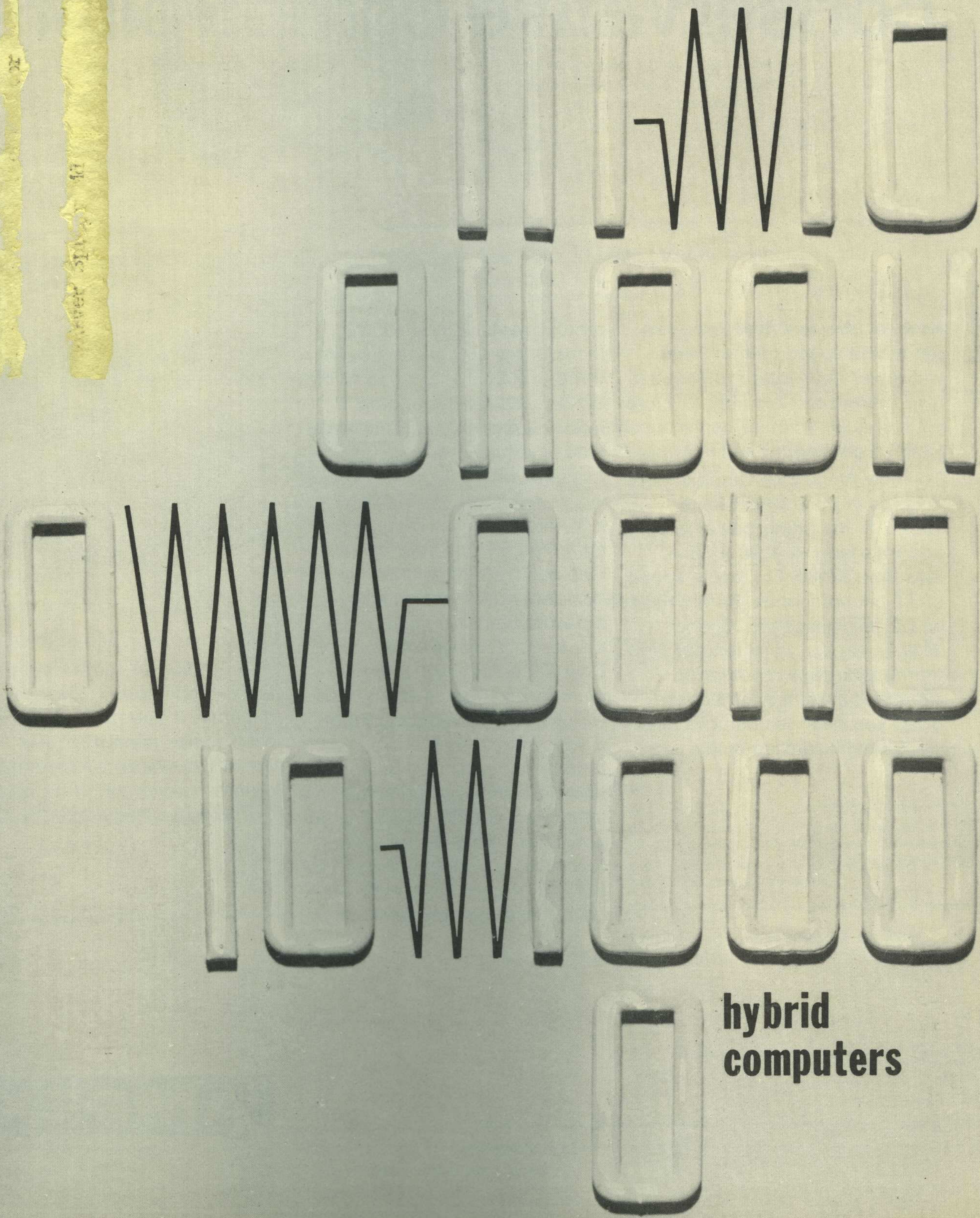
DATAMATION

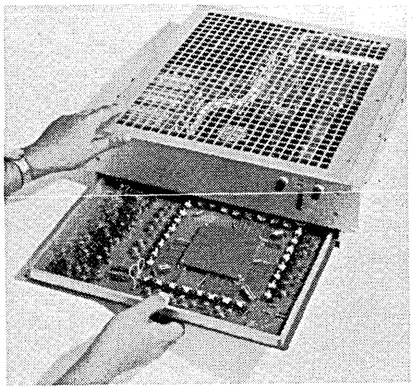
October



hybrid computers

A new 2 μsec memory for imaginative engineers and conservative comptrollers.

Now for the first time you can get a high speed memory that will lower your total system cost, give increased flexibility to meet your specific requirements and simplify packaging engineering. The new Ampex RF Core Memory costs less than $3600 for a 1024 x 8, including power supply and interface. A 4096 x 18 is less than $7100. Full cycle speed of 2.0 microseconds. Buffer cycle of 1.2 microseconds. Speeds 25% faster for word lengths less than 8 bits. *New modularity simplifies system engineering*: gives you new flexibility to meet word length and capacity requirements. The standard module has a capacity of 256 through 4096 words x 4 to 18 bits. Simply add more standard modules and expand at minimal cost to a multiple modular package with a capacity of 4096 words x 72 bits, or 16,384 words x 36 bits. *More flexibility in packaging the RF into your system.* Two basic modules make up the compact rack mount package: a power supply module and a single large size PC "Memory Board" containing the entire memory electronics and interface (or use your own power supply, if you prefer). *New overall system performance, reliability and simplified maintenance:* integrated circuits, silicon semiconductors and encapsulated functional circuits minimize the number of parts, maximize efficiency. The new Ampex RF lets *you*

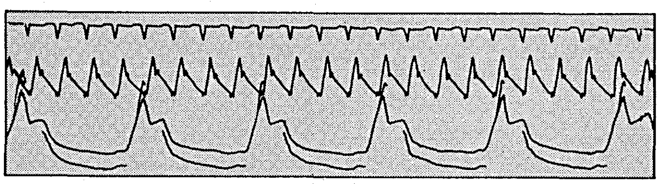


call the shots...and at low cost. Ask Ampex for more data on the RF high-speed, low-cost core memory. If you need larger or even faster memories, ask about the RS and RZ coincident current memories. Write Ampex Corporation, Redwood City, Calif.

AMPEX

AMBILOG200 the only computer designed especially for signal processing

Using the best of both analog and digital techniques, the AMBILOG™ 200 Stored Program Signal Processor is designed from the ground up to handle the "floods of data" generated in test and research programs. Although such programs cover many fields — biomedical monitoring, geophysical research, test stand instrumentation, automatic weapons checkout, speech analysis — all require complex *signal processing:* multiple input acquisition and output distribution, monitoring, editing, arithmetic, analysis, recording and display. Because of its high processing speed and extensive input/output for both analog *and* digital data, AMBILOG 200 is ideally suited for such tasks. Here are some examples.



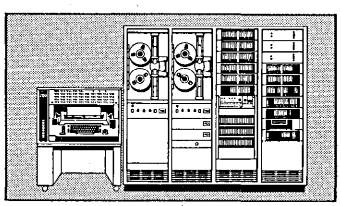
Real Time Waveform Measurement

Peak values, axis crossings, ratios of successive differences, and other characteristics of analog signals are measured in real time. Incoming signals are monitored for events of interest, using complex programmed detection criteria. In a typical biomedical application, the result is a 100-to-1 reduction in the bulk of magnetic tape output records.

$$A(n,w)=\int_0^T W(t)F(n,t)\cos(wt)dt$$
$$B(n,w)=\int_0^T W(t)F(n,t)\sin(wt)dt$$

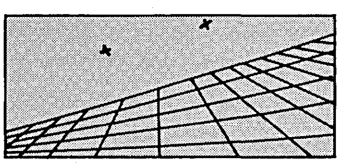
Spectrum Analysis

Parallel hybrid multiplication and summing, 2 microsecond 30-bit digital storage, and a flexible instruction format providing efficient list processing combine to make the AMBILOG 200 powerful in statistical signal analysis techniques such as Fourier transformation auto and cross correlation, power spectrum density analysis, and generation of histograms of amplitude spectra.



Digitizing and Recording

Multiple inputs, from up to several hundred sources, are routed through a multiplexer switch array under stored program control. At no penalty in sampling rates over conventional systems, the AMBILOG 200 converts incoming data to engineering units for recording or monitoring. An analog-to-digital converter performs a complete 15-bit conversion in 4 microseconds for digital storage, recording or outputing.



Display Generation

Multiple analog outputs facilitate close man-machine relationships in systems involving visual displays. Points of an image stored in memory are rotated through three space angles and projected on a CRT at a 50 Kc rate. Co-ordinate transformation is accomplished simultaneously with digital-to-analog conversion.

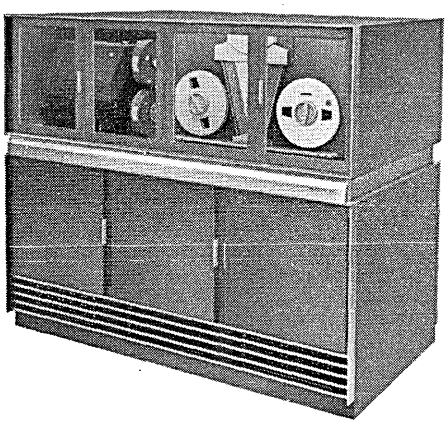
For technical reports describing in detail these and similar AMBILOG 200 applications, write I. R. Schwartz, Vice President.

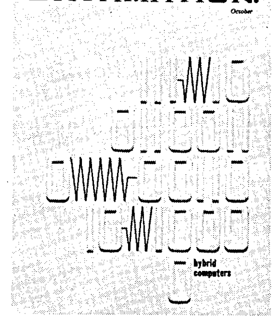
Adage INC
1079 Commonwealth Avenue, Boston,
Massachusetts 02215

CIRCLE 4 ON READER CARD

FAIR

ICONDUCTOR / A DIVISION OF FAIRCHILD CAMERA AND INSTRUMENT CORPORATION ■ 313 FAIRCHILD DRIVE, MOUNTAIN VIEW, CALIFORNIA





october
1965
volume 11 number 10

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BPA — Circulation audited by Business Publications Audit

ABP — Member, American Business Press, Inc.

Microfilm copies of **DATAMATION** may be obtained from University Microfilms, Inc., 313 No. First St., Ann Arbor, Michigan. DATAMATION is published monthly on or about the tenth day of every month by F. D. Thompson Publications, Inc., Frank D. Thompson, President. Executive, Circulation and Advertising offices, 141 East 44th Street, New York, New York 10017 (MUrray Hill 7-5180). Editorial offices, 1830 W. Olympic Blvd., Los Angeles, California 90006. Published at Chicago, Ill. DATAMATION is circulated without charge by name and title to individuals who qualify by our standards and are employed by manufacturers or users of automatic information-handling equipment in all branches of business, industry, government and the military. Available to others by subscription at the rate of $15.00 annually; single issues (when available) $1.50. Annual rate for students: $7.50. Foreign subscriptions are on a paid basis only at a rate of $25.00 annually. No subscription agency is authorized by us to solicit or take orders for subscriptions. Controlled circulation paid at Columbus, O. Form 3579 to be sent to F. D. Thompson Publications, Inc., 205 W. Wacker Dr., Chicago, Ill. 60606.

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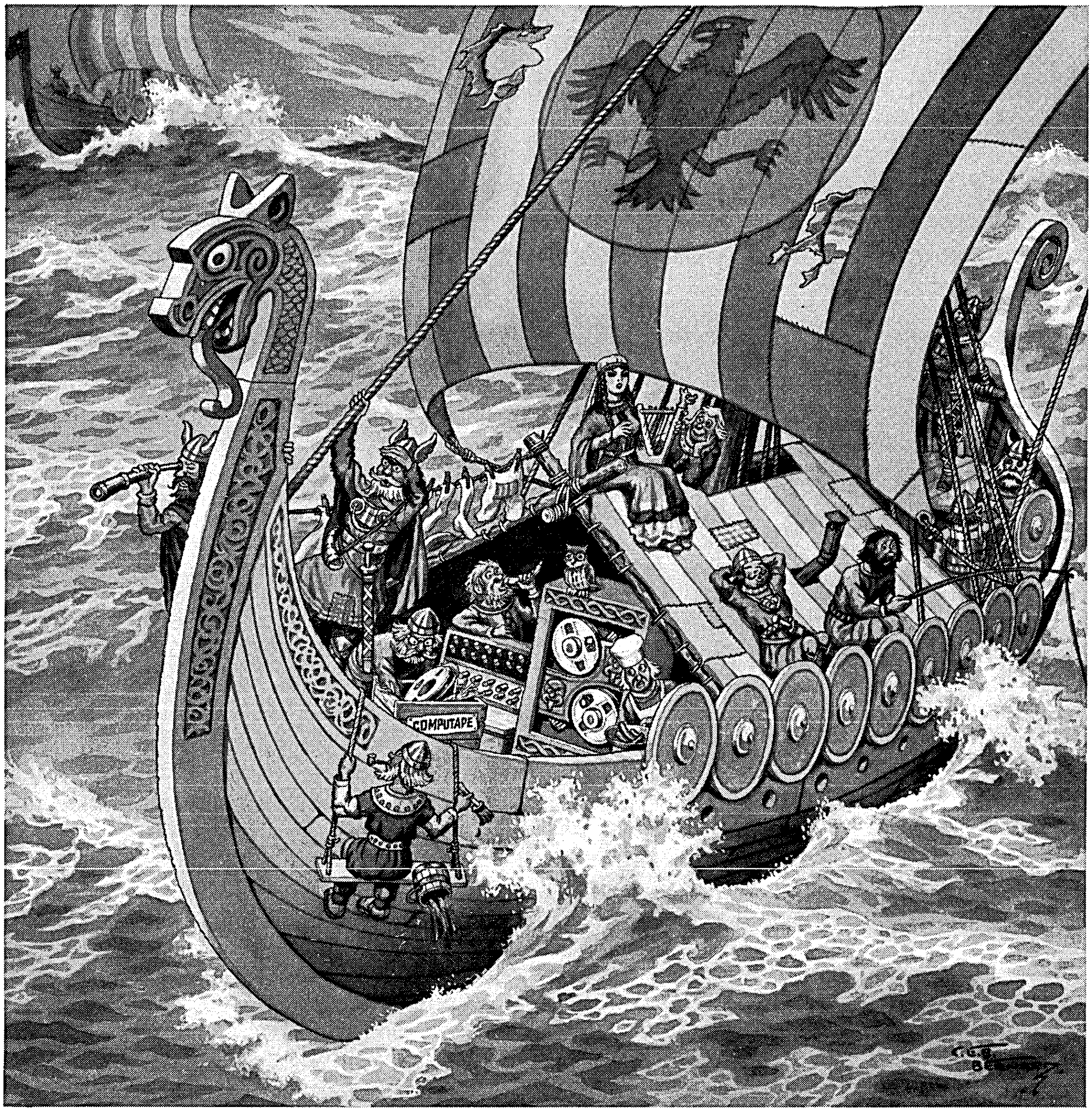
THIS ISSUE 58,952 COPIES

AN OFF-BIT HISTORY OF MAGNETIC TAPE... #8 of a series by Computape*



Did the Vikings introduce computer tape to our shores as early as 789 A.D.?

Dr. Jerome B. Dewdrop believes they did. According to Dr. Dewdrop, the occasion was the landing in Narragansett Bay of a group of Norse singers bound for the first Newport Jazz Festival. The group included, in addition to the Vikings, such long-maned attractions as Erik and the Reds, The Four Norsemen, and one Bea Striceland, who sang "Melancholy Baby" accompanied by lyre.

As for the view that data processing equipment was *not* introduced until much later, as a result of the work of the 17th century mathematical wizard Descartes, Dr. Dewdrop poo-poohs it.

"An interesting theory," scoffs Dr. Dewdrop in his classic study entitled 'The Vikings and All That Jazz', "but just one more case of putting Descartes before the Norse!"

One of a series of documentaries made possible by COMPUTRON INC., a company even more interested in making history than fracturing it. Our Computape is so carefully made that it delivers 556, 800 or 1,000 bits per inch — with no dropout. Available with 7, 8, 9, 10, 16 channel or full-width certification to meet your systems requirements.

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CIRCLE 8 ON READER CARD

DATAMATION 65®

october 1965

volume 11 number 10

24 HYBRID COMPUTATION, by Thomas G. Hagan. *Tutorial fits hybrid developments into historic perspective and classifies systems into four types.*

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37 THE EAI 680, by Paul Landauer. *A look at the latest hybrid computer.*

38 HOW TO TELL IF IT'S FORTRAN IV, by Daniel D. McCracken. *More than two dozen languages are called FORTRAN IV, but they differ widely in source language features. Here are two tests to determine which is the real F-IV. Comparison charts list some of the more important features offered in compilers of leading manufacturers.*

42 COMPUTER CHARACTERISTICS & THE ROLE OF SOFTWARE, by David E. Weisberg. *The quarterly publication is updated with new processors, and, to place hardware features in proper perspective, the importance of software is discussed.*

43 THE DPMA FALL CONFERENCE. *Big doings in Dallas are scheduled by the Data Processing Management Assn. at its annual fall meeting, Nov. 3-5. A technology panel features Eckert and Mauchly, Fred Brooks and John Weil.*

44 PROGRAMMING DOCUMENTATION, by Robert G. Snyder. *Although documentation is a byproduct of a good systems job, this laborious task becomes even more important during computer system conversion. Here's what goes into an effective job manual.*

53 THE ACM NATIONAL CONFERENCE, by Angeline Pantages. *The new "in" term is reactive typewriter, receiving increasing attention at this Cleveland computer conference, attended by more than 1,000.*

54 OPERATING SYSTEMS: ONE INSTALLATION'S EXPERIENCE, by Robert F. Brockish. *Covering both business dp and scientific computing, the author considers the pros and cons of operating systems in discussing job throughput and programmer productivity. He also describes procedures followed in a system conversion.*

67 CIRCUIT MODULES & COMPUTER TRAINING, by David B. Denniston. *Described is the Army's use of off-the-shelf circuit modules to teach the fundamentals of computer organization, operation and maintenance, as well as programming. Student-soldiers build a digital computer, and experience simulated on-line operating conditions for I/O gear.*

69 MENCKEN REVIEWS AUTOMATION. *From an acrid attic archive is retrieved what may be the year's most important literary find.*

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automatic information processing for business industry & science

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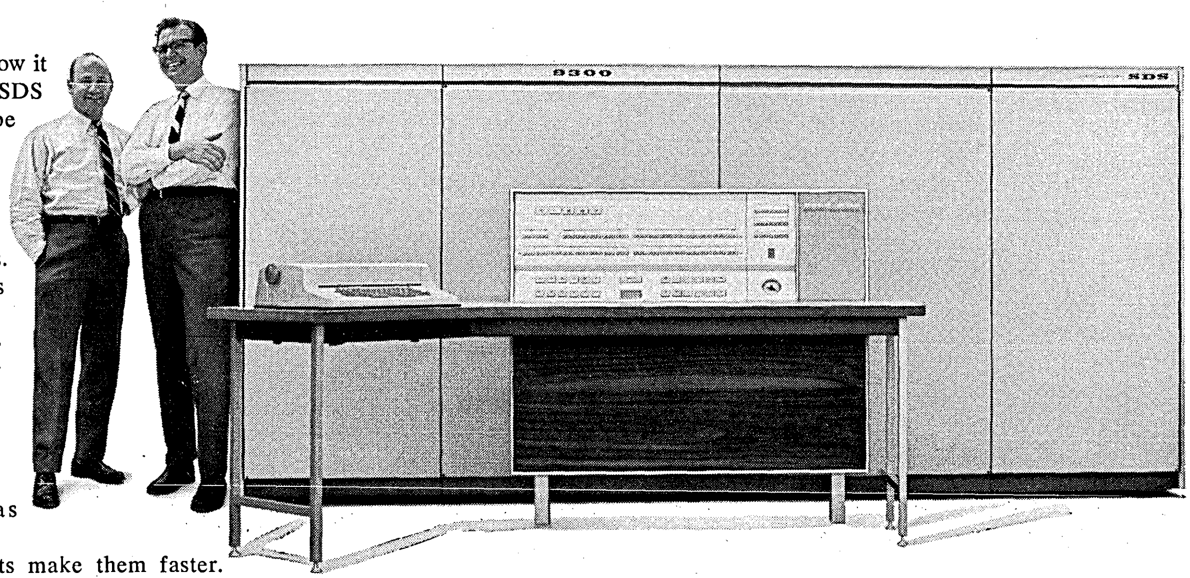
To make computers as good as these you've got to be simple-minded.



People ask us how it is possible for SDS computers to be faster, more reliable, and cheaper than other companies' machines.

The answer is simple.

SDS computers are simpler than other people's. They do the job with fewer circuits. Not nearly as many parts.

Fewer circuits make them faster. Fewer parts make them more reliable. Both make them cheaper.

It's hard to design simple computers. Much harder than designing complicated ones.

It's so hard that nobody will try to do it without a strong incentive.

Our incentive is greed. We believe that if we can make better machines than anybody else, and sell them for a lot less money, we can get rich in the computer business.

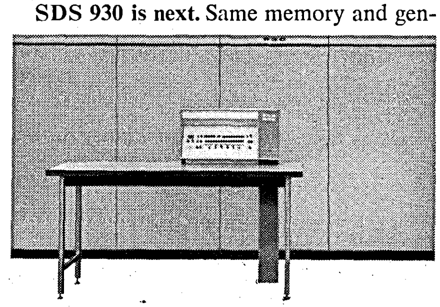
So far we're doing very well.

We've found a lot of people who are willing to pay less money for computers that do more work.

We make these six real-time computers and a lot of stuff to go with them:

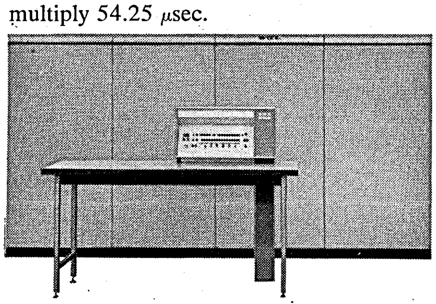
SDS 9300 is our biggest. It has a basic core memory of 4096 words, expandable to 32,768 words, all directly addressable. One standard and any number of optional buffered input/output channels with rates to 572,000 words per second. Input/output simultaneous with computation up to 1024 levels of priority interrupt. Memory cycle time 1.75 μsec. Execution times, including all addressing and indexing: Fixed point (24 bits plus a parity bit): add 1.75 μsec, double precision add 3.5 μsec, multiply 7.0 μsec, shift (24 positions) 5.25 μsec. Floating point (39-bit frac., 9-bit exp.): add 14.0 μsec, multiply 12.25 μsec.

SDS 930 is next. Same memory and gen-

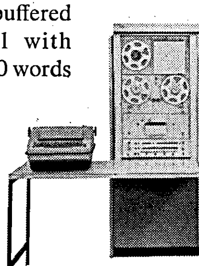


eral description as the 9300. Only the execution times are different: Fixed point (24 bits plus a parity bit): add 3.5 μsec, multiply 7.0 μsec.

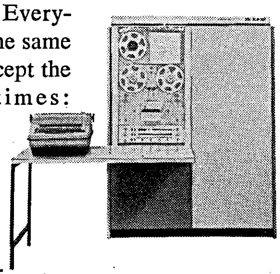
SDS 925's basic core memory of 4096 words is expandable to 16,384. From there on the specs are the same as the 9300 and 930, except the execution times: Fixed point (24 bits plus a parity bit): add 3.5 μsec, multiply 54.25 μsec.



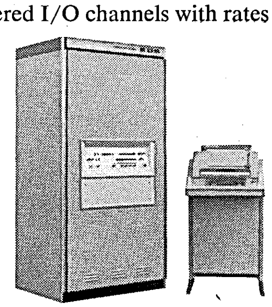
SDS 920 has the same memory capacity and priority interrupt as the 925. One standard and one buffered I/O channel with rates to 62,500 words per second. Memory cycle time 8.0 μsec. Execution times: Fixed point (24 bits plus a parity bit): add 16.0 μsec, multiply 32.0 μsec.



SDS 910 has a basic core memory of 2048 words, expandable to 16,384, all directly addressable. Everything else is the same as the 920 except the execution times: Fixed point (24 bits plus a parity bit): add 16.0 μsec, multiply 248.0 μsec.



SDS 92 is our integrated circuit baby. It has a basic core memory of 2048 words, expandable to 32,768, all directly addressable. Memory "scratch pad" reduces both program size and execution time. Hardware index register; indexing requires no additional time. One standard and any number of optional buffered I/O channels with rates to 572,000 words per second. Up to 256 levels of priority interrupt. Memory cycle time 1.75 μsec. Execution times, including all accesses and indexing: Fixed point (12 bits plus a parity bit): add 3.5 μsec, multiply 8.75 μsec, divide 22.75 μsec.



And here's some of the stuff that goes with them:

Fortran IV for all SDS computers (it's ASA Fortran IV, and then some).

SDS Rapid Access Disc Files (we call them RAD Files) which store from 528,000 to 8,000,000 characters, with access times as low as 500 μsec and transfer rates as high as 480,000 characters per second. RAD Files give the speed and capacity of drums at the price of discs.

SDS new high-reliability magnetic tape drive. Single capstan and full-vacuum columns eliminate tape wear and skew, maintain uniform tension. IBM-identical tape format and guide path assures compatibility.

SDS Business Programming Package permits SDS computers to perform decimal and character operations with the same ease as standard arithmetic.

Scientists and engineers have snapped these machines up. We have more computers working on line in real-time systems than any other company.

Some of them use their leisure to run payrolls. It's a nice change of pace after the hard work of real time.

How much do SDS computers cost?

If you ask us we'll tell you.

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SDS

CIRCLE 9 ON READER CARD

DATAMATION calendar

● Advanced Seminar for ADP will take place in Rome, Italy, Oct. 7-April 7. Four months will be devoted to theoretical studies, and two months on the practical training in governmental and private organizations in European countries. Sponsor is International Computation Centre. Cost: $1,050.

● Following courses are being offered by American Univ., Wash., D.C.: "Management Information and Data Transfer Systems," Oct. 18-21; "The Computer and Urban Affairs," Nov. 8-10; "Information Problems in the Pharmaceutical Industry," Nov. 15-18; Short course on "Electronic Information Displays," Nov. 15-18; "The Computer Impact on the Law," Nov. 30-Dec. 3. Cost: $150-200. Place: Twin Bridges Marriott Motor Hotel, Wash., D.C. except for the pharmaceutical meeting, which will be held at Drexel Institute, Philadelphia, Pa.

● Symposium on economics of edp is scheduled Oct. 19-22 in Rome, Italy. Sponsor is International Computation Centre.

● The H-800 Users Assn. will hold its fall conference at the Jung Hotel, New Orleans, La., Oct. 20-22.

● Members of CUBE (Cooperating Users of Burroughs Equipment) will meet Oct. 20-22, Sahara Hotel, Las Vegas, Nev.

● Society of Photographic Scientists and Engineers will hold a symposium, "Photography in Information Storage and Retrieval," Oct. 21-23, Mariott Twin Bridges Hotel, Wash., D.C. Co-sponsor is Army Research Office.

● The national electronics conference will be held at Chicago's McCormick Place, Oct. 25-27.

● Computer workshop for civil engineers is scheduled for Oct. 25-27, Purdue Univ., Lafayette, Ind. Co-sponsor is American Society of Civil Engineering.

● Courses on "EDP Audit and Controls" will be held Oct. 25-29, Doric

3200 FCI

(Phase encoding recording at 1600 BPI)

Effective October 15, a new MAC Panel heavy duty computer tape will be available full-width tested and guaranteed at 3200 FCI {Flux Changes per Inch.} This new magnetic tape is especially manufactured and tested for IBM's new 2400 series tape units. Another result of MAC Panel's continuing research and technological efforts designed to meet the ever-changing needs of the data-processing industry.

MAC

MAC PANEL COMPANY • High Point, North Carolina

CIRCLE 11 ON READER CARD

Dinkler Motor Hotel, Los Angeles. Courses are sponsored by the Automation Training Center, Phoenix, Ariz.

● Electronic Associates Inc. is offering the following courses: "Hybrid Computation," Oct. 25-30, Princeton Computation Center; "Digital Computation," Oct. 4-8, Los Angeles Computation Center, Nov. 29-Dec. 3, Princeton Comp Center; "Modern Methods in Analog Simulation," Oct. 18-23, Princeton Center. Fees are from $200-275.

● Business Equipment Maufacturers Assn. will hold its business equipment exposition/conference Oct. 25-29, New York Coliseum and New York Hilton.

● Seminar "EDP: Purchasing-Buying by Computer" will be held Oct. 19-21, N.Y., Oct. 26-28, San Francisco, Nov. 2-4, Atlanta, Ga. Cost: $250 members, $275 nonmembers. Sponsored by National Defense Education Institute.

● SWAP Users Group will meet Oct. 4-5, Radisson Hotel, Minneapolis, Minn. and CO-OP Users Group will meet Oct. 26-28, Maison Internationale Des Chemis de Fer, Paris, France. Both are Control Data user organizations.

● The Systems and Procedures Assn.'s International Systems Meeting is scheduled for Nov. 1-3, Palmer House, Chicago, Ill.

● RCA Institutes, Inc. will sponsor two seminars: "Digital Systems Engineering," Nov. 1-5, Hotel Astor, N.Y., and "Digital Electronics," Dec. 6-10, Marriott Key Bridge Motor Hotel, Wash., D.C. Fee: $300, group rates available.

● Symbolic control seminars are being offered by IIT Research Institute, Chicago, Ill. – "NC Management," Nov. 2, and "APT PERT Programming," Nov. 15-19. Fees: $35, $200, respectively.

● Data Processing Management Assn. will hold its fall meeting and business exposition, Nov. 2-5, Adolphus Hotel, Dallas, Tex. Theme: "Management–Technology and Direction."

letters

interrupts & software

Sir:

While the article, "Characteristics of Priority Interrupts" by Emil R. Borgers (June, p. 31) covered many important characteristics, design considerations, and future design goals of priority interrupts, I believe that Mr. Borgers omitted several design features which would be useful from the software viewpoint and which would increase priority interrupt flexibility. These features are an interrupt "ignore," an arm/disarm mask control, and a software-generated pseudo-interrupt.

In programming, it is sometimes desirable to "ignore" an interrupt that has arrived during the interval for which that interrupt line was disarmed after the line has been "rearmed." The programmer may wish to ignore the interrupt which occurred during the disarmed period because, if the interrupt is "spurious" (due to malfunction) or neither desired nor needed for program control, the recognition of the interrupt would cause control problems. Yet, within the same program, he may wish to service interrupts occurring on other disarmed interrupt lines when they are rearmed. This "ignore" feature can be program implemented, but adds to program overhead and complexity. The interrupt hardware can be designed to always "ignore" or not "ignore," but this approach is inflexible. In a recent computer-to-computer communication application, this feature could have been most useful. In this application, it was essential on some interrupt lines that the interrupt was either "ignored" or "not ignored," depending on the circumstances at the time that the interrupt was received.

A programmable arm/disarm mask control would be most useful to arm/disarm subsets of interrupt lines with one operation. Here, each bit in the mask would represent an interrupt line which would be armed or disarmed depending on whether or not the bit was set. The programmer would arm or disarm subsets of interrupt lines by setting the appropriate bits in the mask. This feature is especially useful in real-time applications where execution time and core storage come at a premium. While some general purpose computers have this arm/disarm mask control, it is often unavailable even as an option.

When a general purpose computer has a priority interrupt feature but not the capability to selectively arm and disarm interrupt lines, a means of generating a "pseudo-interrupt" would be useful. This pseudo-interrupt would be program-generated and would permit a program to be advanced to a higher interrupt priority level without the necessity of receiving an interrupt at that level. The purpose of this feature is to avoid being interrupted at the higher interrupt level as well as all lower interrupt levels. The result would be a specialized arm/disarm feature with flexibility somewhere between a simple priority interrupt and a fully selective arm/disarm capability.

Several further comments on the subject of priority interrupts come to mind. When the selective arm/disarm or the pseudo-interrupt capability is added to a system, a separate method should be available for disarming all interrupts whether armed or not and, at some later time, rearming only those interrupts which were armed prior to the "general" disarming. In other words, the entire interrupt system could be disarmed, but when rearmed, the previously existing arm/disarm status of the interrupt lines would be restored. The ability to disarm all interrupts is useful in eliminating the necessary housekeeping of arm/disarm status and the later restoration of this status which would otherwise be required. However, this ability would be essentially useless if the previously existing arm/disarm status was not automatically restored.

Thus far, several logically different but related types of arm/disarm capability have been either explicitly or implicitly covered. These are the "generalized" arm/disarm of the previous paragraph, the selective arm/disarm of the subject paper, and the arm/disarm implied by priority where all interrupts of the same or lower levels are disarmed while an interrupt of a given priority level is being processed. There is at least one other type: a programmed capability to ignore one or more interrupt stimuli that may cause an interrupt on a single interrupt line when there are not enough interrupt lines for all required interrupt stimuli.

Furthermore, there are at least three synonyms that are used interchangeably with arm and disarm: namely, for arm—enable, allow, and uninhibit; and for disarm—disable ignore, and inhibit. Consequently, it is most awkward to document or discuss clearly and concisely a system which uses all of these types. Considerable confusion arises when one is forced to go from one terminology to another as he goes from one system to another. The diversity of symbology and terminology seems to be common in other areas of the digital computer field. Time wasted in the translation process wastes the resources available to the field; obviously, standardization is essential.

I propose as standard priority interrupt terminology the use of enable/disable for the "generalized" arm/disarm capability, of arm/disarm for the selective interrupt characteristics described in the subject paper, and of inhibit for the temporary disarming which results from a higher priority interrupt.

J. G. Bennett
Silver Spring, Maryland

reprogramming conference

Sir:

I agree with Mr. Gordon that there was relatively little material presented at the Reprogramming Conference (July, p. 88) which the professional programmer could find stimulating or new. However, I think that Mr. Burge's presentation was an outstanding exception . . . and . . . the highlight of the sessions.

I felt that it was a refreshing exception, that the level of reflection and creative power that the paper represented was unique, and Mr. Burge had once more confirmed his international reputation as an important source of new ideas in information processing. I am a little put off that Mr. Gordon chose to make a somewhat glib comment about the presentation, rather than to consider the potential of the contents of the paper. If booby prizes are awarded for lack of taste or judgment in critical review, I am afraid that this reward has been earned by the last paragraph of the published review.

One further observation, with reference to Mr. Goetz's paper. I should like to find the systems programmer, confronted with a Datamation-published comparative compilation speeds and with users who are very concerned nowadays about executive system overhead, who feels he can afford the luxury of not considering minimum object time execution as the *"ne plus ultra."* Of him, it can be said, as Solon said of Pisistratus, "He is more brave than some and more wise than others."

H. Lorin
New York, New York

Author's reply: The content of Mr. Burge's paper may indeed have the qualities attributed to it by Mr. Lorin. But this alone does not

qualify its author to make the presentation orally — so the fact of its presentation and the comments of my neighbors tell me. I refer again to my letter to the editor in the July issue to support my view.

The seeking and finding of a systems programmer who is concerned with effectiveness may be likened to the search of Diogenes: doomed to fruitlessness. Who should care how fast the wrong problem is solved if no one cares enough to consider that it might be the wrong problem? Of course, the coders of this world.

answering the call

Sir:

Re: Thogonal, R., "Pessimum Programming" (Aug., p. 48). Although his heart was in the right place, the author has made a serious blunder which could result in vast losses of inefficiency. His square root routine, PROOTY, appears to be considerably more efficient than he intended. By setting PABIT with the PON pseudo-operation (equal to 2^{33}) he has created a situation whereby all arguments less than or equal to 2^{31} will exit in approximately 50 usec (7090 time). Even though his results will be incorrect, this is intolerably fast. Utilization of the pseudo-operation PABIT PZE I will result in execution times more in line with the stated goals, while still preserving the inaccuracy of the results.

Furthermore, Mr. Thogonal has overlooked one of the oldest and most obvious pessimization techniques in the industry—assembling all data as program constants. Judicious use of this technique will insure re-assembly for every run of a program which, in the case of frequently-used production jobs, can compensate for any efficiencies accidentally built into the coding.

E. LYPTICAL
El Segundo, California

Author replies: It's nice to know that the eggheads are in accord with us squares in our search for inefficiency. Mr. Lyptical's correction is in complete accord with my original intention. This also illustrates that an incomplete understanding of the assembly routine can aid in Pessimation. An occasional incorrect answer is good for any program.

Sir:

Mr. Thogonal's discourse overlooked some of the more effective tools of his trade. Rather than limit himself to assembly language programming (some of the better macroinstructions can help), he should explore the calling linkages in FORTRAN IV, and with a little effort (primarily in resuscitating an earlier, strictly to design objective, version of IBJOB) can turn out a program which compiles as pessimumically as it executes. Or, with no effort at all, he can use PL/I.

AL GORITHM
Wappinger Falls, New York

marginal utility

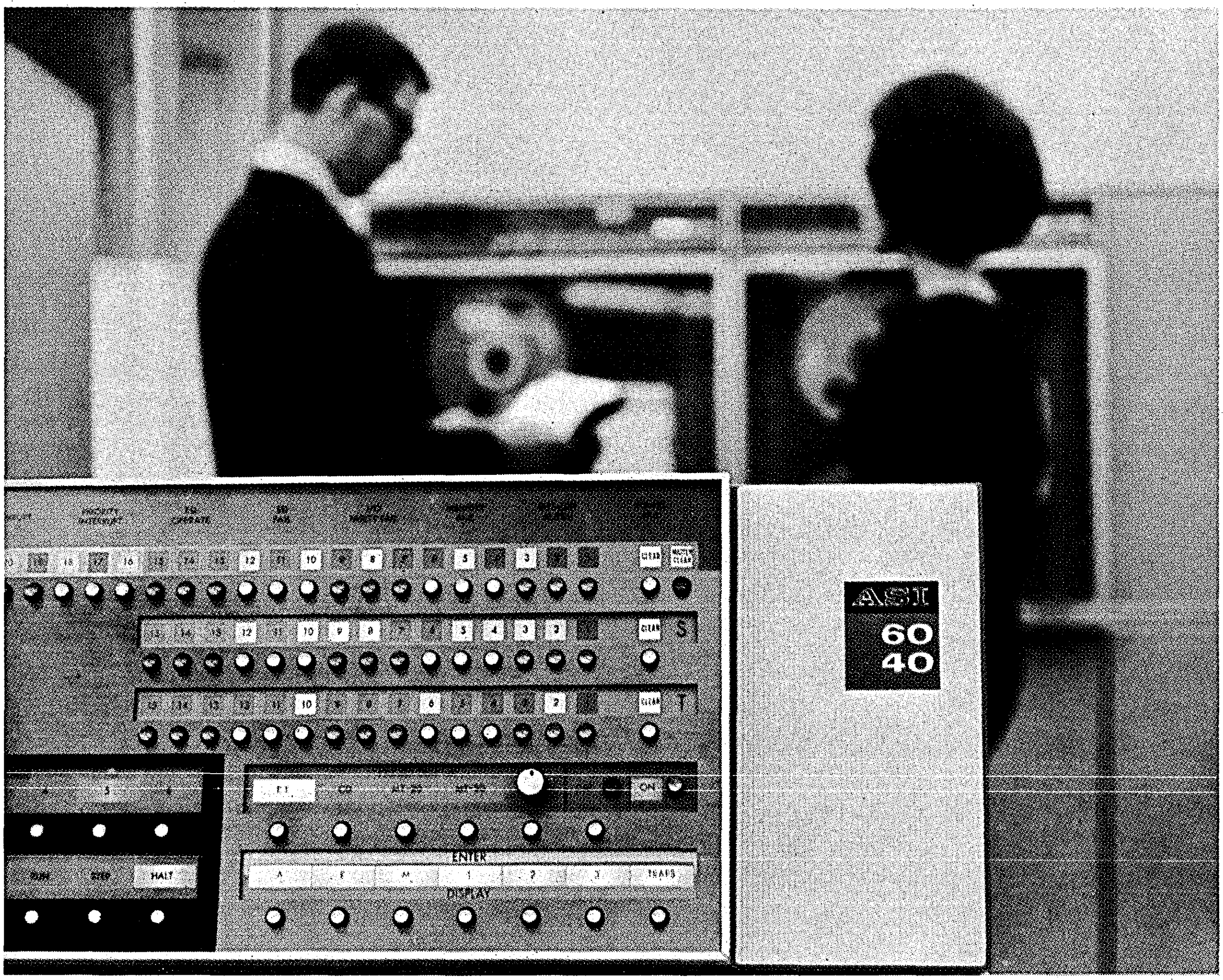
Sir:

At the risk of sounding pedantic, I would like to take exception to some aspects of Donald V. Etz' article, "The Marginal Utility of Information" (Aug., p. 41). The following points seem relevant:

1. Economic theory asserts that demand curves are downward sloping—the lower the price, the greater the quantity of a good demanded. However, economic *theory* says nothing more about the shape of such curves. This is as true of the marginal utility theory that Mr. Etz cites (generally regarded as tautological by modern economists) as it is of currently accepted formulations.
2. Textbook expositions of demand typically draw curves that are either linear or convex to the origin. Empirical work almost always assumes that demand curves are linear in the logs (and therefore convex to the origin). Thus Mr. Etz' demand curves, which are concave to the origin, are in no sense "typical."
3. The identification of the slope of the demand curve with terms such as "affluence" and "subsistence" is due to Mr. Etz, not to the economics profession. *A fortiori*, so is the explanation of the (purported) neglect of marginal utility by the early economists.
4. It is entirely possible that the demand curve for information is concave to the origin, as Mr. Etz asserts, and thus that his conclusions are in fact correct. However, economic theory neither supports nor rejects the assertion. The educated guess of most economists would be that the demand curve is not concave to the origin over the relevant range and thus that linear extrapolation of the curve would not provide an overestimate of the response to a price decrease. But that would be only a guess. Either result is possible in theory.

I hope that these complaints will not be taken as an attempt to stifle the utilization of economic theory by the computing profession. A great deal can and should be done to bring the two together. *Datamation* is to be congratulated for encouraging such

(Cont. on p. 133)



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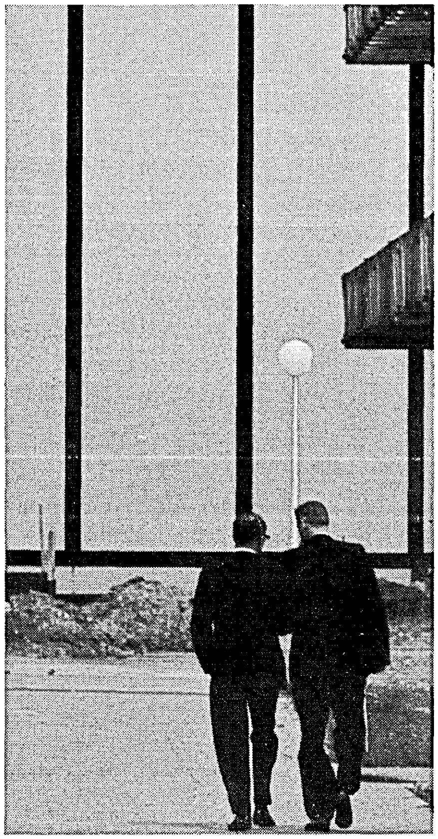

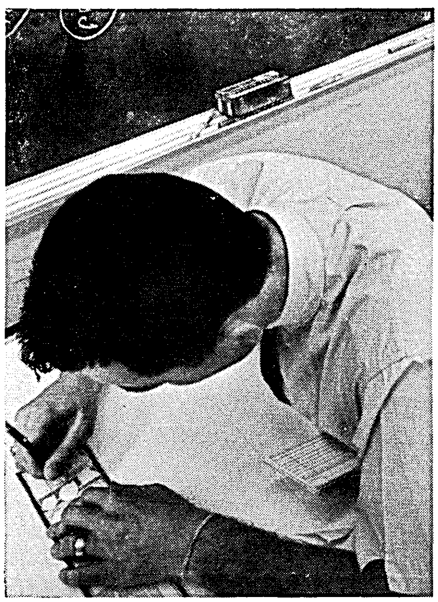

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DATAMATION

BUSINESS & SCIENCE

SOME 360 SOFTWARE DELAYED

Don't look now, but IBM is slipping some of its 360 software deadlines. Exactly what's being delayed is hard to pin down, but IBM does admit that there will be "deferments on some of the more complex programs," noting in the same breath that all of the "basic programming support" has been delivered on schedule. Background: IBM offers three levels of programming support for the 360. In order of increasing complexity, they are: basic programming support, basic operating system, and OS/360. Thus the delays -- expected "generally" to range from 30-90 days -- seem to affect the two upper categories, including Cobol. No measurable delays are expected on emulators. Says IBM: "Most of our customers will be unaffected."

STOCK MARKET TIP:
BUY INTO LAW FIRMS

Scientific Data Systems is throwing rocks at Scientific Control Systems, new Dallas computer firm, with a suit filed in U.S. District Court for the Northern District of Texas. It alleges that SCS has appropriated SDS product design, copyrighted material, business reputation, trademark, and trade name value. The SDS complaint says that the defendant "has entered into a scheme to appropriate plaintiff's business, good will and business organization and its products by deceptive use of the mark SCS and the name Scientific Control Systems so that defendant's products have been and will be passed off as those of plaintiff's...has been and continues publishing, selling, and otherwise marketing its computer manuals which are in a large part copied and/or paraphrased from the computer reference manuals of plaintiff..." SCS, however, says that SDS "is using litigation as a means to slow down the progress and recognition that we have attained in the data processing field."

MORE ON-LINE UTILITY
HOPEFULS APPEAR

Tieline, a new San Fran outfit, kicks off a big promotional campaign Oct. 27, offering 16 bay area franchises for computerized classified ads. Using Sanders Assoc. display terminals and an RCA 3301, the franchises will sell "space" for classified listings on the computer, which will match phoned-in requests against the appropriate file, displaying the phone no. of listings which meet the requestor's specs. Later, Tieline plans to offer a total of 58 franchises covering 111 cities, broaden the scope of services to include hotel reservations and the like, eventually aims at a universal credit card. A franchise will cover a telephone exchange area; prices will be based on the number of phones, are expected to be "extremely competitive" with classified rates. If Tieline succeeds, Sanders expects to sell 1000 CRT's, with the computer orders going to RCA.

"They laughed when I sat down to play the Mathatron."

"Little did they realize then that this was no ordinary $5,000 Mathatron. All they could see was the simple algebraic keyboard, and the paper tape readout.

"But underneath the Mathatron, cleverly disguised in the table, was capacity bringing the totals to 48 individually addressable storage registers, 480 steps of program memory, 18 prewired programs of 48 steps each, increased speed, and added program control!

"By my right hand, unknown to those snickering on my left, close by the candelabra, was an additional control box which told me, by blinking lights, which of the 10 loops I was addressing. And there were other buttons there, too.

"When I finished my evaluation of the formula involving trigonometric, logarithmic and other functions, matrix manipulations, triangulation and the solution of polynomials, they applauded generously." Send for complete details.

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Opportunities exist in other Honeywell Divisions. Send

Meanwhile, Peter James, president of Photomagnetic Systems in D.C., says he's getting ready to put a computer in every small business and home -- via touchtone telephone -- for $15/month.

PROPRIETARY PROGRAM PROGRESS: 10 COPYRIGHTS, ONE JAIL SENTENCE

Only 10 programs had been listed with the Copyright Office at last check, a few from individuals but most from corporations. New listings came from Burroughs -- with a version of FORTRAN II for the B5500 developed at the U. of Indiana -- and from Bell Labs for a permutation index program. Meanwhile, another angle on the whole copyright/proprietary information problem appeared as a Texas Instruments employee drew five years in jail from a Texas court for selling a TI programming system to a user firm.

HEY, MAC, YOU WANNA BUY A USED COMPUTER...CHEAP?

Shady wheeler-dealers are appearing on the used computer scene. Making verbal bids for used computers, they then try to line up a customer. If none appears, they welch on the deal, leaving their "client" with a machine that has depreciated even more. Advice from one legitimate broker: deal with the likes of him, somebody who works on a percentage basis, and who usually reveals names of buyer and seller. Check the credit rating of the company you're buying from. Try to get a deposit.

One legitimate outfit which made it big in used tab equipment -- Management Assistance Inc. (from $10K gross in '60 to a projected $11-12 million in '65) -- is moving into computers in a big way, offers reconditioning and nationwide service. Another NYC firm, International Office Appliances, Inc., is offering NCR 310's, thinly disguised CDC 160's, which NCR has evidently given up on.

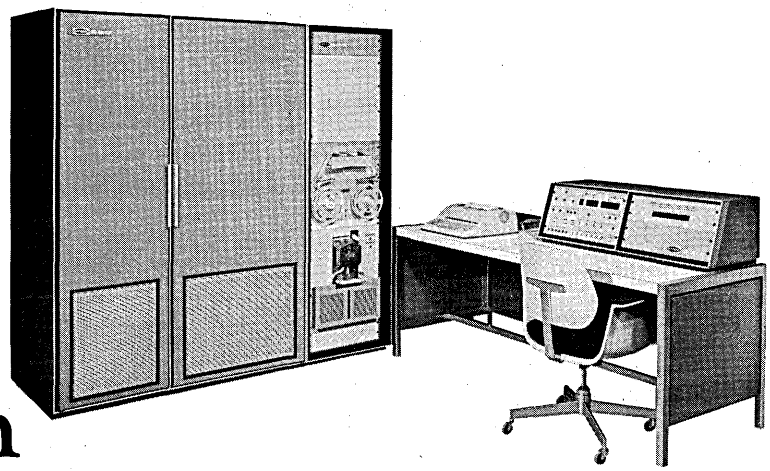
ON THE PL/I FRONT: 7094 SUBSET DEVELOPED; AMBIGUITIES THINNED

A "quick and dirty" PL/I subset compiler has been developed at Caltech's computer center to allow those considering or evaluating the language to play with it, and to foresee implementation problems. Despite problems posed by vague early documentation, first users seem to like the language's ease of programming. The current version is now being converted to a form to permit it to run under standard IBJOB, will hopefully be distributed through Share. The compiler, written in the TMG language of TI's Bob McClure, took two man-months to complete. We understand other early PL/I compilers are under way at Aerojet/Sacramento and at Stanford (for the B 5000). Elsewhere, one consultant has thinned an early list of 3000 PL/I ambiguities down to about 100.

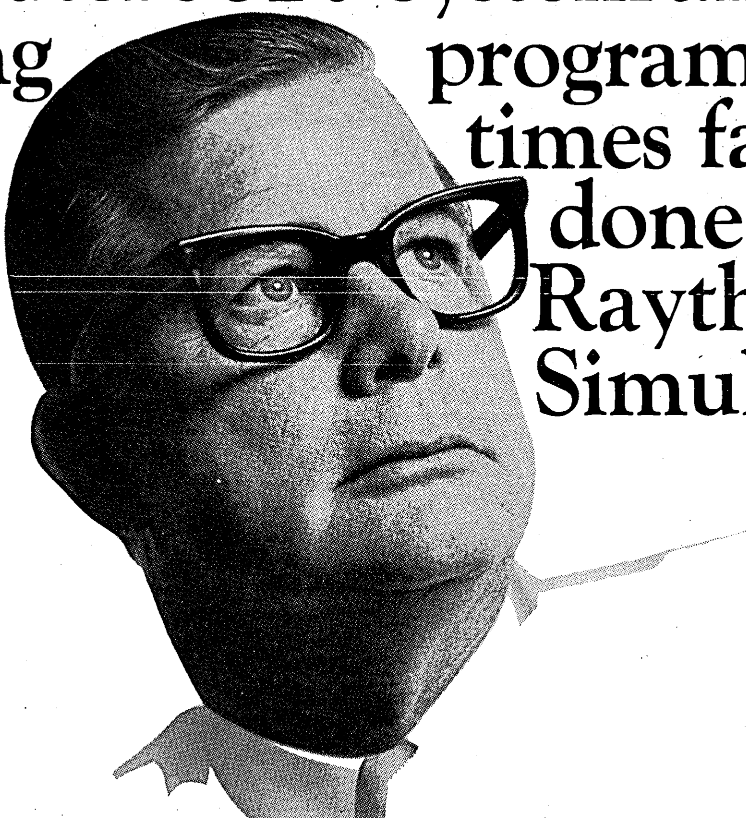
IT'S TALLY HO! IN SEATTLE

Seattle's once sluggish Tally Corp., perforated tape peripheral manufacturer, looks as if it's beginning to move under new president Russ Dubois, former Data Products Co. marketing man. A recent $1.5-million Autodin subcontract puts teeth in Dubois' ambitious plans: a minimum of 40% growth per year, with a target of $20 megabucks by 1970, profit goals of at least 10%. The company grossed $3.4 million in '65. Dubois points proudly to a recent test in which Tally gear read 1 million characters, punched 800K without error, says bookings for the first half of '65 were double those of last year.

(Continued on page 139)



1620 Users, you can move up to Raytheon Computer's 520 System and process existing programs three times faster. It's done with the Raytheon 1620 Simulator.



Raytheon Computer's 1620 Simulator allows you to move up to the 520 and still use your valuable 1620 I or II program library. Not only do you keep your existing programs, but you can run them much faster and more efficiently. And there are *no* program conversion costs.

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You'll also get a software system second to none, including FLEXTRAN, a compiler-assembler, 520 FORTRAN, and the BOSS operating system in addition to the 1620 Simulator itself. Raytheon's new 520 FORTRAN processor makes it possible for you to run your 1620 FORTRAN programs approximately 60 times faster than you can with your 1620.

There is no more practical way to move up to a modern system that will satisfy the requirements of both management and your programmers. Why not switch to the Raytheon Computer 520 System? Write or call for details. They're all in Data File C-114. Raytheon Computer, 2700 South Fairview Street, Santa Ana, California 92704.

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WASHINGTON REPORT

UNIVAC COMPLAINS AGAIN ABOUT IBM AWARD

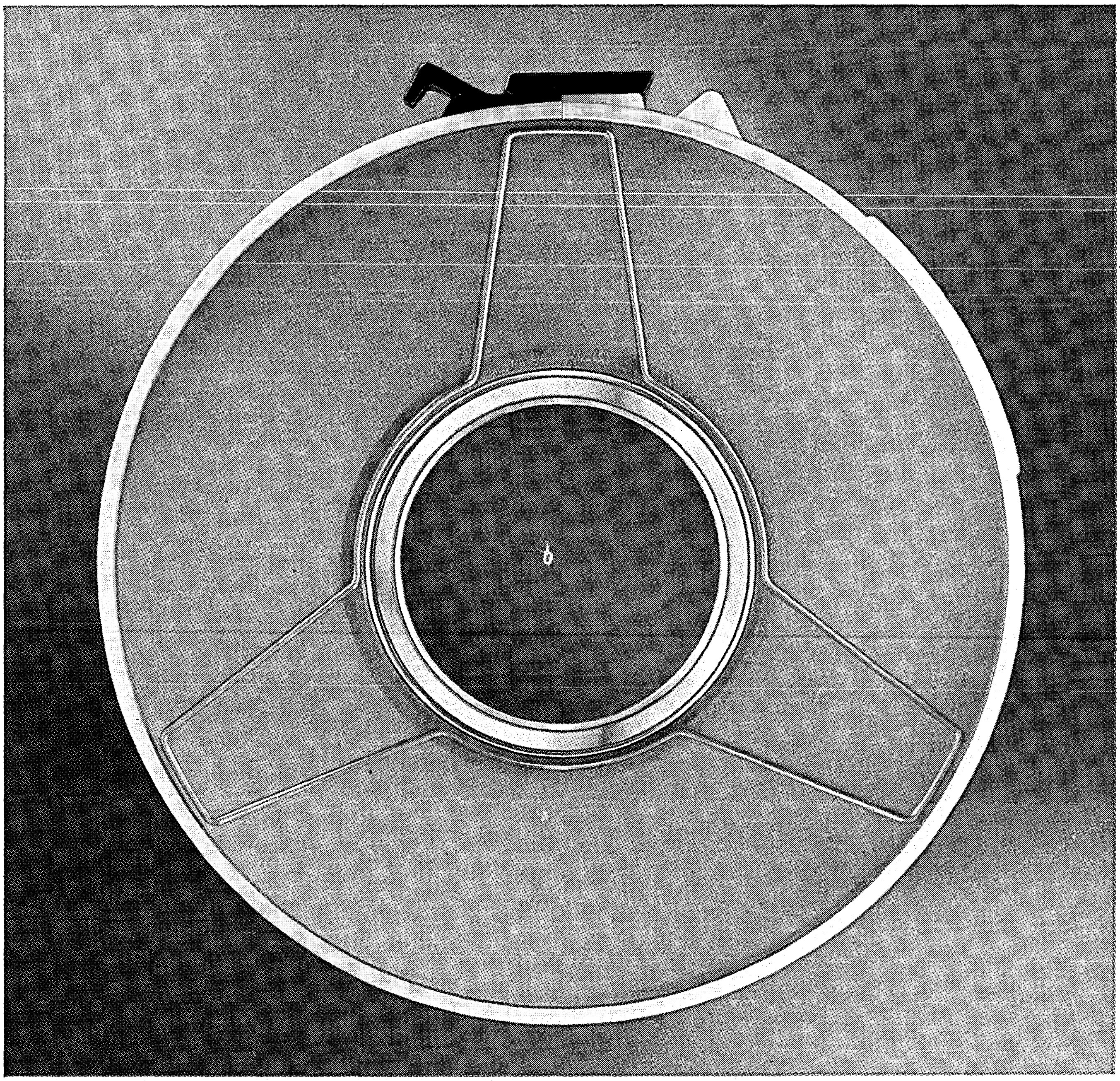
The Defense Department and the General Accounting Office are entertaining a formal complaint by Univac concerning IBM's selection last summer by the Marine Corps to provide five 360 configurations, worth $3 to $5 million, for an inventory and logistics control system to tie in with AUTODIN. Reportedly the Univac complaint alleges that IBM didn't play cricket in providing the demo machine as required in the RFP specs, and that it listed a fanciful software capability in its proposal. The complaint, directed first to GAO, was passed on to DOD, which is presently conducting its own tight-lipped investigation. Earlier this year Univac squawked about another IBM award, this one by the Federal Aviation Authority (see March, p. 23). This protest has not yet been officially resolved, but FAA indicates it will soon rebid this equipment since its initial procurement of seven 1401-G's was only an "interim" step anyway.

BROOKS BILL PASSES HOUSE, FACES COMMITTEE OBSTACLE

The Brooks Bill, HR 4845, which would centralize government adp procurements, passed the House easily by voice vote, but not before another effort to limit its scope was beaten back. Rep. Arnold Olsen, Montana Democrat, proposed an amendment to limit the jurisdiction of the revolving fund to be created to "equipment pools and data processing centers," in effect excluding about 95% of government adp equipment. The amendment was defeated. "The revolving fund is the heart of the bill," noted one advocate of the bill. "With that intact, we've got a law; without it, we're back to BOB policy guidelines." Next stop: The Senate Government Operations Committee, which was the graveyard for HR 5171, 4845's predecessor in the last session.

A POLICEMAN'S LOT IS NOT A HAPPY ONE

Difficulties are being encountered by the State Department in its effort to maintain an effective embargo on the shipment of computers to France which might aid in its atomic/military program. Though several large, new computers have been held up dockside in the U.S. for almost a year because of the French refusal to go along with the Partial Nuclear Test Ban Treaty, technological traffic between the two nations overall has increased, with more U.S. edp firms linking up with French companies. "We're keeping a close eye on arrangements between GE and Bull, and others, to make sure there is no information leakage," said a State Department official, "but this sort of thing is hard to police." Another complication is the growing lack of distinction between "commercial" and "military" computers. The State Department has to reckon with the possibility that a large commercial computer, ordered by a civilian company, might subsequently end up doing military/atomic chores.



EDITOR'S READOUT

BIG BROTHER

A couple of months ago, four computer types sat around, their heads powdered, Kleenex around their necks, warming up for their televised discussion on L.A.'s educational channel of the topic, "Are Computers a Menace?"

While the cameramen adjusted lights, sought the best angles, the reformed, positive-attitude Herb Grosch got the ball rolling: "Big Brother is going to be a computer. Let's face it." And he told how, returning to the states from his sojourn as a European consultant, he had been nabbed for a five-year-old traffic ticket. Pretty soon the cameras were recording the panelists: RAND's Bill Maron, Max Palevsky, Dick Hamming and Grosch.

After raising the opening question, moderator Keith Berwick of UCLA led the panelists down some familiar corridors: computers were compared to rocks, sharp tools, autos, traffic lights, steam shovels, and books. The main fear of people, it seemed to Maron, was that they would be treated like machines. Berwick asked about this business of computers arranging marriages. "Any method would be preferable to the current one," answered Grosch.

The examples of computerized credit management and university placement were used to show how a system might exclude "personal" considerations . . . leave the individual at the mercy of a narrow machine efficiency. But Hamming disagreed: "We have for the first time the possibility of infinite variety. We don't know how to get there. But it's possible."

This catapulted the speakers into a discussion of how a democratic society achieved its goals. Palevsky maintained that technological goals were not obtained in a democratic fashion, that it was profit pressures which determined direction. Others felt that education, civic pride and such intangibles could be used to shape the future use of a technology which all agreed has a profound impact upon our society.

The discussion was lively, the participants articulate and earnest. As in most similar discussions, the question posed was not answered, partly, of course, because it's both vague and loaded, partly because basic terms — e.g., computer — were never fully defined. But many of the right questions were raised.

One such question is, "Can a computer-based system — credit management, marriage management, or whatever — be humane?" Unfortunately, the question is easier to raise than to pin down, partly because people have fairly fuzzy notions of what is humane. Often that term is used to describe error, forgetfulness, inconsistency, and sloppy thinking.

It is precisely the human failure and inability to quantify all of the elements of the decision-making processes which makes it — right now — impossible to provide systems which are consistent, flexible and fair. But this doesn't mean that designers shouldn't try to design systems to take over some of the more mundane clerical work involved in the total process.

And it doesn't mean that because a system isn't perfect that it shouldn't be tried. The real tests are: is the new system better than the current system — or no system — at all? And, does it free the human involved to spend more time on decisions which are so far beyond the scope of the computer and the systems designers?

Hidden in the surface cynicism of Grosch's comment about arranging marriages is a solid truth. We believe that it *is* possible to be sane and organized about some problems which today are left to emotion, whimsy and chance. We think it's possible (and wise) to try to organize and to weight factors which affect a decision, even if the final decision has to be left to the marvelously inefficient emotions.

Perhaps the Big Brother we fear is really that part of us we do not yet understand and which we so far cannot control.

HYBRID COMPUTATION

by THOMAS G. HAGAN

"Computing Machines, Electronic. Electronic computers can be divided into two classes, analog and digital. These two classes use such different techniques, and are put to such different uses, that they will be treated separately . . ." — *Encyclopedia Britannica, 1963 edition.*

" . . . We have two classes of machines, the digital and the analog . . . To me, some of the most interesting machines built by man are neither digital nor analog. I think that this field is somewhat neglected today, yet in it lies much of the promise of the future. I think many of us have been too closely associated with one of two definite paths without looking at the intermediate ground . . . " — *Vannevar Bush, at the MIT Symposium, "Management and the Computer of the Future," 1961.*

Analog computers are very fast. That fact, and the fact that they are most seriously limited precisely where digital computers excel—i.e., in ability to carry out complex logical operations or to perform high-precision arithmetic—has inspired interest in hybrid systems in which analog and digital techniques are combined, each to the advantage of the other.

Such interest began in earnest about 10 years ago. The first substantial hybrid computer installations were two systems installed in 1957 for engineering simulation on the Atlas missile program. Each consisted of a large analog computer and a large digital computer, tied together with a linkage system that performed analog to digital and digital to analog conversions, to permit exchange of information between the analog and digital computers.

It is possible to run a "real-time" engineering simulation of the flight of an aerospace vehicle on such a system, whereas the same problem might be completely beyond the capability of either an analog computer or a digital computer operating independently. A hybrid of this type, formed by combining an analog computer and a digital computer, can handle a vehicle simulation by solving the

Mr. Hagan is vp and director of Adage Inc., Boston, Mass., which he helped to form in 1957. He has been involved in the development and marketing of a-d converters, hybrid computer linkage systems, and the Ambilog 200 stored-program signal processor. Prior to the firm's founding, he was with Grumman Aircraft Engineering Corp. and with Epsco, developing data acquisition, signal processing, and PCM telemetry systems. He holds a BS from MIT.

rotational dynamics equations (which require high speed but not high precision) on the analog computer, while the translational kinematics equations (which describe the trajectory through space taken by the vehicle and which require high precision but unfold more slowly) are solved on the digital computer. The linkage system provides the information exchange necessary to account for the interactions that take place between the dynamics and the kinematics. By partitioning the problem in this way, the hybrid system achieves a solution more accurate than that achieved by analog computer alone, and at much higher speed than if the entire problem were to be run on a digital computer.

Experience with early hybrid installations revealed that there were formidable problems encountered in attempting successful interconnection between analog and digital computers. Many prospective users, although convinced of the ultimate attractiveness of the hybrid approach, decided to "wait watchfully" until feasibility of reconciling the contrary natures of analog and digital techniques could be more clearly demonstrated. The U.S. space program produced some simulation problems for which hybrid techniques were very attractive, and provided the impetus for continued experimenting in the late 50's and early 60's, both in the universities and the aerospace industry.

By 1963, there were more than a few admitted failures, and some qualified successes, but also four or five definitely successful hybrid installations, and interest began to spread rapidly among the simulation fraternity. Today there are over 100 hybrid computer installations of various types in existence. Most of these are combined analog/digital computers being used by simulation groups whose previous experience was primarily with analog computers, but new types of hybrids have come into being, and new types of users have found applications for hybrid machines. Further rapid growth seems to be in store for this interesting corner of the computer field.

Running counter to the idea that use of hybrid computers will continue to expand is the notion that as digital computers get faster and faster, they encroach more and more upon the small preserve that has historically been occupied by analog computers, and that there will shortly be no need for analog computers, or for hybrids incorporating them. This view is based upon the possibly faulty presumption that while digital techniques get faster, analog techniques do not, and fails to note the very large speed advantage still maintained by analog techniques for certain applications.

Analog computers are very fast, a statement worth repeating and worth illustrating with an example. At the IFIP conference in May, a digital computer was shown which can solve the kind of simulation problems that have historically been solved by a 100-amplifier analog computer, and, provided that natural frequencies of the system being simulated do not exceed about 5 cps, can produce solutions in real-time; also shown was an analog computer capable of solving such problems at about 1,000 times faster than real-time.

evolution of the analog computer

From the days of its earliest development, the analog computer has been organized as a highly parallel machine, with the parallel machine organization reflected in the programming techniques. The program for an analog computer of the classical type is a patch panel with an array of patch cords plugged into it and a set of potentiometers adjusted to provide appropriate coefficient values. The patch panel interconnects a set of operational amplifiers to form a parallel network of operators which simultaneously receive and transmit analog signal voltages[1] to one another. Time is the independent variable, and as the problem is run, outputs are in the form of analog voltages whose time histories can be recorded by various means.

Operational amplifiers and potentiometers provide the linear operations of summing, sign inversion, integration with respect to time, and multiplication by a fixed coefficient. Operators are also available for the non-linear operations of multiplication of variables and arbitrary function generation, but these were rather inconvenient and expensive operations in early analog machines. As a result, analog computers first found their widest field of application in the simulation of systems that can be characterized by sets of reasonably well-behaved linear differential equations, with only a few non-linear functional relationships.

Real-time solution rates are needed when the analog machine, programmed to simulate a system, is to serve as a "live model" of the system, responding to inputs and producing outputs in the same way and in the same time scale as would the actual system. This permits coupling the model to actual hardware and running simulations with the man "in the loop." The model is easily changed by manual intervention to study the effects of changing various parameters of the system being simulated.

For this kind of simulation mission, it is all important that the computer perform in real-time, but there is no particular merit in being able to go faster than real-time. Typical real-time simulation problems do not make very severe demands upon the dynamic performance of modern analog computers. There are other problems, however, where faster than real-time ("fast-time") solution rates are desirable, and it is instructive to review the evolution of analog computers used for fast-time problem solving.

The first fast-time analog computers were the so-called rep-op (for repetitive operation) machines of the late 40's and early 50's. These produced solutions at a 30- or 60-per-second rate, so that a CRT could present a flicker-free display of a complete solution, showing, for example, a graphical plot of the response of a system to a step change in its input stimulus. The operator could vary coefficients manually to achieve parameter optimization.

the iterative analog

Rep-op analog computer techniques led naturally to the development of means for automating the variation of parameters from run to run by using results achieved in one run to influence parameter values in the next run. This implied some storage means for storing variables from run to run, and also some control means for influencing successive iterations. At full flower, this type of machine is known as the iterative analog to distinguish it from the older rep-op machines in which no automatic parameter search techniques were possible.

The iterative analog is, as its name implies, amenable to a variety of iterative problem-solving strategies. It exploits the inherent data processing capabilities of its analog components more efficiently than either the older rep-op machine (which would crank out 30 or 40 identical solutions within the response time of its attendant operator), or the classic "real-time" (now called slow-time) analog in which most components operate at only a fraction of their ultimate speeds.

The iterative analog also permits sequential operation which provides substantial hardware economies for some problems. An oft-cited instance is the problem of simulating a distillation column consisting of a stack of similar plates, with fluid flowing downward from plate to plate. The computer is set up to solve the equations determining material balance between liquid and gas phases for a

[1]For discussion of analog representation of variables, see inset, p. 28.

single plate of the column, and a series of sequential runs are made. Final conditions from one run serve as initial conditions for the next run, so that the solution for the complete column is achieved sequentially on a plate-by-plate basis, with only the hardware required for solution of a single plate. This contrasts with the old all-parallel analog solution which would require enough hardware for every plate in the column.

A fast iterative analog can produce a complete solution to a fairly complex set of differential equations in one millisecond. This is not just one step in the solution, but the complete solution—for example (again), the transient response of a system to a step change in its input. Thus, it is feasible to conduct statistical studies or to perform parameter searches for optima that require hundreds of thousands or even millions of complete solutions.

For all of its processing power, the iterative analog remains limited. The form of the equation set it is programmed to solve can be changed only slightly in the course of a succession of iterations; it provides only relatively volatile analog storage, and allows for only limited decision making or branching under program control. It remains for hybrid systems to harness the processing power of analog devices by coupling them to digital elements providing these missing virtues.

hybrid computers

Classifying hybrid computers has become an almost respectable intellectual pastime, all the more fascinating because of the many different kinds of hybrid computers that have been built, or at least studied on paper. Hybrids can be highly parallel or highly sequential in organization. Operation can be under control of a stored program, a wired (patch panel) program, or both. Value representation can be analog, digital, or both (as when analog and digital computers are combined) or even hybrid analog/digital—for example, where magnitude representation is analog and exponent is digital, or where the most significant part of a data word is represented digitally and the least significant part is represented . . . analogically? Arithmetic operations can be performed by analog or digital elements, or hybrid devices which act upon both analog and digital operands, or any combination of these.

A comprehensive classification system for hybrids would have to encompass all computers, for the purely analog and purely digital machines are clearly just special cases, particular branches on the complete family tree. There would even be genus and species for such strange fauna as the "all-digital hybrid," which consists of a digital differential analyzer coupled to a general purpose digital computer.

A less ambitious classification system, but one perhaps more useful for fitting hybrid developments into historic perspective, classifies hybrids which combine analog and digital techniques by the way in which they incorporate analog or digital computers previously designed for independent existence. There are four types, comprising the complete set of possibilities:

1. An analog computer with digital logic added,
2. A digital computer with analog elements added,
3. A digital computer linked to an analog computer, and
4. The "true hybrids" containing neither an analog nor a digital computer intended for independent existence.

The iterative analog computers discussed previously are actually hybrids of the first type above, since they include some parallel patchable digital logic used for controlling iterations of the analog elements. Analog computers have always been equipped with provision for at least some digital control, originally in the form of electromechanical relays, more recently in the form of digitally-controlled solid-state analog signal switches and banks of patchable flip-flops, gates, and counters. As a result, most modern commercial analog computers are capable of iterative operation, although not all are suited for very high-speed fast-time operations.

The term "all-parallel hybrid" has sometimes been used to describe the first type of hybrid, an analog computer fitted out with a set of digital elements available on a patch panel. Such systems possess great processing power and are capable of limited sequential operation, but lack the logical power and more flexible sequential operation that would come with stored program control.

Hybrids of the second class above have been the object of research at MIT, UCLA, and elsewhere. In this approach, analog elements are added to a digital computer, and serve as an extension of its arithmetic unit. They are under close programmed control of the digital computer, and communicate via an I/O channel and A to D and D to A converters. The analog elements are not intended to function independently of the digital computer, but instead are organized to take up some of the digital processor's computing work load. This kind of hybrid has sometimes been described as "a digital computer with analog subroutines." By building in appropriate "analog subroutines" the processing power of the digital processor may be increased by a factor of 10 or more for such applications as engineering simulation, operational flight trainers, and solution of partial differential equations.

the popular configuration

Hybrid computers of the third type, formed by linking analog and digital computers, have been extant longest and have been the focus of most of the hybrid computer activity in the commercial marketplace. They are now widely used for engineering simulation and there have been a number of significant applications in the field of biomedical research. It is fast becoming commonplace to form such hybrids by linking new or pre-existing analog and digital computers with a standard package linkage system capable of exercising all the data conversion and control functions necessary for forming a well-integrated hybrid.

All sizes of digital computers have been used in linked analog/digital hybrids. Successful systems have been formed with even very small digital computers serving primarily as controllers for the analog machines. More ambitious systems, however, have used larger digital computers ranging from medium-sized scientific machines upward to the very largest.

Many hybrid systems of the third type also contain patchable logic elements and hence are also capable of solving problems within the province of hybrids of the first type.

Input/output capabilities of digital computers have improved in the last several years, and, in particular, data interrupt techniques for getting information transferred in blocks at high speeds in and out of the digital computer memory have helped simplify what once was a bottleneck. High-speed multiplexers and A to D converters now make possible A to D conversion of multiple analog channels at overall system rates of approximately 100 KC. D to A conversion data transfers at the 100 KC rate have been possible for some time. Linkage systems are now available with multiplying D to A converters capable of serving as digitally-controlled analog attenuators, so that digital values fed into the linkage system from the digital computer can directly set coefficients in the transfer functions of analog signal paths within the analog computer.

Hybrid computers of the fourth class, the "true hybrids," contain neither an analog nor a digital computer intended for independent use. They differ from the other hybrid types in that more intimate combinations of analog and digital techniques are possible. Hybrids of this class can take many different forms. Considerable work has been done with them at the Univ. of Arizona primarily for differential equation solving and statistical system studies. One system of this class has been developed as a standard product, and has been successfully used for a number of signal processing applications.

simulation

Simulation has always been an important application for hybrids formed by linking analog and digital computers. These systems have reached maturity in that they are now in widespread use and are an accepted means for attacking a variety of simulation problems. Almost all major space vehicle simulations are now carried out with such systems. Engineering simulations for the OAO, Gemini, Apollo, LEM, and other space vehicles have all been conducted with linked analog and digital computers.

Linked analog/digital computers lend themselves well to vehicle simulation because the equation set describing the motion of a vehicle through space can be partitioned into two sets with, in many cases, relatively little interaction between the two. One set describes the kinematics of the vehicle, essentially the trajectory or track through space taken by the vehicle. The other set describes the rotational dynamics of the vehicle, with variables representing the angular position or attitude taken by the vehicle in space. The rotational dynamics equations require high-speed solution for real-time simulation but need not be carried out to extremely high precision; the precision available from typical analog methods is adequate. On the other hand, the translational equations describing the trajectory of the vehicle unfold more slowly but require higher precision for meaningful results. The high precision requirement can be fulfilled by digital solution of the kinematics equations, and a digital computer is sufficiently fast for solving most trajectory problems in real-time.

Although separable on a gross basis, there are, of course, interrelations between the dynamics and the kinematics of a vehicle, and hence the need for simultaneous solution of both equation sets for meaningful mission simulation, and the need for coupling, via a linkage system, the analog and digital computers used for solving the two parts of the problem.

Other tasks assigned to the digital computer in such systems include the simulation of on-board digital control systems and sometimes the generation of non-linear functions, especially the generation of functions of two or more variables, a very arduous task for solution by analog means.

There has been an interesting upward trend in the number of A to D and D to A converter channels associated with linkage systems used in linked analog/digital hybrids for simulation. Systems frequently are built with a few channels in each direction for early trials, then expanded to 16 or 24 channels each way for serious hardware simulation, and then later expanded to 32, 64, or even 128 channels as the hybrid technique proves itself and as more and more uses are seen for communication between analog and digital portions of the system. The increased channel capacity frequently reflects a shifting of more and more of the problem into the digital computer. Even if the entire problem is shifted into the digital computer, a requirement still exists for a large number of A to D and D to A channels in those simulations where the computer must interface to actual hardware, and displays are required for human participation in the problem.

The idea of dropping the analog portion completely and going to all-digital simulation has had its staunch advocates. However, at least one group which started out all-analog, perfected hybrid techniques, and then decided to go all the way to all-digital techniques, has made the discovery that for large-scale engineering simulations it is very difficult to expunge completely the analog portions of such hybrid systems without paying unpleasant cost and performance premiums for the luxury of all-digital operation. Linked analog-digital computer hybrids therefore are probably here to stay for vehicle simulation work.

Partitioning equations of motion into sets representing dynamics and kinematics is actually a rather crude method for dividing labor between analog and digital parts of a hybrid system, although it has been used frequently and effectively. Improvement in the utilization of hybrid computers can be expected as more sophisticated methods are developed for dividing labor between analog and digital parts of the system; some fruitful work has already been done along these lines.

signal processing

Engineering simulation is the application area where hybrid developments have received the most attention; an almost completely separate path for the development of hybrid processing techniques has been in the area of signal processing.

Signal processing problems arise in conjunction with the acquisition, recording and analysis of data in such fields as aircraft flight tests, sonar, physiological research, seismology, experimental stress and vibration analysis, automatic production testing, and experimental communications research. Useful signal processing operations include conversion of raw data to engineering units, limit testing, measurement of waveform parameters such as peak values and time intervals between arbitrary threshold crossings, and the measurement of statistical parameters such as amplitude spectra, correlation functions, and frequency spectra.

For 12 years or more, hybrid analog/digital signal processing techniques have been undergoing continuous and intensive development for instrumentation data acquisition and data reduction applications. Refinement of information processing techniques for these purposes has taken place outside the mainstreams of analog and digital computer development. Here, information processing problems are frequently direct extensions of instrumentation and measurement problems, and workers in these fields have generally had relatively little communication either with simulation people or with the population of digital computer users interested in general scientific applications.

Special purpose analog and hybrid devices, such as harmonic wave analyzers, have proliferated along with data acquisition systems designed simply to convert analog signals into digital form for subsequent analysis by conventional digital computers. Digital data acquisition systems of this type are now used in many scientific and engineering fields.

Linked analog/digital computers installed primarily for simulation purposes have sometimes found themselves applied in a major way to signal processing chores that were originally anticipated as candidates for purely digital processing, with the hybrid system to serve merely as an A to D conversion system. For example, analog and hybrid techniques for prefiltering data were found to result in a very significant unloading of the digital processor in a power spectrum density analysis application.

A perpetual source of surprise is the ease with which it is possible to saturate even the largest digital computer with the task of editing and analyzing the masses of data that can be generated in a short time by a relatively simple experimental process. Many experiments can produce multiple analog outputs such that overall system sampling rates must exceed 50 or even 100 KC in order to capture all data of interest. Some experiments can produce data at high rates for extended periods of time. For example, a biomedical researcher might be interested in following the progress of a subject for a 24-hour period, monitoring 10 or 20 physiological variables at various sampling rates, resulting in an overall system sampling rate of 10 or 20 KC. If all the input data were digitized and recorded on magnetic tape, a 24-hour data collection period would produce about 100 reels of magnetic tape. Performing such monitoring on, say, 100 subjects would result, among other things, in the problem of finding storage space for 10,000 reels of tape.

fast data rates

Most of the traditional business and scientific digital computer applications involve the processing of source data which at some point in the cycle is entered by manual keyboard. There is a vast quantitative disparity between input data rates associated with traditional digital computer applications and data rates associated with analog/digital acquisition techniques. One conventional A-D converter can produce input data to a digital processor faster than 50,000 keypunch operators working full time. This knowledge has frequently come as a rude shock to those who had mistakenly assumed that an A-D converter is just another input device to be hung on the central processor.

The converse problem appears when relatively wide-bandwidth analog outputs are required of digital processors. The data rate required to paint flicker-free pictures on a cathode ray tube of the complexity and quality of a typical television picture is in the order of 10 megabits per second. Needless to say, such pictures are not yet being generated by any kind of computing system.

Hybrid techniques have been applied to signal processing operations to cope with the floods of data encountered in many experimental situations. The very high processing speeds achievable with analog elements have been combined with the storage, decision-making, and control capabilities of digital techniques to reach otherwise unachievable performance levels for signal analysis and generation of complex wave forms.

Maximum effectiveness in the use of hybrid techniques for signal processing applications requires a more intimate combination of analog and digital elements than can be achieved by the linkage of analog and digital computers. Special purpose systems organized to achieve this end have been built for six or seven years, and a general purpose stored program hybrid signal processing system employing these principles has been designed and is now in use at a number of installations for a variety of purposes —analysis of seismic wave forms, high-speed real-time reduction of physiological signals, analysis of sonar signals, wind tunnel and flight test telemetry data reduction, and arbitrary function generation. In each case, analog inputs or outputs are present, data rates are high, processing to typical analog accuracies is adequate, data storage is necessary, and the flexibility of stored program operation is either necessary or at least highly desirable. Today this combination of circumstances spells "hybrid", and probably will for some time into the future. ■

digital and analog representation of variables

Primers on digital systems usually explain the selection of 2-level logic for use in such systems with a few words to the effect that nature prefers bistable states, an assertion with a comforting Aristotelian ring to it, like "nature prefers a vacuum." For their part, the analogers, to explain the curious persistence of systems using continuous representation of variables, may be heard to point out that, after all, nature is analog (i.e., continuous), as though Chinese Checkers and quantum mechanics had never been invented.

In a digital system, information is represented or conveyed by voltages appearing on wires at discrete levels. In an analog system, the value of a variable corresponds to the value of the voltage appearing on a wire, and the voltage can vary smoothly through a continuum of values. It would seem that there is no middle ground between these two techniques, but such is not the case. Digital systems can be built in which voltages can occupy more than two discrete levels. For example, with voltages still being constrained to specific quantum levels, systems might be designed with voltages constrained to 2, 3, 4, 5, or *n* levels. Thus, if one wished to represent a variable to about one part in 1000, one could use 2-level logic and with straight binary representation of the variable would require 10 wires to convey its value to one part in 1,024. On the other hand, if, instead of 2-level quantization, one could impose 4-quantum levels on each wire, then only five wires would be required to represent a variable to one part in 1,024. Finally, if it were possible to constrain voltage on a wire to one of 1,024 levels, then one could represent the variable with a single wire, referenced to ground.

In the case where a single wire is used to represent the variable, it is quite feasible for the system design to allow noise to exceed the quantizing interval used in the system. Noise will, of course, limit performance of the system but will not introduce gross errors. Multi-wire systems, on the other hand, are predicated upon the assumption that noise levels will be well below the quantizing intervals in order that errors of plus or minus one quantum level will not be introduced into the more significant portions of the data word.

The *n*-level logic case, therefore, represents a kind of mid-ground between analog and digital techniques, and it is sometimes instructive to think of analog techniques as simply the one-wire, *n*-level logic case carried to an extreme where the quantum intervals are small compared to the noise levels experienced in the system.

Although *n*-level logic has come in for some attention on its own in recent years, the facts of history are that computers have generally been built either as digital machines with two-level quantization of voltages (and hence multiple bits for representing values) or as analog computers in which values have been represented by continuously varying voltages. ■

SIMULATION SOFTWARE

the sds approach

by DR. RALPH T. DAMES

The operational philosophy of most large-scale, all-digital computing systems is founded on over two decades of extensive experience. In such computation centers emphasis is usually placed on minimizing "job," rather than "problem," throughput time. This implies a minimum of operator (manual) intervention during or between jobs; little, if any, on-line debugging, and quite often a strictly closed shop operation. This philosophy is based on the theory that maximum system efficiency is gained when idle time of the computer is minimized. In the all-digital world, this principle is frequently sound and is implemented by monitor programs which provide for automatic debugging and "batch processing." Hybrid computation, on the other hand, generally requires on-line communication between man and machine and, thus, in simulation there is greater emphasis on minimizing "problem" throughput time.*

Early work in digital programming was expended on developing software for utilizing the digital computer to speed up problem setup and checkout. The software and techniques that resulted from this effort have developed into useful tools and procedures which are generally applicable to the digital portion of a hybrid system; they are not, however, adequate for a total simulation system.

Simulation software requirements differ from those associated with general purpose data processing in several respects. These differences have made many vendor-supplied standard software packages unusable for simulation work or at best simply inadequate.

In the past few years there has been a significant trend toward developing simulation oriented languages.[1,2] At first glance, it would appear that such languages serve only as a crutch to evade the use of FORTRAN or other programming systems. On the contrary, however, use of a simulation language provides implicit benefits not always immediately recognized. For example, rather than have the programming task for a hybrid problem treated in two completely different ways, usually by two people with differing backgrounds, a simulation language can describe the entire problem and be easily used by a simulation engineer. This convenience and economy is a strong consideration for including such a language in the total software package supplied by the vendor.

One of the most basic and important requirements of simulation software is that it operate in a real-time environment. For example, signal and control lines between analog and digital must be serviced on demand. Furthermore, accurate time synchronization to initiate data conversions and other simulation events must also be handled on an interrupt basis. Thus, the operating system, hardware and software, must be capable of processing both synchronous and asynchronous priority interrupt re-

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* Although the term "simulation," as used throughout this discussion, is identified primarily with hybrid computation, it also applies to all-digital simulation. That is, on-line modification of problem structure greatly enhances the ability to realize the reproduction of a physical process, regardless of the computational mode, be it hybrid or all-digital.

[1]Brennan, R. D. and Linebarger, R. N., "A Survey of Digital Simulation: Digital Analog Simulator Programs," *Simulation,* Dec. 1965.

[2]Levine, L., "The DES-1, A New Digital Computer for Solving Differential Equations," *Simulation,* April 1965.

quests initiated by an arbitrary number of external sources. This requires that programming systems be recursive (or reentrant). That is, interrupted subprograms or subroutines can be reentered during their execution any number of times (as a result of several interrupts), and upon subsequent return resume computation without loss of intermediate data. Without this software feature, simulation programming can be extremely inefficient, difficult or even impossible.

The simulation programmer requires general software control over interrupt hardware. In particular, for SDS computers which employ the matrix control type of interrupt structure,[3] the arm/disarm and enable/disable features are important. The arm/disarm feature provides the option of detecting, but not activating, external interrupts; the enable/disable feature determines whether or not an armed interrupt is placed in the active state when it occurs. In some cases it is important to disable interrupts during program execution to assure immediate completion of the associated function. Subroutines are then "protected" from delayed execution, and incoming interrupts are not lost if the system is armed. This ability to protect subroutines, or alternately to make them recursive, is a programming requirement that should be built into the simulation software system.

speed vs. accuracy

An implicit software requirement for real-time simulation is the generation of efficient object programs. Although this feature is important to all computation centers, it can mean the difference between success or failure for the simulation laboratory engaged in real-time applications. Specifically, the simulation programmer can frequently trade accuracy for execution speed in certain hybrid simulations since digital-to-analog conversions essentially truncate data to lower precision. Thus, subroutines designed for maximum accuracy and which use full word precision are not always needed or desirable. Most standard software, however, is so characterized.

Hybrid simulation places additional software demands in the area of diagnostic routines. Not only must standard diagnostic programs be available to check the digital system, but the hybrid interface and analog subsystem must also be tested. Furthermore, since many of the setup and checkout steps involved with hybrid computation are amenable to semi or full automation with a digital computer, routines must be supplied for exercising general interface control.

On-line problem debugging and optimization are commonplace in simulation. Software to support these tasks represents a new dimension in conventional debugging aids familiar to the digital programmer. Moreover, the ability to monitor problem solutions on display equipment and then adjust the program structure on-line is typical of the man-machine relationship that exists in simulation. Although it is not a strict simulation software requirement, this direct communication between man and machine should be emphasized in the software design.

The previous paragraphs indicate some of the more important considerations in the development of simulation software. These factors, however, are in no way intended to minimize the necessity for software features usually associated with general purpose computation. For example, the capability for all-digital batch processing is also a requirement in the well-organized simulation laboratory. This feature is important, not only for multiple assemblies and compilations of digital programs, but also for off-line debugging and for obtaining independent digital check solutions for both hybrid and pure analog problems. More simply stated, the automatic processing features that are commonplace in the digital computation center should be equally available to the simulation user.

SDS simulation software consists of modular elements all subordinate to a real-time, system control monitor. Individual modules provide useful tools for all phases of problem solving on a hybrid system and thereby tend to minimize problem throughput time. Programming economy is realized by having all modules call on a common set of hybrid interface subroutines. The latter routines represent the only systems programming that is configuration dependent. Using this organizational structure, SDS has adopted a unified approach to simulation software.

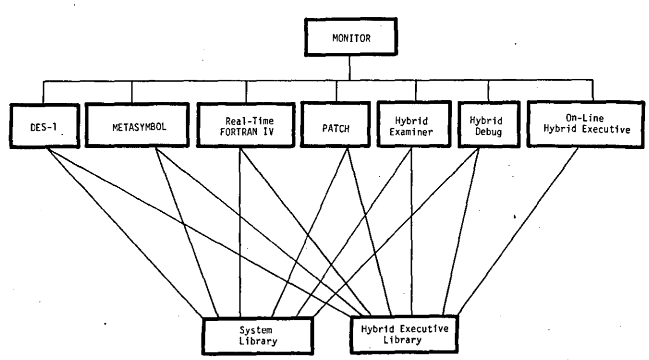
The software modules discussed in the following sections are designed to run on the SDS 9300/DES-1 computing system. With few exceptions, this software is currently operational.

simulation software modules

There are 10 simulation software modules in the system, as shown in Fig. 1. The MONITOR module provides supervisory control for all software elements, including three language processors. The first of these processors is Real-Time FORTRAN IV, which produces object programs suitable for operation in a simulation environment. METASYMBOL is a high-level symbolic assembler and the third processor, DES-1, compiles programs written in a simulation-oriented language. Sub-programs written in any combination of these three source languages can be combined to form a total simulation program. In addition to a System Library containing utility routines, there is also a Hybrid Executive Library. This provides for program control of all system hardware and, when used in conjunction with the On-Line Hybrid Executive module, manual control is also available.

All software is permanently retained in auxiliary storage such as magnetic tape, disc file or drum, and during system operation a portion of MONITOR is resident in core memory. Upon request, each of the seven second-level modules is retrieved by MONITOR from auxiliary storage and loaded into core memory, together with library subroutines required to complete the total program. Once loaded, each module controls its own operation, with the exception of those functions reserved for MONITOR until

Fig. 1 SDS SIMULATION SOFTWARE STRUCTURE



control is again returned to MONITOR either by program transfer or operator intervention.

Hybrid Examiner is a diagnostic module for checking both the digital subsystem and hybrid interface. Analog components such as amplifiers, potentiometers, etc., are statically checked via PATCH. Completing the set of

[3]Borgers, E. R., "Characteristics of Priority Interrupts," *Datamation*, June 1965.

modules is Hybrid Debug, which assists the user in program debugging and problem checkout and/or optimization.

The vertical and diagonal lines in Fig. 1 indicate program interfaces and the general control level for each module. There is a minimum of redundant coding in the total system since each major second-level module in the diagram draws on a common set of subroutines from the two libraries. Furthermore, common system functions, such as standard input and output and interrupt processing, are all executed by MONITOR. Additionally, the entire set of software remains unaltered from one hybrid system to another with the possible exception of certain interface subroutines included in the Hybrid Executive Library. This structure reflects the SDS unified approach to simulation software development.

Hybrid Examiner is typically run for a fixed period of time at the start of daily operation. Each diagnostic program is executed sequentially to verify proper operation of all digital and interface hardware. Malfunctions and marginal operations can, thus, be detected and isolated. Next, PATCH is applied in the component-by-component hardware check mode to diagnose analog reliability. When all calibrations and other necessary adjustments are complete, the system is turned over for simulation use. If, during subsequent operation, hardware errors are suspected the operator can direct MONITOR to reload PATCH or Hybrid Examiner, as the case may be, and rerun selected diagnostics.

MONITOR is a supervisory program which provides overall system control for both hardware and software. In particular, it provides the facility for automatic batch processing of digital programs with a minimum of manual intervention. Programs can be constructed under MONITOR control from a combination of three different source language processors, plus previously compiled programs and routines retrieved from both the standard System and Hybrid Libraries. Thus, when operating in an all-digital mode (for example, with sequential compilations, assemblies and program executions) MONITOR allows continuous processing without operator intervention. This provides efficient system operation for those jobs which are hybrid independent.

In conjunction with batch processing, MONITOR contains a linking relocating loader and maintains orderly control over all requests for input/output using standard digital peripheral devices. An active list of such requests is maintained, and MONITOR services these requests as I/O channels become available.

Perhaps the two most important features of MONITOR for a simulation environment are its ability to service external priority interrupts while allowing complete recursive use of all subroutines. Thus, subroutines can be interrupted during execution and then reentered by the interrupted program without loss of partial or intermediate results.

MONITOR automatically queues, and subsequently checks, the sequence in which "stacked" interrupt subroutines are processed. Upon receiving an interrupt, complete register protection is provided, including provision for saving all temporary storage. In addition to recursive and regular subroutines, protected subroutines are also allowed. The latter programs disable interrupts during their execution and are useful for (1) avoiding the overhead time for full recursion checking in short routines, (2) assuring completion of a sequence of calculations and (3) avoiding disruption of a sequence of specialized input/output operations, such as digital to analog conversion. Some service routines which provide for recursion cannot be interrupted during their execution and, hence, disable interrupts for short periods of time. In no event, however, do they disable interrupts for more than 50 microseconds.

SDS Real-Time FORTRAN IV is one of three processors available for compiling simulation programs, or program segments, under control of MONITOR. The compiler is based on the standard ASA FORTRAN IV language, but also includes several additional features. One example is the case of generalized subscripts such as with the variable ALPHA ((I-3) *BETA/3).

Real-time features of the compiler, together with the interrupt and recursion portions of MONITOR, provide necessary functions for operation in a simulation environment. One such extension to a standard FORTRAN IV compiler provides for the introduction of symbolic (machine language) coding intermixed with FORTRAN statements. This allows the programmer to optimize certain portions of his program where timing control is critical, initiate hybrid input/output without recourse to special subroutines and to perform character manipulation, otherwise difficult within the standard FORTRAN IV language.

A second real-time feature of the FORTRAN IV is the addition of a CONNECT statement to the compiler language. This statement allows the programmer to tie a FORTRAN or machine language subroutine to a specified interrupt. Further ability to release, enable/disable, arm/disarm and clear interrupts is provided by special subroutines included in the System Library.

Subroutines and functions generated by the FORTAN IV can be either recursive, protected or regular at the discretion of the programmer. This is accomplished by adding RECURSIVE and PROTECTED qualifiers to the FORTRAN IV language. The qualifier RECURSIVE in a subroutine declaration causes the compiler to generate completely recursive coding. Similarly, use of the qualifier PROTECTED generates coding which disables interrupts during the subroutine (or function) execution. In the absence of a qualifier, the coding generated generated conforms to usual FORTRAN IV standards.

Fig. 2 DELAY PROC

```
METASYMBOL SOURCE STATEMENT              COMMENTS

P       PROC
DELAY   N
MAX     EQU    114683
C       EQU    P(1)-7                    Subtract out minimum over-
                                         head time.  P(1) = first
                                         parameter on calling line.
B       EQU    C/MAX                     Integer number of loops
                                         each MAX microseconds long.
        DO     B,2                       Assemble next 2 lines B
                                         times.
        LDX    =077777777,1              This loop is MAX  sec long.
                                         Maximum index count with -1
                                         increment.
        BRX    $,1                       $ denotes current instruction
A       EQU    C-B*MAX                   Compute additional number
                                         of BRX loops to be executed.
        LDX    =((A*4)/14)++077700000,1  ++ denotes merge.
        BRX    $,1
        END
```

METASYMBOL is an automatic programming system which provides for the assembly of coding in symbolic machine language. This processor and associated language extend significantly the symbolic coding features contained in Real-Time FORTRAN IV; the latter, in fact, are a subset of METASYMBOL. The capabilities of METASYMBOL include provision for non-machine instructions (psuedo operations) byte and character manipulation, data formating and conditional in-line code generation. The latter is attained by two directives, Procedure (PROC) and Function (FUNC), in the METASYMBOL language which instruct the processor on how conditional code is to be generated during assembly. The essential difference between a PROC and a FUNC is that the former generates coding and the latter a value.

An example of a PROC that generates conditional coding is a delay PROC as presented in Figure two (see p. 31). This sample PROC with calling line.

DELAY N

delays computation by *N* microseconds ($N > 7$) to within an accuracy of two machine cycles (3.5 usec). During assembly SDS 9300 coding is generated to load and count down index register one as indicated in the specific example of Fig. 3. Note that when the input parameter *N* is greater than MAX = 114,683 (the maximum time required to count down the index) more than one LDX (Load Index) and BRX (Increment Index and Branch) loop is generated.

Fig. 3 Machine Code Generated by DELAY PROC (N = .3 second)

```
Calling line:      DELAY    300,000 usec

Generated Code:    LDX      =077777777,1

                   BRX      $,1

                   LDX      =077777777,1

                   BRX      $,1

                   LDX      =077747323,1

                   BRX      $,1
```

Operationally, METASYMBOL consists of an encoder and a translator. The encoder compresses the basic source language data to a fraction of its original size before it is processed by the translator. After an original assembly, encoded source data may subsequently be presented to the computer. Maintaining source programs in encoded form is not only convenient from the aspect of bulk storage, but also efficient for modify-and-load assemblies. METASYMBOL, like Real-Time FORTRAN IV, also operates under the supervision and control of MONITOR. Furthermore, FORTRAN subroutines can be used as segments in a METASYMBOL program, and vice versa, with complete cross referencing of global variables.

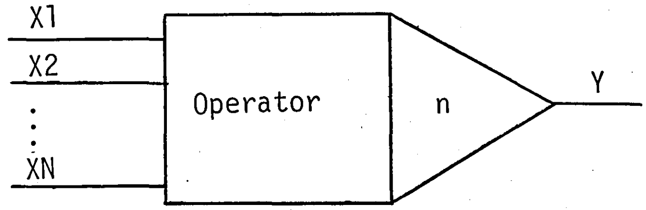
DES-1 is a programming system based on a simulation oriented language and compiler that operates under its own executive monitor in conjunction with a special on-line control console.[3] The DES-1 programming language uses mathematical "operator" notation with emphasis on those functions commonly implemented by hardware components in an analog computer. This allows problems posed in analog block diagram form to be transcribed into a digital program with a minimum knowledge of digital computer programming. Special analog operators include Dead Space, Limiter and Bang-Bang. There are also seven different integration operators ranging in scope from simple rectangular integration to an Adams-Moulton procedure with error checking and control. The general form of an operator statement is

n OPERATOR X1, X2, . . . ,XN=Y

where *n* is an optional statement number for identification purposes, each XI is an input and can be a product of an arbitrary number of terms, such as XI = A*B*C, and Y is the label for the output variable. The symbolic representation for the operator statement appears in Fig. 4.

The DES-1 language also allows algebraic statements which combine any set of variables and constants with the basic arithmetic operations of add, subtract, multiply and divide. The language structure further contains a subroutine call capability which enables the use of METASYMBOL and FORTRAN IV subroutines for special purpose operations such as hybrid interface control.

Fig. 4 DES-1 OPERATOR SYMBOL



The DES-1 executive-monitor supervises the execution of DES-1 programs in conjunction with on-line control via the DES-1 console. Both real-time and asychronous modes are available. The former mode is associated with hybrid and simulated analog/hybrid computation, whereas the latter mode is used for all-digital check solutions and general problem checkout. This on-line communication between user and machine, together with the powerful structure and simplicity of the DES-1 language, significantly expedites problem checkout and optimization.

system library

The SDS System Library contains a large number of utility subroutines for use with the three processors, Real-Time FORTRAN IV METASYMBOL and DES-1. These programs include a full complement of elementary mathematical function routines such as sine, cosine, tangent, etc., in both fixed (24-bit) and floating point (39-bit mantissa, 9-bit exponent) arithmetic. There is also a duplicate set of floating point routines that are programmed for four decimal digit accuracy with proportional increases in speed. The latter routines can be used in simulation programs where full accuracy is not required and execution time must be minimized.

The System Library also includes many other important mathematical programs. Specifically, there are seven numerical integration routines, arbitrary function generation for functions of one, two and three variables, and a complete real and complex matrix package. Special mathematical programs which assist the simulation user in problem analysis are easily incorporated into larger main programs for preliminary investigation of the frequency content of simulation variables as well as other problem characteristics. Polynomial root solvers and curve fitting routines are typical of the available programs in this category.

Conversion routines to format data between single or double precision, BCD or binary, and fixed or floating point format are also a part of the System Library. These routines are of special importance for input and output of data through analog-to-digital and digital-to-analog conversion links. Additional subroutines are available for data conversion between different output media.

The Hybrid Executive Library consists of a large number of subroutines which provide for control of hybrid system hardware. All programs in this library are basic interface subroutines and are generally hardware dependent. Hardware elements normally controlled by these routines are interrupts, analog-digital converters, interval timers, sense lines, signal lines including analog mode control, analog pot set, analog readout and computer to computer data exchange. Both operator and hardware error diagnostics are included within these routines.

All programs in the Hybrid Executive Library which refer to analog components access a Symbolic File. This file defines changes between program symbolic references and actual hardware elements. Special subroutines within the library permit the user to conveniently make these changes. Thus, run-time reassignment of analog hardware can be accomplished without program modification.

Interrogation of the Symbolic File by Hybrid Executive routines require additional execution time and program storage that is proportional to the current number of hardware reassignments. With no alterations, however, the overhead costs are negligible.

Hybrid Examiner is a software module which controls the execution of both digital and hybrid interface diagnostics. The program calls not only on digital diagnostics from the System Library, but also on hybrid interface subroutines from the Hybrid Executive Library. Included among the hybrid interface diagnostics are routines to verify operation of such devices as a real-time clock, interval timer and priority interrupts. Checking the performance of conversion equipment is accomplished by three additional programs, the DAC Open Loop Tests, ADC Open Loop Test and the DAC/ADC Closed Loop Test. The first of these programs provides statistical performance data on conversion channels and can also be used for equipment calibration or detecting maintenance requirements.

Hybrid Examiner is designed to operate in two modes, automatic and manual. Both are selected from the console typewriter. In the automatic mode, all diagnostic routines, both digital and hybrid, that can be executed without manual intervention are loaded into core memory together with their dependent system and hybrid interface subroutines. This entire set of diagnostic routines is then executed cyclically, each for a fixed length of time, until the program is terminated from the computer console. Equipment malfunctions detected during program execution result in the output of printed diagnostic messages, as well as output of statistical data on the performance of conversion channels. This automatic procedure is especially useful during periods of preventative maintenance or just prior to the start of daily system operation.

Those diagnostic routines which cannot be treated in the automatic fashion described above are executed in the manual mode. In this mode the operator selects via the console typewriter, any particular diagnostic routine for execution. Hybrid Examiner then loads the selected routine into memory, initiates its execution and continues performing the given diagnostic function until the program is terminated by the operator from the console. At operator discretion, any other diagnostic program may then be selected, loaded and executed in a similar fashion.

manual control

On-Line Hybrid Executive is a control program which permits the manual selection and execution of subroutines from the Hybrid Executive Library. Manual input commands are communicated to the program via the console typewriter or card reader.

On-line functions that can be accomplished via this program correspond, generally, to the same basic functions provided for in the set of Hybrid Executive subroutines. However, since manual, on-line operation is involved, use of the latter library routines is structured differently than for real-time operation. For example, a basic executive subroutine will read a specified ADC line. In real-time operation, this routine is used in conjunction with a larger program that not only reads the ADC line, but also assigns the value read to a problem variable. With manual operation the value read is simply printed for immediate inspection.

The On-Line Hybrid Executive provides the user with direct manual control over hybrid hardware, either before, during or after a simulation run. When used prior to run time, it enables the operator to implement unforeseen changes in problem setup, as well as make final system checks. Discovery of inoperable analog components can be corrected by reassigning hardware elements via the Symbolic File feature. The On-Line Hybrid Executive can be automatically called into use from within a simulation program to provide intermediate on-line checking of elements and data. Control is subsequently returned to the main program at the point of previous exit. Furthermore, typewriter initiated requests, and resulting typewriter output, provide documentation of all on-line activities.

Hybrid Debug is a utility module designed to assist the simulation user in both program and problem checkout. As an adjunct to the On-Line Hybrid Executive, it also accepts commands from the console typewriter. For program checkout, it services requests for obtaining snapshots at selected points, masked memory searches, and decimal or octal memory dumps. A trace routine further provides for step-by-step program debugging with print out of symbolic machine language coding and decimal results. In-core corrections and logical insertions can also be made on-line to eliminate the necessity for immediate reassemblies or compilations.

Once the simulation user is satisfied with the successful operation of his basic digital program, there can still be concern over correct and/or optimum problem solution. Hybrid Debug contains additional features for facilitating such problem checkout. A typical typewriter request the operator can initiate in this area provides for the insertion of digital filters in the operational program to filter specified problem variables. The type of filter is selectable among several options; filter parameters are also specified by the user. The request format is

FILT, TYPE, VAR, ADD 1, ADD2, DECIMAL LIST

Hybrid Debug then locially inserts before address ADD 1 the digital filter specified by TYPE. VAR is the input to the filter and the output is placed in address ADD2. DECIMAL LIST contains the filter constants.

Noise generation, based on time dependent functions with specified variance, can also be requested in a similar manner and added to any problem variable. This allows the user to assess problem sensitivity to computational and other sources of noise. Additional requests serviced by Hybrid Debug provide for modified A/D and D/A conversion, magnetic tape output of variables, timing of subprograms, plus extrapololation and time delay of problem variables. Since all program modifications necessary to implement the above requests are accomplished via logical insertions, they are easily removed by a special DELETE, request. As with the On-Line Hybrid Executive, documentation of all requests is provided by input, and resulting output, on the console typewriter.

static & dynamic check

PATCH (Programmed Analog Total Check) is an analog on-line static check, and off-line dynamic check, program which operates under the control of MONITOR. It can be used for detecting both problem errors and analog equipment malfunctions. By means of PATCH, certain manual procedures are eliminated from daily operation.

Each PATCH source statement includes a variable name, a FORTRAN-like algebraic expression of the variable and, if appropriate, the name of the analog element where the variable may be read. The general form of an input statement is

ANALOG NAME   VARIABLE NAME=EXPRESSION

Program segments are separated by four control words: PARAMETER, INITIAL OPERATE and END.

After problem setup, and with the analog computer in the static check mode, all analog elements appearing in PATCH source statements are read (measured) on-line via the digital computer. These measured values are used, together with other program-defined variables, to evaluate the expressions. The differences between measured and computed values are then compared against prescribed tolerances to detect possible programming errors or hardware failures. Since there is no restriction on what analog elements are read, the static check procedure can be as comprehensive, or as brief, as the user desires.

There are two modes of operation for PATCH when it is used for a static check. The first provides a component by component hardware check and can be applied at the beginning of daily hybrid operation using a pre-wired maintenance patchboard. No variable names are necessary in this mode. When PATCH is executed, only measured analog values are used in the computations, and hardware malfunctions can be isolated.

The second way in which PATCH is used provides a problem static check. In contrast to the first mode, programming emphasis now shifts to problem variables, rather than analog elements, in each PATCH statement. That is, each problem variable appears in a source statement with its corresponding analog element, provided the user wishes to check that particular variable. This type of operation allows the user to (statically) check whether or not the analog mechanization is solving his particular problem.

Both the static and dynamic check portions of PATCH are described by the same input language. Tabular data for function generation may be included in the input for use with special function operators in the dynamic check calculations; user supplied subroutines are also permitted.

General programming assistance is also provided. For example, complex expressions which represent potset values can be computed and, optionally are printed or output on punched cards for subsequent input via the On-Line Hybrid Executive.

Printed output from PATCH is under selective control of the user so that only pertinent data is presented during checkout. If malfunctioning analog elements are discovered in the checkout process, then after repatching, they may be logically circumvented in PATCH by using the Symbolic File feature of the Hybrid Executive. As with all other SDS hybrid software modules, the basic structure of PATCH is analog independent. Interface communication relies solely on routines from the Hybrid Executive Library.

A sample PATCH program and associated circuitry is illustrated in Fig. 5. The first group of statements set parameters which may be changed at run time. For example, DELTA, the integration step size, may be adjusted from .001 to obtain greater accuracy or execution speed on subsequent runs.

The second group of statements set initial conditions and identify problem variables with analog components.

Fig. 5 Sample PATCH Program

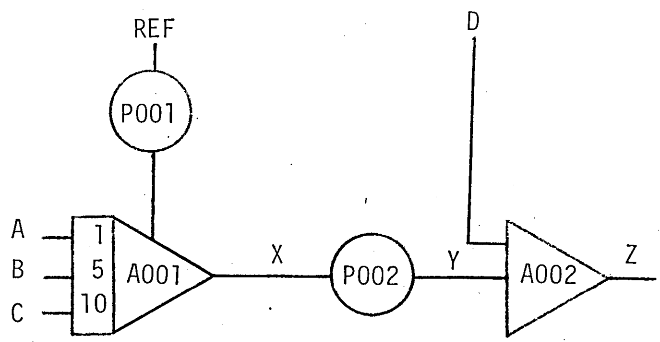
```
PARAMETER

                  TIME    = 0
                  DELTA   = .001
                  TMAX    = 1
                  REF     = 100
                  A       = 5.0
                  S       = 3
                  SET1    = .4
INITIAL

                  B       = .3E-4*A
                  C       = 0
                  D       = A+B*C/S
        K001      K1      = SET1
        K002      K2      = .5
        P001      IC1     = K001*REF
        P002      Y       + K002*X
        A001      X       = P001
        A002      Z       = Y+D
OPERATE

                  X       = INT (A+5*B+10*C)
                  Z       = K2*X+D
                  C       = A*SIN(TIME)

END
```



The code letters K, P and A denote potentiometer setting, potentiometer reading and amplifier, respectively.

The last group of PATCH statements constitute the equations for a dynamic check. The first of these statements contains the integration operator INT which uses the Runge-Kutta-Gill method.

summary

SDS simulation software has been designed to satisfy the special requirements imposed by a simulation environment. At the same time, procedures and techniques normally associated with general data processing operations are also available. The important elements and characteristics of this software are:

- Real-time operating system
- Three automatic programming systems including a simulation-oriented language processor.
- Automatic diagnostic procedures
- Emphasis on direct man-machine communication
- On-line program-problem debugging
- Complete set of interface routines for analog setup and control. ■

THE EAI 680

by PAUL LANDAUER*

The computing industry generally accepts three classifications of computing systems as being hybrid:

1. The analog computer with enough digital logic elements to provide flexible, automatic control of the analog computer and its elements. This concept can range from a small amount of digital logic to a self-contained general-purpose digital computer. The digital logic elements of the general-purpose digital computer (in this class of hybrids) are not used for actual computation.
2. The analog computer with enough digital logic elements to provide a computing capability which uses both the analog components and digital logic elements in a parallel computing fashion.
3. An analog computer and a general-purpose digital computer interconnected and operated together to solve a single complex problem.

In actuality, different problems require different combinations of all three concepts.

The EAI 680 Scientific Computing System, just introduced by Electronic Associates Inc., will satisfy all three classifications. It is available in levels of complexity from a very basic hybrid computer to a full hybrid system including patchable digital logic and a general-purpose digital computer. The basic system is completely wired to accept a full complement of plug-in computing components, permitting the computer to grow as requirements of the user expand. Prices range from $30,000 to $250,000.

The 680 has been designed to handle such applications as, in the process industry, the simulation and design of both analog and digital process control systems, studies of complex reactor dynamics, design of heat exchangers, parameter optimization—such as in non-linear chemical kinetics studies, simulations involving large fixed or variable time delays, automatic data fitting, stage system simulations, simulation of processes and control systems for operator training, system design for nuclear reactor heat exchange and control.

Its role in the university field will be three-fold: a tool for instructing students in the programming and design of a scientific computer; a dynamic demonstration device to portray the behavior of physical systems (hybrid simulation is uniquely capable in aiding student understanding of process and system performance), and as a tool for solution of significant problems in graduate and faculty research.

In the life sciences the 680 will provide the on-line signal processing and data reduction required in EKG and EEG studies. It enables the simulation of virtually any physiological system where the solution of partial differential equations is desired—such as in circulatory systems. It will also be applied to pattern recognition studies and training procedures.

The basic console of the 680 is designed for iterative hybrid computation and employs patchable digital logic elements to control the analog simulation. The analog computing components, the logical interface components, the digital logic elements, and the interface to a digital computer terminate on a single 4080-hole patchpanel. All components are arranged in modules to minimize patching and to provide for convenient access during checkout and operation. The digital section of the patchpanel is clearly separated from the analog section, and different size patchcords are employed to eliminate accidental interpatching of analog and digital logic signals.

The EAI 680 utilizes a 10-volt reference, combining the dynamic performance of 10-volt solid-state systems with a new high in 10-volt component static accuracy (linear component static accuracy is .01%, multipliers are typically .015%). Special resistors and integrating capacitors with effectively zero temperature coefficients eliminate the need for an oven. Since most of the computing components are located directly behind the patchpanel, the 680 is a compact — 5 ft. x 5 ft. x 2½ ft. — unit which can be installed in a medium-sized office or small computing laboratory. No air conditioning is required and its low power consumption (due to the 10-volt reference) permits it to operate from any wall outlet.

In a single console, a fully expanded EAI 680 includes up to 156 amplifiers divided into combination amplifiers (integrator/summers), summers, inverters, and a total of 120 servo-set and 12 hand-set potentiometers. An expanded system also includes a full complement of non-linear computing components such as multipliers, sine/cosine function generators, exponential function generators, arbitrary function generators, and limiters. In addition, a slaving system and a large complement of trunk lines permits expansion of the system by adding any number of additional consoles.

To facilitate the programming of hybrid problems, a comprehensive logical interface is provided. This includes individual control of integrator modes and time scale, track/store units with logical control, high-speed electronic comparators with logical outputs, function relays, and electronic switches. The analog inputs and outputs of these elements are distributed throughout the analog modules and the logical inputs and outputs are terminated in the digital section of the patchpanel.

The patchable logic system employs clocked flip-flops, eliminating the possibility of false operation due to hazards and races, and simplifying the programming and checkout of a logic program. The logic elements include up to six four-bit registers, each of which can serve as a shift register, binary counter, parallel buffer register, or as four individual RST flip-flops. The logic elements also include a complement of AND-NAND gates, BCD up-down counters, monostables and logical differentiators. A complete monitoring and control system is provided for all of the logic elements.

In addition to this basic hybrid capability, the 680 has been designed for expansion with a stored-program digital computer. In this regard, the solid-state pot-setting and monitoring system can be linked to a digital computer to provide automated set-up and checkout. Terminations for both a high-speed data link and general-purpose control interface are provided.

The EAI 680 represents the fourth generation of hybrid computers to be developed by Electronic Associates, and the third major computing system to be introduced by the company within one year. Deliveries are scheduled to begin in the first quarter of 1966. ■

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HOW TO TELL IF IT'S FORTRAN IV

by DANIEL D. McCRACKEN

There are currently more than two dozen languages that go by the name FORTRAN IV. As the accompanying table shows, they differ widely in their source language features, leading one to wonder how to decide whether a given language *is* FORTRAN IV if you meet it in the dark, without its label showing. As a service to the industry I wish to propose two tests for distinguishing between FORTRAN IV and other languages—very similar—that go by some other name, such as FORTRAN (no number).

1. What is the name of the square root function? If it is SQRT, you have FORTRAN IV; if it is SQRTF, you don't.
2. Can an EQUIVALENCE affect the ordering of variables in COMMON? No = FORTRAN IV; Yes = something else.

There are no other dependable distinguishing marks. I was once of the mistaken impression that FORTRAN IV implied a logical IF, double precision and complex variables, labeled COMMON, a DATA statement, adjustable dimensions, and other such items not found in FORTRAN II. However, there are many respectable FORTRAN IV languages that do not have these features.

I also used to think that FORTRAN IV was pretty much the same thing as the FORTRAN language proposed as a standard by the American Standards Association FORTRAN Working Group, and that FORTRAN II was about like ASA Basic FORTRAN in scope. It is clear that the ASA FORTRAN Working Group intended such a correspondence, as reported in the October, 1964, *ACM Communications.* But I am again mistaken, because there are languages called FORTRAN IV that lack many of the features of ASA FORTRAN.

In short, the "IV" tells you next to nothing.

It would be simple to suggest that everybody go by ASA, and use the words FORTRAN and Basic FORTRAN, without numbers, to mean what the proposed ASA standard says they mean. That is, FORTRAN would be "complete," and Basic FORTRAN would be a subset of FORTRAN. That, unfortunately, is too simple. It would be great if you could make the transition in terminology, but you can't get there from here.

According to today's folklore, FORTRAN-no-number is something teensy that the competition has, whereas FORTRAN-IV-with-a-bow-to-ASA has bells and whistles. In order to make "FORTRAN" the equivalent of the "complete" version, we would have to do a flip-flop, so that FORTRAN-no-number-no-modifier would mean the full treatment, and to attach the modifier "Basic" would be a mark of shame. But nobody wants to have to add a word that proclaims the *lack* of something. Modifiers are for bragging, not apologizing.

The proper word for the present situation is chaos. The only practical solution I can see would be for all concerned to agree that FORTRAN IV means ASA FORTRAN, and accordingly not title a language FORTRAN IV unless it has *very* nearly all of the ASA FORTRAN features. Omission of ASA FORTRAN features *might* be justified if machine characteristics made the items in some sense unnecessary. I would not care to see too many statements like "Our FORTRAN IV is just like ASA FORTRAN except that we don't have double precision or complex variables, a DATA statement, or three-dimensional variables." One is reminded of the definition of a bicycle as being the same as a car except that it has only two wheels and no motor.

Perhaps the self-discipline required to establish a meaningful correspondence between the terms "FORTRAN IV" and "ASA FORTRAN" is too much to expect of our highly competitive industry. And maybe nobody cares.

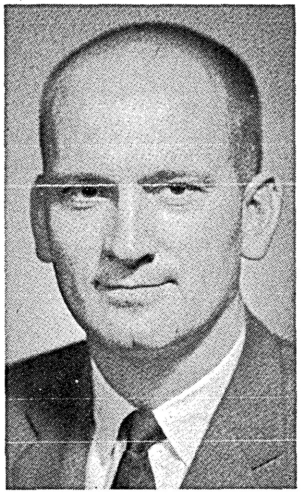
It does seem a shame, though, not to grasp the opportunity provided by the excellent standards work of the ASA Working Group to establish *some* meaningful nomenclature.

■ ■ ■ ■ ■ ■ ■ ■ ■ ■ ■

The accompanying table is not intended to be a complete list of features in which FORTRANS vary. It lists some items in which languages of necessity vary, such as variable sizes, about which there is no dispute. The remaining entries are divided between features that distinguish ASA FORTRAN from ASA Basic FORTRAN, and features that go beyond either of them.

Roughly two-thirds of the languages described in the table have running compilers. The rest are from a few weeks to many months in the future.

An asterisk indicates that a feature is present; a blank, that it is not. The one exception to this rule is the case of the blanks for ASA number sizes, on which there is no standard. ■



A New York-based consultant who spends most of his time writing, Mr. McCracken is the author/co-author of nine books on programming. Prior to the text from which this article is adapted, he published "Numerical Methods and FORTRAN Programming" with W. S. Dorn of IBM. Mr. McCracken holds degrees in mathematics and chemistry from Central Washington State College.

This article is based in part on Mr. McCracken's book, "A Guide to FORTRAN IV Programming," just published by John Wiley and Sons.

	ASA Basic	ASA	ASI[1] 6000 Series	Burroughs B5500	Computer Control DDP-24, 116, 124, 224	CDC 1604 3600 3800	CDC 6000 Series	PDP-6[2]
Maximum statement number	9999	99999	99999	99999	99999	99999	99999	99999
Maximum continuation cards	5	19	No limit	9	No limit	No limit	No limit	19
Specification statements must all precede first executable statement	*	*	*		*	*	*	*
INTEGER constant, maximum digits			7	11	7	14	18	11
INTEGER maximum magnitude			$2^{23}-1$	$2^{39}-1$	$2^{23}-1$	$2^{47}-1$	$2^{59}-1$	$2^{35}-1$
REAL constant, maximum digits			11	11	7	11	15	8
DOUBLE PRECISION constant, digits					14	25	29	16
REAL, DOUBLE PRECISION magnitude			10^{76}	10^{69}	10^{76}	10^{308}	10^{308}	10^{38}
Variable name maximum characters	5	6	6	6	6	8	8	No limit
Mixed mode arithmetic permitted			*			*	*	*
Assigned GO TO		*	*	*	*	*	*	*
Logical IF, relations		*	*	*	*	*	*	*
DOUBLE PRECISION operations		*			*	*	*	*
COMPLEX operations		*			*	*	*	*
LOGICAL operations		*	*	*	*	*	*	*
Dimension data in type statements		*		*	*			*
Labeled COMMON		*		*	*	*	*	*
Maximum array dimensions	2	3	3	3	3	3	3	3
Adjustable dimensions		*	*	*	*	*	*	*
Zero and negative subscripts								*
Subscript may be any expression, with subscripted variables permitted				*		*	*	
Subroutine multiple entries and/or non-standard returns							*	
DATA/statement		*	*	*	*	*	*	*
Object time FORMAT		*	*		*	*	*	*

[1]Advanced Scientific Instruments
[2]Digital Equipment Corp.
[3]Electronic Associates Inc.
[4]Scientific Data Systems

	EAI[3] 8400	GE 200 Series	GE 400 Series	GE 600 Series	Honey-well 200	Honey-well 800 1800	IBM 1401 1440 1460	IBM 1410 7010
Maximum statement number	99999	32767	32767	99999	99999	32767	99999	99999
Maximum continuation cards	19	No limit	No limit	19	9	19	9	9
Specification statements must all precede first executable statement		*		*	*	*		*
INTEGER constant, maximum digits	5	6	7	11	20	13	20	20
INTEGER maximum magnitude	$2^{16}-1$	$2^{19}-1$	$2^{23}-1$	$2^{35}-1$	$2^{119}-1$	$2^{44}-1$	$10^{20}-1$	$10^{20}-1$
REAL constant, maximum digits	7	9	8	9	20	12	20	18
DOUBLE PRECISION constant, digits	14	18		19		20		
REAL, DOUBLE PRECISION magnitude	10^{76}	10^{76}	10^{127}	10^{38}	10^{99}	10^{76}	10^{99}	10^{99}
Variable name maximum characters	6	12	6	6	6	6	6	6
Mixed mode arithmetic permitted	*	*						
Assigned GO TO	*	*	*	*	*	*		
Logical IF, relations	*	*		*	*	*	*	*
DOUBLE PRECISION operations	*	*		*		*		
COMPLEX operations	*	*		*		*		
LOGICAL operations	*	*		*	*	*	*	
Dimension data in type statements	*	*	*	*	*	*		
Labeled COMMON	*			*	*	*		
Maximum array dimensions	7	63	3	7	3	3	3	3
Adjustable dimensions	*	*		*		*	*	
Zero and negative subscripts	*							
Subscript may be any expression, with subscripted variables permitted		*						
Subroutine multiple entries and/or non-standard returns				*				
DATA/statement	*	*	*	*	*	*	*	
Object time FORMAT	*	*	*	*	*	*	*	

[1]Advanced Scientific Instruments
[2]Digital equipment Corp.
[3]Electronic Associates Inc.
[4]Scientific Data Systems

	IBM 7040 7044 (8K)	IBM 7040 7044 (16-32K)	IBM 7090 7094	IBM 360 D level E level	IBM 360 H level	NCR 315	Philco 2000 Series	RCA 3301	RCA Spectra 70 Size A	RCA Spectra 70 Size B	SDS[4] 9300	Univac III	Univac 1107
	99999	99999	32767	99999	99999	99999	32767	99999	99999	99999	99999	32767	32767
	4	9	19	19	19	19	19	No limit	19	19	No limit	9	19
				*									
						*			*				
	11	11	11	10	10	11	12	7	10	10	7	6	11
	$2^{35}-1$	$2^{35}-1$	$2^{35}-1$	$2^{31}-1$	$2^{31}-1$	$10^{11}-1$	$2^{39}-1$	$10^{7}-1$	$2^{31}-1$	$2^{31}-1$	$2^{23}-1$	$10^{6}-1$	$2^{35}-1$
	9	9	9	7	7	12	11	8	7	7	12	10	9
		16	16	16	16	21	21		16	16	19		17
	10^{38}	10^{38}	10^{38}	10^{75}	10^{75}	10^{150}	10^{616}	10^{99}	10^{75}	10^{75}	10^{77}	10^{50}	10^{38}
	6	6	6	6	6	No limit	6	6	6	6	No limit	6	6
				*	*	*			*	*	*		*
		*	*		*	*	*	*		*	*	*	*
	*	*	*		*	*	*	*		*	*	*	*
		*	*	*	*	*	*		*	*	*		*
		*	*		*	*	*			*	*		*
		*	*		*	*	*	*		*	*	*	*
	*	*	*	*	*	*	*		*	*	*	*	*
		*	*		*	*	*	*		*	*	*	*
	3	3	7	3	7	No limit	3	3	3	7	No limit	3	7
		*	*		*	*	*	*		*	*	*	*
						*					*		
						*					*		*
			*		*	*				*	*		*
		*	*		*	*	*	*		*	*	*	*
	*	*	*		*	*	*	*		*	*	*	*

COMPUTER CHARACTERISTICS

the role of software

by DAVID E. WEISBERG*

In past issues of DATAMATION, while also supplying information on computers recently added to the *Computer Characteristics Quarterly*, this column has discussed some of the more significant computer hardware trends. Several recent developments in software, however, indicate that this aspect of computer technology is assuming increasing importance and may soon overshadow changes to physical equipment. This is all the more likely in view of the mounting evidence that improvements anticipated in computer hardware during the next few years will not be as spectacular as those of the past several years. Rather, it will probably be a period of consolidation in which manufacturers who have not already done so will announce compatible series of computers and then, with minor additions and modifications, extend the market life of the series. An example of this is IBM's recent announcement of the System/360 Model 44 and the expansion of the basic series capabilities through the availability of 1,600-bpi magnetic tape.

Those who are relatively new to data processing may

SECTION I

	Monthly Rental Typical Range	*First Delivery* Month and Year	*Processor Speed* Complete Add Time in Microseconds	Storage Cycle Time in Microseconds	*Internal Storage* Capacity in Thousand Words	Word Size	*Magnetic Tape* Thousands of Characters per Second	Buffering	Read Forward and Reverse	*Disc Storage* Capacity per Unit	Access Time in Milliseconds	Thousands of Characters per Second	*Drum Storage* Capacity per Unit	Access Time in Milliseconds	Thousands of Characters per Second	*Peripheral Devices* Cards per Minute In / Out	Paper Tape Characters per Second In / Out	Printer Lines per Minute	Off-line Equipment	*Other Features* Program Interrupt	Index Registers	Indirect Addressing	Floating-point Arith.	Memory Protection	Byte. Manipulation	Console Typewriter	*Software* Algebraic Compiler	Business Compiler
IBM 360 Model 75	$80,000 (45-170)	11/65	.8[C]	.75[D]	262-1048	1a[F]	30-340	MR WC	√	207 M[K]	75	312	4.175 M[L]	8.6	1200	1000 300	— —	200[P] 1100	1800 360	√	√[S]	—	√[U]	√	√	√	√	√

C. Overlapped core banks allow increased internal speed. Add time is for four characters or a 32-bit word. D. Cycle time is for eight characters. F. Each character is eight bits or two decimal digits. See IBM 360, Model 92. U. Double-precision floating-point included. Note: Replaces computer formerly marketed as Model 70.

IBM 360 Model 65	$50,000 (34-100)	3/66	1.3[C]	.75[D]	131-1048	1a[F]	30-340	MR WC	√	207 M[K]	75	312	4.1 M[L]	8.6	1200	1000 300	— —	200[P] 1100	1800 360	√	√[S]	—	√[U]	√	√	√	√	√

C. Add time is for four characters or a 32-bit word. D. Cycle time is for eight characters. F. Each character is eight bits or two decimal digits. K, L, P, S. See IBM 360, Model 92. U. Double-precision floating-point included. Note: Two slower versions, the Model 60 and Model 62 will be delivered in late 1965 and be replaced in early 1966 by the Model 65. A multi-processor version of the Model 65 will be available as the Model 67.

HONEYWELL Series 200 Model 8200	$36,575 (33-80)	12/67	3.8[C]	.75	131-1048	1a[F]	7-124[G]	MR WC	√	15 M[K]	95	100	2.6 M	27.5	102	800[M] 100	600[N] 120	650[P] 950	800 200	√	102	√	√	√	√	√	—	—

C. Normal three operand addition. Add time of 22.8 microseconds for two five-character fields. F. Binary and decimal arithmetic instructions are available allowing eight characters to be used as 48b or 12d words. G. One-half and three-quarter inch tape units available. Numeric information can be transferred at up to 186,000 ch/sec. Tape units have programmed error correction. K. Magnetic card device. Units with up to 300 million characters with access times of 225 milliseconds are available. M. Punch speed varies up to 400 cpm depending on number of columns punched. 240, 400 and 650 cpm readers and 250 cpm punch available. N. 200 and 1000 char./sec. reader available. P. Up to 1,266 lpm for numeric only, 132 position printers available. 150 and 900 lpm available. Note: Up to nine programs can be processed concurrently.

UNIVAC 494	$25,000 (22-35)	3/66	.75	.375	16-131	30b	8.5-96	MR WC	√	132 M[K]	92	126	1.3[L]	4.25	1200	800 300	400 110	922 700	1004 1050	√	14	—	√	√	—	√	√	√

K. Fastrand II. Modular Fastrand holds 11M characters with average access time of 67.5 milliseconds. This drum is listed under disc storage because its function is similar to a disc in this system. L. FH880 drum with 3.9M characters capacity, 17 milliseconds access time, and 300K char./second transfer rate also available.

UNIVAC 491, 492	$17,000 (13-22)	10/65	9.6	4.8	16-65	30b	8.5-96	MR WC	√	132 M[K]	92	126	3.9 M	17	300	800 300	400 110	922 700	1004 1050	√	7	—	—	√	—	√	√	√

K. See UNIVAC 494. Note: Model 491 has 8 input/output channels as standard equipment and Model 492 has 14. Model 491 may be increased to a maximum of 14 channels.

COMPUTER CONTROL DDP-124	$2,500[A] (2.1-6)	1/66	3.5	1.75	8-32	24b	25-150[G]	MR WC	—	—	—	—	—	—	—	200[M] 100	300 110	300	—	√	1[S]	√	√	—	—	√	√[Y]	—

A, G, M, S, Y. See DDP-224. Note. System is program-compatible with the DDP-24 and DDP-224.

*Mr. Weisberg is a senior staff member of Charles W. Adams Associates, Inc., and editor of that firm's "Computer Characteristics Quarterly," available for $10 a year from Adams Associates, 575 Technology Square, Cambridge, Mass. 02139.

not realize that until a few years ago virtually no software was supplied by most of the manufacturers, and it was necessary for individual users or groups of users to supply such commonplace programs as assemblers and batch-oriented operating systems. Those that were available were not very convenient to use or efficient; but, for that matter, neither were the computers. Gradually, manufacturers began furnishing these software items and the users, led by the universities, turned to advanced software projects such as syntax-directed compilers, multiprogramming, problem-oriented languages, and time-sharing.

It is becoming apparent that these techniques are no longer laboratory curiosities but will be available for numerous computers in the near future. Many manufacturers are using new compiler-building techniques, such as syntax-driven generation, to reduce the cost of compiler development and produce families of compilers. Operating systems with multiprogramming capabilities are being offered by GE, IBM and CDC, among others, and DEC has for several months had a time-shared operating system available for its PDP-6 computer.

In addition to these new software techniques, some effort is being made to give the smaller business user the means for implementing new applications more rapidly. Examples are NCR's BEST programming package, which is data processing system-oriented, and the banking programs available from NCR and Burroughs. The key factor is that this software is all being supplied by manufacturers rather than by users. Even the producers of small scientific computers are finding it necessary to provide compilers and operating systems.

This stems from several factors: the cost of some of this software is so high that only manufacturers can afford it; the competitive nature of the market dictates the provision of such software as a condition for basic survival; and the complexity of the equipment requires that a very machine-oriented group of programmers be used to prepare these routines. An important effect of this situation is that the user must consider both the hardware and software together when evaluating a system, for he will rarely use the equipment without the manufacturer's software acting as a buffer between the programmer and the computer.

The future will probably see an expansion of the manufacturers' involvement in software development as they attempt to solidify their positions. Hopefully, a significant amount of concentration will be placed on producing software that is better oriented to the creation of new programs. The software available for debugging and validating programs on most computers is grossly inadequate, and one dreads the thought of the flood of paper possible with a large multiprogrammed operating system if programmers continue to debug by asking for complete core dumps every time they are in trouble. More emphasis will undoubtedly be placed on using the computer to aid in debugging its own programs through a high degree of output selectivity and responsive interaction with on-line users. ■

dallas doings

THE DPMA FALL CONFERENCE

The boys in Big D have lined up some big doings for the DPMA Fall Conference and Business Exposition. An outdoor barbecue and rodeo will be supplemented this year by 33 seminar sessions (21 panels and 12 papers) and a panel reunion of Eckert and Mauchly. All this and more will occur Nov. 3 to 5 at the Adolphus Hotel in Dallas, Texas. Sponsored by the Data Processing Management Assn., the conference is open to people interested in systems, management and dp, and related areas.

Receiving top billing is the Technology Panel, the morning of Nov. 3. It will feature five PhD's: J. Presper Eckert, John Mauchly, Cuthbert C. Hurd (moderator), Fred P. Brooks Jr., and John W. Weil. Eckert, vp of Univac, will discuss "The Status of Computer Components and Technology;" Mauchly, president of Mauchly Associates, handles "The Status of Computer Applications for Management;" Brooks, formerly with IBM and now chairman of the Dept. of Information Science at the Univ. of North Carolina, "The Status of Compatible Computer Families;" and Weil, who is manager of Systems and Processors Operation for GE's Computer Dept., will look at "The Impact of Time-Sharing Systems."

In the seminar sessions, topics will range from automated design engineering to utility company management information systems, and include graphic dp and the universities' contributions to data processing. The business management implications of dp will be discussed on the Presidents Panel by the chief executive officers of four corporations: Clyde Skeen of Ling-Temco-Vought Inc., Harold P. Goodbody of Goodbody & Co. (stockbrokers), Peter G. Peterson, Bell & Howell Co., and Pat Haggerty, Texas Instruments Inc.

The conference convenes with a keynote address by T. J. Watson Jr., board chairman of IBM. But the day before the opening, there will be a repeat of the COBOL Seminar Program that DPMA presented earlier this year in Los Angeles and San Francisco. Chaired by Stanley M. Naftaly, this program will present a well-rounded view of the business language by implementors, users, and language designers, as well as people in the standard activities.

For conference-goers tired of seeing the boys in the back room, this is a chance to mingle with the fellows in the front office. They're the ones who paid the $85 registration fee; DPMA members paid only $75.

PROGRAMMING DOCUMENTATION

for smoother conversion

by ROBERT G. SNYDER

The subject of computer systems documentation is receiving increased attention in the U.S. as conversion to newer computers becomes more frequent. Without adequate documentation, the obstacles of conversion are practically insurmountable. Even with documentation, the task is difficult.

On the surface, documentation appears to be a time-consuming, laborious chore. But when the subject is closely examined, it becomes obvious that the bulk of the documentation is created as a result of doing a good systems job. This will be true unless the documentation requirements are so elaborate that to conform with them would be as time consuming as doing the complete systems job.

Why document in the first place? Without documentation a flaw exists in the overall system. Some analysts and programmers retain pertinent information in their desks; others retain the information in their minds. The information retained is never uniform. Specifically, some programmers prepare very elaborate flow charts, but fail to make program comments. Hence, they are defeating the purpose of easy identification. The scope of information retained has a wide range. Some programmers keep every scrap of paper directly or indirectly involved with the program. The other extreme is, "Here is my post list; what more do you want?"

In order to establish a degree of uniformity, standards must be written to specify clearly the scope of information to be documented; the location of each piece of information; information which must be standardized such as flow chart symbols, character writing conventions, certain forms to be used, etc. When the documentation is assembled it could be called a job manual. The contents of a typical job manual are illustrated in Fig. 1. Observe the arrows to the right of the pages.

Such a manual is comprised of three sections. The first section applies to each job even though it is not a computer application. Since some departments are engaged in all forms of office improvements and business applications, not all documentation is necessarily computer oriented.

The second section is devoted to noncomputer or EAM applications. The title of this section is self-explanatory.

The third is documentation which is prepared for each computer program written. Notice that a certain amount of this information can be duplicated, thereby creating an operator's manual to be used for processing the operational programs.

general section

In the first section there are six groupings, A through F:

A. *The Title Page* is the first page. It specifies the name of the job, and all programs contained in the manual are listed under the title. The job coordinator (the individual responsible for overseeing the job) and programmers' names appear in the right hand corner.

B. *Table of Contents* is next and is prepared last. Each page in the manual is given a section number and page number. The general section of the manual can be section 01, the noncomputer or EAM section 02, the record layouts and systems-run diagrams can be in section 03, and each program has its own section number. For example, if six programs comprise a job or system, the first program will be in section 04, the second program will be in section 05, and the sixth program will be in section 09. This form of numbering provides a great deal of flexibility, as 99 sections can be used with an infinite number of pages in each section. Each section and page is recorded in the table of contents, along with a descriptive title of the page.

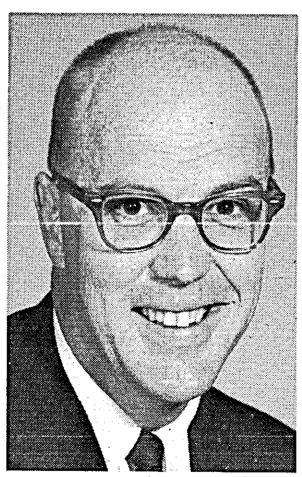
C. *Background of the Project.* A concise, narrative statement which describes the existing system is written on this page. The description includes background information to show why the job was initiated and the ultimate objectives.

D. *Description of New System.* A narrative description of the new system is the subject of this page. The description should explain, in general terms, how the new system functions, what fixed personnel responsibilities exist, basic understandings which exist, shortcomings and limitations which must be recognized, and any plans for the future.

E. *Economic Evaluation.* The economic evaluation is an itemized breakdown and definition of systems costs. Included for consideration are:

1. The analyst's or programmer's time spent in defining the computer system. Specifically, this includes the time spent talking to personnel, preparing flow charts, record layouts, etc. In effect, all work done before writing the program is considered to be definition.
2. The time spent writing and testing the program.
3. Time spent documenting—i.e., preparing the operating instructions, control instructions, and general documentation.

The estimated times are multiplied by a charge for personnel and/or equipment to be used. The sum of the separate totals becomes the job cost.



Mr. Snyder is lead systems analyst in the Business Systems section of the Systems Development Dept., Tennessee Eastman Co., Kingsport, Tenn., where for two years he has been developing and implementing program and documentation standards. He is also chairman of GUIDE's Program Standards and Documentation subcommittee, and has been a programmer and analyst with Eastman Kodak since '58. He holds a BBA in economic statistics from the U. of Georgia.

Despite the author's position in the user organization, the contents of this article is in no way sanctioned or endorsed by GUIDE International.

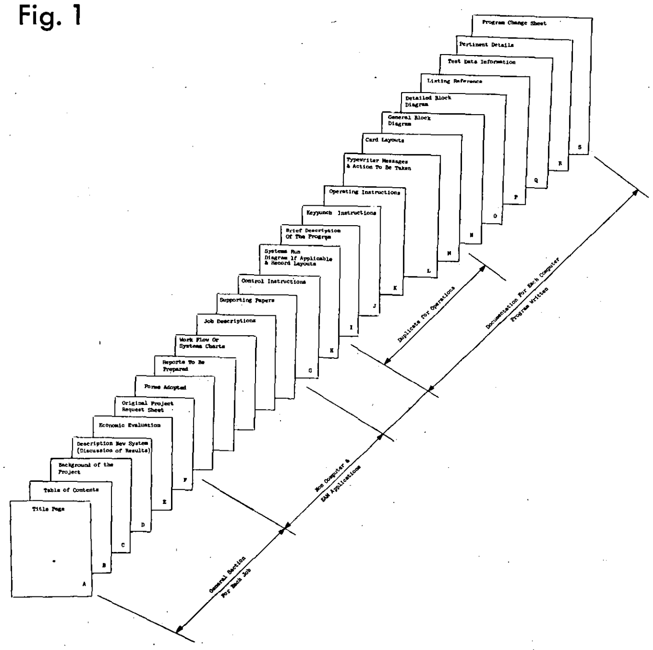
When a computer or EAM system is to replace an existing system, a comparison is made between the existing and the proposed systems. For example, how many dollars will be saved over the existing system, or when cost isn't a prime factor what intangible benefits are to be derived—i.e., easier forecasting, saving of supervision's time, etc. Even when an investigation is conducted for potential machine applications but is turned down as being economically impractical at the time, all figures are retained for future evaluation. When new hardware or equipment is announced, some evaluations are reviewed to see if installation of the system would now be feasible.

F. *Original Project Request Sheet.* The final page in the first or general section is the project request form, completed at the initiation of any large project. In effect, it is a history of why the project was initiated. It covers the data showing why the project was proposed, the tangible savings which can be derived from the proposed system, personnel who are responsible for design and implementation of the new system, target dates, and, quite important, the signatures of management who approved the project.

(Although the main emphasis of this article is on computer documentation, the EAM or noncomputer section should be mentioned here, for it is a consideration in a job manual).

G. *Control.* Where a control group is involved, section G would apply to any operation whether it be EAM, EDP, or noncomputer. Members of the control section are not responsible for programming or machine applications, but are responsible for seeing that the input data is on time for the respective machine applications, that all input data is in the proper sequence, and that all control checks have been made. The same group is also responsible for the output; i.e., know what to do for each error message; make sure all control totals

Fig. 1



balance out, and that the output is sent to the designated personnel. The control instructions in section G merely specify in a concise, step-by-step manner what specific duties will be performed by the control clerk, and how each error message is to be handled.

H. *Systems Run Diagram and Record Layouts.* Each job is treated as an entity, and only programs which apply to the specific job are shown on the systems-run diagram. The same stipulation applies to the tape record layouts.

operator's segment

A certain amount of information which appears in the job manual can be duplicated for the operating department. The page which might seem superfluous is the brief description page. When jobs are processed monthly, quarterly, or when longer periods of time are involved, it can be beneficial for the brief description to appear in the operator's manual. This allows the operator to review the purpose of each program.

I. *Brief Description of the Program.* A concise statement of the program objectives is given in this section. In addition to the objectives, a detailed explanation of what the program is doing is given in a narrative description which follows the logic of the program.

J. *Keypunch Instructions.* Generally keypunch instructions defined in this section apply to control cards as opposed to data cards. Usually two types of control cards are involved.
   1. Cards which contain both fixed and variable information and/or
   2. Cards with fixed information only.

For cards which contain both fixed and variable information, each field must be defined. For fixed fields the information will be written in the actual form in which it is to be keypunched. When a field is variable, the information which is to be keypunched in the field is defined. For example, program number, current computer date, actual date of run, etc. A multiple card layout form is generally used for this purpose.

Where the entire card contains fixed information, the card can be keypunched once and inserted in a pre-prepared card pocket opposite the operating instructions. This eliminates keypunching every control card for each computer run. Cards of this type would include program select cards, sort cards, etc.

K. *Operating Instructions.* The information on the form would consist of some of the following:
   1. Program name
   2. When the run is scheduled
   3. Job number
   4. Program number
   5. Estimated run time
   6. Alteration switch settings
   7. Tape units used
   8. Names of tapes
   9. Tape retention dates

L. *Typewriter Message.* The next page is for listing all programmed typewriter messages, which should include: (1) The message number; (2) the message verbatim; and (3) action, if any, to be taken by the operator. Typewriter messages are restricted to messages which require specific operator action or which are for control purposes.

M. *Card Layouts.* Each card used in a program is shown in its order of entry, and the format is defined in the card layout section. The upper and lower limits of each field are clearly defined. Why show card layouts in the operator's manual? Should an accident occur between the hours of 5 p.m. and 8 a.m., the operator would be able to assemble the cards without assistance and could run the program. Also, should the control clerk inadvertently omit a control card or a date card, the operator could prepare the card and insert it in the proper location in the program.

final sections

N & O. *General and Detailed Flow Charts.* It is hard to draw a clear line of distinction between the general

and detailed flow chart. Where small computer programs are written, a combination flow chart is drawn. Large programs require both general and detailed flow charts. The general flow chart consists of one block for every subroutine. Cross referencing between the flow chart and the program is accomplished by labels.

For uniformity a specific form of flowcharting paper is used. Generally the paper is 17″ x 11″ with a space reserved for job name, program number, author's name, and other information which is deemed necessary. Usually standard flowcharting symbols and character writing conventions are used.

P. *Listing Reference.* A copy of the latest program listing appears next. It can be used for reference, patching, switch settings, etc.

Q. *Test Data Information* is documented and filed in this location. Test data used prior to installing the program on an operational basis should be retained in card form and filed along with the program source deck. Where test data has been designed to test specific routines, the test cards should be identified with the name of the routine. The name of the routine and its objectives will be documented and filed in section Q of the manual.

Another approach is to keep the keypunch forms on which the test data was created and adequately note the purpose of each card or set of cards.

Why retain and document test data? The primary reason is to test minor program changes. Where changes are necessary the old test data would serve as a basis for comparing new tests to the last test run prior to changes. Such a test would insure that other data fields are not being inadvertently changed. Retention of test data could expedite the checking of program failures which occur during a production run. Also, on rare occasions hardware failures could be checked.

It is suggested that along with the test data a copy of the last test run be retained. This would include the input and output data as well as a memory dump.

R. *Pertinent Details.* These include some of the following items:
   1. Tables—their significance and core locations. A brief description of the function of the table is highly desirable.
   2. Switches are identified, and their significance in the program is defined.
   3. Key memory locations and their significance should always be identified.

S. *Program Change Sheet* is the final page in the job manual. To make sure that all program changes have been made, the sheet must be completed whenever a change goes into production. Information on the change sheet includes:
   1. Program number being changed
   2. Who authorized the change
   3. Programmer who made the change
   4. Date change went into effect
   5. The nature of the change

   All change sheets remain at the end of the job manual until the programs are completely rewritten, or discontinued because of obsolescence.

To verify compliance, all documented job manuals are turned over to one person for review. The reviewer checks the manual to insure that it is complete and conforms, in all respects, with the prescribed standards on job manual documentation. When errors are detected, notations are made and the job manual is returned for corrections. This cycle is continued until the manual is acceptable. Then the documentation is reviewed by the supervisor, computer operations, to insure that all phases of the computer operations are completed. If any information is lacking at this point, the manual is again returned to the programmer for further correction and revision. When the manual is finally accepted, it is given to the central librarian along with all related information, consisting of the source deck and test decks.

central library

The central librarian manages a central library for filing the information generated and other computer-related information. One girl can be responsible for the library and have the following responsibilities.

A. *Maintaining a Reference File.* The reference file contains all computer manuals and brochures. Emphasis is placed on computer publications; however, all technical publications, computer newsletters, product announcements, bulletins, etc., are kept on file. This information remains in the library at all times.

B. *Job Manuals.* All computer information created for each computer program and filed in a binder or notebook is in the library.

C. *Program Listings.* For each program, a binder can be prepared. The binder contains a pre- and post-listing of the program, a copy of the last debugging run made with a core dump, and a listing of the test data used for debugging the program.

D. *Card Decks.* The source and test decks can be given to the librarian when the program is completed. The object deck is given to operations, and the source and test decks are filed by the librarian until checked out for program revision or obsolescence. The librarian would be responsible for filing and knowing the location and status of these card decks at all times.

E. *Textbooks.* Books which are purchased by the programming and systems departments are turned over to the librarian. The books usually pertain to computer systems or data processing. The books can be checked in and out.

F. *Program Numbers.* When a program is written, the librarian assigns it a number. At the time the number is assigned, she will be given the title of the program, information to show how the program is to be used, the programmer's name, etc. This information is keypunched on a card and filed. Periodically the cards are sorted and listed, thereby making available detailed information about each program.

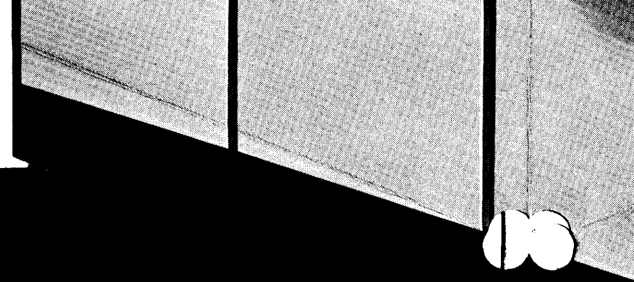
G. *Forms and Supplies.* The librarian could be responsible for maintaining an adequate supply of forms to be used in programming.

It can be seen that the library would have two purposes: (1) Information about a particular job would be extracted from the programmer's desk or transcribed from his mind. The information is put into a concise package known as a job manual and filed in a central location. It can be used in the future by the original programmer or by a maintenance programmer. And (2) a central location is available for filing all computer-related information.

Uniform documentation of all computer programs, filed in a library, simplifies conversion. The system described in this article is not necessarily the best, but it does provide information which is necessary for conversion, or even program maintenance; and the best part is that most of the information is generated as part of doing an adequate systems job. ■

what does it take to come up with a small-scale, high-speed general purpose computer?

CONTROL DATA
CORPORATION



the new CONTROL D

Power comparable to many "large-scale" computers; ability to handle other jobs between real-time decisions

Take speed—the memory cycle time for the new CONTROL DATA 1700 is 1.1 microseconds—faster than many large-scale systems. But highly specialized applications such as industrial control, high-speed data acquisition and communications require high analog-to-digital and digital-to-analog conversion rates. Here's where the 1700 really shines. Analog data is "digitized" at speeds in excess of 250,000 words per second while digital data can be converted at rates in excess of 500,000 words per second. Input/output subsystems permit utilization of mathematical analysis and filtering techniques in real time—convert the 1700 into the most advanced and versatile data acquisition and hybrid computer system available today. Software is organized so you can easily take advantage of these real-time, on line capabilities. And as a 1700 bonus, you'll discover extra processing time available for on-line simulation of future control problems, or for "background" Fortran processing.

Price/performance ratios that mean savings for any on-line control system

Under certain conditions, we can offer 50% more performance for 30% less cost.* Of course, we cannot make a similar claim for every user—there are just too many variables to be measured when analyzing highly individualized industrial control, high-speed data acquisition and communications applications. However, The CONTROL DATA 1700 System gives you, within a coordinated selection of standardized off-the-shelf modules, these variables to choose and mix. You get a total package flexible and versatile enough to be tailored to exacting specifications with only minor modifications. In this way, the best possible cost/performance ratios are achieved. Our design objectives were defined by the same considerations. The result is a unique selection of hardware, software and special programming that you can readily mix to meet specific rigid requirements.

*Recommended system prices begin at $1200 monthly lease.

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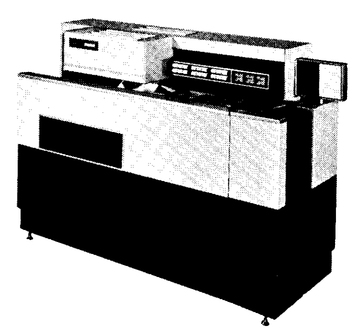
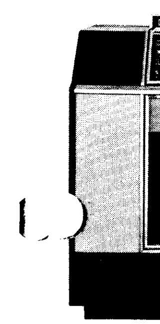


PAGE READERS



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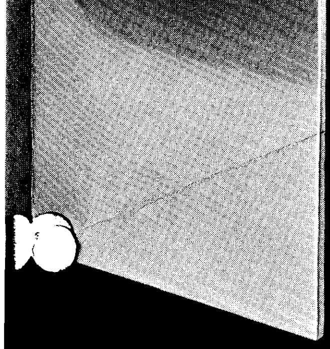


DATA® 1700

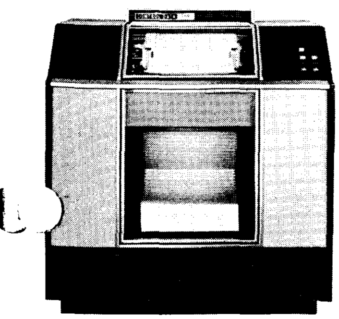
Interrupt that "never forgets," and program protection for computation and I/O functions

The CONTROL DATA 1700 offers a choice of two or sixteen levels of interrupt. This means that program priorities can be established to keep the flow of information on an even, essentially time-shared basis. A unique program protect feature allows unprecedented confidence in multi-programming of combined on-or off-line routines, and in simultaneous operation and program debugging or simulation. Many peripheral devices may use the computer simultaneously. Two types of data channels are available to avoid input/output traffic jams. This superb interrupt organization is another reason why the 1700 can do so many things. For example, "background" Fortran processing can proceed simultaneously with "foreground" or primary control applications. But whatever the application, foolproof interrupt keeps the 1700 operating efficiently, continuously, dependably.

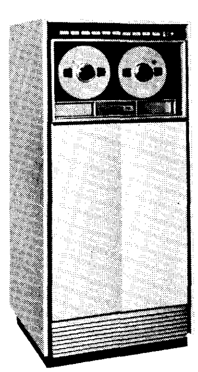
The reliability of proven circuitry to guard against system downtime

Industrial control systems challenge a computer's reliability to the utmost—a simple processing error can be extremely costly. The CONTROL DATA 1700 offers "industrial control system reliability" for *any* application including those involving tricky direct digital control techniques. The circuit design is based on the same advanced silicon transistor technology used for the famous "6000" Series Super Computers. This circuitry, plus a forced-air cooling system, keeps the 1700 operable even when temperatures vary from 40° to 120°F. and the relative humidity rises to 80%. It is also protected against line dropouts, line transients, power surges, sharp noise spikes and other failures including inadvertent computer hangup due to non-responding input/output equipment. Special remote entry and display peripheral devices are also available for supervising the system at all times.

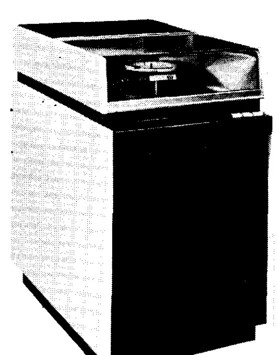
d systems support for INDUSTRIAL
QUISITION...COMMUNICATIONS



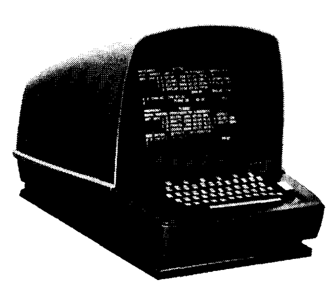
LINE PRINTERS



TAPE TRANSPORTS



DISC STORAGE FILES



VISUAL DISPLAYS

Only a few of the CONTROL DATA 1700 package peripherals are shown here. For more on peripherals, please turn page.

CONTROL DATA 1700 Computer System

Design Features

The 1700 computer system is a unique "off-the-shelf" approach to industrial control, data acquisition and communication applications. It means you can order a system as a complete package without the time and expense of custom tailoring. It means you can work with memory modules in increments of 4,096 eighteen-bit words—up to 32,768 words. Standard software packages are available for the 4,096; 8,192; 16,384 and 32,768 modules; however, large memory increments are not necessary to implement software. It also means that you can take advantage of the space saving economies inherent in modular construction as well as the convenience of modular installation and expansion.

Peripherals

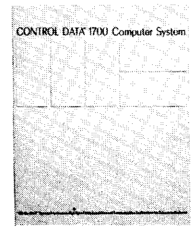
The 1700 package was developed to lead the field in applications involving the utilization of analog information, digital relay closure signals, thermocouple inputs, pressure and temperature transducers, process instruments and flow meters. To do this, the package includes a wide variety of peripheral and I/O gear plus a special device to simplify the synchronization of I/O equipment. In addition to the standard data processing input/output equipment, there is an extensive list of system components to meet individual job functions within the major areas of 1700 system application.

Software

Standard software packages for the CONTROL DATA 1700 include a monitor or executive system which will oversee the operation of other standard or special packages within its framework; an extensive, modular, industrial control package; basic and expanded assemblers; an efficient Fortran compiler; and various utility, I/O, and arithmetic packages. All standard CONTROL DATA 1700 software will operate on-line and in real-time, and has been designed to expand system utility by minimizing the need for specially designed software routines.

CONTROL DATA
CORPORATION

Please send me complete details on the CONTROL DATA 1700 Computer system. My area of application is



- ☐ INDUSTRIAL CONTROL
- ☐ DATA ACQUISITION
- ☐ COMMUNICATION
- ☐ OTHER

Name________________

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THE ACM CONFERENCE

The bloom is almost gone from the terms "time-sharing," "real-time," and "man-machine interaction." But the definitions are still muddy, and the tremendous software effort needed to make these concepts efficiently and universally applicable has just begun. These were points illustrated at the recent national conference of the Assn. for Computing Machinery held in Cleveland.

More than 1,000 persons gathered in the Ohio megalopolis to take their pick of 16 technical sessions, seven panel discussions, and 25 special meetings. With no opening session, perhaps the best lead-off could have been "Computer Aids to the Handicapped." Besides discussion of specialized aims, it was noted that some of the basic obstacles to computer use by the physically or mentally handicapped also face those with normal handicaps – of memory, idea correlation, etc. Needed are inexpensive I/O equipment, elimination of the language barrier, sophisticated software able to do a variety of tasks, and psychological rapport by man and "aid." Economic motivation – not charity – and ingenuity are required for fast and proper development of these devices, the panel noted. E. Avakian of Bunker-Ramo emphasized that the paralytic doesn't need expensive elaborate machinery to drink a glass of water, when a "straw will do."

The computer "in every pot" idea found proponents among the panel for the "Next Step in Programming Languages." The articulate group mostly agreed that the next progression would be to natural, English-language input which subsumes mathematical expression; various subsets of this would be identified by each class of user. There was great confidence that the inefficiencies of English would be overcome in refinement of the subsets and in education and control of those who write them (say one of 10 "users"); inefficiencies suffered would be offset by the value of permitting more people to use the computer. But, said one attendee, this giant step was so casually treated that one was led to believe it was almost an accomplished fact. Too much agreement among the panelists was unfortunate. Specific comparisons among this approach, the present languages, and other choices were lacking; and in the melee of questions from the floor, even the definition of "natural language" was blurred.

PL/I received a small share of the attention, including some potshots. A direct swat came from G. Hayman of Case Institute with his paper on "An Extended Algol-Based Language," whose approach "makes New Programming Languages which are amalgamations of most currently used languages completely unnecessary."

An all-manufacturer panel on time-sharing did a beautiful job of fielding some good questions, but it was still informative. Questioned on ease of operating time-sharing systems, G. Oliver of GE noted that the Dartmouth GE system has an instruction manual printed on two sides of one piece of paper. On the other hand, said Watts Humphrey of IBM, as you go to larger more general-purpose systems, you have to match a wider range of users to a system, and thus have to get more involved in paper work. R. K. Nelson of Control Data, who had discussed the 6000 series (and noted a forthcoming smaller t-s system in the 3000 series), had a difficult time with the question of hardware checks in the CDC systems. Is time-sharing here to stay? Well, the number who say "nobody should use it" is decreasing, said Humphrey.

The verdict on the conference was generally very favorable. A particularly excellent paper noted was T. H. Nelson's (Vassar College) paper on his proposed Evolutionary List File for complex personal filing and manuscript assembly. Another was on a new discovery and induction program for games, BOGART (affectionately known as Humphrey), which was written by C. Newman and L. Uhr, Mental Health Research Institute, Univ. of Michigan. It consists of a set of board game routines written in MAD and developed to "illustrate that it is possible to solve a large class of dissimilar problems by the use of learning techniques."

R. J. Nelson of Case Institute gave a remarkably lucid paper on automata theory; in one conclusion he debunked the idea that there are "truths human beings can discover which are not open to computers . . . The field is wide open."

Little hardware was discussed in the technical sessions, but somehow the term reactive typewriter (low cost, upper and lower case capabilities, fast responsiveness, hooked from afar to a time-shared computer with large storage) got itself into several sessions and is working its way into popular jargon.

Stanley Gill, talking on Great Britain, noted that "computer developments in the U.K. during the next three years will be worth watching." Concerning the problem of competition from imported machines, Gill noted that the Ministry of Technology, newly created, is setting up an advisory unit to study government purchase of computers, and it is hoped this will result in more sales of British machines.

Two sessions which pleased academicians were the panel on graduate programs in computer science and the special interest meeting on university computer centers. In the latter, the change in government policy toward centers was hailed. Now government-sponsored persons can be charged more for computer time than the non-sponsored, which means the government assumes greater center support.

Other news from ACM included the formation of a special interest committee on Computer Systems Installation Management, and the reactivation of the SIC on Numerical Mathematics, which proposes in part to serve as a channel for information on algorithms and as a liaison with mathematical societies. The ACM Southeastern Region awarded the prize for best student paper to A. J. Gabura of Univ. of Toronto, who presented original work on "Computer Analysis of Musical Style."

For the last few years ACM meetings have obviously suffered from location and multi-conference competition; running parallel to WESCON this year didn't help. But that's supposed to change, as next year it's Los Angeles, a little town with lots of potential, Aug. 30-Sept. 1. Then it'll be Washington, D.C., Chicago, and San Francisco.

—ANGELINE PANTAGES

OPERATING SYSTEMS: ONE INSTALLATION'S EXPERIENCE

by ROBERT F. BROCKISH

An operating system can be defined for our purposes as a set of programs which handle the internal management and service functions of a computer. These functions, which are analogous to the overhead activities of running a business, are supervision of job-to-job transition, program loading, input/output control, job accounting, and program preparation. Compilers and assembly programs handle this last function.

In 1957 ideas about operating systems were beginning to spread amongst IBM 704 users through their exchanges at SHARE. Although their machines were among the most powerful available at the time, these users were challenged to get more productive work out of their computers. A considerable amount of the workday was taken up by operator handling of each job. It was recognized that the urgently needed computer was idle during manual job-to-job transition. Operating systems were born. Known generally as monitors, they were examples of simplicity compared with the sophisticated, all-purpose systems of today.

users started it

Although operating systems have been used with computers applied to scientific problems for a number of years, these systems are, as yet, used by a relatively small number of commercial installations. Part of the reason has been that until quite recently operating systems have not been supplied by the manufacturers. The early monitors were developed by the users themselves, either independently or on a cooperative basis.

In the data processing center at Thiokol's Wasatch Div., located west of Brigham City, Utah, we have an IBM 1410 to process business applications and an IBM 7040 for scientific computations and test data reduction. These machines are supported peripherally by two IBM 1401's. Here at the Wasatch Div. we have been convinced for some time that operating systems are necessary on large computers. In addition to increasing the efficiency of the computers, they facilitate integration of related applications and permit central storage of records and use of common data files.

Thiokol devised its own monitor programs when the manufacturer had none to provide. These homemade, straightforward batch processing systems written for the IBM 704 and 1410 have since been replaced by full-blown operating systems to handle our data processing. Two similar systems supplied by the manufacturer control our commercial data processing and our engineering-oriented computations on the two different computers. The next phase in our evolution will no doubt be the consolidation of all of our processing, both scientific and commercial, on one type of machine under one operating system. Current operating systems are designed to support such a consolidation if a user sees fit to operate in this manner.

installation background

The Wasatch Div. of Thiokol Chemical Corp. produces solid propellant rocket motors. Most notable of our products is the first stage booster for the Minuteman ICBM. Our facility carries out both production of operational motors and research activity on advanced solid propulsion systems. Although our data processing is divided into scientific and

Mr. Brockish is manager of DP Operations for the Wasatch Div. of Thiokol Chemical Corp., Brigham City, Utah. After a stint as a programmer for Martin-Denver, he joined the division as head of the scientific dp department. He has served on SHARE's executive board, as SHARE representative to JUG, and as manager of various study groups. He holds a BS in math from Regis College, Denver, and has done graduate work at Denver U.

commercial applications, both installations are located and supported by staffs that work within the Computations Div. Computer operations, data preparation, input/output control, and programming systems are functions of a single department within Computations. Other departments are assigned to carry out the functions of digital scientific analysis and programming, management systems design and programming, and analog simulation.

The commercial, or management systems data processing, includes engineering release, manufacturing planning, configuration control, inventory management, financial management and industrial relations applications. Our 1410, which is equipped with 80K of storage, a 1301 disc file, and magnetic tapes, supports this area of processing.

Currently we are engaged in integrating many of our applications into an effective management information system. The program-to-program linkage provided by the 1410/7010 operating system is proving to be valuable in this effort. The communications region of the system monitor provides a machine storage area where common information can be made available to independent programs working as a system.

Our scientific applications include reduction of static and flight test data, nozzle design, propellant core configuration analysis, trajectory simulation, and chemical equilibrium calculation. The latter program simulates the effect on a propellant's properties by variations in the ingredients and formulation of the materials. IBM's IBSYS controls the 7040 which processes these and other programs.

operating system advantages

The primary advantage of an operating system is the nearly non-stop mode of operation it affords. Control of the computer normally is returned to the operator only when the I/O unit configuration requires changing or a batch of programs completes processing. Supervisory programs of the operating system control the transition from one job to another and will automatically terminate processing, produce machine accounting data for one job and immediately initiate processing for the next job in the batch. Of course, the operator must assure that the tape setup is correct for each program before it is processed. The operator is guided by explicit rules for loading and assignment of I/O units and for starting, interrupting, and removing work. He is not burdened with a great number of details which are a source of error during long runs. Keeping track of the progress of a system of inter-related programs can be a difficult task for the operators without an operating system. Using a system, control statements and monitor routines guide the progress of the job even to the extent of checking to see that the data tapes called for are mounted where they should be. Operating systems thus significantly increase the amount of work which can be put through a computer in a given time period by minimizing operator intervention time. Under previous operating conditions we could meter about 18 hours per day on the computers. With the current mode of operation we can exceed 20 hours of production time when our workload demands it.

Another advantage of an operating system is the contribution it affords to program development. The assembly program and the compilers for COBOL and FORTRAN are constructed so that program segments written in the various languages can be integrated into a single object program. This allows the programmer to use whichever programming language is most appropriate to individual portions of his program. Another powerful aid the systems offer program development is the ability to "compile-and-go." This is also a particular case of program transition. Through control cards the first program processed in a job is the

compiler or assembly program which translates the source language into a machine-language object program. The second program in the sequence is the execution of the just compiled object program, thereby giving the programmer the benefit of test results as well as a compilation from one turn on the machine. New source language segments and previously compiled object segments can be inter-mixed and processed as a single program with this feature. To avoid the execution of newly compiled programs which contain programming errors, the programmer can specify error criteria that will prohibit the test run if errors of a given severity exist in the source program.

some drawbacks

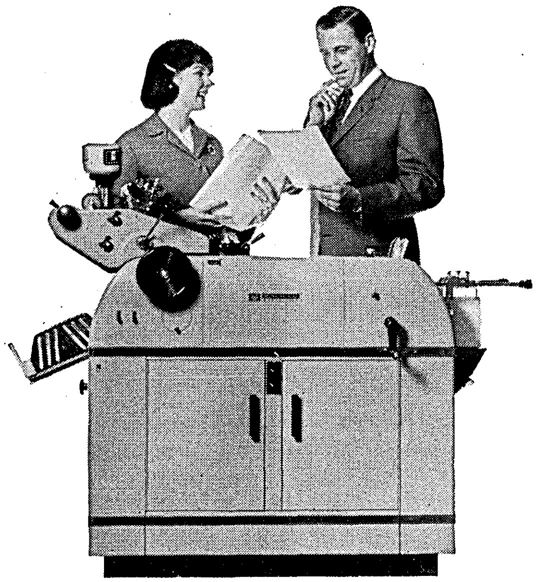
This ability to inter-mix programming segments of various languages and also to combine source language and object code is made possible by relocatable addressing. Relocatability, or the deferring of assigning absolute storage locations to a program until it is loaded into the machine for execution, assists in program maintenance as well as providing for the combination of various programming segments. Although relocatable addressing provides flexibility, the computation of absolute addresses each time a relocatable program is loaded requires significant computer time. This time, usually called loader time, is the major element of systems overhead time. The relocatable loader must actually perform the address calculations which would normally be done as the last phase of an assembly or compilation. Our loader time on the 7040 runs about 10% of our total utilization. On our 1410 system the loader time is about 6% of our usage. Most of the difference between the two percentages is due to the larger size of 7040 object programs and the longer execution time of the 1410 programs.

A disadvantage not entirely attributable to the operating system as such is the execution time required by programs written in COBOL and FORTRAN. Although the compilers translate from source language to machine language very rapidly, they also can produce programs which execute very inefficiently. A program can be extended to two or three times the running time required by an assembly language program by using workable but inefficient source statements. In an effort to minimize this problem, we have attempted to isolate particular statements that cause compilation of inefficient coding, and instruct programmers regarding their use.

The manufacturer has recognized this problem and provides in the language manuals suggested techniques by which a programmer can attain the most efficiency in a given situation. In many of these instances, however, the programmer is faced with a dilemma of either inefficient program execution or having to give up the programming power of the language. He must make a professional judgment as to which course is better for his particular problem. A more general solution would be provided if the manufacturer would provide two compilers for each language. One would be a checkout compiler affording rapid compilation without regard to the efficiency of the object program; the second compiler would be primarily concerned with efficiency of the object program without necessarily minimizing compile time. Here at the Wasatch Division we have rewritten selected modules of the manufacturer's 1410 COBOL compiler to help us attain better object time efficiency.

i/o control routines

Input/output control routines are an important part of



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an operating system. Transmission of data between main memory and the tapes, disc, or other I/O devices is handled by these routines. The I/O control routines also provide file checking and labeling. These systems functions eliminate the necessity for each programmer to write routines to handle these functions in each individual program. The input/output control routines, along with other parts of the system, serve as a good foundation for standard programming practices. Programmers performing common programming functions in a standard manner add considerably to the efficiency of an installation. These standards assist in the area of program maintenance, conversion to subsequent equipment, and documentation.

getting started

For a functioning computer installation there are two primary means to begin use of an operating system. The cleanest way is to put operations under control of a system at the time new equipment is installed. The effort to become compatible with the operating system can then be included within the reprogramming or conversion effort for the new equipment. If equipment is not scheduled to be changed, then an installation can initiate utilization of an operating system through conversion of its existing program library. This conversion is generally not as expensive as that required to convert to new equipment but it does take effort that should be well organized.

It is possible, although not convenient, for a computer installation to operate partly under an operating system and partly in another mode of operation. Because this is true and since the same type of equipment is used in both cases, an installation can schedule the conversion to its own requirements. Certain programs can be converted to the operating system when the procedures by which they process data are revised and the programs must be rewritten anyway. It is difficult to justify conversion simply in terms of dollars and cents, since the advantages of using an operating system tend to be highly intangible.

As in any conversion, the first step in converting a program library to run under an operating system is to insure that the source program decks and documentation are updated to correspond with the currently operating machine-language programs. Machine conversion programs are generally available to change source-language statements valid under one system to statements valid under a given operating system. The conversion programs usually recognize unconvertible statements, flag them for manual rewriting, and often suggest several possible approaches to the rewrite. At the Wasatch Division we have taken both conversion paths to the comprehensive operating system. In our scientific work we converted from our own monitor to the IBSYS system on the 7040 at the same time that we converted from the 704 to the 7040. In our commercial data processing area we converted our existing 1410 programs to operate in the 1410/7010 operating system.

704-7040 conversion

In preparation for the installation of the 7040, we converted many of our 704 SAP programs to 7040 MAP source programs in advance by using the IBM 1401 to analyze programs, flag I/O areas, and replace unique 704 instructions with instructions common to both machines. After completing this phase of the conversion, we were able to continue to run these programs on the 704 until

installation of the 7040 without maintaining duplicate source decks.

When an IBM 7040 became available in the local IBM branch office several months prior to our scheduled installation, we replaced the I/O areas and performed extensive testing. Of course, from this point until we installed our own 7040, it was necessary to maintain duplicate decks because of the replacement of the input/output coding. FORTRAN programs were not converted in advance. They were manually converted when the system for testing was installed in the branch office. In all, about 200 programs were converted from our homemade supervisory system on the 704 to IBSYS on the 7040 in just under six months. These programs ranged in complexity from straightforward equation evaluations to bit manipulating data reduction routines. Average size of the assembly language programs was about 6,000 words with several larger programs requiring multiple core loads on our 16K 704.

To assist the conversion from our own 1410 supervisor to the IBM 1410/7010 operating system, there was available from the manufacturer a conversion program. We modified this conversion program to handle the specific requirements of programs which had been developed for use with our own monitor. The altered conversion program helped us to reduce conversion time for some 250 commercial programs to four months. Before conversion these commercial programs averaged about 20K positions of core storage with some of them requiring overlay in the 40K of core then available on our 1410.

Our two departments, which are responsible for operations and programming, coordinated very closely on this conversion. The checkout of the converted programs and newly written routines was accomplished under the 1410/7010 operating system while, in the meantime, all production running was being performed under the existing monitor. Although we attempted to have a clean cutoff from the old supervisor to the new system for production, it turned out that for a short time after implementing the 1410/7010 operating system we still had a few programs running under our old supervisor.

We did make some equipment changes at the time we introduced the full-blown operating system. During the conversion to the new operating system, programs were screened for use of on-line unit record equipment. Coding to use designated system input and output units replaced program areas which utilized the on-line card reader-punch or printer. When the operating system was installed with the programs converted, the 1410 became operational as a completely tape and disc-oriented system, and the unit record equipment was returned to the manufacturer. Also it was in conjunction with the conversion to the operating system that we installed the 1301 disc file, giving us our first random access capability. A number of the programs which were converted to the new operating system were also converted to use the disc file.

In general, the manufacturer supplies master tape files containing all the systems elements including the monitor, I/O control programs, language processors, sort routines and utility programs. Also supplied were routines to generate the operating system tape. Periodically we receive new versions or modifications of these elements. Utilizing special control cards, our systems programmers generated a systems tape designed for use in our own installation. Our policy is to minimize our own particular requirements in order to reduce the effort required to maintain the manufacturer's supplied systems. Some things that we do add to the system supplied to us are our own machine accounting routines and our own installation macros. Of course, when generating the system for an individual installation, it is necessary to specify the particular I/O units which will be assigned to the various system functions.

systems overhead

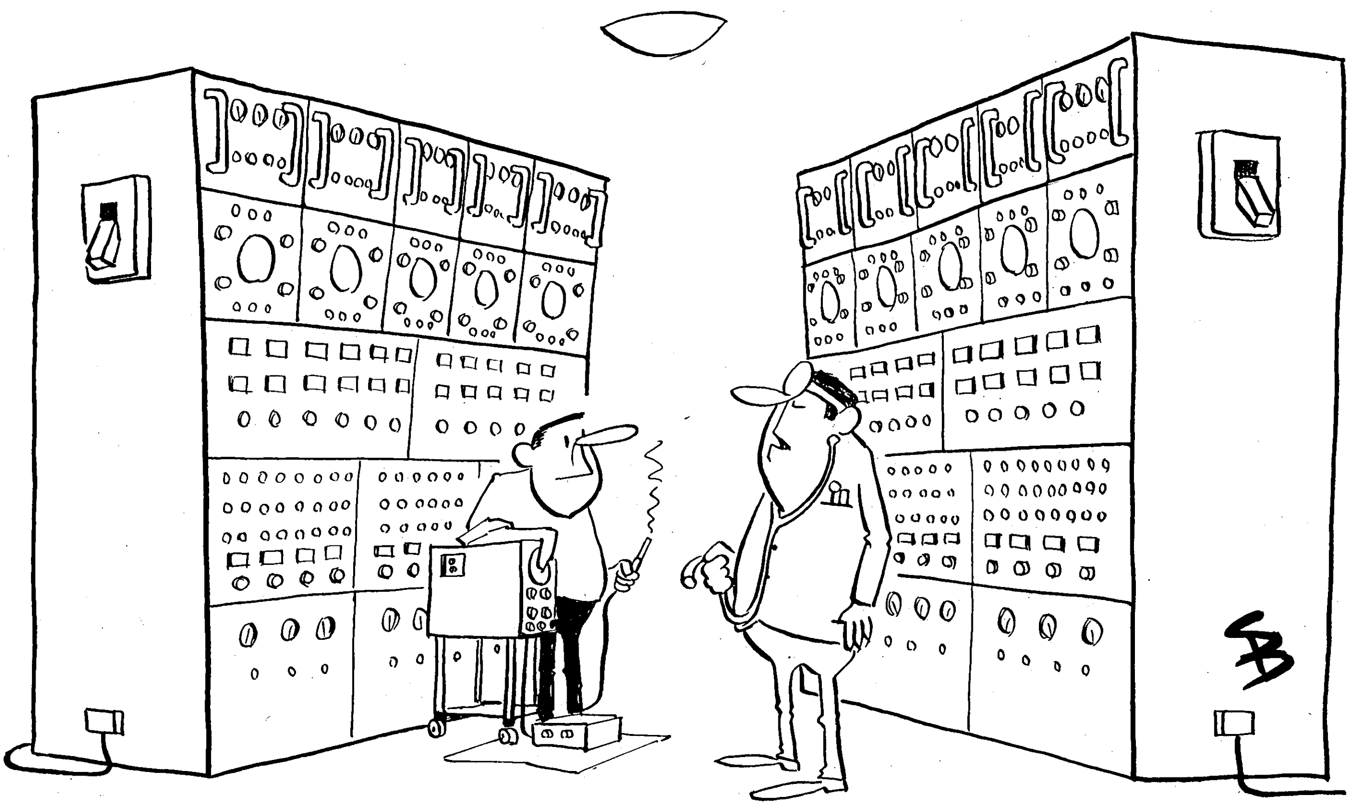
In evaluating an operating system one must consider the amount of systems overhead processing required in order to perform productive work. A factor which contributes to this overhead is the place of residence of the system file. An operating system normally resides on a magnetic tape or a bulk storage device such as a drum or disc file. In our installation we utilize both. On our 1410 the system resides on a disc file, while on our 7040 the system resides on magnetic tape. Where a system resides on a random access device, the ordering of the systems components is not important as far as overhead time is concerned. But, in the case of residence on magnetic tape, the order of the various routines and system elements on the tape can contribute significantly to the effect on systems overhead.

In cases where overhead becomes critical, systems search time can be diminished by the utilization of two magnetic tapes to contain the system and the library. Another technique is to repeat various frequently-used system functions periodically along the tape, thereby compensating somewhat for the sequential constraints. Wherever the system resides, be it on disc or tape, another technique for reducing systems overhead time by the reduction of loader time is the placing of selected programs on the system resident unit. Selection of these programs is based on the frequency of their use, their size, and the degree to which they are free from possible modification requirements.

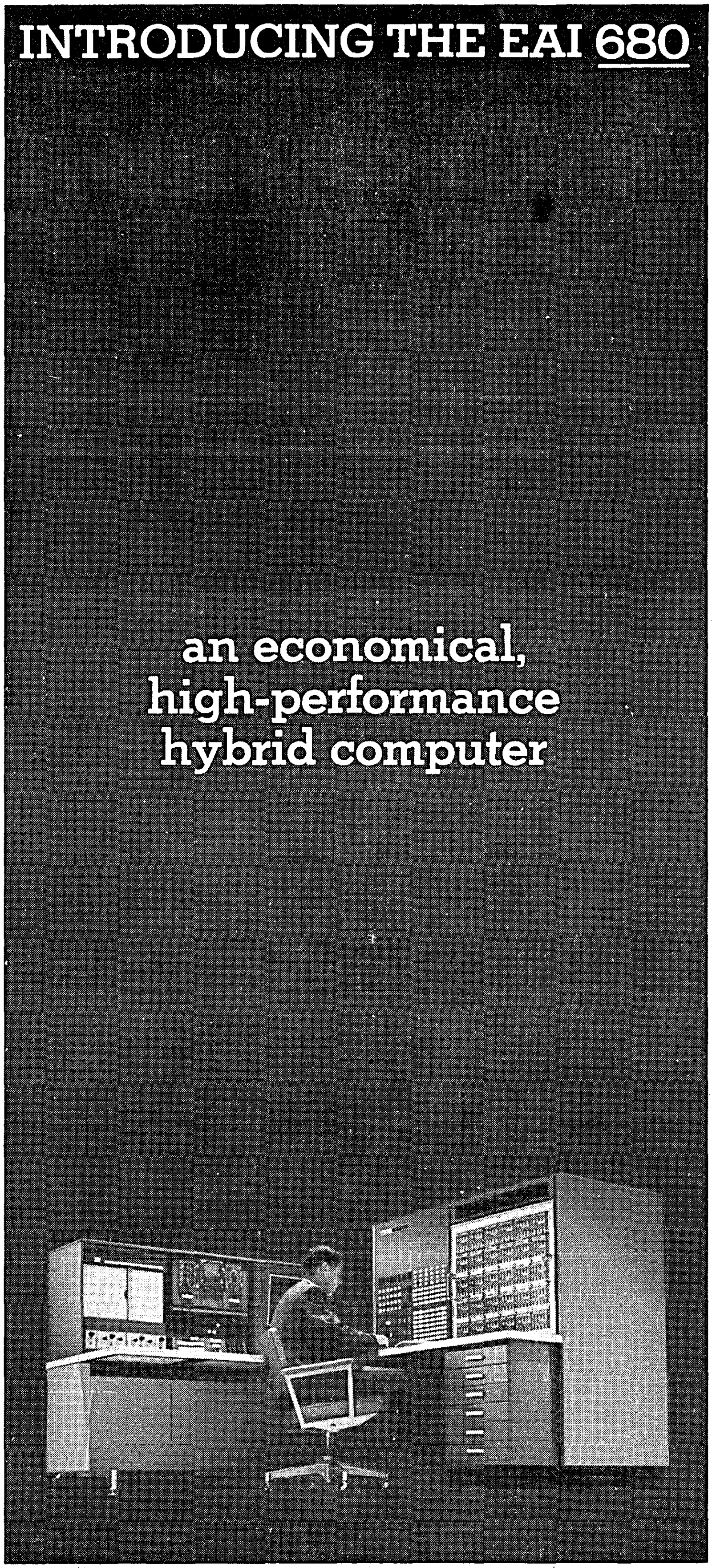
Bulk storage devices such as we now have in the form of our 1301 in our commercial installation more than pay for themselves in improved performance of the systems. Sorts and "compile-and-go" runs are faster, overall productivity is improved, and the file provides more accessible storage facilities for records that are updated frequently.

The combination of an operating system and a bulk storage file tremendously facilitates sorting, which is a significant part of commercial data processing. Sorting under the 1410/7010 operating system is accomplished by providing control cards which specify the file to be sorted. Prewritten routines which will be tailored to fit the file specifications are called out by these control cards to perform the required sorting. This, of course, eliminates establishing sort programs for each application. Using the disc file as intermediate storage allows processing to proceed into most sorts without halting the computer to mount the scratch tapes required in a tape sort. Only the very large sorts must utilize tapes as intermediate storage. Sorting represents 22% of our 1410 utilization; disc sorting accounts for 37% of that time. We have 80 programs utilizing the disc sort and 42 which require tape sorting. When a data file grows too large for the sorting area on the disc, the applicable sorts can be changed from disc to tape by merely changing the control cards.

The processing of dozens of programs in virtually uninterrupted sequence is vivid testimony to the improved effectiveness offered by operating systems. It demonstrates, moreover, that such systems can be installed successfully to support both commercial and scientific applications. In our case, we have a more efficient service organization: the operating systems employed on our two major computers, in addition to improving operational efficiency and contributing to faster program development, provide a tool for better installation management. ■



" . . . Nothing organically wrong, they're just incompatible"



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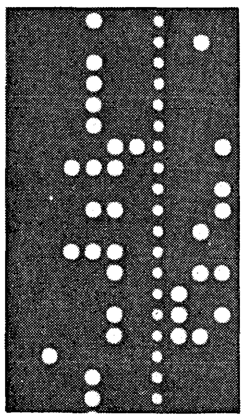
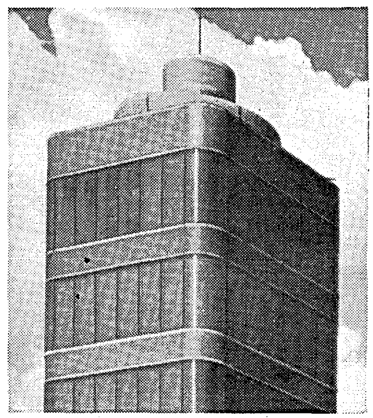
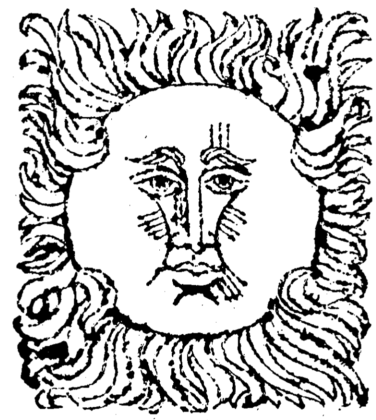


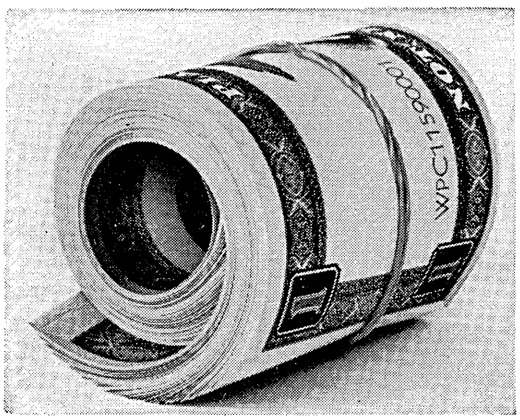
When re-orders are issued to Johnson salesmen in the field, they are immediately entered on an NCR 160 Adding Machine equipped with a paper tape recorder.



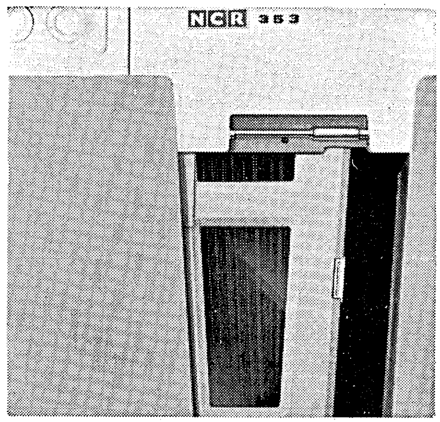
These orders are then transmitted to Johnson headquarters in Racine, Wisconsin, via AT&T lines. In Racine, the tapes are removed from the Teleprinters and forwarded to the NCR computer.



Incoming orders and inquiries are processed by early the next morning. Changes in demand (and, naturally, inventory) can be decided by this system within 24-48 hours. Thus revisions in production and distribution can be implemented, immediately. This uniquely flexible NCR Total System gives Johnson Wax a completely closed loop of control—from the sale of the product—all the way through to the next sale...ad infinitum.



(Among other benefits: they've reduced their inventory by about 7-10 days supply.) Quite an investment.



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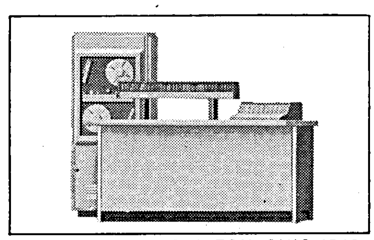

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CIRCLE 31 ON READER CARD

CIRCUIT MODULES AND COMPUTER TRAINING

maintenance men in khaki

by DAVID B. DENNISTON

The advent of the mobile, field-based digital computer forced the Army to do a basic about-face in its attitude toward training technical personnel. Until then, new equipment was usually available for a while to train the men who were going to use it. But the MOBIDIC-7A—first of the field-based computers—raised special problems. Accelerated, virtually wartime schedules were imposed upon development and training programs.

It was obviously impractical to place a multi-million dollar, one-of-a-kind system in the classroom while a field command waited for it. Somehow, the men who would have to maintain and operate the MOBIDIC-7A had to train on something else.

Originally, the first MOBIDIC was to reach a field unit in late 1962, and all plans for training programmers, operators, and maintenance men were made with that date in mind. But in August 1959, the Dept. of the Army directed that the first unit be shipped in late 1960 to the Seventh U.S. Army, whose existing, fixed-plant computer was rapidly becoming obsolete. The directive stipulated that trained operating and maintenance personnel be on hand to receive it when it arrived at Seventh Army's Stock Control Center in Zweibrucken, Germany.

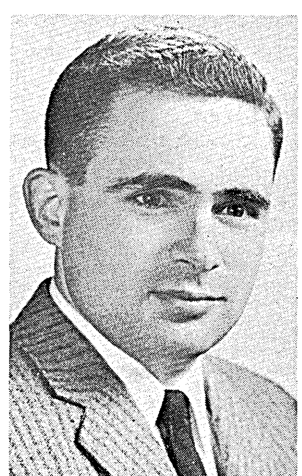
Further complicating the training situation was the requirement that the men who would use and maintain MOBIDIC and the Army's other mobile Fieldata computers up front with tactical units would be soldiers, not the manufacturers' field service personnel. In another departure from the past, the training was also to be planned and given by Army personnel.

When the problem was handed to the U.S. Army Signal School at Fort Monmouth, N.J., which trains most of the men who maintain and use the Army's automatic data processing equipment, the school staff decided to reconsider the assumptions underlying the training courses.

dropped component approach

"The whole problem typified by MOBIDIC-7A made us realize that a system approach to training was needed to replace the component approach we had taken earlier," said Frank Boynton, one of the supervisory instructors. "We formerly turned out a specialist who knew one piece or one type of equipment thoroughly. Now we wanted to turn out a man who knew the function of every element in a computer installation and who understood completely the electronic and mechanical principles involved in the operation of any device in any system."

As a result of this reappraisal, it was concluded that the computer technicians would undergo a thorough grounding in all basic computing principles. This course would be amplified with use of training aids that could simulate the functions of any computer. A brief, on-the-job training period would then familiarize the man with a specific machine. If successful, this approach promised to solve the problem of duplication of effort in teaching



Mr. Denniston is manager of the New York district office of Digital Equipment Corp., with whom he had been an applications engineer. He was formerly a district engineer for the Federal Aviation Agency, and served in the Army Signal Corps at Fort Monmouth, N.J. He holds a BS in electrical engineering from Worcester Polytechnic Institute.

fundamental portions of each of several specialized courses.

The intervening three years have borne out the soundness of the approach. Not only was a trained crew waiting in Germany for MOBIDIC-7A, but each succeeding Fieldata computer has found capable men ready for it.

Each of these men acquired his knowledge of computer fundamentals through the use of special simulation training aids, designed and built for the school three and a half years ago by Digital Equipment Corp. of Maynard, Mass., and still in daily use.

year-long evaluation

The school's faculty spent a year in investigation before settling on the modules. The goal was to find circuits that could be modularly assembled into progressively more powerful digital devices, to explain and demonstrate all functions from flip-flop to complete computer system.

Off-the-shelf devices were specified, durable enough to withstand the physical handling involved in continuous training—as well as the electrical surprises that beginning students can arrange. Characteristics sought were flexibility in performance, ease of modification and reliability.

Students use this equipment in the 36-week computer maintenance course and the 25-week input/output maintenance course initially to learn the electronic fundamentals of computers. Having assembled a computer with it, they move on to other studies and leave the assembled machine for other students.

"This lets the student see the equipment running under conditions like those in actual installations," said Robert MacDonald, who plans the computer and peripheral equipment courses. "It lets the student really grasp the logic of the system and enables us to teach concepts rather than equipment."

The logic elements are used by students to build counters, shift registers, adders and subtracters, synchronizers, decoders, comparators, and converters. The circuit types include inverters, OR-NOR's, AND's, flip-flops, variable clocks, and pulse amplifiers.

Says MacDonald: "Use of the modules and buffers gives the student a psychological advantage, too. Being so much smaller than a complete installation, the modules don't overwhelm him. He can pick them up and examine them closely. He can connect one and see how it functions, add another, and gradually gain confidence."

The training modules are similar to Digital's laboratory modules, but with minor circuit modifications and standard military symbology in their circuit diagrams. They are encased in aluminum boxes and plug into power jacks as they are inserted in mounting panels. Signal circuits are built up on the diagrammed faces with stackable miniature banana-jack patch cords. The modules use single-polarity logic and can operate at any frequency from DC to 500 kilocycles per second. Instructors can demonstrate and experiment using classroom modules, which have circuit illustrations enlarged four times.

combine modules with buffer

The students work up gradually to using a Memory Buffer with several sets of modules. The Memory Buffer actually serves as a relatively inexpensive nucleus around which digital control devices can be built. Using the buffers and modules, the class actually builds a small, general-purpose computer.

Each buffer contains a core memory of 512 16-bit words, with 9-bit memory address register and 16-bit memory buffer register. It also contains three general-purpose registers and control, indicator, and patch cord panels. The control panel includes switches for loading the memory manually and a digital printer for output copy. The indicator panel lets the operator examine the contents of any register bit, and pushbuttons on the control panel let him clear, set, or shift the registers. Input/output jacks permit the buffer to function with the computer control circuitry assembled by the students or other external control systems.

The buffer is used in the peripheral equipment repair course to provide simulated on-line operating conditions for the keyboard devices, paper and magnetic tape equipment, and line printers that familiarize the students with the input/output equipment they will have to maintain.

how courses are organized

The Army's computer courses are intensive and well-organized. They leave the students with a thorough grounding in computer fundamentals, requiring little more than a normal high-school education as a starting point.

Students begin the 36-week course with a 10-hour introduction to Fieldata computers, followed by 18 hours reviewing decimal, binary and octal numbering systems. Then they have 76 hours of drill in diagrams, flow charts and other aspects of organization and techniques. Next comes 114 hours of fundamental computer circuits, including Boolean algebra, use of an oscilloscope, and analysis, construction and troubleshooting of registers, counters and other elements.

Students are then ready for construction and analysis of a computer system; 190 hours are devoted to this, using the modules as building blocks. The machine is then left assembled for other students to use in programming and operating studies. The class then turns its attention to a thorough study of electrical and transistor fundamentals, from practical instruction in how to use soldering tools to a theoretical examination of the composition of matter.

At this point, students begin to learn specifics about the central processors, circuits and input-output systems they ultimately will work with. This, the balance of the course, occupies somewhat less than half of their total course hours.

input/output course

The 25-week course is intended to familiarize the student-soldiers with maintenance and repair of input-output equipment. Students taking the shorter course have 72 hours of instruction on the training computer constructed from the modular building blocks and use the modules separately or in various combinations to other computer basics.

Computers are just one aspect of the Army's vast educational enterprise at Fort Monmouth. The school also offers courses in a variety of subjects, including radar, radio, meteorology, and photography, graduating an average of 6,600 enlisted students a year. The enlisted students average a little under 21 years of age; 89.8 per cent are high school graduates, and 22 per cent have had one or more years at engineering school or college.

The new look at the Army Signal School reflects a world that has changed immeasurably since the days when a soldier could live with his equipment until he became an expert at it. Military hardware—like its counterparts in business, industry and science—has become in many cases too expensive or too scarce to tie up in the education of beginners. In the case of the Army's computer courses, the solution had the happy result of turning out students who have an all-around competence in a large new field, rather than men who are narrowly confined to a specific piece of equipment. ■

MENCKEN REVIEWS AUTOMATION

The late H. L. Mencken, the Sage of Baltimore, was noted for his bombastic pen, his acidic approach to his pet peeves (which were many and varied), and his iconoclastic approach to the world and all he found in it. Mencken flailed far and mightily, and few were the confused souls who felt not the sting of his lash. Included among his targets were clergymen in general, all the Presidents of the United States who held office during his lifetime, most politicians and William Jennings Bryan in particular, and almost anyone stupid enough not to live near the center of a large, old city.

Not so well known was Mencken's penchant for foretelling the future. Among papers found in a musty old trunk only a few miles from the Sage's home within a few months after his death was the following, printed here for the first time. Whether the manuscript is Mencken's or not, it reveals a preposterous—if pompous and pontifical—prescience.

Programmaticus

Among the more asinine manifestations of imbecilic ratiocination characteristic of the *mens Americana* is the belief, prevalent in certain quarters of our fair land, that some giant hobgoblin called *Automation* threatens our very life, limb, and soul. This ectoplasmic poltergeist, we are led to believe, constitutes a more massive threat than Red China, the Black Muslims, or DDT. For preposterous rubbish this warped view of the *status quo* is comparable only to the television-promoted belief that Bufferin goes through its recipient's gastric system in cast iron galvanized pipes.

Throughout the midwest Bible Belt daily incantations are held in the forlorn hope that Heaven will ward off digital computers. In the privy halls and high chambers of our august Federal Government learned men daily ponder the drastic effect on our public *opera Oekonomika* of this presumed transistorized Armageddon. Committees diddle and dawdle in the halls of Congress, hands are wrung, garments are rent, and reports are sent forth unto the waiting world by the Government Printing Office.

Business men of note study the Gospel according to CODASYL. The stone-pated pundits of lower Wall Street alternately view with alarm and bow with obeisance toward the fascinating fluctuations of the electronics shares analysis charts upon whose second derivatives their highfalutin published rumble-bumble, couched in pure Kiplinger Newsletter jargon, is based. More palpable tosh than this has not formed a part of the public superstition since the Sermon on the Mount.

This current and quite preposterous national worry has no basis whatsoever in fact. Rather it is like the daily interruption of commercial machinations in order to bow slowly toward Mecca, prevalent and popular in the Middle East. To presume that an inanimate electronic computer can contrive to get things in a more confused state than can a mortal human is a belief equivalent to holding that Edmund C. Berkeley operates on two-hundred-twenty volts DC.

The congenital inability of the reverend public utilities to credit any legally-tendered payment correctly, or alternatively, the ability to credit it twice, is firmly based upon modern-day automation technology. Sadly, though, it is not due to such technology, we are assured by the simpleton-like spokesmen of the inner circle, muttering incoherently through their technical symposia, but rather to the utterly distressing fact that *every* such multi-megabuck collection of printed circuits *must* be programmed by some bumble-brained, overpaid human. Therein lies the Achilles heel of automation.

The real dangers of automation are found, instead, in quite another quarter. The potential horror stems from the very shattering performance of these card-racheting black boxes. They hold forth to a long-suffering world the real hope that the idiocies of some rattle-brained file clerk will be perpetrated far and wide upon one and all in a mere handful of microseconds. All mankind, severally and Pike, stands at the stupid mercy of the purveyors of button-pushing.

Since we find, then, that rather than standing at the mercy of automation, the shoe is on the other foot, what hope can be found for halcyon days of a distant future? A good deal indeed.

The very astronomic performance potential of these modern-day, solid-state bit-manipulators holds forth the ever-present excelsior banner that someday soon something will *really work*. At this golden hour the face of this fair earth will change. The world will see the beginning of the end of its long-suffering permissal of mediocrity, incompetence, pomposity, and sheer asininity. The computer will have begun to replace people.

Think of the golden universe in which a Methodist bishop is replaced by a core memory! View in your mind's feeble and jaundiced eye the magnificent millenium in which the hordes of present-day ten-thumbed garage mechanics are swept under the rug to be superseded by high-density magnetic tape servos. Consider in your silver dream the multitudes of surly New York City head waiters done away with in favor of punched card reading devices. Many and loud will be the hallelujahs in the vineyards of the Lord as troops of starved, unemployed, vapid-eyed retail store clerks march to their reward, done out of their secure and incompetent doldrums by chrome-plated automata.

It may indeed be true that the day of the second coming draweth nigh. Automation may be the *Deus ex machina* capable of expurgating the ills of the universe.

Hence we come inescapably to the conclusion that if Automation is a force at all, it is a spiritual force, and, as such, it must stand back to back with the rest of the world's philosophical folderol and be measured. I confidently predict that it will not be found wanting if, as may soon be manifest, it can remove *homo sapiens* from the important business of this vale of tears. ■


KEEP OUT

FOR FABRITEK CIRCLE 37 ON READER CARD——

Esprit de Core

While you are reading this, billions of ultra-miniature ferromagnetic memory cores in computers all over the world are magnetically switching millions of times per second. Every single one of these billions of tiny magnetic "doughnuts" is manufactured with a precision greater than a fine watch, and tested more carefully than any other single part of computer electronics.

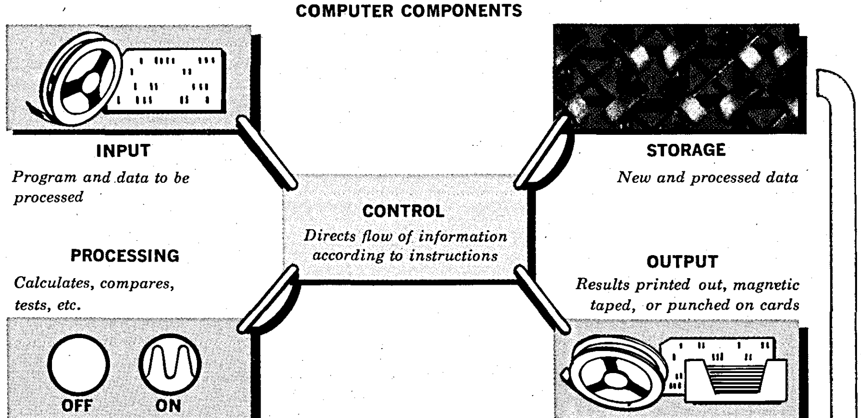
Core manufacture follows the established practices of ceramics, but with exhaustive exactness; material preparation, pressing, sintering, and testing. Core production technology requires rigorous process and quality control procedures, including 100% dynamic testing.

First, certified chemically pure ferrite compounds containing iron oxide and bivalent metallic oxides are evaluated for purity, particle size distribution, particle shape, and apparent density. This step may take hours. Satisfactory material is weighed, and then check-weighed, dry-blended, calcined, ground, and mixed with an organic binder. Then, it is dried, granulated, and screened to a size classification. Very important to successful powder preparation is the time-temperature profile during calcination, and the particle size distribution attained during grinding operations. Process adjustments must be constantly made to compensate for deviations in the raw material quality characteristics.

Prepared material is pressed in automatic, single-station tablet presses to produce "green" cores. For today's ultra-miniature core, dimensions are .022″ outside diameter with a .014″ inside diameter hole. Dimensional tolerances of ±.0003″ are monitored by an electronic gauging system. Electronic balances control pressed core density within ±.08 g/cc. A visual inspection of each core by high power magnification is also included.

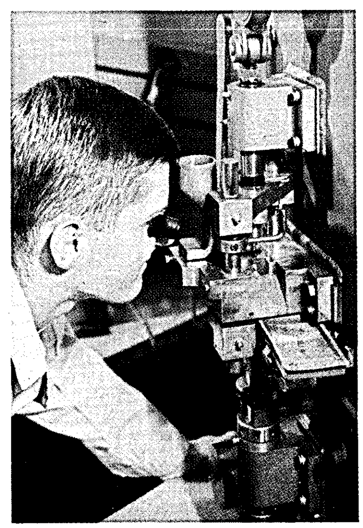
Next, cores are sintered by batch firing in periodic kilns to control lot to lot uniformity. Preliminary sintering runs on each lot establish optimum time-temperature cycles. Kilns are regulated by saturable reactor controls.

Sintered cores are ultrasonically cleaned, then automatically gauged "go-no-go" to dimensional specifications. Cores are handled mechanically to avoid contamination. Each core is electrically interrogated by an electronically controlled automatic handler. Depending upon its performance to magnetic specifications, each individ-



New input data goes through control to storage. Control sends it with old data to processing and then back to storage or output or both.

As many as 20-million of these ultra-miniature cores may be used in one computer memory stack. Standard sizes range down from 50 to 20-mil outer diameters. Dimensional tolerances are held to ±.0003″ and densities held within ±.08 g/cc.



Each of the billions of cores used in computer memories is pressed individually under precise electronic monitoring of size and density.

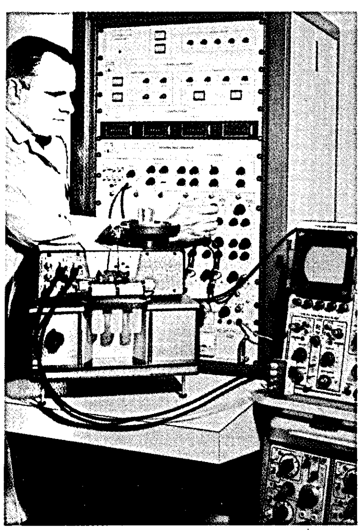
This is the second of a series of six brief discussions on the basic principles of core memories. If you would like the complete series in booklet form, please circle 57 on reader card.

An estimated $250-million worth of this chemically pure ferrite compound is now at work in the nation's electronic data processing industry in the form of ferromagnetic memory cores.

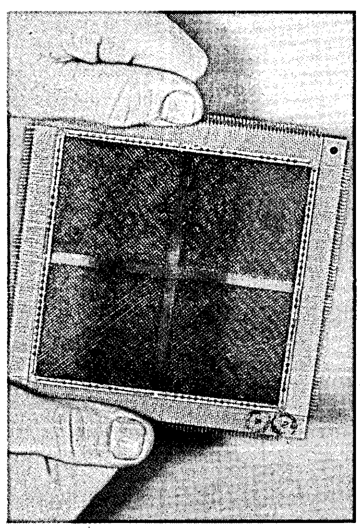
ual core is graded at a speed of 10 cores per second. Selected core lots are then statistically sampled and re-evaluated to assure the validity of production testing.

All this meticulous care is applied to a part that can hide behind a period on this page. The reason is simply that each individual core of the thousands that make up a memory stack must switch in a closely specified time, within a limited range of switching current tolerance, and must provide a specific flux output when it switches. Quality assurance for an entire memory system begins with the core. Without 100% control over core quality, all subsequent effort in memory manufacture becomes a frustrating waste of time.

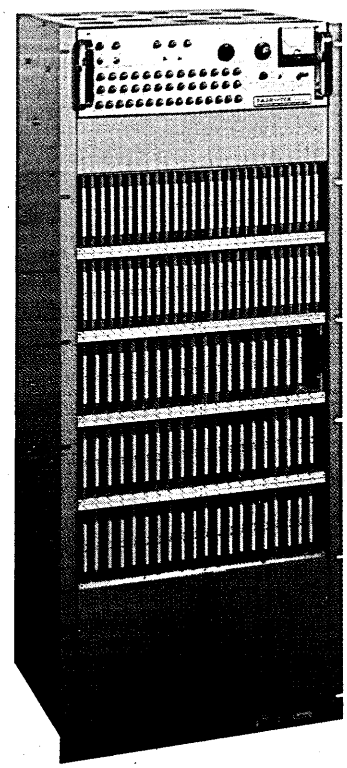
In the first of this series of brief discussions concerning magnetic core memories we called the memory the "heart" of the computer. If the memory is the heart, then ferromagnetic memory cores are the "blood corpuscles" that give the memory life.



An electronically-controlled test unit interrogates each core for its magnetic properties at a rate of 10 cores per second.



A typical memory plane with 16,384 cores must function 100% before it is wired into a memory stack. Core quality assurance is the basis of all subsequent product quality control.



This typical 2-microsecond cycle time memory system has a capacity of 16,384 words with 26 bits per word. A total of 425,984 memory cores store information. For complete information about Fabri-Tek memory systems, write: Fabri-Tek Incorporated, Amery, Wisconsin; or call 715-268-7155; or TWX 510-376-1710.

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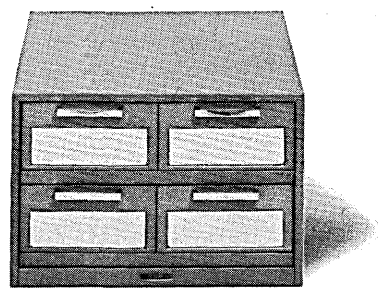

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CIRCLE 42 ON READER CARD

COMPUTER SCIENCE EDUCATION IN EUROPE

catching on fast

by PETER C. PATTON

The European computer market is burgeoning these days and market analysts forecast several thousand more computers to be installed in Europe in the next few years. These machines will require professional staffs, but what are European universities and technical universities doing in preparation for current and expected demands? Although European computer application trails that of the U.S., the present rate of growth in Europe is somewhat greater. To meet this catch-up effort, a tremendous number of computer professionals and subprofessionals will have to be educated and trained. There are more than 260 computers in European universities compared with about 500 in U.S. universities. Many of these university computers are used for data processing rather than education; most of the rest are small-scale computers like the IBM 1620, but at least 50 are large-scale systems. In fact, two of the largest computers in operation are in European universities: London and Manchester in Great Britain.

In spite of the fact that patterns of European education are different from the U.S., it may be of value for the American educator to consider the various European responses to this problem. European university computer education is, in general, developing later and developing around existing commercial hardware. Also, in spite of the traditional conservatism of academic institutions toward new disciplines, a number of very progressive educational programs are now under way. We may not have to wait until 1975 to see universities with "Synnoetics" departments as described in the provocative paper by Louis Fein in DATAMATION, September 1961.

historical background

Perhaps the best way of presenting the situation in Europe to the American reader is to survey briefly the historical development of computer science education in Europe as compared with the U.S. After having arrived at several approaches, different universities and technical insitutes can then perhaps best be classified as being in one group or another. A statistical classification by country is rather sterile and moreover runs the risk of overlooking mention of a progressive organization. We shall use the word "university" in a generic sense to apply to both universities and technical universities in Europe. This distinction is more thoroughgoing in Europe than that between universities and institutes of technology in the U.S., but is not important for this discussion.

Historically, computer science in the university springs from two sources: the engineering school and the mathematics department. Specifically, computers were designed and built in computer laboratories which were subdepartments of Engineering; e.g., Manchester and Cambridge in Great Britain or Harvard and the Moore School of the Univ. of Pennsylvania in the U.S. In both cases, computers were studied and taught for their own sake, literally; for, in fact, the computer education programs of these schools were quite "hardware" oriented. In most other cases, computing was taught as a sideline or technique subsidiary to numerical analysis. The more modern approach, by contrast, is to teach the computer as a general symbol manipulator. Briefly, one might separate these as (a) the tin-god approach, (b) the fast slide-rule concept, and (c) the notion that a computer is an amplifier of human intelligence. This latest approach is actually the oldest, for Babbage and his associates made statements regarding the analytical engine in such a way.

Although departments of computer science have appeared only recently, there have been schools from which one could get a Ph.D. in a computer oriented subject, such as a new computer application or even a circuit design innovation, for at least 15 years. Examples are the famous computer laboratories at Harvard and Manchester. Even

Mr. Patton is manager of the Univac 1107 facility of the Division of Aircraft Technology at the Technical Univ. of Stuttgart, Germany. Most recently a scientific consultant for Univac in Europe, Mr. Patton has been associated with Boeing-Wichita, Univ. of Kansas, and the Midwest Research Institute. He holds an A.B. from Harvard and an M.A. from Kansas.

such august European universities as Muenster in Germany have given Ph.D.'s in mathematical logic for theses on learning programs. But to the dismay of many graduate students attempting to get a computer oriented thesis accepted, universities recognizing computing even as a research specialty are few.

variety of approaches

The various approaches to computer science education in Europe describe a spectrum between two opposite points of view. The most conservative approach is of course that computer science (or in some cases, technology in general) doesn't belong to the university. This point of view has been voiced in Scandinavia, in spite of an otherwise progressive approach to computing outside the university. In Scandinavian educational institutes in which research is being done, there is a demand for computing and consequently some programming instruction: examples are Uppsala with a CDC 3600 and the Norwegian Technical Univ. in Trondheim, which educates hundreds of ALGOL programmers yearly on a Univac 1107 and a GIER[1]. The Royal Institute of Technology in Stockholm will nominate a professor of computer science next year. The next spectral line is the university which gives some sort of "diploma" or certificate of attendance in a course of numerical analysis and computer science. In most such cases, such a diploma, or the work that went into it, is *not* applicable to a graduate degree. This seems to be a left-handed way of satisfying technology's need for trained computer people. Oxford and Cambridge have such programs and at both organizations computing is clearly a technique subsidiary to numerical mathematics. Cambridge has recently announced a new chair in computer science, so one may expect to see some changes there in the next year or two. The Univ. of London has an extensive Institute of Computer Science but as yet offers only such a diploma. Southampton Univ., also in Great Britain, has built a bridge from an Oxford/Cambridge type diploma program to a master's degree. After a successful nine months' diploma effort, the student who stays three additional months to complete a research project in computing gets a master's degree in numerical analysis and computer science. Several other British universities and colleges of advanced technology have master's degree programs in computer science or numerical analysis and computer science. Examples are Leeds, Glasgow, Manchester, Liverpool, Belfast and Newcastle. Edinburgh is planning a master's program to start next year.

Perhaps only 30 European universities have a department or subdepartment of computer science and 15 of these have advanced to graduate degree programs (compared to 40 such graduate degree programs in the U.S.). Most such programs have only started in the last year or two and at least five will begin within the next year. Few have arrived at the situation of Purdue with its Div. of Mathematical Sciences having pure mathematics, applied mathematics, statistics and computer science as equal departments. Such an organization is excellent; it may tend to sacrifice the engineering aspects of computer science (called "Architecture of Computers" nowadays) to some degree but, in general, it provides the best milieu for a new computer science department. Most European universities, especially those on the Continent, seem to be working toward such a solution. In Great Britain, however, the engineering aspect of computer science is still important in some schools. British universities have played a major role in the development of computers generally and new hardware technology specifically. Both Atlas I and Atlas II were designed in university computer laboratories. But Great Britain is the only country outside the U.S. with an indigenous computer industry; in other European countries computing is largely an imported technology, so naturally applications are stressed more than basic development.

two examples

To illustrate this distinction, we can comment on two of the best computer science departments in Europe, those of Manchester Univ. and the Univ. of Paris. Manchester has been a leader in the computer field since the very beginning and still is, judging from hardware developments (Atlas I) and the educational program. Manchester offers a B.Sc. in computer science. This program is very well balanced, being equally divided between mathematics, programming and engineering. The curriculum includes such course titles as: large scale systems design, memory systems and pulse techniques, mathematical programming, applications, system programming and, of course, a great deal of numerical analysis. A terminal research project in programming and/or engineering is also required. After obtaining the B.Sc., a student can go on to study for an M.Sc. or Ph.D. degree in the subject.

Before leaving Great Britain to turn toward the Continent we should also mention the Brighton College of Technology (roughly equivalent to an American junior college), which has a Dept. of Computing, Cybernetics and Mangement and offers an undergraduate degree in computing and data processing. The Brighton curriculum is very broad like Fein's Synnoetics approach and very eclectic, borrowing course titles from economics, mathematics, accounting, psychology, statistics, and systems engineering. While this program may not produce computer designers or artificial linguists, it should produce some very imaginative computer applications analysts and some forward thinking managers.

The Univ. of Paris has recently established an Institut de Programmation, which will give examinations applying to the French equivalent of the American bachelor's and doctoral degrees. Although the Institut does not yet have chairs or professorships, it is presently directed by two very eminent French scientists. The director is also Professor of Numerical Analysis at the Sorbonne and his assistant is Professor of Astrophysics. The Institut aims to educate three classes of students in computing:

a) Subprofessionals, as operators, coders, systems analysts, etc., at about American junior college level.
b) To provide serious academic work leading to one of the seven examined elements of the French equivalent of the B.Sc. degree. Although not much experience has been gained yet, instructors in the Institut expect the Programmation element to be as tough as the "formidable" Electronics element.
c) Computer scientists *per se:* an examined element applying to a third cycle doctorate has just been announced.

The program is very good, even though it has little engineering content. It is quite theoretical (as is most French education), stressing such topics as abstract algebra, information theory, formal systems, theory of automata, and mathematical logic. The major problem in the educational program is the lack of a large-scale computer. The Institut has a couple of small ones and a time allotment on the larger machine of the Institut Blaise Pascal; hopefully, a large-scale system will be ordered soon.

[1]The GIER is a binary machine with 1K core store, 12K drum backing store, printer and paper tape input-output. It is manufactured by Regnecentralen, Copenhagen, Denmark.

The Universities of Toulouse and Grenoble have similar Institutes de Programmation.

The development of a computer science department like those at Manchester or Paris creates problems whether in Europe or America. Though the problems are similar, they are perhaps more severe in Europe, due to more conservative attitudes toward applied science and older academic traditions. The obvious problems, such as justifying the expense of a large-scale computer and the interdepartmental politics due to computer science overlapping several existing disciplines, may not be as bad as convincing academicians that computer science ought to be taught in the university as a discipline in itself. Those who have taught programming generally agree that it has, as do the study of Latin, Greek or pure mathematics, great value for developing a disciplined mind. It has the further advantage, however, that the graduate trained as a programmer finds it very easy to locate employment requiring his skills. In computer science generally we may actually have a discipline which is as practical as engineering and as intellectually rewarding as any of the liberal arts. However, computer science education is unfortunately not yet regarded by most scholars as being a legitimate academic pursuit. The applicability of computer science to so many areas of modern life may tend to make it undesirable as a university endeavor, since it is in fact a high-level type of vocational training.

intellectuals vs craftsmen

Computers bring science down from the ivory tower to the man in the street (literally, a Univac 1107 controls the traffic signals in Toronto, Canada), or in the air (airline reservation systems), or in business enterprise (mathematical programming). The use of computers as amplifiers of human intelligence is placing trained "sources" of human intelligence at a premium in the professional labor market place. If the university will aid society by training such people, then the university may be coming into a new role. This dilemma was eloquently stated by Professor Stanley Gill of London's Imperial College at a recent meeting on the subject of computer science education in Liverpool. Professor Gill noted that until recently the real work of running the world—that is, the important jobs—did not require high intelligence. The intelligent people occupied their time by studying the arts in universities which were expressly designed for them. As a mark of distinction, they avoided anything that might be described as a "vocational training." In our new technological era, the important jobs *do,* and increasingly *will* require the intelligent people, and it will be the less intelligent who will have the time to study the arts. Hence the dilemma: are the universities going to take the intelligentsia and give them a vocational training, or are they going to take second-rate citizens and fit them for life as intellectuals?

A number of problems facing the development of a computer science program were brought up at the Liverpool symposium. This conference rapidly divided into two major camps: those who considered programming a semi-manual technique useful to the numerical analyst, or at best vocational training, and those who were actual practitioners who considered both programming and numerical analysis to be parts of computer science. Rather than retread this ground, which will soon be mapped by the published conference proceedings, let us assume that computer science *is* a science and not merely vocational training. If this is so, there are two urgent questions to be answered: What is the subject matter? Who will teach it?

in math departments

As regards the subject matter, computer science is closely related to mathematics; not only does it require the same type of generality, abstraction and close attention to logical detail, but is also a supradiscipline, as is mathematics. Most computer science departments are closely linked with mathematics departments and perhaps rightly so, since the characteristics of these disciplines are so similar. An excellent study of the subject matter problem has been made by the Committee on the Undergraduate Program in Mathematics.[2] This report gives a good curriculum suggestion, together with text-book recommendations, covering the areas of computer science more closely related to mathematics (for example, numerical analysis, applied programming, logic, theory of automata). It also ventures into non-numerical information processing, theory of compilers, artificial languages, and simulation techniques; the only major areas missing are those relating more to the engineering aspects of computer science, such as logical design, circuit design and architecture of computers. The Manchester curriculum,[3] on the other hand, is more evenly balanced with respect to the mathematical and engineering aspects of computer science, but is somewhat weak in non-numerical information processing content (except for systems programming). The Association for Computing Machinery has an Education Committee and has devoted an issue of *Communications* to the curriculum problem.[4] The Univ. of Paris syllabus[5] is built around a basic core of theoretical computer science subject matter with final options in numerical analysis, non-numerical processing, business data processing and operations research, and machine organization and electronics. So, although there is not an established curriculum that all computer science educators and researchers would accept without comment, there is certainly a broad area of agreement. The existence of successful departments of computer science in both European and American universities indicates that lack of a universal curriculum definition is insufficient reason for not beginning now.

Now, given that there is a general agreement on the basic subject matter, who will teach it? Computer science ought naturally to be taught by computer scientists, but there are too few computer scientists for industry and government and not many of these have the academic qualifications considered necessary for teaching. Their very scarcity commands salaries which are probably out of proportion to most academic pay scales. The Manchester Computer Science Dept. is staffed by a professor (department head) and 12 lecturers and senior lecturers. It would be difficult to form a new department of this magnitude, considering the present availability of qualified computer scientists. However, it is possible to build up slowly, taking advantage of the overlap between computer science and neighboring disciplines. Many of the subjects the future computer scientists need are also topics of interest in other disciplines; thus, a set of courses, some of which are already available, can be listed under the heading "Computer Science." The course list of the Dept. of Information Science at the Univ. of North Carolina is indicative of what can be done with only a couple of top computer scientists, plus judicious borrowing of course titles from mathematics, philosophy, statis-

[2] "Recommendations on the Undergraduate Mathematics Program for Work in Computing," Committee on the Undergraduate Program in Mathematics, P. O. Box 1024, Berkeley, California 94701.

[3] A copy of this curriculum may be obtained from the Dept. of Computer Science, Univ. of Manchester, England.

[4] *Communications of the ACM,* Vol. 7, No. 4, April 1964, pp. 205-227.

[5] This information may be obtained from the Institut de Programmation de Faculté des Sciences, Université de Paris, Impasse d'Aubervilliers, Paris (19ème).

tics and other related disciplines. This same eclectic approach is being used in European universities; for example, the Institut de Programmation of the Univ. of Paris has no professorship yet but temporarily is borrowing professors and lecturers, as well as computer time, from other institutes.

how to attract talent

The major problem in developing a computer science department is finding good people; but it should be possible for the university to attract qualified computer science teachers. The university has a powerful attraction which can well be used to gather top computing people. Any computer scientist worthy of that title has one great pressing need which the university is better able to satisfy than industry or government: that need is for more computer time to do the little (and big) research projects which constantly occur to him. But the financial value attached to computers results in their administration by people who generally do not appreciate the motivations of a research oriented computer scientist. His request for 20 or so hours of unused computer time over a weekend yields a crushing rejoinder about overhead, maintenance cover, management responsibility, a time evaluation of hundreds of dollars per hour, etc. He may consider the computer an amplifier of human intelligence but management more likely considers it a very expensive piece of production machinery. Computers are costly to universities too and, unfortunately, many administer them in the same cost-sensitive way that industry does. But if universities do not sell cyclotron time to local industry, why should they sell computer time? If universities will consider and treat computers as research instruments like cyclotrons and astronomical telescopes, then they will attract first-class computer scientists in the same way they now attract first-class physicists and astronomers. This solution is already standard operating procedure for attracting university staff in most other fields of science in Europe as well as in America.

The general state of computer science education in Europe is progressive. As pertains to the major countries, one might summarize as follows: Great Britain is naturally furthest ahead, since it has an indigenous computer industry. There are at least 10 departments and subdepartments of computer science, mostly offering a post-graduate diploma or M.Sc. degree, but several offer B.Sc. and Ph.D. degrees also. There are also several institutes of technology in Great Britain offering degree and diploma work at about American junior college level. In France there are at least three university Institutes or Departments of Computer Science offering education at junior college, B.S., M.S. and Ph.D. levels. German universities have a number of chairs or professorships for various areas of computer science and some of the larger technical universities have Institutes of Computer Science, but it is not yet possible to earn a degree in computer science there. One may get a good education in the subject in Germany but the degree will be in mathematics or engineering. Scandinavian universities will soon have a few professorships in computer science; the approach there will probably follow the German pattern, since most other technical education does. But there will have to be an acceleration in computer science education development in Europe if even the top professionals in the field in five to 10 years will have learned computing in school and not through the present on-the-job technical apprenticeship. ■

eight offices linked

AN ON-LINE S&L SYSTEM

by NEAL J. McDONALD

Twin City Federal Savings and Loan went into on-line computer operations for one basic reason: to accommodate continued business growth—profitably. From this generalized objective stem a number of inter-related goals. Since a prime function of any savings and loan institution is simply service to its customers, improved service was a major consideration. In order to handle a growing volume of business profitably, operational savings had to be effected. Further, these savings had to begin at the teller window and extend into the "back room," streamlining and updating functions all along. The flow of information to top management had to be improved.

These goals are being met through an IBM 1440/1062 system which went on-line December 14, 1964, and is currently the largest multi-branch savings and loan complex in operation. On-line processing brings the power of the computer right to the teller in our main office and all seven branch offices, the farthest being 30 miles away. One indication of the significance of this move to on-line can be gained from the following fact: throughput from the 21 teller terminals now in operation is greater than what used to be obtained from 45 teller machines previously used.

configuration

The on-line system consists of these basic elements:

1. Twenty-one teller terminals for input to and output from the computer. Each of our terminals is capable of accommodating two tellers, plus a relief teller for either operator. They provide nine columns of numeric data keys and three columns of transaction code keys for transaction identification, and can handle 135 different savings or loan transactions. Through use of a switch the terminals can also operate in the off-line mode. In such cases they are used much like a combination adding machine, typewriter and posting machine. Passbooks can be posted while the unit is off-line, but in order to update master record files any transaction so processed must be re-entered into the system when the terminal is on-line.
2. Fourteen data sets to make machine signals compatible with communications facilities. Ordinary telephone lines link the teller terminals to the data processing center.
3. Four 1311 disc drives are on-line, each disc pack capable of storing four-million digits of information. Three packs are used for 180,000 savings account records; the fourth holds computer control programs, teller totals and a daily transaction log.
4. A 1448 transmission control unit which functions as

Mr. McDonald is controller of the Twin City Federal Savings & Loan, Minneapolis, Minn. He joined the firm's accounting department in 1949, and is a graduate of the Univ. of Minnesota, Duluth branch.

the communications traffic center. The multiplexer channels all messages flowing to and from the teller terminals and the computer, providing character assembly, checking and coordination of input from the terminals, and sequencing and routing of replies.

5. A 1447 console, used to monitor all operations in the Minneapolis headquarters office and seven branch offices.

6. A 1440 computer with 16K storage, which acts as the processor and performs all necessary computations and data transfer operations. The 1440 exercises program control over the entire operation.

The order for this equipment was placed in April of 1964. During April and May, we trained three of our own people as programmers for the new system. In June and July, the staff worked on tele-communications programming techniques, customer record organization and systems planning. All 60 of our tellers were trained in operation of the new terminals during November; the average training time required was about seven hours per teller. The system was tested and debugged in October and November, operated in parallel for three days in December, and placed on-line December 14.

Currently on order is a System/360. Our plans are to incorporate the on-line complex as part of a management information system.

the system

The data processing cycle is as follows:

To initiate a transaction, the teller keys in each element successively—account number and book balance (this primarily as a verification check), transaction amount and transaction type. The terminal prints each element on the journal tape and simultaneously sends it through the 1448 transmission control unit to the computer.

The computer locates the proper account on the disc file and reads it into storage. After calculations are performed within the computer, the updated customer record is returned to storage on the file. The computer then assembles a reply message and routes it through transmission control to the terminal. At the same time details of the transaction are entered into file storage for an audit trail and subsequent processing.

The computer's response message contains the transaction amount and type (coded), the new account balance, and all previously unposted items accumulated on the disc file. The teller is notified by printout on the terminal if there is a "hold" or referral on the account, or if a transaction is rejected for error. In this case, no controls are affected and nothing is posted to the record, the passbook, or the loan document.

At the end of the business day, 10 separate transaction totals for each teller are fed back to the terminals for balancing, and an auditor clears each of the terminals for the next day's operation. Then the system sorts the day's transactions—which have been recorded chronologically on the disc file—by account number and transaction code. This is a disc-to-disc sort and takes about 10 minutes.

At this point, a 1401 tape-oriented system which was installed several years ago and which we now own, comes into play. The 1401 serves as an off-line system to help minimize after-hours processing.

After the disc sort, the 1440 sends the sorted transactions across a direct data channel to the 1401. Processing from here on is off-line. A final trial balance check is made as transaction totals transferred to the 1410 are compared with teller transaction data used to update savings and mortgage account master tapes, create new account records, and prepare the journal.

file organization

Contributing to the speed with which the system was placed on the air was the availability of an on-line savings package, which provided a large portion of systems design and programming and complete supporting routines for file loads, sorting, etc. The record format of the IBM on-line savings program was used in its entirety. The master file consists of a skeleton record for each customer with linking trailer records for unposted transactions, dividends, hold information, and control records.

The master record format is as follows:

Account Number—four positions (two kept separate from the record)

Book Balance—six positions

Control and Trailer Linkage—four positions

A variable number of master records and their associated trailers are stored in a logical block called a quintile.

It will be noted the account-number field in each master record is only four positions. The master file is loaded sequentially with open numbers for new accounts. A sophisticated indexing technique is used for direct access to each record: a master index resides in core; this points to a specific cylinder index located in the executive routine stored on disc; the cylinder index further defines the account location by referring to a quintile index located on the appropriate cylinder. Five small indices are kept on each cylinder of each master pack, and a look-up in the appropriate index gives the quintile containing the master record. At this time, the four high-order digits of the account are no longer needed. The remaining digits are used to find the master record within the quintile or to indicate the absence of such an account. Hence, only these four are actually required in the master record and quintile.

The other major function incorporated in the executive routine services the communication lines to include terminal control, error checking and processing, and operator communication. Routines controlled by the executive program are stored on disc and called down as needed.

The function of the processing program is to handle the specific requirements of each transaction after given control by the executive routine. These would include master record updating, posting teller and control totals, logging transactions, formatted messages, or, in general, control over the processing of 135 unique transactions.

In conclusion, data is made available to the processing routines through a call to the executive program while communication with terminal control is monitored in an idle loop.

results

As can be seen, the system makes any one of 180,000 savings account records immediately accessible to every teller in all eight Twin City Federal offices. The entire processing cycle on a typical transaction has been reduced to a matter of a few seconds. Thus, each teller can handle a significantly increased number of transactions daily. We are stabilizing operating costs while providing the capability for almost unlimited business growth. At present, the system processes on an average between 3,000 and 4,000 customers daily; it can handle growth to more than 12,000 daily customers.

Every transaction—savings or loan—is recorded on a journal tape to provide an in-sequence audit trail for the teller. The combination of alpha and numeric printing capability makes for clear computer-to-teller communication, particularly in error or exception situations. Both

transaction input and the computer's response are printed on a journal tape at the terminal as a visible teller check. The system is programmed to transmit any one of 32 English-language instructions should the teller make a keying error or attempt to enter erroneous data. Until the situation is corrected, no record updating or passbook posting is completed.

The system accumulates savings dividend payments to be made to each customer on a 30, 60 and 90-day basis; it also accumulates all previous unposted no-book transactions (transactions made when the customer does not have his passbook with him). The next time the passbook is presented, the system automatically posts dividend and no-book items in chronological sequence with the correct action dates. As previously noted, special conditions such as "hold payments" are automatically brought to the teller's attention.

The time required for day end teller balancing has been reduced by at least 50%. This is made possible by the separate teller transaction totals which are automatically maintained, including categories for savings payments, withdrawals, checks issued, and loan payments. The system assures positive control of individual teller operations—and provides a detailed audit trail for each teller. More efficient and reliable trial balancing—right up to the general ledger—is handled internally. The system prevents errors other than keying in an incorrect transaction amount.

Daily reports on dollar totals by branch office, by type of account, trial balances on every active account, savings and mortgage transaction journals are quickly extracted from the disc and tape files to provide management data which highlights the current situation. Periodic summaries of savings account classifications by dollar volume, totals of anticipated dividend payouts and dollar loan totals by interest rates provide management with helpful planning and control guides.

In addition to the reduction in teller machines from 45 to 21, we have been able to eliminate a punched-card installation which had been maintained in our large St. Paul branch office. Also eliminated are the six IBM 1001 transmission units which used to provide data communications to and from suburban branches.

The complete, in-sequence journal record of teller transaction activity on disc gives us almost all the input data we need for planned teller scheduling and simulation programs. All that is needed is to add time increments to get an accurate picture of office-by-office and window-by-window activity patterns. Such studies should lead to more efficient allocation of teller personnel.

From the customer's point of view, the new system makes Twin City Federal more accessible while minimizing waiting time at teller windows. A depositor or loan customer can utilize any one of our offices; he is no longer limited to the office where his account originated. This centralization of account records also facilitates handling of deposits and loan payments made by mail.

As to teller window service, our studies show that the new system cuts window time in half. In the first five days of January—always a peak period—our offices handled 88% more customers and 100% more transactions than in the same period the previous year. Such an increment in business volume could not have been handled using previous methods, with anything like a comparable degree of efficiency.

Obviously, this implies a two-edged benefit with a direct relationship to our overall goal in installing this system: better service to customers, with a vastly improved capability for handling business growth. ■

INTERACTIVE SESSION ON INTERACTIVE SOFTWARE

At this year's FJCC in Las Vegas, 30 November-2 December 1965, several sessions will be presented which assume that the attendees have studied the scheduled papers in advance. In lieu of formally presented material, informal discussions on the scheduled topics will take place among the authors, invited guests, and the audience in general. To make these discussions more fruitful and to enhance audience participation, DATAMATION offers the following preview of the topics to be discussed at the session entitled, "On-Line Interactive Software Systems." This session is scheduled for the Convention Center's Gold Room, 3.45 p.m. Tuesday.

The software session chaired by D. G. Bobrow of Bolt, Beranek and Newman will feature five papers. The session should prove to be quite interesting since the papers run the gamut from the very large effort to the very small. The content covered is also broad. One reports on the current status of work in the very difficult area of symbolic mathematical computations, another describes the ferocious effort necessary to inject the computer into the range of activities which fall into the purview of civil engineering, and one angry young man (from Cal-Berkeley, of course) is making his non-violent appeal for increased aid to the machine-oriented symbolic language programmer.

"MATHLAB: A Program for On-Line Machine Systems in Symbolic Computations," C. Engelman, Mitre Corp., Bedford, Mass.

As early as 1954, bright mathematicians in the Boston area were trying to use general purpose digital computers as intelligent assistants for the manipulation of mathematical statements in symbolic form. When a conventional computer program is written, a programmer transforms the simplified mathematical statement of the desired process into a series of semi-sequential declarative or conditional statements which define how a solution is to be obtained. These statements are usually transformed into machine code automatically where they then control the hardware to produce the solution desired. The process of obtaining the simplified mathematical statement of the desired process is both creative and "mechanical." Efforts like the MATHLAB program reported by Engelman are aimed at easing the burden of the mathematician by placing the "mechanical" chore on the machine, thus freeing the mathematician for the more creative portions of his duties.

The word "mechanical" may be a little misleading. To be sure, the straightforward functions of recording the equations, copying them, renaming variables, and recalling previous versions are included; but an attempt is being made to broaden the machine's abilities by providing it with the following abilities: to differentiate with respect to a named variable—a non-trivial task if the variables are not separable—to simplify equations by gathering like terms, integrate a little, and to solve certain equations. Of course, the ability to determine the arithmetic value of the resulting symbolic equation is also being sought.

The paper is oriented towards the programmer and describes in a readable form the status of the work and the steps of those that have gone before. One of the things that may come out of the discussions is a statement of how such work might be accelerated to progress more swiftly. The progress has been slow and methodical. Has this been due to the difficulty of the subject, the level of effort, or the type of personnel available? The paper also assumes the reader appreciates the work of the endeavor. While each of us can imagine where such a set of programs would be useful, these may not coincide with the goals of the author. I, myself, could use such a set of routines to augment my meager mathematical ability. However, I would not expect this enhancement to result in any great breakthroughs on my part, for I lack a fundamental founding in the science.

On the other hand, many of the mathematicians with whom I have been associated (none of them really great) had little personality quirks which would have had to be resolved even if a Super MATHLAB were available. One of these fine gentlemen changed his notation every time he changed his shirt. I had a very difficult time keeping variables and constants separable since he would use the same symbol for both on two consecutive days. Another had a few pet Afro-Egyptian-Greek hieroglyphics which were very troublesome for me and are not on any keyboard I have ever seen. In his defense, I must agree that 88 characters were insufficient for him to state what he wanted to say.

Finally, I have frequently found that the mathematically-oriented programmer makes a very real non-mechanical contribution to the problem definition process in that his programmer training makes him very methodical. In his madness, he determines initial conditions which were omitted, checks for reasonableness, watches for difficulties of a numerical nature, and *revises the method of solution to avoid them.* The programmer-type is continuously and unconsciously aware of the limitations of the computer he must eventually use. When he finds the solution time approaching his life expectancy, he initiates a search for an alternate method. Although the programmer-mathematician is going to be hard to replace, I'm glad someone is trying. I've always found that to be a thankless, dull, boring programming assignment.

"Structuring Programs for Multi-Program Time-Sharing On-Line Applications," Kenneth Lock, Calif. Institute of Technology, Pasadena, Calif.

Meanwhile down southern California way, Ken Lock of CalTech has been studying program structures suitable for on-line time-sharing applications, or that is what may be inferred from the title of the paper. Unfortunately the paper is mis-titled. If one is willing to wade through recursive ALGOL, the reader may discover that author Lock has some interesting ideas.

To ease the problems associated with program preparation from a console, each statement is held in memory in a source form and is treated by an "incremental compiler" immediately before execution. The incremental compiler, if it is truly incremental, would have been a very interesting discussion in its own right. Although author Lock did not treat it in detail, the discussion session might. If it merely compiles one-statement programs (using previously constructed tables) it probably does not qualify for the name given. However, if it is fundamentally different in organization, to reflect the changed nature of its task, an interesting discussion should ensue.

In the introduction to the paper, the author repeats a list of problems the batch-mode of operations was designed to eliminate. He, as frequently done by time-sharing authors, neglects to list one of the difficulties eliminated by the batch systems which is re-introduced by the online programming systems of today.

Rightly, the author notes that pre-batch operations were noted by systems (if you could call them that) which serviced only one programmer at a time. This was expensive in dollars and in elapsed time. Only one programmer could be served at a time, and a big staff made a long queue. We might have solved this by adding more computers, except that programmers on-line were not getting the job done very well.

The debugging aids were primitive, the problems grew, and the programmers were primitive. Be that as it may, even the best programmer lost track of the contents of core after several execution attempts and some console patches. The attitude, partially due to the howling queue urging you to get on with it or get off, was to try something and see what happened. Thinking was at a low ebb, action was plentiful, and little or no records were kept.

The problem of associating which patch (either source, symbolic, or absolute) with what results is *still* present. Source level patching and a chronological typewritten hardcopy record are only a partial solution. They may let slightly larger problems be attacked before the onset of confusion . . . but the problem still remains.

Whenever a program is executed, it alters itself, its tables, or its data in some combination. A spot change to a partially executed program is a touchy thing which requires the presumption that the consoleer *knows* the configuration of memory. For student problems this may be true. But for a man-sized program I would prefer some form of an audit trail. A before and after dump, with a program so structured to make it compact and meaningful, may be all that is required. Perhaps the author will provide us some of his ideas verbally.

Another operational problem worthy of discussion is the subject of core space required and execution time expended. Over the years, managers have shied away from devising a programming system which required a programmer to shift his modus operandi during the program preparation progress. The arguments have been more emotion than logic, but they ran thus: "The poor overworked programmer was sufficiently burdened by one mode, two would increase the training, and the investment in systems maintenance, etc." For many years, many of us have discussed pairs of compilers with compatible source languages which produce two forms of object code: checkout and production. This has never sold very well. Consequently, most of the systems have been designed with production in mind. The result: checkout has suffered.

The system proposed by Lock seems to be very good for the early stages of the program preparation process when I am searching for unassigned symbols, statements never executed, variables never referenced, etc. His process is slow, the overhead is high, but it may be worth it if it reduces this initial phase sufficiently. I hope the discussion will bring out what happens when the application in preparation has no more obvious deficiencies and a few data sets need to be run.

Do we shift gears, change to a conventional compiler and revise all of our techniques? Does he have some other ideas? Or is the technique principally of benefit only to short jobs that never run production? He is a little audacious when he suggests some changes to fundamental hardware architecture when he offers no data to measure the value (worth) of his interesting ideas.

"An Integrated Computer System for Engineering Problem Solving," Daniel Roos, Dept. of Civil Engineering, MIT.

The third paper lays the foundation for revolutionizing the profession of civil engineering. According to the paper (I am not familiar with the actual work), some of the reasoning may be a teeny bit specious. Back in Boston, overlooking the Charles River, an industrious group of fifty programmers are busy spending two million dollars on a large system of computer programs with the following goals:

"Computers should provide the mechanism that enables *engineers* to do *better engineering.* By permitting faster and more accurate and complete problem analysis to be performed, computers assist the engineer in his computational and *decision making* roles. The engineer today is faced with problems of increasing magnitude and complexity where the effects and inter-relationships of all relevant information must be considered. *The computer provides the coordinating and integrating mechanism for the problem information needed by the engineer in the decision making process.* Computers enable engineers to perform *total problem solutions* where all pertinent information is properly considered.

"This role of the computer in engineering is only achieved when the computer is adequately *integrated* in the problem solving environment. This integration must be both *external* and *internal*. The computer must be integrated externally with the engineer using it and the programmer developing it, and internally through the proper coupling of hardware and software.

"The *engineer* must do more than use the computer. He must *actively participate* in the computer solution. To do this he needs a *language* to *communicate* with the computer, physical *accessibility* to the computer, and a mechanism for obtaining *engineering oriented results* from the computer. The communication language must be *oriented* to the *problem* rather than the *machine*, and must allow the engineer to easily specify his problem solving requirements. Accessibility, provided through some type of *remote computing* facility such as *time-sharing* permits the engineer to *interact* with the computer during the problem solution."

(The italics added to the above quote were emphases placed by Daniel Roos, the author).

Having almost been a civil engineer once and having carried a transit for many a mile to earn beer money, there are several items about the intended engineering user of the system I do not understand. To be sure, I see the immediate value to a large engineering school. Students may solve problems using ICES (Integrated Civil Engineering System) which would otherwise take weeks. They could participate in the development of a whole structure: survey the land; design the building; choose the materials; detail the building and the integrally related sub-systems like drinking water, lavatories (hot, cold, sewage, noxious gas), lighting, air conditioning, fire protection (prevention and suppression); physical structure (foundation, enclosure, frame, stress analysis); post-construction maintenance (exterior and interior); and then actual construction sequencing (PERT for the construction process). The actual design and construction of a skyscraper is indeed a complex engineering process.

Several years ago the digital computer allowed a fundamentally sound approach to be developed for the stress analysis of a welded, multiple joint, three dimensional steel frame structure. The equations had previously been too cumbersome to solve so no one bothered to write them down. The initial techniques for solution were adapted from those used for the flat slab wings on Convair's B-58.

While the computer can make some fundamental advances possible in areas where no adequate solution now exists, this is not the flavor of the project being undertaken. Except for furthering the education of several engineering students by allowing case studies to be performed in an expeditious manner (a laudable goal not mentioned in the paper), the other natural user for ICES is the huge engineering house which has enough volume to justify expensive equipment, staff, and programming.

Being conservative for a moment, the typical civil engineer is either a generalist working for a small firm, or a specialist working for a specialty house. The guy who surveys a few lots, sets a construction grade or two, and appears in court as an expert witness doesn't have enough volume even to justify a console. The big specialty house has little use for the integrated file scheme since the guy who does the foundation may not live in the same city as the guy who does the frame. Drawings have evolved over the years as the common language between the two. The drawing also serves a useful purpose in being available for construction.

Even if the justification for the entire Charles River project is controversial (it may even be questionable, but I suspect the writing rather than the project), the byproducts of the efforts may be worth more than the computer program. For many years, civil engineering (as with many other aspects of our society) has been marked by a considerable amount of known but undocumented art. In the course of this project there is a fine chance to transform some of this art into science by writing it down.

In addition, regardless of the name of the college department that sponsors it, it appears that some fundamental progress will be made in the art of designing a user-oriented language, holding combined files for multiple access (data management), and in automatic storage allocation for a real environment. *These* three problems are currently unsolved in the computer field. It will be interesting to hear how well they are yielding to solution.

"The UCB-SDS 930 Time-Sharing System, W. W. Litchtenberger & M. W. Pirtle, Univ. of California, Berkeley, Calif.

Meanwhile, back at Berkeley, Lichtenberger and Pirtle have done another time-sharing system. Their references do not list the previous work of Licklider et al (AFIPS) 1963). The paper does not immediately impress the reader with its creativity and uniqueness. I trust the discussion will bring out points where this approach is sufficiently superior to warrant retracing the earlier work.

"Interactive Machine Language Programming," Butler W. Lampson, Univ. of California, Berkeley, Calif.

A very refreshing piece of work is offered by Lampson, also of Cal-Berkeley. He addresses the long overlooked problems of the machine language programmer. He is quite correct: the generally available literature is indeed sparse when one is looking for proven aids (or discarded faulty techniques) which relate to the problems of the

guy who has a task which so taxes the available equipment that he must resort to machine language.

As a side tangent, it would be interesting to know why the literature is so sparse. Were we too busy? Struck dumb? Or overwhelmed by the restrictive styles and requirements set by our erudite academic editorial boards? Probably some of all three. This would still be an interesting post-mortem as the problem of editorial policies still bugs us. Most of the work-a-day techniques of the field are still passed as folklore because the proper vehicles for their editorial presentation do not exist.

Back on the mainline, Lampson's system is aimed at providing some of the benefits of on-lineism to the machine language programmer. He advocates selective examination and alteration of memory locations, something which requires the programmer to be truly *sympatico* with the core map, or uses a fair amount of storage so that modification and interrogation are possible using names rather than addresses. Like author Lock, he neglects to treat fully the record keeping problems that must be faced after the consoleer has modified, inspected, and partially executed several chunks of code during a debug session.

He describes a rather clean symbolic assembly program which is impressive due to its very simplicity. Another bright flash is the treatment of undefined symbols. The single pass assembler stores the instruction whether the symbol is defined or not. If the symbol is not yet defined, it links like references together in a list. The reference in the symbol table points to the head of the list. When the symbol is finally defined, all of the references are filled in by lacing through the linked list for that symbol. Thus, the storage used (over and above the conventional treatment) is trivial. The assembler is truly designed for the on-line environment, not merely adapted from tradition. Several sections of the paper are an excellent refresher on symbolic coding.

Unfortunately, the author loses some perspective in the last half of the paper. The first half is very readable (to an old coder, of course) and quite interesting. The second half moves too rapidly. He treats the debugger (a control program which facilitates symbolic interrogation and patching) and the symbolic editor all too quickly. Given the creativity demonstrated in the first half, the second half could easily have been twice as long. Alas, such additional material, together with its careful development, is unsuitable for verbal discourse and should not punctuate the discussion session.

On the other hand, three topics for discussion seem to cry out. The techniques shown seem to be inextricably married to the SDS 930. The assembler makes use of the inviolate divisions in the 930 instruction format for its simplicity. In turn, the resultant assembler is fast and compact. This allows it to be used as a loader. It would be interesting to know if the techniques used are generalizable to machines architecturally more complex than the 930.

Another topic that goes begging is the handling of buffered I/O. Given a machine that has independent I/O channels, so that simultaneous operation is possible (and mandatory for the class of application he is pursuing), how does symbolic load, modification, and edit affect the channel program? Traditionally, the channel program must be independent, have links to the main program for initiation, completion, and error notification, and in this case *MUST BE STORING DATA INTO A MAPPED MEMORY THAT MAY BE CHANGED AT ANY MOMENT.*

Finally, it would be interesting to hear why author Lampson has second thoughts about a relocatable output form from his assembler. Some of our modern software systems offer only relocatable load form: the efficiency of binary absolute is forever lost in favor of a more flexible load form. In the first portion of the paper, the author depends heavily on the fact that the programmer is facile in symbolic, octal, the idiosyncracies of the hardware, and has almost total recall. Even though these programmers are in short supply, the additional burden of relocatable is too much to bear. The techniques explained seem to require highly trained programmers and absolute locations.

The sessions in the offing are approached with great eagerness and some trepidation. We're eager to be freed of the dull talks by pedantic programmers who must speak to justify the trip. Eager to be freed of the dull droning layreader who writes well (enough to get past the program committee) but has no audience contact. Eager to be rid of the slides which show so much detail that the screen appears shimmering white and must be studied minutely before the fine points have meaning. Eager to learn from others as painlessly as possible.

Trepidation stems from a certain knowledge that the speakers will not consistently define terms and insist that the audience adopt their definitions or keep quiet. We're certain that the usual bores will monopolize the floor microphones with a rate of information delivery that is within an epsilon of zero. Certain that most of the audience will neglect to read the papers in advance, or barring that, will shamefully compose a question after they have gained the mike. Certain that some of the lesser known, but bright professionals, will get cold feet before they capture the mike even though they have written their well thought-out question in advance.

The prospects for a stimulating session are all present. Y'all come.

—R. L. PATRICK

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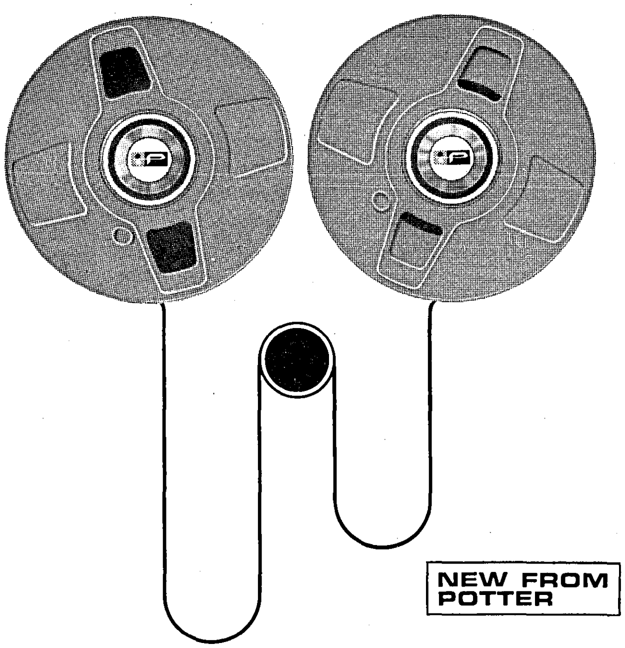

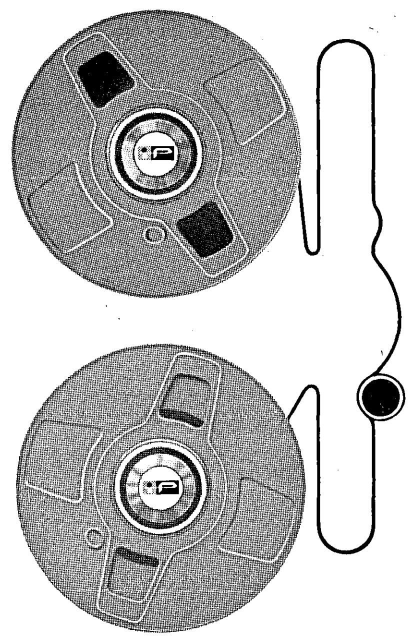

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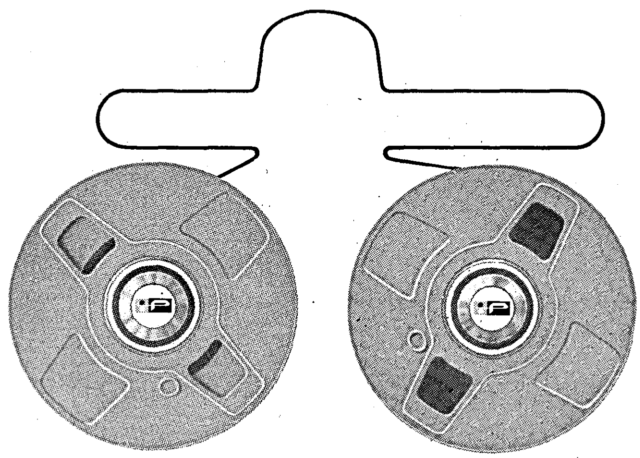

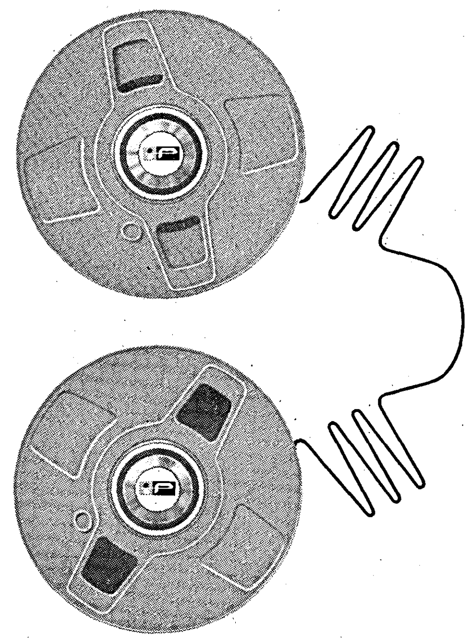

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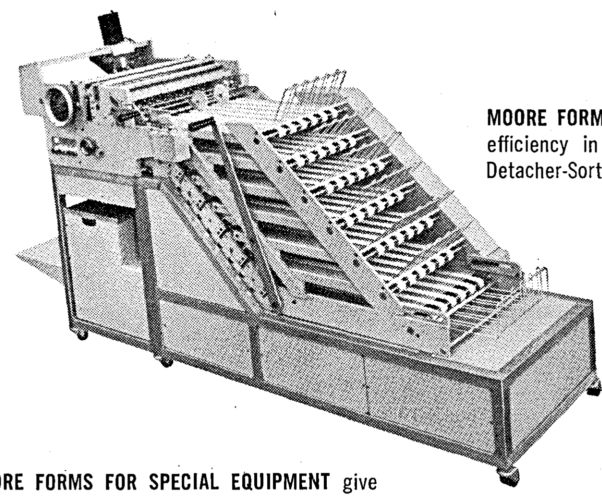

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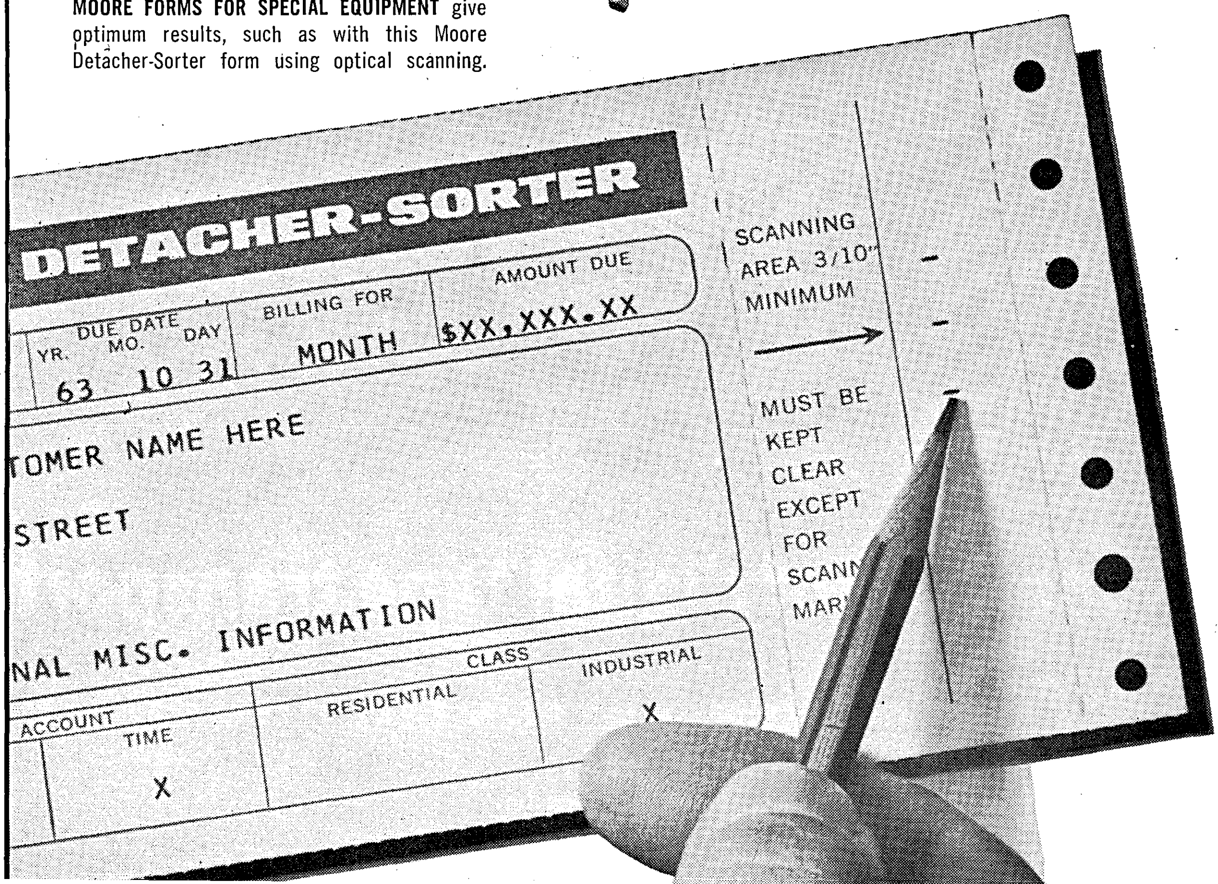


BOOK REVIEW

Beyond Automation, by John Diebold, McGraw-Hill, 1964.

As stated on the attractive book jacket, the author attempts to give a "dramatic picture of automation's impact on society and, particularly, on business management . . . as derived from the public addresses . . ." In other words, the publisher and peripatetic author are getting a little more mileage out of public utterances made in Brussels, Paris, New York and the Congress of the United States, among others. Although not always specified, apparently the talks extend back at least to 1957 with some footnoting to bring the reader along to 1963.

I take no strong issue with Mr. Diebold's comments except in two particulars: first, he does not give the reader (listener?) any real perspective about the early history of automation and, secondly, he does not give us much detail to show the present vitality of the subject. On the other hand, he succeeds in his attempts to paint in a non-technical manner some really sweeping vistas of the breadth and impact of automation. For example, speaking before the American Association for the Advancement of Science, he states, "the artistic, religious, and moral, as well as the political and economic perspectives of man will be affected irreversibly by machines which, as I have already pointed out, must alter the individual's very concept of himself and his relationship to the universe." The book pretty much elaborates on this theme throughout, using a style and depth rather similar to the science section in one of our national weekly news magazines.

He mentions very briefly that automation "roots are far in the past . . . steering engines of ships, Watt's governor, Dutch windmills, Roman float control, Chinese chariot linkage systems" (I think this last reference is unusual enough to justify expansion), but he also states very early in the book, "Automation is a new concept —the idea of self-regulating systems— and a new set of principles." The phrase "new concept" is not very precise but presumably the author is thinking in terms of the last decade or so. I would remind the author that J. Clerk Maxwell did his usual elegant analysis on three kinds of governors just about a hundred years ago.[1] Independently, a Russian engineer, J. Vyshnegradskii, also recognized the importance of analytical control-theory with his publication in French in 1876.

As for the "vitality" criticism: Mr. Diebold and his management consulting firm associates have undoubtedly applied some of the generalities touched on in his book to specific cases, but the reader is told essentially only that automation is a great thing, that not too many people will be replaced by machines if the revolution is properly controlled, that it is really not so technical that only engineers and technicians can understand and use it and, finally, that benefits may accrue to even the small company using it. But nowhere does Mr. Diebold give us even one detailed case history; what is happening at duPont, Standard Oil, U.S. Steel, General Motors, A.T.&T., ad infinitum where automation to one degree or another is and has been applied for years? Even one chapter with a well-treated example would have raised the level of the book to more than the pleasant little soporific that it regrettably is; surely his company has these data available.

One might argue that most of his contracts develop proprietary information which customers do not want

[1]Proceedings of the Royal Society of London, Vol. 16, No. 1868, pp. 270-283.

yammered about outside their board rooms. Then he could tell us about agencies whose inner workings are public knowledge and which sometimes go to considerable trouble to so inform us. The U.S. Post Office is one specific example where the development of machines to perform automatic mail sorting is well under way, and I would think they would welcome a survey in depth as to the economies brought about through automation. A second example is the use of computers and control for some of the newer steam-electric power stations, TVA for example. Generally speaking, electric utilities, both public and private, regularly and meticulously compute their cost of operation on a standard basis showing the effects of change to the plant operation.

The book should be of some interest to newcomers to the field, about as useful as an article in one of the better news magazines. Even for this purpose, however, the reader should be warned of excessive repetition.

As a final thought, if I were a manager of the McGraw-Hill Book Company and had to charge $7.50 for 220 pages of mostly dated and reprinted material, I would immediately convert my printing operation over to one employing automatic type font generation, hyphenation and justification.

JOHN ALRICH

DATAMATRON

Gung ho, automation!
And dinner gets cold
While daddy's debugging
And mommie grows old

Alone with our offspring
And memories proficient
Of times when by-hand
Was considered sufficient.

I too have a memory
With stored information
On years of togetherness
Pre-automation.

A girl from the office,
I'd know how to fight
But that's not where daddy
Is spending the night.

I've lost and I know it.
He thinks that it's fun.
Hey, how do you poison
A 1401?

— LOU ELLEN DAVIS

WORLD REPORT

THE MONTH FOR U.K. SHAKE-UPS

To herald the onset of fall, Britain's computer industry ended the month with its biggest shake-up ever. In six days, starting September 18, IBM-United Kingdom's managing director Thomas C. Hudson resigned; ICT rowed in its new baby processor to complete the small end of the 1900 series: English Electric-Leo-Marconi finally unleashed System 4; and ICT revealed an unexpected management overhaul, the resignation of chairman Sir Edward Playfair.

LOW END ADDED TO POPULAR 1900'S

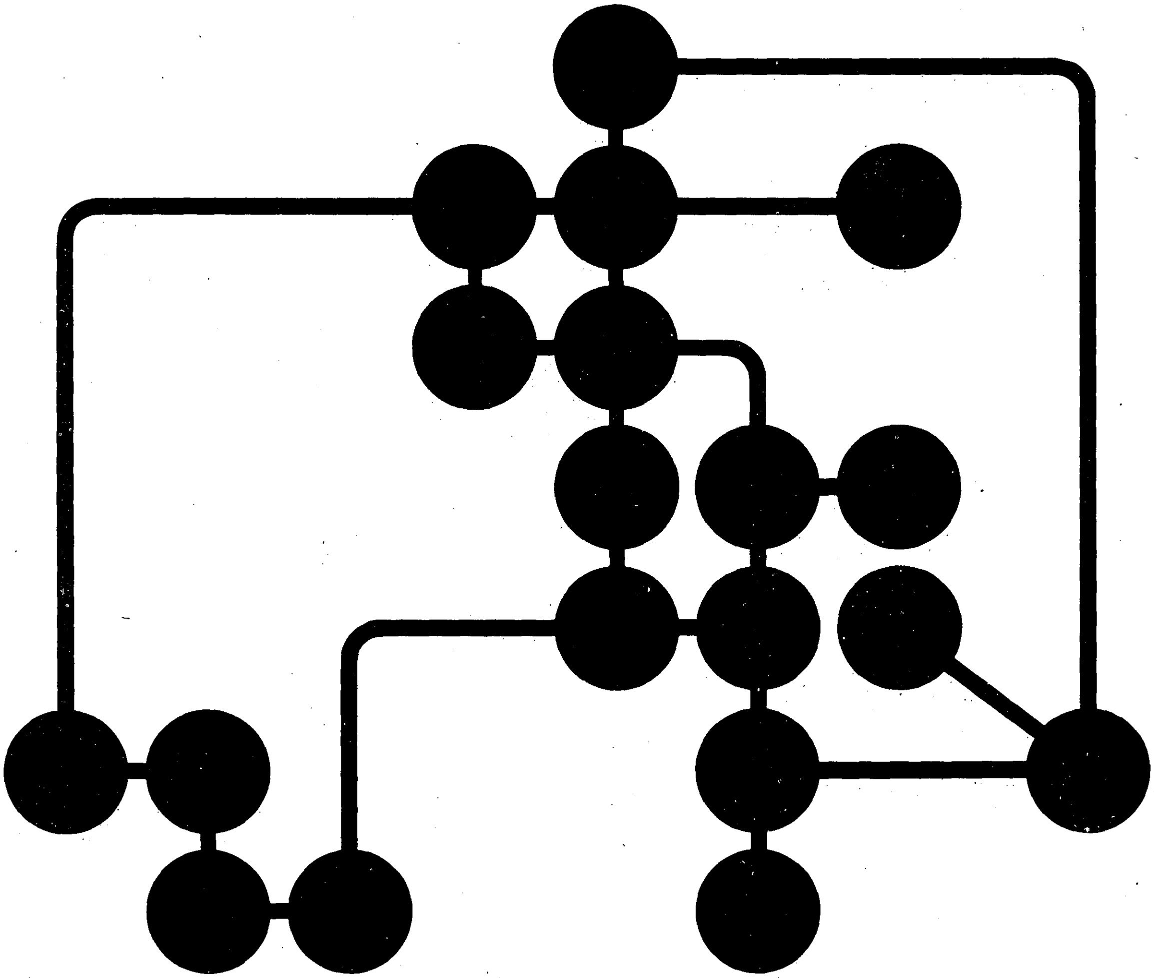
Not unexpected from ICT was the 1901, at a basic price of $60K. But main selling points are a new magnetic tape file, and the Nicol programming system. The ICT Cassette tape handler provides a magnetic file dp system for $120,000. One handler holds four Cassettes, each with a continuous loop of one-inch tape on which to store a total of 3.5 million characters. Data transfer rate is 10,000 cps. A 1901 processor deals with each Cassette as an independent unit to yield the equivalent of a four-tape configuration. Programming system Nicol is a 12-verb language corresponding closely in structure and terminology to tabulator concepts. With four days' training, ICT claims, a tab man can become proficient in Nicol. With this in mind, they hope to skip interim stages offered by 1004's or model 20's.

Compatible with its series, the 1901 uses 24 bits; four, eight or 16K of 6-usec store; Cobol and Fortran for larger configurations; and add-subtract time of 34 usec. Before the 1901, sales figures for the series stood at 250 machines with the first six delivered. Target is to double this figure by early next year.

THE EELM SYSTEM 4: A SPECTRA SIBLING

"A higher degree of compatibility than ever before" is how one EE-Leo man described System 4. A very close cousin to Spectra 70 — swapping of technical dope between RCA and EELM has been rapid in the past few months — it comprises four processors, all integrated circuits. The biggest (System 4-70) is a carbon copy of its RCA counterpart. Hence, order codes are set for the series. The other machines incorporate additional registers to boost throughput. Smallest machine, model 10, has a 1.5 usec store. An 8K configuration with exchangeable disc costs $180,000. The two middle machines, numbered 35 and 50, and the 10 are to be constructed in an integrated circuit technique devised by the Marconi Co. for its military machine, Myriad. Among the features: program compatibility with Spectra 70 and System/360; nine-channel tape; acceptance of ISO seven-bit codes for paper tape operation. On the model 50, optional microprogram hardware is on offer for emulating IBM's 1401 and 1410, ICT's 1500 and Bull's Gamma 30 (European labels for RCA's 301), RCA's 501 and EELM's own

(Continued on page 136)



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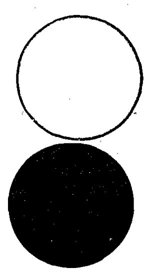
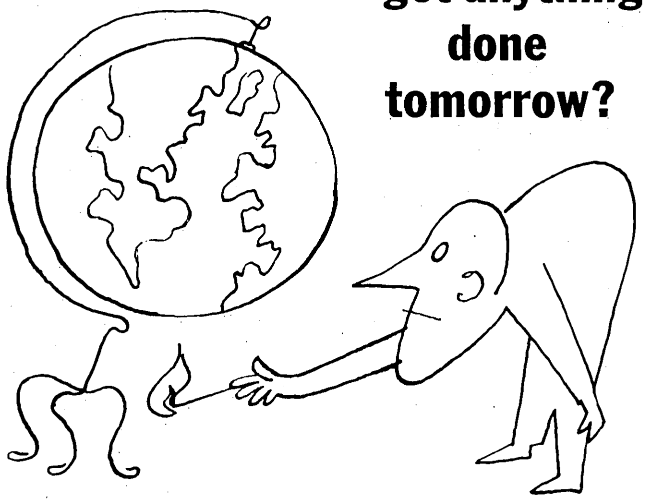


think you'll get anything done tomorrow?



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NATIONAL AIRSPACE SYSTEM — We need people in MITRE's Washington, D. C. office to provide system engineering assistance to the Federal Aviation Agency for its new air traffic control system. MITRE's increasing responsibilities include broad level system design, computer program operational specification, equipment specification, configuration management, system integration, and system test planning. Experienced staff additions are needed in all areas.

NATIONAL MILITARY COMMAND SYSTEM — We need people for systems analysis and feasibility studies, communications systems analysis, systems design, integration and design verification of the NMCS. This "capping system" contains all the facilities, equipment, doctrine, procedures, and communications needed by national command authorities to give them strategic direction of the armed forces. MITRE's main concern is with the technical design and integration aspects of the NMCS and the communications between NMCS and various other command systems, including the World-Wide Military Command and Control System — a group of systems operated by the unified and specified commands.

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BIOMED RESEARCHERS REPORT INTERIM PROGRESS

A program for simulation of the human lung has been developed by Columbia Univ. Dept. of Medicine and IBM Advanced Systems Development Div. The mathematical model, built around the concept of three compartments with different ratios of air flow to blood flow, will be used primarily to predict a patient's reaction to different gas mixtures used in lung therapy. It will also be used as a teaching tool in medical schools. The program has been written in FORTRAN II for use on a 1620 and 7090.

Elsewhere in biomedical research, Philco Corp. reported recently on its Myocoder-computer study of human movement patterns, to a meeting of the American Academy of Physical Medicine and Rehabilitation. The study, intended to produce matrices for aid in design of control circuitry for artificial limbs, has led to production of an experimental model which will be clinically evaluated in a joint program with Temple Univ. and Moss Rehabilitation Hospital. The Philco-developed Myocoder measures energy, torque, and tension of muscle motion and digitizes the information for pattern analysis by a program, MULTINORM, on the Philco 2000 computer.

Case Institute of Technology has bought a DDP-116 to study actual computer control of remote manipulators and artificial or disabled human limbs. The study is a continuation and extension of the work Case has been doing with computer-controlled arm aids. NASA and the Department of Health, Education, and Welfare are supporting the study.

NEW PROGRAM TRANSLATOR REPORTEDLY 100% AUTOMATIC

The development of a fully-automatic program translator has been announced by Celestron Associates Inc., Valhalla, N.Y. The X-ACT system (automatic code translation for any, X, computer) is said to accept machine-language programs for any computer and translate them to machine-language codes for any other. Required are the binary source program with its loader and a description of the external data to be processed by the program; generated by the translator are a binary target program and a flowchart of the original program.

According to the firm, two X-ACT systems have been developed. One involves two medium-scale computers, and the other is a 7090-to-1604 system. The latter was developed under an Air Force contract.

Unlike past attempts, X-ACT is said to operate on sequences of instructions. In its four major steps, it (1) acquires the source program; (2) detects all (including hidden) instructions, discovers relationships, and generates a memory map; (3) isolates instruction sequences based on information from step 2, and outputs a meta-language to be implemented by a meta-compiler, which (4) takes the symbolic description of the program and generates the target codes. Steps one through three are reportedly target-machine-independent.

TEACHERS STUDY COMPUTERS AT LOUISIANA CONFERENCE

Teachers and administrators from colleges in 23 states, Canada, and South America gathered at the Univ. of Southwestern Louisiana for a three-week conference. Under a grant from the National Science Foundation, the conference had the dual goals of familiarizing the visitors with computer use and helping small colleges establish their own computing facilities.

The attendees were exposed to lec-

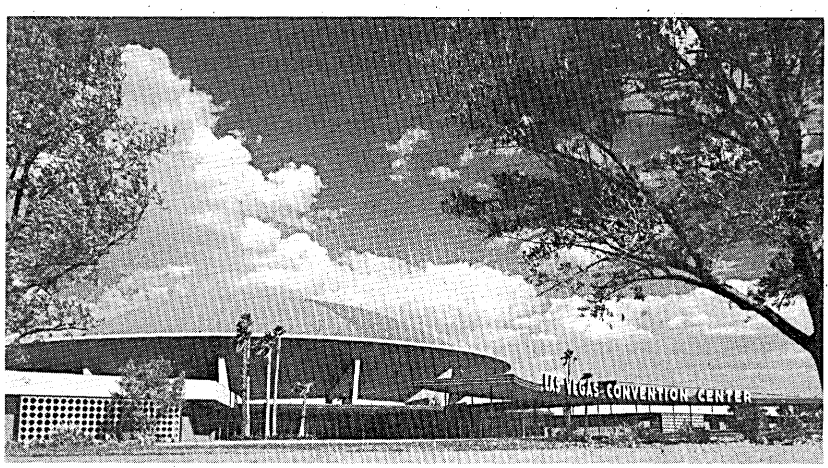
FINAL PLANNING FOR FJCC: PREPRINTS NOW AVAILABLE

Plans for the AFIPS Fall Joint Computer Conference in Las Vegas, Nov. 30 through Dec. 2, now call for five discuss-only sessions, three in hardware and two in software. The titles and chairmen are:

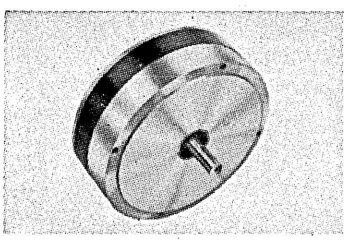
- High Speed Read-Only Memories, J. Reese Brown, Jr.
- Time-Shared Computer Systems: Software/Hardware Considerations, J. B. Dennis
- On-Line Interactive Software Systems, D. G. Bobrow
- Scratchpad Memories, Gordon S. Mitchell
- Memories for Future Computers, D. Meier

Preprints of the papers to be discussed at all of these sessions are now available for $5. The payment will be credited toward the conference registration fee on presentation of the receipt at the registration desk in the Las Vegas Convention Center when the conference opens. Checks should be made payable to AFIPS and sent to:

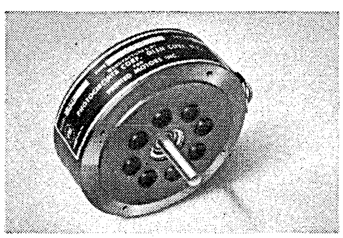
E. S. Gordon, Chairman, FJCC Registration Committee, System Development Corp., 2400 Colorado Ave., Santa Monica, Calif.



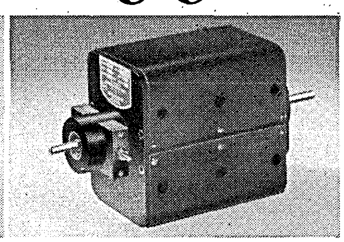
The performance of PRINTED MOTORS *begins where ordinary motors leave off!*



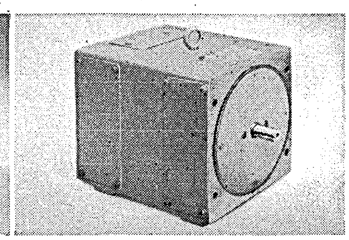
Precision Printed Motors—high performance printed armature servo motors in 10 standard sizes.



New Low Cost "U" Series— 4 models of printed armature motors at greatly reduced prices.



The Incredyne—cylindrical armature motor with the fastest possible speed of response.



Minertia Motors—low inertia, slotless armature dc motors in sizes up to 200 h.p.

Are you designing tomorrow's electromechanical systems with horse and buggy motors?

Maybe you're not aware of the recent revolution in the design of high performance actuators that has made the problems and limitations of traditional motors obsolete and unnecessary. Unique advantages offered by PMI's complete line of precision and industrial servo motors include:

- *Low inertia/high torque capability armatures give exceptionally fast speed of response.*
- *Wide speed ranges, typically 0 to 3000 rpm.*
- *Smooth, cogging-free torque, even at very low speeds; allows direct coupling of the motor to the load.*
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tures, seminars, and laboratory sessions that included programming, statistics, and numerical analysis. They had the use of an IBM 1620 and a PDP-8. In addition, a terminal was available for time-sharing a PDP-6 at the Maynard, Mass., headquarters of Digital Equipment Corp.

To prepare participants for the hazards to be expected in establishing their own computer centers, a panel of center directors presented their experiences in generating faculty participation and designing suitable courses. The conference was directed by Dr. James R. Oliver, dean of the USL graduate school.

EIGHTEEN BANKS TO SHARE BURROUGHS 300 SYSTEM

A Boston corporation, equipped with a disc Burroughs 300, has been set up to provide on-line data processing services for a group of Massachusetts banks.

Bankers Data Processing, Inc., now has seven banks with 19 offices signed up, expects to handle 18 savings and cooperative banks with 44 separate offices. The central 300 is tied to teller window posting machines by telephone lines and will eventually process mortgage and savings records for some 500,000 customers.

SIGPLAN DEVELOPS BUSINESS DECISION TABLE PACKAGE

To encourage use of decision tables in business data processing, the ACM's Special Interest Group for Programming Languages is offering a preprocessor to convert the DETAB/65 decision table language into COBOL. The programming system was developed by Working Group 2 of the Los Angeles chapter's SIGPLAN, with contributors from both manufacturers and users.

Written in required COBOL 61, the preprocessor converts limited-entry decision tables, incorporated by the user into his COBOL program, into the required form. It has been designed for use with any computer with a COBOL 65 compiler; so far it has been used successfully by Control Data 1604-A, 3400, and 3600 computers and by the IBM 7040, 7044, 7090, and 7094.

The package includes the preprocessor on cards, documentation, an abstract, DETAB/65 language description, an annotated bibliography on decision tables, a test problem, an algo-

NEWS BRIEFS . . .

rithm description, user's manual and maintenance manual. It can be ordered without cost from: Chairman, JUG, c/o ACM Headquarters, 211 East 43rd St., New York, N.Y.

ACM SETS STANDARDS FOR MEMBERSHIP

Professional membership standards established by the Association for Computing Machinery have now been approved by the members. Requirements include a bachelor's degree or equivalent level of education from an accredited institution—or at least four years of experience in information processing. Endorsement by two members of the association is also required.

A new category, associate membership, has been created for those interested in joining but who do not yet qualify for professional membership. It offers all member benefits except the right to vote.

Student and institutional memberships are not affected by the changes.

TIME-SHARING SDS 930 DEVELOPED AT U. OF CAL.

The Univ. of California at Berkeley has added a 32K SDS 930, modified for time-sharing, to its collection of computers, and SDS will offer a production version of the machine as the 940.

Now on-line to the Univ. of Illinois and Stanford Research Institute in Menlo Park, Calif., it will be ready for six users when a 1.3-million-word drum is added this fall. Response time for six users will be under one second; 30 can be accommodated with a response time under three seconds.

System development was supported by the Advanced Research Projects Agency of the Dept. of Defense and carried out by Dr. David C. Evans, M. W. Pirtle, and Dr. W. W. Lichtenberger.

● A contract to supply engineeering, control equipment, and technical assistance for what is claimed to be the country's largest chemical process control system has been awarded to Westinghouse. Using Prodac process control computers, the system has been ordered by U.S. Steel for the Clairton Works, near Pittsburgh. The equipment will be used in the production of anhydrous ammonia and the extraction of salable chemicals from coke-oven gas. System design has been assigned to Hagan Controls Corp., a Westinghouse subsidiary.

● A new service for users of business, professional, and scientific books has been announced by Personalized Bibliographic Service of Santa Ana, Calif. The firm offers monthly descriptive listings of all professional titles published in English. A subscriber can choose his field of interest from over 1000 topics, ranging from absorption spectroscopy to zoological taxonomy, for the monthly bulletin and can also get detailed descriptions of any of the books on request.

● The Univ. of Chicago announces formation of a committee on information sciences, which will sponsor a graduate program leading to the SM or PhD degrees. A faculty of eight has been named, with R. H. Miller, director of the Institute for Computer Research, as acting chairman of the committee.

● Approval of the acquisition of CPM Systems by Informatics has been completed and the new division has moved its facilities to the Informatics building in Sherman Oaks, Calif. Informatics is owned by Data Products Corp. CPM supplies consulting and data processing services to the construction and process industries. The major portion of their business is use of a proprietary programming system for scheduling and cost control of single and multiple unit residential building, a service now used by 90 contractors.

● Five computer display consoles have been sold by Stromberg-Carlson to Univac for use in the Army Operations Center System at the Pentagon. The S-C 1090 Direct View Displays use the Charactron tube and have keyboard entry and printer. Two of the consoles will be used for system interrogation and response, two for representatives of the Army Chief of Staff and Secretary of the Army, and the fifth for formatting large-screen projector output displays.

● With a half-million-dollar grant from the National Science Foundation, Brown Univ. of Rhode Island will expand its computing center under the direction of Dr. Walter F. Freiberger. The university will get a 360/50, with delivery scheduled for around the end of the year.

NEWS BRIEFS . . .

● The American Institute of Technology of Phoenix, Ariz., has arranged for remote stations in classrooms tied to a GE-235 at GE's Computer Department in Phoenix. The institute now operates three schools, in Phoenix, Tucson, and San Diego, offering courses in systems analysis, programming, and other data processing skills. Plans call for at least 10 terminals over the next three years and experiments in computer-assisted instruction.

● An $875,000 Electronic Associates hybrid computing system has been ordered by NASA's Marshall Space Flight Center for use in design studies on the Saturn booster program. This is the second large hybrid system to be ordered by NASA from EAI recently, the other going to Houston facility for project Apollo. The Marshall installation consists of a combined EAI 8400 digital machine and an 8800 analog scientific system. Delivery is scheduled for early next year.

● For the first time, the Census Bureau will offer the results of its agricultural census on magnetic tape. Data includes a full breakdown of farm and operator statistics, including value of products sold, by country and state. Special tabulations of final data to fit requirements can be had at cost. In standard form, the price is $60 per state plus $35 per reel of tape; some reels will have information on more than one state but no states take more than one reel.

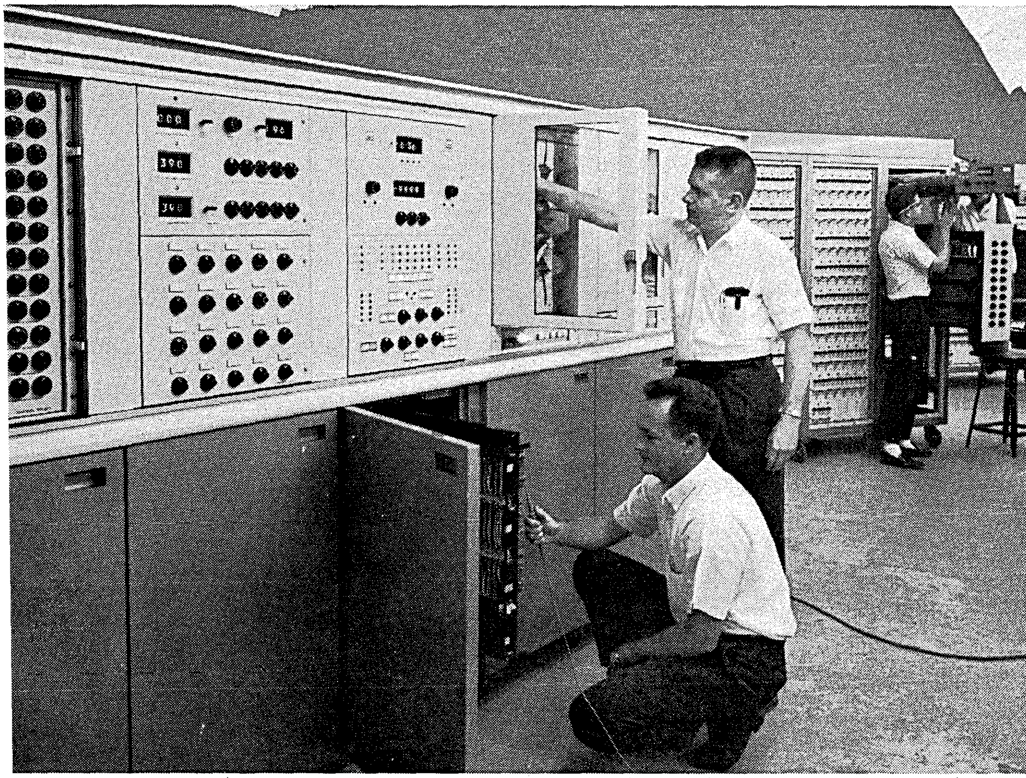
● Reports from the eighth quarterly meeting of the Diebold Research Program predict that the present employment of some 250,000 in various computer-connected jobs may reach 650,000 by 1970. The proportion of systems analysts is expected to increase substantially while operating classifications will decrease as a percentage of the total. The group's study foresees a decline in operators from 25% to 8% as a result of technological improvements.

● A student essay contest has been announced by the Special Interest Group on Programming Languages of the ACM's Los Angeles chapter. Subject is Communicating with Computers and the contest is open to all full-time college students, including graduate students. Deadline is Jan. 3 and entries or requests for information should go to Chairman, SIGPLAN Essay Contest, Los Angeles Chapter ACM, P.O. Box 892, Pacific Palisades, California 90271.

● An Air Force Machinability Data Center has been set up in Cincinnati, Ohio, to provide data to government and defense industry on all types of material removal operations (fabrication of parts by machining and other methods). The center, which now uses a 407 accounting machine, will install an IBM 1130 with discs next year to handle data from a projected 5-10,000 documents.

● NASA hopes to use color television in manned spaceflight control. Under contracts totaling over $900K, Philco Corp. will develop an on-line display system which will include a digital-to-color television display converter and color TV monitor. Alphanumeric and/or graphic data from computer, keyboard, trackballs, and Grafacon tablets will be shown in up to seven colors on the 729-line screen. The all-electronic system will permit computer recall of all display data, digital combining of real-time and static data, and on-line programming.

Complete on-line computer controlled systems



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SYSTEMS

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SEL 600 BASIC SYSTEM SPECIFICATIONS	
NUMBER OF CHANNELS	1 to thousands
INPUT VOLTAGES FULL SCALE	± 4 MV to ± 100 volts
ACCURACY	to ± 0.05% ± ½ bit
RESOLUTION	to 14 bits binary or 17 bits BCD
SYSTEM SAMPLING RATES	to 220,000 samples per second

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SEL 840 Scientific Computer
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Immediate openings for logic design engineers and systems programmers • An equal opportunity employer

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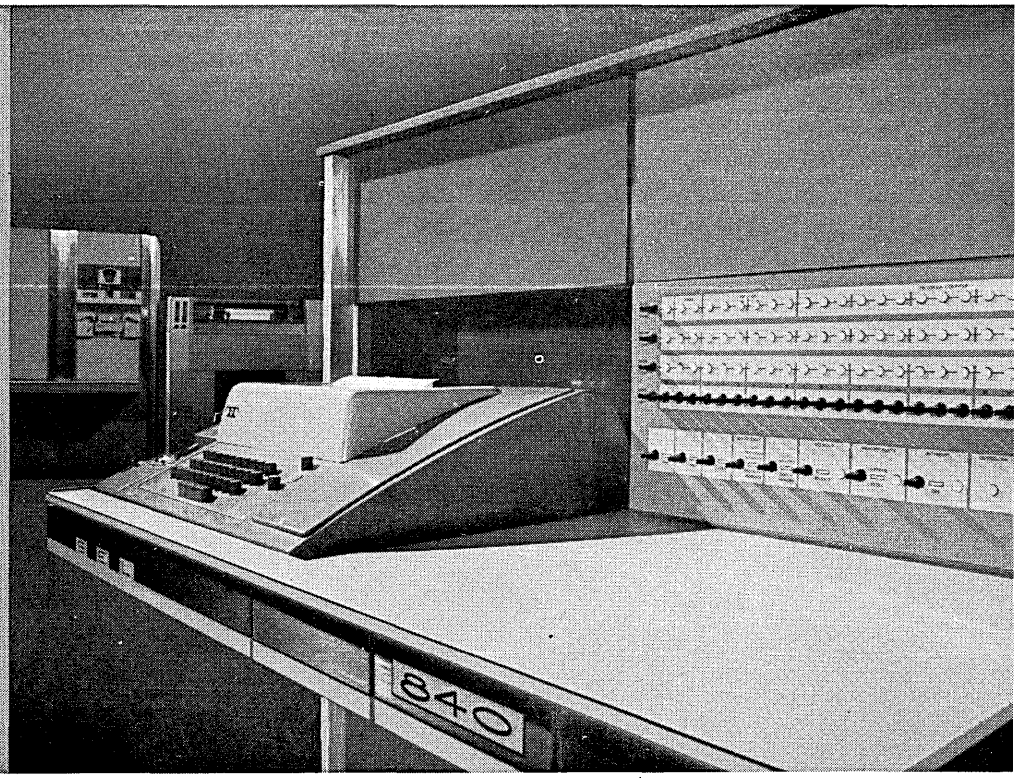
GENERAL PURPOSE

DIGITAL COMPUTERS



Total systems capability plus state-of-the-art techniques and realistic pricing are reasons why an increasing number of large industrial corporations are coming to SEL with their requirements . . . and why SEL has become one of NASA's major suppliers (No. 52 in the first half of last year). The engineered approach to total systems design—using all compatible SEL subsystems—eliminates the problems inherent in matching one manufacturer's equipment with that of others. Data measurement systems, real time digital computers, and real time control systems are all **proven** SEL accomplishments.

BASIC CHARACTERISTICS

SEL 810 COMPUTER
WORD SIZE ....16 bits
STORAGE ....4096 words
Hardware multiply Included

SEL 840 COMPUTER
WORD SIZE ....24 bits
STORAGE ....4096 words
Hardware multiply and divide included

- All silicon monolithic integrated circuits
- 1.75 u second machine full cycle time
- Fully parallel operation
- Two independent I/O channels
- Typewriter, tape reader and punch
- Hardware index register and program counter
- All software including FORTRAN IV for real time and scientific use

810 AND 840 OPTIONS

- To 32,768 word core in main frame—all directly addressable
- External drum or disc storage
- Up to 8 I/O channels
- Up to 6 direct memory access channels
- Any standard peripherals
- **Double precision floating point hardware for SEL 840 (operates independently of main frame)**

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NEW PRODUCTS

document retriever

Randomly-stored records in the form of cards of various sizes, microfilm jackets, embossed address plates, etc., can be retrieved in less than one second. System consists of keyboard console document or record coder, selector module, and document trays. Con-

sole can control 16 or more selector modules, each of which holds more than 1,000 edge-coded cards. By proper coding, documents can be retrieved by numerous criteria, and cross-correlation is said to be possible. ACCESS CORP., Cincinnati, Ohio. For information:

CIRCLE 150 ON READER CARD

i. c. core memory

The ICM-40 is an integrated-circuit system with an access time of less than 500 nanoseconds and a full cycle time of 1 usec. The coincident-current unit is rack-mounted, has front-of-rack access, and up to 16K words. Standard operating modes include clear/write, read/restore, and read/modify/write cycles. Optionally the address register can be equipped for sequential addressing, address-out signals, and external count controls. COMPUTER CONTROL CO. INC., Framingham, Mass. For information:

CIRCLE 151 ON READER CARD

time-sharing computer

The 940 is a 930 modified for t-s with up to 32 users. At full capacity, response time is 3 seconds; with 20 users, 2 seconds; with six, 1 second. Memory cycle time is 11.75 usec, and there are 16-64K (24-bit) words of core. Other features: built-in multiply and divide, automatic checking of memory transfers and I/O operation, multi-level indirect addressing with indexing at any level, and up to 1,024 levels of priority interrupt, each with a unique priority and address in memory. Software includes FORTRAN II, a conversational algebraic language, SNOBOL for string manipulation, QED (a conversational text editor), and LISP. Under development is ALGOL. A typical configuration costs $430K. SCIENTIFIC DATA SYSTEMS, Santa Monica, Calif. For information:

CIRCLE 152 ON READER CARD

media conversion

The PTS-1000 is an off-line converter of paper tape to mag tape. It reads 5- to 8-level tapes at 1,000 cps, and converts into IBM-compatible tape in any code format. Models are also available to go to 7- and 9-channel tapes. It can handle up to 1,300 feet of 4½-mil or 2,350 feet of 2½-mil paper tape, chad or chadless, oiled or not. The unit measures 45 x 22 inches and stands 45 inches high. AMPEX CORP., Redwood City, Calif. For information:

CIRCLE 153 ON READER CARD

flowchart generator

AUTOFLOW produces flowcharts on a printer, operating from assembly or higher-level languages for the RCA 501, 301, 3301 and Spectra 70; the

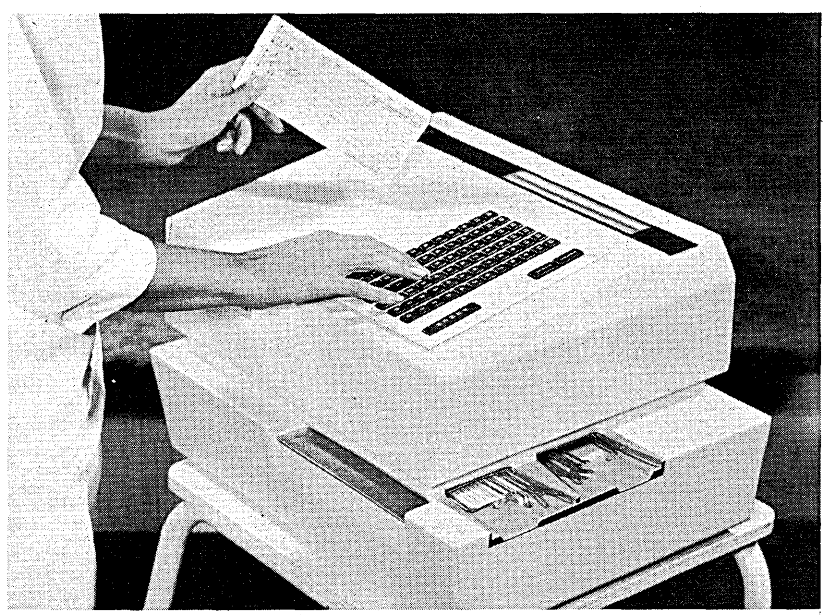
PRODUCT OF THE MONTH

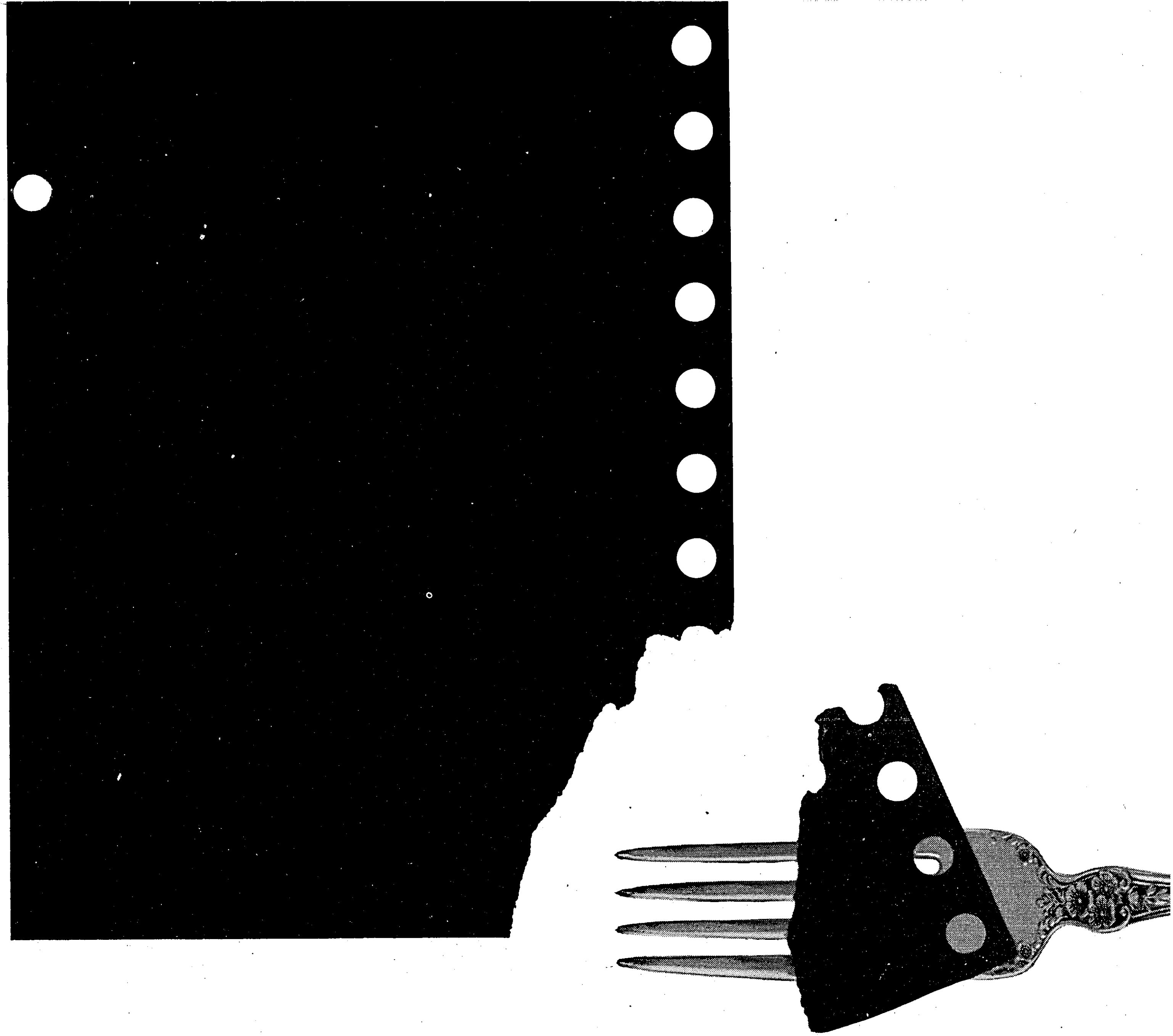
The Source Record Punch is an off-line, point-of-origin data collecting machine that records information in both printed and keypunched form on the same document; the operation is simultaneous. It enables transactions in a serial process – such as in hospitals and retail stores – to be captured for subsequent EAM or computer processing.

Input data can be fixed (e.g., an embossed plate), semi-fixed, or variable . . . various models include a master card reader, imprinter, keyboard, data-station mechanism, card punch, and interpreter. Selection of hardware features can be based on application. The keyboard is designed for sight checking before a bar is depressed to activate punching and printing. Punching speed is 10 columns/second, and the keyboard is a 6-row, 12-position unit with automatic and non-auto clearing; automatic zero is optional. All units are table-top models.

THE STANDARD REGISTER CO, Dayton, O. For information:

CIRCLE 154 ON READER CARD



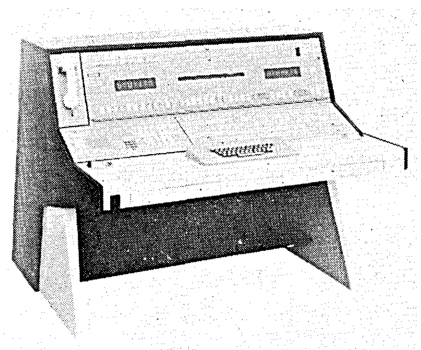


IBM 1401/60/10 and 360's; and the Honeywell 200. For assembly language input, the placing of a special chart code in the comments field is reportedly the only effort required. The software edits all information within a flowchart symbol, allocates columns and pages and draws connecting lines. APPLIED DATA RESEARCH INC., Princeton, N.J. For information:

CIRCLE 155 ON READER CARD

communications console

The 544 is an I/O unit with multiple input controls and the capability of presenting data before message transmission and displaying data generated by external equipment. Preselected program options can be stored for transmission at the discretion of the operator. Input can be by an al-



phanumeric (FORTRAN) keyboard, by program option switches, and special functions switches. The 544 can also be linked with up to 15 slave subconsoles operating under control of the main unit. Control logic locks out others so that one subconsole gets the transmission facilities. TASKER INSTRUMENTS CORP., Van Nuys, Calif. For information:

CIRCLE 156 ON READER CARD

digital plotter

With a plotting area of approximately 60 x 60 inches, this unit is said to have a lifetime accuracy of .002 inches, repeatability within .001 inch. It features an 8-character, 10-symbol print head and "absolute position sensing" via photoelectric readers scanning 19-track, linear, binary-coded scales on each axis. Plotting speed is 25 ppm, slewing speed is a minimum 50-mm/second, and printing speed is 25 per minute. DISCON CORP., Fort Lauderdale, Fla. For information:

CIRCLE 157 ON READER CARD

mag tape

The Micronetic 404 uses a binder which is said to reduce dropout of oxides because it does not stretch or soften with heat. The 800-bpi tapes come with seven and nine channels. MICRONETIC CORP., Alexandria, Va. For information:

CIRCLE 158 ON READER CARD

late-hours transmission

New feature of the 201A Data-Phone set enables its use, with an 801-type automatic calling unit, without human intermediary. Thus, data-collection points can be polled during off-hours, under computer control. Transmission can be computer-to-computer, as well as with paper tape, mag tape, and card transmitters. BELL TELEPHONE SYSTEM, New York, N.Y. For information:

CIRCLE 159 ON READER CARD

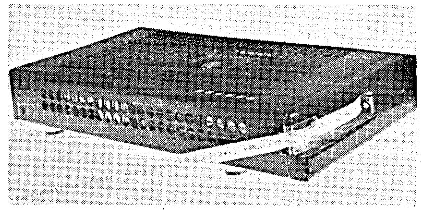
drum memory

The 1116 drum system stores up to 524K 18-bit words. It is word addressable with 8.5 msec average access time; sequential words can be accessed at 17 usec. Error rates are proven at less than 1 in 10^{11}. Maximum-size system is said to cost less than 10 cents per word. VERMONT RESEARCH CORP., North Springfield, Vt. For information:

CIRCLE 160 ON READER CARD

compact printer

The 118A measures 5 x 10 x 2 inches, weighs about 4 lbs., and prints about 22,000 characters on a self-contained 3-inch roll of tape at varied speeds up



to 10 cps. Characters are .098 x .062 inches, number 9.3 to the inch; any 64-character alphabet can be furnished. Applications include monitoring of phone calls and use in ground mobile equipment. MITE CORP., New Haven, Conn. For information:

CIRCLE 161 ON READER CARD

card-to-tape converter

The 3011 card reader combines with an 1106 Data Recorder (an 1101 with circuitry to handle the reader) to perform card-to-mag-tape conversion. The reader translates the data into BCD code, which is transmitted through the 1106 80-character core memory onto mag tape and automatically back into memory for verification. In continuous-run mode, the 3011 reads 75 cards (51- or 80-column) a minute. In single-cycle mode, handwritten data can be keyed to tape on the 1106, and pre-punched data is machine-read to complete the record. The 1106 can be operated alone. MOHAWK DATA SCIENCES, Herkimer, N.Y. For information:

CIRCLE 162 ON READER CARD

hybrid expansion

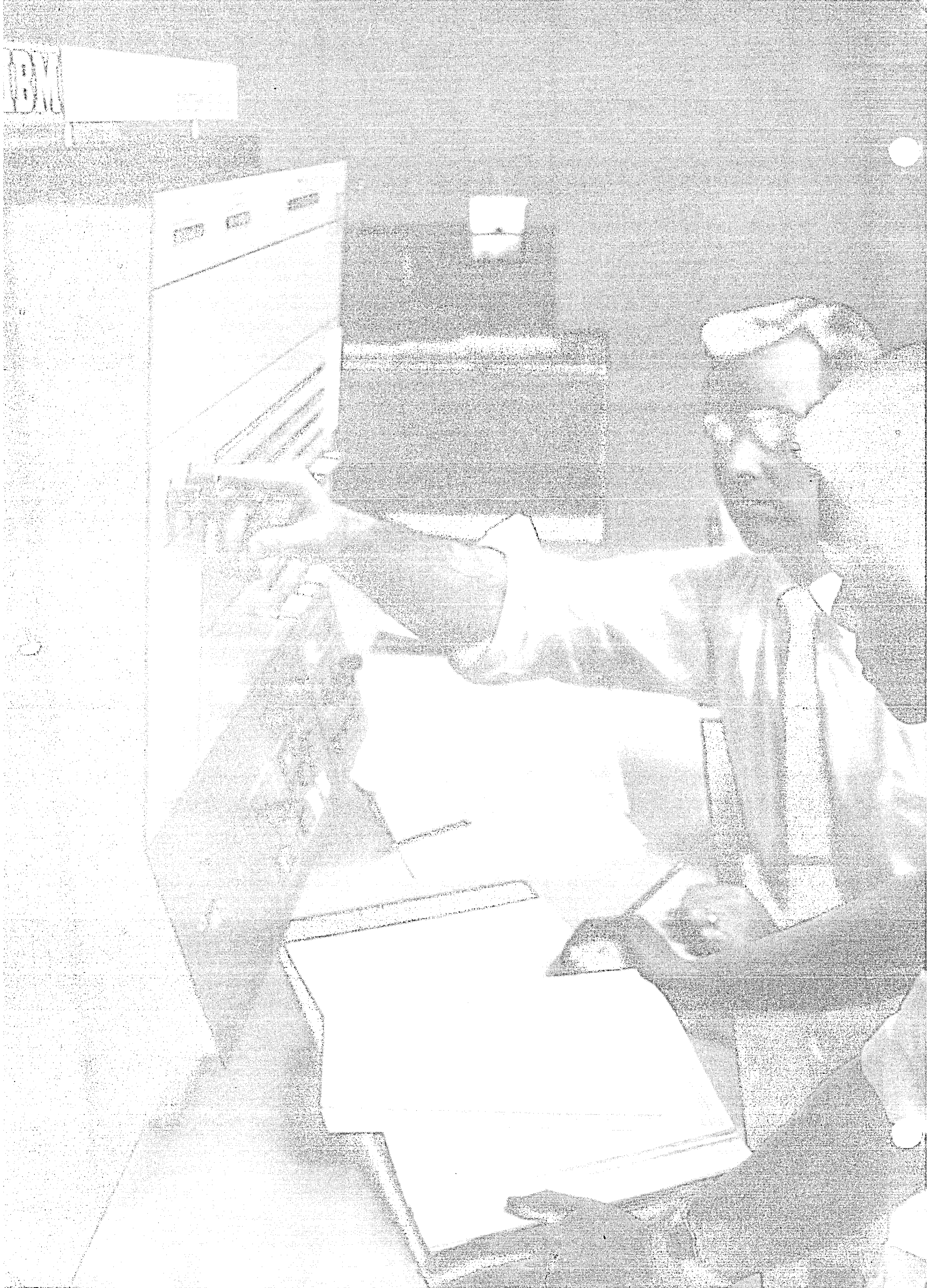
Three plug-in logic modules enable addition of hybrid capabilities to the firm's 40- and 80-amplifier analog computers. These are the 3326 flip-flops, 3327 logic gates, and 3328 time/event control. SYSTRON-DONNER CORP., Concord, Calif. For information:

CIRCLE 163 ON READER CARD

display terminal

The S-C 1100 is an inquiry unit with keyboard and CRT which can display either 100 characters or up to 500. The desk-top device has its own refresh memory and can be used with a separate hardcopy printer. The unit was originally designed and sold by Information Products Corp., recently acquired. STROMBERG-CARLSON CORP., DATA PRODUCTS, San Diego, Calif. For information:

CIRCLE 164 ON READER CARD



NEW LITERATURE

CONTROL DISPLAY PANELS: Four-page booklet provides description and specifications for display panels available for the MARC alarm, control and telemetering systems. Included are encoder and decoder display units, plus specialized displays and supporting devices. MOORE ASSOCIATES, INC., San Carlos, Calif. For copy:
CIRCLE 130 ON READER CARD

PORTABLE KEY PUNCH: Data sheet describes device which weighs eight pounds and punches data into standard tabulating cards. PAUL G. WAGNER CO., Los Angeles, Calif. For copy:
CIRCLE 131 ON READER CARD

DISC STORAGE SYSTEM: 16-page brochure describes model 611 DATASTAK system and includes application data, major design features, access and capacity information, and interfacing considerations. DATA PRODUCTS CORP., Culver City, Calif. For copy:
CIRCLE 132 ON READER CARD

MAG TAPE SYSTEM: Brochure describes automatic cartridge loading, principles of operation, performance characteristics and specifications for RAM system that records at 1000 bpi and has average access time of 90 msec. POTTER INSTRUMENT CO., INC., Plainview, N. Y. For copy:
CIRCLE 133 ON READER CARD

CANADIAN COMPUTER CENSUS: Booklet shows total number of installations and breaks down distribution by industry and listings for each organization showing type of processor, location, delivery date, and size of central and auxiliary storage. Price: nonmembers, $2; members, free. THE COMPUTING AND DP SOCIETY OF CANADA, Ottawa, Ontario.

MEDIUM-SCALE COMPUTER: Two brochures cover hardware and software aspects of 520 system for scientific and engineering applications. 16-page hardware brochure covers system characteristics, describes central processor, details performance including comparison of performance with competitive computers, and describes I/O system and various application areas. 12-page software brochure describes programming systems including FLEXTRAN, BOSS monitor and I/O control program and 1620 simulator. RAYTHEON COMPUTER, Santa Ana, Calif. For copy:
CIRCLE 134 ON READER CARD

NC EVALUATION METHOD: 20-page booklet supplies answers to 41 questions for prospective numerical control purchasers. Provides information on performance, reliability, application, flexibility, maintenance, service and computer software. Worksheet is offered as aid to evaluation. GENERAL ELECTRIC CO., Winston-Salem, N. C. For copy:
CIRCLE 135 ON READER CARD

RANDOM ACCESS DRUM: Characteristics of the PhD-170, its operating modes and on-line application capabilities are described in four-page booklet. BRYANT COMPUTER PRODUCTS, Walled Lake, Mich. For copy:
CIRCLE 136 ON READER CARD

ACCESS FLOORING: Brochure describes 1000 series flooring available in four types of panels. Each floor panel is illustrated and companies using free access flooring installations are listed. EVANS PRODUCTS CO., Grand Rapids, Mich. For copy:
CIRCLE 137 ON READER CARD

METER READING AND CASH COLLECTIONS: Eight-page brochure discusses system which can be used in gas, water and electric utilities. Cost factors and systems considerations are compared when using SODA (Source Oriented Data Acquisition) method of recording information on mag tape, and accounting applications are discussed. UGC INSTRUMENTS INC., Houston, Tex. For copy:
CIRCLE 138 ON READER CARD

CORE MEMORY SYSTEM: Series MFA 1 with 400-nsec access time and word capacities up to 32,000 is described in eight-page bulletin. Included are specs of four cycle operations, six access modes and nine combinations of address and data registers, power supply and self-test circuitry. FABRI-TEK INC., Minneapolis, Minn. For copy:
CIRCLE 139 ON READER CARD

DESK SIZE COMPUTER: 44-page booklet includes section dealing with hardware and software, artificial languages, and problem-solving advantages of PDS 1020 for engineers. Other sections cover operation using the keyboard interpreter combination and retained operations. PACIFIC DATA SYSTEMS, INC., Santa Ana, Calif. For copy:
CIRCLE 140 ON READER CARD

ANALOG-TO-DIGITAL CONVERTERS: 8-page brochure contains specifications, technical descriptions, block and timing diagrams and coding. SCIENTIFIC DATA SYSTEMS, Santa Monica, Calif. For copy:
CIRCLE 141 ON READER CARD

COMPUTER TAPE: Four-page brochure describes how Sigmatape was developed and various user-oriented parameters which were considered. Also includes detailed specifications and testing information. MEMOREX CORP., Santa Clara, Calif. For copy:
CIRCLE 142 ON READER CARD

USES OF MICROFICHE: Four-page booklet, "Microfiche: for publishing and general document distribution," offers description of concept, advantages, uses and applications. MICROCARD CORP., West Salem, Wisc. For copy:
CIRCLE 143 ON READER CARD

TIME-SHARING SOFTWARE: 20-page booklet describes concurrent operation of several user programs. Shows manner in which time-sharing monitor system schedules multiple users, allocates facilities to particular users, accepts input from and directs output to all I/O devices, and relocates and

protects user programs in memory. DIGITAL EQUIPMENT CORP., Maynard, Mass. For copy:
CIRCLE 144 ON READER CARD

PUNCH CARD READER: Bulletin furnishes information on terminals, card size, contact form, output bussing, contact rating and insulation, physical dimensions and control for reader which senses first 22 columns of standard IBM 80-column card. DREXEL DYNAMICS CORP., Horsham, Pa. For copy:
CIRCLE 145 ON READER CARD

USED COMPUTER MARKET: Four-page article reprinted from DATAMATION, describes market and its effect on computer upgrading and replacement policies and lease-purchase decisions by major corporations. INFORMATION PROCESSING SYSTEMS INC., New York, N. Y. For copy:
CIRCLE 146 ON READER CARD

MICROELECTRONICS: 34-page report discusses impact of integrated circuits on conventional component manufacturers and users. Details also how industry's future will be shaped by the leading companies' technological paths. Feasibility of an in-house microelectronics facility is analyzed and evaluated. Price: $48 to subscribers of Samson Trends; $60 to non subscribers. SAMSON SCIENCE CORP., New York, N. Y.

AUTOMATED MILL: Eight-page brochure describes approach toward fully-automated mill through 756 computer system. Brochure explains how control system can be made up of pneumatic, electronic or a combination of both types of units. Controls illustrated include stock consistency, pressurized headbox, brown stock washer, multi-effect evaporator and bleach additive. BAILEY METER CO., Wickliffe, Ohio. For copy:
CIRCLE 147 ON READER CARD

HARD COPY GENERATION FROM CRT DISPLAYS: Four-page illustrated folder discusses hard copy requirements, describes various photographic techniques, and offers criteria for application of specific techniques to specific problems. Included is a two-color comparison chart detailing relative performance, design and costs of nine photographic hard copy systems. PHOTOMECHANISMS, INC., Huntington Station, N.Y. For copy:
CIRCLE 148 ON READER CARD

MEMBERSHIP DIRECTORY: 100-page directory lists member firms located throughout the U.S. and Canada of the Assn. of Data Processing Service Organizations, Inc. Price: $1. ADAPSO, Abington, Pa.

COBOL: Bulletin contains 186-page working document, "Language Specifications for a Proposed COBOL Standard," produced by the Amer. Standards Assn. subcommittee X3.4, and elements chosen from the total COBOL language, as defined by CODASYL to be considered for the proposed Amer. Standard. Business Equipment Manufacturers Assn., N.Y. For copy:
CIRCLE 149 ON READER CARD

COMPUTER TAPES: Eight-page brochure gives specifications and lists computer systems and transports with which tapes are compatible. REEVES SOUNDCRAFT, Danbury, Conn. For copy:
CIRCLE 165 ON READER CARD

DP PROCEEDINGS: 497-page, hard-bound book (Vol. VIII) consists of 40 seminar sessions covering new applications, education and techniques in dp discussed June '65 at the International DP Conference. Price: $5.75, members; $6.75, nonmembers. Data Processing Management Assn., Park Ridge, Ill.

CIRCLE 63 ON READER CARD

THE AUSTRALIAN COMPUTER MARKET

There is a potential market in Australia today for some 700 computers worth more than $225 million. This estimate comes from a survey just completed of the market here. Current estimates are that computer orders are running at about $40 to $45 million and increasing at about 35% annually.

The study shows IBM in top place with an estimated 55% of the dp market, including computer and punched card installations. Of the more than 200 IBM computers installed and on order, more than 60 represent the 360's, deliveries of which have already begun.

The firm has been strongest in its sales of medium-scale hardware, of which it has sold three times as much as the combined effort of the competition. Its forte here has been the 1401 and 360/30. IBM's hardware, however, has missed out in the larger orders placed so far in Australia; Control Data and Honeywell have taken these honors. Similarly, the firm nearly missed the market for small computers, which developed so rapidly in the past 12 months. The complexion may change with the introduction of the 360/20, of which 15 are on order. Chief competition in this area were the Honeywell 200, GE 125 and Univac 1004, which was sold so successfully in Australia by International Computers & Tabulators.

ICT, which has 15% of the market, was the local representative for RCA, Univac and Ferranti of England. Although most of these products were sold under ICT's name, they presented problems in compatibility and backup support for customers. With the introduction earlier this year of the 1900 series, however, much of this problem should be overcome. Nevertheless, it has been the small 1004 that has been responsible for keeping ICT in the marketing race; the firm has sold 70 systems at an average cost of $90,000. The company's 400 punched card customers represent a lucrative and continuing market, prompting ICT to believe that the small computer market will be the key to success in Australia and that 90% of the installations in the next five years will be in the under $150,000 bracket.

In third place is Control Data, with 10%. It recently returned a profit in excess of $110,000 for its second year of operation, and recent expansion moves include the construction of a headquarters in Melbourne. Of the more than $13 million in sales, the largest portion is represented by two large federal government contracts: the Bureau of the Census and CSIRO (see March '65 issue). The recent sale of a 6400 to Adelaide Univ., probably the fastest to be sold to an Australian customer, gives Control Data an excellent chance of pulling off the next federal government order (in the $3-million bracket) for the Bureau of Meteorology.

Honeywell holds down fourth place and, like the other three, returns a profit from its computer division. Give it 9%.

National Cash Register is probably fifth on the list with an estimated 3.5%. Australia is now in the throes of changing office and business equipment in preparation for the introduction of decimal currency on Feb. 14, 1966. And NCR and Burroughs are concentrating their energies on this conversion program for cash registers, accounting and adding machines. But the profits from these operations will give both companies a solid base for computer expansion late next year.

General Electric has had some success in the banking field in Australia, but has had a lean sales record of late; it probably accounts for 2.5% of the market.

This leaves 5% being shared by Burroughs, English Electric-Leo-Marconi, Elliott, Scientific Data Systems, and Digital Equipment Corp. Digital Equipment is starting to move in Australia, and is one company that is expected to take out a substantial share of the market in the years ahead.

—RIC ALLEN

people IN DATAMATION

■ Dr. Mortimer Taube, founder and chairman of Documentation Inc., Bethesda, Md., and a pioneer in information retrieval, died last month. He was the author of "Computers and Common Sense," a thoughtful critique of research efforts in artificial intelligence.

■ Andrew J. Singer, formerly director of Systems Research Bio-Medical Computing Facility, NYU, has joined General Analytics Corp., N.Y., as vp and manager of systems design.

■ G. Stanley Johnson, president of Computron Inc., Waltham, Mass., has resigned. He will be succeeded by Hans Versemann.

■ William B. Hall has been promoted to director, systems analysis, Communication Systems, Inc., Falls Church, Va. CSI is a subsidiary of Computer Sciences Corp., Los Angeles, Calif.

■ In the DOD, Dr. Harold Brown, former director of Defense Research and Engineering, has been appointed Secretary of the Air Force; John S. Foster, Jr., formerly director of the Lawrence Radiation Lab, Livermore, Calif., was nominated Director of Defense Research and Engineering; and, Thomas F. Rogers was named Deputy Director, Defense Research and Engineering, Electronics and Information Systems.

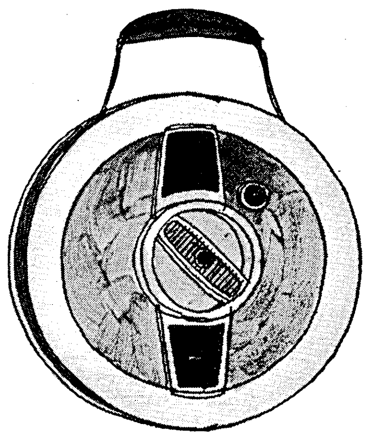
■ Jackson W. Granholm is newly appointed vp, Wolf Research Corp. and will direct their western division, Los Angeles, Calif. He was formerly with Informatics, Inc.

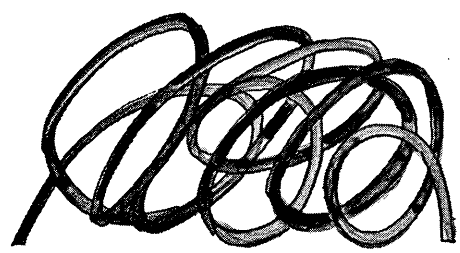
■ Robert J. McDowell has been named director, compiler development group for the edp division, Honeywell, Inc.

■ Dr. John E. Meggit has been appointed manager, advanced design section, and Glenn L. Holtkamp, manager, system programming section, Electronic Associates Inc., West Long Branch, N.J.

■ Robert D. Holland has been elected president and Robert Dee, formerly vp marketing for RCA dp division, will join CEIR, Inc., Wash., D.C.

Why should programmers consider us?





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There are positions currently open for all levels of programmers and EDP project planners with one or more years' experience, preferably utilizing IBM 1401 or 1410 equipment, although experience with other computers will be considered.

Xerox's 7010s are completely random access oriented utilizing 2302s and are being used to implement our total systems concept. This will require the systems programmer to be familiar with systems and procedures, production planning, inventory control, accounting and other related functions. Real time and operating systems experience helpful. Bachelor's degree required.

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Xerox's Scientific Computing Center has recently installed an IBM 7040 system. Opportunities exist for personnel desiring to develop Fundamental and Applied Research applications. Additional openings exist for personnel experienced in systems programming, PERT, operations research, and information storage and retrieval.

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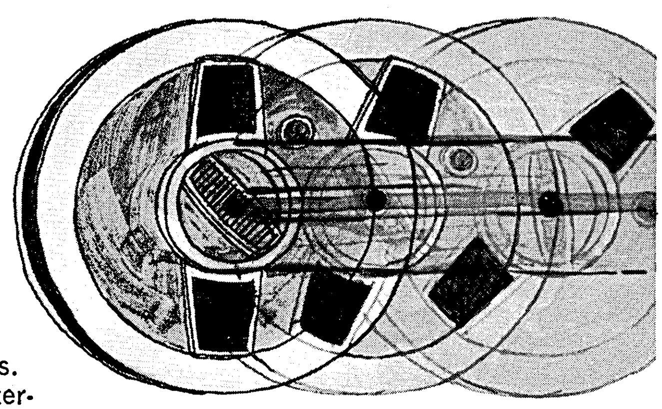

These positions are in Rochester, New York. Please forward resumes in confidence to Mr. David E. Chambers, Dept. DA-10, Xerox Corporation, P.O. Box 1540, Rochester, New York 14603.

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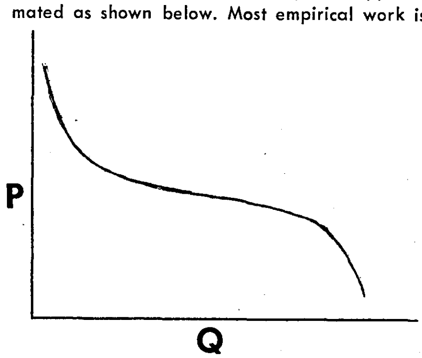
articles; hopefully there will be many more.

WILLIAM F. SHARPE
Univ. of Washington
Seattle, Washington

Author's reply: I apologize for confounding economic "theory," which says nothing about the shape of the demand curve, with the empirical work of economists, which "assumes that demand curves are linear in the logs," as Mr. Sharpe notes in item No. 2. Perhaps I used the term "theory" too broadly. Economic theory cannot even assert that demand curves are downward sloping, for some few are not. I presume Mr. Sharpe prefers the more modern indifference curve approach over marginal utility theory. I would like to think, with Leftwich, that "indifference curve theory furnishes both an alternative and a supplement to the classical utility explanation of consumer behavior and individual consumer demand curves for commodities."

To say "textbook expositions of demand typically draw curves" is not to say "textbook expositions draw typical demand curves." They generally use straight line demand curves for their examples, these being simpler to draw and explain. But I don't believe anyone would maintain that the demand for most goods is rectilinear, except within a very limited range. The typical demand curve is probably best approximated as shown below. Most empirical work is



concerned with demand operating in the left-hand portion of this curve, and therefore views the curve as convex. I was concerned primarily with demand operating in the right-hand portion, and therefore perhaps oversimplified matters by using a concave demand curve as my example.

I acknowledge that the use of the terms "subsistence region" and "affluence region" is mine, not that of professional economists. I'm not sure how significant this fact is. However, my discussion of classical theory's neglect of marginal utility relied upon Bell for the fact and upon history for the reason.

The term "relevant range" is the keynote. It is my firm conviction that the right-hand portion of the representative demand curve shown must be counted in the relevant range of the demand for information, in these decades of the information explosion. This was the theme of my article.

key punch in the snoot

Sir:
This is to protest the action of your recent correspondent (Letters to the Editor, Aug.). Taking vitriolic pen in hand, he dashed off a scurrilous attack on the elegant new IBM 029 keypunch, which he then signed with *my* name. If he finds it necessary to hide behind a pseudonym, he should invent, rather than borrow, one.

AUSTIN O. ARTHUR
Palo Alto, California

Sir:
Re: the 024/026 keypunch. What I wanted to do was put a light under the program drum hood to illuminate the column indicator. The final touch was to put a ruby over the light, imbed it in the hood, and connect the light across the power source so one could tell at a distance whether the power was on.

And while we're coming up with red hot suggestions, why can't some move be made to eliminate the whip-socket bracket from the next version of computer printer equipment? I refer to the carriage (appropriate name) control tape. Is it too simple to have a special area of addressable core to control form spacing and skipping? A built-in counter would increment for every line printed from a reset-start point. Presence of a word mark at Channel bit so-and-so would have the same effect as encountering a punch in a tape, etc. Programs would carry their own spacing, and when jobs are stacked (as certain hardware components would have them do) one could come a lot closer to travelling from one job to the next with a minimum of fumbling at the printer.

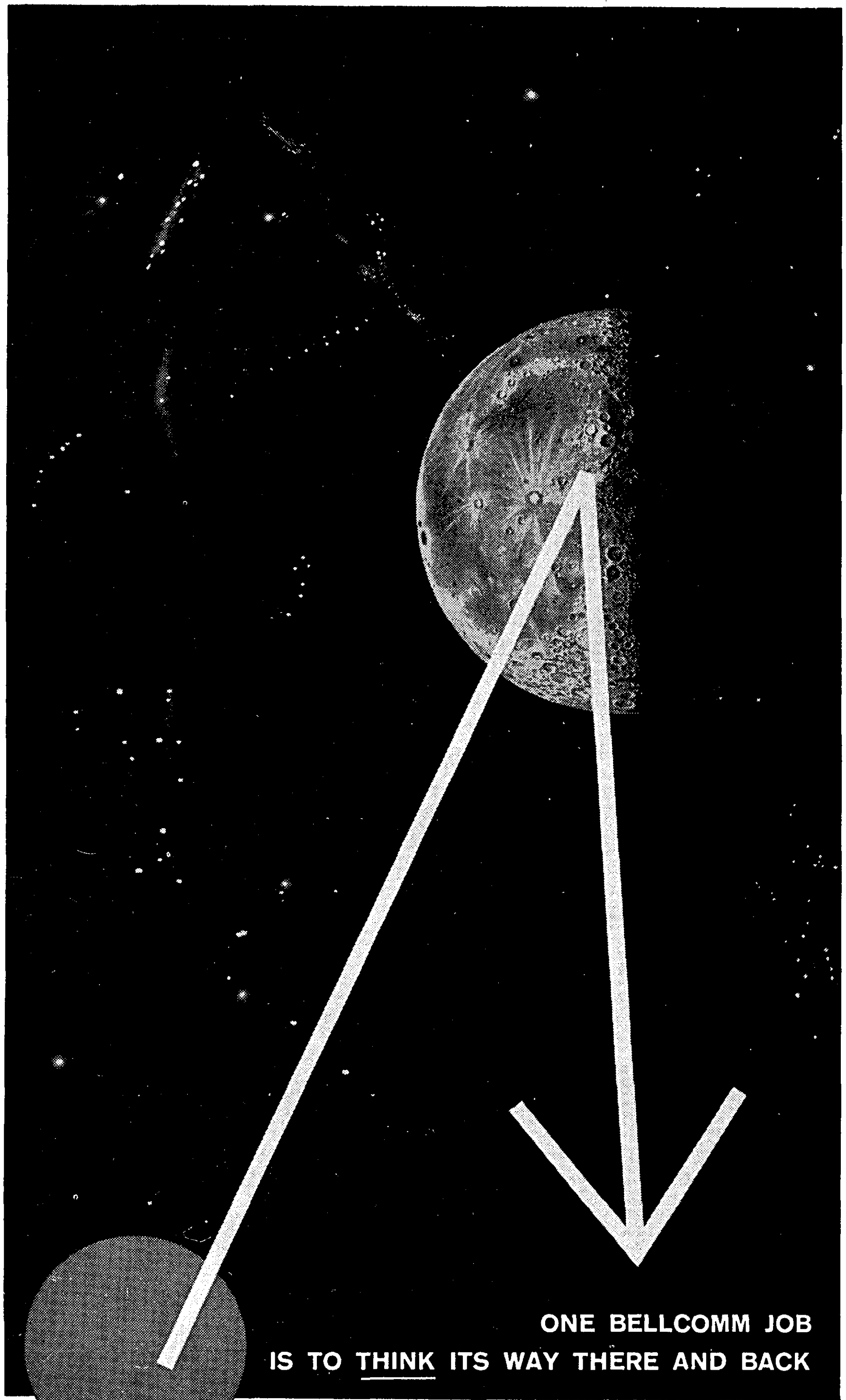
W. M. LIDDLE
Seattle, Washington

lowered drum price

Sir:
Your story in "Business & Science" (Aug., p. 19) states that the rental of a 2301 drum, with control unit, is $6,700/month. This is incorrect; with control unit, it is $4,300/month.

R. D. ANDERSON
IBM General Products Division
San Jose, California

The drum and control unit were originally priced at $6,700 when announced in April 1964. The price has since been reduced by 36% and stands at $4,300/month for the pair. *Datamation* apologizes for its sales-manual pages being out of date.



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CIRCLE 106 ON READER CARD

(Continued from page 99)

KDF8. Software lists Cleo, Cobol, Fortran and Algol with PL/I under review for implementation if acceptable to users and meeting requirements.

ICT SHUFFLES TOP COMMAND

With a full order book, news of a top management shake-out at ICT came as a bolt out of the blue. New boss Cecil Mead steps up from deputy chairman to take over as chairman and chief executive officer. The latter title brings a change in management policy and gives over-riding responsibility on all matters to Mead. Previously, top policy rested on an executive committee. Reasons for the change are read as ICT's final shakedown from mergers and as being in line with its more aggressive approach to the market, sparked by the introduction of the 1900. Mead is regarded as a tough industrialist with a management career in dp going back to the 30's when he was sales manager in British Tabulating Machines, one of the pre-merger companies.

IBM – U.K. FOUNDER IS NUDGED OUT

Resignation of IBM's U.K. managing director Tom Hudson caused consternation because a week elapsed before it was made known, followed by another and into a third before a replacement hove in view. In 1951, Hudson established IBM in Britain after a five-year sales stint in Canada. His original staff of three has since grown to more than 5,000 with an estimated 40% share of the dp market. President of World Trade Corp., G.E. Jones, was quoted: "The company will sorely miss his very considerable managerial abilities." From his home in London, however, Hudson said that the situation resulting in his resignation had come unexpectedly and as a great shock. He did not feel that the issues involved were such as to call for resignation. On company performance, he stated that IBM has been more than satisfied with progress in the U.K., and it was not on this topic that his resignation occurred.

ODDS & ENDS

Expanding into Europe, Honeywell has opened a marketing and service support center in Brussels equipped with a 200. Already active in the U.K., Scandinavia, and Germany, coverage across Western Europe is expected to be completed with data centers in Paris, Milan and Zurich ... NCR brought Britain's first automated traffic scheduling for a port into operation at Avonmouth Docks, Bristol. Data links have been set up between the quayside and a 315 center ... Elliott Automation has taken another million dollars in orders from Russia and East Germany for Arch process control computers. Jobs will be controlling an ammonia plant in Russia and an oil refinery in East Germany. In the past 12 months, Elliott has taken $4 million in business from Eastern bloc countries ... EELM has also gained Iron Curtain business in Czechoslovakia. Two large systems, total value about $3 million, are on order. One will handle payroll for one large industrial firm, the other is for a combined process control and dp job. Machines involved are not System 4. With its newer technology, this will be covered by the strategic embargo list. ... Striving to become No. 1 in the U.K., EELM estimates it delivered a greater value of British-built computers last year than ICT, and expects to repeat this year.

(Continued from page 19)

RETAILERS BEGIN SCRATCHING A FIVE YEAR ITCH

At the dp conference for retailers, held last month by the Natl. Retail Merchants Assn., retail edp-types, looking for a way to conveniently capture sales data, were directed away from optical scanning as a near-term solution. No significant scanner developments were foreseen for the next five years by Kenneth Guinther of Booz, Allen & Hamilton. Not so, says a retailer with recent in-store experience. More like two years.

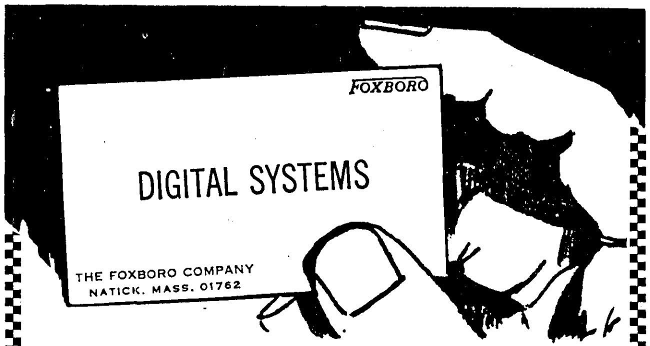
The idea was also voiced at the Conference that there would be no on-line, real-time store system for another five years. Needed: a good point-of-sale recorder. Then they won't need a scanner.

"COMPETITION, CONFUSION" CAUSE CONSTERNATION AT CONTROL DATA

Concerned by "competition and confusion in the market place" -- the cause of a lower-than-expected order rate -- Bill Norris lashes out in the '65 CDC annual report: "Our major competitor in the very large computer part of the market is making a highly concentrated effort to hinder our progress by making frequent announcements of changing characteristics and new models, at reduced prices, of large computers reported to be under development." But he thinks the mess is temporary. Or devoutly wishes so: he estimates that first quarter earnings for FY '66 may just break even. The CDC annual report also tells how the company will write off computers on a straight-line method, at 25% a year for four years. (They used to write off 50% the first year). It's designed to meet the increased percentage (up from 40% to 55%) of leased systems.

RUMORS AND RAW RANDOM DATA

Newest face in the computerized typesetting business is Alphanumeric, Inc., Hicksville, N.Y. The 10-man outfit is readying a photocomposition system with printer outputs of two and 10K cps. They'll set up one system, including a 360 and another machine, as a service bureau. Meanwhile, Mergenthaler is supposed to be readying the Linotron, due in Jan. ... We understand that United Airlines has narrowed its choice of a supplier for a new $30 million reservations system to Bunker-Ramo and Univac. ... Despite some welcome innovations, the FJCC will open minus two starring attractions it had hoped to line up. One was LBJ as the keynote speaker. Another: a session tentatively titled "How to succeed in the computer business without contributing to the state of the art." ... Inside poop is that new RCA vp Jim Bradburn, most recently of Burroughs, is being groomed to become top edp man replacing Arnold Weber, slated for retirement in a year or so. ... Latest guessing game: which of the top 10 U.S. firms will order a Burroughs B 8500? Two can be scratched: IBM and GE. Look for Burroughs to announce a new line — the 2000 — before the end of the year. ... Commercial time-sharing received its first set-back recently when Keydata (see May Bus. & Sci.) had to delay its debut. With a Univac 491 replacing the PDP-6, Keydata is open for business. ... Hank Watson, founder of Data Processing Systems (recently swallowed by Informatics), has started a new firm in southern California called Software. ... One user claims it's easier to convert 1401 programs to an H-200 than to a 360.



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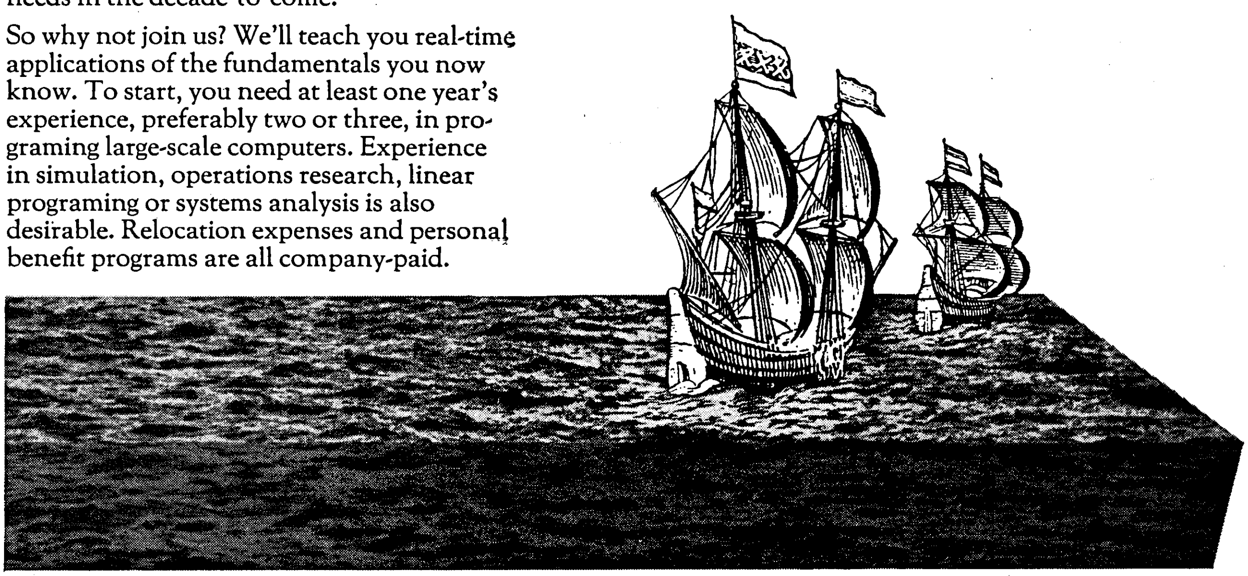

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New Opportunities in EDP with Burroughs

Pioneer in advanced concepts of EDP, Burroughs again leads the way with its new B8500 . . . the most powerful computer system ever announced for commercial and military use.

Featuring monolithic integrated circuits, TOTAL thin film memory and a functionally modular system organization, which permits efficient multiprocessing and time sharing, the B8500 is intended for the user, whose data processing needs demand state-of-the-art design.

The B8500 has a broad range of applications: centralized management information processing, large time sharing requirements, real time communications, store and forward message processing, centralized or decentralized scientific and engineering communications, as well as military command and control.

IMMEDIATE OPPORTUNITIES FOR:

PROGRAMMERS—Challenging positions in design and implementation of software systems for large modular multiprocessing systems. Positions are available in the following specific areas:

SOFTWARE SYSTEMS:

- executive control programs
- compilers
- computer simulation
- diagnostic programs

COMMAND AND CONTROL SYSTEMS:

- message switching
- on-line reservation systems
- air defense systems
- information storage and retrieval

SYSTEMS DESIGN ENGINEERS

To analyze system requirements and devise best solution, using available system components. Requires BSEE or equivalent, plus minimum 5 years' experience in systems design, logical design and/or programming. Thorough knowledge of computer technology essential. Knowledge of related technologies, such as display and communication, desirable.

LOGICAL DESIGN ENGINEERS

To perform logic design for special and general purpose digital computers and assist in development of diagnostic procedures. Requires bachelor's degree in EE, math or equivalent, and minimum 2 years' experience in logical design.

CIRCUIT DESIGN ENGINEERS

To design solid state circuits, as required for some of the following areas:

- fast ferrite core or magnetic film memory
- operational amplifiers
- A to D or D to A converters
- deflection and driver circuits for CRT display systems
- disks and drum circuits
- power supply systems
- solid state digital and interface circuits

Candidates should have a BSEE or equivalent, and minimum 2 years' design experience.

Component engineer to support circuit design in the areas of:

- part selection and specification
- part testing
- integrated circuit evaluation
- design review

Requires BS in EE or physics or equivalent experience.

ADVANCED DEVELOPMENT ENGINEERS

To conduct investigations in state-of-the-art and future techniques in the following areas:

- computer organization
- programming research
- magnetic film memory investigation
- information retrieval

Located on Philadelphia's famous Main Line, Burroughs' modern facilities are convenient to many historical, cultural, educational and recreational facilities unsurpassed anywhere in the country. The Main Line is a semi-rural area of unusual attractiveness.

To explore these unique professional opportunities, you may arrange for interviews with our Engineering Management Team by sending your resume, AIR MAIL, in confidence to Mr. A. J. Bellace, Department 2205.

Burroughs Corporation

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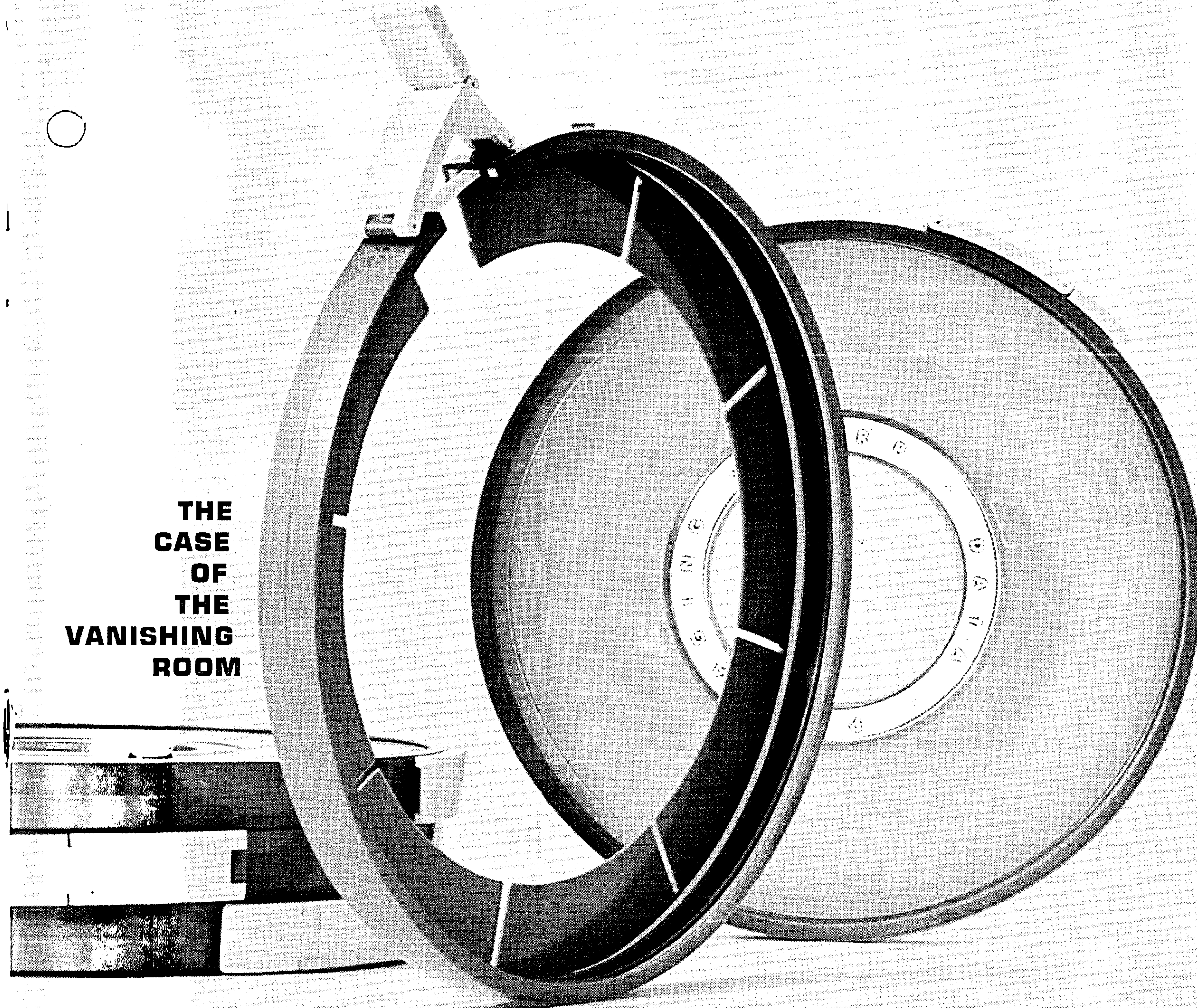

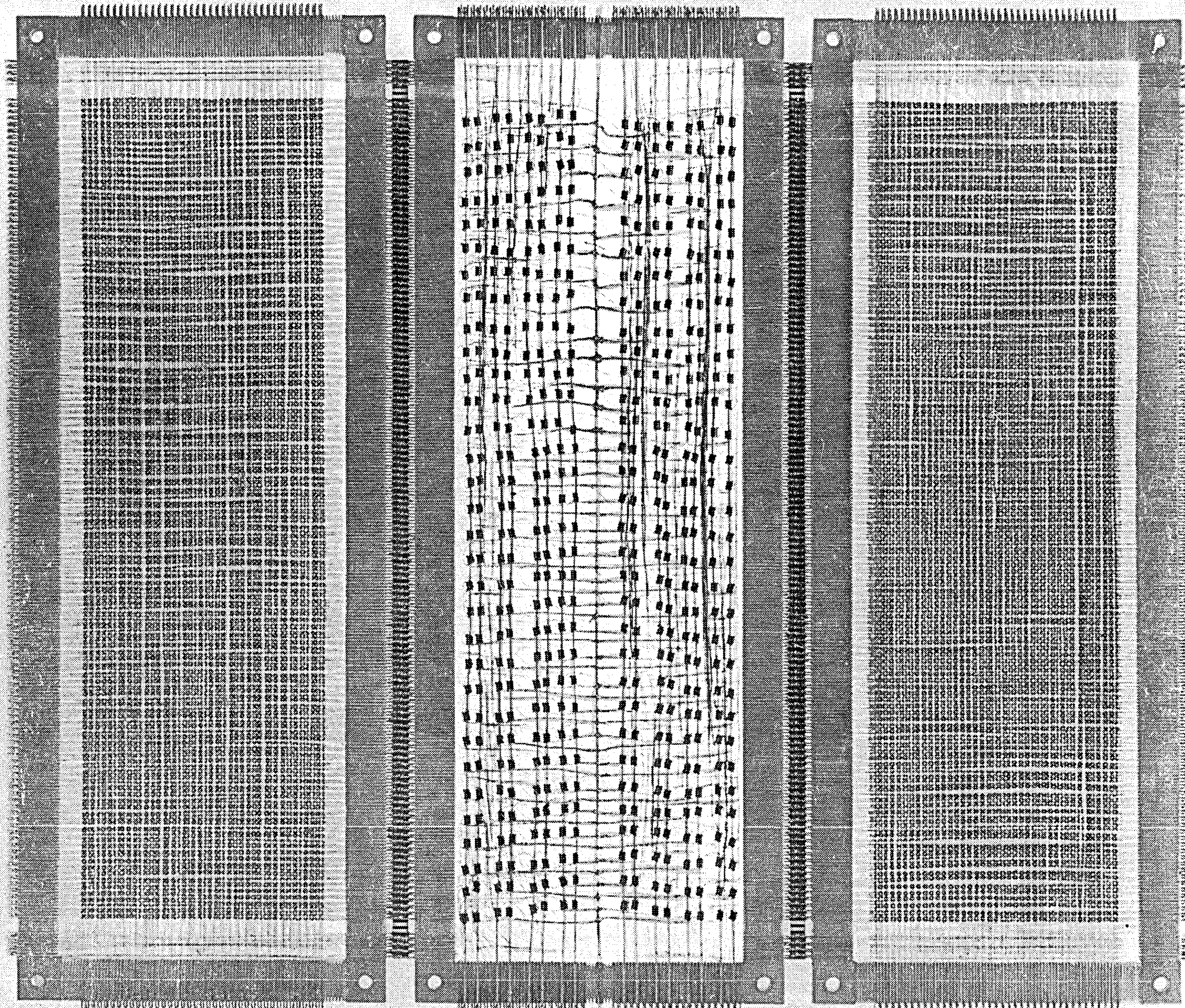

To all those who don't believe that we can deliver a 5,000,000 bit random access memory system for $87,500, we reveal our secret:

A coincident current "write" technique,
coupled to a word select "read."
A 2-wire plane array.
And switch cores instead of diodes.

It's cheaper when you know how.

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