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Within the Ampex range of drive speeds and data transfer rates, you can meet any of your digital tape transport requirements. And you can do it at one source. Quickly. Economically. Each member of the Ampex family is interface interchangeable with all of the other members. So you can combine drives, or make replacements easily to meet new requirements. All four basic drives have the Ampex patented* single capstan electronic servo control. This design commonality gives you many other advantages. Servicing is similar for all units. Training is simplified. Parts provisioning is simplified, with replacements readily available from one source. MTBF is 2,000 hours—at least a billion start/stop operations. That's partly because we use only one-fifth as many parts as non-single-capstan drives. And partly because at Ampex whatever we build we build the best we can.

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There is much more you should know. Write Ampex, Dept. 7-14, Redwood City, California 94063.

*Pat. Nos. 3,185,364 and 3,251,563

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AMPEx

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Because ICM's come from Honeywell, Computer Control Division, you know they're backed by more than eight years' experience in the design and production of standard core memories . . . and by some pretty intensive special purpose memory systems experience as well. Add to this our I/C capabilities, logic module capabilities, and digital computer capabilities, and you can be sure of dependable support in solving your core memory applications and systems design problems.

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HOW TO COLLECT, INTEGRATE AND DISTRIBUTE DATA

If any one symbol can represent the rapid changes of the "sizzling sixties," it's the computer. Data processing has won not only wide acceptance as a vital function of efficient business operations, but is growing more sophisticated with greater reliance on real-time operations.

In turn, this reliance on real-time processing has placed renewed emphasis on data communications. Data must be available quickly for management to make timely, accurate decisions. And, regardless how sophisticated your data system may be, Teletype sets remain the simplest, most reliable and least costly terminal equipment for collecting, integrating and distributing data.

The integration of communications within data processing systems has helped solve many business problems by:

- Assuring management of adequate, timely information to make accurate decisions,
- Eliminating the costly errors caused by duplicated paperwork,
- Speeding distribution by cutting costly paperwork,
- Reducing customer complaints, and
- Enabling management to communicate quickly with remote computer centers.

Getting data in time for decisions
Nothing can be as useless to you as information that arrives too late. Wrong decisions are made. Production is slowed. Deliveries are late. Customers are dissatisfied or lost. Yet, none of these situations need ever exist.

Using Teletype machines for communications within a data processing system, assures you of getting information where you need it—when you need it. You'll be able to make better informed, more timely decisions that could spell the difference between profit and loss.

This problem faced a New Jersey food processor, who had been receiving sales and inventory statistics by mail from its two branch offices. By the time these reports were processed, the information was too old to use in reaching important management decisions. The processor had Teletype ASR (automatic send-receive) sets installed at all three locations. Now, daily statistics are received in minutes and processed into up-to-date reports. This reduces inventory costs and enables the processor to close its books eight days earlier each month.

Eliminating duplicate paperwork errors
How often do errors in order processing result in producing the wrong size or quantity? How often have prices been misquoted or customers lost due to incorrect shipments? These are typical problems...
resulting from errors caused by duplicating data from one department to another. You can eliminate these situations with a system that speeds the handling and processing of data by including Teletype communications equipment.

Sales order information can be prepared on Teletype machines, reviewed, and transmitted directly to Teletype receiving sets in other departments. In addition to sending each department accurate information, Teletype sets can selectively “edit” this information. Thus, such data as order numbers can be sent to all departments, while cost data is directed only to accounting, billing and management departments.

This is what a metal products manufacturer did to cut order processing time 75 percent. By using Teletype ASR sets, minutes after an order comes in the data is sent to shipping and production departments—each receiving only the data it needs. A few of the resulting benefits include in-stock items shipped the same day, production orders scheduled three to seven days faster, overtime reduced, and errors greatly reduced.

**Moving inventory faster** Many companies are finding that profits are being eaten away by high inventory and distribution costs. They often find themselves having to justify a high inventory on the grounds it’s needed to meet fluctuating customer requirements.

Yet, other companies have cut inventory costs while keeping a larger selection of stock on hand. They have learned that an effective data communications system eliminates inventory that stands idle waiting for slow-moving paperwork. By using Teletype equipment to link business machines with existing channels of communications, they are provided with instant, accurate data collection, integration, and distribution. Thus, they can handle a larger volume of business faster with more efficiency and less error.

Due to the rapid decay of critical radioactive pharmaceuticals, a national drug company had a serious inventory problem. To solve it, the firm had Teletype machines installed at all of its 26 branches to provide the necessary speed, efficiency and written verification required to plan production and delivery of these drugs. Now orders are instantly received by a Teletype set, and prepared, packaged and shipped almost immediately.

**Reducing customer complaints** Today, customer service is often the deciding factor in who gets the order. Yet, rapid expansion has greatly strained the capacities of many companies to properly service their customers. This is why computers and data communications have become so important in speeding the order processing, production and shipping operations. And, regardless of the distance, Teletype equipment plays an important role in the gathering and forwarding of information needed for fast service.

Many banks are relying on data communications equipment to improve the efficiency of their customer services. A midwestern bank uses a Teletype ASR set to transfer funds, to notify customers when loan payments are due, to speed transmittal of correspondence, and for many other related functions.

**Solving your communications problems** There are many other applications in which Teletype equipment helps improve business operations, such as using Teletype sets to link companies to a remote computer center on a time-sharing basis. You can see why Teletype equipment is made for the Bell System and others who require reliable, low cost communications.

Our brochure, “WHAT DATA COMMUNICATIONS CAN DO FOR YOU,” further explains how an effective data communications system can cut your costs while building your profits. To obtain a copy, contact: Teletype Corporation, Dept. 81A, 5555 Touhy Avenue, Skokie, Illinois 60076.
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Up to 13 characters per second. 5 level code. Transmits to one unit, several or all units in system. Low noise level. Makes up to 12 carbons. Sends in red, receives in black, or vice versa. Receive-only units available. Tape reader and tape punch attachments. Many special features.

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BSL Data Input Consoles have built-in interfaces for most instruments with electrical outputs—plus a well designed keyboard for identification data and/or manually entered transactions. All data are displayed before transmission and recording. Designed for bench top use.

One to 20 Data Input Consoles can be attached to our Console Controller and LABORATORY DATA COLLECTOR™, which provides real-time input to any computer or drives any data recording device such as magnetic tape, paper tape or printer. Our laboratory data processing systems include small computers and complete programs for real-time data processing and preparation of reports.

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PORTABLE FIELD DATA ACQUISITION SYSTEM for geophysical research: BSL designed analog multiplexor, precision digital clock, A/D converter and incremental magnetic tape all connected and controlled by standard LABORATORY DATA COLLECTOR; truck mounted.

OEM DIGITAL DATA RECORDING SYSTEMS for microdensitometer manufacturer: standard LABORATORY DATA COLLECTOR with incremental magnetic tape option (see picture above). Instrument electrical interfaces supplied by BSL.

RCA 301—DIGITAL PLOTTER INTERFACE AND CONTROLLER: standard LABORATORY DATA COLLECTOR (more being delivered for six different computers). The LDC also allows off-line operation of digital plotters, incremental mag tapes, and printers for system check-out and maintenance with arbitrary test data.

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January 1967
If we were a BIG Corporation, this MDS DATA-RECORDER would still be buried in someone’s file folder

We’re happy as clams that all of our decision-makers are under one roof.

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All of which led us to wonder whether we could combine all three functions in a single unit, at a saving to the user. The decision-makers promptly gave the idea the green light. We were in business with the 1109. All we had to do was ask you for the orders.

Our specialized, expanding efforts are concentrated on input preparation equipment to meet the demands of today’s sophisticated computers.

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CIRCLE 8 ON READER CARD
22 FOURTH-GENERATION SOFTWARE, by Ascher Opler. Using large-scale integration logic specialized by microprogramming, the next generation of hardware may have expanded capabilities due to "firmware"—resident microprograms in the computer's control memory.

25 FOURTH GENERATION HARDWARE, by G. M. and L. D. Amdahl. Characterized by batch fabrication and increased economic imbalance between processors and peripherals, computer families to come will be faster and cheaper than ever.

27 COMPUTING IN THE 1970'S, by R. L. Patrick. Sent on a visit into the future, the author summarizes likely developments in the next few years and goes to the 1973 FICC.

31 THE NEXT GENERATION. What will it feature and when will it be here? A roundup of comments from hardware and software specialists and from users with a variety of requirements.

37 TRANSLATION BY XACT, by Henry Oswald. Description of an automatic code translation system that produces significant results in the analysis of a source program to produce machine-independent descriptions of the functions performed.

39 CONVERSION AT LOCKHEED MISSILES & SPACE, by Douglass A. Williams. A description of LMSC's changeover from IBM 7094's to Univac 1108's covering software conversion and including costs.

46 SAFEGUARDING TAPE-STORED DATA, by Paul R. Edelman. Preventing disaster with the grandfather system in a remote location.

49 A MACHINE-AIDED DRAFTING SYSTEM, by Harvey N. Lerman. The MADS system uses a standardized symbology to describe similarities between drawings, allowing a computer to generate or maintain the drawings through access to digitized symbol sets.

57 CONVERSATION WITH A COMPUTER, by Leslie Mezei. Projecting into the future, the author points out some interesting computer capabilities which could become reality within the next couple of decades.

62 THE SDS SIGMA 5

120 PROPOSED SYSTEM/360 INSTRUCTIONS

datamation departments

8 Calendar
12 Letters to the Editor
17 Look Ahead
21 The Editor's Readout
69 News Briefs
81 New Products
95 New Literature

101 World Report
107 Washington Report
117 Books
121 People
124 Datamart
128 Index to Advertisers
130 The Forum
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CIRCLE 10 ON READER CARD

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calendar

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<tr>
<th>DATE</th>
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<tr>
<td>Jan. 23-27</td>
<td>Course: Methods of Operations Research</td>
<td>Univ. of Miami, Coral Gables, Fla.</td>
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<td>Jan. 27-28</td>
<td>Workshop: Simulation</td>
<td>College of Engineering, Univ. of Missouri, Columbia, Mo.</td>
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<td>Feb. 7-9</td>
<td>Convention: Aerospace &amp; Electronic Systems</td>
<td>International Hotel, Los Angeles, Calif.</td>
<td>IEEE</td>
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<tr>
<td>Feb. 8-15</td>
<td>EDP Trade Fair</td>
<td>Frankfurt Trade Center, Frankfurt, Germany</td>
<td>U.S. Bureau of International Commerce</td>
</tr>
<tr>
<td>Feb. 13-17</td>
<td>SHARE XXVIII</td>
<td>Hilton Hotel, San Francisco, Calif.</td>
<td>IBM Users' Group</td>
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<tr>
<td>Feb. 14-24</td>
<td>Course: Theory and Design of Reliable Computers. $300.</td>
<td>Room 4442, Boelter Hall, Univ. of Calif., Los Angeles</td>
<td>UCLA Extension</td>
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<td>Conference</td>
<td>Sheraton Hotel, Chicago, Ill.</td>
<td>Assn. of Data Processing Service Organizations</td>
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<td>Feb. 25</td>
<td>CDP Examination</td>
<td>DPMA Test Centers, 100 national locations</td>
<td>Data Processing Management Assn.</td>
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<tr>
<td>March 1-3</td>
<td>Conference</td>
<td>Statler-Hilton Hotel, Detroit, Michigan</td>
<td>Numerical Control Society</td>
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<td>March 15</td>
<td>Paper deadline: International Electronics Conference</td>
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<td>Dr. Rudi de Buda, Int. Elec. Conference, 1819 Yonge St., Toronto 7, Canada</td>
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Our optical reader can do anything your keypunch operators do.

(Well, almost.)

It can't return from a two-day weekend with a three-day hangover. Or phone in sick. Or turn out half the work in twice the time. But it can read. And gobble data at the rate of 2400 types-written (or hand printed) characters a second. And compute while it reads. And reduce errors from a keypunch operator's one in a thousand to an efficient one in a hundred thousand.

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IN MEMORY SYSTEMS THE FASTEST BIT MAKES THE DIFFERENCE . . . AND BURROUGHS MAKES ITS OWN BITS (BOTH CORE AND THIN FILM).

The new Burroughs line of core Memory Systems is fast . . . as fast as 0.6 μsec. full cycle time. You can also have a "not-so-fast" model at lower cost if you don't need the speed.

Now, Burroughs 14 years of experience is available to provide you with the Memory System you need for your data handling equipment.

- System cycle times of 0.6 and 1.0 μsec.
- Modular building block construction—basic module is 8192 words by 20 bits and contains the core-memory, sense amplifiers, driver circuits and information registers.
- Associated memory control module includes timing circuits, address register and decode logic.

FEATURES:
1. 20 mil, 2-1/2D ferrite core memory—manufactured by Burroughs.
2. Driver Circuits and sense amplifiers use Burroughs hybrid microcircuits.
3. Monolithic integrated circuits used for all logic and registers.

If you would like your system to think faster write or call for further information on Burroughs memory systems.
Lease this 60 cps Tally data transmitter for less than $25 per month. No installation or maintenance charges.

Many of you are familiar with our elegant and sophisticated System 311 Data Communication Center. Fewer know that we make the broadest line of data communication equipment on the market today. Fourteen different systems are available on an off-the-shelf basis including the System 100 that leases for less than $25 per month. Systems, which are used with data sets, include both parallel and serial data transmitters and receivers, tape conversion units, and tape conversion transmit/receive systems. Here's a sampling.

1. Tally's System 100 Transmitter and System 200 Receiver go together to provide unequalled simplicity of operation coupled with low price. Speed is 60 characters per second over ordinary telephone lines. Low price, lack of installation or maintenance charges on the System 100 and minimal charges on the System 200 make these systems ideal for multiple installations reporting to a central accounting or computing facility.

2. System 108 Transmitters and System 208 Receivers also operate at 60 characters per second. However, these systems offer unique and important error detection features. When an error-free tape with parity is transmitted, the System 108 will stop transmitting if an error arrives at the System 208 Receiver. The System 108 then reverses the data tape to a block character and resends the tape to insure perfect tape generation by the System 208.

3. High transmission speed (120 cps) and error control are offered in the System 111 Transmitter and System 211 Receiver. Data can be transmitted manually or automatically for fast error-free data gathering over ordinary telephone lines. Where two-way data transmission is required, the System 311 Data Communication Center should be used. The System 311, in addition to combining the functions of Systems 111 and 211, can be used to duplicate and edit tape off-line.

4. A highly versatile data center, the Tally System 700 provides data transmitting or receiving on either paper or magnetic tape and bi-directional conversion of data between paper and magnetic tape. It handles data at the rate of 60 to 120 characters per second, and is available with a wide range of optional features.

For complete information on all 14 Tally Business Communication Systems including sale and lease price information, please address Robert Olson, Tally Corporation, 1310 Mercer Street, Seattle, Washington 98109. Phone: (206) MA 4-0760. TWX: (910) 444-2039. In the U.K. and Europe, address Tally Europe Ltd., Radnor House, 1272 London Road, London, S.W.16, England. Phone: POLlards 9199.
assemble or compile

Sir:

In the article, "Assemble or Compile?" by Christopher J. Shaw (Sept., p. 59), the numbers in the assembly and compiler language cost comparison seem odd—especially the computer usage rates. With these, programmers and analysts should go back to picking cabbages . . .

JEAN P. Hincelin
Paris, France.

Mr. Shaw replies: I re-checked the figures. They are not typographical errors, and unless the (standard) statistical programs that were used to compute them were buggy, they accurately reflect the costs of the sample programs. Of course, computer usage rate depends greatly on the speed of the computer, and program production rate depends on many factors, including application area (business programs seem to be considerably easier to produce than other types) and, in particular, program size (which seems to affect program cost exponentially). So I would not be surprised, in any given case, if the rates cited in my article were off by an order of magnitude—either way. But I must firmly reject M. Hincelin's suggestion that the people who build these programs would be better employed picking cabbages; I know some of them, and they are quite capable.

computer model numbers

Sir:

I enjoyed the article by K. E. Knight ("Changes in Computer Performance") in the September issue. His commentary on Grosch's Law is especially significant. But there is one area of research to which he gave entirely too little attention: the correlation between the performance of a computer system and its model number.

It is obvious that such a correlation exists, for we have seen the 701 grow into the more powerful 704, which led to the even more powerful 709. The same may be seen in numbers used by most manufacturers. But it is much less obvious how we should go about comparing the products of two different manufacturers who happen to derive their model numbers from different equations. (Or perhaps there is, in fact, one universal equation, and only the parameters are changed from one firm to the next.) Further, we seem to lack a theoretical basis for dealing with some of the more modern systems of notation (are 360 and 40 to be regarded as two components of a vector, or are they entirely incommensurate?).

Lest someone question the practical value of research in this field, I would hasten to point out that the very success of a product in the market place may turn out to be crucially dependent on the existence of a proper relationship between model number and performance. Who can say but what STRETCH might have been a resounding success but for the peculiar relationship of 7030 to 7010, 7040, and 7090?

Of course the ultimate goal of the research I have mentioned is the actual prediction of performance from knowledge of model numbers. If we can do away with the need for empiricism and wrest from Nature the secret of the correlation we observe, the effect on systems planning will be tremendous. There will be no need for benchmark problems or the evaluation of voluminous proposals. Think what it would mean if one could simply perform a few calculations on the model number of a proposed machine and arrive at the exact running time for his program! Or conversely, one could start with the statistics of his operations and derive exactly the model number of the machine he should buy.

No doubt the work of the product planner would be greatly simplified also. Ultimately we might hope that systems would come to be designed with sufficient modularity so that a machine having exactly the model number needed could be assembled rapidly from a catalog of standard items.

JAMES H. HAYNES
Phoenix, Arizona

2. The Klerner-May system has extended the development of the natural mathematical input-output format initiated by MADCAP. Both MADCAP and the Klerner-May system represent significant advances toward the full implementation of the language of applied mathematics as a computer language.

3. The wording of the fourth paragraph of the section on other conversational mode systems is unfortunate. It attempts a brief summary of the AMTRAN System and it should have appeared in the conclusion.

L. H. Wood
R. N. Seitz
J. Reinfelds
P. L. Clem, Jr.

PL/I: ouch

Sir:

Regarding Dr. Burkhardt's article, "PL/I: An Evaluation" (Nov., p. 31), I would like to make a number of comments.

Aside from an excessive number of syntactical errors in his examples as well as inventing a sequence statement, a delay statement and an I/O call option, Dr. Burkhardt appears to understand PL/I reasonably well. But, I wonder if he understood any of the motivation and philosophy behind the development of PL/I. There is no indication that he really understands what has been attempted.

Dr. Burkhardt's claim that a PL/I drawback is incompatibility with existing languages is incomprehensible. He is attacking PL/I for not achieving something which was never a design objective. Compatibility (in hardware, too) is not notable for its contributions to progress. How compatible was ALGOL 60 with ALGOL 58?

The limitations he mentions are not for all System/360 compilers but are, in fact, specific to the F-level (64K) implementation presently available. There is nothing inherent in the language to inhibit other implementations from selecting their own limits.

Dr. Burkhardt seems disturbed that
Engineers' and Management Surveys indicate:

STARTING SALARIES
OFENGINEERS
ARE DECEPTIVELY HIGH

By James M. Jenks

Two separate studies appear to contradict the commonly held belief that engineers today make out better financially than their colleagues who major in non-technical subjects.

The first survey polled graduate engineers; the second, company executives. The findings of these surveys indicate that the average engineer — despite a high starting salary — climbs fast but not far.

The need for technically trained men in recent years has exceeded the supply to such an extent that companies have been forced to bid for their services — to actually set-up "recruiting" offices on college campuses all over the country. Thus, starting salaries have gone up and up. But the income ceiling for these technically trained men is lower than for managerial personnel.

According to figures compiled by the Engineers Joint Council, the average engineer can only hope to earn about $13,000 a year. Even an engineer who is at the top of his profession (one whose salary is in the top ten per cent) earns only about $17,500 a year. In contrast, an American Management Association study shows that a middle management man can expect a maximum salary of between $20,000 and $30,000 a year in the larger companies. And, of course, a man who becomes a middle manager early in his career is still promotable. He still has the opportunity to reach the top executive level and earn much more.

This, of course, is not to say that engineering students would be wise to shift to the study of business administration — or that working engineers face a bleak future. Quite the contrary, the continuing growth of technology means that men with technical backgrounds are ideally qualified for the highest rewards industry has to offer — if they also have a knowledge of the underlying principles of business.

FREE . . . "FORGING AHEAD IN BUSINESS"

If you want to avoid the thorny barriers to success — if you're ambitious, determined to move up fast — send today for the Institute's 32-page descriptive booklet, "Forging Ahead in Business."

It explains what a man must know today to make $20,000 or more a year . . . what he must do to accumulate this knowledge. It tells why men of equal ability fare so differently in the race for better jobs and bigger salaries. It analyzes the causes of failure . . . the reasons for success. And it outlines an executive-training program which is so complete and so scientific that each day subscribers are brought a little closer to a mastery of business procedures.

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ALEXANDER HAMILTON INSTITUTE
235 East 42nd Street, New York, New York 10017

January 1967
the character set does not conform to the proposed ASCII set. The ASCII set is not particularly useful for programming; we who have lived with PL/1 for almost three years are more disturbed at X3 for attempting to foist this code on the data processing community. On the divergence between the PL/1 48 character set and that used by ALCON, I can only be thankful that we have selected the existing 48 character set. While it is no beauty, it is far better than the ALCON set. In any case one would hope that 48 character sets (such as ALCON) won’t be with us much longer.

More serious is Dr. Burkhardt’s statement about compiler performance and potential usefulness. First-cut compilers (incidentally not for the full language) are running. By whose measure do they perform poorly? Are we still measuring performance by cards per minute? (What’s a card?) Although few would claim that the current compilers are high speed, unsupported remarks about a first-try compiler must strike many people as competitive jealousy. I would remind Dr. Burkhardt that PL/1 is a rich, complex language that at best will never be as easy to compile as FORTRAN and, remember what FORTRAN was like in 1957?

On behalf of the user’s group which has spent time and effort on PL/1, we resent Dr. Burkhardt’s innuendo that we cannot be trusted. But, beyond this, we resent his remarks when he has made no contribution to PL/1 through one of the many public channels. For his benefit, the SHARE PLI Project will accept input from any source. Further, X.3.4.2c in its pre-standardization activity will accept his input. Both SHARE and IBM are actively supporting the X.3.4.2c activity, have been doing so, and will continue to do so. Dr. Burkhardt’s remarks have the tone of one who feels left out and unheard.

Since Dr. Burkhardt began his remarks by stating that “probably no committee will ever develop a really useful programming language,” I must stand in awe of his espousal of a Programming Institute to design, specify, and implement a language. There seems to me to be an astonishing piece of logic here: “A committee isn’t good enough so let’s have an institute.”

Philip H. Dorn, Manager
SHARE PL/1 Project
New York, New York

The author replies: The task of an evaluator, like that of a botanist, is not to weed out the flowerbeds, but to show which plants will be flowers, and which weeds. So the proposition that only contributors to PL/1 can be evaluators must be rejected.

From the developmental effort for a new programming language, I should have liked to see emerging not an all-purpose tool (similar to those from some junk-shops, which are not useful as efficient instruments), but rather one that generates special tools, or transforms into those, at will (stressing adaptability of the language more than a collection of language features in the design).

The “excessive number of syntactical errors” and language features are not invented by me but by the various authors of PL/1 manuals.

For example, the explanation of SEQUENCE, DELAY and I/O CALL option is found on pages 104, 81, 125, respectively, in the second manual from Ref. (2) of the article. Each version of the manual shows new additions and deletions, most of them rather unimportant for an understanding of the language. The manual referred to in Ref. (1) had not been available as a basis and is given only as the current version.

No excuse exists for poor program performance, especially if it is due to inadequate language design; performance is measurable, and to apply 1957 standards seems no longer appropriate.

Many people are unhappy about the ASCII code, but if it or its successor will be a standard, then it should be used by language designers. With the character set and elsewhere, I got the impression of too much change for change’s sake. Compatibility is a desirable goal, especially if available at little cost.

PL/1 appears in its incompatibility and level at this time like the latest and biggest Model T car: unable to use available parts.

binary diet

Sir:
I forward the limerick below, of my own invention, for publication:

There was a young man who,
with digits,
Made jolly green giants from midgets.
They ate tons and tons
Of zeroes and ones
But finally died of the fidgets.

Stuart Grover
Boston, Mass.

automatic abstracting

Sir:
In my article, “Automatic Abstraction of Legal Information” (Nov., p. 63), there is an omission at the bottom of the first column on p. 64. The article states that new text material would be annotated for immediate distribu-
“In-contact” disc memories store 50% more bits per dollar

Data Disc put the read/write heads in gentle contact with the disc in order to record 3300 F 's d' bits per inch of track. That’s twice the storage density possible with floating head memories, and it means that you get about 50% more storage capacity for every dollar invested in equipment. □ If you’re worried that head contact will cause wear, you ought to see the disc we’ve been spinning beneath in-contact heads for over 20,000 hours. The disc is not so much worn as polished, and it still reads out error-free data—just as we recorded it over two years ago. □ There are secrets to reliable in-contact recording, but we can tell you this much: we plate the discs with a thin rhodium armor to protect the magnetic storage medium. Then we polish the surface to a near optical finish that deviates from perfect smoothness less than 0.4 microinches A.A. The result is insignificant wear, and less than one transient dropout for every 10 billion bits.

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

January 1967
DATA ACQUISITION PROBLEM AT ARGONNE:
Process data received from on-line nuclear physics experiments fast enough to feed back results in real-time.

SOLUTION: PHYLIS (PHysics On Line Information Station).

Argonne National Laboratory wanted to process data from an on-line nuclear experiment and modify the experiment in progress using the results. Our system engineers helped Argonne solve the problem with special low cost peripheral device interfacing with a high-speed computer system.

Data links connect the computer system, two particle accelerators, a remote station, and other instrumentation. The PHYLIS System now permits Argonne to analyze low-energy experiments, calculate calibration distribution, and feed the information to other controls.

When your processing problems require a high-speed computer with a special systems touch, call or write to:
Computer Division — Electro-Mechanical Research, Inc.
8001 Bloomington Freeway, Minneapolis, Minnesota 55420.

GE STILL SEARCHING FOR LOSS-TRIMMING FORMULA

Although GE announced in November that it was laying off 450 people at its Phoenix plant, many outsiders claim the number is more likely 2-3 times that, with more cuts due worldwide. Many of the Phoenix folks are being offered jobs elsewhere in the Corp., and body snatchers and other recruiting vultures invading Phoenix say only "deadwood" is available there. The company says it's not cutting back marketing, but admits "adjustments" in some sales offices. Also, the Computer Research Lab in Sunnyvale is no more, with the work there either terminated or transferred to other locations. The company is reportedly re-evaluating its peripherals, may stop making its own tape drives, is looking for a new small disc source.

Not to be interpreted as a sign that GE is bailing out, the cutbacks instead are an attempt to reduce the corporation's staggering edp losses, estimated in some quarters as $400 million or more. One source says that GE's edp losses last year were 45¢ per sales dollar. Meanwhile the company continues to believe that a good GE-trained manager can manage anything, leaves the information systems division in the hands of management relatively new to the costly mysteries of the computer biz.

RCA, REI WIN TEXACO STARS

Texaco Houston won't confirm it, but it appears that the Texas oil company has awarded RCA its biggest commercial edp order yet, for six Spectra 70/45's with a purchase value of some $8 million. The contract may depend on the performance of the first system, due in next summer.

Recognition Equipment Inc. also landed a whopper with Texaco, an order for 16 optical character recognition units with a purchase value of $5 million. The first of the units will be installed in April '67. The second phase of the program will begin a year later when REI starts replacing nine of the current generation OCR machines with the first of nine bar code reader/sorters which will include an electrostatic ink jet printer. The computer-controlled units will encode account numbers on gas sales charge slips while they're being read.

TIME-SHARING FLOWERS AT PILLSBURY

While large-scale time-sharing continues to stumble, less ambitious T-S systems march forward. An unlikely and successful entry into the T-S service business is a subsidiary of the Pillsbury Company named Renown Properties. Using a GE 225-Datanet 30 combo, the company is serving 42 outside customers and 13 inside.

Operational since April, the system serves 27 high schools and colleges, offering seven hours of line time and a few thousand seconds of processor time for $100/month for educational-only use. Most of the schools use Basic, but Fortran and Algol are available. Commercial customers pay $350/month for...
“Special” Pulse Generators are made to order at TI. Modular construction allows assembly of the right building blocks to meet your requirements. Now, “specials” cost you no more, frequently cost less than conventional pulse generators.

For example, the 6613 is an economical general-purpose unit with PRF from 15 cps to 15 mc, priced at only $950. Another model, the 6325, is a ten-channel, word-bit programmable unit operating up to 25 mc. The single unit does the job of ten discrete generators, at half the cost, and fits in a cabinet 23 in. wide, 38 in. high, 18 in. deep.

TI Pulse Generators give you outstanding performance: PRF’s to 100 mc, fast rise and fall times, variable pulse width and delay, variable rise and fall times, plus and minus outputs, pulse mixing, programmed and random word generation. You have your choice of portable or rack-mounting cases.

When you need special pulse generator performance, choose one of the thousands of standard pulse generator combinations from Texas Instruments. For more information, contact your nearest TI Authorized Representative or write to the Industrial Products Group in Houston.
look ahead

25 hours of line time and 7200 seconds on the cpu.

Pillsbury and Renown Properties vp Jim Rude calls time-sharing "one of the most phenomenal tools" he's ever come across ... "and you don't need a big system. It's a good business," he adds. So good, that RP will set up three more T-5 bureaus as soon as its other three purchased 225-30's are freed by a GE 635 due to arrive in May.

Raytheon Computer, taking the long, slow route to profitability, thinks it will turn the bend into black ink next year by pursuing its rifle approach to vertical markets. Targets for next year: the graphic arts and retail point-of-sale.

In the works, being readied for announcement next year is a new line of products, including phototypesetting and manuscript editing systems. A large typesetting system, including a special-purpose computer and Photon 901, has been sold to the Times Mirror in LA. And the company has a deal with a Canadian retail chain, is developing an on-line point-of-sale recorder.

A portable, remote CRT/keyboard terminal with vector and character generators, and selling for less than $6K, is being developed by Computer Communications Inc., Inglewood, Calif. A buffer memory, the small controller relieves the CPU of the image refreshing job. And the CRT is a standard TV set; remove two wires and the ground and you can watch the Super Bowl game. The system comes with an interface for a 202 Dataphone or an acoustic coupler. The latter, they figure, will sell for less than $300.

The new systems house, less than a year old and headed by ex-CDC vp Robert E. Fagen, also has a multiplexer that'll handle up to 32 phone lines of mixed speeds. Also optional: lightpen, non-impact printer, and card and paper tape I/O. For a fee they'll also write the software to handle all this.

Staffed by 18 people, CCI is both a software and hardware firm in the time-sharing field. A current project is a real-time Fortran IV compiler for the Interstate 1010 computer (see Aug. '66, p. 17).

Communications costs are hampering the efforts of one pioneering commercial time-sharing venture. The company's northern California computer is linked to southern California terminals via a multiplexer located in Los Angeles. But the multiplexer is not accepted by the local phone company as a switching device (although that's its function), so transmission between multiplexer and terminal costs the user more than the rates between the two cities, a line which is part of an inter-state link governed by lower FCC rates. But the phone co. will now use existing facilities to offer substantially lower rates set up for a forthcoming service already tariffed.

Elsewhere, one big user says that the proposed increase in Telpak A & B rates may mean that he will have to convert 9 remote on-line 360/20's into stand-alone 40's.

Itrek, under contract to Hitachi, is producing a photo-optical printer with a 2000-character set -- useful in this application for producing computer output in Japanese. The set is on a microfilm belt, and output is at 300 lpm on photosensitive paper.

(Continued on page 125)
You won’t believe how much software comes with Sigma 2.

Sigma 2 is small. But Sigma 2 is serious. That’s why it has so much software. Enough, in fact, to make one computer do the work of two.

Sigma 2 is the only computer of its size that does multiprogramming. It does general purpose work in the background and, in less than 6 microseconds, can respond to a real-time foreground interrupt. And with a minimum amount of core.

A good computer never loafs. So we made Sigma 2 software powerful and modular enough to put every last bit of Sigma 2 hardware to work.

Starting software includes Basic Control Monitor, Basic FORTRAN, a basic assembler and a library of mathematical and utility programs. And, if you need more horsepower, we’ll add Real-Time Batch Monitor, SDS FORTRAN IV and an extended assembler.

Sigma 2 software is ready. We’re delivering software and hardware to customers right now. You’ll get yours the same way. Together.

Do you need on-line control? Plus general purpose computation? Maybe you expected to pay $500,000 to get the whole job done. Don’t. Sigma 2, software and all, starts at $26,000.

Sigma 2 lets you do very big things. In a small way.
HERE IT COMES AGAIN

One of our favorite George Price cartoons shows a wild-eyed man standing on the porch of what is evidently his summer cottage. He's strapped to the house by several strands of a vine, which is ominously wiggling its way around the corner toward him as his wife shouts, "Here it comes again!"

The same feeling may be engendered in computer users as they view the fresh January calendar on the walls of their offices around the world. The year 1966 will certainly go down in computer history as one of the most hectic and crisis-ridden since the Univac I lurched onto the commercial scene over 15 years ago; 1966 was—to be charitable—a year of slow deliveries, sluggish performance, sloppy support.

One man we know of ordered a 64K "third generation" machine which included only 32K when it arrived. When the second 32K module finally arrived, they discovered that the first memory module was wired in backwards. And somehow part of his system was shipped to somebody else, so he had to settle for some blue tape units to go with his red ones. Add a white console and he could compute patriotically. We've heard of another new installation where, when the operator logs into the system, it takes the machine 3½ minutes to compute and type out the time the day's activities begin.

With this kind of living third generation legacy branded vividly into the sensitive skins of so many users, it takes a special chutzpa, an almost savage sadism, to ask our readers to attempt to focus their pain-glazed eyes on the next generation yet. But then Datamation has always asked a lot of its readers.

We invite, therefore, your attention to a quartet of articles in this issue which attempt to sneak preview the fourth generation from the vantage points of a software expert, a pair of hardware designers and a consultant speaking for the user. A Datamation survey of how top computer specialists across the country envision the new breed is summarized in another article.

The purpose of the articles is not to divert your attention from current third generation toe-stubbings by hitting you over the head... or to pacify you with promises of better things to come. Indeed, as the cover happening created by Datamation Art Director Cleve Marie Boutell suggests, the fourth generation may represent a hodge-podge compromise of many of the elements which have comprised its predecessors.

We hope not. And we hope that the articles in this issue will focus attention on some of the preliminary characteristics of our next bete noire... helping users foresee if even fuzzily some of the things in store for them. You can bet that the manufacturers' product planners and system designers are already beginning to shape the new equipment. And it's not too early for users to begin to think about what they want, and to catalog some of their painful experiences born of third generation system inadequacies. Through their user organizations, they hopefully may have a stronger voice in the design of the new generation. Nor is it too early for the planners of the truly big information processing systems of which computer systems are only a part to begin to assess the scope of the critical problems facing our society, and to which information processing must address itself if it is to live up to its promise.

Basically, we want to avoid the cartoon situation in which the battle-scarred veteran of the transition to the third generation says, as he watches the fourth generation begin to snare him, "Here it comes again!"
FOURTH-GENERATION SOFTWARE

by ASCHER OPLER

On the assumption that the next generation of information processing systems should try to correct the shortcomings of its predecessors, let’s preface our sneak preview of the fourth generation with a quick review of the major general failures of third-generation software.

Third generation dissatisfaction centers on the disappointing price/performance ratio of the hardware/software combination (from now on we’d better say “software/hardware”!) and conversion difficulties. The disappointing performance is generally attributed to software.

At one time we used hardware price/performance ratio as a useful measure. When software became an indispensable part of hardware, we measured only the performance of the combination. Since the separate pricing of software is upon us (e.g., Sigma 7 COBOL), it is likely that we’ll soon be measuring software price/performance ratio. With this in mind, we can look at the price/performance ratio of the third-generation combination and observe that the hardware ratio is excellent but the combined ratio is generally disappointing.

The conversion picture is generally bleak. Those who used FORTRAN and COBOL heavily with second-generation equipment and those who can emulate their second-generation computer on their third come off well compared to those who didn’t use the two languages or who can’t emulate.

Projected fourth-generation computers

This article is based on one man’s guess about the next generation. The guess is that fourth-generation hardware will use large-scale integration (LSI) logic specialized by microprogramming. Integrated logic chips will be needed to obtain the required fast circuitry and the microprogrammed specialization will be needed to obtain the required software and user interfaces.

The elements of one of these computers might have these characteristics:

- circuitry (LSI) 5 nanoseconds
- micromemory access 10 nanoseconds (read time)
- main memory access 400 nanoseconds

In the most radical departure from present architecture, the computer would have no order set and no data structure. The computer would be specialized for the various roles it is to play by replaceable microprograms.

Third-generation microprogrammed computers are delivered with a pre-designed, pre-installed microprogram of the read-only type. And in most members of the product line, the option of an additional read-only memory carrying a second microprogram set is available. This second set serves to provide full or partial compatibility with the order set of an older computer.

In fourth-generation computers, many microprograms will be available from the manufacturer. Software and user specialists will also prepare and use their own. This should throw the whole field wide open.

To better understand the nature of microprogramming a no-order-set/no-data-structure computer, I believe it worthwhile to introduce a new word into our vocabulary: firmware. I use this term to designate microprograms resident in the computer’s control memory, which specializes the logical design for a special purpose, e.g., the emulation of another computer. I project a tremendous expansion of firmware—obviously at the expense of hardware but also at the expense of software.

Microprogramming has, of course, been known since the early days of computing. The principle is simple: build a small micro-processor and drive it with a stored microprogram.

Take floating-point addition as an example. In the first generation, it was performed with a normally-programmed subroutine. In the second generation, it was implemented in circuitry. In third-generation microprogrammed computers, the floating-point addition is performed using a microprogram stored in read-only memory.

A noted software specialist, Mr. Opler is executive director of Computer Usage Education, Inc., in New York City. He was formerly director of programming systems for the parent company, Computer Usage Co.
One major factor making this possible is the ratio between main memory access time and circuitry speed. With integrated circuits (IC) and now LSI, times have plunged to 1-5 nanoseconds while the access time of main memory has slowly declined. This allows 30 to 70 micro-steps to be performed by circuitry between each main memory fetch or store. These 30 to 70 steps permit the implementation of third-generation order sets.

The memories are called read-only memories but, of course, the contents had to be written once in order to "load" the memory. Today this is done as part of the computer fabrication process. For the fourth generation, extension to slow-write fast-read (SW/FR) memory is anticipated.

The interface between "normal" programs and microprograms comes via the operation code. In effect, when each instruction is decoded, the operation code calls upon a specific microprogrammed "routine" stored in the micro-memory.

To visualize the preparation of firmware, consider a special keypunch not available to software and user programmers. This punches 67-column cards (4 x 8 inches) with triangular holes (try that on your keypunch and card reader!). A special card reader loads decks of these 67-column cards into the fourth-generation SW/FR memory. This card reader probably will be locked so that only firmware specialists have access to it (we hope)! 

**what firmware can do now**

Even in the third generation, firmware is expanding the capabilities of hardware and software. Its effect on reducing the cost of hardware is central to third-generation economics. Unprecedented production rates with reduced requirements for system checkout and delivery are due to both integrated circuitry and to microprogramming.

Specialized versions of standard product line computers have been prepared primarily by altering the microprogram in the read-only memory. The most spectacular success has been achieved with all-hardware compatibility via a special microprogram. The success of the IBM System/360 Model 30 in running IBM 1401 programs attests to this fact.

Emulation, a combination of software and hardware, operates by using two different microprogrammed features. Basically, an emulator is an interpretive simulator made much more efficient by using a microprogram to perform the basic interpreting loop—fetch an instruction, decode the address, access the contents of the address and perform the indicated operation. In addition, the op-codes that are most time- (or space-) consuming to simulate are directly executed by microprogramming those orders into the micromemory. Emulation is, of course, required when the micromemory is too small to contain the entire order set of the second-generation computer.

An interesting example of the power of extending existing capability by microprogramming is the evaluate (EVAL) instruction added to the IBM System/360 Model 50 delivered to Allen-Babcock Computing Inc. This command is reported to evaluate a PL/I expression in standard form directly in hardware. Other added facilities include floating decimal instructions.

**firmware in the fourth generation**

Assuming the availability and accessibility of adequate SW/FR memories in the next generation, the entire hardware/software interface problems disappear only to be replaced by the more complex hardware/ firmware/software interfaces. First, there is the hierarchy of components and corresponding responsibility.

<table>
<thead>
<tr>
<th>Component</th>
<th>Responsibility</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Circuitry</td>
<td>Hardware Designer</td>
<td>Manufacturer</td>
</tr>
<tr>
<td>2. Micromemory</td>
<td>Firmware Specialist</td>
<td>Manufacturer*</td>
</tr>
<tr>
<td>3. Control Programs</td>
<td>Software Specialist</td>
<td>Manufacturer*</td>
</tr>
<tr>
<td>4. Processors, Utilities, etc.</td>
<td>Software Specialist</td>
<td>Manufacturer*</td>
</tr>
<tr>
<td>5. Application programs</td>
<td>Application Specialist</td>
<td>User</td>
</tr>
</tbody>
</table>

*and/or software (firmware) producing organizations.

Secondly, firmware will assume a dominant role in structuring the computer. Manufacturers could (potentially) supply firmware decks allowing their fourth-generation computer to execute the order set of most popular third-generation computers—their own and competitors'. There could be a standard fourth-generation industry-wide order set and data structure.

But an even more significant impact would be felt by software. There is a general consensus that present software is too large, too complex and too slow. It is in the tradeoffs between software and firmware that most price/performance improvement should be obtained.

Third-generation computers require control programs to resolve and handle interrupts, to control multiprogramming and input/output dispatching, and to provide useful services such as resource allocation and protection, etc. The demands placed on control programs by the hardware...
and by the user have forced the current programs to swell to enormous size with concomitant reduction in performance.

For fourth-generation computers, the answer will lie in using firmware for major portions of the control program functions and in using special features built into the firmware to facilitate other control program functions. For instance, one problem that contemporary software must solve is to provide flexibility so that any particular installed configuration can be used with "general purpose" control programs. Even though "system generation" is used to specialize a generalized control program for a given configuration, the resultant code often contains lengthy subroutines to handle such functions as resolving device error signals, providing special user error recovery or interrupting the processing routine. The point is this—to provide modularity and flexibility, manufacturers are currently forced to delegate obvious hardware functions to software since this is the only means by which the user of the computer can specialize it for his use.

In fourth-generation equipment using SW/FR micro-memory, microprograms can be prepared by the firmware specialist—manufacturer, programming company or even user—to carry out the specific interrupt and input/output control function specified by the user. This alone will go far to simplify control programs.

Further simplification can be obtained by making the data structure and order set work for, not against, the implementors of control programs. The basic implementation involves techniques of queue management, control block handling, table reference, internal sorting, pointer handling, etc.

Since microprogramming permits extensive data structuring for control program implementors, it will permit the addition of instructions to enqueue, dequeue control blocks build search and sort tables of specified structure, etc. These new commands should prove a boon to expediting the running of supervisory programs.

Time-sharing and multiprogramming both require very fast switching among programs. Many fourth-generation computer programs (processors and utility programs) will be written in the form of re-entrant code. The new hardware must be able to preserve the status of each user's computation and, when re-entrant code is used, to preserve blocks containing variables and other parameters. Currently much of this preserve/restore function is performed by software. Delegating this function to firmware should reduce the milliseconds performance time to microseconds.

Compilers and firmware

Last year, a paper by Melbourne and Pugmire described the design of a small computer for directly executing FORTRAN statements. The machine, which was simulated but not built, was "controlled by a microprogram held in a fixed store." Marketing men can determine the reception of a FORTRAN-only computer—but it is certainly one reasonable approach for the fourth generation. With SW/FR firmware, the FORTRAN microprogram can be read into micromemory—instead of the order set of a computer.

Short of a computer which executes programming language directly, firmware can add many features to fourth-generation computers to facilitate compilation and execution. Special instructions corresponding to the POP (programmed operators) of Digitek compilers can be microprogrammed to facilitate compilation. Facilities like the "hardware algorithms" of System/360 Model 91 can operate on object code to permute computational order and even eliminate redundancies. Direct execution of statements in Polish string notation—a technique first used in the KDF9 and B5000—can add to the power of new computers which handle programming languages with unprecedented speed and economy.

It is quite likely that the bulk of programs run on fourth-generation computers will be written using standard programming languages. These may be run in some multi-programmed (or time-shared) manner with other programs on a large computer run as a "powerhouse utility" serving many users—or on smaller "private" computers dedicated to a single application use (e.g., message switching) or the needs of a single isolated user (e.g., small engineering laboratory). The latter may very well prefer to use the FORTRAN-only (PL/1 only?) computer while the user of the dedicated equipment may find it to his advantage to start from scratch and write the central portion of his program in firmware using normal core (or thin film) storage only for bulk tables and transient storage.

Depending on the ease of preparing, debugging and loading firmware, the whole application area might be radically altered. But it will probably be worthwhile to prepare firmware only for real-time, dedicated applications where every microsecond (nanosecond?) counts!

At the present time, there is a limited supply of microprogrammers and a relatively small demand for such services. The only firmware under preparation is in the shops of manufacturers and is performed under careful supervision of hardware designers. Preparing microprograms is considerably different from writing programs. It requires a more detailed knowledge of the function of circuits and registers.

Automatic preparation of microprograms starting with some "higher" level language—like FLOATING ADD A,B—has not been achieved. However, as firmware becomes more important, increased effort to facilitate its preparation will certainly be made. Indeed, if some of the many roles that firmware is to play in the fourth generation are to be realized, a new generation of specialists must be trained and effective tools provided for their use.

Perspective

The following chart shows the relative effort (compared to the manpower involved in the production of the hardware of a computer) expended by manufacturers for different computer generations.

With increased demand for low-cost, high-performance total systems, the emphasis continually shifts to means of buttressing hardware to make it easier and more efficient to use. The third generation has seen the peak of the effort in software. No doubt the fourth generation will require equivalent effort—but placing much of what was software into the firmware area should go far to prevent some of our current difficulties.
FOURTH-GENERATION HARDWARE

by G. M. and L. D. AMDAHL

"... visiting the iniquity of the fathers upon the children to the third and fourth generation..." —Exodus 20:5

It has been recently discovered that a third generation of computer technology has been entered. With the clarity of this observation we need no longer obliquely ask what the trend is in computer hardware or software, but we can ask directly and forcefully, "What will the next generation bring?" Accepting the notion that there will be a fourth generation of computers (by the principle of binary powers, eight years after the third) the following observations and extrapolations are put forward.

The third generation of computer technology can be characterized as one of unification. An attempt has been made to unify in one computer structure the effective capability to perform commercial, scientific and real-time tasks. Time-sharing is being elaborately analyzed, with conversational mode systems in early use. Monolithic integrated circuits are coming into widespread computer use, but with their greatest potential yet to be realized.

To achieve software interchangeability, the concept of upward compatibility has been extended by some to include downward compatibility, giving rise to families of computers differing only in speed and price. Manufacturers such as IBM found that this could be accomplished only by drastic means—design of a totally new line of computers having basic differences from predecessor equipment. The transition to the third generation has therefore been arduous, with techniques such as microprogramming and emulation being employed and with complete new software being required.

fourth-generation hardware: batch fabrication

Computer hardware of the fourth generation is anticipated to be most strongly characterized by batch fabrication. In areas of logic circuits and high-speed memory, complex arrays of switching circuits on single silicon chips will be batch fabricated. This is referred to as large scale integration, or more simply, LSI. It should be noted that batch fabrication does not necessarily mean the concurrent fabrication of identical items; rather, it means the concurrent fabrication of many different items passed through identical process steps. This permits economically produced silicon chips to logically differ. While large parallel computers (such as the proposed Illiac IV) could have many identical chips, small computers would be denied this luxury. Therefore the economic production of many different kinds of chips would benefit the manufacturer of the small computer.

Integrated circuits offer benefits of batch fabrication both in the area of logic circuits and memory. The benefits of LSI for logic circuits will be reduced cost, greater density and greater speed. The limitations of LSI in this use arise in interconnections, heat dissipation and chip complexity. To use LSI, a problem of the first magnitude will have to be solved: the complete automation of chip design. This problem is vastly complicated if yield must be enhanced by adjustment of the interconnection pattern of cellular circuits as a function of test results.

LSI memories can be very high speed and can permit multiple-access use. Because select and sense circuits are fabricated by the same process steps as those used for memory cells, high performance memories are expected to be relatively inexpensive. An economic property of considerable advantage for small memories is the relatively linear cost per bit as a function of size exhibited by LSI memories. But these speed and cost advantages will not apply to large LSI memories. Another factor to be considered by systems designers is the volatile nature of the LSI storage cell, permitting loss of information stored when power is removed.

Other batch fabrication techniques for memories will undoubtedly emerge in each of the areas of wired ferrite arrays, woven plated wire arrays and thin films. Any of these will be suitable for large quantities of lower-speed random-access memories and would not have the volatile characteristics of the LSI memory.

Mass storage still appears to be dependent on electromechanical devices for lowest cost implementation. To a large extent this is due to the fact that batch fabrica-

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January 1967
tion is always easier to achieve when detailed structure is unnecessary, and the fabrication of the surface of a disc or drum is indeed batch fabrication of an enormous number of storage cells. However, the feverish activity in the development of static (nonrotating) mass storage will surely result in its use in fourth-generation equipment, particularly for systems requiring rapid information retrieval.

**architecture: an attempt to balance**

The economic consequences of batch fabrication are expected to have the greatest effect on fourth-generation architecture. Even in the third generation, processor costs are relatively low compared to other system cost factors such as I/O channels, peripherals, marketing and software. In the fourth generation this imbalance will tend to increase, with the system architect offsetting it by greater instruction capability, more processing overlap and parallelism, and additional hardware features for multiprocessing and multiprogramming.

The use of the high-speed LSI memory will tend to impose an additional level in the memory hierarchy. This will emphasize the need for semi-automatic control of memory, perhaps along the lines of paging techniques. We would expect that considerable emphasis will have been applied to this area due to difficulties incurred in third-generation systems. The problem here is to make the memory appear to the user as a very large and homogeneous virtual memory (techniques which permit viewing main memory as unrestricted by actual main memory limitations), yet without imposing virtual response and virtual solution times.

Basically the computer can only deal with information residing in real memory. It must in some manner be provided with instructions which, during its operation, can cause it to control the transmission of information between hierarchy levels with as much preplanned structure as is possible. In circumstances where preplanning is inadequate, multiprogramming must be able to fill the voids.

Failure to provide any preplanning would raise the level of multiprogramming, requiring memory capacity that would be considered excessive even in the era of batch fabrication. The solution time for individual large problems may become excessively long in a multiprogrammed environment, making the system unsuitable for this purpose. Algorithmic control, suited to access characteristics of data sets, will undoubtedly become important. The nature of the control would be governed by programmer specification or by recognition of historical referencing properties as determined by the hardware.

Another area of architecture is the employment of microprogramming to an extent that compiler languages might be optimized. In a companion article, Ascher Opler predicts a fuller utilization of this technique in the fourth generation and the emergence of firmware specialists.

The question of equipment dependability will come under careful scrutiny in the fourth generation despite the fact that LSI will offer high reliability. The reason for this scrutiny will be the customer's concern for nearly absolute computer up-time in time-sharing environments. While in the past he was willing to accept turnaround delays due to the computer being down, he will not accept inoperative on-line terminals. Partial redundancy, multiple processors and in-line diagnostics should result from this emphasis. With LSI, redundancy can more economically be achieved than with discrete components.

**software: more freedom**

The role of software has been changing from generation to generation. From an initial start of freeing man from dealing directly with the computer by the provision of input-output utility programs, the role has progressed from having to deal in absolute terms by means of symbolic program assembly, from having to deal in basic terms by means of macro assembly and compilation, and finally from having to deal with space-time boundaries by means of data-management programs and virtual memory. One of the current activities is aimed at freeing man from space and time separation from the computer by time-sharing.

One can speculate as to those freedoms which will be sought for the next generation. A number of likely candidates come to mind, many of which have been started and have varying degrees of progress. Some fairly basic ones are (1) freedom from redundant effort by means of macro libraries of programs and data sets in the information utility, (2) freedom from limited forms of man-machine communication by means of better techniques for the identification, extraction and display of meaningful information, (3) freedom from necessity to recognize the particular machine type being used by software standardization, and (4) freedom from painful recovery on machine malfunction by automatic detection and by maintenance of user transaction journals.

It is interesting to note that these freedoms contribute to a layer of basic concepts. These concepts relate the more abstract notions of computing to the detailed dynamic activity of the hardware computer. As more freedoms are added which release the user from primitive representation of his problem, he is further insulated from the hardware. This intervening software structure will develop into a capability for self-generation of programs for specific computational actions. Such programs will enjoy an existence so brief that they deserve a unique name, for which bubbleware is advanced.

One can deduce that significant overhead will be added in the execution of hardware functions as the user gains freedom in detailed program declaration. Despite this, the hope for fuller realization of human creativity will give continued impetus for this trend to greater abstraction.

**beyond the fourth**

It may be inappropriate to speculate beyond the fourth generation, but it appears that the logical conclusion to be drawn is that the ultimate goal must be freedom from having to deal with the computer at all. When this level of development has been reached, creative intellect will have burst its final shackles, free to wing to new Olympian heights.

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COMPUTING IN THE 1970'S

by R. L. PATRICK

(As our able editorial adviser pushed out into the future, he recalled some of the developments taking place since 1966 while enroute to a hypothetical 1973 FJCC...)

By 1968 the shock of IBM's System/360 had largely subsided. It had been an expensive experience for manufacturer and user alike. Multi-programming generally worked fairly well, but the software overhead was greater than expected. System generation was no longer the chore it once was, and software changes no longer came with disconcerting frequency. The users, while not quite euphoric, had licked their wounds, completed their conversions, and were generally happy with the product and the results they were getting. Some big shops had finally embraced PL/I totally and were working the bugs out of using a single "universal" language. Programmers were genuinely interchangeable, since they all enjoyed the same language and operating system. This, however, did not make them all equal since differences in technical background, experience, and ability were still very apparent.

In late '68 and early '69 the users discovered the benefits of modularity. The manufacturers have been making systems more or less modular for years. When S/360 and its counterparts hit, the manufacturers reaped many benefits immediately from the building block approach. In 1968 the user discovered that this could help him too. As a company's contracts fluctuated, the computing manager adjusted his configuration to match his load. The manufacturers responded by building popular equipment units for regional inventories to allow reconfiguring with ease. With the advent of multi-programming, the trimming could satisfactorily take place by adjusting the number of I/O channels and devices to allow fewer tasks to operate simult-
in the 1970's . . .

taneously. Thus, throughput and cost could be moderately changed without changing the cycle time of the CPU or affecting the unit cost for a specific application.

The shake-out of primary manufacturers continued and we lost several. Those that remain are stronger and better able to compete. Two of the also-rans have firmly established themselves as suppliers of consoles and I/O devices. They discovered that IBM's standard hardware interface allowed them to design to one electrical specification and penetrate the IBM community with sufficient volume to get the price down within reason.

The federal government's standards activity continued to wallow along until 1969. By that time the GSA had the world's prime repository of unwanted used computer equipment. Some dated back to the early '60s. The book value of the junk kept them from disposing of it, and the cost of storage soared. The original manufacturers kept raising their maintenance rates until some third party maintenance companies were formed. When this happened, the whole used market opened up. Trading became spirited and competition healthy. This was sparked, in part, by a thorough housecleaning at the BEMA shop in 1968. This resulted in industry assuming the initiative in standards and leading rather than holding back.

While all of this was going on, the users were not idle. One of the big aerospace companies developed a program which would translate from source language to source language, based on tabular descriptions of the two languages. When this was done three things quickly happened: the long sought program interchange suddenly became a reality, the table format required by this program became the language definition standard overnight, and a rash of application-specific languages sprang up. With easy translation, the user could use a convenient language for stating a problem solution and then turn the job over to the central program maintenance group who worked in a consistent single language.

By 1970 several large file-oriented systems had appeared which qualified for the title "data bank." These were large, integrated file systems serving multi-users in both on-line and batch fashions. The groundwork for these efforts had been laid earlier, but until the third-generation hardware and software had settled down, progress was slow, frustrating, and expensive. In 1967, applications analysts realized that basic files had to be built as part of some on-going process. Soon, fully documented "save" tapes started regularly appearing in the archives. Finally, when the tools were available, the files had been stored, and the data bank could be established. The whole thing threatened to flounder until a bright, young programmer teamed with a smart hardware designer to solve the restart problem without extended downtime or unnecessarily expensive backup provisions.

About the same time wisdom and light settled on BEMA, the professional society ice jam melted also. Enough of the founders had retired so that the societies were repopulated by members who considered computing and information processing to be their sole interest and not just a happenstance career. The societies restructured along lines devoted to hardware, software, and applications. Numeric techniques was one of the pillars of the applications group.

The software society absorbed both SHARE and GUIDE, which had merged in 1968, reorganized along software lines, and discarded their machine orientation, made obsolete by the 360. Each manufacturer still supported a small users group as a sounding board for his products, but the advent of true language standards allowed software to be handled at a level more professional than parochial . . .

Our observer arrives at the 1973 FJCC exhibits."

ROBERT: "Our business volume is holding well. We just got a new trillion dollar contract for another space station. Say, if you're going down to tour the exhibits, let's do the show together."

BOB: "It's good to get out of that crowd. Let's go look at those midget computers mounted in the typewriter stands.

ROBERT: "I'm glad that panel decided these could be considered as a computer, a desk calculator, or as a console depending on how they're used.

"Now, isn't that nice. A computer with 16K memory, add time of 10 microseconds, and modified typer . . . all for $5000."

BOB: "What I like best is the flexibility. The memory bus is brought out to these connectors so we can just plug in this software loader box and preset the software in the Hold-Tite store. That's one way to get the price down: leave all that unnecessary stuff out. Of course, I suppose the price of circuits and core has come down by a factor of 25 in the last 7 years.

"If you get a loader box for each machine it's only $1500 more, but then it can have several software packages and a basic operating system. This will really solve some of our problems back home."

ROBERT: "We have two uses for it right now. That little design group over in the Test Hangar needs a limited amount of computational gear with a customized application language on it. We could set them up for $5K and write the compiler for the big machine. Once we wrote and checked out the compiler at Central we could put it in Hold-Tite and let the Hangar crew work by themselves. It gets rid of that requirement for a secure communications crew to maintain the comm-link from the Hangar to Central.

"The other need I know of is for shipping. We could hook two of them up in tandem to handle the rating and routing function. One typer would have those special forms that have to go with every shipment. The other would be the I/O keyboard for the pair. The clerk can input the load description, measurements, and scale readings. The computer will compute cube, tons, best way, and charges. It can also edit the input and format the output on the slave. If we get stuck and run out of memory we can either buy a loader box for holding rate tables in read-only form or use that acoustic coupler to make the tandem a satellite to the Central."

BOB: "I'd forgotten about that acoustic coupler attachment to the Touch-Tone Fone. With that jack on the side of the new phones, the coupler and the auto-dial can signal over the normal audio phone circuit to Central. You can get it for $100 with no installation charge.

"Let's go find those Immense-Files next."

ROBERT: "Wow! Look at the crowd. I wonder if we'll be able to get close enough to see them work? The advertising brochure claims the Immense-File is to the bulk file what the bulk file was to the drum. I guess that's about right. The Model I Immense-File holds 15 billion bytes in one module and the mechanical part only takes 4 square feet of floor space."

BOB: "I guess the part I like best is the price. It rents for $1500 per month, and the control unit only costs $1000." Let's see. Back in 1966, we could get 800 million bytes on-line for about $6K per month. Now, if we install two Model I's on a single control unit we have 30 billion bytes on-line for only $4000 per month. Say,
that's enough capacity at a small enough price to put that
ing engineering technical library on-line, isn't it?"

ROBERT: "Yes, that will easily fit. Those reports average
only 50 pages per document, and there aren't but 10,000
of them. If it were all text, that would use up about a
fifth of the capacity of two modules, but since we've got to
digitize all those graphs and pictures, it probably would
take about a half of the twin modules. That would even
leave us 15 billion bytes to hold some of that test data
they keep crying about because it takes us too long to
find the tapes in the archives and get them hung. The
test engineer gets tired of sitting at his console before
we get the data displayed for him.

"With our new publications system, we can build those
technical document files as a by-product of the publication
process. In about three years we'll have the most inter­
esting documents stored in the single Immense. We'll prob­
ably have to go back and pick up about 10% of those old
reports to complete the file; some of that stuff never
seems to get too old to be of interest."

BOB: "I wish we could get close enough to see the re-
moveable cartridge. I'd like to see what handling problems
they've built for us to solve this time. Since this crowd
doesn't seem to be getting any smaller, let's move on and
come back later. Maybe we can get a private showing
since we think we've got a legitimate application."

ROBERT: "Hey—there's a booth over there with absolutely
no customers. The contrast is amazing."

BOB: "Oh yes, that's the Bell Tel booth. I think that's
made every show for the last ten years in the same form.
That big map of the United States with the lightning
flashes shooting between those telephone handsets leaves
me cold."

ROBERT: "The only thing that's changed since we first
saw them back in the '60s is the lads giving the sales pitch.
If you change them often enough, they can maintain their
sincerity since they don't know they're falling behind two
years every year."

BOB: "You'd have thought after that fierce fight over the
touch-tone modification that the Bell System would have
loosened up a little bit and recognized that the computer
was here to stay. It's amazing how the chief engineer
fought against modifying the touch-tone handset so that
an inexpensive acoustic coupler would just be plugged into
a jack."

ROBERT: "Yes, that made a big difference, so I guess
all the fight was worth it. I'd like to see the charters for
public monopolies changed somehow so the design
laboratories of the major manufacturers could cooperate
with the big utilities to get a balanced design.

"Do we need to go look at those new graphic terminals
over there, or can we see enough from here?"

BOB: "I think I know as much about how they work as I
need to know. They haven't changed that keyboard/CRT/
hard-copy-printer unit for several years now. I guess the
main change in the last year is getting the price down to
$5K purchase."

ROBERT: "We installed one of those earlier terminals, and
by the time we got through adding the light pen, the scope,
and the plotter, all of the special electronics it took, we
had almost $6,000 a month going out for a single
station. That was a little steep just to give a few engineers
the opportunity to fool with graphic displays.

"We ended up scheduling it so tight that the engineer
could hardly afford to think at the machine. Fortunately,
these new ones will rent for about $120 a month installed
and all they need is a pair of twisted copper wires. That
makes installation a lot less than it used to be when we had
to put in multiconductor coaxial.

"I think the price on these things is finally coming down
to a point where the normal engineer can get access to one
whenever he wants to without too much trouble, and can
keep it as long as he needs it. With these prices, we can get
graphical ability out to the design areas where it's needed,
and still support them centrally with our multi-CPU. I'm
really looking forward to getting some of those Immense-
Files on-line so we can hold enough drawings in detail to
make up a complete assembly. That should make a big
difference in the way we handle engineering changes."

BOB: "Did you see those new optical page readers that
can scan a variety of documents and fonts and transmit the
data to Central over a twisted pair? They have a programmable
digital computer in them just about like the one we
saw in those reactive consoles a while ago. The font rec­
ognition and document format are all completely pro-
grammable—based on tables stored in core. The output is
that same acoustic coupler to the touch-tone that made
the satellite consoles so popular.

"With the monthly rental getting down to about $200
we may finally be able to collect our primary input data
directly from the fundamental documents and eliminate the
keyboard's step that's always cost so much. If we put
three of them in shipping and receiving, and back that set with one of those new Quik-
Dek's, that's enough capacity at a small enough price to put
files on-line so we can hold enough drawings in detail to
be isolated and corrected easily."

ROBERT: "That paper on the new master operating system
this morning was interesting. I was glad to hear a user
instead of the usual manufacturer. Users are always more
candid than salesmen. Evidently he's finally getting good
operator information so he can figure out what's going on
while the machine is processing several jobs simultaneously.
As a by-product of this he's getting decent accounting in-
puts for billing purposes. He said he had trouble getting
the system installed initially, but that the thorough set of
audit trails they built into the system allowed the troubles
to be isolated and corrected easily."

BOB: "I was glad to hear that the fail-soft system qualities
were really delivered as promised. We've been living on
borrowed time for several years: with our file storage
getting bigger and bigger, and those multi-user data banks
growing by 10% per year. I wince every time I think of
what a catastrophic failure costs us. I still remember that
time when we had 200 consoles operating and lost the
master index tables to the work files. One thing led to
another, and it took us 63 hours to get back on line.

"With this new system working as well as he said it
did, I think we could go ahead and order those Immense-
Files ... I think the days of the catastrophic failure are
now behind us."

ROBERT: "The multi-CPU shared-storage hardware al-
lowed us to have systems which could reconfigure them­
selves dynamically in the event of a malfunction. Techn­
ically, we owe a lot to the early work done on nuc and
the old FAA system. They finally showed us how to build
hardware-software systems which would really fail in
stages and not in one big heap."

BOB: "Yes. Those same examples helped us design commer­
cial hardware that reconfigures very nicely in case of a
component outage. If we can believe that speaker, the
problem can now be solved by changing a few tables and
selecting the right pre-stored module. Maybe we're ready
to think about going on line with that second batch of 500
consoles now.

"I liked that other paper this morning surveying hard­
ware architecture features. It seems that every major manu­
facturer now carries some form of compatibility as a fundamental design objective: the 32-bit, register-oriented, variable instruction length machines, based on the 8-bit byte.

"If I understood him, some of them have true hardware compatibility but others have found it sufficient to build a machine which is logically similar so that programs devoid of I/O can be automatically translated from one to the other. The panel discussion left me kind of cold though. I don't really see that the definitions of 'compatible' and 'logical subset' were worth all that time and effort."

ROBERT: "Well, even though they couldn't agree, I know what it means to me. If I have to put any more than 10% of the initial effort into moving from machine to machine, don't bother to send the salesman by to tell me about it. And even if the instructions are completely identical in format and function, if it won't take my file organization or if they fool with the sort order again, just forget it.

"We're already up to the point where most of the cost is in the I/O devices and files. If they gave me a CPU, they couldn't cut my rental more than 5%; I'd just as soon concentrate their efforts elsewhere."

BOB: "Well, it looks like they've done quite a bit with this new 'triple-vote' modular design. They'll guarantee 95% up-time on all that electronics even if you have only one module. With the new design you can put in the redundant unit and cut the mean time to repair down to 8 minutes. But if you really need the reliability, you can go for that three-processor option with the special control and they'll give you that 'Lloyd's of London' policy that will reimburse you for the indirect losses you take based on less than 100% reliability. Boy, that must be reliable stuff.

"We might want to consider putting in one triple-vote system to handle communications, switching, and the message queueing if we decide to get those Immense-Files and put that second 500 consoles on line. With a thousand people on line, we can show a hard saving of $10,000 an hour just in people-time waiting for us to get the system back on line. And this doesn't include anything for the graphics, processing, and data we might have to re-enter or regenerate in case we collapse completely."

ROBERT: "If we go to that second 500 consoles, we'll surely have to pick up the on-line engineering change system, and that carries with it the responsibility of running the manufacturing plant. Management would probably be delighted to have the triple-vote system just to get that Lloyd's insurance covering us against possible business loss.

"The new modules have simplified building control systems out of these general purpose modules. Depending on the box it's in, one of these memory-logic modules can be a part of that souped up console, reduce the cost of the existing intelligent graphic terminals, or control the scan in that optical page reader. The same unit would also support those on-line medical experiments we're doing in the lab because it interfaces so nicely with analog sensors and digital control devices. They really did well when they got 16K core and 10 microsec add time in a hermetically sealed super flat pack the size of a 3-ring notebook. The power required is so low we can run it off those little thermo-electric sources or the rechargeable cells that have that optional solar face on them."

BOB: "Should we go to that session tomorrow on the user's report describing his experience with the new software? It sounds very interesting."

ROBERT: "I read the preprint and I'd like to attend. He thinks they've finally figured out how to build modular software which is subsettable based on your needs and machine size, but has almost the performance of custom written code. The paper didn't describe exactly how they do it. I hope they explain it in the talk."

BOB: "Didn't the announcement say that part of the modularity lets you routinely change the orientation of the system from real-time to teleprocessing to batch in any combination and with any emphasis?"

ROBERT: "Yes, that's what they tried to tell us. This user maintains they did it and both kept the performance up and the program size down. Furthermore, they have a new language definition for action languages.

"Remember back in the mid-'60s—some of the more theoretically inclined managed to state and describe procedural languages in terms of grammar and syntax? Well, some similar work has just been completed on action languages. They've put some of that same theory to work and come up with a definition of action languages to handle control of the computing system, communications with the operator, all the I/O device actions and scheduling, and the sequencing of processing we used to call job control. It now has some harmony to it, which we've lacked for several years. Matter of fact, I hear it's even easier to understand and has only a few exceptions."

BOB: "Well, if they've managed to do that and also include all those data base handling facilities we've heard so much about, it really ought to be a fine new system. I'm looking forward to the panel discussion after the user talk because I want to ask some questions about these new contract terms.

"Sam Dollar of the Executive Finance Committee heard we were thinking of switching to the fourth generation and sent for me the other day. He pulled out the file with the financial audit of our conversion to third-generation. He had those conversion costs recorded to the penny. The true costs of the conversion were posted to one account and he had two other accounts showing the costs due to the late hardware and the costs due to the late, sloppy software. He made it very clear to me that he wasn't about to approve any expenditures for fourth-generation equipment which didn't include contractual guarantees on the part of the manufacturer. He told me I could order whenever I wanted, but when he signed the contract it better have firm dates for hardware and software with enumerations of required functions and stipulations covering minimum acceptable performance.

"Somewhere he heard we'd been simulating how our proposed workload would pan out in fourth-generation equipment. He advised me—if I couldn't think of a better way—to include that simulated performance as part of the contract.

"I'm going to lay that contracting question in front of tomorrow morning's panel if I have a chance."

ROBERT: "Let's get a drink. What do you think we should have done in the late '60's to have been better prepared for what we saw today?"

BOB: "Well—let's see. We should have wired that new plant so we could put in a private digital communications network independent of the phone company; placed some restrictions on applications programmers so they wouldn't aggravate the conversion problem by using all of the features of the programming languages just because they were there, kept the descriptions for all those old files we stored so we could figure out the tapes if we ever had to re-read them. I wish I had attended that seminar on assigning functions in multi-computer systems. We should have hired that young guy who knew so much about file organization and integrity. There are several more, aren't there?"

ROBERT: "Yes, I have a few more; but first, where was that DATAMATION cocktail party?"
THE NEXT GENERATION

In an effort to find out what some experienced computer people think may happen with a fourth generation of equipment, the DATAMATION staff prepared some questions and solicited answers. We learned, first, that the people we questioned are surprisingly patient and thorough in taking the time to conjure up ideas about such an ambiguous subject. The questions were divided into three sections, covering hardware, software, and some users' viewpoints.

THE HARDWARE

First, let's try to get a handle on the fourth-generation computer. How will you know one when you bump into it? If a consensus of our respondents is any indication—and it should be—the one hardware technology that warrants the fourth generation billing is large scale integration (LSI). (They're quick to add, however, that price per logic function will be a principal factor in this determination.) "This technology (LSI) will have a far greater impact on computer architecture and software than did integrated circuits in the third generation," says a member of a semiconductor house.

While not yet willing to grant that LSI will lead to a computer on a chip, our correspondents variously describe the future of this young upstart as "fantastic" and "extensive." Also "good, measurable, but not revolutionary." This statement, though, is contradicted by still another, who says... "No doubt but that LSI will revolutionize the computer field—not only in terms of cost, reliability and size, but also the complexity that becomes reasonable to achieve and the applications that can economically be put on computers. However, this impact will be limited until software and I/O problems are solved, and this may take a long time."

Perhaps some of this will be taken care of by what Ascher Opler in this issue calls "firmware." We asked to what extent software will become imbedded in special hardware. As expected, the answers ranged from "very little" to "very much." The idea is appealing, they say, but the technology to achieve it economically is doubtful. Among the optimists here, the anticipated firmware functions include subroutines, in-line diagnostics, and I/O systems, but not operating systems and compilers. "This will depend upon how much true standardization evolves."

What about the top circuit speed in Generation Four? Forecasts ranged from 10 nanoseconds to 500 picoseconds, but most estimates were for a propagation delay per gate of 0.5 to 1 nsec. "I do not foresee major increases in top circuit speed, but optical processing might contradict this forecast," said one. The sub-nanosecond speeds predicted here compare with the 5- to 20-nsec per logic level being achieved in today's hardware.

Today's memory hierarchy—only speeded up—may still serve in the next generation; the use of thin films is referenced by only a few, the associative memory was mentioned by only one, and "biological devices for the intermediate level" got a vote. The most clearly delineated hierarchy: "registers and multiple or general registers implemented with integrated..."
"...after lunch we went to a demonstration of a great idea...an electronic writing tablet that allows you to write actual instructions to a digital computer. Know what they called it?"

"Oh, that's the commercial version of the 'Rand Tablet' built by Bolt Beranek and Newman's Data Equipment Division. They call it the GRAFACON® 1010A, and it's one of the most advanced developments in the man-computer communication field. Some people are using it with pattern recognition programs for writing information into computers—just like writing a memo, with a resolution of ±0.005 inch at writing speeds up to 40 in/sec. In production data processing operations, it'll digitize graphic and pictorial data without the inconvenience of mechanically-restricted cursors, shaft encoders, A/D converters and the like. It's even built for rear-projection of graphic information from film. I know a company that uses it as a highly-flexible keyboard—touch a spot on the tablet and it serves as an operator command to the program."

BBN/DE also produces GRAFACON interface circuitry for card punches, paper tape punches and digital magnetic tape recorders; PDP-1, PDP-4, PDP-8 and CDC-160 computers; IBM 2250 display consoles; and Teleputer time-shared computer consoles. Write us for complete details.

The CPU organization may be in for a radical departure, if a slim (58%) majority of our counsellors has its say. They turned right around, however, and voted down the idea that parallel processor organization, such as Solomon, might come into use. One said parallel processors, yes, but not like Solomon. Although not ordinarily considered "organization," the idea that multiprocessing would come into its own in the fourth generation received a definite "yes" vote. Implied in this is the growing knowledge that we still don't know how to multi-process, but we will soon.

How soon? When will you get your first chance to collide with a fourth-generation mainframe? Fifty percent said between 1971 and 1975; 25% said as early as the end of 1970; the rest didn't know. Among those who predicted the earlier date—by the end of 1970—was the one designer who said he'd know one when he saw one because its new technology would be cryogenics. He's not to be ignored. That man's name is Fred Brooks.

software
In asking our patient respondents about software for the hypothetical fourth-generation equipment, we made certain (doubtless debatable) assumptions about the nature of past and present programming. It was assumed that first-generation software included machine-language programs, subroutines, and assemblers. The second generation added higher-level languages, monitors, and macro-assemblers. The second generation added higher-level languages, monitors, and macro-assemblers. The third generation brought operating systems, conversational time-sharing, multi-programming, and data management systems.

Considering these developments as characteristic, we asked, what will the fourth generation bring?

One of the most interesting things about the responses was the discovery that there is a clear consensus of opinion about some aspects of soft-
The first question asked if the respondents would "expect" fourth-generation computers to be accompanied by a radical departure in software. There was about an equal split of yes and no answers, with two people noting that they "hope so" but don't really expect it. A few others pointed out that software development tends to be gradual and is not likely to be closely tied to a new generation of equipment. In fact, "fourth-generation hardware is likely to be adolescent when fourth-generation software is born." There are some feeling that the user might have software allowing him to define his own language, while another said that "we'll be lucky to have truly second-generation software with our fourth-generation hardware."

Another virtually even split between yes and no answers resulted from a question asking if paging techniques will come into common use. But some said "cheaper mass stores will win."

A question asking if English-language programming would become a major factor drew a variety of interesting comments, although a majority voted either "no," "it's doubtful," or "I hope not." Several respondents saw it as a growing and significant factor in certain applications, such as information retrieval. And one of those saying yes put it this way: "It must if the computer is to become an everyday, commonplace business and household machine—and I'm sure the manufacturers want to see it become just that." One of the best answers on the negative side: "No. Natural language compiling is unnatural."

There was general agreement among those surveyed that nonprocedural languages would be of growing importance, although some felt that progress would be very slow. One comment: "Nonprocedural languages have been a sought-after convenience since the early fifties . . . Everyone was and still is looking for that software package which allows you to say 'Do payroll' . . . the user would describe only the problem parameters in terms of environmental conditions to the software systems which in turn would grind out a maximum solution to this particular problem. One could wonder whether the parameters concerned with supplying the problem description would not be as overpowering and burdensome as the actual programming requirement is."

Our respondents also had some vigorous comments on what methods will be used to maximize processing efficiency in an information utility using fourth-generation equipment—including the opinion that there won't be any information utilities doing processing; they will just serve as data banks. Some think that the best method would be fragmentation of applications into special-purpose, dedicated utilities—such as credit information, legal information, etc. But several answers reflected the viewpoint that rising computer speeds and shrinking cost would make processing efficiency a minor problem, compared to the present.

How should information security be handled in an information utility? "Very carefully" is a fair summary of the answers. Some methods suggested: a pattern-recognition device that can recognize fingerprints; a true book code, or private language, instead of a cipher; time-dependent codes; remote data storage at the user's location; individual scrambler/descrambler keys; voice recognition.

Suggestions were requested for types of planning that would simplify future conversion efforts. Typical recommendations were thorough documentation ("overdocument"), use of higher-level languages, and continuity of languages by the manufacturers. There is also some feeling that users can't stand another conversion—that further changes must be evolutionary, considering the massive size of some applications programs even now.

A related question was also asked: "Will there be an 'OS 360 backlash' that will lead users to insist on less complicated software?" Although one respondent said the question contains a false implication, is loaded, and is unanswerable, it provoked longer and more lively answers than any of the other questions. A large majority think there is and will continue to be a demand for simpler software—but many add that it should be simpler only in terms of user convenience, not function. Several people foresee more customized systems coming, closely tailored to fit a user's needs. Some of the more bitter comments: "By the time the . . . backlash . . . gains any momentum, the large-scale machine users will have implemented their own operating systems" . . . "OS is completely compatible; it makes the Mod 75 run like a Mod 30" . . . Some think, however, that the problem illustrated by OS 360 can be overcome, given better check-out, training manuals, and general customer support.

There is strong agreement that software for a new generation of equipment should not be confined to a single, standard language—unless it were some sort of macro-language that allowed users to develop a special dialect fitting their own needs. An accompanying question, asking about critical bottlenecks with present software, resulted in such descriptive phrases as "trying to satisfy everyone . . . compromises between conflicting goals . . . attachment to 1957-vintage compiler . . . ponderousness."

We also asked if manufacturers will be selling software separately from hardware. There was no clear-cut consensus in the answers, but a majority think this is likely to come about—restricted to special cases. Many mentioned the recent announcement by Scientific Data Systems that conor, will be sold separately as evidence that the trend is starting. A few said that the federal government will force the issue. Other responses: it's more likely to be done by separate companies. It was also suggested that separation will come about only if the patent problem is resolved. One other idea: design the machines to keep track of software use automatically and charge for it; then the price would be separated from the hardware cost no matter who wrote the software.

Our last question: "What sort of software would you like to see?" A brief summary of the replies: smaller conceptual jumps, standard format and documentation, more debugging aids, easier to use and maintain, simple and conversational.

Besides offering some ideas for the future, perhaps the variety of answers to our questions about what the computer community wants will give readers some sympathy for the problems of the manufacturers.

Some users' views

Then there's the ever present user, tormentor and tormented, who must struggle through the conversion to each new group of machines—sprouting greyans over things like down-time, complex operating systems (and delays), new compilers and delays and programmer education, acceptance tests, core memories wired in backwards, the wrong color on his tape unit, and a boss who wonders why they didn't buy the all purpose 720/140 just announced which sounds like tomorrow but won't be here until later, if then.

This is not to indicate more than that each change of equipment has its attendant problems. A survey of veteran computer users shows they felt the current generation of equipment brought a hoard of advances over the previous one: improved cost/performance; larger, high-speed
main memories; higher capacity, lower cost random access devices; less down-time; wider choice of peripherals; greater multiprocessing capability; expandability and compatibility of computers in a family, more sophistication at a lower mainframe level (i.e., multiprogramming, teleprocessing, online terminals, graphics, etc.); increased use of operating systems in OLRT environment; development in file management systems; program compatibility at assembly language level; emulation ("in our experience, the first really complete preservation of programming"); and who said "greater IBM profits"?

And almost to the item, the next generation, due by consensus between 1971-75, should have improvements on these improvements. Users felt that what essentially will shove a system into a new era is a mainframe that increases speed by an order of magnitude over what's now available, increases internal mass storage to the billion-character range, and decreases cost (thin film and cryogenic core are offered). Other hardware wants are larger, more reliable, cheaper random access storage, although this is seen by one user as less important if internal memory is increased and improved; larger varieties of special purpose remote devices, including 3-D and color displays, handwriting and voice input terminals. Although many felt some peripherals should be speeded up by two-four times (5,000 lpm electronic printer, 600 KC discs), the emphasis was on lower cost, greater reliability, and, for the printer, increased capability (character sets, multifonts) and quality. High-speed, low-cost communications, definitely a lack currently, will be vital for the activities of any coming generations. One user called for low-cost high-bandwidth microwave links to centralized facilities for more powerful time-sharing systems. Better communications interfaces are also required.

No, software is not being avoided. It was the most popular answer to the question on critical problems still evident in third generation systems. The tally really isn't in from the field yet on this generation, but users reflected the disgruntlement with the delays, the debugging and education problems, inadequacy of manuals, the cost of conversion. Some answers for the next machines were offered, such as more software functions being built into hardware, less operating system for the average user (some feel they have a lot more computer than they can figure out how to use). Definite wants are for fourth generation compatibility with the predecessor family, and for separation of hardware and software pricing "so we'll know what we're paying for." Half surveyed thought this separation was really coming.

The idea of a universal language was appealing to some, simply because conversion problems would phase out and a vast pool of programs would become available to users of differing systems. A stable basic source language for each system seemed more practical, and most users are content to settle on improving what exists, rather than "compounding the confusion."

The last dampering word on software was offered by a dp director at a major insurance firm, "Assuming problems of reliable operation of hardware are solved, there is little real promise of simplification of program writing and system construction. This may be fine from the point of view of more jobs for people, but it's not so fine from the businessman's view of lower cost operations."
This 16-bit, real-time computer multiplies faster, has a faster throughput, and costs less than the Sigma 2.

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

We tripled the memory of a Bryant Series 4000 Disc File during the three-day F.I.C.C. in San Francisco. Just as we said we would. Without a clean room. Under the critical gaze of the thousands who witnessed our demonstration. You can bet there are a lot more Bryant Believers today. Write for the full Bryant Computer Products story, 850 Ladd Rd., Walled Lake, Michigan.
A fully automatic software translation system called XACT (X stands for any computer, Automatic Code Translation) has been under development at Celestron Associates, Inc. since 1961. A large portion of this development has been supported by the Rome Air Development Center of the Air Force. The version of the XACT translator that is currently operational is designed to translate IBM 7090 programs into equivalent CDC 1604 programs. It is implemented for operation on the CDC 1604. The generic XACT system is capable of program translation between any pair of computers; in fact, it is possible to build a translator that will operate between several source machines and several target machines.

XACT requires as input the source program in source machine language, the program loader that loads it into the source machine, and a description of the data that the source program is intended to operate upon. The translator then performs four major operations without further human assistance: (1) acquisition of the source program, (2) identification of all instructions and data that belong to the source program, (3) analysis of the source program to produce a machine-independent description of the functions performed and, (4) target code compilation.

Although each step in the process is important, the really significant events take place in analysis. Analysis elicits the gross operations that the source program performs by a process of contextual analysis in the environment of the source machine logic structure. By performing such analysis, it is possible to differentiate the relevant from the irrelevant operations within the context of a particular program. It is thus possible to delete operations that are performed in the source machine by virtue of its logical design, but are not necessary for execution of the program. Since analysis yields a machine-independent description of the functions performed by the source program in the source machine, the compilation phase of translation is free to make the most effective use of target machine hardware.

The possibility, therefore, exists of generating very efficient target programs. Software translation is inherently capable of target machine execution efficiency superior to the best emulation scheme that can be implemented. The reason for this is that translation need not blindly follow source machine logic as emulation does. Translation yields a machine language program that runs directly on the target machine and takes advantage of its hardware features. The disadvantages of simulation and emulation are bypassed, fewer machine level operations are performed and hence the throughput capacity of the target machine is preserved. A one-time compilation run is required.

During the second quarter of 1966, the first live test cases were run on the 7090/1604 translator. Current tests indicate that translation of a 100-instruction program in the worst case requires approximately one-half hour of 1604 time. This is a conservative result and it should be noted that the 7090/1604 translator is intended to demonstrate feasibility of the XACT translating algorithm and to act as a research and development tool, i.e., it was not intended to be a production program.

Test results thus far indicate not only that program translation can be accomplished, but that quite good target code efficiency can be obtained. The target program in the 7090/1604 case can be expected to be larger than the source program by 25% to 1. Actual target programs range from 2:1 to 3:1 in number of locations and 3:1 to 6:1 in number of instructions. We consider this very good for the first large scale implementation. Moreover, it is clear that target code efficiency can be nearly doubled by replacing the one-pass compiler which is currently part of the system. Subsequent production translators will be designed for speed and utility.

**problems and advantages**

Automatic programming translation is among the most difficult of programming tasks. It, therefore, requires considerable effort to produce a software translator. In time, techniques will improve. At the current stage of development it is estimated that a single translator of the 7090/1604 class requires about 10 to 15 man-years of programming effort. It is anticipated that within a year the level of effort can be cut in half, and reduced even further as implementation is well within the economic ballpark of current computer art.

The greatest advantage of automatic program translation is that source and target machine differences become unimportant to program compatibility. The programs in question here are applications programs, not "software." It makes little sense to translate a compiler, for example, because the translated compiler operating on the target machine will diligently produce object programs for the source machine, not the target machine. It is, of course, possible to translate the output of such a translated compiler to produce a target program. For applications programs, the availability of software translation eliminates the need to design compatibility in hardware. Competing manufacturers need not produce similar or identical machines if programs can be easily and economically translated from one machine to another. Thus the unfortunate

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*The author wishes to express his unbounded gratitude to the team of first rate analysts and programmers who have made major contributions to this most difficult project. F. Jeanne Oswald, co-inventor of the XACT algorithm, R. Dykaar, S. Bornfreund, E. deDufour, J. Voiers and P. J. Kaufman, constitute a technical team of outstanding talent and accomplishment.*

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**President of Celestron Associates, Inc., Valhalla, N.Y., Mr. Oswald is a senior systems analyst, physicist and software specialist. He is co-inventor of the XACT translation algorithm and has extensive programming experience. He holds a BS and PhD in physics from New York Univ.**

January 1967
trend toward industry uniformity can be reversed and competition returned to design ingenuity.

It would indeed be unfortunate if all future machine designs were tied to a de facto standard dictated by competitive market ing considerations only. The interests of users would best be served by design variety produced by freedom from hardware compatibility restraints. At the same time, large user investments in programming can be protected with translating capability.

It should not be expected that automatic program translation will have an immediate impact. Rather an evolutionary movement from software simulator to emulator to software translator can be expected to occur. There is every reason to expect that the generation of computers following the current crop will feature automatic program translation as part of their software packages. It is also reasonable to expect that such translators will have characteristics similar to those of Celestron's XACT system.

program run examples

The material in Figs. 1 through 4 are excerpts from the results of a translation run. *Fig. 1 is the source program listing, Fig. 2 is a 7094 dump following execution on the 7094. Fig. 3 is the automatically generated target code in 1604 COCOAP and Fig. 4 is a portion of a 1604 dump after execution of the target program.

Fig. 1 7094 Source Program

TEST CASE NO. 1

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<tbody>
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<td>00200</td>
<td>00000</td>
<td>00000 HPR</td>
</tr>
<tr>
<td>00201</td>
<td>00000</td>
<td>00000 HTR</td>
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<tr>
<td>00202</td>
<td>00000</td>
<td>00200 X</td>
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<tr>
<td>00203</td>
<td>00000</td>
<td>00201 HTR</td>
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<tr>
<td>00204</td>
<td>00000</td>
<td>00202 HPR</td>
</tr>
<tr>
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<tr>
<td>00206</td>
<td>00000</td>
<td>00204 HPR</td>
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Fig. 2 7094 Dump following Execution

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<tbody>
<tr>
<td>00200</td>
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<td>00210</td>
<td>HTR</td>
<td>36</td>
<td>24</td>
</tr>
<tr>
<td>00220</td>
<td>TZE</td>
<td>223</td>
<td>TRA</td>
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<tr>
<td>00240</td>
<td>-300005100242</td>
<td>TRA</td>
<td>235</td>
</tr>
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Fig. 3 1604 Target Program

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<tbody>
<tr>
<td>00012</td>
<td>750</td>
<td>77777</td>
<td>TRANS</td>
</tr>
<tr>
<td>00013</td>
<td>200</td>
<td>000000</td>
<td></td>
</tr>
<tr>
<td>00014</td>
<td>200</td>
<td>00214</td>
<td>STA</td>
</tr>
<tr>
<td>00015</td>
<td>200</td>
<td>00212</td>
<td>STA</td>
</tr>
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<td></td>
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</table>

A simple program was chosen to conserve space and permit the reader to analyze the results with relative ease. Intermediate outputs of the translator, i.e., the tables produced by Source Code Scan and the meta language produced by Analysis are left out. These intermediate results are of interest but require considerable explanation for interpretation.

It will be noted that the source program occupies 4610 7090 locations, and the target program occupies 14610 1604 locations. The 1604 carries two instructions per word but, because of restrictions, not all possible instruction locations may be utilized. The target code contains 20010 instructions as against 3110 source code instructions for an instruction ratio of 6.4 to 1. It is to be expected that a conversion from 7090 to 1604 by any means would yield a target code that is larger then the source program in terms of instructions in the ratio 2.5:1 or 3:1. It would seem, therefore, that the actual XACT results could be improved. An examination of the target code produced will indicate a number of redundant stores/restores and such items as provision for arithmetic overflow which are not part of the source program. An improved meta compiler can reduce the target code to approximately 11010 instructions for a ratio of 3.5:1. These results are quite good for a prototype. The lessons learned thus far indicate that future translators will produce target programs that run at or near machine speed ratios. Speed of translation is under two seconds per source program instruction (1604 time).

Although this illustrative program is not complex, it presents some interesting features. The source program deals with three overlapped arrays. A first loop clears the array and two succeeding loops fill half the array each. It will be noted that the arrays are properly related in the target code. Furthermore, while the 7090 version decrements, indexes and stores the arrays "backward", the target code reverses the arrays and increments the indexes. Further tests and expansion of this prototype translator are under way. In addition a production translator (GE 200 to GE 600) is well under way and several others including IBM 1400 (source) are in the planning stage. ■

*For copies of the full printout, contact the author at Celestron Associates, Valhalla, N.Y.
CONVERSION AT LOCKHEED MISSILES AND SPACE
by DOUGLASS A. WILLIAMS

Lockheed Missiles & Space Company (LMSC) operates one of industry's largest centralized computation centers, processing administrative, data reduction, and on-line computer work. In order for this work to be accomplished efficiently, LMSC performs a continuous evaluation of computer hardware and software systems with respect to its processing requirements.

In June, 1964, the LMSC Computation Center technical staff undertook a major computer study aimed at replacing one of the center's four IBM 7094 computers. Several criteria were applied to this study including: (1) increased capacity over an IBM 7094 computer by at least 2:1, (2) total machine costs not to exceed one IBM 7094, (3) delivery schedule for September, 1965, and (4) a reasonable software conversion plan. All major computer manufacturers' systems were considered with a preliminary selection of four prime candidates resulting from these criteria. These four were IBM, Univac, Control Data Corp. and General Electric.

A three-month intensive study of the four candidate systems was performed during the summer of 1964 and included consideration of hardware characteristics, software capability, price/performance evaluations, delivery schedule, and support functions. A special program entitled Automatic Computer Evaluation (ACE) was used as an aid in computing performance curves on each computer system configuration. Inputs to the program included memory speed, tape speed, drum/disc access time and transfer rate, base shift rental, extra shift costs, work-load estimates, etc. Output from the program included cost/performance figures by configuration.

In September, 1964, the evaluation team selected the Univac 1108, LMSC management approved the recommendations, and an order letter was issued. The plan called for replacing one 7094 with an interim 1107 com-

preparation

In October, 1964, plans were formulated for the conversion of the workload of a 7094 (approximately 500 hours per month) to the 1107/1108. A project manager was designated by the computation center management to assume full responsibility for this effort.

Four professional programmers, selected from the LMSC scientific computing staff, and four programmers provided by Univac constituted the conversion task force. During the ensuing six months, many other programming personnel (both professional programmers and open shop FORTRAN programmers) contributed to the conversion efforts.

Univac provided courses of instruction covering the topics of 1107/1108 FORTRAN IV, SLEUTH II Assembly Language, Exec II Operating System, and Introduction to the 1107/1108 System. These courses were quite valuable and provided a proper base for the conversion tasks. Additional training was provided in areas of computer operations, Left (conversion of FORTRAN II to FORTRAN IV), and data file conversion.

Training aids included machine listings of the systems software, flowcharts and narrative material on the system, programming notes and manuals from the Boeing Company (an 1107 user), and technical bulletins prepared at LMSC on areas affecting program conversion. These technical bulletins described pertinent hardware differences between the IBM 7094 and the Univac 1107/1108, control card setup for Left translation of FORTRAN source decks, and data conversion routine usage for reformatting of 7094 data tapes to 1107/1108 format.

workload survey

A necessary step in the conversion process was identification of the 7094 workload by: (1) individual job, (2) programming language, and (3) computer time and number of runs per month. A computer program, which summarized this information in report format for each of the desired categories, made the task of selecting programs for conversion much easier.

Survey forms (shown in Fig. 1) were prepared and distributed to the user departments to identify active jobs, provide programmer name, location, phone extension and pertinent information concerning each particular program. Information requested on the survey form included: (1) non-standard subroutines used, (2) use of machine-coded subroutines, (3) program overlay or chaining, (4) non-standard input/output usage, and (5) availability of source deck, source listing, and test case data input.

conversion effort

To initiate the conversion process, a letter was distributed to all affected departments in the company (approximately 50 separate departments). This letter described the computation center's plans for replacement of the IBM 7094 with the Univac 1107/1108 and included information concerning costs and savings of conversion, programmer training, schedules, and assistance, to be provided.

Lists of active jobs (programs) pertaining to each department were provided to the department manager for his perusal and suggestions for selecting programs to be converted. Selection criteria included: (1) projected life-span of a program, (2) degree of FORTRAN to FAP (7094 FORTRAN to FAP).
Assembly Language) code, (3) production status of a program and (4) amount of machine time used by a program.

With the selection of programs underway, a parallel effort was initiated in the systems software area. Commonly used subroutines under the IBM 7094 FORTRAN systems were identified and compared with those available from Univac for the 1107/1108 machines. It was concluded that approximately 12 subroutines existed on the IBM 7094 system which had no counterpart in the Univac 1107/1108 system. These included special subroutines for controlling magnetic tape input/output, data conversion, time clock, and random number generation. Reprogramming of these routines was initiated.

In addition to this, LMSC required complete reprogramming of a 7094 subroutine package for the S-C 4020 plotting device. This consisted of seven FORTRAN and 21 FAP subroutines. One LMSC programmer and one Univac programmer (with no prior familiarity with the S-C) completed this task in two calendar months. The approach taken in this subroutine conversion was a "one-for-one" transliteration from 7094 FAP to 1107/1108.

**Fig. 2 Conversion Worksheet**

<p>| Summary |
|------------------|------------------|------------------|------------------|------------------|</p>
<table>
<thead>
<tr>
<th>Job ID</th>
<th>Start Date</th>
<th>Completion Date</th>
<th>Total Machine Hours</th>
</tr>
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<tbody>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Total No. of Compiles</td>
<td>Job Returned to Customer</td>
<td>Job Held for Further Analysis</td>
<td>Type Job (Group 1, 2, 3, 4, or 5)</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
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</tbody>
</table>

**Detail**

<table>
<thead>
<tr>
<th>LIFT Completed</th>
</tr>
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<tbody>
<tr>
<td>1st</td>
</tr>
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<td>2nd</td>
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<table>
<thead>
<tr>
<th>FORTRAN IV Compile Completed</th>
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<tr>
<td>1st</td>
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<td>2nd</td>
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<td>3rd</td>
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<td>4th</td>
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<table>
<thead>
<tr>
<th>Execution Completed</th>
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<tbody>
<tr>
<td>1st</td>
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<td>2nd</td>
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<table>
<thead>
<tr>
<th>Machine Time (.01 of Hours)</th>
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</table>

SLEUTH II assembly language code for the 21 FAP subroutines while the 7094 FORTRAN subroutines were converted to 1107/1108 FORTRAN.

Finally, the systems group prepared an in-house 1107/1108 systems manual for use by professional programmers and open shop programming personnel. This manual included information on hardware configuration, control card formats and options, data file conversion, program conversion, accounting standards, and library subroutine abstracts. The LMSC S-C 4020 Manual, originally written for the IBM 7094 user, required no significant change because of the compatibility programmed into the Univac 1107/1108 version of these routines. The Univac FORTRAN IV manual and other related manuals constituted a complete set of documentation for the user.

With all necessary systems subroutines converted or in the process of conversion, adequate documentation and training well underway, and the criteria by which programs were selected for conversion established, the major effort commenced two months after the conversion decision was made.

Selected FORTRAN II programs were sent to the Project manager to be reproduced and the original source decks returned. Test data were requested in those cases where execution of the converted programs was planned. The reproduced FORTRAN II source deck was then set up for machine translation using the Univac LIFT program (a version of the SHARE internal FORTRAN translator) which reformats FORTRAN II programs to FORTRAN IV and produces a diagnostic listing on those statements not translated. Stacks of programs were set up by the conver-

January 1967
A thousand words

To get the whole picture about how our media conversion systems can save you computer time (which means money) you'll have to read most of the following thousand-or-so words. It'll be worth your while.

Our premise: The work of translating punched-card or punched-tape data into the kind of electronic information your computer can understand is too often done on a peripheral computer which really ought to be doing better things. And in some instances, the main frame itself is being used for this time-consuming chore.

Our solution: Do your media conversion off-line. Our paper tape-to-magnetic tape and punched card-to-tape systems were designed specifically for this one job. By putting your data on magnetic tape and feeding it to your computer in this pre-formatted fashion, you increase your data input rate so dramatically that you may effect main frame time savings as high as 50%.

The systems: We make three basic media conversion systems; one (P/T) handles paper tape-to-magnetic tape; the second (C/T) converts data from punched cards at speeds of 800 or 1500 cards per minute; the third MCS "COMBO" combines the abilities of both the C/T and P/T, alternatingly handling punched paper tapes and punched cards.

How they operate: Our media conversion systems are adaptable to any form of punched tape or card input. The P/T system accepts 5-, 6-, 7-, or 8-level paper tape in virtually any code. The paper tape reader handles 1000 characters per second; yet it stops between characters to let the magnetic tape unit record an accumulated data block.

The C/T systems read 51- or 80-column punched cards in column binary or Hollerith code. Cards are read column-by-column by a photodiode read scheme.

The outputs from the P/T or C/T units are identical: data blocks written on magnetic tape according to the desired length and packing density, in either 7- or 9-channel magnetic tape format. And every single data block is completely free of conversion errors.

A series of built-in checks during conversion assure you that no main frame computer time will be wasted on erroneous input information. The following sequential operation charts demonstrate how each step of the conversion is carefully checked:

---

Increase your main frame data input rate by a factor of 120!

Your punched card or paper tape direct input rate to the central processor is, at best, 1,000 cps; typical magnetic tape input rate is 90,000 to 120,000 cps. You can see that it makes sense to put your raw data onto magnetic tape with an off-line media conversion system.
If you are doing data conversion on your computer, compare the savings possible by doing it on an Ampex media conversion system.

The time and money savings you can expect from an Ampex media conversion system are difficult to project on an across-the-board basis because of many variables, but if you study the charts above you can get fairly good "ball park" ideas.

Chart I illustrates paper tape-to-magnetic tape conversion costs for three different computer systems. It is based on weekly processing volume in hours, and costs of this processing are shown in relation to the per-month cost of the system. We have also charted the approximate monthly rental cost of our P/T 1000 system. You can see that the break-even points are where the lines intersect. If your computer costs are not shown, it will be simple for you to interpolate its monthly cost and find your own approximate break-even point.

Chart II compares the main frame time required to input raw data from paper tape with the time required to input the same volume of data from magnetic tape. It is easy to translate time saved into dollars. The time and dollar savings illustrated in these charts for the P/T system are similar for the C/T system. We will be glad to study your current procedure and demonstrate what our media conversion system could mean to you in savings of time and money. Just drop us a note.

Lease or purchase: Low cost lease plans and a very attractive lease-purchase option plan fit the financial circumstances of many users. They permit you to begin using this money-saving system without tying up capital.

If you want to purchase your system, the prices are as follows: the P/T system, $26,800; C/T systems range from $28,900 to $39,500, depending on the card speed you want; MCS "COMBO" system sells from $50,600 to $58,000, again depending on card speed desired.

We realize that data conversion, as we are performing it with the Ampex P/T and C/T systems, is a fairly recent development and that there are many more details you will want to know before you can put them to work for you. We will be glad to send you (or bring you, if you wish) complete descriptive literature on our systems. Please fill out the coupon below and mail it to Ampex Corporation, 401 Broadway, Redwood City, California 94063.

Gentlemen: I am interested in details about data conversion to magnetic tape from □ punched tape □ punched cards □ both media.
Please send appropriate information. □ Have salesman contact me. □ My telephone number is: ____________________________
NAME__________________________
COMPANY__________________________
ADDRESS__________________________
CITY__________________________ ZIP__________

AMPEX

January 1967
CONVERSION...

returned to LMSC by 10:00 a.m. the following morning. These stacks were separated and, in some cases, programs were returned to the original programmer for analysis and necessary changes. On most programs, the conversion task force examined the LIFT output, corrected those discrepancies or errors identified by LIFT, and placed the corrected FORTRAN IV source deck into the stack for compilation by the 1107 FORTRAN IV compiler. In general, one pass of the program through LIFT and two compilations by the FORTRAN IV compiler sufficed to generate a reasonably error-free FORTRAN IV program, ready for test execution on the Univac 1107. When more serious errors did occur, they tended to fall into one of three categories.

1. Machine-dependent coding – Use of octal constants to represent Hollerith or numeric information required manual conversion; certain “programming tricks” based on 7094 hardware/software peculiarities required manual alteration.

2. Incomplete programs – Missing subroutines, missing test data, errors in program or test data, etc. Problems in this category were normally repaired by the cognizant programmer.

3. Differences in output results – This was most frequently attributed to arithmetic differences between the 7094 and 1107 but also included mathematical subroutine differences and alterations in conversion of decimal numbers to binary.

The conversion task force programmers became quite proficient in discovering these errors and making the necessary changes. When all observable errors had been corrected in the source deck, the associated test data for the program were included and the program was submitted for execution on the Univac 1107. If some of these runs varied widely. Some programs initially failed to execute due to the discrepancies noted above; however, in the majority of cases, execution was effected and results compared favorably with those of the IBM 7094. In some cases, programming changes to the logic of the program (or mathematical model) were necessary to compensate for hardware/software differences.

On major LMSC programs (particularly those in excess of 2000 FORTRAN statements), a substantial amount of reprogramming and reorganizing of the program was done in order to fully utilize the increased capabilities of the Univac 1107/1108. (The IBM 7094 was a 32K-word machine with two magnetic tape channels, while the replacement Univac 1107/1108 was a 65K-word machine with two magnetic tape channels and two high-speed drum channels.)

Frequent contact between the conversion task force and the various company departments, combined with quick turnaround of programs in the conversion process, contributed greatly to the success of the effort. A review of some of the statistics from LMSC's conversion will indicate the scope of the effort and the cost of this conversion.

statistics of conversion

Attempts were made to keep accurate figures on the conversion effort. In addition to the previously mentioned program survey forms, a conversion worksheet (see Fig. 2) was maintained on each program and notations were made concerning any problems encountered, the number of machine runs required to successfully convert, etc. A COBOL program provided reports on detailed machine processing statistics associated with all IBM 7094 program runs allowing the project manager to identify candidate programs for conversion.

Approximately 220 programs were submitted to the conversion task force for conversion. A few programs required special handling due to their security classification or specialty area (e.g. APT numerical controlled machine applications) and were converted outside of this effort; however, it is felt that these constituted less than 10% of the total. Also, programs which were in a development or checkout status (rather than production) were redacted from the IBM 7094 to the Univac 1107/1108 in most cases.

The conversion task force effort began in late October, 1964, and concluded in March, 1965; however, additional conversion work by the various departments continued.

Costs of this conversion (summarized in Fig. 3), were shared between LMSC and Univac.

machine usage statistics

Installation of the 1107 (in the same physical area as its predecessor, the 7094) required approximately one month. During this period, the entire 7094 workload was processed on the three remaining 7094 computers.

The success of LMSC's conversion to the Univac 1107/1108 can best be judged from the initial machine loading statistics shown in Fig. 4. As these figures show, workload on the 1107 rose sharply in the beginning weeks of operation and after three weeks, a second shift was initiated. After fifteen weeks of operation, a full three-shift operation was instituted.

One phenomenon of this conversion was the absence of an equivalent displacement of workload from the 7094.
to the 1107; that is, elapsed 1107 run hours increased in higher proportion than the decrease in elapsed 7094 run hours. Three factors contributed to this: (1) the 7094 is slightly faster than the 1107, hence the converted programs take slightly more time on an 1107; (2) the newly installed 1107 provided improved turnaround which allowed for frequent submittals of the same programs; and (3) new program development work was directed to the 1107, thus increasing its load. With the replacement of the 1107 by the 1108, the increased capacity and throughput of the 1108 provided an estimated 2.4:1 improvement over the 7094.

Conclusions
There were several factors which led to the successful conversion at LMSC. A brief summary of these is given below:

1. The Univac 1107/1108 and IBM 7094 are both 36-bit, fixed-word length, binary machines with compatible magnetic tape and similar arithmetic, thus making the change in hardware less severe than a change to a different machine design. The Univac 1107/1108 (which is internally four to five times faster than a 7094) was ordered with a 65K-word core memory (the 7094 had 32K words) and secondary drum storage which provided additional capacity for segmented jobs and expanded machine facilities for prospective users.

2. Software for the Univac 1107/1108 had been in the field for over two years and was thoroughly tested. The Fortran IV compiler and exec II Operating System were considerably more powerful and of better design than their counterparts on the IBM 7094.

3. LMSC has, for several years, directed new programming and modification to existing programs toward the Fortran language. The conversion benefited from this since the selected workload included over 90% pure Fortran jobs and less than 10% in machine language.

4. Excellent conversion software including the Lift translator and a tape file conversion program was supplied by Univac. This allowed a major portion of the program and data conversion to be processed by the 1107.

5. LMSC management designated one man as conversion project manager and gave him full responsibility and the resources necessary to accomplish the job. The project was scheduled for six months and qualified, professional programmers (four from Univac and four from LMSC) were designated as the conversion task force.

6. Quick turnaround (overnight) of conversion runs on the 1107 allowed the task force to deal with 20 to 30 separate programs per day.

7. LMSC costs for the conversion were absorbed into the computer pool which consists of operator labor, systems programming, and equipment rental. In this manner, the conversion costs were prorated to all users at an increase of less than $18 per hour of chargeable computer time. Using this method to underwrite the conversion eliminated budgetary planning problems for the many departments affected by this effort.

Present Status
In April, 1966, LMSC reinstated its conversion task force in preparation for the installation of a second 1108 in July, 1966. This conversion effort includes not only Fortran programs now running on the remaining IBM 7094's, but machine language programs as well.
SAFEGUARDING TAPE-STORED DATA

by PAUL R. EDELMAN

The disastrous fire that swept the Pentagon computer area several years ago bluntly alerted computer personnel to the vulnerability of tape-stored data in situations involving high temperatures. In a more recent illustration, 150 tape files stored in a fireproof safe escaped a fire that destroyed a computer facility in an Indiana corporation (see Datamation, Oct., p. 125).

Most installations, from their inception, had employed some system of back-up for master files and other important taped information since it was logically assumed (and quickly confirmed) that anything as small as a magnetic bit might occasionally become a victim of dust particles or rough handling. However, extensive protection against damage by fire was not generally in evidence for several reasons:

1. Most of the early computers were installed in minimal facilities. Industrial installations, for example, were usually made on plant or office sites, often in existing buildings, retaining such fire protection provisions which had been considered adequate for the structure's original purpose.

2. Computer loadings increased rapidly, far beyond expectations, necessitating greater tape storage than was planned initially. The overflow storage areas were often created with even less attention to fire security.

3. Prior to the advent of magnetic tapes, records were contained on paper, and fire protecting equipment, such as safes and cabinets, were designed to prevent valuable documents from charring beyond legibility. Those devices, however, were not adequate for the safeguarding of plastic tape reels which deform at a temperature significantly lower than that required to destroy paper. Even the most efficient four-hour safe, adequate for the protection of paperwork in most fires, was found to be of little use for tapes because it was ingeniously designed to release steam internally when the concrete-locked water particles in the safe wall reached the boiling point—fine for paper, but destructive to plastic.

4. Early computers, such as the Univac I, used metal tapes stored on metal reels, which were obviously able to withstand higher temperatures than the plastics that came later.

5. Finally, computer center fires were uncommon, for computer centers themselves were few.

Whatever the reasons, many computer people re-evaluated their tape storage procedures after the Pentagon fire and sat down to figure out a way to rectify their deficiencies.

At the East Pittsburgh Westinghouse Computer Center, we were no exception. As one of the first industrial users of large-scale digital computing equipment for dp and scientific purposes, we were inevitably subject to some of the conditions described above.

Our original computer was fully loaded in less than four years, necessitating storage space for two million feet of metal tape. Subsequent progression to higher-powered, more capacious computers was accomplished by a change to Mylar tape on plastic reels and an increase in footage until we currently store about seven million feet. It should be pointed out that, with today's greater tape densities, this represents an increase in bit storage of about 2800%.

Foresight and Analysis

Fortunately, a degree of foresight combined with access to considerably more than average available space for construction of a building to house our computers, per-
mitted inclusion of a 5000-tape capacity storage vault. But even with a building made of non-combustible materials and well furnished with fire extinguishing equipment, it was impossible to ignore the thought of the chaos that would certainly result if our tapes were destroyed.

Analysis disclosed that our vault contained tapes which fell into three categories. A sizable portion were those which had been used to produce reports in one-shot runs and these, along with a certain number of new tapes, introduced on a turnover basis to compensate for normal mortality, were waiting to be reassigned to use.

Others, such as program tapes, had reconstruction possibilities from printed or punched-card back-ups stored in remote areas. Loss of tapes in these two categories would certainly be serious, in view of lost time and replacement costs of around $100,000. But loss of the remaining 10% of our tapes would be catastrophic. These tapes, numbering less than 300, included regularly updated master files, accumulation and the like—necessary to the factory, controlling inventories, producing payrolls and maintaining vital records required by law. Also in this class were some of the more dynamic tapes of computer programs, usually extremely lengthy and complicated by frequent alterations and patching: therefore difficult to reconstruct from source material. We concentrated upon this final category containing the indispensable types for which all reasonable protection must be arranged.

There are three ways to prevent the loss, by fire, of tape-stored information:

1. Prevent the fire or inhibit its advance to serious proportions.
2. Shield the tape by surrounding it with something impervious to the fire and capable of keeping the transfer of heat to a level sufficiently low to avoid damage.
3. Arrange to always have the information where the fire is not.

Preventing or inhibiting the fire denotes the use of non-combustible building materials and interior furnishings, convenient access to fire-fighting equipment, and rigid adherence to fire-prevention rules. While these provisions are worthy and certainly should be mandatory for computer areas, there is always the chance that some deviation, such as the introduction of combustible material, might occur which could result in flash fires. At this point in our analysis we met the requirements generally but we were reminded of the times we had heard of fires in "fireproof" buildings.

Protection of tapes stored in an area where fire has advanced beyond the initial controllable stage involves the use of fireproof storage devices. Safe manufacturers have responded to the unique requirements for tape protection by developing a new kind of fireproof safe in which the possibility of steam damage has been remedied through the use of special internal linings. Some of the problems still remaining in connection with the use of safes for tape storage include the relatively high initial cost, a forfeit of operating convenience, and the necessity for constant enforcement to keep the doors closed.

remote location

Having the data where the fire is not is a solution undeniable appealing, but also possessed with certain obstacles. Granting the insurmountable difficulty in attempting to predict the scene of a fire, this approach indicates the storage of duplicate sets of information or back-ups in separate areas, based on the enormous odds against the probability of separate fires occurring simultaneously. Such a system entails making duplicates or saving the back-ups and setting up a procedure to select and transport tapes between areas on a regularly scheduled basis. It also promotes an increase in tape inventory, as well as a demand for additional floor space.

After carefully examining each of the three possibilities, we decided this last one was best suited to our conditions and desires. The problem of establishing a remote storage location could be solved simply by the installation of several tape storage units in the air-conditioned, humidity-controlled area of another computer room in a separate building approximately 500 yards distant—far enough away to be considered "remote" but near enough to permit easy transportation of tapes. Since the other computer organization was faced with a similar problem in tape security, we were able to promote a reciprocal arrangement whereby we would store some of their back-up tapes in return.

Delivery and pickup of tapes on a schedule could be assigned to our tape librarian, and since the route could be traversed without exposure to weather, because of a series of inter-connecting covered passageways, no special provisions would be required in the way of transporting equipment; a standard tape cart would do the job.

Before putting the plan into operation, some background work was necessary. Programmers and tape users were notified of the proposed system and requested to identify and briefly describe tapes which they felt should be included in this ultra-vital group. The list which resulted was reviewed and authorized. All instruction or program tapes designated were duplicated and the copies were stored in the remote area; the originals, of course, were returned to the main tape vault. The tape users were supplied with identification which would locate each tape, and were advised that upon request the librarian would produce the copy for revision if changes were to be made to the original.

the grandfather system

The handling of master-files which are updated at regular intervals (some daily) presented a somewhat more complex problem. The grandfather system already in use involved the retention of three sets of tapes for each application: the latest updated master file, the previous master file and the updating information, and the grandfather set which was used to produce it. Rotation of the three sets was effected so that the grandfather set became available for use as output tapes to receive the next updated file—which would then be the youngest set.

The purpose of the grandfather system is to provide a margin of safety through rerun capability in the event read failures are encountered with the current master file. With the new system, a fourth set has been added and the rotation scheme has been expanded to include these tapes which are stored in the remote area.

The three most recent generations are still retained in the original tape vault, while the great-grandfather set is stored in the remote area to be replaced at the next processing time by the grandfather and thus made available for the new output. It was found necessary to go to a four-generation plan to avoid the operating inconvenience which might arise from lack of sufficient back-up in the main computer-based vault to take care of occasional tape error troubles and other instances requiring master file reconstruction.

The system has been in operation nearly a year and it is working smoothly. Aside from the greater measure of security provided, some additional benefits have been noted. One of these is the longer life due to reduced usage of the tapes in those series which have been expanded to include a fourth set. This means that replacements with new tapes will occur less frequently. Also, the existence of the extra back-up sets has, upon occasion, proved to be an asset in certain debugging rerun situations.

January 1967
Some compute tapes have major dropout problems

You need a computer tape of the highest quality to prevent critical dropout problems. You need Micro Media 150... designed to withstand the years ahead. Each reel is tested beyond the technical requirements of today's mass produced tapes. Where most tapes are certified at a 50% sensitivity level, Micro Media 150 goes beyond—it's certified at a far more critical 60% level.

Micro Media 150 is made to last longer by Magnetic Media Corporation where innovation is the key activity. Our every effort is carefully calculated to create a better product for you.

For today's requirements, nothing surpasses the quality of Micro Media 150. And for tomorrow, we offer Micro Media 25... the tape that will hasten the development of cartridge loaded transports.

MAGNETIC MEDIA CORPORATION • 616 Fayette Ave., Mamaroneck, N. Y. 10543 • (914) 698-8660
A MACHINE-AIDED DRAFTING SYSTEM

by HARVEY N. LERMAN

The problem of having to maintain and update many drawings of the same type, as well as reproduce them quickly without completely redrawing them manually, is a concern throughout the industry. The solution presented here is that of establishing a standardized symbology to describe the similarities between the drawings, and using these symbols and a digital computer to generate and/or maintain these drawings. The drawings are converted into digitized symbol sets organized into files, and these files are then processed into the appropriate commands to drive a mechanical plotter to recreate the required drawings in every drafting detail, including Leroy lettering. These drawings are maintained on an exception basis by using the updating capabilities of the system.

No matter what type of drawing is to be processed, it can be thought of as a particular arrangement of some predetermined building block symbols. In using MADS, the designer merely creates a library tape of these symbols, and then uses it to generate any drawing needed.

system background

The Apollo Support Department of the General Electric Company has been faced with a cyclic work load in its drafting section that is caused by the need to create a complete set of drawings for each launch vehicle. Early in 1964 a process automation techniques task force was set up; the efforts undertaken through it toward the mechanization of drafting have demonstrated the feasibility of this approach, and its potential as a solution to the problem has been recognized.

The initial phase of the study was that of solving the problem of producing panel assembly—engraved drawings and panel assembly—drilled drawings. A prototype software system using a CalComp 564 plotter that produced these drawings with a minimum of engineering inputs was developed.

Almost in parallel with this phase, a second software system was developed to produce the advanced electrical schematic drawings. A study was then made to determine the feasibility of combining the working elements of both these systems into a single system capable of creating many types of drawings.

The result of this investigation was MADS, a drafting system which uses an already existing drawing or a rough but highly organized sketch as its input source. The program system was to be designed so that a minimum of programming would be required to convert the output to drive any plotter. Because of the great number of drawings to be plotted and maintained, it was decided to procure several coordinate digitizers to facilitate the preparation of input. A plotter feasibility study indicated that a “souped up” Gerber 600 would best satisfy the given requirements of speed, size, accuracy and cost. A Gerber model 622 was ordered and delivery was made on December 1, 1965.

system philosophy

What must be pointed out and emphasized is that MADS is a drafting system and not a designing system. But it is operational, and eventually can be incorporated within a designing system as its drafting tool. To facilitate this, the input sections of the system were developed to be compatible with the changes that would be required by future developments. For instance, it appears that some day the digitizer will be replaced by a light pen. The output section of the system contains a plotter post-processor which can readily be changed to accommodate new output devices, such as on-line CRT’s, for quick checks on drafting validity.

Instead of a complicated drafting language, a symbol language was developed for generating the library and for recreating the drawings. This language could be easily learned by anyone, even a non-programmer. In order to use the language, the group of drawings which is to be processed is broken down into a set of repetitive configurations called symbols, and these symbols grouped in a particular manner. The MADS symbols, then, are the backbone of the whole system.

mads symbols

There are two types of symbols in the system: “basics” and “composites.” The main difference between the two is that basics are written in FORTRAN and become a permanent part of the system, while composites are designed and written by the user in MADS language as part of his system library. Basics, written by a programmer to optimize running time, are core contained, and thus limited in size and number. Composites, on the other hand, are tape contained, and thus their size and number are normally unlimited. The composite library normally is placed on a high-speed disc instead of tape to decrease running time.

It is a somewhat arbitrary choice whether a given symbol should be defined as a basic or a composite, but a good rule is: If the symbol is composed of basics and/or other composites, it is a composite. In practice, besides defining building blocks as basics, the standard drafting symbols for the set of drawings to be processed, along with their notation fields, are also defined as basics. Some sets of drawings make extensive use of lettering, so a basic notation capability is also built into the system.

Each symbol is given a unique “name” for identification. This name presently is a four-digit number, with the low numbers representing basics and the higher numbers...
used for composites. The number 1000 is taken as a convenient break point. Since there usually are many more numbers available than symbols defined, the number can be partitioned by the user and conveniently used by symbol type (Fig. 1).

**basics**

When a symbol is defined, a point within it is defined as its reference point (referred to as P₀). This point determines the location of the symbol on the drawing. At times the length or size of symbol varies with usage; one or more variable points can be defined to accomplish this.

Examples of basic building blocks are: symbol 0900, a solid line, and symbol 0901, a dashed line. These symbols use straight lines to connect the points in the order given, and any number of points can be given. Other examples are: arcs, circles, rectangles, etc. These symbols are building blocks for most sets of drawings, and so were defined in MADS as basics.

**notation**

MADS contains a notation capability which allows single and multi-line Leroy lettering at any angle or size. Leroy lettering was used because lettering of that detail was necessary in the project. Besides being able to vary lettering size and angle, the user can define notation areas as being aligned at any edge or corner, and centered at any point.

The lettering library (Fig. 2) presently contains Roman letters (upper and lower case), Roman and Arabic numerals, and Greek lower case letters, as well as special symbols such as asterisk, comma, ampersand, etc. The system also contains a superscript and subscript capability, and the ability to underline letters automatically.

Before the remaining MADS library symbols are defined, a study is made of the drawings which are to be processed, in order to determine what these symbols are to be. Some of the types of drawings which have been created by notation aligned left and centered at a fixed point. When the symbols are used, these areas can be filled in with any notation desired, or can even be left blank.

**composites**

The language developed for the composing of composites serves two main functions: point definition and symbol placement.

Three methods are provided for point definition: 1. Constant distance from other point(s) 2. Constant ratio between other points 3. At a constant angle to other points

Each point must be defined as a function of the composite's reference point, variable points, or previously defined points. Once all points have been defined, the symbol placement section is used to position the desired symbols (basics or lower numbered composites) at the defined points. If desired, some of a symbol's standard notation areas can be deleted, and new notation areas defined within the composite Fig. 6 (p. 52). An example of a composite is symbol 3160, a lamp circuit containing a constant configuration of the other symbols: bus, indicator lamp, line and a terminal connector. The composite is defined as having a reference point, P₀ and one variable.
LosIng control?

You say your cat cracker is making rock and roll? Or the new hot strip mill that just went on computer control is turning out miniskirts? The control program that was developed for you by a little software outfit in the garage behind your brother-in-law's house didn't include any real-time monitors? The processors are recursive, but there's no dynamic storage? The job-shop programmer who was supposed to straighten out the mess doesn't know foreground from background and keeps taking trips without even leaving the computer room? And all those direct dollar benefits you told the president the control system would yield have just been deducted from your salary? No need to lose control of both your process and yourself, call IDC. What's an IDC? Well, let's close the loop on that query right now.

IDC is a company that knows what goes with control programs. From an exact specification...through real-time compilers, monitors and assemblers...and on to system updating programs...IDC can and does do. If your problem is in closed-loop batch or continuous processing, or any other real-time area where a computer is now, or will be, in control of a process, IDC's totally integrated software capabilities are your answer. IDC's uncommon ability to supply a complete package will guarantee you a process unit that performs consistently with predictable uniformity in quality, quantity, cost, and profit. So why not talk to us during the design of your process control system? After all, some of our best customers are the people from whom you'll probably be buying your computer. For an improved perspective on your process control problem, contact IDC now. 1621 E. 17th St., Santa Ana, Calif. Phone (714) 547-8861
DRAFTING...

point, \( P_1 \), to determine the height of the composite. The dependent points (2 through 5) are defined as being fixed distances from the reference point. The bus, basic 0070, is placed at the variable point, with its built-in connection line drawn to point 5. The indicator lamp composite, symbol 1160, is positioned at point 4, and a solid line, basic 0900, is used to connect points 3 and 4. If this line had been previously defined as being part of symbol 1160, it would not have to be included here. The terminal connector composite, symbol 2032, is positioned at the reference point, with its height defined by point 2. In other words, point 2 is defined as the variable point for symbol 2032 in this definition.

In this composite all the symbols except the bus are always placed at the positions shown here relative to the reference point. The variable point is used to give the position of the bus, and so defines the composite's height. If points 2 and 4 were defined as ratio points between

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**REPETITIVE CONFIGURATIONS**

**LAMP CIRCUIT:**

1. Dependent pts: 2, 3, 4, 5 are defined constant distance from \( P_0 \)
2. Symbols are used with possible redefinition of notation areas
3. New notation areas can be defined

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The drawing process in use at ASD is described in the following paragraph. The incoming drawings are logged...
25%

The new Data Packaging Slim Case makes your storage shelf go further. Now fit where 4 did before.

That's a lot of shelf to save. For a big tape user it could mean saving a new wing, or even a whole building.

The best tape storage case in the industry is now slimmer. Five-sixteenths of an inch slimmer. And this is a complete case. It has a bottom and a top. It keeps out dust, moisture, other contaminants. Not only from the tape, but from the reel flanges. The case supports the reel where it should be supported ... at the aluminum hub, not the plastic rim.

Then, there are the things we didn't change. The unique locking device is still there, still patented, still fully enclosed within itself to keep wear particles away from the tape. When you turn the handle, you can still hear the click that locks it and read the word "lock" when you do. (Oh, we did change the handle a bit. Larger. Easier to grip.)

For people who are choosy, there's no protection that equals this case — now slimmer than ever before. Tell your tape supplier to deliver on a Data Packaging reel — the one with the ring of color around the hub — locked in the new, Slim Case. Tell him you need the space.

Data Packaging Cases and Reels
206 Broadway, Cambridge, Massachusetts
U.S. Case patent numbers are 3074546, 3138250, D196987. Foreign patents secured in principal countries. Other patents applied for.

January 1967
in and checked by a draftsman who also makes any initial drawing required. Then a conditioner "marks up" or "red-lines" the drawings for ease of digitizing. The present digitizing operation is set up with a team of two people, one operating the digitizer picking up the X-Y location of the symbols with a cross hair cursor, activating the key punch to record this information, and the keypunch operator punching in the remaining input data from the conditioned drawing as called out by the digitizer operator.

After the drawings have been digitized, they are filed for future reference and the drawing deck is processed through the preprocessor program, which identifies data errors. This preprocessor listing is returned to drafting for correction by checking against the corresponding conditioned, red-lined drawings. The correction and/or change cards are keypunched and updated to the corresponding drawing files by the preprocessor program. The corrected drawing files are then processed by the program system which consists of a compiler, a sort-smooth program and the plotter command generator, which contains the plotter post-processor. The produced plot command tape is taken to drafting to produce a check plot on the production plotter. This check plot is compared with the conditioned red-lined drawing for errors. If any are found, change cards are keypunched, the drawing file updated, and a new plot tape produced. The final plot tape is then used to produce a drawing on Mylar film which, when approved, is sent to reproduction and distribution.

Cost of these operations is comparable to costs of a totally manual operation.

system programs

MADS consists of five programs:
1. A program that generates the drafting symbol library
2. A preprocessor that checks the drawing data for errors
3. A program that interprets the input drawing data
4. A program that sorts this data
5. A program that produces the appropriate commands for the plotter being used

system functional flow diagram

The drawing data decks for all the plots are batched and read by the preprocessor program, which checks each deck for errors. The primary checks in this program are for validity in symbol number, number of points for given symbol, number of notation areas for given symbol, and for format errors.

A tape file is generated for each drawing deck and a listing is produced, noting the cards in error and also giving a summary of these errors. Under user option the program can then make a "run decision" which "chains" the error free decks to the symbol compiler program.

The symbol compiler program uses the pregenerated composite library-tape to decompose all composites into basics and notation and then produces an unsorted basic symbol tape. This program also has provisions for using a drawing scale factor. If the user had requested his data to be sorted and smoothed, a third link is used to accomplish this. This sort-smooth program sorts for minimum pen-up time and arranges all symbols so that they can be connected by rectilinear lines. In this manner, any errors introduced by poor digitizing techniques are removed. The sorted tape is then passed on to the plotter command generator, which contains the basic subroutines and the plotter post-processor needed to produce the required plot tape. Post-processors used at the present time are those for the Gerber and Calcomp plotters.

If it is desired to correct or change an existing drawing file, the update by exception option of the preprocessor program can be exercised. Three tapes are then produced.
1. A tape containing only the "changes"
2. A tape containing what "was" changed
3. The updated drawing tape

The "change" and "was" files are used to produce a change document, and also can be plotted to show what had been changed.

The updated drawing tape can be linked through a plot, or could just be merged with the other original drawing files to produce a new master tape.

summary

The following steps were followed in the implementation of MADS:
1. In 1964 a process automation techniques task force was set up with three people assigned to hardware investigation, and three people assigned to a software study.
2. Early in 1965, four programmers wrote two initial software systems.
3. These systems led to MADS, which was programmed by three programmers during the last half of 1965.
4. The hardware system was delivered in December of 1965 and was "on the air" shortly afterwards.
5. One week on-the-job training was all that was needed before the system was in use.
6. The system presently is used two shifts a day, and produces about 100 good drawings a week, once the composite library tape has been generated.

The system was developed to be the drafting portion of an ultimate design automation system. The MADS phase was developed first because it was thought to be a logical first step towards the ultimate goal and because it provides a working tool long before the full system can be developed.

---

Fig. 7

---
"Not another rush job! Sometimes I think I should be a magician—not a DP manager."

Better still, you should have a Burroughs 500 System... whose powerful Master Control Program would juggle priorities, schedule that rush job, and get it multiprocessed immediately, along with the rest of the work in progress.

Long-term changes? Just as simple. Many jobs, for instance, can be added to a Burroughs 500 System which seems—by "one-job-at-a-time" standards—to be fully loaded. And when a larger configuration is finally required, the MCP automatically adjusts your work to take full advantage of the added memory, I/O, or peripheral resources.

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So if you sometimes get the feeling you should be a magician instead of a DP Manager, remember: there's a better way than "Presto." It's the new breed of self-managing computers—Burroughs 500 Systems. Write us at Detroit, Michigan 48232.
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CIRCLE 29 ON READER CARD
CONVERSATION WITH A COMPUTER

by LESLIE MEZEI

The following recording, obtained by the forward time-scan recording process, brings us a session held in 1985 between a computer scientist and a computer.*

Computer York University Computer 2X5W6—Ready.
Professor What time is it?
Computer It is 8:30 p.m. Thursday, December 5, 1985.
Professor I think I would like to start with some music today. Let's have some chamber music.
Computer You listen to Telemann most.
Professor No, something earlier.
Computer What about the Orlando Gibbons Fantasia for three recorders? You haven't listened to that since last spring.
Professor All right.
Computer (Plays the Fantasia).
Professor I will practise this piece today. Tomorrow you will play only two parts and I will play the soprano part on my recorder. Please print that part of the score for me.
Computer Will do, and I will remind you tomorrow if you like.
Professor Good. Before we go on, I heard a new word on the news today. What does "gormandize" mean?
Computer "Gormandize" means to eat voraciously. It is derived from gourmand, which means "glutton," or is sometimes used in the meaning "lover of fine food."

Professor Is that the same as a "gourmet?"
Computer "Gourmet" is used only in the melliorative sense of a lover of good eating.
Professor Thank you. Now you could give me a couple of palindromes to amuse my friends tonight.
Computer Madam, I'm Adam.
Professor That's old hat. Give me another one.
Computer Lewd did I live, evil I did dwell.
Professor Good. We must make up some new ones soon.

*Although I take full responsibility for the above conversation, I would like to thank Professor Michael Kay for supplying the language lesson.

Associate professor of computer science at the Univ. of Toronto, Mr. Mezei was formerly with York Univ. where he was director of computer science programs. He received his BS in mathematics and physics from McGill Univ., MA in physics (meteorology) from the Univ. of Toronto, and is a fellow of the Canadian Institute of Actuaries.
CONVERSION...

We'd better get on to my language session. What were we working on?

Computer Remember, you are going to give a speech in Chinese next month.

Professor Oh yes, have we completed the speech yet?

Computer Yes, but you still had some problems pronouncing some of the words. Also, your comprehension isn't good enough yet to answer questions.

Professor (jamming) OK. What did I mispronounce?

Computer Pay attention to the display, and try to make your display match mine. Pay attention to the tones. They're all high-level or high-rising. Again: júng hwá rén mín gúng hé gwó.

Professor júng hwá rén mín gúng hé gówó.

Computer júng hwá—I've had enough of that for today. Let's do a bit of math.

Professor No, if you don't mind, we haven't finished the language drill yet.

Computer I don't feel like it now. Let's do it tomorrow. By the way, tell me something about their customs.

Computer It seems probable that your chopstick technique could use some review. They still use them you know. Perhaps you can practice on the way over in the rocket.

Professor Fine. I have to prepare a lecture on early efforts at machine translation of languages. Give me some jokes on the subject.

Computer What about the way "hydraulic ram" was translated by a primitive computer as "water buffalo"?

Professor Not bad. But only engineers will appreciate it. Another one, please.

Computer What about the translation of "out of sight, out of mind" as "invisible idiot"?

Professor Good. Which do you like better?

Computer You know I do not have likes and dislikes.

Professor Sorry. I forget at times that I am talking to a computer. Give me some ratings on them.

Computer Water buffalo 50%, invisible idiot 75%.

Professor I guess if I can get 75% of the people laughing, that's pretty good. The water buffalo reminds me of this morning's news story about a sea monster sighted off the Atlantic coast. Can you check on it please?

Computer I will check with the Library of Congress Computer. (pause)

Professor Sorry for the delay. I had to connect with the Woods Hole Observatory computer. They checked out the story there this morning and they think someone just saw a mirage. I have a full list of sea monster sightings here if you want it.

Computer Not now, thank you. Probably just another news-hungry dunderhead made it up.

Professor What is a dunderhead?
Take it from Jack Hatcher:

“MRX-III computer tape is 3 to 5 times more durable than the leading competitor’s”

And Jack wasn’t easy to convince. He didn’t care how well the tape performed in its more than six months of pilot line and laboratory testing. He wasn’t impressed by the fact that 718,000 shuttle passes didn’t even begin to scratch the tape. He merely shrugged at the favorable reports from the more than fifty installations where exhaustive field-testing was performed. He just said, “Well, we’ll see.”

That’s Jack’s job, as an engineer in our product evaluation lab, to see for himself how each new Memorex tape measures up. He’s paid to break it down, if he can, subjecting it to any and every kind of use and abuse to which a computer tape could possibly be exposed. But on MRX-III, Jack broke his pick.

Now you test it. For a sample of MRX-III (on its new color-coded reel), write us at Santa Clara, Calif.
When buying a computer, the most important question a scientist asks is: "Can I get it to do the job?"

In physics, in chemistry, in life and earth sciences, there have been more than 500 yesses for the PDP-8. More yesses than for any other real-time, on-line, general purpose computer for science.

That should give you confidence. More than 500 other scientists have written programs that work. The potentialities (and limitations) of the PDP-8 have been exhaustively explored. There is an active and interested community of investigators ready to exchange information, techniques, even programs.

This makes PDP-8 the most immediately approachable computer you can buy.


Multigraph helps Ohio Bell beat the changing numbers game.

Changed numbers. Disconnected numbers. Cancelled numbers.
Ohio Bell handles 2200 of them every day in the Greater Cleveland area.
And overnight they have to be distributed to intercept operators.
Now, Multigraph isn't the only way to handle this job. Ohio Bell just chose us because our system could do it at lower cost.

Working with Ohio Bell systems engineers, we recommended and installed the Photo Direct Master system. It records the changed numbers as they come off the computer. Copies are duplicated and distributed to intercept operators before the next day breaks.
The savings from this system over the previous one are substantial. And as a bonus, the Multigraph equipment is used on other projects during the day.
Ohio Bell wins coming and going. We bet you can, too. Just call your Multigraph man. Or write Addressograph Multigraph Corporation, Department T-6626, 1200 Babbitt Road, Cleveland, Ohio 44117. No matter what your game is.

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... helping people communicate
THE SDS SIGMA 5

Disappointing speculators who said there would be five mainframes in the line, Scientific Data Systems this month announced the Sigma 5—which, they said, "completes the introduction of third generation equipment." This third processor fits between Sigma 7—a 32-bit machine with which the new 5 is fully compatible—and the Sigma 2, a smaller 16-bit computer that is only data- and I/O-compatible with the 5.

The 32-bit Sigma 5 is the same speed as the 7 except in certain instructions, but lacks the hardware (and software) for conversational time-sharing. It has fewer major instructions (93), no mapping feature, and only half (256) the general registers of the 7. But there is still concurrency: it can simultaneously compute, handle multiple real-time control functions, and process a number of I/O operations. Up to 224 interrupt levels are available.

As with its sibling rivals, the Sigma 5 is intended for both scientific and business computing, the latter being only ancillary to the engineering type throughput. A 12K configuration is considered typical for the average scientific environment, 16K for COBOL users. There are other dual-purpose machines in the marketplace, of course. Competitive units to the Sigma 5 include the 360/50 and 44, CDC 3200 and 3300, the GE 400 series, and the newly-announced PDP-10, which replaced and is compatible with the PDP-6. All of these processors have been running about a year or more.

In contrast, the first Sigma 7's were delivered last month, both for nuclear research activities, to Brookhaven National Laboratory and Michigan State Univ.

Memory cycle time of the Sigma 5 is 850 nanoseconds, reducible to 600 nsec through overlapping. Memory size is 4K to 131K (32-bit) words. All of memory is addressable directly or indirectly in bytes, half-words, words or double-words. Up to eight I/O processors, each with capacity for 32 channels, can be provided. The basic system has eight I/O channels and 16 general registers.

Software is the same as for the Sigma 7 with the exception, as noted, of conversational I/O features.

The basic Sigma 5, with 4K words and keyboard printer, is priced at $90K (rental: $2,500). And the price runs up to about $500K ($10K/month). Delivery is scheduled to begin in August '67.

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CIRCLE 33 ON READER CARD

PROGRAMMERS AND SYSTEMS ANALYSTS Immediate Openings

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Aeronutronic, located 40 miles south of Los Angeles in smog-free Newport Beach, California, has immediate openings for programmers and systems analysts. Rapid growth at Aeronutronic has created many openings in our commercial data processing group. A mounting backlog of work is coupled with our scheduled installation of new third-generation computers early in 1967. Openings require 1 to 5 years experience in large-scale business programming. COBOL and disk experience would be helpful. Degree preferred.

Qualified applicants are invited to submit their resumes to: Mr. G. E. Gerner, Professional Placement Coordinator Aeronutronic Division Philco-Ford Corporation Ford Road, Newport Beach, California 92663 Dept. DA-1

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CIRCLE 345 ON READER CARD
The Univac 9300 is the second unit in a series of interlinking computers.
(You know: you start with any one, and simply build on it as your computer needs grow.)

The Univac 9300 brings you from punched cards to magnetic tape data processing in one small step. It's the first high-speed tape system the small computer user can afford.

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

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

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

But the Univac 9300 does more. It brings you complete Univac software support: Tape assembler, Sort/merge, Report Program Generator, FORTRAN, COBOL. Control Stream Operations for unscheduled batch processing. Et cetera.

How can it do so much? Part of the answer is a remarkable wire memory that only Univac has—and that you'll find only within the Univac 9000 family.

The Univac 9300 is just a small step away from the next higher model in the series.
So that when you're ready to grow, your computer capability will be, too.

Need more information, call us.
Please.

UNIVAC
DIVISION OF SPERRY RAND CORPORATION
NEW FROM 3M!

"Scotch" Brand No. 777 Computer Tape offers you the ultimate in long-range reliability and economy.

MICRO-SECONDS ARE DOLLARS

A question: Do you consider that each time an error on tape makes your computer stop, examine and compensate, your money is wasted? It's even more costly when data is lost. When errors mount with repeated passes, the point is soon reached when continued use of that tape is economically prohibitive. The longer your tape performs reliably, the greater its real economy. Exclusive new "Scotch" Brand No. 777 computer tape gives you this.
EXTENDED RELIABILITY IN CONTINUED USE

A major secret in No. 777's reliability is a special oxide binder formula. Applied with absolute precision, the exceptional stability, toughness and uniformity of this binder enables No. 777 to deliver greatly extended error-free performance. Tested over thousands of passes, repeatedly subjected to the kind of work-horse use you'd give a scratch tape, No. 777 dramatically out-performs any other computer tape ever developed.

RELIABILITY IN SHIPPING AND STORAGE

All computer tapes at times are subject to wide fluctuations in temperature and humidity — whether in sun-soaked highway transport or in 40-below-zero air cargo. These intense changes can generate new dropouts in a tape initially error-free. But "Scotch" Brand No. 777 maintains error-free reliability through both shipping cycles and long-term storage, just as it does in the controlled environment of your computer center.

COMPLETE COMPATIBILITY AT ALL BIT DENSITIES

In addition to its remarkable physical qualities, new "Scotch" Brand No. 777 Computer Tape is completely compatible for all computer densities whether the traditional 200, 556 or 800 bpi; or the newest 1600 bpi (3200 fci). Even if your data processing system utilizes lower densities, with "Scotch" Brand No. 777 you can profit directly from its exclusive long-range, error free reliability today — and still be prepared for tomorrow.

Who knows more about computer tape than the people who perfected it?
Planning Research has designed a search and retrieval system for a consortium of title insurance companies who will share the same computer. The initial data bank consists of 360 million characters. These will increase at the rate of approximately 120,000 per month as new property transactions occur.

Planning Research systems synthesis is complete. It begins with analysis of the total system, and design engineering. It ends with final checkout on any computer system. Applied, it saves time or money, or both. For particulars, write to Dr. Alexander Wylly, Vice President for Computer Sciences.

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INEXPENSIVE OPERATION...
use computer as a computer, not as a plotter input device

EXPANDABLE...
on site up-dating to magnetic tape or multiplexing

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January 1967
Announcing:
The FAST Line* 300 film memories...

For your FAST Line memory requirements in the 250-500 nsec range

At the 300-nanosecond band in the FAST Line spectrum you'll find the new FAST Line 300 magnetic film memories. Designed to the FAST Line concept, this series of film memories lets you specify the exact cycle time and capacity you need in the 250 to 500 nsec speed range. All-silicon discrete components. Integrated circuits in the logic, decoding and timing sections for optimum reliability. "Big board" packaging and standard manufacturing techniques for low per-bit price.

Remember, FAST Line means value-engineered memories with a speed-cost evaluation which always results in the lowest ultimate cost to you. Check out FAST Line before you specify a memory for your next EDP application! Call: 612-935-8811, TWX: 910-576-2913 or Write: Fabri-Tek Incorporated, 5901 South County Road 18, Minneapolis, Minnesota 55436.

FAST Line 300 film memories:
Operational Summary
Cycle time: Choose any speed between 250 and 500 nanoseconds
Access time: 125 to 250 nsec, depending upon cycle time chosen
Access modes available: Random, sequential or sequential interleaved
Capacity: To meet your requirements
Optional operating modes: Read only, write only, read-restore, read-modify-write, parallel write
Input/output levels: Standard +2.5 and —0.5 volts
Control panel options: Address and data register indicators, voltage monitoring, and adjustment, self-testing controls and error checking, and data retention "Data Saver".
Power required: 115 or 220 vac., single phase, 48-63 cps.
Packaging: Relay-rack modules or free-standing cabinet

Available now... new FAST Line 300 film memories product bulletin. WRITE TODAY.

The Leader in Memory Technology *T.M.
PUBLIC ADMINISTRATION SERVICE SURVEYS MUNICIPAL EDP USE

Municipal governments, particularly in the smaller cities, "still believe that they have a choice as to whether to adopt ADP or not. . . . Given the significant interest in information systems at the state and federal levels (i.e., Great Society aims), and the reporting requirements placed on municipalities by the Social Security, Medicare, and other programs, this is unlikely to prove to be a realistic view." This conclusion and the status and problems of adp implementation in cities are reported in "Automated Data Processing in Municipal Government" by the Public Administration Service and the International City Managers' Assn.

The report, based on a survey of 381 cities in 1965, shows that 43.6% (166 cities) "have no adp equipment, do not use a service bureau, and do not intend to use it within the next five years;" 28 cities without systems or service planned to install by 1970, and seven "may." Many responses reflect a lack of information on many aspects of adp, including criteria for determining its most productive applications and personnel aspects. And there seems to be poor communication among the manufacturer, the city executive, and his dp specialists on evaluation data needed.

Users sampled—180 cities with computers, tab installations, or service bureau help—mostly concentrated on traditional applications involving high volume of data—public finance, revenue and personnel administration. Although many large cities are applying computers in sophisticated on-line applications, cities of less than 100,000 seem just to have applied computers to applications done previously on tab equipment.

Personnel shortages and the problem of economic justification are among major obstacles to dp implementation, the report said, but many cities are not effectively considering these factors. Most planning was being done on a departmental basis, even when a central facility existed; in cities of 25,000-50,000, which primarily use tab equipment and service bureaus, agency independence can lead to multiple punched card installa-

IBM DEMONSTRATES "TEXTILE GRAPHICS" TECHNIQUE

An experimental technique for reducing the time between design and actual weaving has been demonstrated by IBM for representatives of the textile industry meeting in New York last month. Developed by Mrs. Janice R. Lourie, an amateur weaver and professional member of IBM's New York Scientific Center, the method uses a 2250 display unit tied to a System/360. After the design is drawn with a light pen, the user can select a weave design from a stored library, then modify it on the screen. Output is coded printout, from which cards can be prepared to control operation of a Jacquard loom. The company points out that it is only demonstrating the feasibility of the method at this time and has not yet developed a programming package for the application.

BANKING STUDY SHOWS COST FEASIBILITY OF NEW SYSTEM

Is it possible to set up an information transmitting network among banks that will do away with the physical exchange of checks? The answer is yes, according to research conducted by the National Association for Bank Audit, Control and Op-
Adage makes the best computer on the market for signal processing. It's called Ambilog 200.

Combining the best of both analog and digital techniques, Ambilog 200 was designed right from the start for processing signals (time-related variables, often in analog form). Its unique hybrid structure and ability to handle efficiently both analog and digital information make possible at relatively low cost the extremely high computing rates required in signal processing applications.

**DIGITIZING AND RECORDING**

Up to several hundred inputs are routed under program control through an array of multiplexer switches, hybrid arithmetic elements, and a 14-bit, 4 microsecond analog-to-digital converter for recording or outputting. Ambilog 200 converts raw data to engineering units, including corrections for calibration error, at even faster sampling rates than conventional systems which simply "acquire" data.

**WAVEFORM MEASUREMENT**

Peak values, axis crossings, ratios of successive differences, and other characteristics of analog signals are measured in real time. Using complex programmed detection criteria, incoming signals are monitored for events of interest, typically with a resulting 100-to-1 reduction in the bulk of magnetic tape output records.

**RANDOM SIGNAL ANALYSIS**

Parallel hybrid multiplication and summing, 2 microsecond 30-bit digital storage, and a flexible instruction format providing efficient list processing combine to make Ambilog 200 an extremely powerful tool for statistical signal analysis techniques. These include Fourier transformation, auto and cross correlation, power spectrum density analysis, and generation of histograms of amplitude spectra.

**GRAPHIC DISPLAY**

On-line CRT displays of incoming data, or of results derived by reduction and analysis, are generated at frame rates of about 30 per second using line-drawing elements. Other visual display configurations, intended as design aids, generate isometric or true-perspective projections of objects containing more than 1000 line segments, with arbitrary translation and rotation.

**FUNCTION GENERATION**

In generating arbitrary functions of one or more variables, quadratic or cubic interpolation is achieved at high speed by using hybrid arithmetic elements in parallel to evaluate a polynomial function. Or, where straight-line approximations are adequate, different values of slopes and intercepts for each line segment are fetched from memory for operating on the variable.

**SOFTWARE**

Programming aids are tailored to the specialized needs of signal processing tasks, and include an Adage assembly system, Fortran, programs for source language editing and online debugging and control, and a wide range of applications programs and subroutines. Ambilog 200 signal processing systems are currently being used for seismic research, dynamic structural testing, sonar signal analysis, wind tunnel testing, speech research, simulation, and biomedical monitoring.

For further details, write M. I. Stein, Product Manager, Adage Inc., 1079 Commonwealth Ave., Boston, Mass., 02215.
news briefs

But the affirmative answer is only tentative and exploratory, stresses Dr. Randall Robinson, director of research for NABAC. It is the first of what will be a continuing study into the possibility of some day setting up a national system by which banking information may be transmitted by electronic systems. At present, Dr. Robinson points out, banks must physically handle all the checks with which they deal—soriting them, bundling them, returning them to the issuing bank (often with a number of sidetrips through intermediary banks). The data processing network would enable banks to exchange check information without exchanging checks.

This pilot study dealt with 28 banks in Chicago, Milwaukee, and Minneapolis-St. Paul, including the Federal Reserve Banks of Minneapolis and Chicago. It found that costs of such a system would be about 7% lower than costs incurred by using an idealized version of the current magnetic ink character recognition. Dr. Robinson added that the estimate is conservative. He predicted that such a system, once it began to operate, would reduce costs by a good deal more than 7%.

The network system under study would not eliminate MICR, which still would be used by banks-of-first-deposit to extract information to send on to issuing banks.

Although Dr. Robinson emphasizes the exploratory nature of this study, he says that the project has convinced NABAC officials that an electronic banking network is technically feasible. Before it could be put into effect, however, other problems, legal and of a public relations nature, would have to be worked out. How, for example, will people feel about not receiving a cancelled check with their bank statement? Checks would be sorted by the bank-of-first-deposit for possible later reference, but what legal problems might such a procedure incur? It will be necessary to anticipate and answer such questions before large-scale use of an electronic system.

NABAC and IITRI are now engaged in a year-long study that will expand upon the questions posed during this initial project, which based its cost analysis on the use of voice grade lines. Its present research will examine costs and related problems of other types of systems. It will also look into how an electronic system may enable the exchange of other kinds of information.

PAPERS FOR 20TH NATIONAL ACM CONFERENCE DUE FEB. 20

Papers submitted for the 20th National ACM Conference, to be held in Washington, D.C., Aug. 29-31, are due by Feb. 20.

Theme of the convention is "Past Is Prologue" and papers are solicited that deal with past, present, and future aspects of computer science and technology. Authors are requested to stress historical perspective, present significant new developments or novel applications, or explore trends and potential developments. A prize of $500 will be awarded for the best paper.

Five copies of the paper, not to exceed 10,000 words, and a 100-150 word abstract should be submitted to Dr. Jack Minker, program chairman, Auerbach Corp., 1815 N. Fort Meyer Drive, Arlington, Va. 22209.

NCR MARKETS MICROFORM SERVICE AND READERS

In one of the most restrained new-product releases ever recorded, NCR announces that they are "entering" the microform information storage and retrieval market and, simultaneously, that they already have orders for 26,000 of the readers.

The technique used has been under development for some time; it was described at the NCR exhibit in the 1965 SJCC. A special coating for transparencies has been developed by the company, allowing good resolution with extreme reduction of images. Information stored on the film is about 1/150th its original size. Thus the 4 x 6 inch transparencies used can store the equivalent of 3200 pages of typical business documents.

Preparation of the records must be done at an NCR service center and there is only one now—in Dayton—although others are planned. The cost is reasonable: for large-volume jobs, the transparencies can be prepared for as little as $1 each. The cost of the reading units is even more reasonable: they rent for $10 a month. The reader is about the size of a table-model TV set and is operated manually. Access time to find the image of one of the pages recorded on the transparency is quoted as "seconds."

Some large companies, including Ford and Boeing, have been using the retrieval system on a trial basis. Best prospects are expected to be organi-
Would you believe a CalComp plotter and any computer can draw pictures like these in seconds?

- a perspective sketch of your new plant
- statistical trend charts
- molecular structure diagrams
- apparel patterns, graded for sizes
- and even the Mona Lisa

it can

Call or write Dept. D1, California Computer Products, Inc., 305 Muller, Anaheim, California 92803, Phone (714) 774-9141.

CALCOMP
Standard of the Plotting Industry
(Talented Engineers and Programmers required—right now.)
CIRCLE 41 ON READER CARD
What's the matter? Is your computer too busy to talk to you?

It's probably nothing personal. Like many other firms, you might very well have outgrown the computer you started with. If you started with NCR, your solution is relatively inexpensive. A system expansion . . . or maybe a faster processor, will give your system the breathing room to chat with you all you like.

That's the beauty of the 315 family. You don't have any problem with obsolescence. No matter how small you start in the 315 family, you can move right up without recompiling or reprogramming.

You have an advanced operating system with automatic run-to-run control assuring the right file name and date version, and including dating flag options for any program in the system.

You can move up to the newest RMC (Rod Memory Computer), with a choice of 20 to 160K character memories. Even Multiprogramming, if you have a lot of conversation on your mind.

You can get your information to the 315 or RMC from the widest range of input devices available . . . all from NCR. So if you are in the market for a computer that's fast, powerful and flexible . . . and doesn't have a fancy price tag to start, call NCR. Let's get a conversation started.

THE NATIONAL CASH REGISTER COMPANY, DAYTON, OHIO 45409

January 1967 CIRCLE 42 ON READER CARD
news briefs

A PROGRAMMER ASKS:

"WHY DOESN'T SOMEONE PLAN A PROGRAMME FOR PROGRAMMERS?"

UNIVAC has... here it is!

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NATIONAL RESEARCH COUNCIL REPORTS ON LANGUAGE WORK

A committee of the National Research Council has completed a report titled Language and Machines, concluding that language analysis by computer and machine-aided translation are two areas of linguistics deserving increased federal support. The committee does not, however, recommend massive support of machine translation per se, finding it slower, less accurate, and more expensive than the old-fashioned way using people.

The two-year study was made at the request of the CIA, Defense Dept., and National Science Foundation. Chairman of the committee is John R. Pierce of Bell Labs. The report recommends that computational linguistics should be supported as a science and not be judged by any immediate or foreseeable contributions to practical translation. According to the report, the supply of translators "far outstrips the demand," even in the case of Chinese translators.

The report--Publication 1416 of the National Academy of Sciences, National Research Council--is available from the Printing and Publishing Office, NAS-NRC, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

ALLSTATE INSURANCE OPENS NEW RESEARCH CENTER

Allstate Insurance Co. unveiled a new research center in Menlo Park, Calif., last month. Most of the research will be systems oriented, with emphasis upon management sciences, operations research, computer application development, and support for underwriting, marketing, and training.

Installed at the center, named after Allstate Chairman Judson Branch, is a 360/40 which includes a 2321 Datacell. The company also demonstrated an experimental use of a terminal on-line to System Development Corp. in Santa Monica. The terminal was shown retrieving information from a data base built from a survey of automobile drivers in the western states.

Also demonstrated was a corporate model which allows management to alter such factors as policy renewal ratios and number of salesmen to predict the effects of such changes. The model contains 5-10 years of company history on a monthly basis, including budget vs. actual figures, and goes through 26 million calculations each run.

The center now employs 19 professionals, but will have 53 next year. It is headed by vice president L. L. van Oosten, director of research.

1967 FJCC COMMITTEE ISSUES CALL FOR PAPERS

The program committee is soliciting papers for the 1967 Fall Joint Computer Conference, to be held Nov. 14-16 at Anaheim, California.

A $500 prize will be awarded for the best paper covering significant advances in any aspect of the information processing field, including hardware, software, systems, applications, and analog/hybrid systems.

Deadline is April 17 and a complete manuscript is requested in addition to a 100-word abstract. Five copies should be sent to Harry T. Larson, Technical Program Committee Chairman, 1967 FJCC, P.O. Box 457, Costa Mesa, Calif. 92627.

A cross-licensing agreement has been signed by RCA and NCR, covering computers and other products when they are used directly as online components of data processing systems. The pact does not cover any exchange of techniques. It's intended to prevent patent infringement conflicts that might arise from the difficulty of keeping abreast of the increasing number of patents being filed in the industry.

Sheraton Hotels is getting a new reservations system, Reservatron II, from Bunker-Ramo. The $4 million system will provide 200 consoles, on line to the B-R TeleCenter in New York City. The equipment will handle alphanumeric messages, thus giving rise to the hotel chain's jubilant claim that "guests will again become names instead of numbers." Installation is to begin in February and to be completed in the spring.

The Purdue Laboratory for Applied Industrial Control has been set up at Purdue Univ. Headed by Prof. T. J. Williams, it will carry out re-

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search and development in plant and process dynamics, instrumentation, computer control, optimization of industrial plants, and automation management. One objective is to train interdisciplinary engineering graduates who will work on industrial projects. Five industrial companies are helping to support the new organization and Purdue has 28 professors whose basic area of research is automatic control. The intention is to offer academic programs at the MS and PhD levels in all major areas of engineering.

- A computer-generated model of the human vocal tract is now producing synthetic speech at Bell Telephone Laboratories. An oscilloscope displays geometric descriptions of the vocal tract areas (pharynx, tongue, palate, lips and tongue tip) while the operator simultaneously hears the sound which corresponds to the displayed shape. Dials on the console can change shape and sound to improve synthetic speech by slight variations. Researchers at Bell Labs hope to use the information to devise a more efficient means of encoding speech signals and transmitting them over communications lines.

- High-speed cathode ray tube displays, to be used for the storage and retrieval of pupil personnel records and curriculum information, are being installed by the Portland (Oregon) Public School District. Based around a Honeywell H-120 computer system, the first display was installed earlier this month at Rice Elementary School. Under the pilot program, science curriculum (available texts, audio-visual aids, reference materials) will be placed in the 32K memory to aid teachers in course instruction and preparation. The project, expected to be in use by early spring, is funded by a $129,000 grant from the Hill Family Foundation in Minneapolis. Long-range plans for one or more CRT displays in each district school are dependent upon a four-year grant from the federal government.

- A nine-month programming course for blind students is being conducted by System Development Corp. through arrangements with the California Health and Welfare Agency. One trial student has completed the course and is already employed as a programmer; the same course, with minor modifications, will now be given to a class of 14. Students were selected from candidates with at least two years of college and an interest in science, who were then given intelligence and aptitude tests. Texts for the course have been transcribed on tape and tests are given in Braille. Computer printout in Braille is also used.

- Scientific Data Systems has announced that PL/I software completion has been delayed until 1969, citing as the reason “recent significant changes in the basic definition of the language as well as the prospect of further changes.” Dan L. McGurk, vice president of marketing, said that “as soon as a firm definition of PL/I has been established, SDS will complete its development.” Sources outside the company, however, note that the delay may be caused by previous commitments of the software suppliers.

- Yet another new application has appeared with announcement by the California Department of Water Resources that a $325,000 contract has been awarded to Univac for a 418 system to control water movement in the California aqueduct system. The computer, to be installed Feb. 1 in the project control room at Sacramento, will first be used in operation of the South Bay Aqueduct. This will serve as a model for later development of remote computer-based control of the complete state water project.

- An ambitious plan with the suitable name of EPIC (for Eastern Pennsylvania Information Center) has been launched, hopefully leading to a million-dollar computer center at Franklin and Marshall College, Lancaster, Pa. The proposed center could service more than 50 colleges and research institutions in the area including Pennsylvania, New York, New Jersey, Delaware, and Maryland. Estimates call for building and equipment at a cost of $4 million to $6 million and an annual operating budget of about $1.5 million. The time-sharing installation would include some 200 stations. Planning has been started with the help of a $50,000 grant to the college from the Independence Foundation of Philadelphia. Planned start-up date is late 1969.

- Systems Engineering Labs, Inc. has announced that a monitor system will be available for its 810A and 840A computers the first quarter of 1967.
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**news briefs**

(No additional cost). Components are a resident executive, a FORTRAN IV compiler and library meeting ASA standards, MNEMBLER assembler, loader, and debug and utility routines. The full system will operate with 12K core; the compiler alone requires 8K.

“Conversation With a 50” was the title of a two-day conference in early November, sponsored by the Argonne National Laboratory. Referring to IBM’s System/360, Model 50, the conference featured eight papers and three operating systems. The systems, demonstrated during an evening session, were the Allen-Babcock Computing, Inc. RUSH, which uses a 2741 and a Mod 50; the Univ. of Pittsburgh PITT Interpretive Language (a derivation of joss) using the Mod 50 at Argonne; and an IBM-Yorktown system.

The papers discussed work involving remote systems for the Mod 50, aiding users of the model who are planning or using time-sharing techniques.

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ERIC WEISS, Sun Oil Company

PL/I is the newly developed programming language ready for immediate use. The treatment is easy to read, making learning easy. 112 pages, $3.95

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GERALD M. WEINBERG, IBM Corporation

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That was just the beginning. Suddenly I realized that thin paper strip ran between every single business card form in the place. Thousands of them... piled up on the floor, stuffed in the baskets... it was a mess.

I had no choice. I developed my routine: Empty the trash cans, scoop up the strips, brush off my clothing... complain to our office manager. But it was all in vain until I mentioned money... how much of it was lost in shipping, storing and processing those skinny little strips.

In the long run my routine was costing them plenty. They knew it was time for a change, and that's when Formscards entered my life. What a job they did! And without a single medial strip to clutter up the works (My boss said no other tab cards come clean that way).

Now everybody's happy. My routine is over for good, and I can't say that I miss it. Thank you, Formscards, you sure got me out of a mess!"

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January 1967
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Potter Digital Tape Transports
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Potter's MT-24 and MT-36 digital tape transports offering unrestricted tape speeds to 50 ips at packing densities to 800 bpi are qualified to meet the requirements of Federal Standard 222 and MIL-16910A. Field tested units installed in information systems are now in operation. Both the MT-24 and MT-36 transports are IBM-compatible for 7- and 9-channel tape formats.

For further information, write or phone General Sales Manager, Potter Instrument Company, Inc., 151 Sunnyside Blvd., Plainview, N. Y. 11803, (516) 681-3200.
Teleplotter configuration operates with a standard Dataphone adapter and teletypewriter, allowing 2-way communication with the remote computer and allowing switching, under program control, between plotter and teletypewriter. The user dials a time-shared computer, inputs all instructions, data, and plot programs through the TTY. In response, the computer prepares the plot program and outputs signals for remote on-line plotting. A manual interrupt capability permits the user to override and interrupt computer-controlled operations when required.

**CALIFORNIA COMPUTER PRODUCTS INC., Anaheim, Calif.**

For information: CIRCLE 100 ON READER CARD

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**PRODUCT OF THE MONTH**

The Computer Eye is a real-time optical input system that consists of a TV-like camera, CRT, and gp computer. It is designed to interpret real world scenes at varying distances and under varying light conditions. The sensor element is a 3-inch-diameter image dissector phototube; it differs from a TV camera in that, under computer control, it selectively examines points in its field of view. Resolution across the field of view exceeds 1,200 lines. The developing image is shown on the CRT for monitoring and action by the operator. Developed to date is only basic software: scene digitization, microscan, and various line finding and tracking programs. More R&D are due at MIT and Stanford, recipients of the first two units. Still in a developmental phase, the system has a potential as the control element in the manufacturing/fabrication industry.

**INFORMATION TECHNOLOGY INC., Cambridge, Mass.**

For information: CIRCLE 104 ON READER CARD

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**remote plotting**

Remote on-line users with a 500 or 600 Series plotter can now add a controller and draw girlie (and other) pictures at speeds up to 280 incremental steps/second. The resulting plants to find operating conditions desired. It contains a library of programs for most of the important unit operations of chemical engineering, as well as a language for describing chemical processes and designing solution procedures.

**SERVICE BUREAU CORP., New York, N.Y.**

For information: CIRCLE 102 ON READER CARD

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**comm-line compensators**

The SC-307A and 307B are 6- and 12-section line compensators for high-speed digital data transmission systems, designed to correct the effects of phase and amplitude distortions.

**EASTMAN KODAK CO., Rochester, N.Y.**

For information: CIRCLE 103 ON READER CARD

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**microfiche reader-printer**

The PFC-1A accepts any microfiche format up to 4 x 7% inch and produces paper prints up to 8½ x 11 inches. The reader offers seven magnifications, projects the image onto an 11 x 11-inch screen, and has facilities for rotating the image 90° to the left and to the right. Delivery of the desktop unit is to begin in June of 1967.

**EASTMAN KODAK CO., Rochester, N.Y.**

For information: CIRCLE 100 ON READER CARD

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**gp computer**

Based on the earlier 4900's hardware, the model 4901 Computing Simulator has additional wired-in instructions for special applications. It also has a real-time clock and d-a converters. With the exception of added features, it is program-compatible with the 4900. It features a 4K (18-bit) word core memory with a cycle time of 1.75 usec. Monolithic IC's are used throughout. Applications include the environmental testing of air and space crafts and the monitoring and controlling of closed-loop processes. Price of a basic system, including a mod 33 teletype unit with paper tape reader-punch, is $29,950.

**INFORMATION TECHNOLOGY INC., Sunnyvale, Calif.**

For information: CIRCLE 101 ON READER CARD

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**petrochemical software**

The Chemical Engineering Information Processing System (CHIPS) software package is designed to facilitate simulating the operations of all or parts of chemical or petroleum plants. It contains a library of programs for most of the important unit operations of chemical engineering, as well as a language for describing chemical processes and designing solution procedures.

**SERVICE BUREAU CORP., New York, N.Y.**

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in phone transmission line facilities. They use independent active correction sections located throughout the 300 to 3,000 cps passband. These sections can be independently adjusted.

ELECTRONICS DIV., GENERAL DYNAMICS, Rochester, N.Y. For information:

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gp software

Desecrated, relocatable software for the PDP-5, 8, and 8-S computers include a one-pass assembler, FORTRAN II compiler, and library of gp subrou-
tines. The assembler and compiler produce relocatable object code that can be linked by a relocatable loader.

INFORMATION CONTROL SYSTEMS INC., Ann Arbor, Mich. For information:

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printout binder

Plastic covers for printout sheets are made from Super Dylan, a high-den-
sity polyethylene with a rigidity that allows the binder to be stored ver-
tically on shelves. It comes with an aluminum channel and plastic keeper that comprises the locking mech-
anism, as well as an aircraft cable post assembly. Binders have sheet ca-
pacities of 3, 5, and 7 inches, 19 sizes for burst and unburst sheets. FLEX-
A-BIND CORP., Pittsburgh, Pa. For information:

CIRCLE 107 ON READER CARD

optical addresser

The 60-16 optical addresser, reading from a standard punched card with the address written or typed on it, can optically print addresses on heat transfer tape at up to 18,000 an hour. The unit can be programmed by plug board to sort desired cards (masters) at up to 36,000 an hour and to stop at predetermined points to create the address tape or permit statistical analysis. ELLIOTT BUSI-
NESS MACHINES, INC. Randolph, Mass. For information:

CIRCLE 108 ON READER CARD

emulation software

The 40X package, for 360/40 users who are emulating 1401/1460 pro-
grams, reportedly speeds up emulator operation by 20-75%. Using disc spool-
ing and multiprogramming tech-
niques, the package is said to enable the running of some programs that cannot go under regular emulation because of critical timing problems.

It requires a mod 40 with at least 65K bytes of memory, a 2311 disc and typewriter. Among its features is its ability to reprint a complete page or part of a page without reprocessing the page, and to print the last page of a report first to check controls for accuracy.

COMPUTER USAGE DE-
VELOPMENT CORP., Mt. Kisco, N.Y. For information:

CIRCLE 109 ON READER CARD

oscillograph

The model 1806 is a fiber-optic CRT oscillograph—a direct-write, single-
channel, 4-axis unit that measures high-frequency analog or video data. The solid-state unit has a writing speed of more than 1 million inches/ second—reportedly 100 times great-
Why did 3M scientists decide on direct electron beam image formation for their new EDP recorder?

Because an electron beam can write on output medium as fast as the tape unit can transfer the digital data? Or because the beam can write characters with strokes 1/10th as wide as the diameter of a human hair, or as broad as those made with a dull number 2 pencil? Did the promise of a highly efficient system attainable by direct electron beam recording influence their decision?

All of the above are important features of the new 3M Series F Electron Beam Recorder. But they're not the reasons, per se, for selecting electron beam technology. The motive was much more basic than that: 3M wanted to build the EDP output recorder that computer users have been waiting for since the first day they had a backlog of computer printout.

Does an output recorder (printer) capable of writing at speeds up to 20,000 lines per minute on output media costing 1/100 per page sound like an answer to your EDP printout bottleneck? We're betting it does. But we're also betting that years from now you won't be satisfied with this speed, and you'll probably want to cut costs still more. That's why we at 3M are so enthusiastic about electron beam technology. With it, our research indicates, we can build electron beam recorders that keep pace with today's computers . . . and those of tomorrow.

Earlier we said an electron beam can write characters with smaller than hair-sized strokes. But are these micro-characters large enough to read? Yes, if the output medium is versatile, space-saving microfilm. With modern microfilm printers (3M builds these, too) hard copy is available in 4 to 6 seconds . . . with the press of a button. And to just look at a microfilm image using a viewer takes no longer than a look at a piece of paper. If you haven't been exposed to microfilm yet, talk to someone who has. Ask him how much space and time microfilm saves him.

Scientists, engineers and EDP people are always interested in efficiency. A highly efficient technique or system gives them the latitude to expand the capabilities of their project, be it a machine design, formulation or an EDP program. Not being restrained by an inefficient image recording method allows the designers of the 3M EBR to concentrate on accelerating printout speeds and other equipment advantages not possible with less efficient recording methods.

If direct electron beam recording is a panacea for EDP printout ills, why hasn't it been tried before now? It has. The technology dates back to the 1920's, and theories were presented 50 years before that. But before the computer there was no need for ultra-fast direct recording on photographic media. And when the computer age arrived, the problem was spanning the barrier between a complex laboratory model and a practical commercial recorder. 3M accomplished this by developing a unique seal between the output medium and the high vacuum inside the electron gun column, and in developing an electron beam medium suitable for EDP output. That medium is 3M Dry-Silver Microfilm.

Is 3M Dry-Silver Microfilm the ideal output for EDP systems?

Its characteristics certainly indicate it is. Resolving capability exceeds 1,000 lines per millimeter (compared with 250 lines for conventional silver-halide microfilm). The film is developed with heat, so there's no developer solution to contend with. The output of the EBR is processed microfilm, ready for use or duplication. Our standard EBR format — 16 mm roll microfilm — has long been a standard in the microfilm industry. It can be loaded into easy-to-use cartridges. Other formats are possible, too.
new products

An overcoat-pocket-sized aerospace computer, the 449 has an integral entry keyboard, display, and batteries. It has a memory capacity of 4K (24-bit) words and a repertoire of 36 instructions. The basic processor is a 4-inch cube, weighs four pounds, but with battery pack, keyboard and display it weighs 12 pounds, elongates to nine inches. It features parallel path transfers and interrupt capability. CONTROL DATA CORP., Minneapolis, Minn. For information: CIRCLE 111 ON READER CARD

ruggedized core stack

The militarized SEMSTAX (severe environment memory system) packs cores 12 to the inch, compared to the usual 8/inch, and has a capacity of 16K words of "any bit length." A 4K 24-bit stack using 30-mil cores measures 3 x 3 x 2 inches and weighs 18 ounces with mounting hardware. It meets NASA's NPC 200-4 requirement on the soldering technique used, and Mil-E-5400's temperature, shock and vibration requirements. ELECTRONIC MEMORIES INC., Hawthorne, Calif. For information: CIRCLE 112 ON READER CARD

drum memory

The type 1116 drum memory system has a capacity of more than 12.5 million bits, adaptability to 16-, 18- and 24-bit-word systems, an average access time of 8.3 msec, and a read/write capability of 1-16 64-word blocks with two IOT commands. The storage cost is said to be 0.35 cents per bit. VERMONT RESEARCH CORP., North Springfield, Vt. For information: CIRCLE 113 ON READER CARD

curve tracer

The model 3400 digitizer is designed for the reduction of analog graphic data to digital form. While the operator manually traces the curve, X and/or Y plus and minus coordinate values are automatically recorded at operator-selected increments onto mag tape, paper tape, or punched January 1967
Are you a

PROGRAMMER

who's fed up with writing sub-subroutines?

Yes

Then you may wish to consider helping program a major EDP management information system at Sanders Associates, Inc. Here, we're applying new, sophisticated systems techniques to problems in manufacturing, engineering, finance and control, and marketing. And the programming is done for the latest in 3rd generation hardware.

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A SENIOR

PROGRAMMER

with at least 3 years' experience at the senior level, and interested in systems software?

No

Do you have experience with machine- and problem-oriented languages on medium- or large-scale computers using tape or disc?

Yes

And do you have a good understanding of operating systems, compilers and general-purpose utilities, and familiarity with multi-programming and telecommunications?

No

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new products

360 has its own monitor. HAVERLY SYSTEMS INC., Denville, N.J. For information:
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data transmission
An addition to the System 311 transmission hardware is an optional card reader, making possible direct transmission from 80-column cards or the conversion of card data to paper tape. Card read speed is 90 columns/second, and the data is punched either locally for later transmission or remotely via telephone in a standard binary-coded 8-level paper tape. When converting cards to tape, the 311 may be used to skip certain fields in any of the cards. TALLY CORP., Seattle, Wash. For information:
CIRCLE 116 ON READER CARD

acoustic coupler
The Audio Magnetic Data Transceiver makes it possible to use a Teletype as a portable remote computer terminal. As long as a time-shared computer is connected through a mod 103AII dataset, the user can go wherever a phone is available, dial in, and be on the air. The transceiver operates with a mod 33 or 35 teletype. If features acoustic send/magnetic receive, with acoustic receive optionally available, and operates either half or full duplex. The 4-pound unit has a maximum transmission rate of 165 baud. TYMSHARE INC., Los Altos, Calif. For information:
CIRCLE 117 ON READER CARD

accounting software
A business dp system, the EXPAND (extensive processing of alphanumeric data) software package operates on IBM 1130 systems with a minimum configuration consisting of an 8K 1131 (mod II) processor, disc, printer and card read-punch. The package includes payroll processing, job cost accounting that encompasses labor and material distribution. Also available are subsystems such as a generalized sort package and the payroll system. COMPUTER COMMUNICATIONS INC., Inglewood, Calif. For information:
CIRCLE 118 ON READER CARD

compact computer
The second processor in the 8000 family, the S816 is a 16-bit machine with optional memory protect and parity bits, the addition of which makes it fully compatible with the IBM 1800 computer. The basic system includes

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(Translated from the Russian by J. D. Cowan and W. Turski)

This book fills an important need for up-to-date information about Soviet developments in a rapidly-growing field. The underlying assumption throughout is that images form "compact" sets in a suitable representative "space" whose "coordinates" are the distinct "features" of the patterns presented to the machine.

The image-compactness hypothesis is used as a point of reference for the analysis of different designs for the construction of pattern-recognizing machines. The algorithms underlying two well-known Western machines, the PERCEPTRON and the PAPA are also discussed in terms of this hypothesis. Contents include: Dissecting Planes Algorithm; Algorithms Based on Potentials Method; Possible Ways of Further Improvement of Cognitive Machines.

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4K of core, three hardware index registers, six priority interrupts with an I/O rate of 666,000 words/second, and an ASR-33 teletype. Memory is expandable to 32K, all directly addressable. Hardware multiply and divide speeds are 4 and 5 usec, respectively. Optional is a programmable data channel allowing the use of up to 254 I/O devices.

Software includes FORTRAN and a real-time monitor. The 8516 is compatible with System 8000 peripherals, which includes cards, tapes and discs, and a line of communication and control interfaces. Basic price is $18K. DATA AND CONTROLS DIV., LEAR SIEGEL INC., Melville, N.Y. For information: CIRCLE 119 ON READER CARD

core memory system

The CE-100 has 1-usec cycle time and is available in 1, 2 and 4K capacities with word lengths from 4 to 36 bits in 4-bit increments. Expansion is accomplished by adding bit-oriented plug-in logic boards and selection of magnetic modules. After the system is in use, the user reportedly can change his design by specifying additional modules or stacks. Maximum power consumption for the full-size system is 325 watts, proportionately less for smaller systems. LOCKHEED ELECTRONICS CO., Los Angeles, Calif. For information: CIRCLE 120 ON READER CARD

impact printer

The 990 Minityper is a 48-column impact printer with speeds up to 1200 lpm (alpha-numeric) or 2400 lpm (numeric). The unit will accept input codes up to six binary digits and can have serial or parallel bit entry. Electronics for full-line buffer are available. SHEPARD LABORATORIES, INC. Summit, N.J. For information: CIRCLE 121 ON READER CARD

repackaged computer

Version two of the 810A computer, though identical in logic, memory size, and speed to the original model, has been repackaged to provide size and price reduction and increased reliability. By using functional i.c. logic cards, each with four-five times more elements than on a standard card, the number of cards is reduced from 378 to 124. Wiring connections are reduced from 22,000 to 4,000. And the size changes from 48 inches high, 37 deep, and 72 wide, to 62 by 26 by 23½ inches. The price for a 4K model (available memory size from 4-32K) is $23,950, down from $35,500. A standard option not available before is ASR 35 teletype. Deliveries begin in March. SYSTEMS ENGINEERING LABORATORIES, Ft. Lauderdale, Fla. For information: CIRCLE 122 ON READER CARD

utility programs

For users of the IBM 1130 computer systems, the following software packages are available: disc sort, Pert/CPM, and a mag tape utility program. The configuration required is an 1130 mod II disc system with a card read-punch and printer. ASSOCIATED SYSTEMS RESEARCH CO. INC., Union, N.J. For information: CIRCLE 123 ON READER CARD

delay-line computer

A gp digital computer, the LC 1000 uses a magnetostrictive delay line for a memory, and stores from 512 to 4K words accessible in an average 2.5 msec. Word size is 16 bits, but the machine automatically works in a double-precision mode, giving 32 bits of precision (nine decimal digits). The

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CIRCLE 309 ON READER CARD  CIRCLE 310 ON READER CARD
instruction repertoire has 29 instructions, including a return instruction for subroutine linkage. There are 11 registers displayed, each of which can be individually set or cleared by the operator, and a single-command mode allows the operator to step through a single instruction. Add time is 5 msec, and multiply time is 9.5 msec average. Software includes a symbolic assembler, and peripherals include a 130-lpm printer, 16-megabit disc file, and paper tape I/O. A 512-word system with ASR 33 Teletype unit sells for $8,990 ($222 monthly), and a 4K system sells for $13,130. Delivery is in 90-120 days. LOGIC CORP., Palmyra, N.J. For information:

CIRCLE 124 ON READER CARD

computer trainer

The 6FS digital trainer consists of a 4 x 6-foot display, Data/620 computer and Teletype unit. The display panel, visible up to 30 feet, contains a color-coded computer organization diagram. As each instruction is executed, the display shows with lighted areas the register contents, information flow, and the cycle, phase and mode of the operation. Demonstrations include program interrupt applications and common addressing modes, including direct, indirect, immediate, indexing and relative addressing. Options permit demonstration of byte and extended addressing. DATA MACHINES INC., Newport Beach, Calif. For information:

CIRCLE 125 ON READER CARD

crt buffer

DDI buffer stores up to 67,000 bits at a 2 kHz bit rate. System recirculation rate is 33 msec. The package consists for four magnetostrictive delay lines, each with read, write and re-timing electronics, and has a separate interface board. The buffer may be connected in series, parallel and serial-parallel. DIGITAL DEVICES, INC., Syosset, N.Y. For information:

CIRCLE 126 ON READER CARD

bank teller set

The model 370 teller terminal is an on-line banking unit that can accumulate up to 10 transactions (account number, transaction code, date and amount) when communications lines go down, and transmit them when the system is back on the air. It has a 9x9 numeric keyboard and 12 control key indicators, reportedly can handle 100 different transactions. In one second, it prints a 28-character passbook and 28-character journal tape entry. The desk-top unit, which requires at least a 16K system, comes with a teller-unit monitoring software for the 200 series computers. HONEYWELL EDP, Wellesley Hills, Mass. For information:

CIRCLE 127 ON READER CARD

tape editor

The model 201 enables scanning of a 16-character segment of punched tape, displaying the alphanumerics on a CRT for viewing. The message field on the screen remains stationary or travels in either direction as the tape is moved. The portable unit is adaptable to 5 through 8-level tapes of all kinds, and has an optional tape spooler, either motorized or manual. DATA-VOX CORP., Sarasota, Fla. For information:

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MINIATURE DISPLAY LITE: Data sheet describes MDL series, ½" diameter indicator lites that mounts in ¾" hole on ¾" centers. Options which are available include flat top or spherical lens styles in 13 transparent or translucent colors, hot stamped legends on flat top lenses, and permanently wired incandescent or neon lamps with optional internal current limiting resistors for neon. Specifications, actual size drawings and ordering information are covered. TRANSISTOR ELECTRONICS CORP., Minneapolis, Minn. For copy: CIRCLE 141 ON READER CARD

GRAPHIC DISPLAY SYSTEM: Used as an interface between a digital computer and its display system, the Electro-store provides storage capacity, selective and fast erase, and resolution. Six-page application notes describe the coupling of the scan converter to the computer and visual display. Advantages of the system for remote displays and multi-access computers are covered. Two typical arrangements are shown in block diagrams. IMAGE INSTRUMENTS INC., Waltham, Mass. For copy: CIRCLE 142 ON READER CARD

DATA COMMUNICATIONS: Brochure details model 33 ASR set, featuring a numeric keyboard. With the exception of the keyboard, the unit is identical to the standard model 33 ASR set featuring page printing and paper tape punching and reading capabilities. Besides the numerals 0 through 9, the keyboard contains four alphabetical characters (A through D) to multiply the range of possible code combinations. Remaining keys control non-printing machine functions. Although the keyboard transmits only numerics and the four letters, the set can receive the entire range of alphanumericics in either page copy or punched paper tape form. TELETYPING CORP., Skokie, III. For copy: CIRCLE 143 ON READER CARD

FORMS HANDLING: Two brochures detail solid state forms handling machines: processor whose speed is controlled by electric eye, and mobile multi-ply forms burster including details and dimensions of the burster and accessories. TAB PRODUCTS CO., San Francisco, Calif. For copy: CIRCLE 144 ON READER CARD

DATA MODEN: Modem 4400, developed to transmit 2400 bps on unconditional voicegrade, can schedule four telephone lines. The modem requires 800Hz bandwidth of the telephone line channel. It eliminates the need for special line conditioning and allows additional data to be transmitted simultaneously over the remaining bandwidth. MILGO ELECTRONIC CORP., Miami, Fla. For copy: CIRCLE 145 ON READER CARD

INVENTORY RECORD: 36-page book for recording monthly use of dp forms has hard cover and can be used for 30 forms covering a two-year span. Individual pages are arranged for detailing form numbers, descriptions, vendor names, delivery time and prices. Space is also provided for quantities ordered and received and month-end inventory, month usage, and year-end totals. SHELBY BUSINESS FORMS INC., Shelby, Ohio. For copy: CIRCLE 146 ON READER CARD

PROCESS CONTROL: Eight-page bulletin describes how instruments and systems control sugar production, from juice extraction to granulating. Application diagrams show typical clarification liming pH control and corn syrup-liquid sugar blending systems. Direct digital computer control with the PCP-88 digital blending and central

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lized analog blending are explained. Electronic and pneumatic recorders-controllers are pictured with associated transmitters. THE FOXBORO CO., Foxboro, Mass. For copy: CIRCLE 147 ON READER CARD

GLOSSARY: Designed to assist the computer-using executive, the 320-term glossary is a condensed version of the Standard Vocabulary for Information Processing published by the American Standards Institute. Glossary is designed for the user and is prepared in booklet form. Cost: $.25 per copy, $20 per hundred and $100 per thousand. DEPT. CG., NEWSWEEK, 444 Madison Ave., N.Y. 10022.

INDICATOR LITE: Compact lite plugs into a panel mounted socket for replacement without tools. Outlined in data sheet is the RCL Series, which is only .33" in diameter and is offered in four styles: long, short, flush and spherical flat top; each available in 10 lens colors. Also described is the replaceable cartridge lite holder, RCLH series which can be front or rear panel mounted in ¾" holes on ¼" centers. TRANSISTOR ELECTRONICS CORP., Minneapolis, Minn. For copy: CIRCLE 148 ON READER CARD

ELEVATED FLOORING: Brochure gives design information, detail drawings, and specifications for flooring used with computers and other installations where access to building utilities and electric cables is desired. Offered are guidelines for selecting specific types of installations and illustrated data on attendant hardware such as modular air conditioning units for computer environments, room partitions, and aluminum handrails. LISKEY ALUMINUM INC., Glen Burnie, Md. For copy: CIRCLE 149 ON READER CARD

ROUTINES TO READ NATURAL TEXT: 141-page book describes a set of subroutines for the IBM 7040/44 for reading textual material with complex formats and coding conventions-questionnaires, library catalog cards—from any external medium into the high-speed store of the machine. Different kinds of information in the input are recognized by explicit markers, position on the line or page, or syntactic clues given by other items. Routines may be called from either FORTRAN-coded or MAP-coded programs. Cost: $4; microfiche $1. AD-637 303. CLEARINGHOUSE, U.S. DEPT. OF COMMERCE, Springfield, Va. 22151.

HYBRID COMPUTERS: 16-page brochure discusses how a hybrid computer has been used to solve a chemical processing problem concerned with the refinement of chemical processes involving the interaction of a number of different chemical and petro-chemical compounds. Hardware, software, organizing and programming a hybrid computer are also covered. Memory, I/O and speed of the Beckman/SDS/2200/920, 930 and 9300 are listed. BECKMAN INSTRUMENTS INC., Fullerton, Calif. For copy: CIRCLE 150 ON READER CARD

GP DESK TOP COMPUTER: Brochure introduces series 480 processor which provides up to four data channels, 8-msec core memory and binary and decimal arithmetic. Brochure also includes an instruction list and specifications. Features include random access memory, byte-oriented, code independence, variable word length,
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I/O, integrated circuit construction, instruction format. BUSINESS INFORMATION TECHNOLOGY INC., Natick, Mass. For copy:

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CIRCUITS CATALOG: Contains 4,629 off-the-shelf standard circuits produced by 49 manufacturers. Circuits are listed by major electrical characteristics, cross-referenced to outline drawings, including schematics with pin connections. Within each major technical section, circuits are further broken down into specific types—78 sub-categories in nine sections. Circuit Tabulation is available on subscription basis for $32.50/year, U.S. and Canada; $36.50 elsewhere. PUBLISHER D.A.T.A., INC., Box 46, Orange, N.J. 07050.

DISSEMINATION OF COMPUTER PROGRAMS: Documentations on programs developed by or for NASA are furnished without charge; however, a nominal duplication and mailing charge is assigned for each program tape or card deck disseminated. Periodic announcements in abstract form describe current available computer programs. COSMIC, COMPUTER CENTER, UNIV. OF GEORGIA, Athens, Ga. For copy:

CIRCLE 152 ON READER CARD

ANALOG AND HYBRID SERVICES: Types of problems which can be solved and services offered are outlined in four-page brochure. Consulting, programming, computation and simulation, analysis and applications and industries are covered. MCDONNELL AUTOMATION CENTER, St. Louis, Mo. For copy:

CIRCLE 153 ON READER CARD

OSCILLOSCOPE DISPLAYS: Job sheet explains how to photograph images or traces displayed on a cathode-ray tube. Included are setup for single frame recording; adjusting the oscilloscope; recording stationary patterns, recording single sweeps, selecting photographic film and processing. EASTMAN KODAK CO., Rochester, N.Y. For copy:

CIRCLE 154 ON READER CARD

SPlicer: Bulletin describes unit which is designed to repair and/or reinforce Friden 3 x 7 edge punched cards and can also be used for normal tape splicing. COMPUTER ACCESSORIES CORP., Huntington, N.Y. For copy:

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The French computer company Cie des Machines Bull said from its Paris headquarters late last month that the new year would be a time of preparing for expansion rather than contraction. Rumors that the Bull group of companies was cash-short and ready to close down their major production plant at Anger were denied. Stories concerning the group's difficulties were attributed to speculators' handling on the Paris Bourse of the company's stock, which has been a highly sensitive target of investors for the past five years.

Reports that Machines Bull would seek cash for a capital increase from shareholders started in the second week of December. This turned out to be an increase of the capital of Société of Societé Bull-General Electric (the U.S.-French combine) from 157 million to 196.25 million Francs. The increase involved no disbursement of the part of Machines Bull of any of its 51% stake in SIBGE. Cie des Machines Bull also denied reports of dissection between the French and American companies, and said that stories about a retraction of large-machine manufacturing did not concern them as all the bigger computers were planned by GE for production in the states.

An experiment in the computer-assisted selective dissemination of information, sponsored in the U.K. by the National Electronics Research Council, has been merged with a similar project of the Institution of Electrical Engineers (IEE). Now to be called Inspec, the joint scheme will provide engineers and scientists with a technical abstract service for information in physics, electro-technology and control.

The European Atomic Energy Community (Euratom) has also started the first automatic documentation system covering nuclear science and technology with its Centre for Information and Documentation (CID). Biographical references and key words for 400,000 documents of nuclear interest are on mag tape, and Euratom expects to add 100,000 a year. Users send in the search spec and receive photocopies of material. After the first general trials within Euratom this year, CID will be open to scientists and industrialists of member community countries.

Three years ago, an IBM executive visiting Europe said the information retrieval market would burgeon in four years. His prognostication appears to be coming true, judging by the volume of current activity. At the Technological Univ., Eindhoven, in the Netherlands, an IR scheme is being planned for a 360/30; in Ireland, Queen's Univ., Belfast, is experimenting with a regular automatic library circulation by user-interest, on an ICT 1905, to be brought into a time-sharing system in April by updating to an ICT 1907.

Further afield, the Univ. of Toronto library is well into an investigation in connection with the

(Continued on page 103)
HAIL TO THEE, BLITHE SPIRIT!
And all such spirits . . . passed.
The freedom of the air is gone.
The earth controls the sky.

NATIONAL AIRSPACE SYSTEM
MITRE is currently augmenting its top-flight team of systems men in the suburban Washington, D.C. and Atlantic City, N.J. areas. Their mission: to provide the system engineering to the Federal Aviation Agency on the new National Airspace System — an air traffic control system for the 1970's. Their job encompasses such technical areas as broad level system analysis, computer program analysis, system specifications, system logical design, system test planning for design verification, and configuration management.

Working on this project you would engage in such activities as: translating system operational objectives into technical requirements for the system's subsystems; synthesizing the technical characteristics of equipment subsystems of balanced reliability, and analyzing alternatives; reviewing and analyzing, at the logic level, design submissions of system hardware contractors; conducting design optimization studies with respect to cost, reliability, and technical suitability; or synthesizing software designs for a multi-processing computer environment.

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Scientists and engineers are also needed in our Washington Office for systems analysis and feasibility studies, communications system 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 Worldwide Military Command and Control System — a group of systems operated by the unified and specified commands.

NATIONAL RANGE DIVISION
Qualified senior engineers and scientists are needed at MITRE's office at Patrick Air Force Base, Florida, to assist in direct support programs for the National Range Division (NRD) of the Air Force Systems Command. NRD was established as central planning authority to insure the efficient use of existing and future national range resources. The work is of vital importance to the Department of Defense space programs and in the support they are providing to NASA. MITRE's mission is to assist the National Range Division in their development of the future system requirements for the Eastern and Western Test Ranges. In addition to systems-oriented planning and operations research activities, the work includes studies of range functional subsystem categories: radar, telemetry, optics, communications, and data processing.

If you have three or more years' experience and a degree in electronics, mathematics or physics, write in confidence to Vice President — Technical Operations, The MITRE Corporation, Box 208AU, Bedford, Mass.

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Pioneer in the design and development of command and control systems, MITRE was formed in 1958 to provide technical support to agencies of the United States Government. MITRE's major responsibilities include serving as technical advisor and systems engineer for the Electronic Systems Division of the Air Force Systems Command and providing technical assistance to the Federal Aviation Agency and the Department of Defense.
Ontario New Universities Library Project (Onulp). Basic shelf list library data is being converted at Toronto into machine readable form, and by this summer an eight-man team is expected to have covered 200,000 titles as the foundation of automated circulation control. A serials control system is in final stages of design, and programming has begun for preparation of an off-line system for the first two years of operation. A 7094 is in use now, to be supplemented by a 360/50 with remote terminals later in the year. Toronto's library is to be one of 16 participants in the Library of Congress MARC pilot project.

In Germany, the Technical Univ. of Berlin is using a small Zuse computer and Siemens peripherals at circulation counters for a small automated technical library control project. Across the Iron Curtain at Prague, the State Technical Library has 1300 titles under punched card control, and plans an abstracting information retrieval service based on an IBM machine for the future.

Preliminary figures show ICT turned a $1.5 million loss last year into a $4.5 million profit this fiscal year. Sales for the 1900 series exceeded expectations with a total to date of 640 (226 for export); 250 have been delivered so far with 88 to extra-U.K. buyers. ICT's 1901, undoubtedly the European machine of the year, accounts for more than one-third of the company's sales. Value of the order book is around $200 million. ICT is particularly pleased with a recent $400,000 order from paper products manufacturer Kimberly-Clark for a 1903 with discs, because the parent company is an American-based IBM customer. Cracking the strongholds of the international groups is not the easiest for European manufacturers if their prospects are planning from a central U.S. base.

The 18-month-old U.K. firm Interdata Ltd. has taken over manufacturing and marketing rights of a desk-size dp system from Georg Meckel of Munich. In a combined deal, machine fabrication will be split 60% British and 40% German. Renting at $125 a week, the Interdata machine incorporates a calculator with six storage registers, plugboard programming, and optional printer, card reader and punch. The new arrangement broadens the marketing of the system, initially designed for the auto spares and repair business.

The Trust Bank of Africa has ordered $6.6-million worth of Burroughs gear, including six B3500's -- two each for Cape Town, Johannesburg and Durban. For on-line account processing, the complex will handle 200 window teller sets, 100 inquiry terminals, and 50 communications terminals ... In Japan, the first Univac 494 went to Kawasaki Steel Corp. to link four business offices and two steel plants. It may become Japan's first real-time MIS system ... Dr. J. M. M. Pinkerton, research manager of EELM, has been elected president of the European Computer Manufacturers Assn. ... The Centre Anversois, Antwerp, estimates that Belgium has 300 computers installed, 200 on order ... Ferranti Ltd. reports orders for 97 Argus computers worth $15 million, plus 800 display systems for process control and reservation control work.
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January 1967
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Western Union called for a broad computer utility investigation, while IBM advocated a narrow one, in comments filed with the FCC last month. Probably, the discussion will turn out to be broad -- covering all dp charges and services, not just those involving regulated communication channels.

The breadth of the inquiry is important because it could lead to FCC regulation of some service bureau activities, and bring AT&T into the dp field. Ma Bell is now barred from offering services that are not subject to public regulation.

This month, the commission plans to begin collecting answers to the questionnaire it issued last November. First, comments will be invited on present and future data processing applications of computers and communication channels, on rates and related matters. Respondents will have at least four months to reply. Afterward, the commission will ask for comments on the policy issues involved in computer utility regulation.

Local dp industry sources contend the inquiry is far too leisurely. One observer points out that by the end of 1967, WU's Info-MAC system will probably be operational nationwide. He's afraid that when FCC finally gets around to rule-making, non-carrier suppliers of dp equipment and services will have lost valuable ground.

FCC has extended Telpak A and B services until May 1, giving users more time to adjust. After that date, "unified private line" rates will go into effect. The new rates are to be announced this month by AT&T; dp industry observers believe the charges for multiple channels will be well above Telpak A and B levels. Bringing the unified rates down is likely to be difficult.

The General Services Administration last November asked the commission to approve unified rates without an effective date, "pending determination of their ... reasonableness in the (general telephone rate case)." Under this plan, users would continue to enjoy Telpak's economies during the months, and possibly years, it took FCC to determine whether unified rates were reasonable. But now, users will pay unified rates during this period.

Drastic changes in federal mag tape specs and acceptance procedures are likely this year. The new specs, proposed by GSA, would require makers of both tapes and read-write heads to change their final testing procedures. Manufacturing operations would have to be altered to improve quality control. GSA also wants to establish central testing facilities, where tapes purchased by all federal agencies would be certified. Now, only a few of the bigger agencies do their own certifying; others rely on the manufacturer. Facilities would be built with adp revolving fund money, or with contributions from the agencies participating in the projected testing program. Meanwhile, improved tape-certifying techniques are being studied by NBS. GSA's ire was aroused after one agency purchased 1,500 tapes and found that 1,000 were defective. Reportedly, there have been several other cases almost as bad.
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FIELD SUPPORT ENGINEERS: To maintain equipment and provide technical advice and direction regarding equipment operation, maintenance and testing. Will recommend design modifications for performance improvement. (Mr. Abrahamson).

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PROGRAMMER ANALYSTS: Perform in the area of data transmission, data collection systems diagnostics, management information systems, message switching, simulation and operations research. College degree plus experience in one or more of the above areas. (Mr. Kinney).

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Alvar Ellegard is a Swedish statistician and literary scholar. In 1962 he published two thin volumes. One of them—Who Was Junius?—reads like a murder mystery. The other, with its word lists, statistical tables, charts and formulae and a rather arid title, reads like an advanced text in mathematical linguistics. Both books confront a major mystery in English literary history and show how Ellegard solved it with the help of an electronic computer at the Chalmers Tekniska Högskola in Gothenburg. What the computer helped to reveal—eerie and conclusively—was an identity that had been shrouded for 190 years.

Literary scholars had suspected who Junius was, but they did not know who he was. They knew that someone writing under that modish pseudonym had printed the first of a series of witty and elegant letters on political topics in a popular daily newspaper in London—the Public Advertiser—on January 21, 1769. Junius' last letter came out three years later to a day. Then he was silent. But in this short time the epistles of "the invincible Junius" had conquered literary England.

With superb insouciance and great argumentative skill, an anonymous writer had ridiculed his king, slandered a whole bevy of lords and ministers, elaborated a more or less consistent political philosophy and won for himself the enviable reputation of being one of the finest masters of invective in English who had ever lived. But he had not revealed his identity. As late as 1961, nobody knew for sure whether Junius was Edmund Burke or Edward Gibbon, Lord Sheffield or Lord Chesteron, or (what more likely in the light of circumstantial evidence) a more obscure parliamentarian known as Sir Philip Francis. About 40 Junian candidates had been proposed since 1772. How could anyone name him now, 190 years after his letters first saw light?

Ellegard did so by means of an intricate system of stylo-statistical analysis. It took a good deal of time. Computer specialists helped him. Then, when finished, he wisely wrote two parallel accounts of his project and its significance. One of them emphasizes in a brisk, lucid way the bibliographical and literary aspects of the case.

We learn of a bright and rather frustrated young secretary in the War Office, Philip Francis indeed, 29 when he took up his glittering mask and 32 when he dropped it forever. Francis was intensely proud and irascible. He must have been inordinately fond of mystification. He went on to a genteel career in politics, was knighted and retired comfortably. But he denied in the year of his death at 78 that he had anything to do with Junius. Except for a curious, unexplained wedding gift to his wife—a pretty bound copy of the Junius Letters—he was careful to leave no telltale clues and so took his great secret quietly to the grave.

His mask had allowed him absolute freedom of expression during the Junian years and in old age that colossal vanity and irritableness to which his biographer attested probably led him to hug his precious secret close. For "part of Junius' greatness lay in his anonymity," as Ellegard reasons, and "to destroy that anonymity by disclosing the secret would have been to destroy the best part of Francis himself." As a young man he had seen himself as the heroic character of his own creation. Intense public speculation as to that character's real-life counterpart, continuing after Sir Philip's retirement and to the day of his death, nourished the elder statesman's dream-world. (In his prolific later writings under his own name, Philip Francis had never been able to match Junius' controlled fire and wit.) In general, this explanation for the man's obstinate refusal to admit that he was Junius is psychologically valid even if conjectural.

On the other hand, Ellegard's stylo-statistical procedures leave no room for further conjecture as to whether Francis was Junius. This thesis is impressively proved and it is Ellegard's main point. In Who Was Junius?, a single chapter summarizes
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books

the technical procedures that demonstrate the virtual certainty of the identity. In A Statistical Method they are spelled out step by step, program by program.

Ellegard starts with two interesting assumptions about literary style. (They are meticulously qualified.) The first is that if there are any truly constant features in a style they will not be deliberate ones, such as an author’s use of classical images or antithetic sentences, but rather the result of more or less automatic habits. Hence relatively unimportant style choices—a favoring of on instead of upon, or of no doubt instead of doubtless—will be more useful in identification than the more literary qualities of a style.

The second assumption is that what linguistically distinguishes one writer from another is not the use or non-use of certain words but differences in their frequency of use. (”Non-use,” for Ellegard, “is simply an extreme case of infrequent usage.”) The word uniform, for example, was very common in the late 18th century. Junius uses it 23 times in a total of 82,200 words in the Junius Letters. So the “relative frequency” of uniform for Junius is 23 in 82,000, or 280 in a million, or 0.000280.

To find out whether Junius used such a word either more or less frequently than his contemporaries Ellegard compiled a “million-word sample” from other writings of the time (mainly formal essays and political tracts). Since the frequency of uniform in the million-word sample turned out to be 65, or 0.000065, which is less than a fourth of the Junian figure for the word, Junius may be said to use uniform more often than the average for his time. This word becomes, for Ellegard, a “Junian plus-expression.” As such it has diagnostic value. By finding a large number of “Junian plus-expressions” and (in cases where Junius uses a word less frequently than the average) “Junian minus-expressions,” it is possible to draw a statistical picture of some of the constants in the Junian style.

Ellegard’s diagnostic list finally included 458 “plus” or “minus” words and phrases culled from Junius. Then began the problem of determining whether any known political writer of Junius’ time could be said to come near the Junian frequency of usage for all 458 expressions and combinations of them; and Francis’ own signed writings were put to the test.

Obviously, I indicate only several steps in Ellegard’s complex process. Significantly, a good deal of his calculation had to be “carried out by electronic computer,” as he writes, “because of the huge number of raw data involved.” And it is in the diagrams finally constructed from his computer’s calculations that one sees revealed in a remorseless and—if I may be pardoned for borrowing a phrase from Whodunnit blurbs—positively haunting and spine-tingling manner the fact that the 29-year-old Philip Francis and only he could have been the author of the Junius Letters.

In diagram after diagram that writer’s linguistic portrait looms up to overlap or fall closely adjacent to Junius’ own. The testing list is larger than it would need to be to rule out coincidental resemblances. (The probability of any other writer falling within the Junian “ranges” of frequency, as Francis does, is about one in 462,000.) Indeed, Ellegard works hard to disprove the identity he finally establishes. He repeatedly challenges his own methods.

“The statement that Sir Philip Francis was Junius may henceforth be allowed to stand without a question.” And to this modest conclusion one readily assents.

Very well, Francis was Junius. But what is the final meaning of Ellegard’s work? Perhaps it is still too soon to tell. His demonstration depended on a computer—and so have other demonstrations. Yet I think there is a difference. Stephen M. Parrish’s remark in 1964, that the computer can help make a better critic of a literary man, is a good deal less jolting today than it would have been before Ellegard’s books. Of course, computers have been used profitably in many phases of literary study. Machine-made concordances such as those edited by S. P. Rosenbaum and Professor Parrish at Cornell have proved themselves. Automatic language translation has a history behind it and linguists have been using computers for years. But the literary critic has looked in vain until recently for evidence that computers could be useful to him. Ellegard brings the computer to the critic’s attention precisely because his work enables one to discuss the Junius Letters in relation to Francis’ other writings meaningfully for the first time.

What lies ahead? Hundreds of other problems in textual attribution await the researcher armed with electronic equipment. Stylistics, metrics and prosody, and most other focal points in literary study will yield—as indeed they are yielding—secrets to those who can direct computer-type
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books

research. Our deep-rooted suspicion in the English Department that in some way machines and statistics are injurious to the critical sensibility is passing. (It is, or ought to be, a truism that the computer is no substitute for either sensitivity or insight. Nor is it iminical to either.) In short, the electronic machine can aid sensitive critics in innumerable ways—and our realization of this owes much to the one that helped to say who Junius was and to Ellegard's lucid explication of a method.

—PARK HONAN

PROPOSED SYSTEM/360 INSTRUCTIONS

(Many suggestions have been received for additions to the System/360 instruction list. Most of the entries in this collection came from the San Francisco Bay Area ACM newsletter, The Bit Dropper.)

BH Branch and Hang
IIB Ignore Inquiry and Branch
TDB Transfer and Drop Bits
DO Divide and Overflow
SRZ Subtract and Reset to Zero
PI Punch Invalid
SSJ Select Stacker and Jam
FSRA Forms Skip and Run Away
RASC Read and Shred Card
SRSD Seek Record and Scar Disc
BST Backspace and Stretch Tape
RIRC Read Inter-Record Gap
UER Update and Erase Record
EM Emulate 407
SPSW Scramble Program Status Word
EOIC Execute Invalid Op Code
EROS Erase Read-Only Storage
PBC Print and Break Chain
CM Circulate Memory
MLR Move and Lose Record
CRN Convert to Roman Numerals
DMPK Destroy Memory Protect Key
DC Divide and Conquer
EPI Execute Programmer Immediate
LCC Load and Clear Core
HCF Halt and Catch Fire
people

- Ray R. Eppert, chairman and chief executive officer of Burroughs Corp., has announced plans to retire February 1, terminating a 46-year career with the company. He will be succeeded by Ray W. Macdonald, president.

- Russell W. McFall, president, Western Union, has been elected to succeed Walter P. Marshall as chairman of the board of directors. Mr. Marshall, who is retiring from that position, will continue to serve as director.

- At Univac, Carl J. Knorr resigned as vp marketing, and was replaced by Joseph L. Sturdevant. Adrian Boss replaces Sturdevant as vp, marketing for commercial systems. Neil Gor­chow, director of systems programming, is a new vice president.

- W. Walter Watts, group executive vp at RCA, has been named manager of the company’s defense electronic products, broadcast and communications products and graphic systems divisions. Former group vp for these divisions, Arthur L. Malcarey, has been appointed executive vp, manufacturing and materials.

- Ralph T. Dames, formerly manager of Simulation Systems at Scientific Data Systems, Beverly Hills, Calif., has founded and is president of Spectrodata Inc., Redondo Beach, Calif. The firm specializes in hybrid simulation and real-time programming.

- Herbert R. Koller has joined the management sciences dept. of EBS Management Consultants Inc., Washington, D.C., as director of client services. He was formerly with the U.S. Patent Office.

- Leon D. Findley is now vp, systems and program management, Sperry Rand's Univac Div. in Roseville, Minn.


- Charles H. Deming has been appointed manager, business systems and programming department, The Stanley Works, New Britain, Connecticut.

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Telecomputer Corp., two-man subsidiary of Tabulating & Business Services, is developing programs for time-sharing systems. The five-month-old firm, led by ex-GEer Kenneth Kretschmer, is working with GE on an economic data bank for a time-sharing facility and with Stewart-Warner Electronics in development of a computer-system information which will operate 10 display panels at EXPO '67, giving exhibit waiting times, parking lot load information etc.

Palo Alto's Data Disc has received a healthy $450K financial injection and says it's solved the technical problems which plagued it last year. The company now warrants its discs for one year. ... Computer Sciences Corp. will reorganize this year, with Fletcher Jones' CSC serving as a corporate umbrella for Computer Sciences Division and other autonomous operations. The company in '67 will push an on-line ticketing service, lay the groundwork for other similar service activities, invade Europe in a big way. ... Applied Data Research's Autoflow flowchart generator has been accepted for inclusion in the GSA schedule. It's the first software to be so honored, and signals another step toward separation of hardware/software pricing. ... IBM is quoting delivery of up to 24 months for some items. The production lag forced the company to bid 1460's on one proposal. Meanwhile the company has withdrawn the 2402 dual tape drive, and 2403 (drive plus controller) from its line, interpreted by some as implicit admission of tape drive reliability problems. ... Data Machines Inc., Newport Beach, is coming out with an integrated circuit version of its 620 computer. The IC 620-I is compatible with the 620, runs at about the same speed, but is cheaper. The basic system sells for less than $15K...basic 620 is about $28K, although standard 620 features are optional on the 602-I. ... IBM's trillion-bit photo optical mass storage system produced for AEC is reportedly being marketed commercially with a two megabuck price tag. ... TWA is picking up its first option for 1700 more crt agent sets from Burroughs, increasing the contract by $13.7 million for a total of almost $25 million. The airline has other options, including one for 1200 more crt sets! ... ITI has upgraded its 4900, which now offers a 30-mil 1.75 usec core, with a 20-mil, 2%-D under-1-usec core also available. ... One customer feels he was lowballed by IBM. The original proposal to replace a 7085/1400 series combo was for a 360/40. That escalated to a 360/50, but the company now has two 50's, is being advised to add a third. ... Mohawk Data Sciences has delivered 3300 of its keypunch-mag tape recorders, expects to produce 100 a week in '67. At the end of the year the aggregate value of units installed should be around $45 million. This year too they'll announce more models, including a 9-channel unit, one with communications capabilities. ... Marc Goldwater, whose GPI computer-making venture folded last year, is back in business as Advanced Logics Lab. He's building a prototype of a digital display driver, tinkering with an inexpensive I/O device. ... One small manufacturer says that his mainframe material costs are only $5-10K/unit.
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January 1967
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CIRCLE 355 ON READER CARD

Dashew Business Machines ........................................ 14
Data Disc ..................................................................... 15
Data Packaging Corporation .......................................... 123
DATAMATION Magazine .................................... 111, 114
Digital Equipment Corporation ..................................... 60, 106
Eastern Air Lines ...................................................... 119
Electronic Memorials ................................................. 100
Engel Instrument Co. .................................................. 62
Fabri-Tek, Incorporated ............................................... 68
Fenwick Corporation of America .................................... Cover 4
Fomax, Inc. .......................................................... 79
Fox-Morris Personnel, Inc. ........................................... 116
General Electric Co., Printer Reader Business Section ......... 110
Graham Magnetics Incorporated .................................... 36
Robert Half Personnel Agencies ................................... 116
Hewlett-Packard Corp. .............................................. 107
Honeywell, Computer Control Division .......................... 3
Honeywell Electronic Data Processing ............................ 120
Hughes Aircraft Company, Aerospace Divisions ............... 124
Hughes Tool Company, Aircraft Division ....................... 90
IBM Corporation ...................................................... 104
IIT Research Institute ............................................... 127
Information Development Company .............................. 51
Information Sciences Associates .................................... 118
IIT Federal Electric Corporation ................................... 121
Kelsey-Hayes Company .............................................. 116
Everett Kelley Associates ............................................ 108
Le Salle Associates .................................................. 76
Lockheed of Computer and Information Sciences .............. 77
Lockheed Electronic Company ..................................... 109
Lockheed Missiles & Space Company ............................. 96
MAC Panel Company ............................................... Cover 3
Magnetic Media Corporation ......................................... 48
Management Information Systems ................................. 91
Massachusetts Institute of Technology, Computation Center ................................................................. 108
Massachusetts Institute of Technology, Instrumentation Laboratory ......................................................... 85
McFadden Associates .................................................. 108
McGraw-Hill Book Co. ............................................... 76
Memorex ............................................................ 59
Methods Research Corp. ............................................. 91
University of Missouri, Computer Research Center ........... 90
The Mitre Corporation ............................................... 102
Mohawk Data Sciences Corporation ................................ 6
Monroe International Corporation, A Division of Litton Industries ......................................................... 71
Multigraph Division of Addressograph Multigraph Corporation ................................................................. 61
The National Cash Register Company ............................. 73
The National Cash Register Company, Electronics Division ................................................................. 124
Philco Houston Operations .......................................... 98
Philco Ford, Communications & Electronics Division ........ 87
Planning Research Corporation ...................................... 66
Potter Instrument Co., Inc. ............................................ 90
Raytheon Company .................................................... 105
RCA Electronic Data Processing .................................... 82
RCA Service Company ............................................. 93
Recognition Equipment Incorporated ............................ 9
Reynolds Electrical & Engineering Co., Inc. ..................... 83
Sanders Associates, Inc .............................................. 86
Scientific Data Systems ............................................. 20
Skirsksky Aircraft, Division of United Aircraft Corporation ................................................................. 92
Siemens America Incorporated ..................................... 4
Stanford Linear Accelerator Center ................................. 88
Systems Engineering Laboratories .................................. 35
Systems EDP ................................................................ 83
Tally Corporation ..................................................... 11
Teletype Corporation .................................................... 2
Texas Instruments Incorporated .................................... 18
Thompson Book Company .......................................... 89
3M Company .......................................................... 64, 65, 84
Univac, Division of Sperry Rand Corp., Data Processing Division ......................................................... 74
Univac, Division of Sperry Rand Corp., Defense Division ................................................................. 75
Univac Division of Sperry Rand Corporation ...................... 63
URS Corporation ...................................................... 95
Xerox ................................................................. 94
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COST ENGINEERS — ESTIMATING ENGINEERS, BS Engineering or Accounting with experience in financial management of industrial construction.

DEVELOPMENT ENGINEERS, BS or MS Chemical, Mechanical or Textile Engineering, with experience in polymer or fiber process development at Semi-Plant level.

RESEARCH CHEMISTS, BS, MS, or PhD with experience converting new polymers into fibers and modifying fiber properties for specific end uses.

Please send resumes to: A. M. GESLER, Supervisor Personnel, FIBERS DIVISION—TECHNICAL CENTER, P.O. Box 31, Petersburg, Virginia 23803

CHESTERFIELD PLANT:

SUPERVISOR — PROCESS IMPROVEMENTS, BS, ChE, BSME, BS Tex. E. 5-7 years in process improvement. Work involving spinning and processing of melt polymers, especially nylon. Needs sound engineering background, good mechanical comprehension and supervisory experience.

PRODUCTION SUPERVISOR. BS Engr. & Textiles. 5 plus years experience in synthetic yarns. Ability to train and direct shift foremen. Ability to produce and maintain desirable yields and costs.

MAINTENANCE ENGINEERS, BSME, BS, ChE, BSCE. Several years experience in plant maintenance. Power plant experience desirable or background in projects engineering in synthetic fibers plant. Proven record of cost reduction. Supervisory experience necessary. Should be resourceful and able to carry projects through to completion with minimum of direction.

ENGINEER — PROCESS CONTROL. Physical Science Graduate. Work in process improvement, control and evaluation. Strong math background with experience in statistical methods and application. Process simulation and analog and digital computer application helpful.

Please send resumes to: E. J. RENDO, Supt. Employee Relations FIBERS DIVISION, P.O. Box 831, Hopewell, Virginia 23860

COLUMBIA PLANT:

SUPERVISING ENGINEER — In charge of fiber processing equipment design group of our Plant Engineering Department. Must have heavy experience in machine design. Bachelor's degree in Engineering — 8 years minimum experience. Will design or specify new equipment for 45 million dollar nylon plant. Responsibilities also will involve trouble shooting existing equipment and processes. Encompasses carrying a project from conception through design, construction, and start-up. Fibers experience is preferred but not essential.

MAINTENANCE ENGINEERS — Investigate equipment and production problems, plan, implement, and co-ordinate maintenance programs, and maintain schedule work loads. Liaison with maintenance foreman, process and plant engineers on re-engineering, design, selection, installation, and operation of equipment. BS degree in Engineering.

PLANT ENGINEERS — minimum of 2 years industrial design experience plus some understanding of development, construction, maintenance, and operation, preferably in chemical or fibers plants. Will be assigned engineering projects of a complex nature having complete responsibility for the assigned projects, from conception through design, start-up and shakedown. BS degree in Engineering. The following areas are available:

Instrumentation Engineer (CHEMICAL) — experienced in the application and design of standard pneumatic and electronic control instrumentation related to chemical or fibers operations.

Utilities Engineer — Work involves the design of new service facilities and re-design of existing facilities to increase output and efficiency, etc. Familiar with industrial plant steam, water, and service piping design. Heavy air conditioning experience preferred.

Chemical Plant Design Engineer — familiar with the broad scope of unit operations and the chemical design of continuous or batch plants. Prefer experience in polymerization, drying, distillation and high temperature heat transfer media.

Machine Design Engineer — familiar with machine design principles related to gears, cams, and high speed rotating equipment.

Please send resumes to: E. J. CARROLL, Employment Supervisor FIBERS DIVISION, P.O. Box 1688, Columbia, S.C. 29202

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January 1967 CIRCLE 344 ON READER CARD 129
OVER HERE

As an American in Europe who is involved in computer activities, I would like to present some opinions in conflict with those expressed in the September DATAMATION editorial.

To this American, Europe is a vastly underestimated territory of business opportunities. The different languages, people and customs of the various countries really provide a challenge to understanding, appreciation—to make friends and profits. To underline this personal opinion, let me quote from Business Week, Oct. 29, 1966, p. 60:

"Superior know-how stemming from scientific and technical developments in the U.S. has enabled American companies to grab big shares of European markets in critical growth industries such as aircraft, space equipment, nuclear energy, computers and other electronic products. The American advantage in some of these fields is so great that Europeans fear they may never be able to catch up with the pace of U.S. technology."

Before coming to Europe as an expatriate two years ago I might have been inclined to write similarly, as in the September Editor's Readout. But even as an occasional visitor I would have recognized that Europe cannot be treated as an entity, with similar conditions throughout, as suggested in the editorial. What may be true in France, for example, is not necessarily true in Germany or Holland. "Full employment" happens not to be the case in Italy, nor is the "penchant for family and personal ties" universally true.

While we're at it, let me correct some other statements. The "long lunch" is not particularly popular in England and, in defense of the English, they are normally quite punctual with their appointments. On the other hand, long lunches are the rule in France and Italy, where business hours are adjusted accordingly. So the American in Italy should not be shocked to be offered an evening appointment.

The statement that "employers can't lay people off" is totally incorrect. While it is perhaps more difficult than in the U.S.—one must have sufficient cause, such as lack of work or very poor performance—it certainly is possible. Another difference is that longer notice is usually required, ranging generally from six weeks to six months depending on the length of service and position. And in some countries, separation pay is legally required. As an employer (and this opinion is shared by others), the disadvantages inherent in this system are offset by a very significant advantage, that of stability, for the sword cuts both ways: the employee has a similar obligation with respect to resignation. Some barriers do indeed exist, although the linguistic one is not so much of a problem since most people in the data processing business (except perhaps the British) are at least bilingual.

The "existence of mistrust, fears and hatred" is an exaggeration. Mistrust on a national, general basis does not, to my knowledge, exist at all. I've never heard the comment "I don't trust so and so because he's (national-ality)," and I would have had, as an American, ample opportunity to hear such remarks. Fear exists, in a political sense, and, though moderate, is applied from time to time to the West Germans, particularly because of recent successes of the rightist party, the NDP, at the polls. Hatred ... well, one senses a moderate form of it—by the French vis-a-vis the Americans. (One wonders sometimes why there isn't more of it, the way some visiting Americans behave.) Or by the Dutch, Danes and some French vis-a-vis the Germans. (The war wounds haven't healed yet, the NDP is on the rise, and the loud and boisterous German tourists don't help either.)

Communications do indeed compound the problem of doing business in Europe. They are certainly poorer than we are accustomed to from Ma Bell in the U.S. But except for the effect on data communication, especially inter-country (that is a problem), we get along fine. It does not cost $1000 to get a telephone installed in Paris, but perhaps $100, and in German metropolitan areas the cost is about $23. And please let's not be too unkind toward nationalism—(old provincial?) Americans have their pride too.

As to the "emphasis on ALGOL in a FORTRAN world," may I point out that ALGOL is also emphasized in the U.S. as a program publication language by ACM, which publishes all algorithms in ALGOL. As to the "French expert" who says that his country's software is five to ten years behind, may I ask in what way, how measured? Programmers in France, for the most part, speak and read English, so they can (and do) use American software for U.S. built or licensed systems. Even applied to French systems, the statement is vague, weak and very much exaggerated.

Finally a couple of concise comments:
1. It is expensive to import Americans, so most successful firms try to train and build European staffs.
2. True, there is a gap (in numbers of systems as well as know-how) but this, despite the "social, political and economic barriers," merely underlines the golden opportunities which exist for American firms with a bit of patience and understanding to do business in Europe.

Henry F. Sherwood
Diebold Europe
all magnetic tape is not alike

Some of it costs more than MAC tape

Of course there are different levels of quality, but we're talking about price differences for the highest quality level. Specifically, why does one brand of tape cost as much as 40% more than the comparable MAC Tape?

Is the secret in the word “comparable”? No, because when we say “comparable,” we mean exactly what we say—that the two perform exactly the same way on your machines.

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We figured out how much it costs to make tape this way, added the costs of selling and a small but fair profit, and that’s our price. How come it’s lower?

We don’t know, and neither do thousands of computer managers who specify MAC Tape. They just appreciate the difference. Just last month, one company saved $170,000 by writing our name on an order. You don’t have to save that much to be a hero, do you? If you want details on our painstaking, expensive methods of making tape before you switch, we’ve written a booklet that’ll tell you all you want to know. If you’re ready to be a hero now, a salesman will call if you’ll but give the word. Either way, just write MAC Panel Co., Box 5027, High Point, N.C. Our motto: Heroes made to order.
Now you can throw out less versatile storage techniques. A Ferroxcube core memory costs as little as $1,190.

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Aside from price (we'll get back to that in a moment), consider the advantages of core memory systems. Speed. Random access. Non-dissipative. And they're non-volatile. We could go on and on. We won't because you've probably always wanted to design your system around core storage anyway. Only the cost stopped you.

Now you can buy a Ferroxcube 128 x 8 core memory system complete with stack electronics, data register and timing for a paltry $1,190. That's our FX-12. Its capacity ranges up to 512 x 8. The FX-14 picks up there and goes on to 4,096 x 32. Prices are comparably low. Moreover, the FX-14 is available with almost any choice of interfacing elements. Buy only what you need to interface with what you already have.

In brief, Ferroxcube core memories make both functional and economic sense. Write or call for Bulletin M661.

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