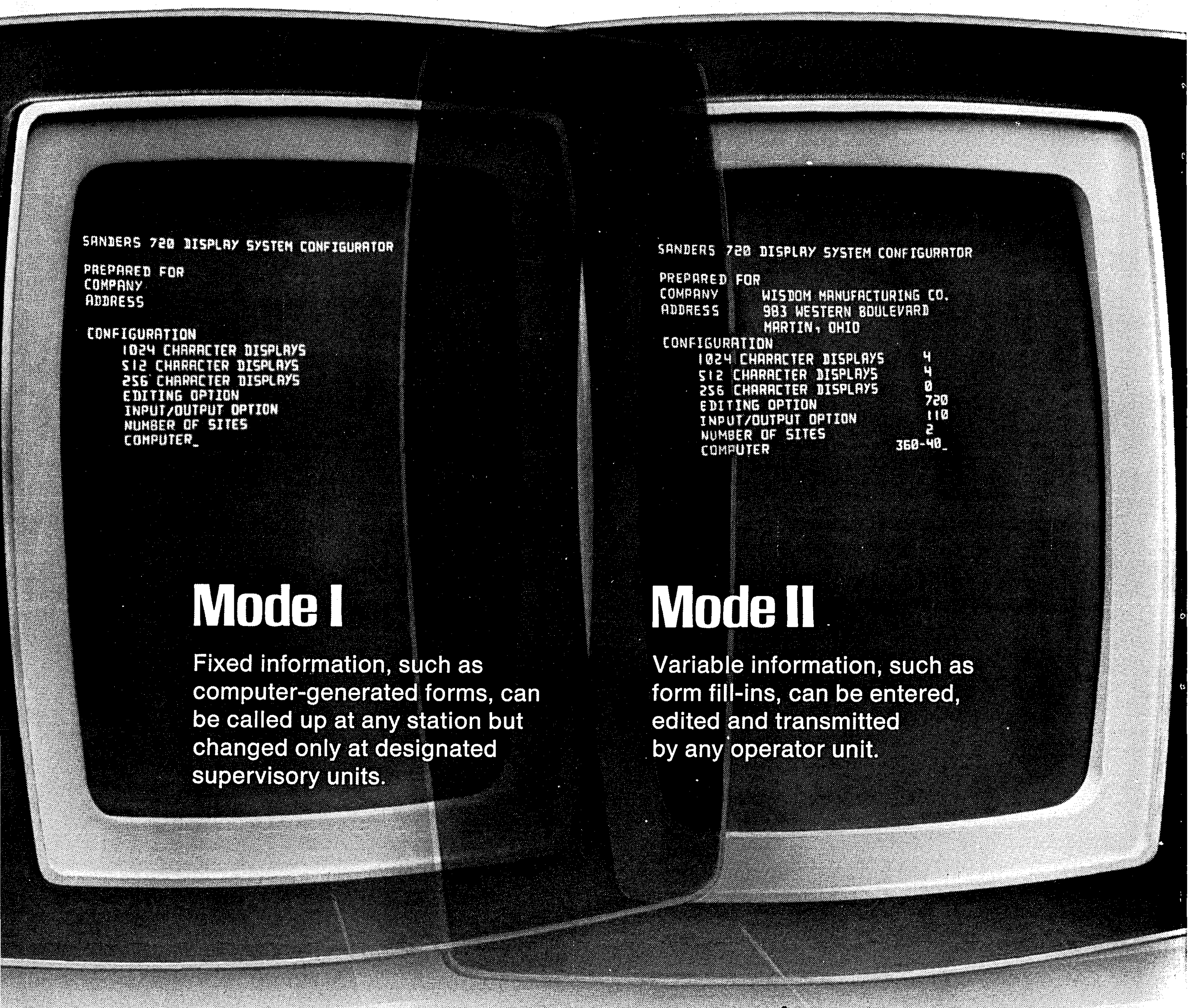
datamation departments

calendar

DATE	TITLE	LOCATION	SPONSOR/ CONTACT
Feb. 20	Paper deadline: 1967 National ACM Conference		Dr. Jack Minker, Auerbach Corp., 1815 N. Ft. Myer Arlington, Va.
Feb. 20-21	Users Meeting	International Inn Washington, D.C.	RCA Computer Users Assn.
Feb. 25	CDP Examination	DPMA Test Centers 100 national locations	Data Processing Management Assn.
March 1-3	Conference	Statler-Hilton Hotel Detroit, Michigan	Numerical Control Society
March 15	Paper deadline: International Electronics Conference		Dr. Rudi de Buda, Int. Elec. Conference, 1819 Yonge St., Toronto 7, Canada
April 4-7	Users Conference	Bellevue Stratford Hotel Philadelphia, Pa.	Honeywell H-800 Users
April 4-7	Users Conference	Fontainebleu Hotel Miami, Fla.	Univac Users & Scientific Exchange
April 6-7	Systems Conference	Americana Hotel New York, N.Y.	Systems & Procedures Assn.
April 12-14	Conference: Electronic Information Handling	Univ. of Pittsburgh Pittsburgh, Pa.	U. of Pittsburgh, ACM SIGIR, O. N. R., Goodyear Aerospace, W. Mich. U.
April 17-28	Course: Advances in Digital Systems Design. $300.	Univ. of California Los Angeles, Calif.	——
April 18-20	Spring Joint Computer Conference	Chalfonte-Haddon Hall Atlantic City, N.J.	AFIPS
April 24-26	Conference: Machine Records	Sheraton Western Skies Albuquerque, N.M.	U. of New Mexico
April 27-28	Conference: Tools of Management	Hotel Muehlebach Kansas City, Mo.	Systems & Procedures Assn.
April 28	Seminar: Computer in Local Government Accounting & Management	McGregor Center Wayne State Univ. Detroit, Mich.	Governmental Accountants & Analysts Assn.



Two Level Editing



Mode I

Fixed information, such as computer-generated forms, can be called up at any station but changed only at designated supervisory units.

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*T.M., Sanders Associates, Inc.

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letters

fait accomPL/I

Sir:

Much of the confusion and perhaps some of the wrath caused by the publication of outdated comments and reports concerning PL/I could be removed if a better notation were applied to the several descriptions of the language, namely PL [i, j].

Thus PL [0, j], j=0,1,2 could designate, respectively, the March and June 1964 SHARE reports and the IBM report on NPL of December '64. And, PL [1, j], j= 0,1,2,3,4, . . . would refer to the finite if perhaps unbounded collection of IBM SRL's.

In the unlikely event that other groups attempt to define a (shell) language of the scope and purpose of that described in PL [1,3] or if the language changes in any substantial but still evolutionary manner, we might agree to change the value of i.

A third subscript could be added to handle the subset problem. Thus our experimental compiler (earlier known as PL [i,j] for all i and some j) might be designated as PL [1,2,k] and we would ask some authority presently unknown to us what value we might assign to k.

In any event, while I feel that comments on PL [0,j] are no longer relevant, I have my copy of PL [0,0] pretty well hidden away in the belief that someday it will be worth more than an early issue of *Batman*.

LON GRACE, JR.
Cherry Hill, New Jersey

a bit confused

Sir:

In the Editor's Readout (Nov., p. 21), your remark, "A cycle is like a bit per second, I think," could be misunderstood.

Actually, the cycle rate of information is half its bit rate at the most, assuming 1:1 ratio between "1" and "0".

In order to get sufficiently discernible information for the demodulator, the necessary frequency band is not equal to the cycle rate but at least 60% wider. So, only in the case that the "allowance factor" is twice the cycle rate—which is half the bit rate maximum—you can state that a cycle is like a bit per second. Besides, you should have written "cycle of transmission bandwidth."

PETER WIRTH
Munich, Germany

We told you we were confused. Thanks for (partially) straightening us out.

data bank: greater freedom?

Sir:

In a recent Forum (Nov., p. 140), Congressman Cornelius E. Gallagher presented some of the problems which have been brought to the attention of the Congress and the general public by the proposal of the U.S. Bureau of the Budget for a data bank. The possible consequences of the availability of this kind and quantity of information and its effect on our right to privacy speaks highly of this country's concern with the liberty of the individual.

So far, however, it seems as though nobody is taking up the cudgels for the other side—for the concept that there might be a possibility of greater freedom if such a data bank were available. There are things to be said for the collection of information by the government, provided there are both technological and legal safeguards. For as many of us know, the problem has long been with us. We know that credit bureaus maintain files concerning not only the financial condition of individuals but also all the personal information which they believe to be important to them. Although banks have traditionally held confidential the confidences of their clients the fact is that banks are also used for credit information. They service inquiries made to them on the status of a particular individual's account.

There are other aspects which may be of greater concern than those of financial position. Insurance companies keep and exchange careful files on health and medical history. The only reason we have not seen much of this before is that the facts have been kept underground.

All of this is done in the name of protecting business interests, and in each case it is difficult to deny the right of business to do so . . . Those who have the monetary resources can find out pretty much whatever they please, but those without money cannot—hardly a democratic situation.

The most outrageous feature of a system in which information is exchanged behind our backs is that the person involved has no idea what information is being exchanged—or indeed if it is correct information. All of us who have worked in data processing systems know that there must be mistakes. Indeed, in a non-checked, uncontrolled system of this sort the error rate must be extraordinarily high. And the implications of garbled information is akin to gossip of the most vicious sort—in that one never has a chance to determine what it is that is being said about him. This constitutes to my mind a greater danger than the data bank now being proposed as a government information center. If such a center were carefully controlled, then a most important inclusion would be the prevention of these mentioned abuses.

All information to be stored in such a data bank should be indicated to the individual involved, for his approval. If he indicates that the information is incorrect an opportunity exists to correct it. If he objects to information being included, he has legal recourse and can prevent it. The individual can then protect himself against incorrect, unprovable or undesirable information.

I have not seen any suggestions made to the effect that one of our individual rights is the right to defend oneself against information being transmitted without one's knowledge, and in the context of modern technology, this may be an important right. It is one that the government, within the context of protection for the individual, could implement. It is difficult to enforce among private users. The individual could certainly determine to whom and under what circumstances information is to be made available. Transmission of information is then available only under his own authorization. The problem of making such information available to a few people in government could perhaps be solved by requiring the authorization of several people at once in order for information to be retrieved, and information on an individual would never be allowed except under that individual's authorization.

It seems to me that the problems and possible dangers of the centralized data bank should be balanced against the abuses which already exist in the system we now have.

EVELYN BEREZIN
Albertson, L.I., N.Y.

management's seat

Sir:

I'd like to fill you in on the reactions I have received from my article, "The Revolving Executive Chair" (Dec., p. 45). From the first day the magazine hit the readers, the telephone started ringing and it has just recently subsided back to its normal intrusion.

In one short period of time, I have achieved more fame—or notoriety, depending on how you look at it—than 10 years of hard work have accomplished . . . Thanks for giving me my moment of glory. And don't let anyone underestimate the power or readership of DATAMATION.

H. J. CADELL
Phoenix, Arizona

How come no one has written *us* about the article?

there's the rub

Sir:

Correct your quotation from *Hamlet* (Nov., p. 27) to be "$2B\ \underline{V}\ \overline{2B}$" and not to be "$2B\ V\ \overline{2B}$."

ARTHUR R. ZINGHER
New York, N.Y.

capital punishment

Sir:

This is a plea to persuade you to discontinue the use of small letters in place of capital letters. Capital letters give character, beauty, and readability to our language; to abolish them willy-nilly creates ugliness and discord. To me, it is in a class with the WORST in modern art and music — and life in general!

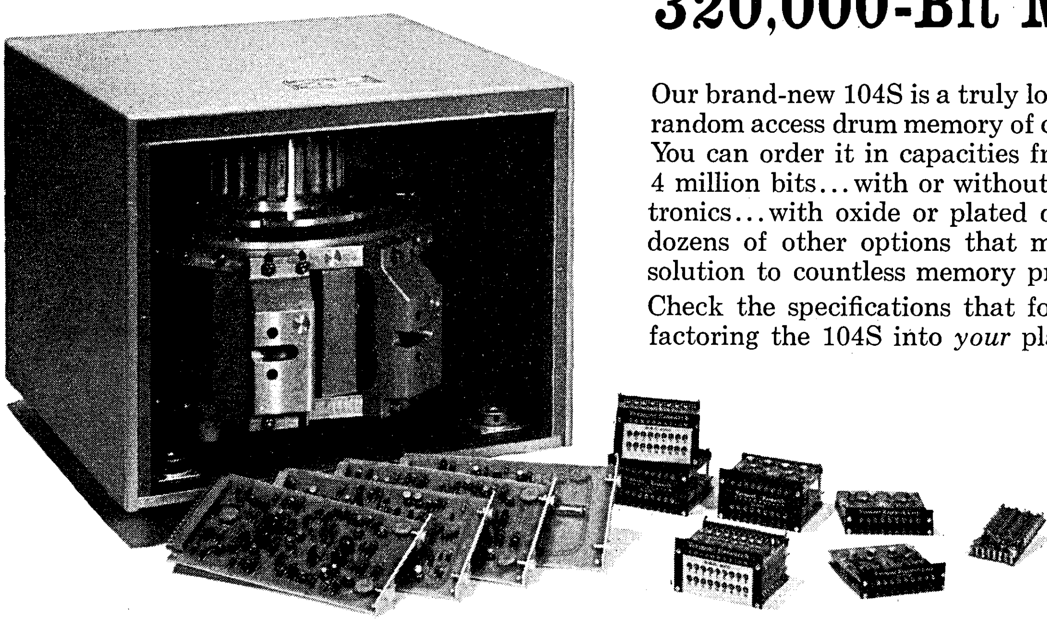
GEORGIA M. NAGLE
Cambridge, Mass.

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.

DRUMS • MODULES • SYSTEMS

A Page from the Vermont Research
MEMORY FACT BOOK

Fact: $3,000 Buys a 320,000-Bit Memory



Our brand-new 104S is a truly low-cost, universal, random access drum memory of computer quality. You can order it in capacities from ¼ million to 4 million bits... with or without read/write electronics... with oxide or plated drum... and with dozens of other options that make it the ideal solution to countless memory problems.

Check the specifications that follow. Then start factoring the 104S into *your* plans.

Capacity. 8 to 128 data tracks provide maximum storage of 200,000 to 4,000,000 bits. Data input format may be serial, parallel or any combination.

Speed. Average access time is 8.3msec; maximum access, 17msec. (Average access to 3.7msec on special order.)

Physical Specifications. Type 104S is a 10″ diameter drum utilizing VRC's patented "flying head" design. Standard enclosure measures 17″ x 17″ x 14″. Hermetically sealed, gas filled version also available for use in rarefied or contaminated atmospheres.

Performance. Design life exceeds 100,000 hours of operation, a figure proven conservative in customer application of similar VRC drums. Bearing lubrication life exceeds 50,000 hours.

Electronics. Read/write electronics can be furnished in rack-mounted card or integrated circuit module forms. Custom interface electronics also available.

Price. Basic price of $3,000 includes: drum, motor, 16 data tracks, 4 clock tracks and diode matrix. Quotations on custom options will be furnished promptly.

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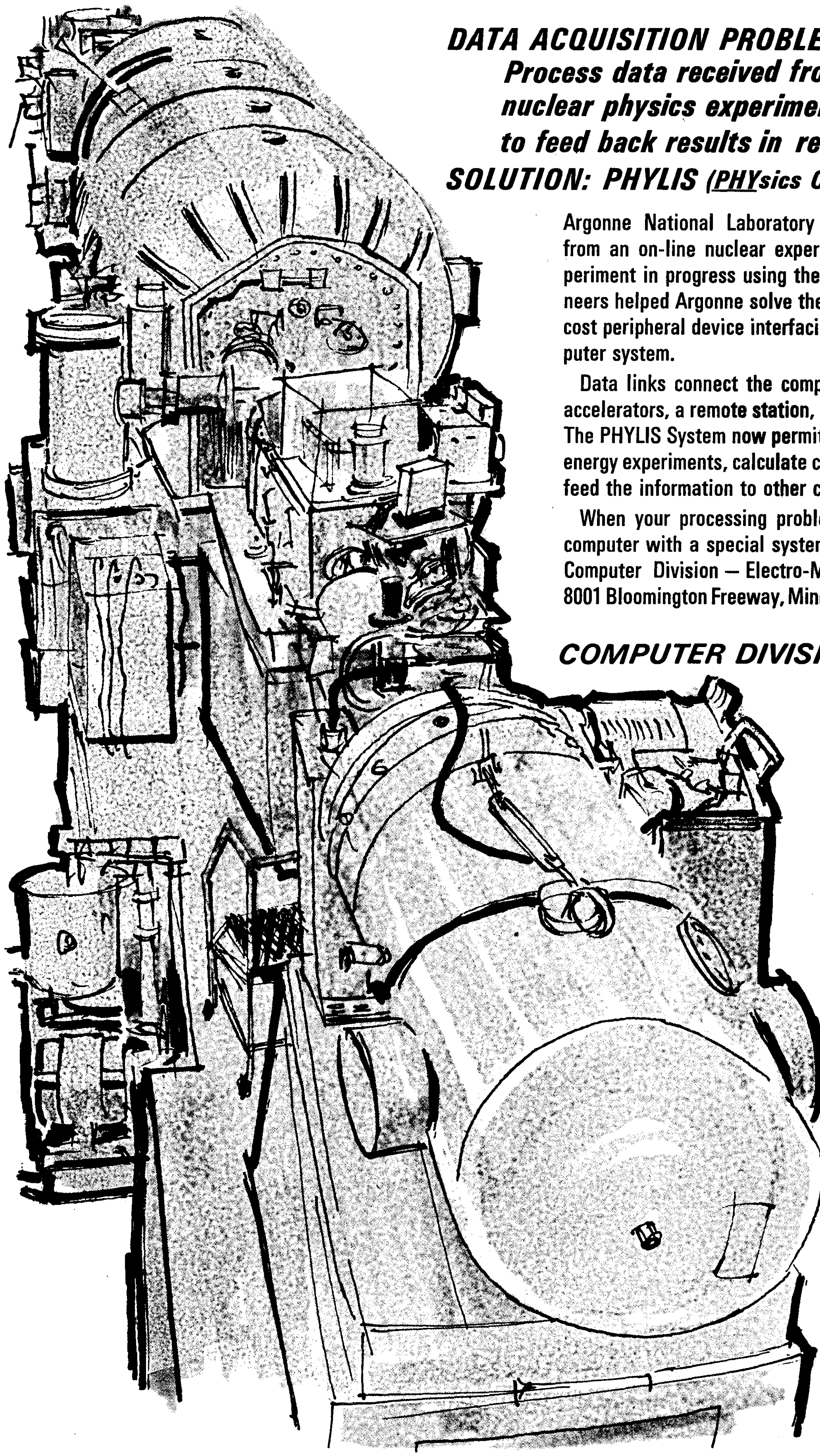


look ahead

CRITICS RISE AGAINST SDC AND AIR FORCE

Software houses that find they are bidding for a contract in competition with System Development Corp. are starting to raise a fuss. They say that SDC, in its role as technical adviser to many government agencies, has gained information not generally known to contractors. This favored position, it is alleged, benefits SDC when it subsequently bids for a job.

A spin-off of the Rand Corp., SDC built up a competent staff and a technical capability with Air Force contracts for its first three years. It acquired its first non-AF job in 1960, has since had over 100 non-military jobs, most still active. But last year the AF figured SDC's capabilities were also available in private industry, and began requiring that SDC bid for AF jobs in competition with them.

IBM EASES UP ON T-S DELIVERIES

Delivery of the Time-Sharing System (TSS) for the 360/67 has not only slipped from August to October '67, but the initial package will be without Cobol, conversational PL/I, sort/merge and remote job entry. These features, or substitutes for them, have been scheduled for the second release, due in mid-68. The mod 67 is still being delivered, but has been placed in "controlled marketing" status, meaning each deal must have approval of the regional IBM vp.

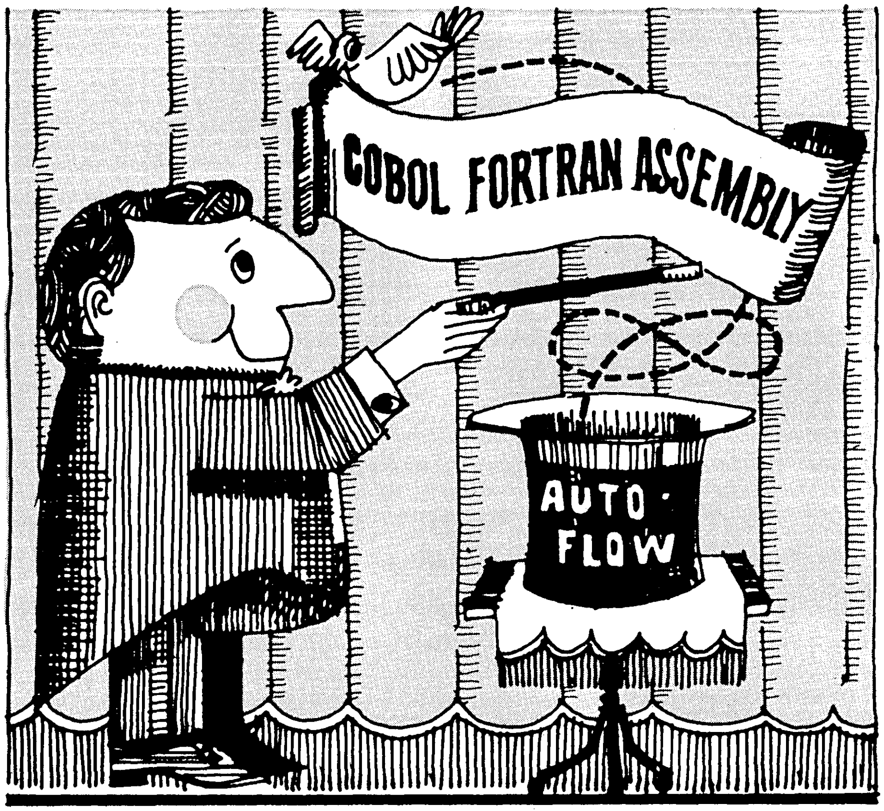
AT&T's PROPOSED TARIFFS RAISE MICROWAVE's IMAGE

Filing of data communications tariffs by AT&T has caused users to start considering the use of private microwave, to order different mainframes and configurations, and just sit and wait. One user figures on saving 40% on his long-distance transmission.

The new private line tariffs cover voice, telegraph, teletypewriter and related services with generally increased short-haul rates and lower long-haul rates, and replaces Telpak A and B with a new wideband 48KC service. Line charges for the new offering are roughly similar to those for Telpak A. Terminal rates are increased across the board. The new tariffs are scheduled to become effective May 1, assuming the FCC approves and no users protest. But objections are virtually certain.

Others argue that the FCC order directing AT&T to file new rates was restricted to line charges. The order said nothing about terminal charges. And critics say that if short-haul private line rates were too high before, as the FCC order implied, AT&T has hardly solved the problem by raising them.

Later this year, AT&T says, it will propose a substantial hike in Telpak C and D rates. We hear, too, that Raytheon is readying an interface system that will make computer-to-computer microwave communication economically and technically preferable over short distances. The new CCT unit, with a 1024 byte buffer (more memory available), will convert and transmit data, do error checking at rates up to 2 megabytes/second (16 megabits), providing automatic



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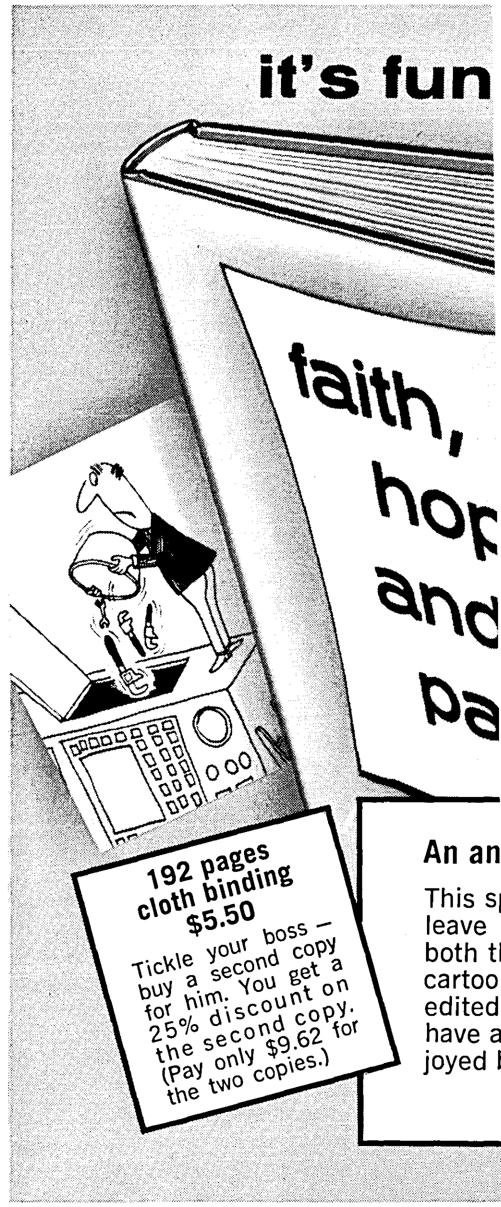

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look ahead

error control and retransmission without returning to the sending cpu. The need for various adapters, modems and some mainframe software is thus eliminated. Use is mostly for distances up to 50 miles, within which repeaters are not required in transmission (50-100 miles is feasible).

Triangle University Computer Center in North Carolina, now serving Univ. of NC, NC State, and Duke, is planning a microwave system using CCT's. When the new system is completed, probably in three years, cost will be about $12K/month for equipment and 500K bytes/second transmission service, versus the present $8K/month for equipment and common carrier services providing up to 48KC (5100 characters/second).

COMPARISON SHOPPING FOR COMMERCIAL TIME-SHARING

Next best thing to window shopping is to ask the man who's tried 'em. Tom O'Sullivan of Raytheon, Sudbury, Mass., tells of seven t-s systems they're using from remote terminals. He says the CEIR GE 235 is great for jobs with high compute times because they charge by terminal hook-up time. Quiktran-New York City is excellent for training new programmers, but too slow for veterans. Popular with the latter is the IBM remote turnaround 7044 with batch IBSYS, also in NYC.

Bolt Beranek's PDP-1 in Cambridge, Mass., he says, has a slow I/O and programs have to be fed in before execution starts. Dartmouth's GE 235 with Basic has a short training period, user could be on the air within several hours, solving problems. They also use Applied Logic's PDP-6 in Princeton, N.J., and GE's 235 in Valley Forge, which will be replaced by GE centers in New Jersey and the Boston area.

A new service recently added is Dial Data in Newton, Mass. They have an SDS 940. This and the Dartmouth hook-up are the only ones with full duplex lines. This means the user can hit a key, see an X typed out, say, and know this is the character that the computer received.

SPECIAL PURPOSE COMPUTER OR SMART MEMORY?

With an eye to a world of automated manufacturing and fabrication, Data Machines Inc. is taking a new approach to the computer biz. The Newport Beach, Calif., firm will soon introduce what they call the Smart Memory, a stripped down computer aimed at the systems and control fields. It has the control, arithmetic and I/O units from their integrated-circuit 620 I computer, but can be had with 16, 18, 24 or 32-bit word length. The software consists of only a minimal assembler and diagnostics.

For the user, it can mean easier tailoring to fit the application. And lower cost: an 8K 32-bit internally-programmable device reportedly costs 50-60% less than a comparable gp computer.

The Smart Memory has forerunners in such devices as the programmable decommutators used in telemetry. But in addition to being another step toward the separation of hardware and software pricing, DMI's move to market them as gp control elements for manufacturing, if successful, could resuscitate arguments about special-purpose vs. gp computers as the way of the future.

ANOTHER ON-LINE SERVICE TO OPEN

Another on-line service bureau is in the works. With a B3500 due later this year, Time-Sharing Services Inc., Los Angeles, will have 36 lines available, figures it can sign up five clients/line. Terminals

(Continued on page 93)

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TOMORROW'S BREED OF I/C COMPUTER...

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I/C construction . . . 16-bit word . . . 960 nanosecond speeds . . . strong software support — unprecedented computer capability in a low cost compact. And these are only some of the features that put 3C's two new μ-COMP machines in tomorrow's computer class today.

THE DDP-516, at $25,000, is the most advanced I/C 16-bit computer now available. Both hardware and software are already operational. Hardware includes high-speed multiply and divide (optional), a 4096-word memory (expandable to 32K), 960 nsec cycle time. The command repertoire includes 72 instructions with such capabilities as byte manipulation, skip-branch conditioning, and extensive memory reference and control.

250 field proven programs are available with every DDP-516 . . . including ASA FORTRAN IV compiler, selectable one- or two-pass assembler with a unique DESECTORIZING loader that lets you ignore memory restrictions. DDP-516 delivery: as few as 90-days.

THE DDP-416, at $16,900, was engineered for a price/performance ratio that can't be beat by any other on-line real-time computer. Hardware features include a 4096-word memory (expandable to 16K), 960 nsec cycle time, 1.92 μsecs add, with indirect addressing.

A 30-command repertoire, priority interrupt and power failure protection are standard. Both the DDP-516 and the DDP-416 may be mounted in standard 19" racks. Best of all, if you decide to get the more powerful DDP-516 in the future, you can continue to use your DDP-416 programs because of direct compatibility. DDP-416 delivery: second quarter of 1967.

Write today for information on both μ-COMP computers. You can't go wrong with either one. Honeywell, Computer Control Division, Old Connecticut Path, Framingham, Massachusetts.

Honeywell

COMPUTER CONTROL DIVISION

A SELECTION ATTITUDE SAMPLER

Our recent survey of how users in four general categories go about the tricky task of evaluating and selecting information processing systems is neatly summarized by Norm Schneidewind in an article beginning on p. 22.

The article does not, however, include the comments triggered by an open-ended question in our questionnaire, which asked the respondents to sound off about equipment selection as it's practiced in their organizations. In the belief that such comments may offer additional insights into attitudes toward selection, we offer the following sampler:

"Since computer rental must be justified to management, cost is the principal factor. The next most important point . . . is ease of conversion from the present configuration. . . . "

" . . . Organizations and personnel inexperienced in computers must not be allowed a strong voice in the selection of equipment for their use. If your company is supported by government contract, maintain *complete* documentation to support possible audits."

"Although the previously listed selection factors are investigated and taken under consideration, I do not feel that our decisions are based upon completely unbiased objectivity. I feel that this situation is a universal problem among a high percentage of computer users. It is common to get the facts and then ignore or discount them. Loyalty to a company or salesmen based upon past experience of our organization or an individual seems to reign high. After 8½ years in the business I have seen little progress in objectivity."

"Selection has been: any computer as long as it is manufactured by IBM. Policy may be shifting in near future."

"We think it costs less to stay with one manufacturer."

"It's a tricky business at best. Advances in hardware and software are so rapid these days that by the time you install the selection it is almost out of date. In general, a quick selection with a good manufacturer will keep you abreast of the game. I don't think you can get ahead."

"All too often, computers are selected on the basis of which salesman does the best 'snow job' or more simply, sticking to the manufacturer of the current equipment. We do write specifications and go out for bids, but this is really window-dressing. Probably this is true in most government controlled situations. Almost any major manufacturer's equipment can be made to do almost any job. All it takes is money. The manufacturers seldom tell the unvarnished truth about capabilities and availability. Logical computer selection seems almost impossible."

"We have hesitated to use any equipment except IBM because of local support limitations. I favor bringing in competition for the sake of competition and Honeywell has demonstrated a superiority over the 360 in performance and cost. But the superiority is in existing applications and liberation of 1401 programs. Will IBM de-liberate our programs if we decided to return to the fold? Will other manufacturers introduce competitive optical scanning equipment similar to the latest from IBM? Will they have applications packages to compete with ALIZ and PALIZ for insurance companies? What is the price tag for turning your back on this 'free' IBM support?"

"Like most organizations, we tend to favor IBM very strongly in our EDP equipment selection. While we look to other systems, by and large this is done more as an exercise than an analytical appraisal. I believe we should be more objective than we are but I almost stand alone in this attitude. The personnel directly involved in EDP functions are united in their IBM orientation and bias. While I disagree with this, in general I am frank to admit there is a certain built-in security in staying with them. I also find the performance of their representatives is generally superior to the competition. I don't believe this is true of the products."

"We are paying a heavy price for the criteria used two years ago—to eliminate IBM from our shop; the competition simply fell on his face, as did his equipment and software."

"Extremely complicated."

a survey of users

THE PRACTICE OF COMPUTER SELECTION

by NORMAN F. SCHNEIDEWIND

A great deal of mystery has been associated with the process of computer selection. And judging by the available literature, little has been done to reveal the current practices of users. In an attempt to illuminate this subject, some DATAMATION readers were surveyed recently. We hoped, in this way, to confirm or reject certain hunches or hypotheses that people have about the selection process.

One would assume, for example, that government agencies rely on the competitive selection of computers (as distinguished from single-source selection) more than the commercial users. And, alternatively, that machines acquired by single-source procurement are of the smaller, lower-cost variety. But are these assumptions correct? Further, is there a correlation between the use of outside consultants and the reliance on objective criteria in the selection process? Probably everyone assumes that subjective criteria overrule any objective measurements that can be made to determine what computer to acquire. But do the facts bear this out?

Answers to these and other questions were sought by this writer with the assistance of DATAMATION. Of course, a survey produces only the raw data; what we've done is to analyze the sample data and, from that, draw an inference about the characteristics of computer selection in the total population of computer users.

Covered in the questionnaire were four aspects of computer selection. These are:

1. *Competition.* The extent to which computer selection takes place on a competitive basis as opposed to single-source procurement.
2. *Methods.* The methods employed in computer selection.
3. *Selection Criteria.* The degree to which various criteria are used in computer selection.
4. *Outside Assistance.* The use of outside assistance—consultants and computer manufacturers.

Data was also obtained about computer applications and the cost of the installation.

A random sample of the DATAMATION readership was selected to receive the questionnaire. The types of computer users or prospective users to whom the questionnaire was directed are listed and defined below.

1. Commercial: non-government, non-aerospace and non-university.
2. Government: civilian, military; federal, state, local.
3. Aerospace: aircraft, missile, space.
4. Universities.

The number of responses received in each category is indicated below.

1. Commercial	37
2. Government	20
3. Aerospace	8
4. University	4
	69

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The small sample size in aerospace and university categories precludes analysis of just these two groups. However, analysis of commercial versus non-commercial and government versus nongovernment can be made. Also, many other breakdowns (cost of installation, type of application, etc.) can be made and analyzed when sample sizes are adequate.

competition

The use of competitive selection in the sample for each group of users and for users as a whole is shown in Table 1. Respondents were asked to indicate the use of competitive or single-source selection. On the basis of responses, we estimate that between 77% and 92% of all users utilize competitive selection. This is based on a 90% confidence level, a term used by statisticians to indicate the degree of reliance that can be placed on the estimate. If a higher confidence were required, the spread of the estimate would be greater.

Table 1

Type of User	Percent Using Competitive Selection
Government	94.4
Nongovernment	
Commercial	80.6
Aerospace	85.7
University	75.0
Total Nongovernment	80.9
Total All Users	84.6

As can be seen, the government uses competitive bidding to a greater degree than non-government users—reflecting the former's concern with competition in computer selection because of its accountability to the public and a desire to maintain competition in the development of the computer technology.

Not surprisingly, we also found that, in general, the smaller (lower cost) installations use single-source procurement, while larger installations go to competitive bidding. The average monthly rental being paid by those who use competitive selection was $62,300 (a standard deviation of $112,600), while that of the single-sourcers was $16,800 (standard deviation: $11,070).*

But one would also think that users employing single-source procurement will depend upon the services of computer manufacturers for their application development to a greater extent than users employing competitive selection. This study does not bear this out. The percent of competitive selectors who rely on the manufacturer is 29.1%, while that of the single-sourcers is 30.0%.

The study also shows that users with only administrative type (business) applications tend more toward single-source procurement than do users with other or additional applications. These users tend to be smaller and less sophisticated in the evaluation of computers than those users with a variety of applications; consequently, they are more likely to be a captive of the computer manufacturer. Table 2 shows this relationship between type of application (administrative-only applications and non-administrative-only applications).

Table 2

Type of Selection	Per Cent With Administrative Only
Competitive	38.2
Single Source	70.0

*Another statistical term, the standard deviation as used here is a measure of the spread between the highest and lowest rentals being paid by respondents in the respective groups.

We can conclude from all this that computer selection is more competitive in government than it is in non-government organizations, and selection is less competitive among users whose application is restricted to administrative dp as opposed to users with a variety of applications. In general, however, the use of competitive computer selection is extensive.

methods

Respondents were also asked to indicate which of the following methods (one or more) are employed in computer selection in their organizations:

- Evaluation of benchmark problems
- Published hardware and software evaluation reports
- Program and execute test problems
- Computer simulation
- Mathematical modeling

Some of the methods listed above are considered more objective than others, although all methods are basically objective. Simulation and modeling are considered the most objective, followed by test problems, benchmark problems and evaluation reports. The programming and execution of test problems is considered more objective than the evaluation of published reports about hardware and software because, in the former, the user can simulate the conditions under which the full-scale system will operate. But in the latter, evaluations may relate to alien applications or may present hardware and software specifications which have limited value to the user's operating environment.

Relative to the methods of computer selection employed, we can hypothesize that government users will employ more objective methods of computer selection than will non-government users. Again, government selection methods are in the public view, via Congress, and, secondly, the government desires to maintain competition among computer manufacturers.

Results: the use of two methods of computer selection, evaluation of reports and programming and execution of test problems, is shown in Table 3 for government and non-government users. There is not a statistically significant difference in the use of the two methods by the two users groups and hence the above hypothesis is rejected.

Table 3

Type of User	Per Cent Use of Reports	Per Cent Use of Test Problems
Government	55.5	60.0
Non-government	67.4	49.0

It was found, however, that larger (high cost) installations use more objective methods than smaller (lower cost) installations. This was expected. Higher cost installations will use more objective methods because there is more at stake in the computer selection decision. Also, larger installations are better staffed to employ sophisticated methods. The relationship between use of the five methods and installation cost is shown in Table 4 (*p. 24*). Statistically significant differences were found in the use of all methods, except test problems.

users of consultants

One might also assume that users who employ consultants utilize more objective methods than users who do not. Consultants, the reasoning goes, will recommend the use of more objective methods in computer selection in order to defend a recommendation and to protect their professional reputation. This does not turn out to be true, based on our sample returns. The relationship between the use of various selection methods and the use of consultants is shown in Table 5. There is no statistically significant difference in these sample data.

Interestingly, too, one cannot say that users with only administrative-type applications use less objective selection methods than those users who have a diversity of applications. This hypothesis rests on the rationale that users with applications limited to administrative work are less likely to have the technical resources required to employ sophisticated selection methods. The use of the various methods by the two groups of users is shown in Table 6. A statistically significant difference in the use of selection methods by administrative-only and other types of users occurred only in the use of test problems. Therefore, the hypothesis, in general is rejected.

Can we say, then, that conventional methods (benchmark problems, evaluation reports and test problems) are used more than sophisticated methods (simulation and modeling)? Yes, it turns out. The majority of computer users have not yet reached the level of sophistication, nor do they have the technical resources which are required, to use advanced methods of selection. The use of the five methods by all users is shown in Table 7. The difference in use between benchmark problems, evaluation reports and test problems, as one group, and simulation and modeling, as another group, is statistically significant.

We can conclude, then, that larger (higher cost) installations use more objective methods in computer selection than smaller (lower cost) installations. Also, conventional, less sophisticated methods of selection are used in preference to mathematically-oriented methods.

Table 4 (Per Cent Use)

Monthly Rental	Benchmark Problems	Evaluation Reports	Test Problems	Simulation	Modeling
$ 0 - 14,000	50.0	80.8	53.8	7.7	0
$15,000 - 49,000	81.8	77.3	54.5	13.6	4.5
$50,000 -	76.9	53.8	61.5	46.2	30.8

Table 5 (Per Cent Use)

	Benchmark Problems	Evaluation Reports	Test Problems	Simulation	Modeling
Use Consultant	61.5	69.2	69.2	15.4	15.4
Do Not Use Consultant	70.0	70.0	54.0	18.0	6.0

Table 6 (Per Cent Use)

Type of Application	Benchmark Problems	Evaluation Reports	Test Problems	Simulation	Modeling
Administrative Only	55.5	66.7	33.3	14.8	0
Other	71.1	68.4	68.4	18.4	13.2

Table 7 (Per Cent Use)

Benchmark Problems	Evaluation Reports	Test Problems	Simulation	Modeling
60.9	63.8	52.2	15.9	7.2

selection criteria

We also asked our respondents to rank the following computer selection criteria in the order of their importance:

- Hardware performance
- Software performance
- Support provided by manufacturer
- Availability of application programs
- Compatibility with present hardware and software
- Delivery date
- Potential for growth (modularity)
- Cost

In the ranking of these criteria and in the four tables that follow, decreasing order of importance goes from 1 to 8. That is, the lower the number, the more important is the criterion. The most objective criteria are hardware and software performance; the least objective are availability of application programs and manufacturer support.

The relationship between average rankings of several criteria and type of user appears in Table 8. It shows that these rankings are fairly consistent among the several user groups. That is, all user groups place greater emphasis on objective (hardware and software) criteria than on subjective criteria. This is also true for users as a whole. *This result is the most significant one of the survey.* It was anticipated that subjective criteria would play a greater role in computer selection, but it appears that objective criteria exert much greater influence.

A test of the difference in average rankings, for all users, of hardware and support provided by the manufacturer was performed. The results of this test indicate a statistically significant difference in the use of these two criteria.

Caveat: The above result is based on the assumption that the rankings provided by the respondents are truly indicative of the weight given the various criteria in the actual selection of a computer. It is possible that some users do not want to admit that a selection is made on other than a rational basis. Several users indicated that a great deal of objective analysis is performed and then discarded when a final decision is reached.

From Table 8, it is also seen that cost is rated less important as a criterion by commercial users than by other types. This was a surprise; it was anticipated that commercial users place great emphasis on cost. In fact, of the four categories of users, cost is rated more highly by aerospace firms!

This study also fails to support the belief that large (high cost) installations use objective criteria to a greater extent than small (low cost) installations. Average rankings of hardware and manufacturer support by cost of in-

Table 8 (Average Rankings)

	Hardware	Software	Manufacturer Support	Availability of Programs	Compatibility	Delivery	Growth	Cost
Commercial	3.11	2.73	3.92	6.57	4.35	6.27	4.68	4.38
Government	2.15	2.45	4.32	7.30	4.85	6.45	4.25	4.25
Aerospace	1.57	3.68	5.29	7.14	3.86	6.43	5.57	2.43
University	2.50	1.75	3.50	6.75	6.00	7.25	4.50	3.75
All Users	2.63	2.69	4.15	6.85	4.54	6.40	4.63	4.10

stallation are shown in Table 9. The difference in average hardware ranking for the lowest and highest cost bracket installations is not statistically significant. The same statement applies to support provided by manufacturer.

Table 9

(Average Rankings)

Cost of Installation	Hardware	Manufacturer Support
$ 0 - 14,000	2.79	3.96
$15,000 - 49,000	2.80	4.12
$50,000 -	1.91	5.25

Similarly, the study failed to show that technical users, who would be expected to use technical methods of selection, place greater emphasis on technical (objective) criteria. In Table 10 is a comparison of the use of the most objective criteria, hardware and software performance, for technical users and for users with only administrative applications.

We can also compare the emphasis on objective criteria by users according to the method they use to procure machines—by competitive bidding or by single-source. Here again, we see in Table 11 the differences are not statistically significant. That is, we cannot say that single-source selections *per se* are based on the use of less objective criteria than are competitive selections.

Table 10

(Average Rankings)

Type of Application	Hardware	Software
Technical Applications	2.70	2.57
Administrative Only Applications	2.55	2.50

Table 11

(Average Rankings)

Type of Selection	Hardware	Software	Support	Availability of Programs
Competitive	2.56	2.69	4.20	6.95
Single Source	3.00	2.70	3.90	6.30

outside assistance

Respondents were asked to indicate the use of outside assistance in computer selection in the form of one or more of the following:

- Independent consultant (single individual or group of individuals specializing in computers)
- Accounting firm (primary business is auditing, but offers edp services)
- Management consultant (primary business is management consulting, but offers edp services)
- Technical firm (software house or firm with primary emphasis on data processing)
- Computer manufacturer

The use of consultants (excluding computer manufacturers) by various groups is shown in Table 12. In general, the use of consultants is not extensive. In the population of all computer users, based on the sample data, it is estimated to be between 12% and 28%.

The results in Table 12 seem to imply that users within the government employ consultants in computer selection to a greater extent than firms in private industry. However, the difference between the two use rates is not statistically significant. Conversely, one would expect that the government—not wanting to be, or at least appear to be, the captive of any computer manufacturer—would rely on the manufacturers for its requirement study to a lesser extent than non-government users. The figures in Table 13, however, show that the difference is not statistically significant. But there is a significant difference when we compare users with a diversity of applications and those with administrative uses only. Users with only administrative type applications tend to be the smaller and less technically sophisticated organizations, and thus more likely to be dependent on the manufacturers for assistance.

Still on the subject of using outside assistance, we also found—not surprisingly—that the larger installations rely less on consultants. The average monthly rental of those who use outside assistance was $33,800 (with a standard deviation of $87,900), while the rental was $71,000 for those who do not (standard deviation: $112,400).

What about the types of outside consultants? As shown in Table 14 about 20% of our sample population uses outside consultants, and some 29% rely on the mainframe manufacturer. The latter have a natural entree to users via their marketing efforts, and many users look upon manufacturer assistance as a "free" service. But the results do not bear out the assumption that there is a strong preference for the use of consultants. And within the general category of consultants, the management and independent consultant are called upon more than the accounting firm and the technical firm.

Table 12

Type of User	Per Cent Using Consultants
Government	30.0
Non-government	
Commercial	16.2
Aerospace	25.0
University	.0
Total Non-government	16.3
Total All Users	20.3

Table 13

	Per Cent of Use of Manufacturers
Government	25.0
Non-government	29.0
Administrative Only	42.9
Non-administrative only	19.5

Table 14

Type of Outside Assistance	Per Cent Use
Independent Consultant	7.2
Accounting Firm	2.9
Management Consultant	8.7
Technical Firm	1.4
All Consultants	20.3
Computer Manufacturer	29.0

Relative to the use of outside assistance, we come to these conclusions:

a. The use of outside assistance is small.

b. The use of outside assistance (consultants and manufacturers) is greater among small (low cost) installations than it is among the larger (higher cost).

c. The use of manufacturers as consultants by computer users with applications limited to administrative problems is greater than by other types of users.

summary

On the basis of the anlysis which has been described, a composite picture emerges of the "typical" computer selection process. In the main, computer selection is *competitive:* it uses *conventional* selection methods; it emphasizes *objective* as opposed to subjective criteria; and the selection is performed *in-house* rather than by the use of consultants. ■

SCERT: A COMPUTER EVALUATION TOOL

by DONALD J. HERMAN

With a large and growing selection of third-generation computers now at hand, it becomes increasingly difficult to justify continued use of manual computer management methods. And yet, this is just what is happening. In an industry built around ultra-fast data handling and processing, the science of computer management is being left behind. Example: it often takes months, and sometimes years, to reach final management decisions about sophisticated new systems. This is understandable since requirements must be defined and specifications prepared before proposals can be obtained, evaluated and final equipment selected. But the end result is still the same—a long time lag.

Or look at some day-to-day computer management problems. How long will it take to program a specific problem? How many programmers are required? How much running time will be involved? What will be the memory requirements? All these questions, plus many others, are still being answered with first generation management methods.

evaluation of hardware/software

But now we are beginning to move into an advanced generation of computer management. With proprietary techniques developed by COMRESS, Inc., the computer manager has a new tool at his disposal—the computer whose talents range from evaluation of other computers to providing accurate flowcharts of programs that may have been patched and repatched without adequate documentation and even to *translating programs* from one computer language to another.*

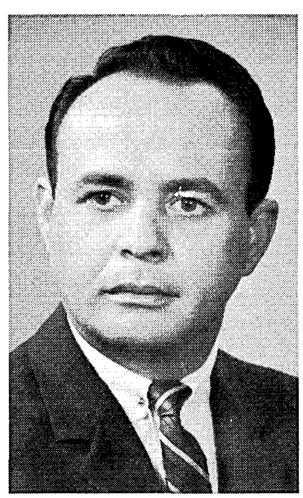
One of these tools, used to assist in making management decisions about computers, is SCERT (Systems and Computers Evaluation and Review Technique), a family of computer programs that is used to simulate the performance of a user's processing requirements against cost/performance models of selected computers. These performance models are built from a constantly updated tape library that contains software and electronic and mechanical hardware characteristics for virtually all available commercial computer equipment.

By using SCERT as a management aid, the director of a computer operation can answer such questions as: Is my present computer equipment utilized efficiently? . . . How can I optimize my computer capacity? . . . What additional operations should I computerize? . . . What effects will changes have on my current system?

For the computer manager who is planning for the acquisition of third-generation equipment, SCERT can help answer questions like these: What is the best processing flow design for my applications? . . . Should I consider on-line, real-time, random access? . . . What complement of equipment is best for my operations? . . . Should I rewrite or emulate our programs? . . . Should I purchase or lease the selected equipment? . . . What programming language should I use?

technical features

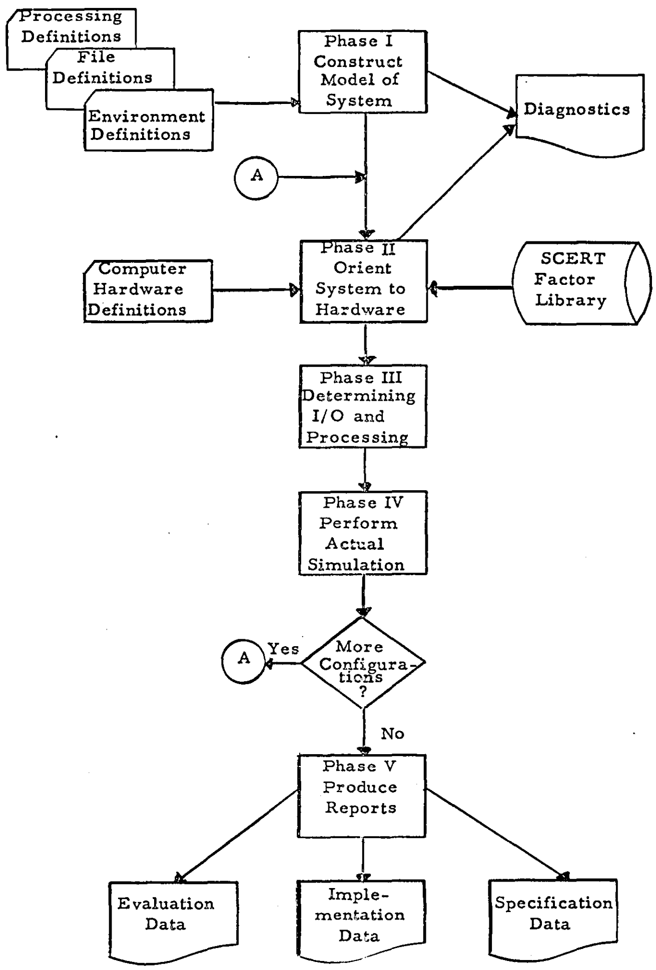
SCERT is essentially a five-phase program (see Fig. 1). Phase One builds a matrix for each computer run or real-time event in the entire system. These matrices array



Mr. Herman is president of Comress, Inc., Washington, D.C., which he co-founded in 1962. Prior to that, he was senior methods specialist with RCA-EDP, and has also been associated with the National Security Agency as deputy chief of administrative dp. He holds a BS in industrial engineering from the U. of South Dakota and has done graduate work at American U.

*We have satisfactorily proven, in testing the prototype, that the TRANSIM program can accomplish 100% computer-to-computer translation for our selected pairs of machines. The software, however, is not being marketed yet.

Fig. 1



the variables which describe the unique processing requirements for each individual computer run and are based on the system, environment and file definitions.

System definitions are basically a verbal portrayal of the system chart, reflecting frequency of occurrence, identification of I/O files, and the type of internal computer activity (see Fig. 2). The file definitions reflect such data as number of records, number of characters per record,

Fig. 2 SCERT Descriptive Verbs

INTERNAL ACTIVITY—Conceptually, internal processing in a computer is caused by, or results in, an input or output file. Based on this theory, internal activity in SCERT is related to the file that triggers or is created by such internal activity. Internal processing is described to SCERT in four general categories. These are:

Functional Level which allows for the description of high level program functions:

ST — Sort
MG — Merge
UP — Update
EX — Extract
VL — Validate
CA — Compute
CM — Compute
Report Generation

Macro Level/Business Orientation which describes subroutine level processing:

MT — Match
SM — Sequence
HK — Housekeeping

Fig. 2 (Continued)

TB — Binary Table Look-Up
TS — Serial Table Look-Up

Intermediate Scientific which describes common scientific computer functions:

SQ — Square Root
SI — Sine
CS — Cosine
AT — Arctangent
EX — Exponential
LG — Logarithm
MA — Matrix Addition
MM — Matrix Multiplication
MT — Matrix Transposition
MI — Matrix Inversion

Basic Computer Activity which describes the common basic elements of computer processing:

DM — Move Data
DC — Compare Data
DE — Edit Data
DT — Translate Data
DA — Add/Subtract Data
DX — Multiply Data
DD — Divide Data
FA — Floating Addition/Subtraction
FM — Floating Multiplication
FD — Floating Division

number of alpha and numeric fields, and the category and data media of the file. The environmental definitions provide SCERT with the necessary data for all computations involving subjective considerations. For example, they allow for the user to specify the experience level of programming personnel; the salaries for programmer and operators to be used in performance/cost correlations; the life expectancy of the computer, and the corporate cost of money. The environmental definitions are also used to specify the software that is to be included in the simulation, such as what level of operating system will be employed, what programming language is to be used, and what choice will be made of other variable software such as sort and IOCS packages.

Fig. 3 Pre-Simulation Algorithms

During Phase Three, SCERT computes the following data for each program run or random event:

1. Internal processing time and memory requirements. As a byproduct of these calculations, it also determines the number of program steps required to perform the internal processing.
2. The assignment of all files to available peripheral devices and channels.
3. The structuring of files to the hardware in terms of record format and size, file blocking or batching and provision for alternate areas.
4. Peripheral device timing for all input/output functions and the memory requirements for such functions.
5. The timing of generalized software packages, such as sorting, compilations, IOCS and operating system overheads.
6. Pre- and post-run timing, such as program insertion, set-up time, multi-media change time, error correction time.

During Phase Two, SCERT's library supplies the hardware and software performance factors of the particular computer configurations that have been specified. These factors are arrayed in the form of a three dimensional matrix and then the mathematical models of the runs in the system are oriented to conform to the hardware requirements of each computer to be evaluated.

During Phase Three, numerous pre-simulation algorithms are performed (see Fig. 3). It is this pre-simulation analysis that makes SCERT unique when compared to all other simulation techniques. By performing these calculations, SCERT adjusts the non-hardware-oriented processing requirements developed during Phase One to the particular hardware/software complex specified in Phase Two so that resimulation of the same processing design on widely differing complements of computer hardware can be accomplished without modification to the basic input definitions.

Fig. 4 SCERT Output Report Summary (Computer Evaluation)

Systems Specifications: A set of flow-charts for each run in the application used to prepare specifications for manufacturers' proposals.

Computer Complement: Complete identification and specifications of each component in each configuration.

Detail Program Run Analysis: A three-part report that analyzes each computer run. Part I shows the total buffered and unbuffered time required for the running of each input and output file, the I/O device assignment by SCERT, the data channel to which the file has been assigned, the number of reels, and the optimum records per tape block. Part II analyzes the internal computation including time, memory, and program steps by function. Part III forecasts the time required for program insertion, multi-media change, real-time interrupt, multi-program delay, end-of-job rewind, the other functions.

Central Processor Utilization: A summary, by individual run, of the forecasted program operation time and total memory requirements, by day, week, month, quarter, and peak month.

Programming Requirements: A forecast of the number of steps to be programmed and the requirements in man-months for each program run.

Application Summary: A list, by sub-application (payroll, inventory accounting, personnel accounting, etc.) of the processor use by month, set-up time, total programming effort, and programming costs.

Cost Summary: A two-part report that specifies the cost to install and operate a computer after all applications have been programmed; includes purchase-versus-rental comparison, recurring costs report showing monthly rental based on the projected use of each component, and total personnel salaries for operation and maintenance.

Computer Capabilities: An indication of critical hardware areas showing the total time needed to process each run plus the time used by each device in each run.

Multiprogram Run Schedule: Shows the main run into which potentially parallel runs have been scheduled, based on frequency, priority, and availability of time, core and peripheral devices.

Real-Time Analysis: A series of reports generated only when real-time processing is involved. The first report analyzes each random event in terms of its unique throughput; the second analyzes every potential queue present in the hardware complex; the third reflects the expected and worst case response times for each real-time event through both the computer complex and the total communications network, and the fourth outlines the memory required for each random event for both the normal and worst case situations.

SCERT Summary: A one-line summary for each computer complement after all computers have been evaluated. It reflects the average monthly rental, average monthly use in hours, and a time-and-cost correlation in terms of computer power per dollar. It also lists the number of hours available for expansion and compares the total cost of rental versus the total cost of purchase (less trade-in) for a pre-determined number of months.

During Phase Four, the models of the processing requirements are simulated on each computer configuration model specified. Three basic stages of simulation are accomplished. These may be summarized as:

A. A throughput simulation to derive the net running time unique to every computer run and real-time event simulated.

B. An event oriented simulation to combine the various throughputs that may occur simultaneously within an individual real-time event or during batch processing.

C. A time oriented simulation to determine the degree of concurrency and its effect on total throughput available in multiprogramming or multiprocessing environments.

Phase Five provides the user with various levels of data developed during the course of the simulation and evaluation computations. This data is presented in the form of management reports (see Fig. 4), capsuling the information required to make intelligent decisions rapidly.

the california experience

Experience with the California Dept. of Motor Vehicles illustrates the time savings that SCERT can offer decision-makers in systems design work. The department decided to build a management information system that would integrate all departmental functions and take advantage of real-time, on-line processing and the use of mass random-access devices for storing information on all state-registered vehicles and drivers' licenses.

One consulting firm advised state officials that at least a year would be required to define the problem and as many as five years might be required to implement the system. Using standard, manual management techniques, the estimate was realistic. Using computer management techniques, however, we were able to define the problem and determine systems feasibility in six weeks. Two weeks later, SCERT-prepared specifications were sent to manufacturers, and their proposals were evaluated within three weeks of receipt. Management decisions were made and final implementation planning completed in 5½ months from the starting date. ■

For God's sake, man, can't you find something better to worry about than the effect on our real time system?

DESIGNING A MACHINE PARTNER

by AIKO M. HORMANN

"Man is always more than he knows or can know about himself . . ."
—*Karl Jaspers*

Man often makes decisions based on something he does not clearly understand and cannot define, and that we call—for lack of a better term—intuition. Personal biases and irrational actions have often been blamed on this ineffable quality, but just as often it is the source of human ingenuity and imagination and creativeness. There is no substitute for these creative qualities, but we have many evidences that the realm of man's intellect can be greatly extended by computer techniques. This extension in the intellectual domain may be somewhat analogous to the extension of man's physical power by the machines and techniques of the Industrial Revolution.

In the frontier work of science and technology, man-machine partnerships can help to supplement and nurture the creative qualities in man by spurring him to explore his hunches, helping him to see his problems from different angles, weighing different alternatives in terms of their consequences, and minimizing his personal biases. So far, however, most man-machine "partnerships" have been based on a division of intellectual labor in which the routine work was done by the machine and all higher-level thinking by the man. This trend is now changing, as Dr. Licklider pointed out.[1] While the conventional uses of computers will continue to be valuable, closer interactions between men and highly sophisticated machines can accelerate advances in science and technology and open up new areas of exploration.

Attempts to develop man-machine systems of increasing sophistication (and the advanced machines they require) have been under way for some time and have resulted in useful and impressive advancements, but there are still many obstacles in the way. In the following, I shall discuss the requirements and desirable features of an adaptive machine partner, and the characteristics of different problem domains and how they affect both the man and the machine when they are closely coupled in a "partnership."

what do we want from machine partners?

In a sense, we humans are "playing God;" within our technological and conceptual limitations, we can mold (by programming) the style of the "machine mind." It is essentially up to us, the users and designers, to specify those qualifications we desire for our machine partners. Do we want many human-like characteristics? Do we want an obedient but inflexible servant to take over only routine work with superhuman speed and accuracy? Or do we want an intelligent, adaptive assistant or partner, which can adjust to our needs and problems and yet utilize its own past experience? Since much of man's intelligence is attributed to his capacity to learn and to use his past experience efficiently, it seems reasonable to assume that a machine partner worthy of the name should also be endowed with ability to learn. I believe that a team consisting of a man and an intelligent, adaptive machine can be especially powerful in attacking complex and difficult problems that are a composite of the well-defined (for which rules and goals are precisely known) and the ill-defined—both of which are sometimes discernible as separate subproblems but are often mixed and interdependent. For such many-faceted problems, the human problem-solving process usually takes several courses. The problem solver will follow rules learned in formal education and rules of thumb gained by experience; he will form hypotheses and modify them; he will use imagination and hunches.

Forming and testing hypotheses and exploring hunches seem, on the surface, to be activities that can only be accomplished by man, but they contain subprocesses that can be specified in computer programs even at the present level of our technology. As time goes on, larger and larger portions of these processes can come within the province of the computer. An optimal combination of man-machine talents, therefore, can be expected to encourage the human user to *concentrate* on the parts of the problem-solving activity of which he has no formal description. A singular advantage accrues in the presence of such a system, for, with it, a creative man can maintain the momentum of his thinking; less frequently will the continuity and impetus of his thoughts be interrupted by tedious hours of non-creative work.

Additionally, the human user can conduct "ideational" sessions with a machine of this kind. It may turn out that man will prefer "ideating" with a machine to "ideating"

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[1] Licklider, J. C. R., "Man-Computer Partnership," *International Science and Technology*, May 1965, pp. 18-26.

with his human colleagues; he can express all sorts of ideas, even wildly impractical ones, without fear of ridicule, and judgment and evaluation can be deliberately postponed until enough evidence, pro and con, has been gathered.

requirements for adaptive machines

Before proceeding, I should warn the reader that I have been using the general term "machine" when I really have been talking about a programmed computer. Also, I have been using some anthropomorphic terms such as "learning," "adaptability," and "experience," but these should be understood to have restricted meaning when applied to machine functions. They are used for convenience and economy of words in conveying, *intuitively* and *informally*, ideas and concepts about machine behavior and capabilities.

Also, much of what follows will describe the machine partner of man in terms of my own concepts and assumptions on the subject of intelligence and learning. These concepts have been formed gradually over many years through my readings, through discussions with many people, and through my own interpretations and introspection. Therefore, it is often impossible to give exact sources of information. However, most of the assumptions used here can be found in one compact book, "The Psychology of Thinking."[2]

Given this mutual understanding about word usage and assumptions, I think we can group the basic requirements for an adaptive machine partner into three major categories.

1. *Adaptability within a fixed problem context.* For the solution of extremely difficult and complex problems—either well-defined (like chess) or ill-defined (like socioeconomic problems)—man can prepare the machine initially, utilizing to the fullest the existing programming techniques and as much knowledge as he has of the given problem. If the machine is equipped with efficient learning capabilities, it can then "learn" the rest of the methods and techniques required for arriving at the solution through interaction with man. Clearly, the man will be learning, too; initially his incomplete knowledge of the problem may restrict the area and method of exploration, but as he gains more information and interacts with the machine—examining and evaluating the consequences of his assumptions, exploring his hunches, and analyzing the data—he may get a clearer picture of the problem situation, may be prompted to modify his problem formulation and his methods of attack, and repeat the interactive process.

2. *Adaptability to the needs of different human partners and situations.* Different problem situations often require different terms for description, and different methods and processes. Also, each person tends to use the same terms and processes in somewhat different ways. A machine can be made to adapt to individual specialties so that each user will think of the machine as "his" partner, even though it may be working simultaneously with many persons.

As the work proceeds, the team of scientist and machine will build up a set of "in-group" terms and expressions, as well as a repertoire of skills. In time, the style and degree of communication between them will change radically. This phenomenon can be observed in two people who have worked together on a project for some time. They begin to assume a great deal of common knowledge in their communication, and stop going back to basic definitions when they discuss their problems. An outsider to the project, hearing such conversations, may be baffled.

[2] Thomson, R., *"The Psychology of Thinking,"* Baltimore: Penguin Books, 1959.

3. *Adaptability to unknown, unpredictable, or inaccessible environments.* After millions of years of evolution, man is well adapted to the environment of Earth. But a sharp deviation from an Earth-like environment makes man quite helpless. Other planets, deep-sea areas, and some artificially created conditions on this earth (e.g., high radioactivity, near-absolute-zero temperatures, etc.), although not directly accessible to man, can still be studied through partnership with an adaptive machine. The machine partner can be in such an environment but man need not be. Distance between them need not hinder close interaction. The machine will be able to make many decisions on the basis of its interactions with the new environment and the man; it will detect regularities in physical objects, or in recurring patterns of events, and thus help man to form hypotheses about the new environment. Man can then learn to cope with that environment, or to alter or control it.

Within each of the above three categories, however, different situations and purposes call for different sets of characteristics and skills in the machine partner. We must study the various problem situations and decide what our needs are.

problem domains

When we recognize a problem to be solved, the main question is, "What do we know about the variables that enter into the problem description?" This question must be answered insofar as possible before we can consider problem-solving methods. First, are all the problem variables known and distinguishable? Or only some? Does it seem likely that new variables will show their effects as the work progresses? (For example, in many socioeconomic problems, factors not thought relevant initially may turn out to have a subtle influence on the whole, or a part, of the problem.) Second, what is the *behavior* of the known and distinguishable variables? It is completely known? Can it be expressed in a functional equation or plotted as a graph? Is it predictable in a probabilistic sense? Is it predictable only within some boundary limits? Or is it completely unpredictable?

Fig. 1 represents my subjective (and necessarily oversimplified) view of the nature of problem domains and the corresponding involvement of man, machine, and man-machine. The three shaded areas represent those problems or tasks that can be attacked by man alone (red), by man and machine together (pink), and by the machine alone (white). The wavy lines indicate that the distinction is not really clear or final; the lines are likely to be shifted as we increase our knowledge and as more and more sophisticated machines are developed.

1) Man alone (red area):

Some problems may remain *man's alone* because they require a high degree of intuition, imagination, personal taste or the "human touch."

2) Man-machine (pink area):

Some problems can be handled by a *man-machine team*, either ideally or awkwardly, depending on the problem and the sophistication level of the team.

3) Machine alone (white area):

Some problems or tasks can be handled by a *machine alone*. This may be either desirable or imperative—because the task must be done in a hostile environment (extreme heat, radioactivity, etc.), or because the task is routine and monotonous, or because it requires a precision or speed impossible for humans.

The nonuniform nature of these three areas (indicated by the circular patches throughout) and other peculiarities are explained below.

The left column represents well-defined problem areas and the right column ill-defined areas. The latter is further divided (by a wavy line, indicating an unclear distinction) into problem areas that can be well-defined in the future, as we come to understand their nature better, and into problem areas that are either extremely difficult or are intrinsically impossible to define. Well-defined problems are not necessarily easier to solve than ill-defined ones. For example, Fermat's Last Theorem has not been proved or disproved for many generations, and the game of chess has no solution in that no known sequence of moves will guarantee a win (or even a draw) every time.

Some problem categories, such as military and socio-economic problems and some creative-artistic fields, are listed in both left and right columns, and some are repeated in both the upper portion (more difficult to solve) and the lower portion (less difficult). The categories are repeated because some parts of some of these problems, or some phases of the task-performing processes, are or can be made well defined, even though the overall problems or tasks are not well defined; similarly, some parts or phases of the same problem can be extremely difficult, while others are relatively easy. The same reasoning explains the presence of patches of other colors in each area.

Some problems are difficult not because of their complexity, but because of the perfection or precision desired (e.g., a slight error can be a matter of life and death). On the other hand, some tasks allow a wide range of satisfactory performance. This range of acceptability, either wide or narrow, may reflect the "relative" or "personal" nature of some problems.

The relative and personal nature of some ill-defined problems (those for which rules and/or goals are not precisely specified) are among the reasons such problems are so difficult to analyze and evaluate. In fact, imprecisely defined rules and goals for a particular line of endeavor (e.g., painting) are among the sources that give rise to creative-artistic expression. The artist can create new rules and goals, or old ones can be given a new interpretation, even changing the criteria of aesthetic appeal.

To explain the two red circles marked A and B at the bottom of Fig. 1, let me relate a practice I observed several years ago in a department store in Tokyo. On each floor, standing at each escalator's starting point, there were two pretty girls, one on each side. These girls smiled and greeted each customer as he passed, and wiped the escalator rails. Such a task is extremely simple to perform and could have been done by a mechanical hand if sanitation were the main purpose, but performing it mechanically could not produce the atmosphere of "personal touch and care" for each customer, created by the smiles of those girls. Here the human element is the essential ingredient.

Notice that one red circle is in the "well-defined" section and the other in the "ill-defined" section. The task of wiping an escalator rail and smiling *can* by defined precisely, giving exact movements of the muscles of hand and face. However, the same task can also be defined simply but imprecisely as "to please a customer at the escalator." What do we know about pleasing different individuals? (To be sure, it is a very personal notion; a wife might be irritated if her husband smiled back at those girls.)

methods and approaches

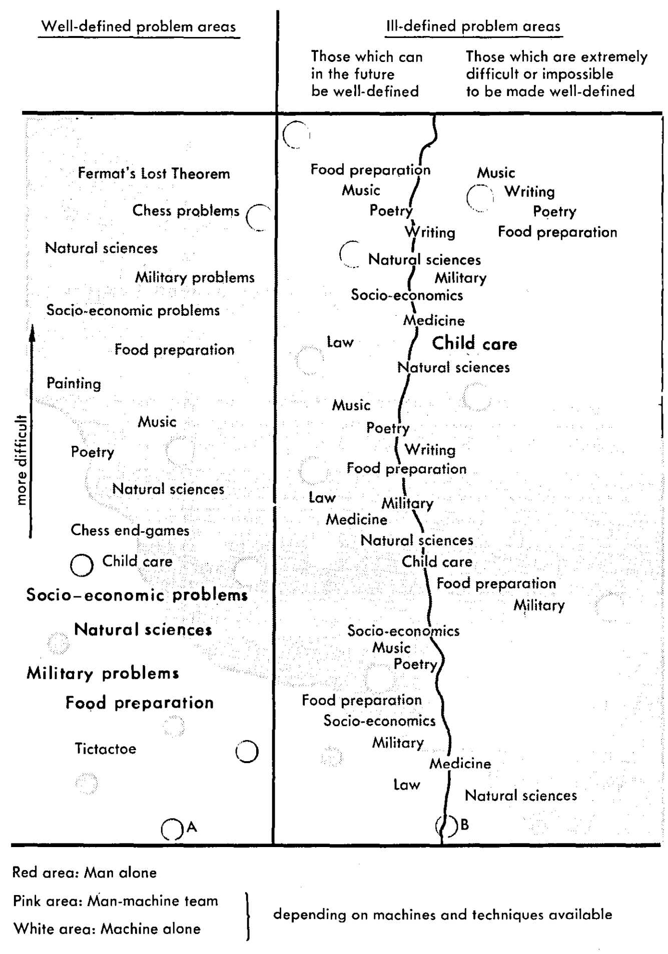
Table I *(p. 32)* allows a quick comparison of some different ways (columns 1 through 4) of specifying a machine's behavior, with a corresponding characterization (rows *a* through g) of each. Columns 1 through 4 are not to be taken as independent or mutually exclusive; methods and techniques applied in the right-hand columns also make use of methods and techniques applied in the left-hand ones. In a loose sense, these columns, from left to right, suggest the historical development of computing.

1. *Completely predetermined specification.* All the steps in the processes required are predeterminable. That is, in problem solving, all the steps in the solution procedure must be known in advance even though the answer to a specific question may be unknown. (As an example, take the set of programs for a payroll calculation. All the steps necessary for the calculation are known, but an answer to a specific question, "How much will Mr. X be paid this week?" can be answered only after the execution of the program.) This is further divided into two categories:

a) *One-to-one.* If no variations are expected or allowed, one program handles one specific problem only. Since the program is custom tailored, it can be made extremely efficient, but a hundred problems require a hundred distinct programs.

b) *One-to-many.* Groups of operations or instructions which are repeated with minor variations are put together into subroutines or subprograms; slight variations are taken care of by introducing parameters that can take on two or more values according to the different cases of the problem. All the parameter values must be specified *before* or *at the start of* the execution. However, such values influence the machine behavior *during* the execution through condition branches. (A single conditional branch in a program can make the machine behave, functionally, like two different machines in different circumstances.) This technique parameterization combined with the use of conditional branches makes it possible for one program to take care of many problems of similar type. Thus, for example, conditional branches built into one payroll-calculation program can take care of thousands of employees with different salary categories, de-

Fig. 1. The nature of problem domains and involvement of man, machine, and man-machine.



ductions, overtime, etc.

2. *Feedback utilization.* Suppose that the task environment includes some unpredictable elements. Then the steps necessary for the performance of the task are not all predeterminable. The decision as to what to do in this case is made *on the spot* during the interaction with the environment. (That is, feedback from the environment plays an important role in deciding the machine's behavior.) A guided missile that follows a moving target uses this kind of feedback mechanism.

The nature of the environment and desired responses may require a special peripheral attachment and/or preprocessor—an input device to accept and pre-select the feedback information. For example, a sonar or visual device, an analogue-digital converter, and/or some filtering or pattern-recognition device may be needed to accept the feedback information as well as to convert it into acceptable form for a computer (currently, we are talking about a digital computer).

3. *Past experience utilization (higher-order feedback).* In (2) above, feedback allows the machine to "interact" with the environment dynamically, but the machine is not given a means of recording and using its past experience. Its self-corrective behavior is only local and specific to the task; if the task were to be repeated, a machine of type (2) would repeat the same trial-and-error behavior before the proper adjustment was made (unless the feedback unit itself were made to set the parameter values and retain the same values).

With extra memory space for recording past experience, and special programs to handle it, the machine can "learn" to avoid previous mistakes and will tend toward straightforward use of successful actions, without going through the groping or trial-and-error actions that were necessary at first.

hierarchical control units

Some behavior changes can be made by a control program at the level of parameter-value setting, but other changes require a higher-level program to change parts of the subprograms. This is conveniently done in stored-program, general-purpose computers in which instructions in the program can be manipulated and altered by other instructions as if they were pieces of data. Internal control units can be hierarchically structured, and modification can be effected at various levels; we can write a program that will modify its own rules and instructions, or will modify the *way* it modifies rules, and so on. Thus, multi-level higher-order feedback units can be constructed so that they interact among themselves as well as with the environment. Some learning machines developed under artificial intelligence research show such characteristics.

4. *Secondary learning (learning from the experience of others).* We humans learn about many facts and rules from other people and from books, without actually experiencing those facts and rules firsthand. Such secondary learning constitutes a large part of an average person's knowledge, although primary and secondary learning are so intimately related and their effects so interdependent that they are often not clearly separable. However, it is convenient to use the separate terms in describing machine learning because endowing the machine with a means for secondary learning can cause an effect that is in significant contrast to primary learning which comes through firsthand experience only. As an analogy, consider a student of chess; he might acquire a knowledge of the game from actual play (primary learning) *only* or from play combined with reading a chess book and the tutelage

Table 1. Different ways of specifying machine's behavior (columns 1a through 4) with the corresponding characterization (rows a through g) of each.

COLUMNS / ROWS	(1a) complete specification (one-to-one)	(1b) grouped or parameterized (one-to-many)	(2) feedback utilization	(3) past experience utilization	(4) secondary learning utilization
(a) Problem examples	automated bakery shop	payroll calculation	guided missiles	learning machines (artificial intelligence research)	
(a) Kinds and amount of outside control after the programming	Start the operation	Set the parameter values at the start	Feedback from the environment during the run	Recorded "experience"	In a form of suggestions and statements
(b) Nature of preprogrammed specification	Most problem-specific	Some generality	General rules for utilizing feedback	Can be more general	Can be highly general
(c) Degree of conditionality in the internal specification	No conditionality	Use of parameters increases conditionality	Added conditionality from the environment		
(d) Kinds and amount of self-correction or self-modification	None	None	Parameter values	Through information and program changes	
(e) Likelihood of observed behavior changing with time	None	None	Some changes	More changes →	
(f) Memory requirements in addition to preprogrammed portion	None	None	Not unless parameters increase	Record of past experience	Record of what has been "taught"
(g) Complexity of the system structure in both factual collection and process collection	Can be highly structured, but no dynamic changes		Tend to be more highly structured and allow more dynamic changes →		

of a good player (primary and secondary learning). The second method would surely shorten the time it took him to gain proficiency in the game.

Similarly, intellectual development of the machine by a mixture of primary and secondary learning can be expected to be faster and more susceptible to human interaction than it can be by primary learning alone. A machine can be made to accept and utilize information about the task environment and suggestions about solution methods or particular steps to take in a current problem-solving context; it can even be given some possible processes of generalization in a given context. Such information and suggestions can take a variety of forms—declarative statements, questions, graphic displays along with some ability to communicate. A machine capable of effective secondary learning must also be capable of sophisticated communication, including an easy-to-use language for humans and the corresponding conversion technique to the machine's internal representation, a two- or three-dimensional visual input/output, some form of sound input/output, etc. Also, from the human user's standpoint, a flexible and near-"natural" communication means is needed in order for him to move smoothly from idea-getting (the conceptual stage) to trying-out (the experimentation stage) to result-judging (the evaluation stage)—usually back to the first stage again. The user's effectiveness as a problem-solver can be influenced greatly by the nature of the communication as well as by the machine's initial and acquired capabilities (the latter, in turn, are effected mostly through communication).

Having an effective communication means is only a beginning for our machine partner. The information gained and methods and techniques learned must be stored, but they should not merely be accumulated in the memory. The contents of such inputs must be analyzed and their implications studied; these in turn must be "assimilated" into the machine's memory in an organized way by establishing a useful relation to previously recorded information. Further, there must be some means of selecting "relevant" items from the vast collection of background material for the information to be of any use. Just how such "self-organization" and selective utilization of past experience can be realized in a machine is a major research area in itself.

when do we use what machine partner?

As the foregoing discussion indicates, there are many conceptual and technical difficulties that must be overcome before we can have a machine "partner" of the sophistication level mentioned. However, there are also many ways we can exploit the existing machine capabilities. The discussions about problem domains and machine capabilities presented along with Fig. 1 and Table 1, are meant to indicate a reasonable match of machine characteristics with the needs indicated by a given problem context. A mismatch of problem and machine sophistication is bound to cause some ill effects; at best, it will lead to costly operation—at worst, to chaos.

As we delve more and more into problems for which no precise solution steps are known in advance, and in which man's ingenuity has traditionally played an important role, we may find that man-machine techniques will provide a fruitful means of combining man's intuitive ability with a "responsive" machine in a wide variety of applications. Through such experimentation, the sophistication level of the man-machine learning through interaction—and by the redesigning of the system after experiments disclose its shortcomings. Through this iterative process, we may gain deeper insights into the kinds of hardware and software techniques needed to push further toward the goal of man-machine partnership. ■

COMPUTERS IN THE HIGH SCHOOL

a tool for explorations

by WILLIAM S. DORN

There seems to be little doubt that computers and computing are gradually making their way into the high schools. In a few schools computers are already firmly entrenched. In the future all schools will find them more readily accessible. For example, the advent of time-sharing means, among other things, that a high school will be able to obtain the use of a computer through a relatively inexpensive terminal connected to a central computing center. Moreover, the proliferation of small to medium-size computers throughout industry and universities means that extra-shift time on these machines can be made available to a school at a reasonable cost. In one way or another the high schools are beginning to find computers within their reach, and the schools are anxious—perhaps overanxious—to get their hands on them. The problem, then, is not so much how to get computers into the high schools, but how to use them once they are there.

One approach to the use of computers in high schools is to teach the elementary concepts and ideas of computer science. That is, one could teach the fundamentals of programming including the notions of procedures, looping, branching, input/output, and the like. One could also introduce some of the details of the general design and operation of a digital computer, such as core memories with a destructive write and a nondestructive read. In addition, one might discuss how a computer can enlarge upon its own capabilities through the use of compilers and assemblers. Of course, specific algorithms should be introduced in order to put these concepts into concrete form so that they could be discussed intelligently. However, the specific algorithms should be kept simple so that they do not cloud over the computing ideas and divert the student.

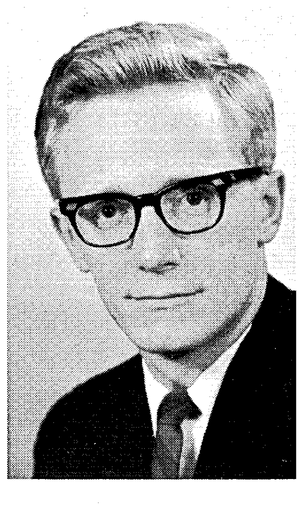
For example, to introduce programming one might use Euclid's algorithm for finding the greatest common divisor of two integers or Horner's (nesting) rule for evaluation of polynomials, but nothing much more complicated than these. For nonnumeric problems, sorting is as difficult a problem as one is likely to encounter. More complex problems require either digressions to provide mathematical background or statements of mathematical ideas with no substantiation for them.

The primary shortcoming of such a course is that there is little intellectual depth to the computer science topics which can be taught at this level. The student will learn a lot of facts, but he will absorb only a few new ideas. For just this reason few universities attempt such a course in computer science below the graduate or advanced undergraduate level. However, a course containing the type of computer science material outlined above is often taught in a university as a noncredit course in ALGOL or FORTRAN programming. The same could be done, and has been done, in the high schools, although at this level of sophistication there seems to be much more preoccupation with machine language in high schools than in universities.

Another shortcoming of such a course is that most of the algorithms which the student will use and program could be solved just as well with paper and pencil or with a desk calculator. One runs the risk that the student may come to think of the computer simply as a large desk calculator, and it may take some time to dispel that notion later.

computer-extended instruction

A second and different approach to the use of computers in the high schools is to teach the student how to use a computer to handle some complex problems arising in one



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of the traditional disciplines. The obvious choice of a discipline is mathematics, although other sciences, including social science, cannot be dismissed arbitrarily. For simplicity we will assume in what follows that we are teaching mathematics. The idea in this case is to allow the student to use the computer to extend and enrich his understanding of mathematics by experiencing certain events which otherwise would be beyond his reach. For this reason, this approach is called computer-extended instruction (CEI).

The computer serves as an experimental tool in the hands of the student and lets him see *what* happens in certain problems. It cannot, of course, let him see *why* something happens, but it may make him wonder why and want to find out why. In addition, it enriches his intuitive understanding regarding the rigorous mathematics he has learned and/or will learn.

The difference between a CEI course and a computer science course is that a CEI course is used to teach mathematics using a computer, while a computer science course is used to teach computer fundamentals using mathematics and physics. As we have pointed out, the high school student is not prepared nor motivated to cope with sophisticated computing ideas. On the other hand, he is prepared for some sophisticated mathematics provided it is problem oriented.

CEI is perhaps best explained through some examples. We consider its use in a mathematics class of high school seniors who have completed algebra, geometry, and perhaps trigonometry. The students in such a class will have already encountered tables of sines and cosines and know their practicality and usefulness. They probably have also wondered how such tables are computed. This leads quite naturally to a study of infinite series. Actually, the study of infinite series can be motivated in a more direct way through a discussion of Zeno's paradox, where Achilles apparently can never catch the slower tortoise in a race in which the tortoise is given any head start no matter how small.

In any case, once the student is introduced to infinite series, he can be asked to find the sum of the following geometric series

$$1 + \tfrac{1}{2} + \tfrac{1}{4} + \ldots + \frac{1}{2^n} + \ldots$$

The following simple FORTRAN program will suffice

```
      SUM = 1.0
      TERM = 1.0
1     TERM = 0.5*TERM
      TEMP = SUM + TERM
      IF (TEMP-SUM) 2, 2, 3
3     SUM = TEMP
      GO TO 1.
2     PRINT 4, SUM
4     FORMAT (7Hb SUMb = b, F10.5)
      STOP
      END
```

Eventually the value of TERM will be so small that TEMP and SUM will be identical to within the accuracy of the computer. In an IBM 7094 or a PDP-6 there will be 27 terms added. In an IBM 1620, 24 terms will be added, and in a Univac III, 30 terms. In any case, the output is SUM = 2.00000.

It is clear that the student needs very little training in programming to write this program. Neither DO loops nor subscripted variables are required.

learning from mistakes

The student may (hopefully) be tempted to replace the IF statement by the simpler IF (TERM) 2,2,3 since the statement immediately preceding the IF tells him that TERM = TEMP-SUM. He should be encouraged to make this replacement if it occurs to him to do so. Of course, if he does, his program will never stop. This program exhibits one occasion when "subtractive cancellation" is used to advantage. It serves as an introduction to this numerical phenomenon, and the student gets a sample of its perversity.

Having discovered that he can sum a geometric series on a computer, the student should then learn that he could have found the result more easily from

$$\frac{a}{1-r} = a + ar + ar^2 + \ldots + ar^n + \ldots$$

Then he tackles the alternating series

$$1 - \tfrac{1}{2} + \tfrac{1}{3} - \tfrac{1}{4} + \ldots + (-1)^{n+1}\frac{1}{n} + \ldots$$

which he is told is equal to the natural logarithm of 2 (= 0.6931471806). In contrast to the geometric series, there is no simple way to determine the numerical value of the sum of this series.

The student will soon find that he cannot sum this series the same way as he summed the first series, since it converges too slowly. For example, more than 130 million terms would be added in an IBM 7094 or a PDP-6 before no change was observed in the sum. Therefore, the student must learn to decide the number of decimal places of accuracy he desires, say 2. He then tests each term as it is added to the sum. If the term does not affect the sum in the second decimal place, then he stops adding terms. A simple FORTRAN program to do this is given below. Notice that we avoid use of the absolute value function. The reason for not using that built-in function is that we have not yet introduced built-in functions. Since we are about to compute logs, sines, and cosines, the introduction of the built-in functions would have destroyed some of the motivation. In any case, the absence of the absolute value function creates very little extra work.

```
      SUM = 0.0
      N = 1
      TOP = 1.0
1     X = N
      TERM = TOP/X
      TOP = - TOP
      SUM = SUM + TERM
      IF (TERM) 2, 3, 3
2     IF (0.001 + TERM) 5, 5, 4
3     IF (TERM) - 0.001) 4, 5, 5
5        N = N + 1
         GO TO 1
4        PRINT 100, SUM
100      FORMAT (7Hb SUMb =b, F6. 2)
         STOP
         END
```

The output is SUM = 0.69 which is the log of 2 correct to two decimals, as we expected.

Suppose, however, the student tries to compute the sum to three, four or five figures. He can do this with minor changes to the statements numbered 2, 3, and 100. The results are 0.693, 0.6928, and 0.68942, respectively.

Now there is something suspicious about these results. The two- and three-figure results are correct, but the four-figure result is in error by 3 in the fourth place, and the five-figure result is in error by 373 in the fifth place. In fact, the five-figure result is not as accurate as the three-figure result!

Before unraveling this dilemma, the student is asked to sum the similar, but simpler, series

$$1 + \tfrac{1}{2} + \tfrac{1}{3} + \tfrac{1}{4} + \ldots + \frac{1}{n} + \ldots$$

On the basis of his experience with the two previous series, the student probably will assume that if he adds terms until the next term to be added is smaller than 10^{-r}, then the sum will be accurate to $r-1$ figures after the decimal point. Based on this assumption a program to sum this

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

THE TWO GREAT TAPES,

series to two figures after the decimal point is given below.

```
        SUM = 0.0
        N = 1
  1     X = N
        TERM = 1.0 /X
        SUM = SUM + TERM
        IF (TERM - 0.001) 2, 3, 3
  3     N = N + 1
        GO TO 1
  2     PRINT 100, SUM
  100   FORMAT (7Hb SUMb = b, F6. 2)
        STOP
        END
```

The ouput is SUM = 7.49. Now, by changing the IF statement and the FORMAT statement, the student can compute the result to three, four or five figures after the decimal place. Those results are 9.787, 12.0843, and 14.2679.

While the results for the alternating series were disturbing, these results are alarming. None of the results agree at all! The problem, of course, is that the last series does not converge. It is now time to discuss the convergence of series since the student is motivated to study this mathematical topic. It is easy and convenient to point out that even though the n-th term of a series approaches zero, the series may not converge.

That still leaves the discrepancies in the various sums of the alternating series to be explained. By now the student should realize that the alternating series converges, but he can't seem to get the correct result. The culprit here is roundoff error. If he sums the series backwards (starting with the smallest terms first), he will circumvent this difficulty. The following program suffices:

```
        SUM = 0.0
        N = 100000
        TOP = - 1.0
  1     X = N
        TERM = TOP/X
        TOP = - TOP
        SUM = SUM + TERM
        N = N - 1
        IF (N) 2, 2, 1
  2     PRINT 100, SUM
  100   FORMAT (7Hb SUMb = b, F8. 4)
        STOP
        END
```

The output is SUM = 0.6931, which is accurate to four figures. Of course, the student will have to compute how many terms he needs ahead of time for a given accuracy, and N = 100,000 is sufficient for four-figure accuracy.

the lessons learned

What mathematics has the student learned from all of this?

1. He has been introduced to the epsilon-delta argument, which is fundamental to the study of the calculus. He first decides how accurate he wants his result. That is to say, he decides upon an epsilon. From this he determines how many terms of the series he should use. Thus, he has found a delta (= 1/N) which produces the sum with an error not exceeding the given epsilon.

2. He has obtained an intuitive understanding of convergence. Moreover, he understands why convergence proofs are necessary.

The student has also learned some mathematics peculiar to computers. In particular, he has learned:

3. A computer can be used to sum a convergent series, but it cannot be used to determine whether or not a series converges. Mathematical tests must be used to determine convergence.

4. In a computer, addition is not associative. This may possibly be the first nonassociative arithmetic the student has encountered, although in the early grades he assiduously studied associativity.

5. In summing a series on a computer, the smallest terms should be added first.

6. In a computer if $a = b + c$, then it may be that $b = 0$ and yet $a - c = 0$. This can happen if a and c have the same sign and are nearly equal.

Having experienced the somewhat painful consequences of disregarding most of these lessons himself before he even knew of their existence, the student is more likely to retain them than if he simply is told that they are the facts of life in mathematics and computing. The computer has extended the student's ability to learn and understand by allowing him to experience for himself the phenomena described above. Without the computer he would have had to deduce what would happen in some cases and to accept it on faith in others. It is important to note again that the computer has only allowed the student to see *what* happens, not *why* it happens. This is analogous to experiments in a physics or chemistry laboratory where the student observes what happens under certain conditions but not why it happens. The why must be determined by different methods.

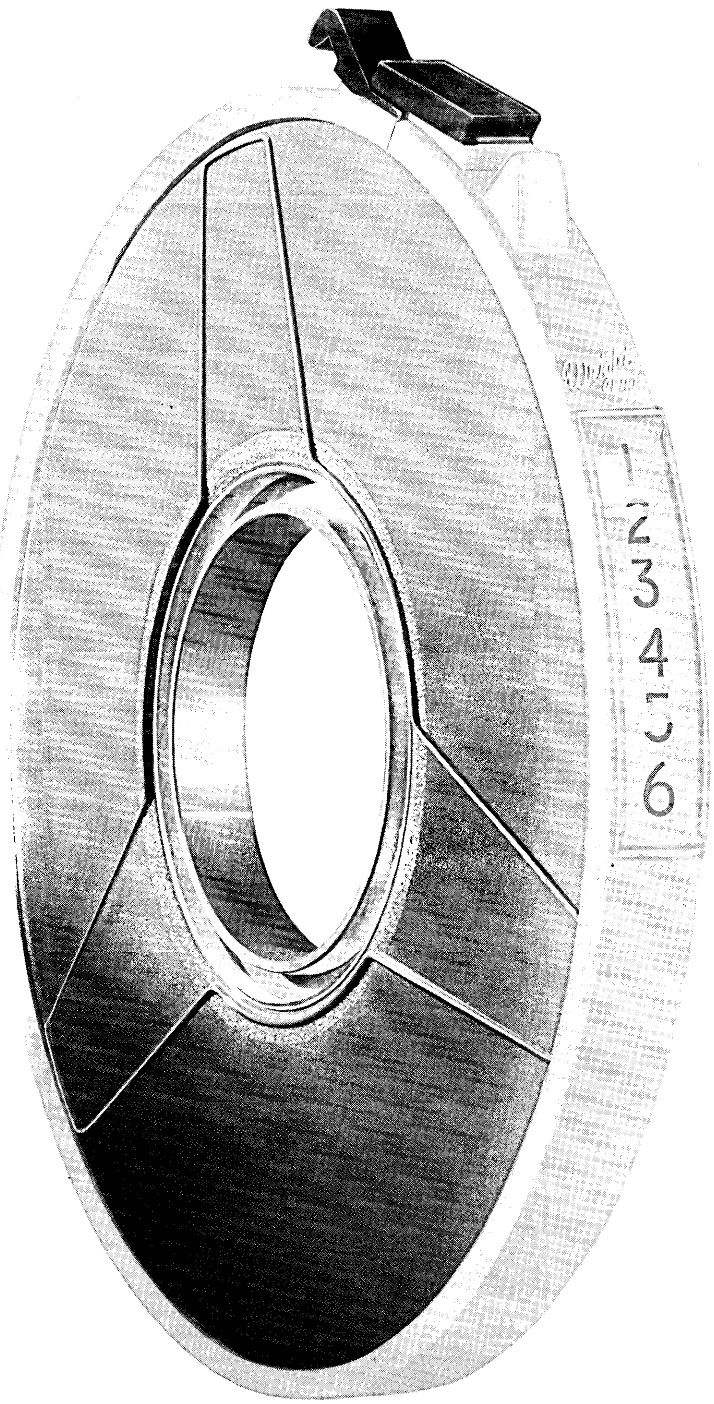
extending his ability

Of course, the student can now go on to more interesting topics like computing tables of sines and cosines from infinite series. If he also learns to compute derivatives (another project loaded with hazards and lessons to be learned) he can discover for himself that the derivative of the sine *appears* to be the cosine. The pre-calculus student armed with this discovery, and others like it, is admirably prepared for a rigorous study of the calculus. Needless to say, without a computer the tedious work necessary for a student to make such a discovery is not worth the effort. The computer has once again literally extended his ability to discover and to learn.

The opportunities for CEI in mathematics are numerous. Monte Carlo methods may be used to obtain an intuitive understanding of the law of large numbers and to appreciate the fact that in a fair game winning and losing streaks are to be expected. Truth tables for complex circuits or logic problems can be computed and compared for equivalence. Large linear programming problems can be solved, and realistic applications involving these types of mathematical models can be studied. In number theory one can write a FORTRAN program which attempts to decompose any prime number into a sum of two squares. This leads to the *conjecture* that such a decomposition is possible if the prime, p, is expressible as $p = 4n + 1$ and is not possible when $p = 4n + 3$.

Of course, one should not expect that all areas of mathematics can be enhanced through CEI any more than all areas of physics (relativity theory, for example) can be examined in a high school physics laboratory. Nevertheless, the mathematics subjects which can benefit from CEI are so numerous that a high school senior can profitably spend a year's course delving into them.

For the engineering or science student going on to study more mathematics, such a CEI course provides him with the intuition to appreciate his later work. For the business or social science student for whom such a course may be a terminal mathematics course, the intuition he gains is of more value than the rigor to which he might be exposed. Moreover, the business student will begin to understand why his mathematical colleagues have an interest in rigor and why their interest and work in rigorous mathematics might someday become vital to him. ■



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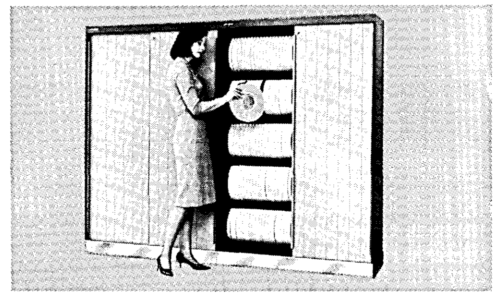

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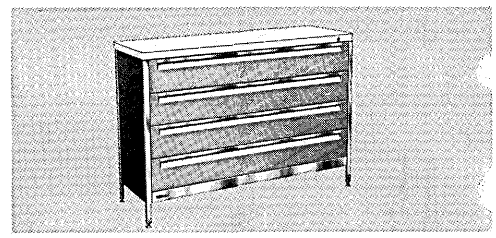

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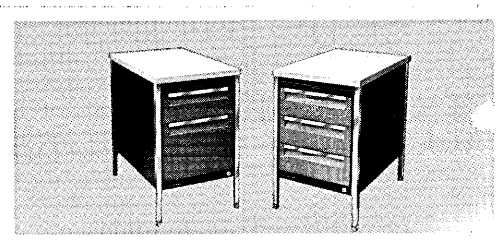

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DATA PROCESSING ACCESSORIES

DIGITIZING CONTOUR MAPS

using portapunch cards

by STEVE CORDELL

There are a number of reasons for using a computer to process contour map data. It may be desirable to project the map in a stereoscopic fashion, the stereo illusion being given by twice redrawing the map in two dimensions. The computer then computes the parallax of the eyes and/or an artificial elevation angle from which the viewer observes the map, or rotates the original map about the z-axis, thus allowing the viewer the freedom to see a particular portion of the map unobstructed by higher areas in front (such as an intervening peak).

In most cases there is no existing contour map, and it is desired to draw a mono or stereo map from raw field data. This data may be analog, from a strip chart recorder, where the linear position on the chart may represent one of the axes (the other axis being somehow known or a correlate of the known axis), or the raw data may be digital, recorded similarly to the analog example, or the digital data may be a discrete x-y coordinate with some corresponding z-value. An example of this, of course, is a geodetic survey—latitude, longitude and elevation.

Let us take an engineering example. Assume that a decision has been made to straighten out one curve of a winding road by cutting through a medium-sized hill. The cost of the operation will depend upon the amount of earth to be removed from the cut (as well as the fill required at some points, which we ignore here) so the contractor needs this information to prepare his bid. The up-to-date contractor often uses the computer; in this example he will superimpose the desired roadbed (and cut, ditches, etc.) upon a prestored contour of the area in question. By computing, at regular intervals along the roadbed, the difference between the prestored roadbed cross-section and the input cross-section of the existing hill, a continuous "volume" of earth will result; from this volume (or cut) is found the number of cubic yards of earth to be moved. The single number printed out after processing may be all that is necessary to the contractor, or he may want a computer plot of the cross-section at each interval.

Now, how did the contour information get prestored? Raw coordinates, height data if available; or directly from a contour map. It is simple, although tedious, to work backward from a contour map to the coordinate data desired. Pick a point on a contour line, record the contour elevation and the x and y coordinates, repeat this for many points, and eventually you have a good representation of the map location in three dimensions. Then, to enter this raw data into the computer, let the x and y coordinates assume some two-dimensional memory map. For example, assume a square contour map of 100 × 100 units; then the memory locations might be represented as follows: The first 100 words represent the coordinates x = 0, and y = 0, 1, 2, . . . 99, the second 100 words represent x = 1, and y = 0, 1, 2, . . . 99, etc. Each of the 100 × 100 words has one elevation associated with it. It is this elevation that is entered into the proper word in memory. After storage, the data is ready for general programmed operation.

outline of method

This method makes use of the Portapunch card, a 12-row, 40-column *pre-scored* punch card which may be read

Mr. Cordell has been involved with computer programming at Douglas and Hughes Aircraft and in computer engineering and logical design at Rome Air Development Center. Since 1965 he has been doing private consulting on pipeline networks and real-time data transmission, is now the owner of Cordell Associates. He has a BS in mathematics from Fresno State College.

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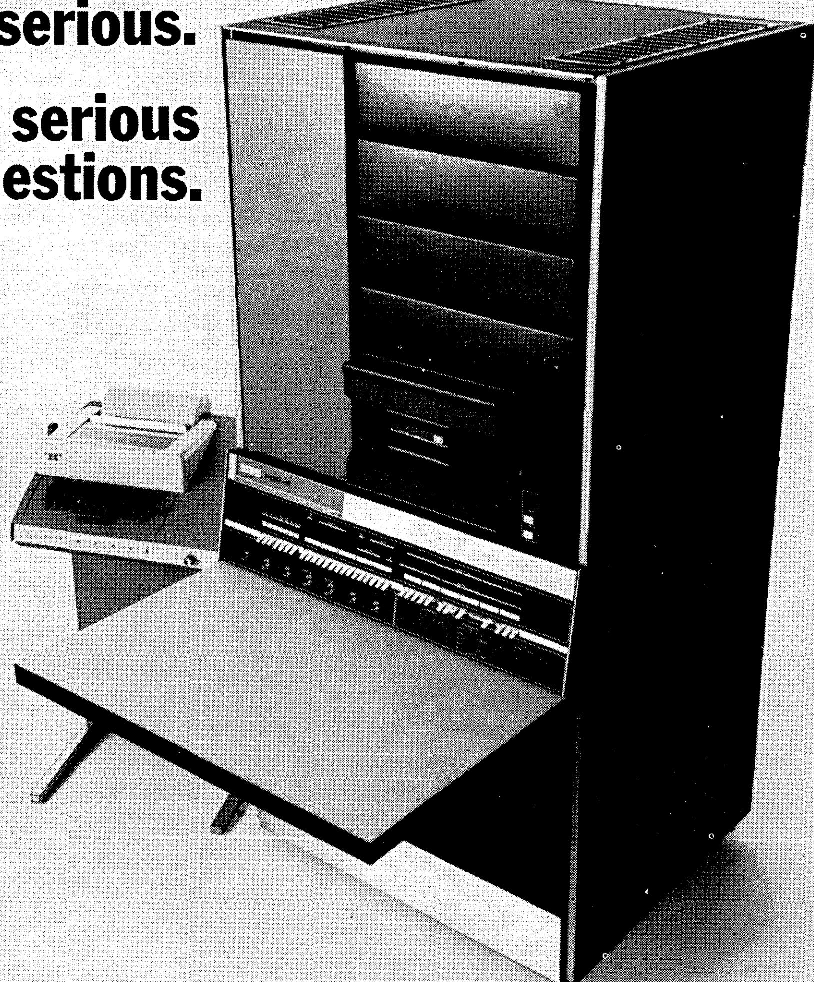

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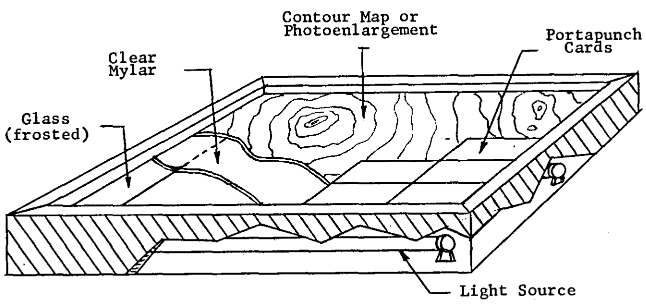
CIRCLE 54 ON READER CARD

by all 80-column readers. Data is recorded by punching out a prescored hole position with a pencil or other stylus.

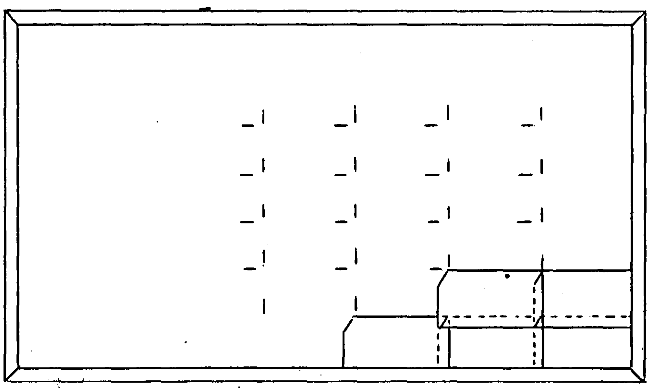
The Portapunch card may be a useful device for entering a variety of data into the computer. Its general use has been in business and education fields whereby untrained persons might prepare raw computer data. The

Fig. 1



LIGHT TABLE: Several cards are shown with the right lower corner as origin.

Fig. 2



TOP VIEW: The vertical marks on the Mylar sheet are used for lining up the edge of a card with the card to its right when filling a row. Horizontal marks are used when positioning each card in its row.

usage to be described here takes advantage of the punch card by assuming it to be a particular plane in space, which may be expanded to any dimensions (x-y) by adding cards to the plane. This is conceptually accomplished by laying out a number of cards in a plane, in some pattern, and naming that plane (z) or assigning a number to it. A set of planes so named or numbered may be used to describe the boundaries of a volume in space or to give some value to every point in the volume.

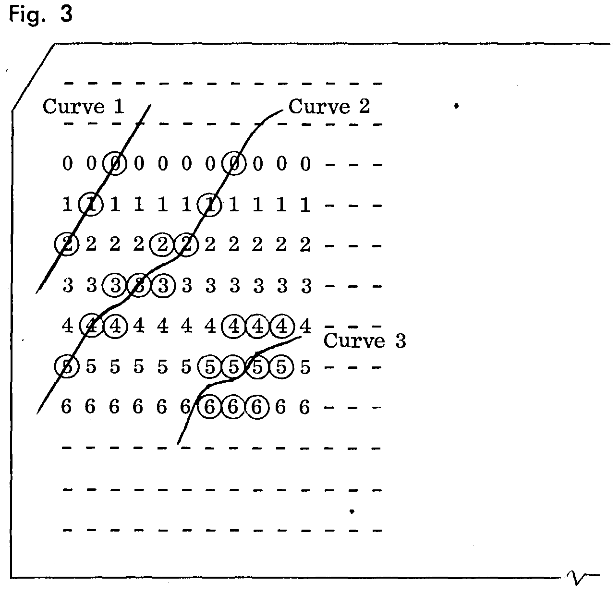
The following method uses the simple recording feature of the Portapunch card to enter information which describes a three-dimensional surface (contour map). The method has particular value in nonproduction (i.e., one-time) applications, where there is neither time nor money to seek a professional map-making establishment with automated equipment, or where such a commercial source is unavailable. Gross errors are completely eliminated, the inherent error being small and of judgment only and of the order of the map resolution. A particular map may be digitized, suitable for computer entry, five to ten times faster than other hand methods of recording.

One of the simplest ways to digitize the map is as follows.* The equipment needed is a large light-table (with high-intensity light sources, e.g., high watt bulbs); the glass may be frosted or not. A first overlay is now placed over the light-table and squared with some reference corner. This overlay is *clear* Mylar upon which reference marks are drawn in dark ink for the correct placement of the Portapunch cards. Over this is placed the contour map (or photonegative of same, or blown-up section of a map, etc.). Finally, the Portapunch cards are placed upon the map in the positions as indicated by the clear overlay reference marks. Figs. 1 and 2 are sketches which describe the equipment.

recording procedure

1. The set of cards on the board will contain information relative to a single elevation, wherever that elevation appears on the map. A map contour is chosen and its elevation is recorded. The contour is traced with a pencil and the contour line followed is recorded on each card as the pencil passes over that card. When the first contour line has been completed, a second and subsequent lines of the *same* elevation are selected and traced. When contours of *this elevation* are exhausted, a new set of cards is placed on the contour map.
2. While on the board, the cards are further prepared: At the edges of the cards, where certain hole positions are covered by portions of the card above (or below) and to its side, the recorded line must be extended to these hidden rows and columns.
3. The cards may be lifted at this time (in some orderly manner) for later punching, in which case they must be marked with the elevation and kept as a separate batch, or they may be punched as they are lifted from the board, observing the above ordering procedure.
4. The cards are punched from the markings as follows: Where a line passed through, or very close to, a punch card hole position, that number is punched out. Where the line has passed between two numbers in a vertical column (and clearly not closer to either), both numbers in that column are darkened. When the line is closer to one number than to another, an optional method is to weigh the closer number by punching both the near number and the next number in that column (away from the farther number), as well as punching the farther number. The example of Fig. 3 illustrates the holes which are to be punched if the line goes directly through the punch positions (curves 1 and 2), approximately between punch posi-

Fig. 3



*Instructions for the programmer and further illustrations are available from the author, 9029 Santa Monica Blvd., Los Angeles, Calif. 90069.

tions (curves 2 and 3), and when the line is closer to one position than the other (curve 3).

5. Procedures 1 through 4 above are followed for each required elevation on the contour map, so that the final product is a *set of single-elevation batches.* If a header card is now introduced to the set which in some manner indicates the elevation corresponding to each batch, the batches may be combined to form a contiguous deck. When interpreted by the computer program, every x-y point on the contour map will have a corresponding elevation associated with it. The interpreting program is rather simple in that all x points are equidistant, as are the y points. The map may easily be scaled to represent the x and y spacings in miles or meters. Note that the column (x) and (y) spacings on the Portapunch card are .174 in. and .250 in., or a ratio of 1:1.438.

6. Procedure to follow at the edges of the card: When the cards are placed on the board, they are positioned from right to left, bottom to top by row. The right margin of each card on the left is placed over the first column of the card to its right; each upper card is placed so that it slightly overlaps the 12-row of the adjacent lower card. The reason for this particular manner of positioning is that there are unused margins on the *standard* Portapunch card and these margins would cause a disjoint distribution at hole positions and thus discontinuities on contour map elevation as represented in the computer.

a. Where a line crosses from the left to the right (or right to left), the hidden *column* is punched as if the covering portion of the left card did not exist and as if the line were actually recorded on the hidden card. The right edge of the left card must be lifted slightly to either punch the card or to mark the hidden column for proper punching after the cards are removed from the board.

b. Where a line crosses from the bottom card to the top (or top to bottom), the partially exposed *row* of the bottom card is punched.

interpreting the card when punched

When the cards are spread out on the board, each row hole position may be thought of as an abscissa coordinate point, and each column hole position as an ordinate coordinate point. Thus, if there were 40 columns on the card, with the standard 12 rows, there would be 480 x-y points, and in any arbitrary rectangular array of n-rows and m-columns *of cards,* there would be 480 nm points in the total array. To each of these distinct x-y points, there is one and only one elevation, applied to the point by punching. (Note: As contour lines become close to each other, it is possible for a second line to cause a point to be punched, even though a previous line may also have caused that point to be punched. This is remedied by allowing the second point's z-coordinate to supersede the first in the memory map, or by increasing the photo enlargement size, or by averaging the first and second point, etc.) Now, if each of the 480 nm points is given a core memory location, then the contents of that location will indicate the elevation at that point in the array. For larger arrays, a small core memory may have to be overlaid, say, after one-half of the points have been processed. If the memory word is long enough (binary computer), more than one x-y point may share the word, or byte-oriented computers may use a variety of packing schemes.

The program to accomplish the memory assignment of elevation is simple: Let the first card of an elevation batch be punched with the elevation for that batch. Since the following cards of the batch are in order, they will be processed always in that order. The first card is examined for punched hole positions; if there are punches, the batch elevation is placed in the memory location corresponding to that x-y hole position. This is done for all cards and all batches, and the final product is a memory array consisting of zeroes and bona fide elevations, the zeroes corresponding to points between contours, that is, areas of small elevation change. By some low order averaging method, or relaxation, these zero points can be given their approximate interpolated elevation, thus completing the array.

conclusion

The Portapunch card decks are read into any size decimal computer with a column binary option. Generally the memory will be too small for the plane array, so a scheme must be worked out so that each x-y point of the input is given its proper z-value and then stored on some external media. After external storage, the problem becomes that of computation using available contour map programs and any computer on which they are normally run.

Aside from surface contour maps and projections, this method may be used to record underground and underwater contours veins and bedding planes in geology, and mineral and oil deposits in property management.

An area which may exploit this type of recording procedure is electromagnetic field pattern measurement such as microphone and antenna analysis. Any field may be recorded even if the raw coordinate map is in polar or spherical coordinates. For example, signal strength may be recorded on a series of plane maps as a function of the (γ, θ, ϕ) coordinates; the input cards are prepared by completing one ϕ-coordinate map at a time, thus recording γ, θ and signal strength for each ϕ-coordinate. ■

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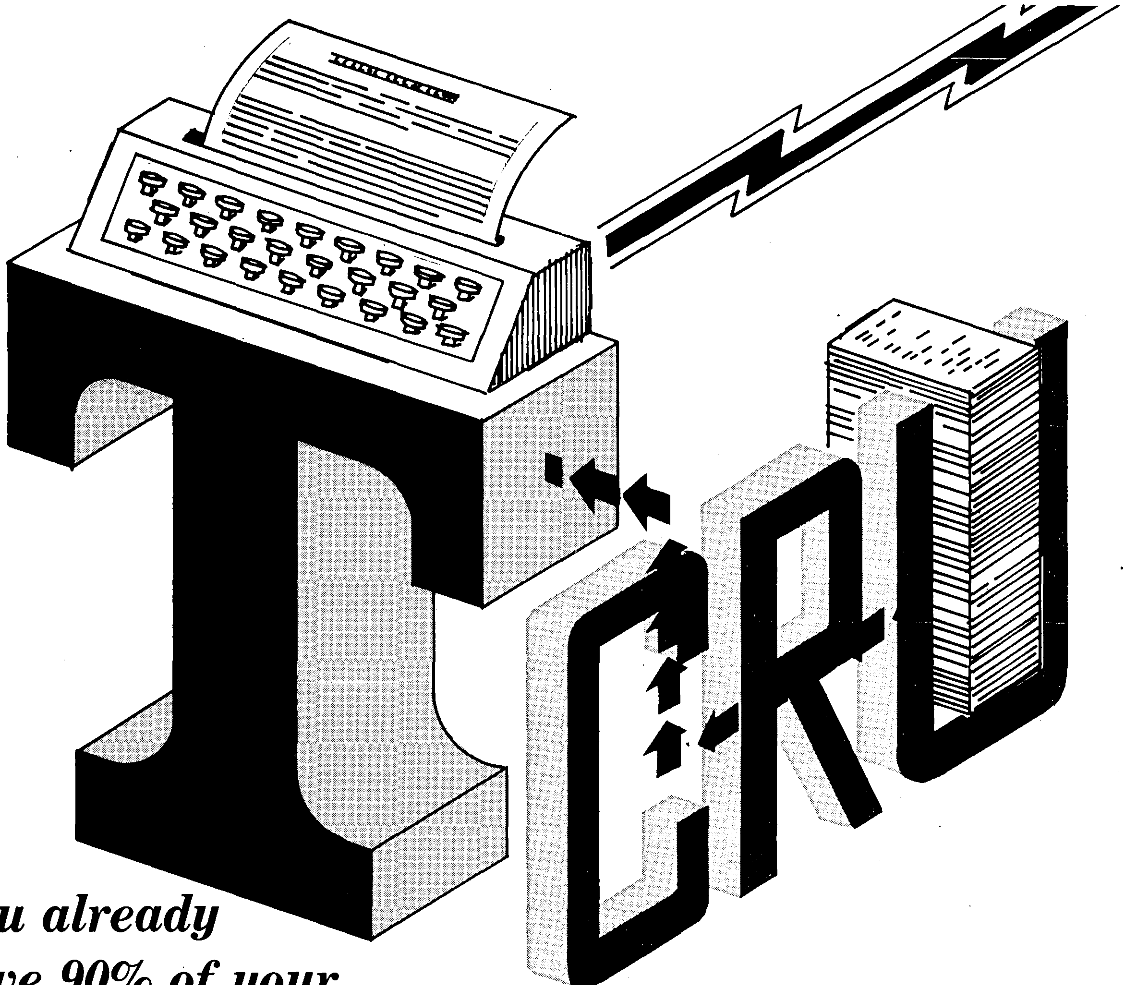

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THE TIME-SHARING BUSINESS

by HARRIS HYMAN

☐ Armed with only sweeping vision, a million dollars or so, and a nagging suspicion that it may be a tough go, an ever increasing number of firms have pressed forward into the glamorous, on-line, real-time, reactively conversational time-sharing world of the computer utility. Although no one has yet cleared a bona fide profit, it appears that time-sharing is really a Good Thing, but not quite what anyone expected it would be.

It is supposedly capable of various wonders ranging from the sublime extension of the human intellect to the amassing of a lot of money for someone. This profitability is surely the most important consideration of all; in our society it provides a direct measure of the value of any project.

Unlike Athena, commercial time-sharing has two parents: SABRE and MAC. The American Airlines SABRE system was instituted to coordinate a higher volume of passenger information at a shorter time interval than manual methods would have permitted. Project MAC was an attempt to reduce costs sufficiently to permit a researcher to use a large-scale computing machine as an extension of his reasoning power; he required a turnaround time short enough to permit some degree of concentration on the problem.

The first of these projects pointed up the type of system that should be built, and the second provided the broad base design techniques for implementing such systems. Commercial time-sharing will probably follow the SABRE philosophy of coordinating and communicating information in an open-ended system that can be extended and programmed from terminals. It will be possible to use such a system as a calculating instrument, but the overwhelming value will be as an information storage and retrieval machine. Large-scale systems will not be used for sharing computer time, but for sharing information. With this view of the future, several things become apparent about "computing utilities;" these then must be considered in the planning and design of large-scale commercial systems.

Not all time-sharing systems are suitable for all purposes. A 4- or 5-terminal system to be used in-house for debugging and inquiries, a system of 10 display terminals for graphic design, a multipoint electrocardiogram data reduction system, and a 25-terminal teaching machine may all be time-sharing systems; it does not necessarily follow that they are suitable for a commercial environment. Commercial systems are characterized by large numbers of terminals, large central files, and relatively simple computations. An appropriate system must be designed for the environment.

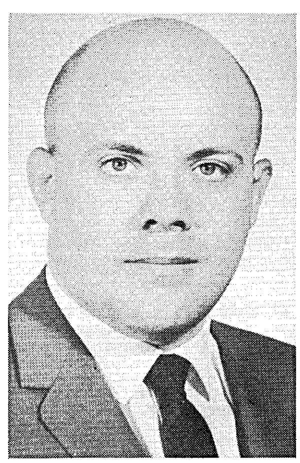
apportioning system cost

And time-sharing is expensive. When measured in terms of raw processing, the computer industry (admittedly showing great imagination for such things) could hardly find a more inefficient use of CPU time. But this is the least bothersome expense. The cost of a moderate-scale system (50-100 terminals) breaks down as follows:

Terminals and multiplexors	40%
Central processing unit	20%
Direct access storage	20%
Peripherals (tape, printer, etc)	20%

In a larger system, an even heavier portion of the cost would be carried in the terminals and terminal-handling equipment, and even this does not include communications cost. Recent developments in the field indicate another round of computer cost reductions, with only a small increase in performance. LSI (large-scale integration) methods for building interconnected circuits and memories cooked to order should cut the cost of electronics by at least two-thirds. In contrast, the cost of mechanicals is probably down as low as it's going to get; a breakthrough in typewriter design appears unlikely in the next 10 years. This also helps shift the cost of the system from the CPU to the terminals. The cost of common carrier communications on top of all this might lead to the idea of a scheme where several processors time-share a terminal!*

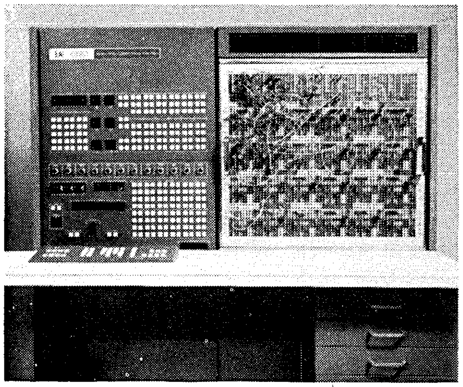
Free-standing machines are far from dead. In a few

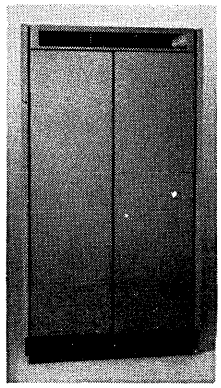


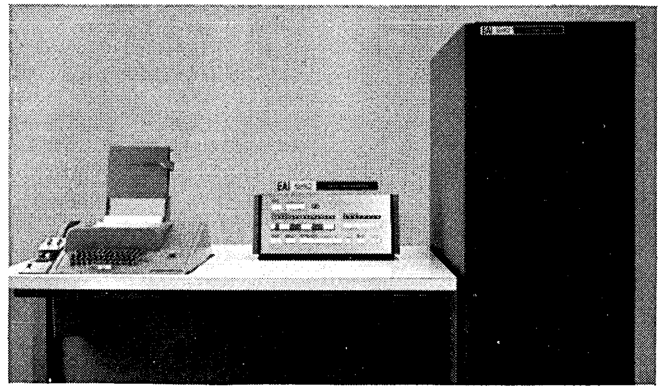
Presently a senior systems engineer with Sweda International Div. of Litton Industries, Mr. Hyman was formerly systems manager of the now defunct Munitype, in New York City, which provided time-sharing services to the financial community. He also has been associated with Digital Equipment Corp. in software development and with Bethlehem Steel as an engineer and programmer. He holds a BS from MIT in mechanical engineering.

* Some people are using a terminal to call several systems, and it has been suggested that it be possible to detach a terminal from one process and start another job with it.

HOW TO USE SIMPLE ADDITION TO SOLVE COMPLEX PROBLEMS:







680+693+640+SOFTWARE=690

THE 690 is the new EAI hybrid computing system. Now you *can* get a working hybrid computing system by adding two EAI computers and an interface together and loading the software into memory.

The new EAI hybrid has an analog computer ready and waiting for a digital that was designed for the hybrid hookup . . . where the interface was designed to take maximum advantage of both computers' features . . . where the software is standard, already written and tested and ready to load. In short, a working hybrid computing system that's still more than the sum of its parts, but is created by straightforward interconnection.

This simple addition means a single responsibility for the system. It also means reliable software maintenance and updating, as well as the advantages of other laboratories using the standard 690 systems.

It means you can start toward a hybrid system from either an analog or digital computer and expand in orderly fashion without running the risk of "experimentation" in your system.

The four parts of the EAI 690 that you add together were designed together to deliver more computational return on your invested dollar.

First in the addition is the EAI 680 analog computer, embodying over a decade of EAI experience. It's a sophisticated 156-amplifier machine, which even in its basic form includes a healthy complement of digital logic and control.

Then there's the EAI 640 digital computer. It was designed from the start with an extremely flexible input-output structure so that it is integrated easily into a hybrid configuration.

Between them is the EAI 693 which functions as both a data converter and comprehensive monitor and control interface unit for the system.

Finally, there's the 690 software which solves problems rather than creates them. It includes hybrid FORTRAN, HYTRAN℠, Operations Interpreter, Hybrid Debug, Hardware Diagnostics and a Hybrid Subroutine Library.

All this adds up to a superior capability for scientific problem-solving. You get high-speed analog capability for the simulation of system dynamics combined with the memory, logic and high-precision numerical capability of the digital computer. The engineer, the scientist, the designer is still "part of the loop", still capable of direct interaction with the program to add his own creative input.

We'll be happy to send a complete technical description of the EAI 680 analog computer or the EAI 640 digital computer, as well as the EAI 690 hybrid computing system. That way we can also get across what we mean by the EAI backup services, such as training, maintenance and five computation centers with standard systems, as well as total system responsibility, software maintenance and the users library. Write today.

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EAI® ELECTRONIC ASSOCIATES, INC.
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years they will probably replace such things as IBM's QUIKTRAN, GE/Dartmouth's BASIC, and BB&N's TELCOMP. Why not? If it costs a terminal user $500-$600 a month for his service, he can multiply this by 30 (months amortization) and get $15,000 to $18,000 to play around with for the convenience and reliability of his own system. A reasonably powerful machine for $10,000 was just announced, and in the next year when someone announces a 4- or 5-terminal system for under $50,000, the swing back to the free standing machine should be on. An inexpensive million-character disc will be the breakthrough item.

So why time-share big centralized computing systems? It provides the only way a widely separated group of people with a common interest can simultaneously share a common body of information. The information may concern bonds, stocks, inventories, medical case histories, legal precedents, or oil well data, and the group of people may include bankers, brokers, salesmen, doctors, lawyers or Indian chiefs. Obtaining the information within minutes may be of sufficient value to warrant the worst possible way to use the nanosecond speeds of today's processors.

pricing the service

Rate structures will ignore the computer. Charges for access to future time-shared systems will take a radical change from today's complex accounting schemes of a minimum charge plus so much for CPU time plus some amount for storage, plus so much for terminal time, or else *n* cents per transaction. Consider what the user of the terminal is paying for prompt access to a body of information. He may actually be willing to wait a half hour, but longer than that would be intolerable—hardly worth the exorbitant rates he is paying. He must continually tie up one access port to the computer, so that it is on call *when it is needed.* In this case there is only one sensible way to allocate costs to the user:

$$U = \frac{S}{N}$$

U, the user's cost, is equal to S, the cost of the system (including a profit to the operating company), divided by N, the number of users that can be accommodated at one time. This is the only possible rational rate structure; other schemes in current vogue fail to reflect what the user is paying for. Actual experience in the financial community has shown that a grade of service where the user dials up the system and takes his chances with a possible busy signal is unsalable; he is willing to pay three times as much for guaranteed access.

From this oversimplified but basically correct formula, it appears that there are only two ways to lower the cost to the user: either lower the system cost or raise the number of users. For a fixed-cost system, we must determine the factors that limit the number of users. The first of these is response time. The so-called outmoded batch job monitors provide a system acceptable to many users, but with a response time that can hardly be called conversational. A single user on the same system will receive microsecond responses. Any given system will have some characteristic curve of response time versus the numbers of users; two such system curves are shown in Fig. 1.

What does response time mean? An interaction between a user and a computer consists of four parts: time to think about what to do (T), time to prepare input to the machine (I), response time (R) when the user is waiting for output to begin, and output time (O). This cycle, shown in Fig. 2, is true of either conversational or batch processing. In conversational processing, when the user is going hot and heavy, the action time (A = O+I+T) has been observed to average about 20 seconds. The amount of processor time necessary to answer this request will vary widely with the nature of the request; it will eat up more processor time to run a PL/I compilation than to answer the request: 1+1=? In the case of the commercial user, his requests will probably be highly interactive, with low action time, and not require very much computing. Further, he will know when he has made a request requiring a long computation and accordingly light up a cigarette or go out for coffee. From observation of a number of typical users, a conversational system becomes intolerable to use when the response time exceeds 10 seconds. This points up the ultimate measure of system suitability: does the user like it?

channels, users, swap time

The *minimum* amount that any user can possibly tie up the processor is that time required to read his program from secondary storage (disc or drum) into core, and dump it back out again. With current drum systems this is on the order of 150 msec for a 32K (bytes) program. All of the users' core images must be on the same drum, and this drum is connected to core by one simplex channel. The channel can only accommodate one program swapping either in or out; this channel capacity is the basic limit on system performance. While the channel is swapping one program, the processor is of course operating on

Fig. 1 Reponse Time Curves

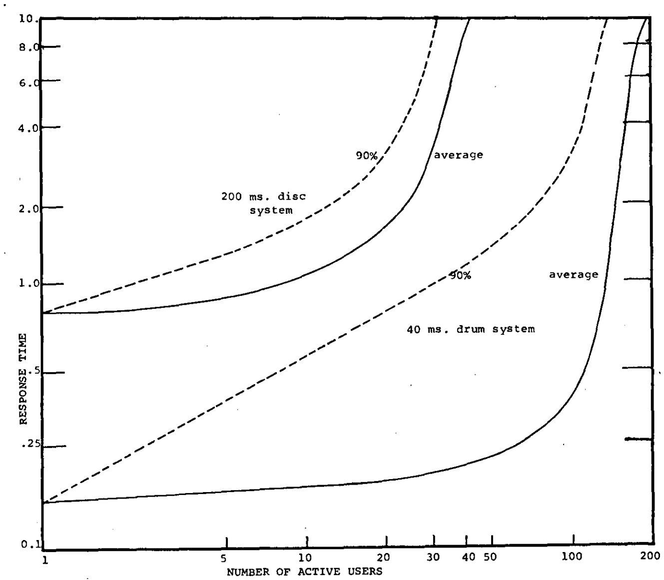
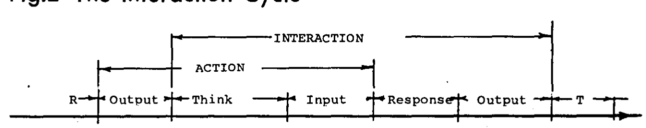


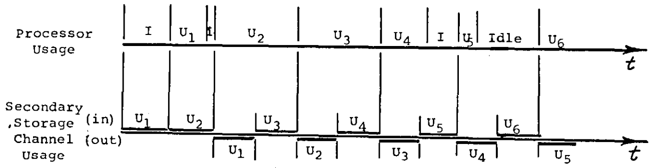
Fig.2 The Interaction Cycle



another, but it can't jump from program to program any faster than the channel can swap them in and out. Fig. 3 shows the relative use of the channel and the CPU.

To improve performance, the channel could be duplexed, allowing simultaneous in and out transfers, or several channels could be connected to the *same* drum. The fact that several users can remain in core at one time is really no help unless the number of user images in core is a fairly large fraction of the total number of users—say, 25%. (If such a system were to accommodate over 100 users, 1,000,000 bytes of core would be required.) When a user finishes, the next user must be activated, and if he is not already in core, he must be swapped in while the CPU waits around. If there are 100 users, and core can accommodate 10, there is a probability

Fig. 3 Relative Use of CPU and Secondary Storage Transfer



of 9/99 that the next user is in core. That some users are more active than others will tend to push this probability up, and the fact that a user will not want another shot immediately, and therefore get swapped out, will tend to push this probability down.

These two facts taken together make the 9/99 a reasonable guess. In this model there is a 91% chance that the next active program will require a swap, and experience with an operating system has shown a fairly high probability of a swap for every user.

So what can be done in 150 milliseconds? That's enough time to solve 20 simultaneous equations, sort 200 numbers into order, calculate the prices of 300 municipal bonds, perform 500 Runge-kutta integrations, calculate 850 payrolls—all kinds of useful things. In a reactive commercial environment, a typical modern computer is so fast that it will sit idle most of the time, waiting for a swap from secondary storage. The channel simply can't move programs around fast enough to keep the CPU busy, and a faster computer won't do much good. The very cleverly conceived schemes for mapping core only tend to aggravate the problem, although they do provide the capability to run jobs requiring huge memories. The desirability of this in a commercial environment is debatable, since most of the existing computers are 1401's or the like; most of the automated data in the world is processed on machines of less than 16,000 characters. A commercial time-sharing system must be slanted toward lots of users performing "trivial" jobs, although I would hardly consider 50 milliseconds of processing by an on-line system on *my* bank account trivial.

Another limit on system performance is the speed of the data base storage device: drum, disc or magnetic card. Since the users of the system are interested in a common body of data, a number of requests will include inquiries to this data base on tertiary storage. If *every* request were to include a seek, the speed of tertiary storage would then clearly be the performance bottleneck, but if only a small fraction of the requests precipitated a seek, the secondary storage speed controls. In some present systems, the same device and channel is used for both secondary (user image) and tertiary (data base) storage, but this system layout will obsolete itself, being too inefficient to service many users.

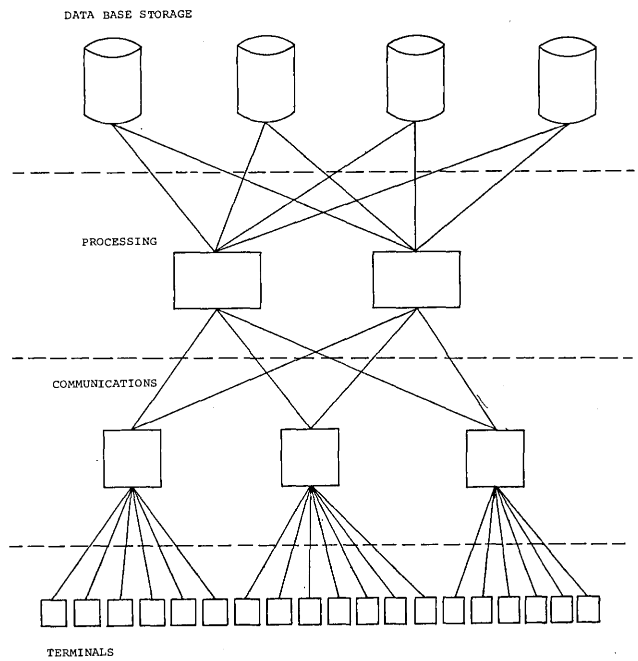
Using the model in Fig. 2 of an interaction cycle composed of a think time, a typein time, a reaction time, and a typeout time, compute quanta of 150 msec for a drum system and 750 msec for a disc system, and a little queueing theory, we get the two pairs of curves in Fig. 1. The solid curves show average response time, and the broken curves represent 90% response time (90% of the time the response is better than this). They show a tolerable service level for less than 200 users per processor.

Still and all, we'd like to have a giant centralized facility supporting a couple of thousand simultaneous users. To make it, there will have to be a number of processors accessing a common data base. Separate processors should also control I/O lines and buffer messages. A small, inexpensive line-handling computer is ideal for multiplexing messages when there are a large number of lines coming in to a processor. An added advantage comes when the multiplexing computer is physically far from the central installation, serving as a remote concentrator, with heavy economies in communications line costs.

system components

This dictates the utility system in Fig. 4. There are basically four components to the system: terminals, multiplexors, processors, and storage. A system like this is fundamentally clean and simple, but can be built up modularly on any or all of the levels.

Fig. 4 Typical System Configuration



Who is going to build, fix or program the largest machines? There appears to be a limit to the complexity of a machine or program that can be made to function with any reliability. Nobody seems to want to admit this, but it has been demonstrated time and again; there are adequate examples without embarrassing anyone. If the scope of the job is beyond one man's attention span it may very well be impossible, given only finite time and money. A tractable system *must* be simple and modular if it is to ever work out.

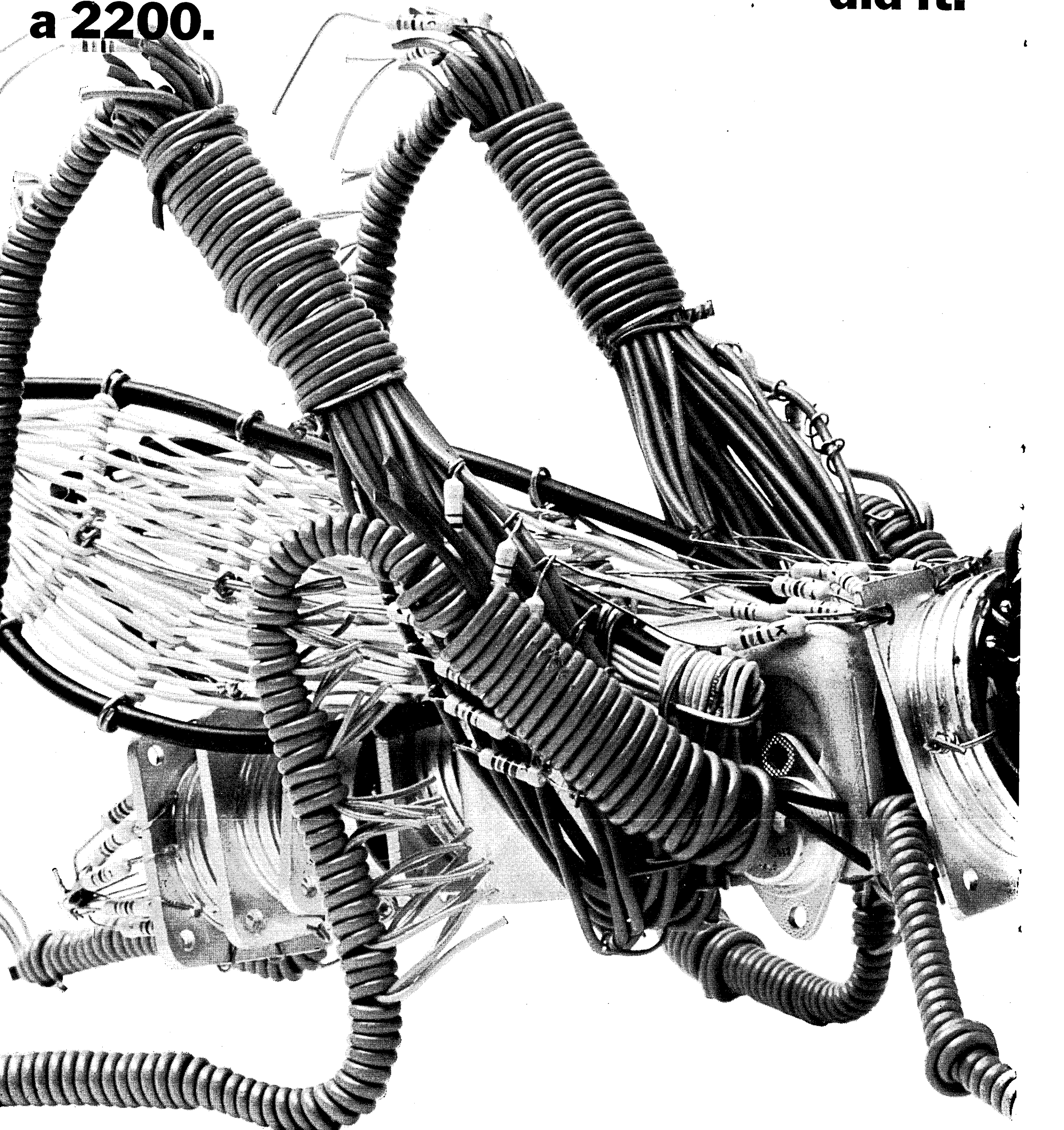
The problem of reliability is also related to the complexity of the system. Reliability is something that must be paid for by the customer and he may be unwilling to pay for a duplex or triplex system. A large system built from relatively simple modules that function in parallel is inherently more reliable than a large Kludge. It can operate at a degraded level and still give partial service. It is considerably cheaper to add a couple of modules for backup than to duplicate the entire system.

From everyone's sordid experience, the software is far less reliable than the hardware. Even when a "mature" system bombs out, it is usually the software. A clean modular system will go a long way toward solving this problem. It is true that it may be impossible to implement a self-organizing machine in LISP on one small processor, but no one has yet suggested a valid commercial use for this sort of thing, and the idea of running the commercial time-sharing center is to make a buck. Incidentally, with so

A Honeywell Report on Conversion to Third-Generation Computers

It's easy to leap from a 1410 to a 2200.

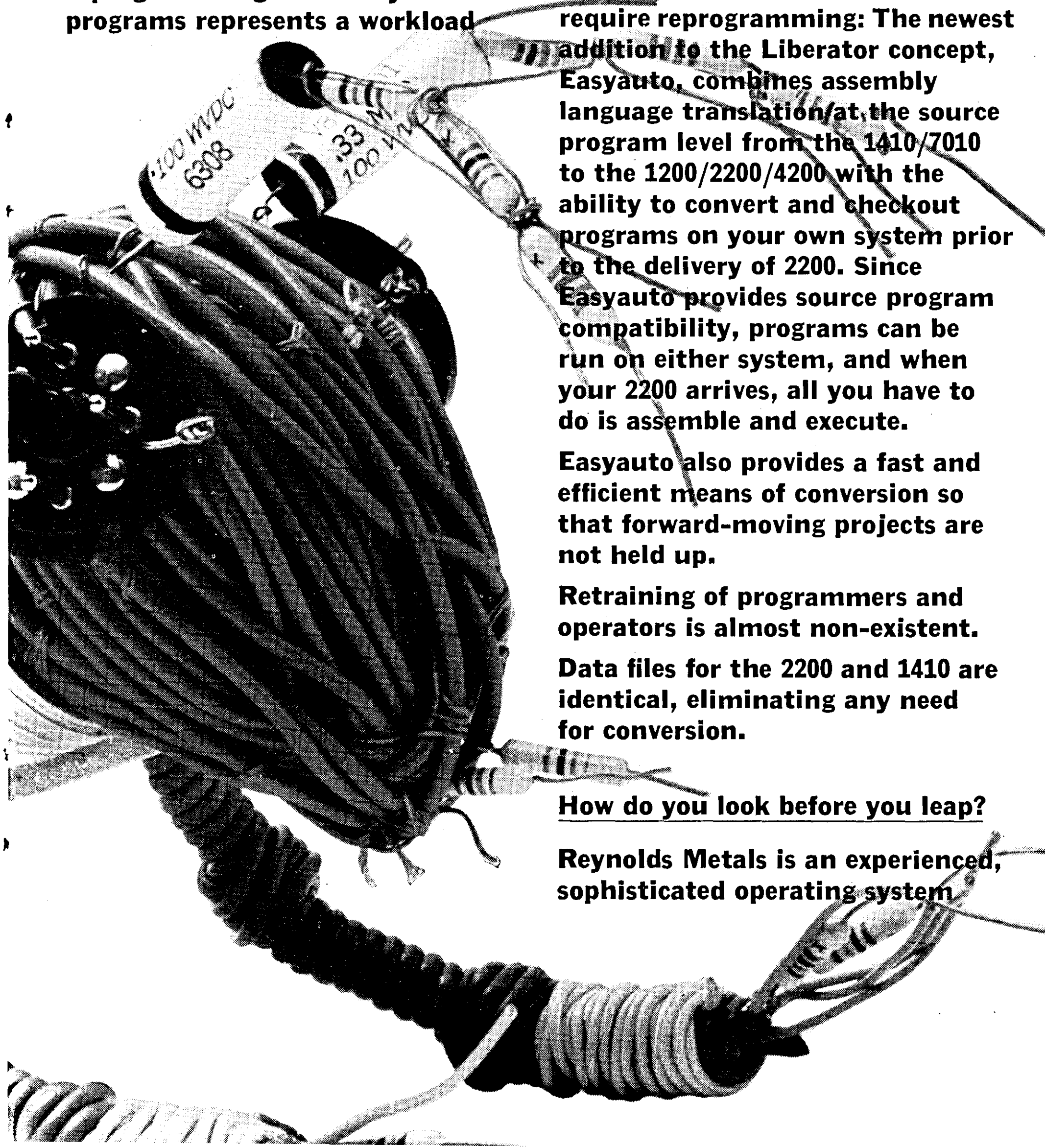
Here's how Reynolds Metals did it.



Reynolds Metals is a company where new ideas take shape in aluminum. Reynolds Metals is also a company where new ideas take shape in data processing. At its forward-looking corporate data processing center Reynolds had continued to build new, more complex computer applications — to the point where the machine load on its 1410 was in excess of 600 hours a month. The capacity of the system was being pushed to its limits and the list of planned projects continued to grow.

At first, the next step seemed obvious: a newer, faster, more flexible computer that would give Reynolds the capacity and expansibility it needed. But speed is only one of the factors to be considered when selecting a new computer. What about reprogramming? A library of 250 programs represents a workload equivalent to requiring the entire programming staff to work full time for two years on reprogramming alone. How do you find the time to retrain all programmers and operators when you are running three shifts per day? Where does one find the time to convert data files for the new computer? How much of the new computer is available for work on an already large list of new projects?

Reynolds Metals next step was to find the best answers to these questions — answers that would enable it to protect the substantial investment in data processing.



How does the Honeywell 2200 answer these questions?

The 2200 provides a dramatic increase in throughput which ranges from two to four times the throughput of the 1410.

The leap to the 2200 does not require reprogramming: The newest addition to the Liberator concept, Easyauto, combines assembly language translation at the source program level from the 1410/7010 to the 1200/2200/4200 with the ability to convert and checkout programs on your own system prior to the delivery of 2200. Since Easyauto provides source program compatibility, programs can be run on either system, and when your 2200 arrives, all you have to do is assemble and execute.

Easyauto also provides a fast and efficient means of conversion so that forward-moving projects are not held up.

Retraining of programmers and operators is almost non-existent.

Data files for the 2200 and 1410 are identical, eliminating any need for conversion.

How do you look before you leap?

Reynolds Metals is an experienced, sophisticated operating system user. It wanted proof, not only of throughput performance, but of all the factors that would have a bearing on preserving its data processing investment. The computers under evaluation were subjected to a number of bench mark programs. The 2200 won.

How has the 2200 performed?

Reynolds has experienced a two-to-four-fold increase in throughput and has eliminated its need for an off-line data transcription system by handling these operations concurrently on the 2200.

Easyauto translates at card or tape-read speed. Total conversion time averages two hours per program.

Programmer and operator training was completed within one week.

No data conversion was required.

Most important of all, normal data processing functions were not affected by conversion.

How about cost?

That's one of the best features. Reynolds job costs are down due to easily gained third-generation performance at second-generation costs.

How can Honeywell help you?

This attention to detail and concern for special needs is one more indication of Honeywell's ability to solve your data processing problems, whether you are looking for your first computer or in a position to move up to one of a series of faster, more powerful third-generation models.

More detailed information on transition from 1410/7010 to the third-generation Honeywell 2200 is available through the inquiry service of this magazine or by writing Honeywell EDP, Wellesley Hills, Mass. 02181

Honeywell
ELECTRONIC DATA PROCESSING

This is the new Tally System 800 for verification and duplication of perforated tape. We call it the "Super Dupe".

It duplicates perforated tape on a bit-for-bit basis at 120 characters per second.

It verifies two tapes bit-for-bit.

It verifies two tapes and duplicates a completely error free third tape.

It detects perforation bit errors as they happen.

The Tally System 800 verifies and/or duplicates perforated tapes from one through eight channels in any code structure at 120 characters per second.
It uses bit echo techniques to make sure that every error is caught on the character and eliminated by comparing each perforated bit with with each bit read by the master reader.
Its price is remarkably low and delivery amazingly good. If it's your kind of baby and you would like the full story, please write our man Crawford.
Address Tally Corporation, 1310 Mercer Street, Seattle, Wash., 98109. Phone: (206) Main 4-0760. TWX 910-444-2039. In the U. K. and Europe, address Tally Europe, Ltd., Radnor House, 1272 London Road, London, S. W. 16, England.

TALLY

much intercommunication among processors, in a couple of years all new computers announced should have 8, 16, 32, or 64-bit words.

The last great software problem for time-sharing systems that remains to be solved is file handling. This remarkable area of neglect can most effectively be blamed on the parents. SABRE did solve the problem as best it could (under the crushing handicap of $50 million) but the idea of a group of users simultaneously updating a single file was completely ignored by the people at MAC, who had other more pressing problems to solve. This problem, hardly trivial, can no longer be swept under the rug. It is absolutely critical to any type of communicative time-sharing system because the files are the *only* reason for the existence of the system. If fairly large files cannot be effectively managed, and data stored and retrieved quickly, the system is almost worthless. There are actually several solutions, but none of them is wholly satisfactory in terms of cleanliness, cost, or speed. Some heavyweight conceptualization is needed, here and now.

users & terminals

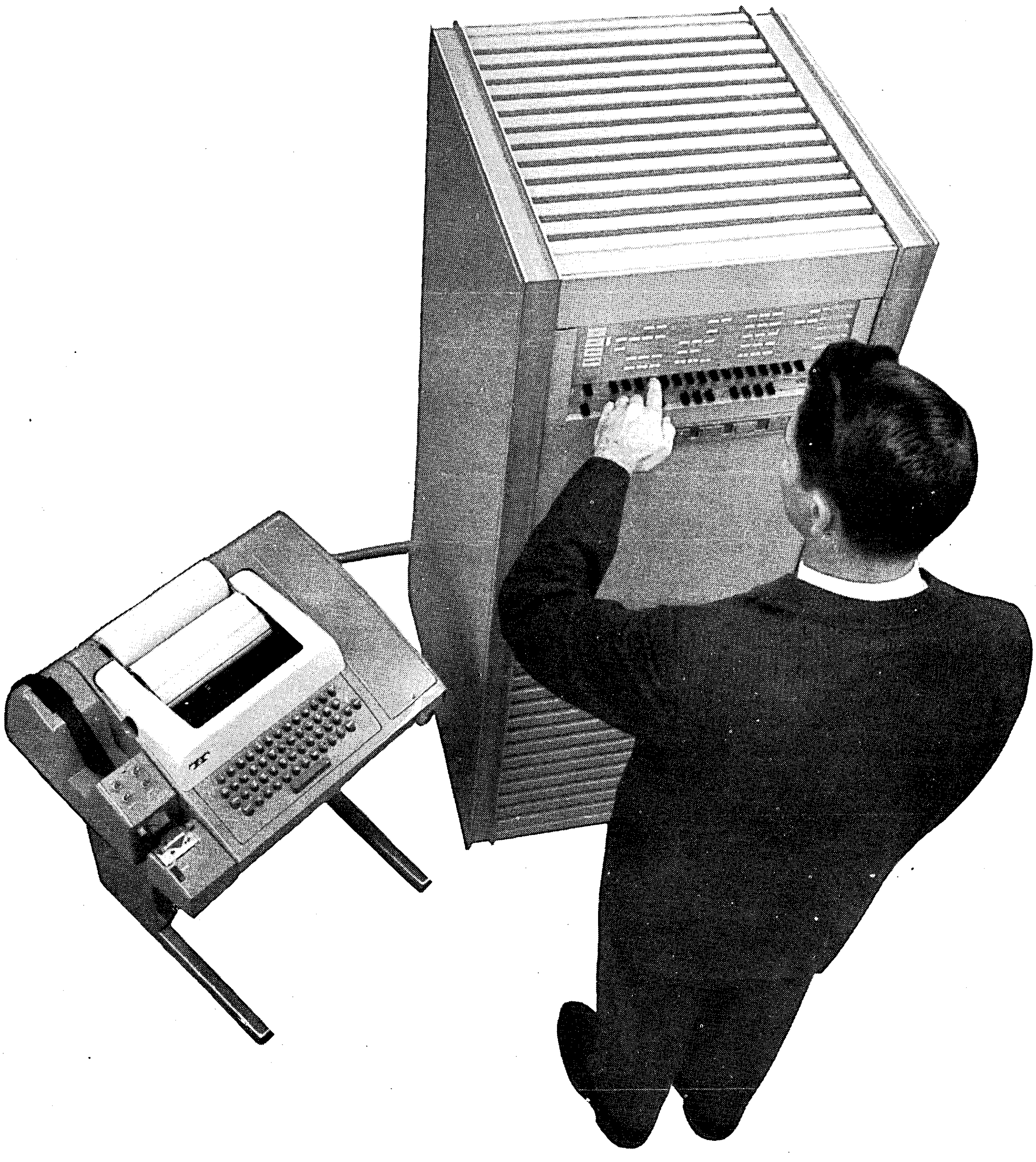
Time-sharing will not lead us to become a nation of programmers. In any commercial system, there must be a large amount of application programs. The principal user of the commercial system is going to be that cute little airline clerk or secretary, and not the bearded, sandaled programmer type. In a year or so, the Playmate of the Month will be at a terminal. This user couldn't care at all about programming, but she does have a problem to solve. She wants a machine that can supply answers to specific questions she can ask. The ability to write programs from the terminal is extremely important—it gives the system an extensible character—but the majority of the users will want their own problem-oriented software to solve their own peculiar problems.

Finally we come to look at the user and his terminal. It appears that this will be a typewriter for a long time to come. This typewriter must have a fairly high output speed; on input, the speed is unnecessary since we have not yet developed particularly fast hands. It will eventually have a wide carriage and a keyboard with lots of characters, lower case letters, a numerical cluster of keys, and a few other features. The basic point is that the terminal will be a typewriter, and not a cathode-ray tube display. Although CRT's have a fantastic amount of sex appeal, their value as an inquiry terminal exists mostly in the minds of their creators and hardware salesmen. Besides the dreadful expense, there is nothing quite so pathetic as seeing a man writing down numbers appearing on the face of the scope. Hard copy is valuable, and highly mnemonic. You can take it home in your briefcase, spread several sheets before you, scribble on it, read it on the subway, and easily reproduce it. The image of the corporate president sitting at his walnut desk-console jabbing away with a light pen is unrealistic.

conclusion

Large time-sharing centers will not replace free standing machines and will not perform all the functions of all the machines that are running today. There will have to be huge amounts of user oriented software written, and new markets developed. Whether this will be done by specialized service companies or computer manufacturers is yet to be determined. But the industry, misinformed about a number of facets of time-sharing, is correct in the supposition that some form of really large time-sharing utility will exist in 1975 or so. ■

This 16-bit, real-time computer multiplies faster, has a faster throughput, and costs less than the Sigma 2.



It's our SEL 810A, for high-speed data acquisition and control. All integrated circuits, 3 levels of priority interrupt, 4K memory, teletype, high-speed hardware multiply and divide, real-time I/O structure, and an outstanding software package. Price: $23,950. Delivery: 60 days. Systems Engineering Laboratories, 6901 West Sunrise Blvd., Fort Lauderdale, Fla. 33310, Area Code 305 587-2900. Offices also in Washington, D.C.; Los Angeles, Calif.; Boston, Mass.; San Francisco, Calif.; Cleveland, Ohio; Huntsville, Ala.; and Orlando, Florida.

Systems Engineering Laboratories

CIRCLE 39 ON READER CARD

news briefs

YEAR-END STOCK QUOTES SCRAMBLED BY MINOR BUGS

It was rather like the evening the lights went out in New York City at the height of the rush hour.

On Friday, Dec. 30, the last business day of the year for the stock market, the trading on the New York Stock Exchange reached an unusually high volume of over 11,300,000 shares. There had been a constant din on the floor all day, frenzied clerks running to their stations, inserting transactions written on mark-sense cards into on-line optical readers. Some were said to be scrambling their cards, recording the transactions out of order, which meant there would be some discrepancy in the quotes, perhaps some losses to the traders. With a trading of two million shares in the last half hour alone, this does not seem improbable, especially since there is no program control over the numerical order marking on the card (said to be impractical in a real-time situation like this).

At closing, the computer processing and transmission of trades was running about 10-15 minutes late, not unusual in heavy trading. Then things, just things, began to go wrong—with the computers at the NYSE and at Associated Press (which prints daily quotes for 300 newspapers), and with some ticker circuits to subscribers, one being AP. The problems weren't all discovered at once, and it took a week of publishing and republishing corrections to get a near-accurate list to the public and to the many institutions that had already done year-end portfolio evaluations based on erroneous quotes (about 490 in the first AP list).

What happened in the 35 minutes after closing? Reports differ slightly, but according to data processing people at each location: the NYSE IBM 7010 computer was logging the heavy volume of data on the drum, then outputting it to core on the 7750 for transmission. The 7750 began to get saturated and told the 7010 to slow down—an inhibit command. But because of a software bug, the 7010 first ignored it, then responded, a few milliseconds too late. The system was out of step; the 7750 was pumping data to the tickers at the full 900 characters per minute speed, output bound. The data processing staff saw the 7010 was inhibited, checked for line failures, found none, then moved at 3:49 to switch to the backup system—done within four minutes. Unknown to NYSE until the following Thursday, some transactions did not get sent to the tickers, but were still on the drum.

AP says its new 360/40 noted the stop in transmission, and when the NYSE computer came up again the 40 indicated that it was receiving from the ticker. The staff checked the initial printout and verified it. Strangely, the computer, though it got transmit signals, was not receiving any data. In the program, a pointer that should have gone forward after the I/O interrupt had, instead, started back at the last transactions transmitted before the ticker had gone dead. This was what provided the initial printout. AP says it verified its totals with those on the backup mod 40, which, it turned out, also did not receive the last trades. A paper-tape unit at AP did, and it was from this that a complete, supposedly corrected list was published on Thursday. (First corrections appeared Tuesday.) On Friday, AP and NYSE published more corrections after NYSE found that some transactions, at point of failure, had not gone to the tickers. It was a chain of events, some electronic failure, some software bugs, that had not appeared in systems tests or operation before.

GALLAGHER, BUDGET BUREAU CONTINUE PRIVACY DEBATE

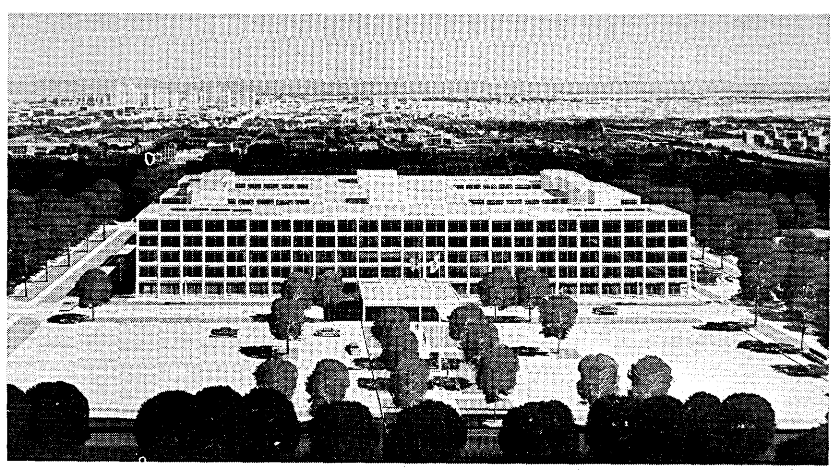
A hot battle has developed between Congressman Cornelius Gallagher, New Jersey Democrat, and the Budget Bureau over a proposed national data bank with statistics collected by several government agencies.

Last November, a task force led by Dr. Carl Kaysen, chairman of Princeton's Institute of Advanced Studies, reported that the bank would, among other benefits, disseminate statistical analyses quicker and cheaper, conserve data now being lost, promote automated information handling, and permit analyses that can't be made now.

In December, in a letter to BOB Director Charles Schultze, Gallagher accused the Kaysen group of bias. He complained that no alternatives to a central data bank were considered and

NEW BURROUGHS CORP. HEADQUARTERS STARTED IN DETROIT

Burroughs Corp. has finally decided to replace the ancient Second Avenue building in Detroit with this $18 million world headquarters. Construction of the five-story, 600,000-square-foot building is to start early this year and will be completed in 1969. It will house all executive offices and administrative activities now scattered about the area in several buildings. The 16-acre site, long owned by Burroughs, allows room for future expansion. The company has also announced an organizational change: formation of the Business Machines Group, to include the former domestic business machines manufacturing and engineering division. Richard O. Baily has been elected vice president and group executive for the new organization.



that the study had failed to offer adequate safeguards against snooping.

"I agree completely that any action to improve the availability of statistical data must fully and completely provide for the protection of the individual's right to privacy," Schultze wrote back on Jan. 9th. The data can be made more available, he added, "without weakening the right of the individual to personal privacy."

If the BOB director was trying to mollify the congressman, he probably failed. The reply says nothing about considering alternatives to the Kaysen concept of a national data bank, and Gallagher had made it clear that the scheme envisioned in the report does not provide adequate privacy protection.

The next round in the data bank battle will occur March 5-7, at a three-day symposium sponsored by AFIPS in Warrenton, Va., where both proponents and opponents will appear.

U.K. PRIVACY PROBLEMS WITH NATIONAL DATA BANKS

As in the U.S., the problems of maintaining personal privacy when national data banks are in use is causing increasing concern in the United Kingdom.

Two public service operations have been proposed, each requiring large files of personal information, and both are meeting opposition from public guardians such as the Council for Civil Liberties.

The first plan, under the Ministry of Health's state-run medical service, involves creation of a computer-based medical records data bank at a new-town development at Woolwich, near London. It's part of the experiment in introducing a more efficient family hospital and doctor plan that could be a prototype for the rest of the country. Doctors would have access to a data bank covering everyone in the township and containing medical data and other social security information. Opponents believe the system would infringe on some basic personal safeguards that are protected by existing medical practice, which stipulates that only the person who originated a medical record may pass it on or divulge its contents to another practitioner—and then only with the consent of the patient. Doctors examining the proposals say that their implementation will only be possible with changes in the statutes and this may call for approval by Parliament.

The second plan would establish a national fingerprint bank. This is now being studied by the Home Office, which has central responsibility for the nation's police forces. Forensic scientists are working with manufacturers, such as ICT and IBM, to find a coding system for defining a full set of prints that will occupy minimum storage. Indignation has been aroused by some unprecedented police action in several towns where whole sections of the populace have been fingerprinted in large-scale hunts for a murderer and an arsonist. Although copies of these prints have been destroyed in public, there is concern that permanent records could be stored by computer.

AAAS SESSION DISCUSSES FUTURE OF TIME-SHARING

The next major development in time-sharing may be user-user interaction via computer, said Dr. David Evans, of the University of Utah, at the American Association for the Advancement of Science (AAAS) meeting in Washington, D.C.

Such a system, he explained, would enable users in different locations to work on common problems simultaneously. Research scientists at widely scattered labs, for example could consult with each other; likewise, auto engineers, teachers, students, and many others. A teacher would thus be able to conduct experiments with several classes of students at the same time. But many potential applications will remain potential, Dr. Evans said, until system costs come down.

He also suggested that ultimately users of computational time-sharing systems will not have to know anything about programming. They'll work with the model of the problem instead. It will be typed out, or displayed graphically, in response to a simple command; then the user will enter the new data and have a simple way of relating it to the logic. Pointing to a place location with a light pen is one possibility. The computer will be able to complete the data processing exercise without any further cues. Dr. Evans mentioned experiments at the University of Utah and elsewhere which are aimed at refining such a user-model operating mode.

The AAAS session, sponsored by ACM, included three other speakers. Informatics' Dick Lemons summarized the present state of the time-sharing art; IBM's Andy Kinslow described a page-turning method to reduce processor delays created by large programs; and Dr. Merrill Flood, of the Univ. of Michigan, discussed information processing networks. These will ultimately develop into an "on-line intellectual community," he said.

The session was chaired by Prof. Jack B. Dennis, who reported that about 100 time-shared systems should be on-line by the end of '67; 60 are scheduled to go into operation this year.

Project MAC and other networks have spawned a number of diversified programs which are accessible through any TWX or Telex network, Dr. Flood reported.

Dr. Flood contended that a serious shortage of data transmission facilities handicaps the future growth of data processing networks. Privacy is another big problem, especially the question of who is liable if stored data gets into unauthorized hands.

BULL-GE AND THE CONTINUAL FRENCH CRISIS

Three quick choruses of the Marseillaise; down with the stars and stripes; and the Paris-based Bull-General Electric company is nationalised by the French Government. This was the threat overhanging the two-year-old group formed by a marriage between GE and Compagnie des Machines Bull as the Gallic computer industry moved into what was promised as the first year of revival.

A new crisis in the affairs of Bull-General Electric, which came to light in January, has served to make all the politicking of Gaullist supporters last year to bludgeon through a go-it-alone computer policy look like a "pas de deux" for two left feet. The present difficulty of the jointly owned French and American group is hard to pinpoint because it has never really settled down since the merger. The profitability of its operations is not entirely divorced from happenings in Phoenix. Trouble over the GE 600, for example, has cost the company an order from the French Weather Bureau and has led to the withdrawal of another 600 system from the French electricity generating authority.

In a bid to resolve these problems, the chief executive of Bull-GE, M. Desbruéres, revealed that the new middle-of-the-range 140 series was to be taken out of production because it did not come up to expectation. Cuts in working hours would result in the 10,000-man labor force, and the research staff was to be redeployed on new design work to expedite a more advanced series that was still in embryonic form.

Some redundancies are expected—although these are stated by the company to be less than 300. Earlier reports that lay-offs may be as high as 2000 were strongly refuted by the

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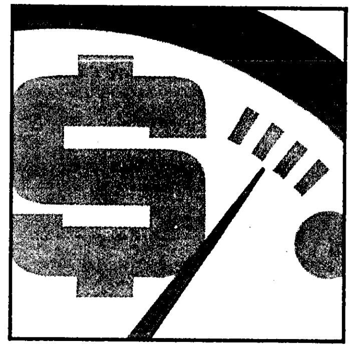

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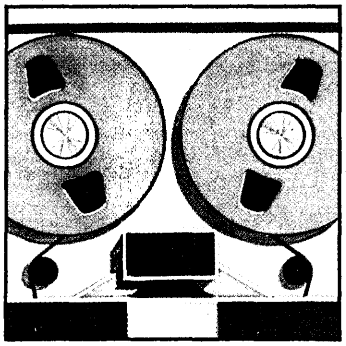

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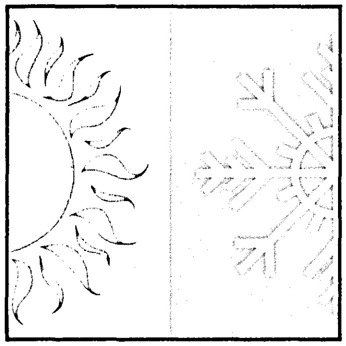

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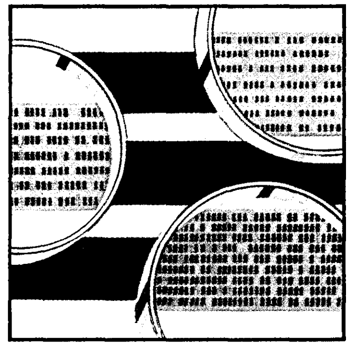

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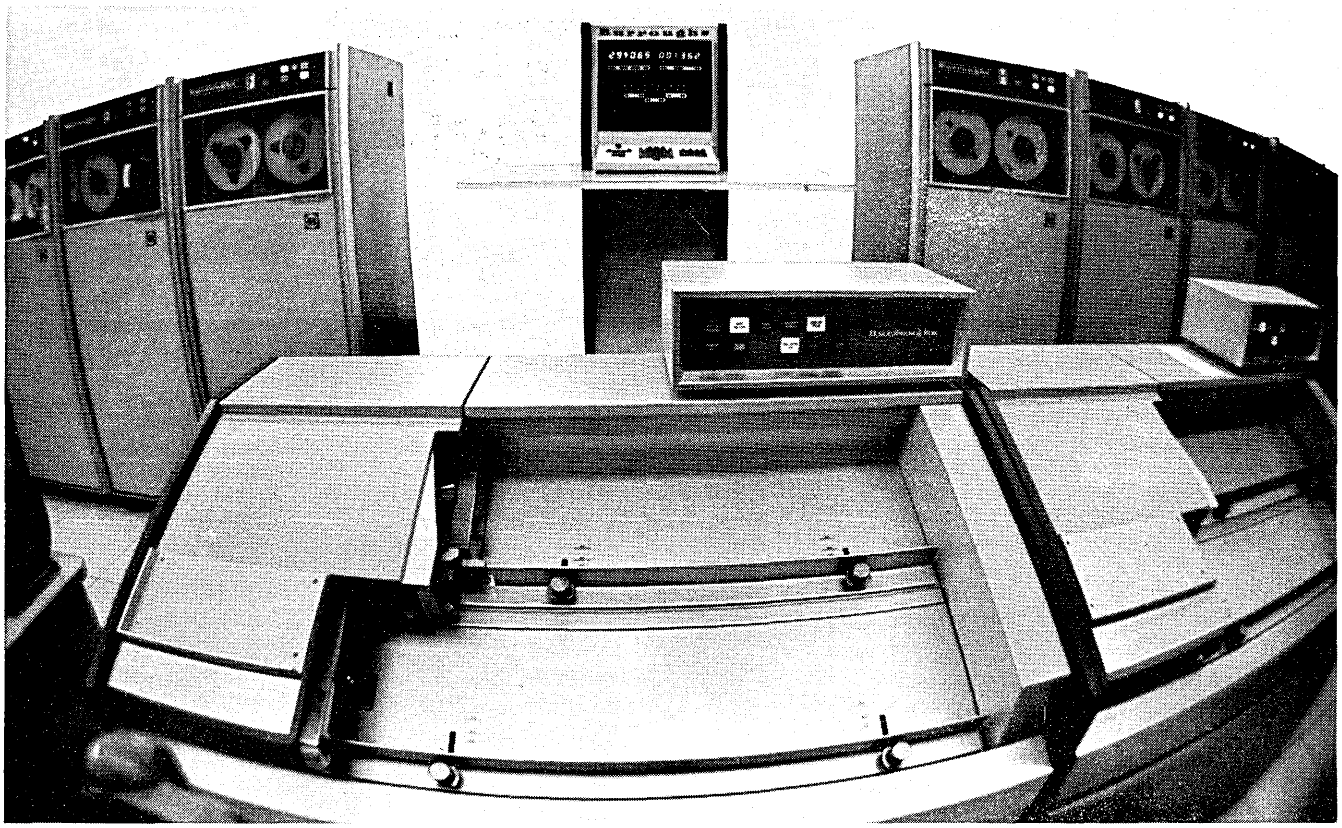

You get more work out of a Burroughs 500 system because more of the computer gets into the work.

That, in a nutshell, is how Burroughs 500 Systems solve two major problems of computer operation: **throughput and system utilization.** Their solution means a much higher ratio of performance to price—and a better return on your computer investment.

1. Throughput. In the past, the only way to increase throughput (the amount of work a computer system delivers in a given period of time) was to get a *bigger, faster computer*—at a sizeable increase in cost.

The Burroughs way is to provide a better organized computer that can do more than one job at a time. This pacesetting computer capability, called *multi*processing, has been enjoyed by Burroughs customers for nearly three years. Thousand-job-a-day installations are not unusual.

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CIRCLE 42 ON READER CARD

management. Union leaders fear that cutbacks may be more severe later this year if company business does not pick up markedly in the next few months.

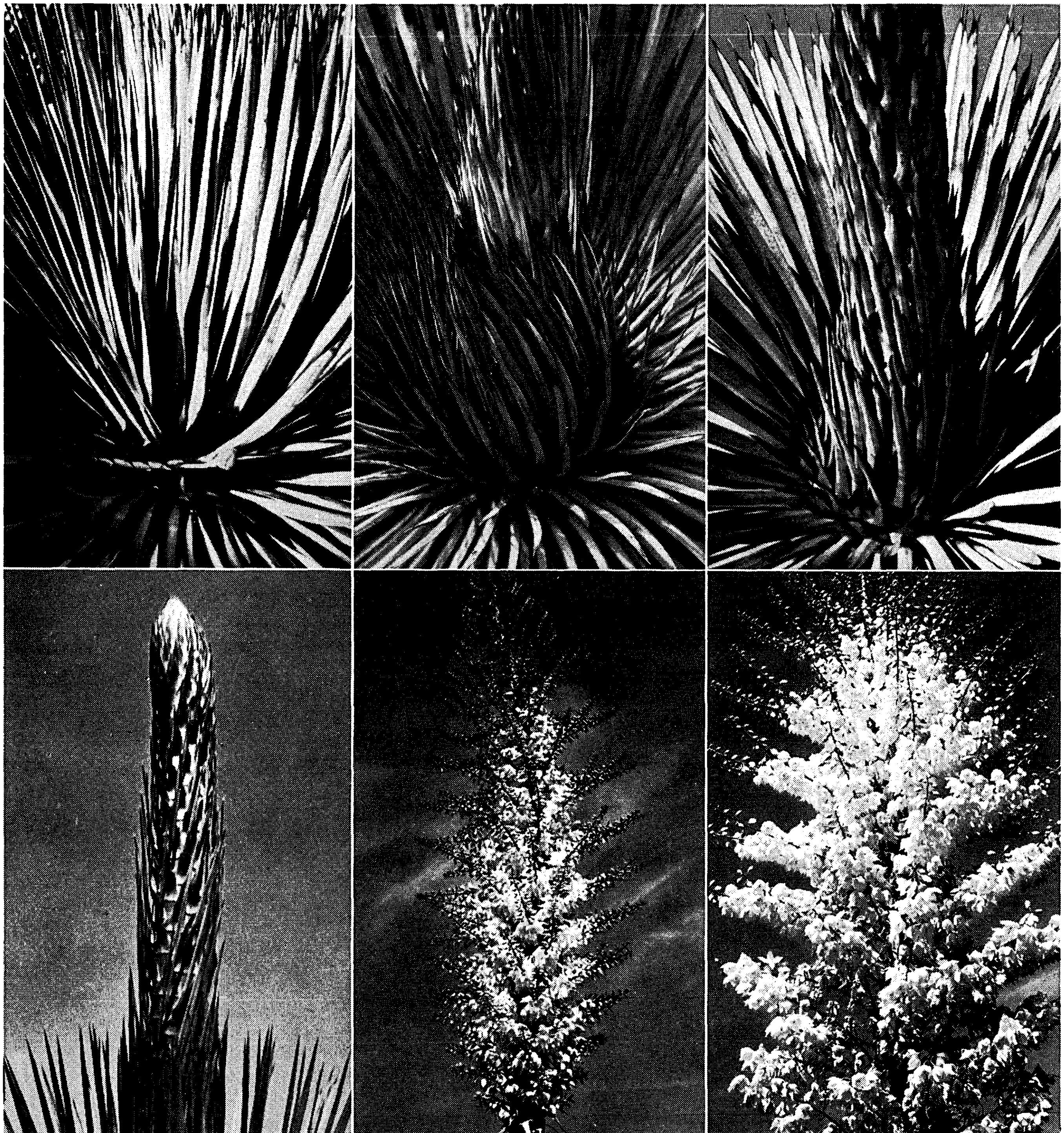
The irony of all this is that Machines Bull was taken over two years ago in the face of bitter opposition from the state and following a bungling attempt at a government-inspired rescue operation. Existing difficulties are therefore bound to open old wounds and, at the same time, revive arguments from other antagonists, in Britain and Germany as well, who regard American investment in Europe as economic-technological colonialism.

Gaullist hostility could be particularly acrid since the French have only recently completed their formulation of Plan Calcul—the five-year $140 million government investment with which a French-based computer industry was going to become a major force in Europe. Although most of the cash is to be injected into local firms, the Bull-GE takeover was allowed to go ahead in the first place after the government had been reassured that a research program would be supported that would contribute to the building of an independent French design competence.

In emergency meetings with Finance Minister M. Michel Debré, the management is understood to have repeated its promises that a big local research program was still to go ahead. This is believed to have placated the Minister, who is far from antagonistic to American investment in Europe, and to have given ammunition to quiet a lobby for a state takeover as the solution to Bull-GE's problems.

The French-American combine consists of a marketing company, Bull-General Electric (51% GE-owned), and a manufacturing organization, Industrial Bull-General Electric (51% Compagnie des Machines Bull owned). Prior to crisis day the product range extended from a $40,000 machine upwards. Reading from small to large and in design group it was the Gamma 55, 10, 115; 140, 145; 400 series. According to the company in January, all except the 140s would remain, including the 600s.

In this type of situation one man's loss must be another man's gain. On the middle-of-the-range machines the you-know-who company is expected to gain from Bull-GE's loss. At Electricité de France, however, Control Data is tipped to notch up a second 6600 with a replacement for the 600. CDC's first 6600 was delivered to



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Electricité's Research and Development Centre, Paris, in December.

As Bull-GE's crisis reached flashpoint last month, the first new company to be born out of the Plan Calcul came into being. The Compagnie Internaionale pour l'Informatique, INFI for short, combines the computer operations of two large existing electronic groups—Compagnie Europeenne d'Automatisme Electronique, CAE, and the Societe Electronique et d'Automatisme, SEA. This company is to get the major share of the $140 million cash injection for design and production of small to medium systems to make their debut in mid-68. They are expected to consist of a series of three labelled P-0, P-1, and P-2. Microcircuit systems starting from $40,000, they will be eight-bit-byte structure, going up in memory modules from 8K to 200K. The management of the new company was also announced during January. Chairman M. Jacques Maillet is a former alumnus of the Polytechnique—training ground for the majority of France's top civil servants, industrialists and administrators. His experience includes government service and executive jobs with aerospace and electronic engineering companies such as Snecma, Intertechnique and CAE.

TIME-SHARING: WHO PAYS HOW MUCH FOR WHAT?

The thorny question of how to charge for time-sharing was discussed at the January meeting of the L.A. ACM chapter by some people who ought to know: Jim Babcock of Allen-Babcock Computing, Ray Wakeman of Tymshare, and Warren Erikson of System Development Corp.

The panel, chaired by Art Rosenberg of Scientific Data Systems, divided the subject into six topics and considered each of them in terms of their own experience in making such a system work.

First subject: what resources of a time-sharing system are we talking about? Babcock said his most precious resources are, in order: cpu and core; space on the disc; fixed functions, such as communications; and overhead, which is equivalent to software. Wakeman cited cpu, communications equipment, and secondary storage. SDC's Erikson noted at this point that just because he doesn't charge his users doesn't mean that they don't pay. (From the audience: "And pay and pay and pay.")

Main point about the methods of charging: Allen-Babcock charges for computer time actually used while Tymshare (and others, such as QUIKTRAN) charge for the time a customer is connected to the computer. Thus it doesn't matter how long one of Babcock's cutomers is on the wire, deciding what to do next. The system keeps track of processing time, adds it up, and charges accordingly (although there is a monthly minimum he must use or be charged for anyway).

The next topic was overhead—how is it distributed and who pays for it? There was general agreement that it's just too complicated to account for the costs accurately; they have to be spread over all the users. But Babcock noted that his system is unavailable to users only 4% of the time and "we pay for overhead" (laughter). Solution to the overhead problem, which is a minor one, is to mask the time with processing, Wakeman said.

The panel also considered the stability of costs as they appear to the user. The problem here is that a time-sharing service is naturally more popular at some times of the day than at others. So a job that takes 10 minutes at 7:00 a.m. might take a half hour at 10:30—when lots more users are operating and there are more shares being taken out of the available time. In this case, Babcock is charging the same amount for both where the Tymshare customer is paying according to the length of time connected. Wakeman noted, however, that the customer is aware of this and can arrange his computing time to take advantage of the unpopular—and consequently cheaper—times of day.

Erikson noted that overload conditions are notorious, but Babcock's service offers a private line to the user, thus avoiding the risk of a busy signal. On priorities and their effect on charging, Erikson said the best answer is to avoid it. But different levels of service—from instant to one or two-day turnaround—could be set up. Babcock offers two levels now: time-sharing (25%) and background (75%). But the commutator is program controlled, so the user can be included more frequently in the cycle by paying more.

In answer to the question of how many terminals can be used, Wakeman said that the SDS hardware limitation is 128—but that the limit was really about 55-65, set by the combination of hardware and software. Babcock's limit is in the same range while SDC, now using only five terminals, will go to 40 March 1, later to 90.

One attendee saw in the session the following lesson: if he has a lot of computing to do, he would tend to go to Tymshare's system . . . or use

ABC's background mode; if he had beaucoup I/O he'd choose ABC's foreground.

Re the FCC problem: "Let's hope we can hold them off until the industry matures."

BELL TESTS LASER COMMUNICATIONS DEVICES

Bell Telephone Laboratories has already designed an advanced communications system—a millimeter wave system with a 70 gigacycle bandwidth —and is continuing experimentation with the ultimate today: laser communications. Even though no one can say when commercial demands will match the potential capacity of optical transmission, Bell Labs has come up with three type of modulators which make lasers practical. (With solid state lasers, a speed of 5 billion bps per beam can be reached. The maximum bandwidth of all optical frequencies, though never likely to be used, is 10^{14} cycles.)

The key to practicality in the three modulators is that each requires less than one watt to produce significant bandwidths. Most existing devices need at least 10 times as much power for comparable bandwidths and use modulating materials harder to fabricate and less reliable. The new devices use either a lithium tantalate crystal, gallium-doped YIG crystal, or a gallium phosphide diode to modulate pulsed or continuous light beams from a helium neon laser. The maximum tested transmission rate with gas laser is 896 million bps.

The most thoroughly tested device is the lithium tantalate electro-optic modulator, which has been coupled with an experimental 224-million bps PCM system Bell announced last year. The modulator receives electrical pulses in coded sequence from the PCM system, using them to modulate the equally fast uncoded train of laser pulses. Conversion to coded light pulses is achieved by the crystal, which acts as a high speed optical gate. Because light pulses are of shorter duration than the PCM pulse repetition period, several converted PCM signals can be multiplexed on a single laser beam. Using four modulators to time-multiplex signals from four PCM terminals, the system could reach its maximum potential of 896 million bps. (Solid-state lasers have an even narrower pulse width, accounting for the future potential speed of 5 billion bps.) The lithium tantalate modulator requires only 10 milliwatts of input power, 1/20th of that needed by the commonly used KDP (potassium dihydrogen phosphate) modulator.

The second device is the infrared modulator, which uses a thin rod of gallium-doped YIG crystal and needs 1/10 watt for a 200-megacycle bandwidth (about 100 million bps) or 1/3 watt for a 400-megacycle bandwidth (about 200 megabits).

The third, a gallium-phosphide modulator using a semiconductor p-n junction, needs 1.5 milliwatts of power per megacycle. Bell says modulation can be achieved in this diode at all frequencies up to 7000 megacycles. Other effective light modulating materials, such as barium titantate and lithium niobate, are also being tested.

This is only a start toward practicality. Since the light beam can't be transmitted through the atmosphere, Bell and others have been working on tubes through which the beam can be directed. The main problem is making the beam follow curves in the tube (since it can't be laid in a straight line over long distances) and this requires development of such devices as gas lenses.

U.K. MINISTRY AWARDS SOFTWARE CONTRACTS

The U.K. Ministry of Technology has started to award the first government-sponsored software development contracts to industry. To date, the Advanced Computer Techniques Project of the Ministry has been involved with hardware developments, but this autumn it came up with cash for ICT's basic machine language development and, in December, decided to share half the costs in a $100,000 job started by CEIR Ltd., now a wholly owned subsidiary of British Petroleum.

CEIR development, under senior consultant John Buxton, is labelled SPL—Software Programming Language—and is primarily intended for use in writing translators and operating systems. The first version is scheduled to be ready for a CDC 3200 in about six months. A saving of 50% in programming manpower effort is claimed for SPL compared with translators using basic computer codes.

The first commercial U.K. software house to go through a general-purpose symbolic language system for compiler work is Computer Analysts and Programmers, which has completed ALGOL and FORTRAN for six manufacturers. The latest ALGOL systems have just been completed for Elliott Automation and Ferranti microcircuit industrial and military systems. Computer Analysts is also completing two on-line control compilers and a teleprocessing operating system for a major commercial bank with the same technique.

UNIVERSITY OF WISCONSIN WILL GET NEXT B8500

The second edition of the Burroughs B8500 will go to the Univ. of Wisconsin. Cost of the mammoth system may reach $14 million when installation is completed in 1971. The system, with three cpu's, will be linked by hundreds of CRT and keyboard terminals to 13 Wisconsin campuses, servicing every department in the university. Time-sharing and batch scientific and business data processing will be performed simultaneously on the 8500, to be housed at the Numerical Analysis-Statistics complex in Madison.

Among major applications for the multiprocessing system are high speed computation of numerical data; on-line man-machine interaction in computation, data manipulation and storage and retrieval; on-line computer control or monitoring of such equipment as a telescope, bubble chamber, and medical and psychological-testing devices.

Installation will begin in 1968. When completed, the system will have three cpu's, 16 memory modules with 262K words of storage, three I/O modules able to handle one billion bps, more than 7 billion bits of disc file storage, and 34 other peripheral devices.

Burroughs is also building a graphic display for the university, in addition to keyboard CRT's. Some remote satellite computers may be used for pre-processing. Software will include the Executive Scheduling Program, COBOL, ALGOL, FORTRAN IV, INTERP (arithmetical conversational language), and TEXT EDITOR (a conversational file maintenance language). For the interim, a B5500 system has been installed to do limited time-sharing, with 60 terminals on-line, and will be used in writing and testing of programs to be run on the 8500. Equipment being replaced includes a CDC 3600 and 160A.

OETTINGER SPEAKS ON TOOLS FOR EDUCATORS

His new activities in the study of media that can be used to augment teaching, learning, and problem-solving were described recently by Professor Anthony Oettinger of Harvard, who is also president of the Assn. for Computing Machinery. Stressing the importance of educational innovation, Oettinger said he is concerned

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PDP-10 is big. Powerful. In the several million dollar class just a few years ago. But it's little, too. Little enough for a scientist to put the system on-line with his experiment as his personal research tool. Little enough for a physics department with time-sharing needs. And little in price, too. Nearest competitor wants 50% more. Write.

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"Artificial intelligence and I are at odds with each other, philosophically," he said, as he addressed the Special Interest Group on Artificial Intelligence of the L.A. chapter of the ACM. Known principally in the past for his work in artificial intelligence, he sees his new role as the intermediary or liaison between educators and the suppliers of teaching aids. He calls his new project Technological Aids to Creative Thought (TACT).

In this role, he said, he would look at the whole area of technology to see what aids are needed and what their design features should be. One problem with on-line CRT consoles in the classroom, for example, is the time spent by the instructor punching the keyboard—while students sit idly awaiting the outcome, or snickering at errors, or breaking up over a malfunctioning computer or communications line. One solution to this, he found, is to tape-record the digital signals from the computer and, in the classroom, play this back to the terminal. There is, he noted, some loss of spontaneity in this simulated on-line mode.

Oettinger also mentioned a sound/slide system to teach students in the use of an on-line console, but found that instructional steps were needed and the reliability of these electromechanical devices was far from ideal. He finds himself, he said, engaged more in programming than in teaching.

Addressing himself to some instructors' obsessive use of on-line devices, Oettinger said that the blackboard sketch still has its place in the classroom. He cited as "technological overkill" the insistence on computer-generated drawings with correct perspectives, corners filled in and lines all meeting. Thus Oettinger seeks to meet the practical needs of educators, rather than emphasize blue-sky technological aids.

IITRI OFFERS SERVICE FOR DESIGN BY COMPUTER

A new cooperative undertaking coordinated by the Illinois Institute of Technology Research Institute (IITRI) will offer computer-aided design service. A number of television and electronics companies, as well as members of the printed circuit board industry, will be participating in the project, according to J. Keith Lehto of IITRI's Computer Sciences Division.

"Participation in this program," says Lehto, "will provide a company with capabilities for computer-aided circuit analysis. It will also provide printed circuit board layout and reliability analysis. And, perhaps most important, it will provide circuit synthesis."

The program, expected to be underway by early March, will be directed by the participating companies, each of which will have a representative on a governing board. IIT Research Institute will provide the resources—the systems men, programmers, and computer facilities. Test problems will be submitted by the participating firms and selected programs will be tailored to their requirements.

An important aspect of the undertaking will be providing Teletype communication between participating companies and IITRI. These Teletype units will be able to transmit data to IITRI's IBM 7094. Information will then be processed and results returned to client companies via Teletype.

The group project is designed especially to aid firms whose staff size or budget does not permit the research and development necessary to adopt computer-aided design.

"Even when companies have large-scale computers," Lehto pointed out, "the engineer sometimes finds that he can use them only around midnight, since they are largely devoted to business uses."

Lehto said the project will also help firms to develop computer-aided design programs. Such circuit analysis programs as ECAP, NET-I and PREDICT are available from various sources, he said.

"However," he added, "additional effort is invariably required to adapt these programs to local computer configurations, to achieve an understanding of the analyses performed by them, and to document their operation in a form usable by engineers who are not intimately familiar with the basic program specifications."

CREDIT SERVICE GIVES UP IN LOS ANGELES AREA

To make the personal check as good as cash—if not better—many banks offer their depositors a courtesy card, indicating to a merchant that the cardholder's check is guaranteed by the issuing bank. In some localities, a big spender can sign up with a service such as Los Angeles's Tele-Credit, which enables subscribing merchants to interrogate a computerized file for unusual check-cashing activities of a customer.

Still a third approach was taken earlier this year by the American Certified Check Corp., using an IBM 1460 with several disc packs. Its Checkmate system resembled the bankers' approach; more than 150,000 customers were on the master file, many more received a plastic ID card that was honored by some 1500 retail merchants in southern California. Early last month, the ACC Corp. suspended operations for lack of funds, another victim of the tight money situation. It is believed, however, that ACC may try again, this time in the San Francisco area.

ACC's troubles appear to be strictly financial, not computer-centered. It needed more funds to get more cardholders who could cash their checks at more retail outlets. And it reportedly needed more bad checks—like 15,000 a day of the bouncing, Checkmate-sponsored variety. It didn't quite meet this goal.

UC BERKELEY GETS DUAL CDC 6400 SYSTEM

Allowing time-sharing for up to 200 simultaneous users, the University of California at Berkeley is installing a Control Data dual-6400 computer system. The first computer in the $2.4 million system, with a 32K storage capacity, was installed in December and is now operative. Flanked by a 500K extended core memory, the system will be completed with the installation of the second cpu in late '67.

Time-sharing Teletype terminals, linked to the system by a university-developed multiplexor, will be installed in remote locations, such as forestry stations, as well as in administrative offices and laboratories. Using UC-developed software, the new system has a turnaround time of 30 minutes, as compared to 2-15 hours on the IBM 7094/7040 system, now being phased out.

Peripheral equipment with the 6400's includes five mag tape units, two high-speed printers, a card reader-punch, and a temporary disc unit. The final system will have the not-yet-available mod 6638 disc unit with a capacity of 167 million 6-bit characters.

HOBBS NAMED GENERAL CHAIRMAN OF 1967 FJCC

L. C. Hobbs, president of Hobbs Associates, Inc., has been appointed general chairman of the 1967 Fall Joint Computer Conference, to be held at Anaheim, Calif., Nov. 14-16.

Mr. Hobbs is vice chairman of the

news briefs

Computer Group of the IEEE, a former member of the board of directors of AFIPS, and was vice chairman of the 1965 FJCC.

GE MARKETING VP MOVES IN TO HEAD DP DIVISION

J. Stanford Smith, who has been GE's vice president for marketing and public relations, will be general manager of the Information Systems Division. This includes all the domestic computer operations, except process-control projects, and the European affiliates as well. The process-control machines are still in the Industrial Process Control Division, set up last September and headed by Dr. Louis T. Rader. Mr. Smith's headquarters will be in New York City.

COMPUTER SCIENCES EXPANDS REMOTRAN IN NORTHWEST

Computer Sciences Corp.'s Remotran service, with headquarters in Richland, Wash., is undergoing a major expansion, with installation of a Univac 1108 and 52 of the new Univac DCT-2000 communication terminals.

Remotran supplies time-shared computing facilities to customers in Washington, Oregon, Idaho, Montana, Utah, and Canada. The additional equipment will allow service to over 100 customers in the area.

The new, 131K 1108, replacing the present 1107, is backed by five high speed drums with a capacity of 8 million characters and two Fastrand II units for another 264 megacharacters.

● The Univac Defense Systems division is now in production with the thin-film memory to be used in the Army's Nike-X system. The 270K-bit memory has a 200-nanosecond cycle time and fits in an 18 x 30 x 22 inch cabinet. Development of the unit, being produced in the St. Paul, Minn., plants, began three years ago.

● Clark O'Neill, Inc., nation's largest medical mailing and marketing service (for 60 pharmaceutical companies), has ordered RCA 70/45 and 35 computers to massage its massive files on doctors and medical facilities. The firm has developed its own software packages for sales territory analyses, physician profiling, automated salesman call reporting, sample accountability, and control—all of which can help the drug company identify the optimal market for its products. Data on 380,000 physicians, osteopaths and dentists, and on every major U.S. medical facility, is supplied by the American Hospital, Medical, Dental and Osteopathic Assns. It is stored on mag tape, although the firm will go to discs later. The RCA systems (the 35 is for backup) replace "third-generation" systems, the IBM 360/40 and 30.

● The University of Missouri at Rolla will offer an eight-week summer institute, "Numerical and Statistical Methods of Digital Computing and Analog Computation," June 12 to Aug. 4 for college teachers of mathematics, engineering, and science. Thirty-six participants will be invited to the institute, sponsored by the National Science Foundation. Application forms are available from Ralph E. Lee, Director of Computer Science Center, Univ. of Missouri at Rolla, Missouri. Application deadline is Feb. 15.

● IBM has announced the opening of three more DATATEXT centers, in New York City, Los Angeles, and Cleveland. Each will offer the service for up to 18 customers, who can type, edit, and update text material from a keyboard terminal hooked by telephone lines to a central computer. The first such center was started in San Francisco last September and the next ones planned will be in Chicago and Philadelphia. Basic cost is $310 a month, plus $85 a month for the terminal and $150 to get it installed.

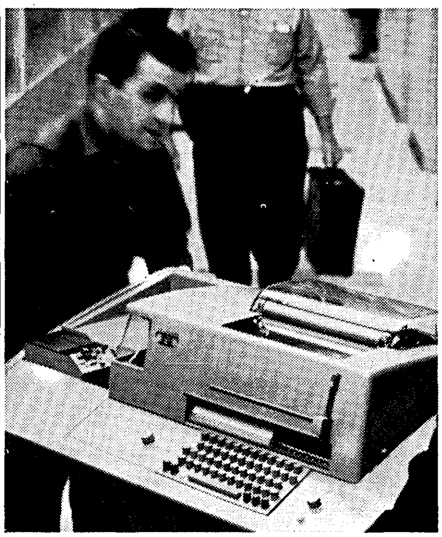
● Another computer-based employment exchange has appeared, this one just for teachers and counselors looking for jobs in elementary or secondary schools. The system is called NEA *SEARCH (probably the first acronym with an embedded asterisk) and is sponsored by the National Education Association. Standardized forms are available to superintendents seeking teachers and to applicants and each pays a small fee for the service. The superintendent indicates on his form a description of the vacancy, type and length of experience and education wanted, etc., while the applicant fills in his geographic preferences, minimum acceptable salary, and other choices. The employer gets from the computer center a list of applicants, ranked according to how closely their characteristics match the requirements. Superintendents then deal with the candidates directly.

● The state of Iowa's System/360 Model 40, used for general state data processing, has now been applied to retrieval of legal information for legislators. The Iowa Legislative Research Committee sponsored the program, devised by Prof. John P. Horty at the Univ. of Pittsburgh. Nearly 3000 pages of state laws, plus the 30 pages of the Iowa Constitution, have been stored and the legislators have been supplied with an index of words and phrases. They can get overnight delivery of printout listing all sections of the state's legal statutes dealing with any of these subjects.

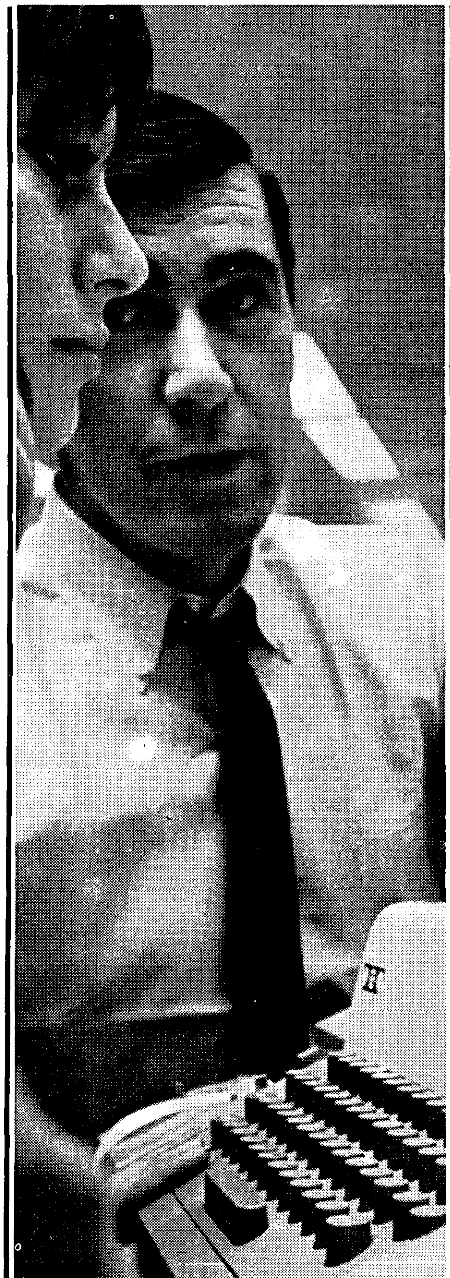
● The University of California at Los Angeles and Informatics are co-sponsoring a symposium, "Computers and Communications—Toward a Computer Utility," at UCLA, March 20-22. About 20 speakers have been signed up from government, academic, and industrial organizations and they will cover such aspects of the computer utility as design, cost, user experience, social implications, relations with government, and sample applications. Registration fee is $60.

● Chrysler Corp. claims to have the largest teleprocessing network for gathering and disseminating manufacturing data. Seven car assembly plants, 77 independent suppliers, and 26 Chrysler parts manufacturing plants are linked to a 360/30 at Car Assembly Group headquarters in Hamtramck, Mich. Phase I of the DIAS (Dynamic Inventory Analysis System) network, which began with 1967 car models, involves storage of supplier shipping data on 13,500 parts. Phases II and III, scheduled for operation later this year, will incorporate assembly plant material data such as production usage, scrap, defective material, inventory adjustments, and engineering changes. Ultimately the system will be tied into a massive management information system which will include such operations as quality control, warranty data, and engineering changes—some already computerized.

● According to Donald G. Audette of CEIR writing in the Communications of the ACM, China will probably develop a "fairly significant computer capability over the next decade." The author thinks that the computers will be modeled largely after Russian machines. Information for the article was obtained from Communist China publications. Audette also predicts that the Chinese will try to get late-model computers from such countries as France and West Germany.



HOW RELIABLE CAN DATA COMMUNICATIONS BE!



Reliability is becoming an increasingly important factor in the growing sophistication of data communications and processing systems. In a real-time system, data has to be available quickly if accurate, timely decisions are to be made. Thus, any equipment breakdown can cause serious delays in the movement of raw or processed data. This is why Teletype sets — the simplest and most versatile terminal equipment — are built to last with little maintenance required.

In fact, you can find Teletype machines still operating daily that were built over twenty-five years ago. Today, this same reliability is still part of Teletype data communications equipment. Modern Teletype sets will stand up continually under all kinds of rugged conditions—regard-less of whether they are used in a steamy jungle, out in space, on ships at sea, in offices or data processing centers.

The following examples point out how Teletype equipment reliability improves the efficient operation of any data system.

Speeds flow of data "Use of (punched) paper tape as our exchange medium has permitted ever-increasing volumes of data to flow between company points at no appreciable increase in cost." That's the way the communications service manager of a midwest automotive parts manufacturer described the results of the company's data processing system.

As finished goods are produced at any of the firm's several plants, shipped to one of the distribution centers, or transferred between locations, data on these transactions is recorded onto a continuous roll of punched paper tape. This is done by the local operator of a Teletype Model 33 ASR (automatic send-receive) set. Periodically the prepared tape is loaded into a Telespeed 1050 high-speed tape-to-tape sending set, which operates at 105 characters per second (1050 words per minute).

This is where reliability becomes an important factor in this data system. Six times during the day and night the company's data processing center automatically polls each of the Telespeed sets at the eight distant plants and distribution outlets, requesting transmission of the prepared tape. As the tape is received at the data processing center, it is fed directly into the computer. In only a few hours after a transaction is made, management has an up-to-date report to assure inventory control and accurate production scheduling.

Since the operation is automatic, no attendant is needed at night. If there were a breakdown, no one would be present to correct it and see that the data is transmitted. That's why Teletype equipment reliability is so vital to this system's operation.

Assures reliable turbine operation An electric generating plant uses computers and Teletype page printers to provide quick and accurate performance information to assure reliable operation and prevent turbine damage. The system's operator control center has three Teletype printers. One is used to provide periodic logging of variable station operations.

Another serves as an alarm, displaying "off-normal" and "return to normal" conditions. The third Teletype machine is used as a demand point log for digital trending, group review of preselected variables, and turbine startup and information log. Thus, without the reliable performance of Teletype equipment, the accurate operation of this electric generating plant would be seriously jeopardized.

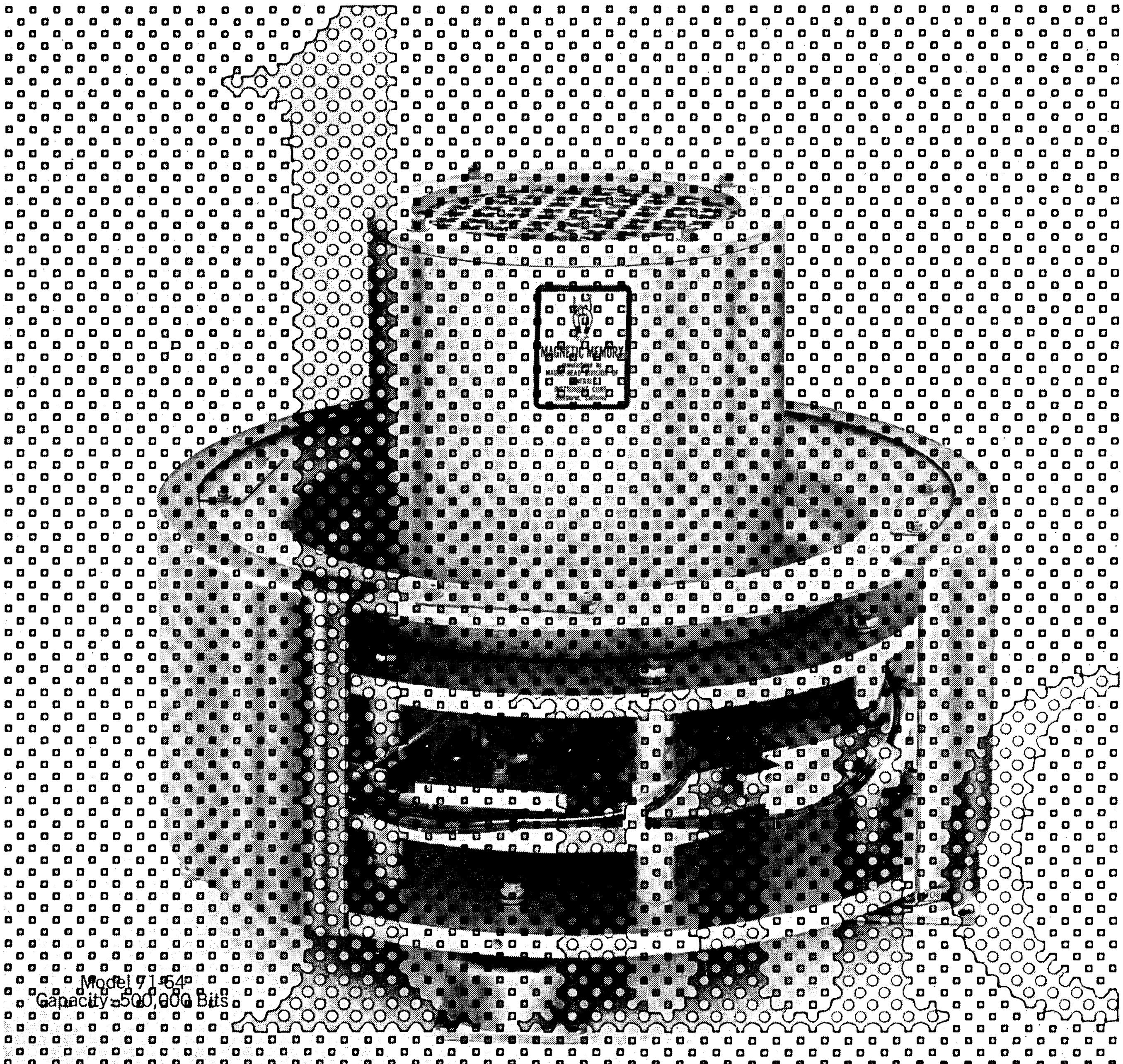
Most widely used terminal equipment Their reliability as well as versatility and other capabilities point out why Teletype machines are the most widely used for transmitting data from where it originates to where it must go to be of value.

And, that is why this Teletype equipment is made for the Bell System and others who require reliable communications at the lowest possible cost.

Additional uses of Teletype equipment in aiding data communications and processing systems within a number of businesses and industries are explained in our brochure, "WHAT DATA COMMUNICATIONS CAN DO FOR YOU." For your copy contact: Teletype Corporation, Dept. 81B, 5555 Touhy Avenue, Skokie, Illinois 60076.

TELETYPE ®

CIRCLE 47 ON READER CARD



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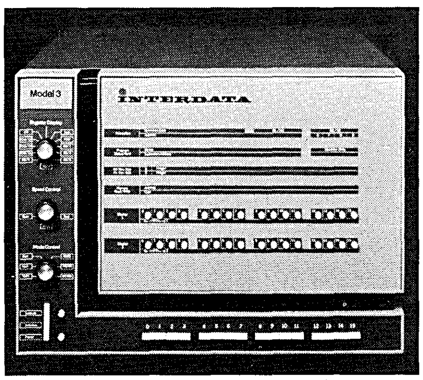
CIRCLE 48 ON READER CARD

new products

low-cost digital computer

Model 3, which starts at $6,000, is designed for use in process control, real-time counting, sequence control, data acquisition, and education. The i.c. system has a 2-usec cycle time, core storage capacity of 1024 to 65K (8-bit) bytes, sixteen 16-bit registers, a 16- and 32-bit instruction word format, and a hardware multiply and



divide capability. The I/O channel can handle 256 devices on a priority basis in a multiplexed transfer mode. Mod 33 Teletypes, card readers, line printers, mag tapes, disc or drum can be incorporated. A different display panel is provided for educational usage, in math, physics, logic, programming. Software includes assembler, subroutines, utility routines, and ALGOL subsets. INTERDATA, Farmingdale, N.J. For information:

CIRCLE 100 ON READER CARD

printer/plotter software

A complete set of SC 4020 Recorder Utility routines are now available to SDS 900 Series users. These routines allow the user to convert results of calculations of FORTRAN programs to codes suitable for processing by an SC-4020, and to record these codes on mag tape. The tape can then be processed through any SC-4020, an output device that accepts mag tape input and converts it to hardcopy graphical form on microfilm or paper. Versions of the system will also be available for other computers having a FORTRAN compiler and 24-48-bit word size. UNITED COMPUTING CORP., Redondo Beach, Calif. For information:

CIRCLE 101 ON READER CARD

production monitor

The 4100 wired-program computer is designed to monitor manufacturing plant operations. It can handle data from 600 work stations, i.e., machines, assembly and inspection areas (scanning all 600 in 1/10 sec.). The 4100 stores information on a Cognitronics-supplied magnetic drum (660K-bit storage, 20 msec access time), displays it on electromechanical numeric counters, and formats it for on-line transmission to a cpu, printer, mag tape unit, or other output devices. Transfer rate is 2800 cps. Operators can, through the master console, interrogate and control data transfer and display. TELECONTROL CORP., Old Greenwich, Conn. For information:

CIRCLE 102 ON READER CARD

digital-audio system

The Speechmaker (digital-to-audio unit) is being offered with a paper tape reader, audio listening device and switch control, forming a system called the Voice Wiring Instructor. Although the Speechmaker can handle buffer memory, computer, punched card or mag tape input in many applications, this configuration is specifically aimed at instruction of the technician on wiring steps during assembly of electronic systems and

PRODUCT OF THE MONTH

Standard Computer Corp. unveiled the latest entry in the hectic computer sweepstakes last month. It's the IC 6000 series, featuring "a computer within a computer" which can interpret "a variety of machine languages," permitting direct execution of programs written for other machines without sifting, lifting or patching. The process is called Miniflow, described by vp and manager of systems programming Laszlo Rackoczi as "a high speed interpretive system (hardware plus software) which executes instructions of other computers using a basic set of computational and logical elements contained in the IC 6000."

At a Los Angeles press conference, Standard demonstrated the first of the line, the 6000-19, as it executed a series of IBM 7094 programs (written in FORTRAN and COBOL) under control of IBSYS version 13. Standard president Roger Hughes claims that the 19 is 25-33% as fast as the 7094, but the price makes that an interesting speed: a 32K core system including eight 30KC tapes, console/typewriter and 100 cpm program card reader costs $9900/month, roughly one-sixth of a similarly configured 7094. And the delivery schedule—four to six months—indicates that many users having trouble taming their 7000 series replacements might see in the 6000 series a chance to ease and prolong the conversion process.

The 6000 features a 36-bit (plus parity) word, two 90KC-transfer rate I/O channels (fully overlapped with each other and with the cpu), and up to 16 seven-channel IBM-compatible tape drives, which can be 30, 60 or 90KC and 556 or 800 bpi. An 800 cpm reader is optional. At present, a user can obtain a 6000-19 which will handle either 7090/94 or 7040/44 programs.

The 6000-19 main memory has a 4-usec cycle time; control memory, which is completely overlapped, has a 2-usec cycle time. The control memory can be loaded with an interpretive system which allows interpretation of another machine than the one originally ordered, but it is protected during operation. Faster memories (2 usec and 1 usec, respectively) will be available on later models.

Using 6000 Fairchild CTL integrated circuits, the eight-tape 6000-19 requires 3000 sq. ft. of floor space, produces 30K BTU, and requires three-phase, 40-amp power.

Formed two years ago, Standard Computer Corp. has private equity capital of over $725K, plus income from its first two customers: Commercial Computers, Inc., L.A., and Data Station of New York, Inc. Co-inventor David E. Keefer is vp and manager of engineering. STANDARD COMPUTER CORP., Santa Ana, Calif. For information:

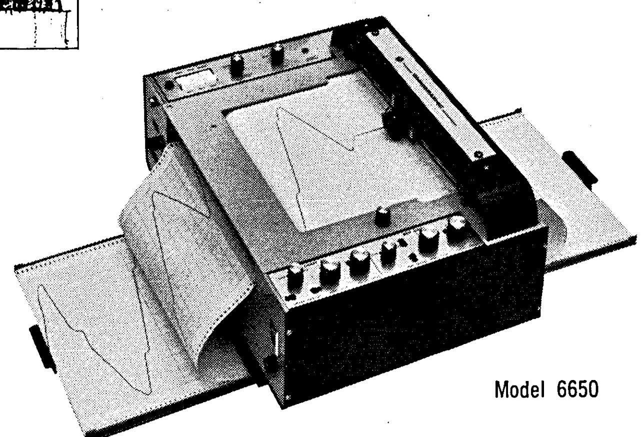
CIRCLE 103 ON READER CARD

"We're movin' two new plotters into computer country"

1. New incremental Omnigraphic™ Plotter

is a bi-directional recorder that operates directly from digital computers, incremental encoders, pulsers, pulse generators or any incremental signal.

- Z-Fold Paper (tears out to standard 8½" x 11")
- 18,000 Increments/min. Speed
- 0.01" or 0.005" Resolution
- Infinite Scale Expansion (Option)
- $2850

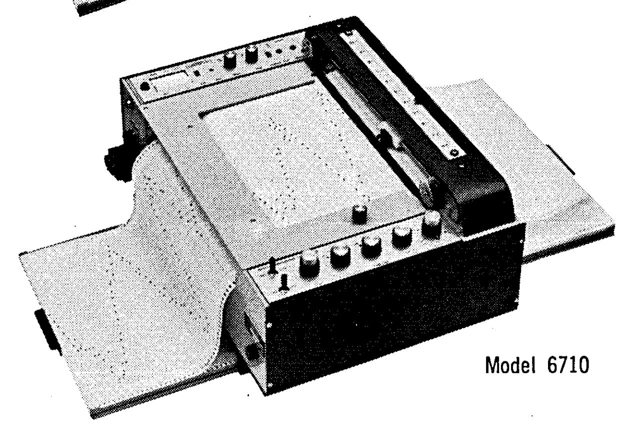


Model 6650

2. New direct digital incremental Omnigraphic™ Plotter

is a high speed point plotter which operates directly from parallel binary or digital BCD data.

- Z-Fold Paper (tears out to standard 8½" x 11")
- 40 inches/sec. Slewing Speed
- Capable of Both Digital and Discrete Analog Operation
- 1½" μsec. Access—Single Point Memory
- $3725



Model 6710

houston **OMNIGRAPHIC** corporation

a subsidiary of houston instrument corporation
4950 Terminal Ave. / Bellaire, Texas 77401
(713) 667 7403 / cable HOINCO / TWX (713) 571 2063

CIRCLE 49 ON READER CARD

components, computers, communications equipment, etc.

The digital signal from tape is decoded by the Speechmaker and words, letters or numbers are verbalized from the pre-recorded audio memory drum (capacity 10-189 words) and fed to the headset. A foot-pedal control unit permits the technician to advance to the next instruction or re-call a previous step. The system can be multiplexed so that several technicians can use it simultaneously, each at his own speed. COGNITRONICS CORP., Briarcliff, N.Y. For information:

CIRCLE 104 ON READER CARD

electronic eye

Optical scanning system can automatically position a precision servo system to accuracies of ± 1 micron. Error signals for x, y and θ positions are provided at a slope of 2 millivolts per micron of positional error. Correlation occurs in 10 msec. One application permits automatic lead bonding of semiconductor devices. ITEK CORP., Palo Alto, Calif. For information:

CIRCLE 105 ON READER CARD

payroll service

Designed for third-generation computers, the Generalized Payroll Service is available nationally to bank service centers, has been in operation in New York for over six months. Written in COBOL, the service will accept and calculate up to 10 types of earnings and 15 types of deductions per employee, and will figure these amounts using combinations of rates, limits, tax liability, input accumulations, and other factors. Reports include all those required for payroll processing and posting, tax calculation and reporting, and labor cost analysis. Available immediately, service is operational 6-8 weeks after initial order. PHILIP HANKINS & CO., Arlington, Mass. For information:

CIRCLE 106 ON READER CARD

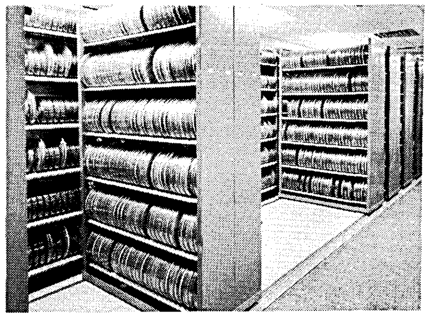
data set interface

The DPI-1 is an interface for data sets (Bell Systems models 100, 202C, and 202D or equivalents), converting parallel computer data to serial for transmission over voice-grade (1200 bps) or private lines (1800 bps). The unit is available as a single-channel system to operate a single data set (as 202D) line, or can be integrated into a multi-channel system for a communications terminal. INFOTEC INC., Westbury, N.Y. For information:

CIRCLE 107 ON READER CARD

mobile tape units

Expansion of tape storage area can be accomplished by converting stationary shelves to mobile units which roll on flush floor tracks. Rolling



stacks may be arranged without aisles, allowing capacity increases of up to 100%. MOBILE STORAGE DIV., DOLIN METAL PRODUCTS, Brooklyn, N.Y. For information:

CIRCLE 108 ON READER CARD

microform reader

The PCMI microform reader takes advantage of a recording process first reported in 1962—photochromic micro-images—which permits storage, feasibly, of up to 3,200 images on a 4- by 6-inch document. Two reader models offer magnification of 115 and 150 times. Using a micro-recorded index for location data, the operator can, with manual knobs, zero the reader's lens in on the desired page "in seconds."

The reader averages $10 a month, but the high cost of producing the master, to be done by NCR processing centers from user-supplied microfilm or original document, makes the system, at present, feasible for volume data applications, such as catalogues, service manuals, and reference libraries, where quantities of transparencies must be produced and updated. The cost for large numbers of transparencies from a master can be as low as $1 each. At the center, each image on the photochromic master can be inspected, erased, and updated while it is in the camera-recorder, preventing errors requiring reproduction of an entire plate. Forthcoming readers will also have a hard-copy capability. NATIONAL CASH REGISTER CO., Dayton, Ohio. For information:

CIRCLE 109 ON READER CARD

tape transport

Model MT-36 tape transport, with a tape speed of 50 ips at densities up to 800 bpi, is designed for small- and medium-scale computers, and mass storage and sequential access applications "for which high-priced, high-performance transports cannot

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It incorporates many of their suggestions for making PL/1 a more efficient language for both scientific and commercial applications.

From helping improve conversion aids and education programs—to writing and documenting new application programs and making them available through a customer-contributed program library—organizations like SHARE, GUIDE and COMMON are vital forces in the computer arts. They are pioneers. And as such, they can be pretty demanding—on themselves and on IBM.

That's fine with us—because as we fulfill their needs, everyone benefits.

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CIRCLE 50 ON READER CARD

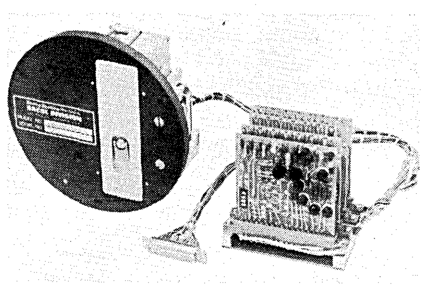
new products

be justified." System consists of transport assembly, manual control unit, and a read-write electronic package. It is compatible with IBM 729 and 2400 series systems; formats utilizing ½- or 1-inch tape are also available, compatible with TIAC (Texas Instruments 21-channel). POTTER INSTRUMENTS CO., INC., Plainfield, N.Y. For information:

CIRCLE 110 ON READER CARD

data recorder

For users of unattended digital recorders with size and weight limitations, the Model SDR scientific data recorder weighs only 4 lbs., including record electronics and reusable tape cartridge, and is capable of fitting an



envelope size of 5.8" diameter x 6" long. Unit can record up to 50K characters at 12 cps on ½" 7-track mag tape; is available with plug-in printed circuit cards for mounting flexibility. DACOL DIV., HERSEY-SPARLING METER CO., Los Angeles, Calif. For information:

CIRCLE 111 ON READER CARD

media conversion

MARK II mag and paper tape station has paper-to-mag tape or mag-to-paper tape transfer; transmits 5, 6, 7, or 8 levels at speeds up to 1000 cps, and receives 5, 6, 7, or 8 level codes. Unit punches up to 150 cps, reads or writes on 7- or 9-channel mag tape at up to 75 inches/sec. Station is included in family of media conversion equipment featuring many combinations of peripheral and communications equipment with appropriate interfaces. Media Conversion/Data Terminal family complies with EIA specs RS 232B, Western Electric 801B, and Bell and Western Union modems. COMPAT CORP., Hicksville, N.Y. For information:

CIRCLE 112 ON READER CARD

recorder buffer unit

Buffer unit increases incremental recording rates of PI-1200 recorder to 1200 asynchonous cps at 800 bpi density. At 556 bpi, unit will write 800 cps; 600 cps is possible at 200 bpi. The PI-1200 recorder can operate at 2 or 4 ips, stopping the tape on a character. Additional features are a 50 msec gapping time, vertical and longitudinal internal parity, high-acceleration DC capstan servo, and integrated solid-state signal electronics throughout. PRECISION INSTRUMENT CO., Palo Alto, Calif. For information:

CIRCLE 113 ON READER CARD

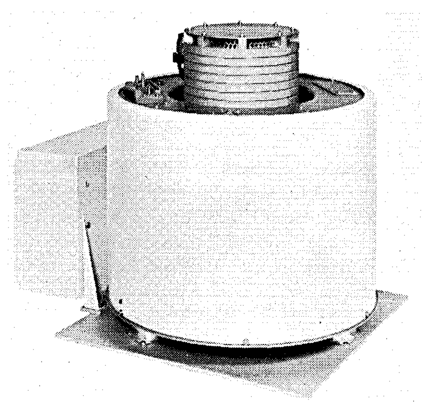
digital interface

Model 6810 digital interface, utilized with Mod 6550 Omnigraphic Plotter, provides a plotting system capable of operations from either analog or digital data. Analog sensitivity is variable from 1 mv to 10 volts/inch with a constant 100K ohm input impedance. Digital input is 10-bit binary or 3-digit BCD. System accuracy is 0.2% at slewing speeds up to 40 inch/sec. HOUSTON OMNIGRAPHIC CORP., Bellaire, Texas. For information:

CIRCLE 114 ON READER CARD

disc memory

Model MDM-12 random access head-per-track disc memory has capacities up to 2,112,000 bytes; transfer rate is 125,000 bytes per second. The unit



has eight-track flying heads with up to 64 data tracks per disc surface; average access time is 17 msec. Availability is three months. COMPUTER ACCESSORIES CORP., Goleta, Calif. For information:

CIRCLE 115 ON READER CARD

buffer memory

Television display buffer memories provide storage up to 67,000 bits at 2 MHz bit rate. Recirculation rate is 33 msec at the standard 30-per-second refresh rate. Package consists of four magnetostrictive delay lines with read-write and re-timing electronics. Separate interface board matches buffer electronics with external system logic. DIGITAL DEVICES, INC., Long Island, N.Y. For information:

CIRCLE 116 ON READER CARD

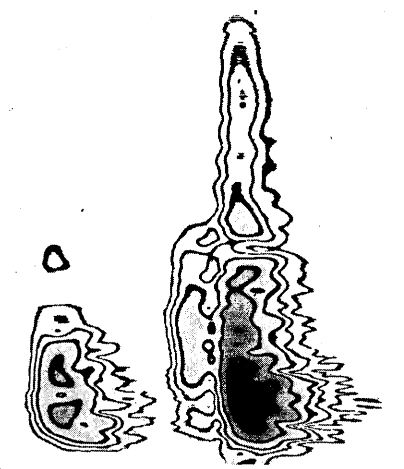
analog memory

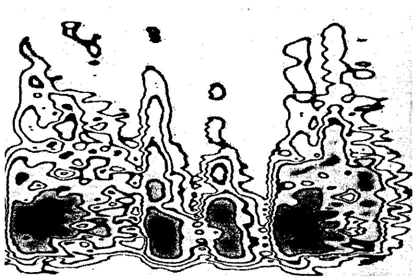
Model 420C ANALOK memory has small signal bandwidth from DC to 150HKz; hold accuracy is better than ±0.05% of full scale for infinite time period. The aperture error is less than 100 nsec, with acquisition time of 6 usec. In hold mode, hybrid circuitry consists of memory capacitator, recharge circuit, digital clock and output buffer amplifier. Holds up to 16 channels. CONTROL DATA CORP., La Jolla, Calif. For information:

CIRCLE 117 ON READER CARD

contour plotter

Giving permanent 3-D plots of time, frequency and amplitude relationship of signals, the ST-701 Spectral Contour Plotter plots amplitude in closed contour lines as well as varying shades of grey. Either logarithms or linear





spacing of contour lines is possible. Units are now being used for medical applications to diagnose heart ailments (upper photo, normal heart beat; lower photo, abnormal heart beat), and are designed for use in communications, signals propagation, geophysics and noise and vibration. NORTRONICS DIV., NORTHROP CORP., Needham Heights, Mass. For information:

CIRCLE 118 ON READER CARD

magnetic tape

Micro Media 25 is mag tape with an "ultra-thin gauge" which "will reduce the amount of storage space required for data by a factor of four" as compared to tape now in the market. An 8½-inch reel will hold 4800 feet of tape. Written at 1600 bpi, more than 829 megabits can be sorted on it. The tape has a one-quarter-mil tensilized polyester base with a thin magnetic coating and is said to be less susceptible to signal drop-outs and other errors. MAGNETIC MEDIA CORP., Mamaroneck, N.Y. For information:

CIRCLE 119 ON READER CARD

printing balancing tabulator

Model 907 tabulator gives numeric listing or totals-only tabulations in punched cards at speeds of 200 cards/minute. A printout is provided for comparing individual amounts punched in cards with original figures in source documents. Eight print positions are available for indicative data, four print blanks give "totals" capacity of eleven places. Available immediately; sold OEM in the U.S. INTERNATIONAL COMPUTERS AND TABULATORS, LTD., London, England. For information:

CIRCLE 120 ON READER CARD

strain gage calculator

The RC-301 is a portable analog computer that provides direct, in-line digital readout of complicated strain gage rosette calculations. It reportedly takes a minute or two to feed in a stress problem and get the answer. Seven basic solutions for 2- and 3-element rosette strain gage problems

are provided by the 24-pound unit. Although designed primarily for use with Budd MetalFilm 3-element delta (60°) or rectangular (45°) strain gage rosettes, the calculator can be used with any 2- and 3-element bonded resistance gages. THE BUDD CO., INSTRUMENTS DIV., Phoenixville, Pa. For information:

CIRCLE 121 ON READER CARD

scientific software

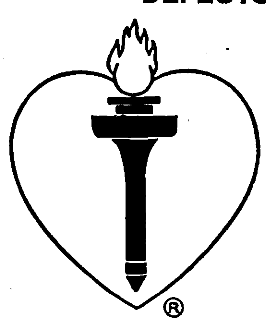
An extension to SSP/360 Version 1, currently available, is Version 2, which adds some 70 subroutines to the original 122. Included is the Cooley-Tukey algorithm for Fourier series analysis, used to describe wave patterns as a combination of simple sine and cosine waves. The Version 2 software is scheduled to be available in the first quarter of '67. IBM DP DIV., White Plains, N.Y. For information:

CIRCLE 122 ON READER CARD

data set

The Modem 4400 is a data transmission device that reportedly reduces cost by eliminating the need for special line conditioning or equalizing needed for high-speed transmission over voice-grade lines. Instead of using the full bandwidth, it uses only an 800-cycle bandwidth to transmit at 2400 bps; simultaneously, the same 3 KC line can carry up to six channels of teletype circuits. MILGO ELECTRONIC CORP., Miami, Fla. For information:

CIRCLE 123 ON READER CARD



IEEE PATTERN RECOGNITION WORKSHOP

From October 24 through 26, 1966, a group of 52 eminent workers in the field of pattern recognition attended the IEEE Pattern Recognition Workshop held in Puerto Rico. Technical difficulties at the originally scheduled site of the workshop in Fajardo forced a move on the first day to another site in Dorado. Despite this inconvenience, a diligent and conscientious group met into the nights of Oct. 24 and 25 and concluded the workshop on schedule on the 26th.

The reason given for holding this workshop was "to provide a stimulating atmosphere for informal discussions of key problems and recent accomplishments at the forefront of the state-of-the-art . . . to give a meaningful perspective to the subject . . . from operational systems to basic mathematical theories." Although every aspect of this indistinctly bounded field was not covered—for example, speech and image recognition were rarely mentioned—and more time was allotted to formal lectures than to informal discussion, these stated objectives were largely met. Whether or not much progress was reported at this workshop is a judgment difficult to make. Progress since when? For one thing, this workshop was the fourth three-day meeting held on essentially the same topic in five months! Nevertheless, both accomplishments and problems were reported and discussed.

Before reporting on the substantive content of the workshop, it may be well to indicate briefly what "pattern-recognizers" work on and what their problems are.

Applications. To have a machine read a FORTRAN code written in your handwriting or mine; or listen to a human voice and identify the talker; or examine a fingerprint and identify its owner; or read a composition written in any font in one natural language and translate it to another; or read an electrocardiogram and from it determine abnormality; or read a weather map and from it predict weather; or read a chessboard and from it determine the next move; or scan a photograph or a natural view and pick out an airfield or tank—these are all examples of applications in the field of pattern recognition by machine. (It may here be noted that patterns are not at all what we want recognized—objects or events are. Probably this field is misnamed "pattern-recognition" because ordinarily sensors and transducers somehow represent the object or event to be recognized by a set of characteristics, called the components of a pattern vector, and then the machine recognizes the object or event by classifying this pattern vector.)

Machine-design problems. Except for a few character readers, there are few "pattern-recognition" machines on the market. In most applications, two common unsolved problems are: (1) to find a comprehensive set of distinguishing characteristics constituting the pattern vector by virtue of which a suitably designed classifier can, with acceptably small error, recognize the object or event; (2) to design the classifier, given only a set of sample pattern vectors and their classification. Few analytic procedures are known for solving either of these design problems. Commercial machine manufacturers of optical and magnetic-character readers use empirical design procedures.

A workshop differs, in principle, from technical conferences. Workshop participants presumably let their hair down and feel free to say what's on their minds, are unafraid to present and struggle with "half-baked" ideas, and to bare their souls, so to speak. Obviously, the anonymity of such goings on must be respected, or future workshops would be imperiled. Thus, people will not be named in the following report—not because all participants would insist on anonymity, but in order to honor the spirit of the enterprise. This policy also provides this reporter with an excuse for not reporting on "everything" that went on, but only on those topics of probable interest to DATAMATION readers.

technical

The opening talk on the present state of the art of optical character recognition machines was excellent. It was so all-inclusive that several speakers indicated later that what was said in it was what they intended to say. Covered were computers, reading, sensing, and scanning, recognition logic, fonts, applications, and new developments. The speaker, a commercial, hardware-oriented man whose company makes optical character readers, is impatient with theorists. His outlook is practical—and refreshing, especially since most attendees and workers in the field are in R & D. Among the surprising things he said were: it is no more difficult or expensive to read optical characters than to read marks; he could design conventional reading equipment having an error rate in reading fixed font, fixed position labels of 1 in 10^{50}; the cost breakdown of a typical reader is as follows: one-fourth for the reading equipment, three-fourths for paper movers, format control, buffers and housekeeping ("when the bankers chose a single line reader, they saved a lot of money"); and no one makes a good letter feeder. He believes that the main problem to be solved in optical character recognition is not the extraction of features by machine, but mask-making or feature extraction and weight assignment by man.

Interesting comments about zip codes were made in the course of the discussion on character readers. Among the objections to the zip code were: (1) there is no redundant digit for checking; (2) no system involving 200 million people can be made to work right in the first place, nor can one modify it under such circumstances; and (3) zip codes cannot be used for local sorting.

A speaker also complained that the typical customer of optical character readers, like the early computer user, does not know how to specify accuracy. He thinks of a reader merely as a fast keypunch and hence has not prepared himself either to specify or to use this new device.

The IBM optical reader at the Social Security Administration, it was reported, replaced 150 keypunch operators. It has an error rate of better than one error in 1,728 characters, which is the average human keypunch error rate. He thus found that the square root of the product of the reject rate and the substitution rate was an especially useful figure of merit for his machine.

A lucid and enthusiastic description of GE's experimental holographic work was given. The speaker pointed out the not-surprising limitations of holograms in character recognition, but made the surprising assertion that holograms were especially good for use in distinguishing fingerprints. He said the GE machine had made fingerprint distinctions that the FBI had failed to make.

The bulk of the conference was taken up with discussions of theory and of experiment. Theorems are the

desired products of theoretical work. Tested hypotheses are the desired product of experimental work. An important and surprising theorem was reported. It says, in effect, that certain disconnected figures are in principle unrecognizable by simple alpha perceptrons.

In the only paper with a seemingly imminent application—identifying disorders from electrocardiograms directly—the speaker described how to obtain polynomial discriminant functions from estimates of probability densities.

A progress report was given on a project for reading hand-printed FORTRAN coding sheets. The objective of the enterprise is to read individual characters accurately to 90%, and with the aid of the FORTRAN syntactical rules to read code as accurately as a keypunch operator can copy it.

An experimental computer program for recasting photographs of objects in three dimensions into line drawings of various views and hidden lines was reported on. One of the few papers proposing problems rather than solutions was given by a researcher who is wondering how, among other things, to design a machine to recognize, say, drawn figures that are nonsensical. For example, how to recognize that, in a circuit diagram, there is a dangling resistor one of whose ends is not connected to anything.

Just as SKETCHPAD is useful, especially because it has a syntax of straight lines and circular arcs, so should we have a syntax of a picture language useful for sketching a picture from a description, insisted one attendee.

A description was given of the objectives and plans of an MIT project for viewing up to about 20 different three-dimensional objects using high-resolution television signals as input and providing a mechanical hand to manipulate these objects in accordance with instructions given by a computer program. This is one of three or four robot projects being undertaken in the U.S. at this moment.

polemical

The field of pattern-recognition is not without its feuds, as was seen at the workshop. Readers familiar with the now moribund feud between the digital computer and analog computer sects will appreciate the flavor, if not the substance, of the feud between the two denominations: perceptronism vs. programming heuristicism, or—to use the irreverent vernacular—parallelism vs. sequentialism. . . . In response to a question from the floor about the application to which a speaker had put his work, he replied bluntly that it served to earn him a Ph.D. degree.

An equipment manufacturer questioned the utility of the work of an industrial researcher working on the recognition of characters by a machine having 95% accuracy. The manufacturer said that to accomplish such an objective would not be useful. The researcher replied that he did what he was doing because he enjoyed it. To which the manufacturer added complainingly that the researcher had an expensive hobby, and that in his opinion there were more important objectives than a 95% accurate character reader to which bright Ph.D.'s could apply their talents.

Feuding schools of thought continued their senseless war. One researcher, in reporting on his computer program for a particular type of pattern recognition, challenged the other school to do such a task . . . One researcher was accused of setting a low standard of scholarship in the field because he apparently was duplicating work reported on in the literature and of which the researcher was accused of being unaware. Ironically, in defense of the accused researcher, the point was made that the literature in the field is so badly and sloppily written that reading it would not serve to enlighten anybody on the work.

One attendee remarked privately to this reporter that people in pattern recognition weren't making rash promises any more although the field of time-sharing graphics was in the blithering mouth stage.

conclusion

Some remarks were made about why progress in the field was disappointing. Some wondered whether or not the problem was well enough defined—or the customer too demanding. It was observed that 10 years ago it was expected that the hard problems would be in theory, not in engineering, but it turns out that the theoretical approach is disappearing and recognition logic is in fact empirically designed. A suggestion was put forward that perhaps there are things that cannot be done in principle—that there are unrecognizability theorems—and this might be the reason for failure. One participant observed that it is time to abandon the single-minded perception approach in recognition and the single-minded parsing approach in language translation simply because we ought to realize that a decade of hard work with them has been fruitless.

—LOUIS FEIN

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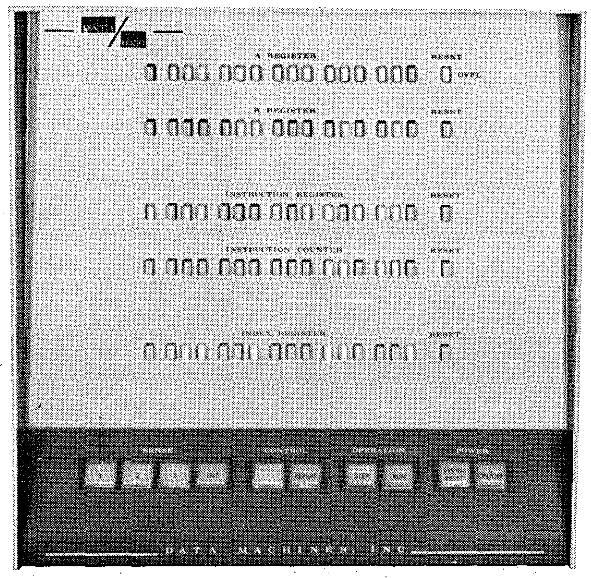

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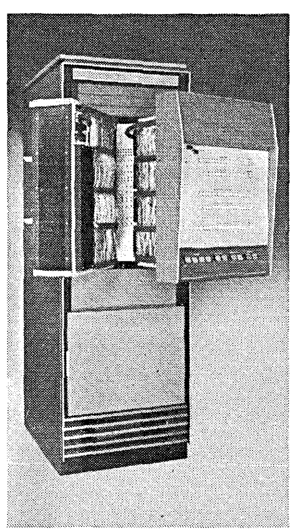

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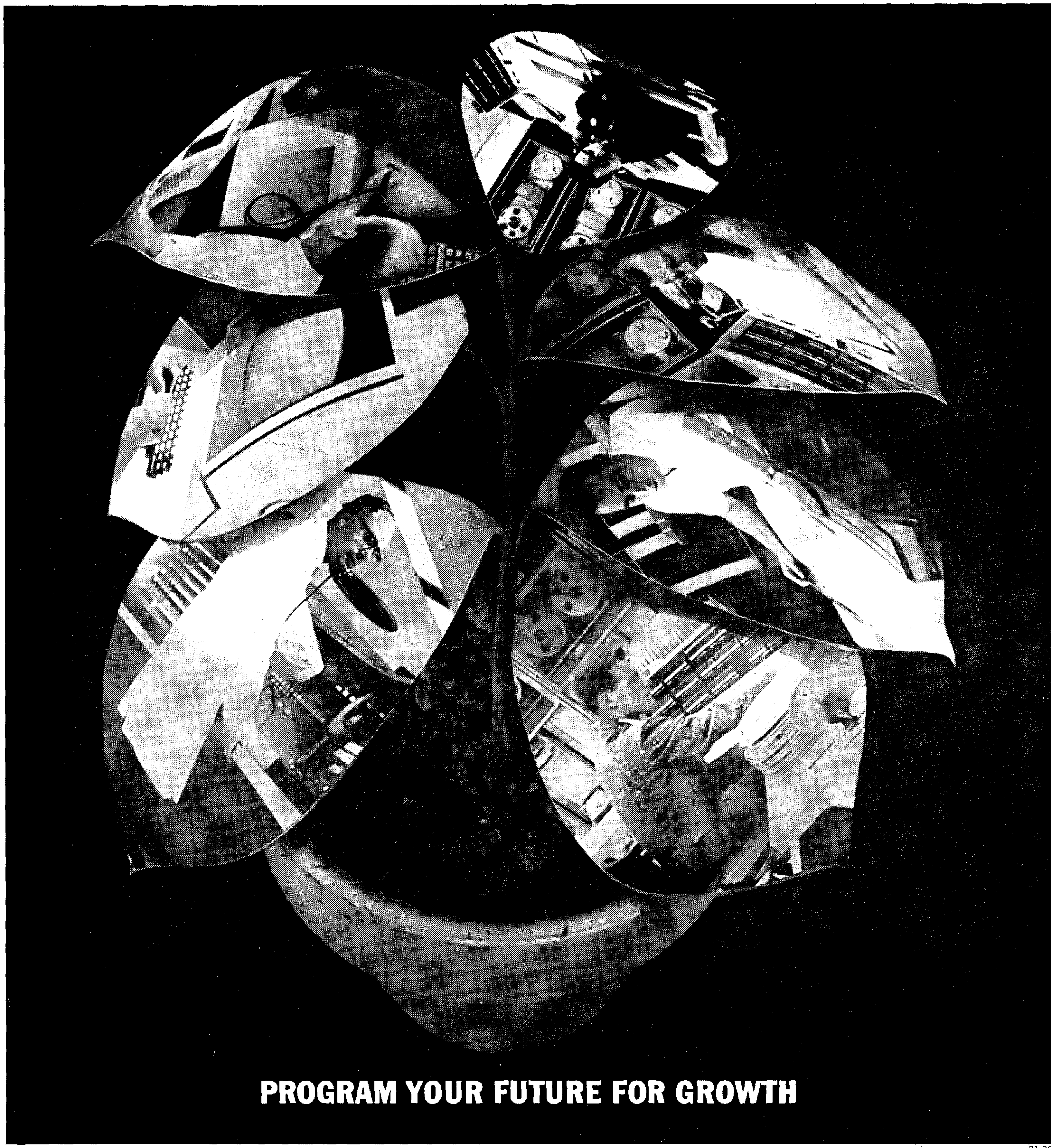

21-302

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new literature

LINEAR PROGRAMMING SYSTEM: Brochure describes software designed for the IBM 360 and includes optimization, report writing, matrix and report generation, and parametric programming. HAVERLY SYSTEMS INC., Denville, N.J. For copy:

CIRCLE 140 ON READER CARD

DESK TOP COMPUTERS: Brochure discusses the economics of the Mathatron and includes information covering add-on peripherals for page printing, paper tape I/O and expanded memory. With applications for scientists, engineers, statisticians and civil engineers, these computers have special prewired programs for automatic solution of frequently used formulas. MATHATRONICS, DIV. OF BARRY WRIGHT CORP., Waltham, Mass. For copy:

CIRCLE 141 ON READER CARD

DISPLAY SYSTEMS: Digital system for use with laboratory spectrophotometers and related instrumentation are the subject of four-page bulletin. Specifications and special features are discussed and modular components that provide integrated readout, printout or calculating capability are individually described. BECKMAN INSTRUMENTS INC., Fullerton, Calif. For copy:

CIRCLE 142 ON READER CARD

CORE MEMORY STACKS: Four-page brochure explains 30-mil core memory stacks with configurations from 1, 2 or 4 bits and capacities from 256 to 16,384 words for 4-wire coincident current, 30-mil arrays and cycle times of 1.25 usec. Standard word lengths, bit lengths, dimensions and frame stacking for arrays are specified. ELECTRONIC MEMORIES INC., Hawthorne, Calif. For copy:

CIRCLE 143 ON READER CARD

RE-ENTRY PAYMENT COUPONS: Eight-page booklet describes kinds of coupons that can be processed in MICR equipment, the variations possible according to the type of account being serviced, and on-premise and off-premise ways in which coupons can be prepared. Type of coupons best suited for installment, club and mortgage accounts that can be processed are also described. ALLISON COUPON CO. INC., Indianapolis, Ind. For copy:

CIRCLE 144 ON READER CARD

BUSINESS PROGRAMMING SYSTEMS: 14-page brochure describes SDS COBOL and other business-oriented programs provided for the Sigma 7. Features of the COBOL-65 package, such as report writer, sort verb, table handling, mass storage and segmentation, are included. Also summarized are a generalized sort/merge capability and a 1400 series simulator program. Interaction of these programs with the Sigma 7 processor are illustrated, and the general COBOL philosophy discussed. SCIENTIFIC DATA SYSTEMS, Santa Monica, Calif. For copy:

CIRCLE 145 ON READER CARD

D-A CONVERTERS: Series has up to 512 channels with word lengths from 8 to 15 bits and full scale accuracies of ±0.05% and ±0.01%. Eight-page brochure details specifications, description of operation, I/O circuit characteristics, model identification tables with descriptions of options and mechanical dimensions. REDCOR CORP., Canoga Park, Calif. For copy:

CIRCLE 146 ON READER CARD

GLOSSARY: Process computer terms are defined in 21-page book. GENERAL ELECTRIC CO., PROCESS COMPUTER BUSINESS SECTION, Phoenix, Ariz. For copy:

CIRCLE 147 ON READER CARD

DIGITAL RECORDING SYSTEM: Three digital magnetic tape recording systems designed for geophysical, mobile and shipboard field recording applications are described in catalog. Units are IBM-compatible for 7- and 9-channel (IBM 360, ASCII) tape formats. Units equipped with 21-channel, dual gap head assemblies (TIAC compatible) are also described. Standard recorders provide three selectable tape speeds from 15 to 150 ips at 800 bpi

packing density. POTTER INSTRUMENT CO. INC., Plainview, L.I., N.Y. for copy:
CIRCLE 148 ON READER CARD

ON-LINE INTERACTIVE DISPLAYS: Described in 35-page book are three interactive programming systems using displays as communication channels by which man and machine can engage in a dialog and solve problems. Information provided in the display enable the user to steer and control the step-by-step progress of the program. Cost: $2; microfiche $.50. AD-640 652. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

MANAGEMENT REPORT SYSTEM: Booklet contains information on how users may improve machine and personnel efficiency while providing secondary functions such as automatic billing of customer and requisitioning departments. Four typical management reporting formats are presented and include monthly computer utilization, daily machine usage, data center comparison, and monthly dp charges. CYBETRONICS INC., Waltham, Mass. For copy:
CIRCLE 149 ON READER CARD

DIGITAL SYSTEMS: Functional details, block diagrams and photographs describe multi-point temperature logging and control system, an integrated digital data printout system, a 3-axis coordinate digitizing system, and digital and A-to-D applications. WANG LABORATORIES INC., Tewksbury, Mass. For copy:
CIRCLE 150 ON READER CARD

COMPUTER INSTALLATIONS: Brochure simulates a coast-to-coast flight in which a dozen representative NCR 315 installations are visited. Installations range from retail stores to government. Included with each installation are units, model and description. THE NATIONAL CASH REGISTER CO., Dayton, Ohio. For copy:
CIRCLE 151 ON READER CARD

TAPE MAINTENANCE: Booklet looks at tape from the financial view and considers the expanding library, replacement tape, tape life, obsolescence, computer safeguards, the problems of waste and their solution. GENERAL KINETICS INC., Arlington, Va. For copy:
CIRCLE 152 ON READER CARD

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CIRCLE 306 ON READER CARD

look ahead

(Continued from page 19)

will be ASR 33's and 1050's. They're planning to have Fortran IV and Cobol, both in the conversational mode, and charge differently for business and scientific work ... Mainly according to CPU time used, not terminal hook-up time, says Jim Foust, Jr., president.

STACK OF COMPLAINTS AGAINST IBM

The complaint of service bureaus that universities with educational discounts are undercutting their prices are among those aired to the Justice Dept., part of the anti-trust charges being toted against IBM. Others relate to pricing, the delivery of equipment in non-sequential model order, and on-line services. Justice is studying the case, has taken no legal action yet, but we hear the number of complainants is high.

UNIVAC EXECUTIVE READY FOR PROMOTION

Univac has demonstrated its new 1108 Exec 8 with simultaneous use of two on-line remote terminals working conversationally and a 1004 doing batch processing. The executive system, according to Univac, has some features that won't be operational on the 360 for a year or more.

Exec is said to allow simultaneous real-time conversational time-sharing, and batch processing. Source-language processors include Fortran V, Cobol, Algol, and the 1108 assembler; interface routines to simplify inclusion of other processors by users are part of Exec 8. The executive system occupies 12K of core and requires one FH-432 drum for permanent storage, including processors and libraries.

For time-sharing (in conversational Fortran), an additional program module is required; it provides variable time slices and priorities, using the Project MAC algorithm. Extensive file management schemes are also supplied by Exec 8, as well as program security keys for file protection. Utility routines include special conversion aids, available according to the needs of a new installation.

RUMORS AND RAW RANDOM DATA

NCR is still delaying announcement of their new line, apparently will wait until they can offer quick delivery, at least on the small end. Price range will be unexpectedly wide, from below the 360/20 to above the 360/67. ... GE rumors proliferate: responsibility for Multics has been transferred out of Phoenix to the defense and space group in Syracuse, N.Y. The DS-250 disc file, important to the 600 series, is running into big trouble. In fact, RCA RACE units are being substituted for the discs at the Dartmouth 625 installation. ... Due soon from Comress Inc., proprietary software house, is Dopic, a documenting technique that takes object programs in core and flowcharts them without programmer intervention. It'll take old patched programs, as well as new, from the core store of the 1401, 1410, 7010, and 1050. More computers will be added. ... To show that it's not directly compatible with the 6600, the CDC 6800 has been renumbered the 7600. They have several firm orders. ... Bunker-Ramo, with its BR-90 display terminal selling well, has emerged into the sunshine of profits after megabuck losses its first two years. ... A 2-year-old systems house specializing in computer graphics with plotters and displays, Infotec Inc. of Westbury, N.Y., is readying a new line of data stations. Among the configurations will be off-line printing units, communications stations, typewriter-to-mag tape, and multiprocessor I/O terminals. Price range will be $12K to $40K.

world report

UNIVERSITY TIME-SHARING MOVES AHEAD

The University of Aachen, Germany, which has one of the biggest science schools in Europe, is the first user to bring on-stream a large conversational time-sharing system. Based on a Control Data 6400 with a 64K central memory, the conversational mode operation works through CDC's Respond system -- which takes up two of the 10 peripheral processors that are linked into a 6000 series. Now 12 local Siemens teleprinter units are tied in; later, 256 remote terminals for the whole campus will be added.

At the other end of the scale, an experimental programming unit at Edinburgh Univ. is developing a mini-access 10-15 terminal system costing less than $200,000 and intended specifically for medical research laboratories. The computer used is an Elliott Automation 4100. The software package (Pop 11), developed for this job, covers 90% of the commonly used mathematical and statistical routines needed by medical researchers. Sponsors were the Medical Research Council.

Edinburgh Univ. has also concluded an agreement with the Ministry of Technology and English Electric-Leo-Marconi for a $1 million software contract to develop the conversational mode package for an EELM System-4, model 75, biggest software deal yet made in the U.K. Participants are the Computer Science Dept. of the university and a new regional computer centre, first of three such centres recommended by a government commission. Decisions on the two other proposed centres (London and Manchester) have been delayed by intense manufacturer-political pressures but are expected soon. But the financing body of the first centre (a University grant committee) has already been criticized by Mr. Sidney Michaelson (head of Edinburgh U.'s computer science dept.) for half-heartedness and niggardliness. He said the project needs more terminals, another $1½ million.

CONCORDE WORK LEADS TO HYBRID COOPERATION

A major derivative of the European supersonic aircraft project, Concorde, is that it has dragged France and Britain into big-time simulation work, particularly for hybrid techniques. At the Toulouse plant of Sud Aviation the largest ($2.5 million) analogue-digital simulator in Europe has been brought into operation. It was mainly strapped together by the Flight Simulation Division of Redifon Ltd. of the U.K. in a joint contract with a French subsidiary of ITT -- L.M.T. The computer part of the simulator is a 16K DDP 224 interfaced with an analogue 250-amplifier Redifon 5000. Its biggest job yet will come in an investigation to find out how supersonic traffic can be merged with existing jets on the congested airlanes of Europe. The Concorde simulator is to be linked to a new $14 million laboratory, officially opened in January at Bretigny by Eurocontrol, to study air traffic control safety in European air networks. A 32K Telefunken TR4 system with a 4K fixed store and 256-

(Continued on page 97)

SOFTWARE PARALYSIS?

So your new Oedipus Whiz-Bang 123 Computer is operational. Too bad your software's 18 months late. An extra $500K for implementation? Of what, Parkinson's Law? Sure you were promised wall-to-wall software. Supposed to handle all languages simultaneously, and while you're waiting, output hourly market news, Big Board quotations, and a fortune cookie for dessert. Fantastic interactive programming, right? Like when the system hung up and you interacted with a karate chop that knocked out 40,000 words of memory? Still believe good software comes as an automatic follow-on with hardware, like cream with coffee, bagged up and ready to go? And to think you could have prevented all this by seeing a software specialist B.C. (before computer), instead of A.D. (after disaster). But don't despair. As long as there's IDC, there's hope. Who's IDC? Good question.

IDC is software: systems analysis to programming, and everything in between. That's all we do, so we have to be good or we wouldn't survive. And we survive quite nicely, thank you. Our programmers receive top salaries, with handsome incentives for extraordinary performance. This is our management philosophy, and it has succeeded in attracting professionals whose competence earns dividends for our clients too. This extra margin of expertise explains why IDC can define new problems faster and quote FIXED PRICES. With no ups, ifs, ands or buts. Never have we gone back to a client for more money or time. In fact, we're often ahead of target. Small wonder we attract repeat business and have expanded eightfold in the last year. We think we'll grow even faster when more users hear about us. Major computer makers—maybe even one you're considering—have already learned to depend on IDC. How about you? If you could use a new perspective on your software management problem, contact IDC now.

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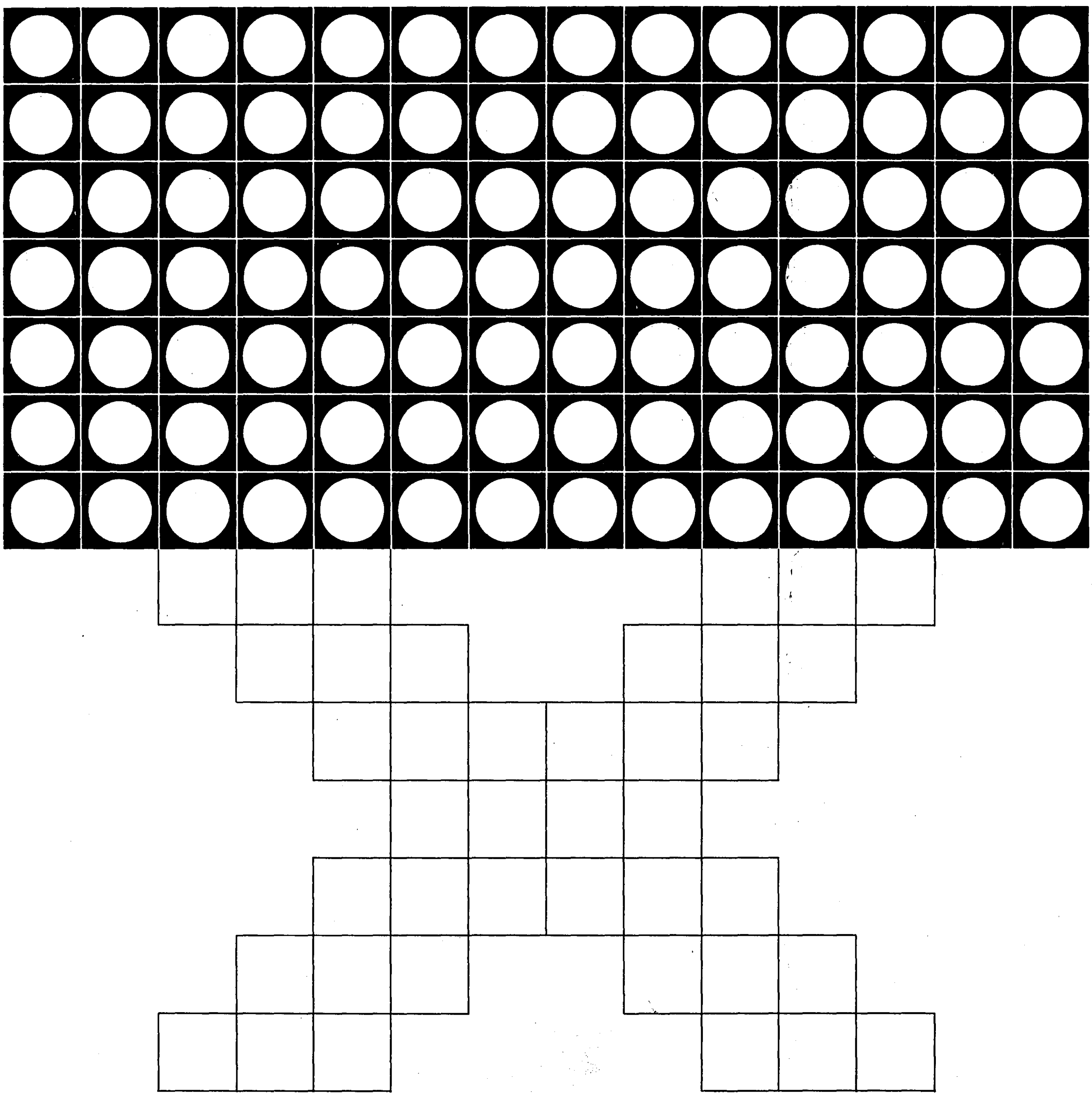


CIRCLE 53 ON READER CARD

(Continued from page 95)

word index forms the computing part of Eurocontrol's simulator. Eight channels take up to eight I/O devices each. Priority interrupt and an internal distribution program copes with simultaneous input from eight peripherals and parallel working of eight programs.

AMERICAN FIRMS REGROUP ACTIVITIES

Three American business equipment firms operating in the U.K. have caught an early dose of spring-cleaning fever: NCR, Burroughs and Univac. Univac's 18-month-installed managing director Cyril Chambers leaves to make way for an American, Don Orr, moving in from New York to cope with the expansion that 1108 and 9000 successes have brought. NCR has brought its computer and edp activity together under Dennis Triggs in a general revamp. Successful in campaigning with the smaller 390 and 500 systems, Triggs now has the task of putting life into the slow-moving big-'uns. With a record sales year behind them (exports from Scottish factories up 75% and sales revenue up by one third from $44 million to more than $57 million) Burroughs plans a $5 million expansion in production.

EASTERN BLOC TRADE INCLUDES ADVANCED MACHINE

A sale by English Electric-Leo-Marconi to BZKG Czechoslovakia, of a System 4-50 is being read in some European quarters as a hint that LBJ is prepared to include computers in his attempt to strengthen the East-West trade bridge. System-4 owes its origins to RCA's Spectra 70, and as one of the most up-to-date designs required an export license from the American government as well as the British Board of Trade.

GE CONSIDERS MOVE IN JAPAN

GE, Tokyo Shibaura Electric (Toshiba) and Mitsubishi Electric Company have decided how to divide the cost of a proposed new company: Tokyo Shibaura 34%, Mitsubishi 33%, and GE 33%.

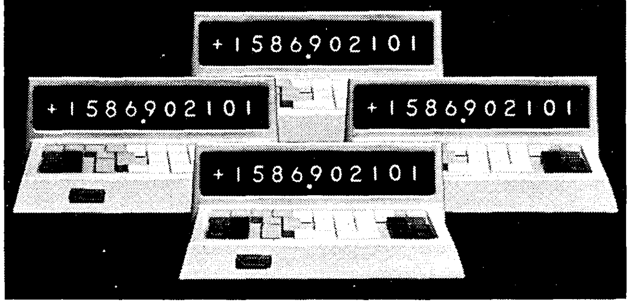
The new firm would be established about the end of this year. At first, it would not produce computers but would undertake computer sales, systems analysis, and customer engineering, as well as setting up a computer center.

BITS & PIECES

On the software front, System Programming Ltd. and Republic Systems and Programming, Inc., have linked so that the former can sell Republic know-how in Europe in return for the corresponding arrangement for SPL in the States ... East African Posts and Telecommunications has taken delivery of a $250K ICT 1902. Two more 1900 machines will be delivered into the area, both to Nairobi, one for East Africa Power and Lighting, and the other for the City Council of Nairobi ... The first export shipment of an IBM System/360 mod 40 produced in Japan was made last month from Yokohama to Bangkok, Thailand, by IBM Japan Ltd., to be installed at the National Statistical Office in the Thai capital ... First software house in Israel, Consultants for Computers and Information Systems, is being formed by Frank Moser and three associates ... Computer Programmers & Analysts in the U.K. is offering an assembly-line COBOL to commercial users. A special group has been set up to prepare tailor-made versions of a modular COBOL ... ICT is building a new R & D centre in Manchester costing $1 million for occupation next year; plans include extension of the two-story facility with an additional 15-story block at the same location for 1971.

CALCULATOR

BREAKTHRU



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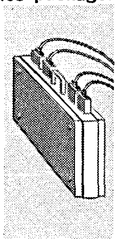

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washington report

BROOKS SUBCOMMITTEE WILL REVIEW COMPUTER MANAGEMENT

Congressman Jack Brooks and his GovOps subcommittee will review the federal adp management program early in March. Ways of improving existing computer sharing arrangements are a likely topic. Idle time on in-house federal computers amounts to about 436,000 hours per month — roughly 20% of the total. Another likely topic is the Center for Computer Sciences and Technology at NBS. It is currently the subject of a GAO study aimed at "discovering what all those people are doing out there," as one Hill source puts it.

INTEREST GROWS IN SYSTEM SHARING

As mentioned last month, GSA wants NASA to time-share a computer complex in Slidell, La. -- with Commerce and Agriculture agencies in the area, among others. GSA is conducting similar negotiations with AEC, and the Navy is studying a third shared network in the Long Beach, San Diego, Corona, Calif., area. Recently, the Navy Ships Systems Command in Boston began using an FCC Univac III in Washington on a shared basis. Previously this Navy work had been farmed out to a commercial dp firm. The Navy will pay FCC $30 an hour for machine time, and expects to save $500K during the 18-month sharing agreement.

A 16K memory module, bought by the Navy, was added to enable the computer to handle the increased load. "The new arrangement," says a GSA source, "will be a valuable test bed for de-bugging the sharing idea."

The immediate future of on-line sharing depends on GSA's pending appropriation request, which includes $1.1 million for adp management operations, plus $10 million for the revolving fund. About $250K is earmarked for analysis of the communication networks required for projected computer-sharing.

CONGRESS USE OF INFORMATION PROCESSING AT PLANNING STAGE

A study of ways in which Congress could employ adp was on the verge of being authorized in the Senate as we went to press. The study is incorporated into the Legislative Reorganization Act of 1967 (S 355). The study would be among the responsibilities of a new Joint Committee on Congressional Operations. Other sections of the bill order the Comptroller General, BOB Director, and Secretary of the Treasury to develop, establish, and maintain a standard classification system for budgetary and fiscal information, plus an adp system capable of analyzing and formatting this data to meet Congressional needs.

The bill is the result of lengthy hearings last year by a Special Committee on the Organization of Congress. Jack Brooks, a committee member, discussed a basically identical system last month at a Civil Service Commission adp seminar. He said a machine-processable, government-wide data base could be developed in 4-6 years, and would save $5 billion annually in administrative costs.

CAPITOL BRIEFS

Two bills related to S 355 have been introduced in the House (HR 2594 and HR 2595). Another proposal (HR 21) authorizes the Legislative Reference Service of the Library of Congress to develop a similar adp system, at a cost of $2.5 million ... GSA is trudging forward with plans to tighten mag tape acceptance procedures, but budget is a problem. FSS specs probably won't be changed until next year.

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books

Player Piano, by Kurt Vonnegut, Jr. Holt, Rinehart and Winston, 1966. $4.95.

A player piano is a robotic device, controlled by rolls of perforated paper, and disguised to look like a real piano. Actuated, it simulates a ghost at the keyboard, invisible fingers depressing the keys in rinky-dink, barroom style. In Kurt Vonnegut's novel this machine seems to symbolize both the beginnings of automation and a nostalgic link with the past at a time when automation has nearly run its course.

Player Piano, first published in 1952, projected trends then developing; it has become more timely today. Accompanying the review copy was a punched card printed: "You have been programmed by the computer EPICAC to receive this copy of PLAYER PIANO . . .", a depersonalizing style which is becoming increasingly familiar.

It is, after all, the choice of people whether the machines, the system, or the organization exist only for their benefit, to be discarded as soon as the intended purpose has been served or whether—a seemingly ridiculous alternative—people choose to conform to the requirements of the machines, the system, or the organization once it has been established, even if it is no longer in their best interests to do so.

The rather fanciful nightmare of people dominated by unaided machines presupposes both a level of technological development and a stage of human underdevelopment which hopefully must be very far into any possible future. Vonnegut presents a believable picture of a system of people and machines—the managers, engineers, and automation devices. A few people backed by sufficient technology can establish a system that comes in time to be sustained essentially for its own sake. The *in* people need not be consciously oppressing nor need they even benefit to a disproportionate degree. The *out* people need not appear to be slaves; they can be adequately, even generously, supplied with material things, but they are most certainly not *free*. The price of freedom is *responsibility* and responsibility cannot be turned over to a machine, not even to the persons who constitute some of its cogs.

Vonnegut's world is peopled not with Orwellian horrors but with familiar types like the organization man and spouse so successfully characterized by White and whom we all number among our acquaintances—if not more intimately.

The giant organization that has grown out of a national emergency seems to be composed of a merger of government and the huge corporations. People are classified according to I.Q. with emphasis on those factors of intelligence needed in management and engineering—a rational system some might agree. The rebel Finnerty observes, "The criterion of brains is better than the one of money, but —" (he held his thumb and forefinger about a sixteenth of an inch apart)— ". . . about that much better."

Bud Calhoun, who is classified as a lubrication engineer but who is incorrigibly a gadgeteer and inventor, develops a machine which can do his job whereupon his classification is immediately abolished. Since his college tests showed him to be low in design aptitude he is technically ineligible for the very work he is most suited to do and the only course open to him is to join the Reconstruction and Reclamation Corps popularly known as the Reeks and Wrecks. This quasi-military, W.P.A.-like organization provides the gainful employment for the vast numbers who, like Bud, no longer have any real jobs to do.

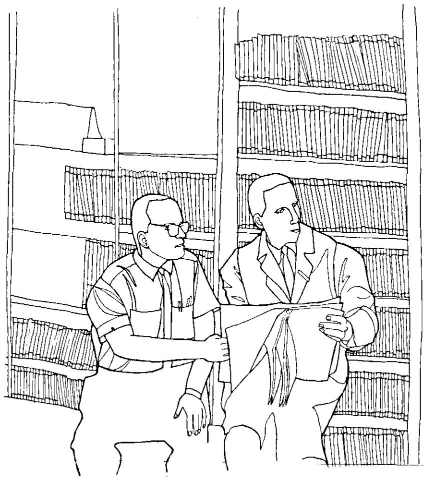
The vagaries of man-devised but machine-administered classification systems are brought out in a rather more humorous fashion when Doctor Ewing J. Halyard of State Department receives a letter informing him that a routine personnel card audit has turned up the information that he had failed to satisfy the physical education requirements for the bachelor's degree at Cornell and hence is ineligible for his M.A. and Ph.D. degrees as well. Put on probationary status, he is informed that he will not have to take the course, merely the final examination: "These tests I understand are quite simple: swim six lengths of the swimming pool, twenty pushups, fifteen chinnings, climb a rope, stand on your . . ." The middle-aged Halyard does not immediately grasp that Professor Rosebury, the harassed football coach at Halyard's alma mater, will take delight in personally administering the examination to a hectoring alumnus and that fraud proceedings are to be brought against him as well.

The Shah of Bratpuhr, whom Halyard has been escorting on a tour of the nation, is not always ready to "appreciate" what his hosts have to show him. While watching a massive troop demonstration—the Reeks and Wrecks cannot accommodate everyone—he exclaims "Takura" meaning "slaves". Informed by the interpreter that the ranks of men responding to commands shouted over a public address system are not slaves but soldiers serving for motives of patriotism, the Shah merely repeats the word "takura" adding that only slaves would submit to such total loss of identity.

The Shah is also puzzled by Epicac XIV, the monster computer which is housed in the Carlsbad Caverns and which incorporates as part of itself the thirteen previous Epicacs. The following passage reminds one of testimonies before Congress during the McNamara era:

"They were passing the oldest section of the computer now, which had been the whole of Epicac I, but what was now little more than an appendix or tonsil of Epicac XIV. Yet Epicac I had been intelligent enough, dispassionate enough, retentive enough to convince men that he, rather than they, had better do the planning for the war that was approaching with stupefying certainty. The ancient phrase used by generals testifying before appropriation committees, 'all things considered,' was given some validity by the ruminations of Epicac I, more validity by Epicac II, and so on through the lengthening series. Epicac could consider the merits of high-explosive bombs as opposed to atomic weapons for tactical support, and keep in mind at the same time the availability of explosives as opposed to fissionable material, the spacing of enemy foxholes . . ."

One of the brightest of the young organization men, Doctor Proteus, who is destined for even greater status within the system becomes disaffected just before the annual session at The Meadows, a sort of training camp for the elite replete with wholesome competition, morale building songs, and



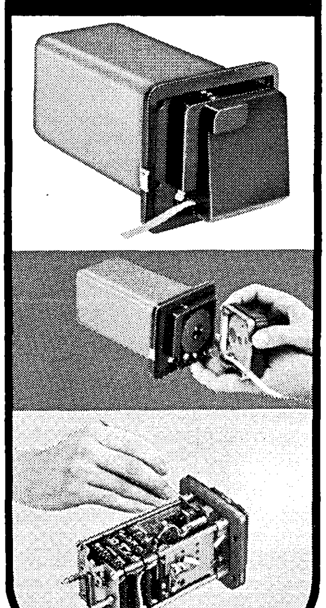
spirit-lifting ceremonies to unite young and old in association and fellowship. These passages are a bit too true to be funny if one has ever had the ill-fortune to get close to this sort of nonsense. The "little red schoolhouse" and "association island" kind of thing are perversions of human relations which considered honestly can serve no other purpose than to suppress individuality in the name of corporate unity.

Proteus plays a minor role in a revolution which fails after a promising beginning. The conspirators were in the habit of gathering in a seedy, run-down bar in Homestead, the place of residence of those with nothing to do. This bar has an automatic bartending machine which has long since fallen into disuse, a live bartender, and the player piano. Ironically, not long after the fighting has stopped, inhabitants of Homestead are to be found scavenging for parts of broken machines with every intention of building more. Of course destroying machines is no answer unless the parts can be put to better use by people and for people.

Enough of the book. It deserves reading. Of Vonnegut himself, now a successful novelist of growing critical acclaim, the concluding page contains the following terse biography:

"Kurt Vonnegut, Jr. once worked for the General Electric Corporation. He is a scientist only in as much as he is interested in the science of living reasonably and kindly. He writes his books surrounded by his large family in a large house on Cape Cod."

—Ned Kelly



people

■ Robert A. Leonard has been elected president of ITT Data Services, New York City. He was previously executive vp and general manager of the division.

■ Richard O. Baily, former vp of the equipment and systems marketing div., Burroughs Corp., has been elected vp and group executive for the company's new business machines group.

■ C. B. Rogers, Jr., has been named vp, marketing, IBM's data processing div., White Plains, N.Y. He succeeds Dr. Thomas R. Horton, who is now director, university relations, IBM corporate headquarters.

■ William R. Orthwein, Jr., has been named president of McDonnell Automation Center, now established as a divisional company. He will continue to serve as a corporate vice president of the McDonnell Company.

■ Paul W. Howerton, former director of the Center for Technology and Administration at American Univ., is now director, client services, EBS Management Consultants, Washington, D.C.

■ At MITRE Corp. Bedford, Mass.: Edward H. Bensley has been named associate department head, information processing systems department. John A. Godsen, formerly with Auerbach Corp., was appointed subdepartment head.

■ Robert Kirby has joined URS Corp., Springfield, Va., as vp and assistant general manager of the information sciences division. He was formerly with the MITRE Corp., where he was associate technical director, national military command systems.

■ Neil Gorchow has been appointed vice president, systems programming, Univac Div., Sperry Rand Corp., Philadelphia, Pa.

■ Paul F. Jenkins has been appointed director of corporate systems and data processing for the Howmet Corp. New York, N.Y.

■ Dr. I. E. Block has been promoted to manager, scientific information div., Auerbach Corp., Philadelphia, Pa. He was formerly administrator of corporate planning.

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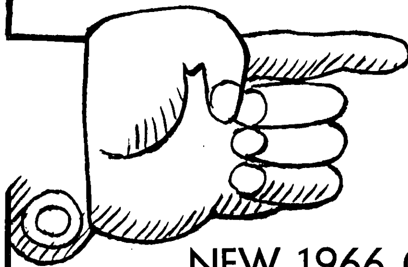

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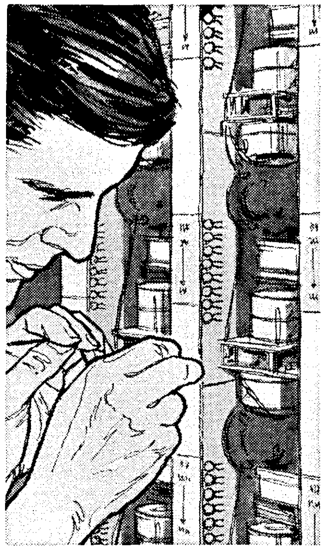

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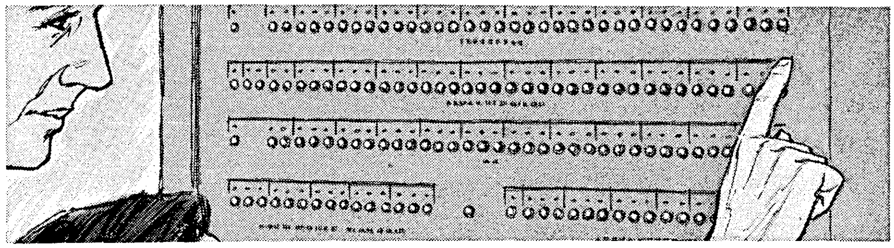

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the forum

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

COMPUTER-ASSISTED INSTRUCTION: THE NUMBERS GAME

In all of our passion for the use of computers in instructional environments—what is popularly called computer-assisted instruction—there seems to have been or to be little attention devoted to the tail we are constructing for our existing dog. What we are doing reminds me of a Dr. Seuss story, *Gertrude McFuzz.*[1] Gertrude ate fruit of the pillberry vine, which caused tail feathers to grow where none had been. So enamored was she of having one more feather that she ate all the berries and grew 85 pounds of tail feathers before she learned she could no longer fly. Then she had to submit to the excruciating act of having them pulled from her one by one until only the original feather remained.

I cannot help thinking that many of those who advocate the use of computers in instructional environments are like Gertrude. So enamored are they of their *individual experiments* with the computer as mediator of instructional materials that they are neglecting critical aspects of the systematic use of the computer outside their laboratories: the world in which *each* of 20,000 university students spends 15 hours per week at a "teaching terminal" is very different from the world in which, occasionally, students make use of perhaps a dozen or fewer terminals.

How many terminals are needed to satisfy the demand of these 20,000 students? First, we note that we need 300,000 terminal-hours per week! Even if each terminal were in use 24 hours per day, seven days a week, we would need almost 1,800 terminals. But our terminals will not be in use 168 hours per week: it is unreasonable to expect a student enrolled in today's kind of university to get out of bed at 3 o'clock on a Sunday morning just because he's scheduled to use a teaching machine. No, we are more likely to find the terminals in use from 8 in the morning, say, to 10 in the evening (although there is no reason to suppose that demand will be uniform during those hours, we will assume it is) on Monday through Friday. On Saturday, the demand drops to six hours; on Sunday it is four hours. Hence, from each terminal we get only 80 hours per week of use (with no allowance for interruption of service, either for maintenance or change of student). Now the number of terminals required is 3,750 (or one for every 5.3 students).[2]

I shall leave as an exercise for the reader the determination of the number and kinds of computers that may be required to service 3,750 terminals. But let me suggest that the quality of performance of these devices must be such that each student is given the appearance of being the only person served. This requires a response time not exceeding one second (that is, no student must be compelled to wait more than one second after he indicates to the computer he is ready to proceed unless, of course, he is requesting a "computational sequence"). Let me suggest also that the faculty serving 20,000 students in the way suggested here will require "several" terminals dedicated to their use as authors. In addition, the faculty will have to devote many hours of intensive effort creating acceptable instructional sequences: this is neither a part-time nor a trivial activity. And, if efficient use is to be made of these thousands of terminal devices, authors probably must pay some attention to the lengths of instructional sequences that are to be devoured by intellectually hungry students; otherwise, the expensive machines may be idle a significant amount of time.

These explicit and implicit questions —and many others left unasked in this brief essay—compel me to observe that what is wanting nearly everywhere are efforts to determine the nature of the total educational environment in which computers can play a major role as mediators of instructional materials. If I may employ a cliché, what we need is a systems approach to education.

—Robert M. Gordon

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[1] In "Yertle the Turtle and Other Stories" (Random House, New York).

[2] One set of assumptions implies that these terminals occupy 260,000 square feet of floor space and rent for $1,400,000 per month! Consideration of other factors probably governing usage of the terminals causes our estimate to be altered to one for every 3.5 students: at our hypothetical university, therefore, we shall need approximately 5,700 terminals just for students' instruction. If the demands for research computing and administrative data processing are considered, too, that number will surely increase past 6,000.

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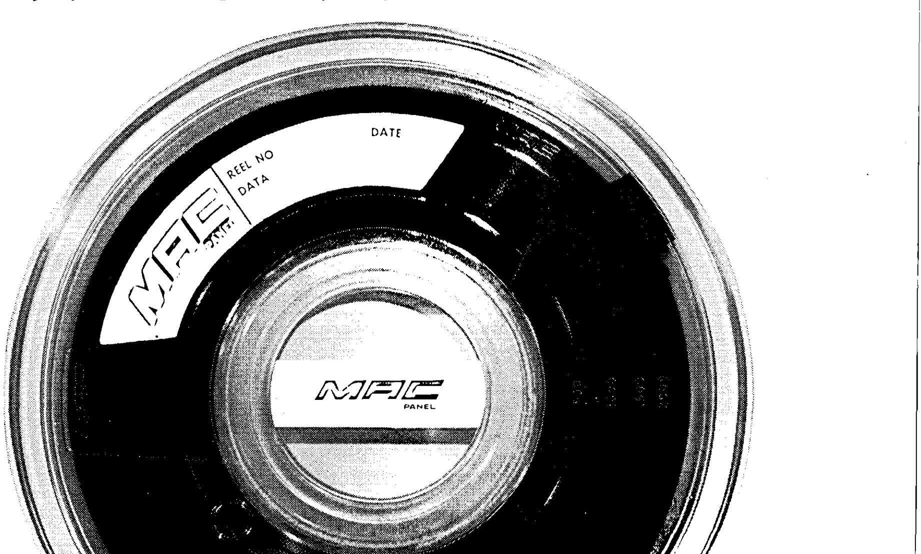

CIRCLE 2 ON READER CARD

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Our new FX-18 Core Memory isn't for everyone. It's for the systems designer who needs 200,000 to 2,000,000 bits of storage—too little for a full scale mass memory, yet too much to justify the cost of stringing a flock of small units together. If you're in this select group, your prize can be a saving of up to 30% on your memory system costs.

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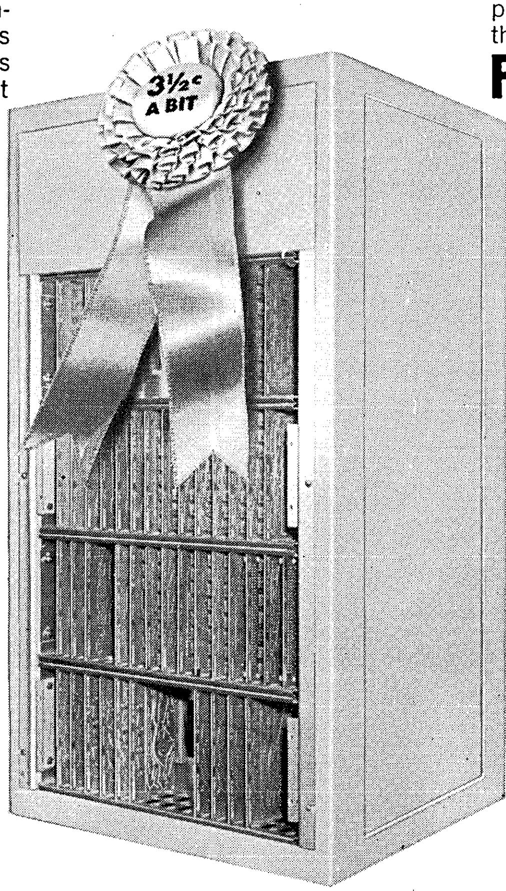

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