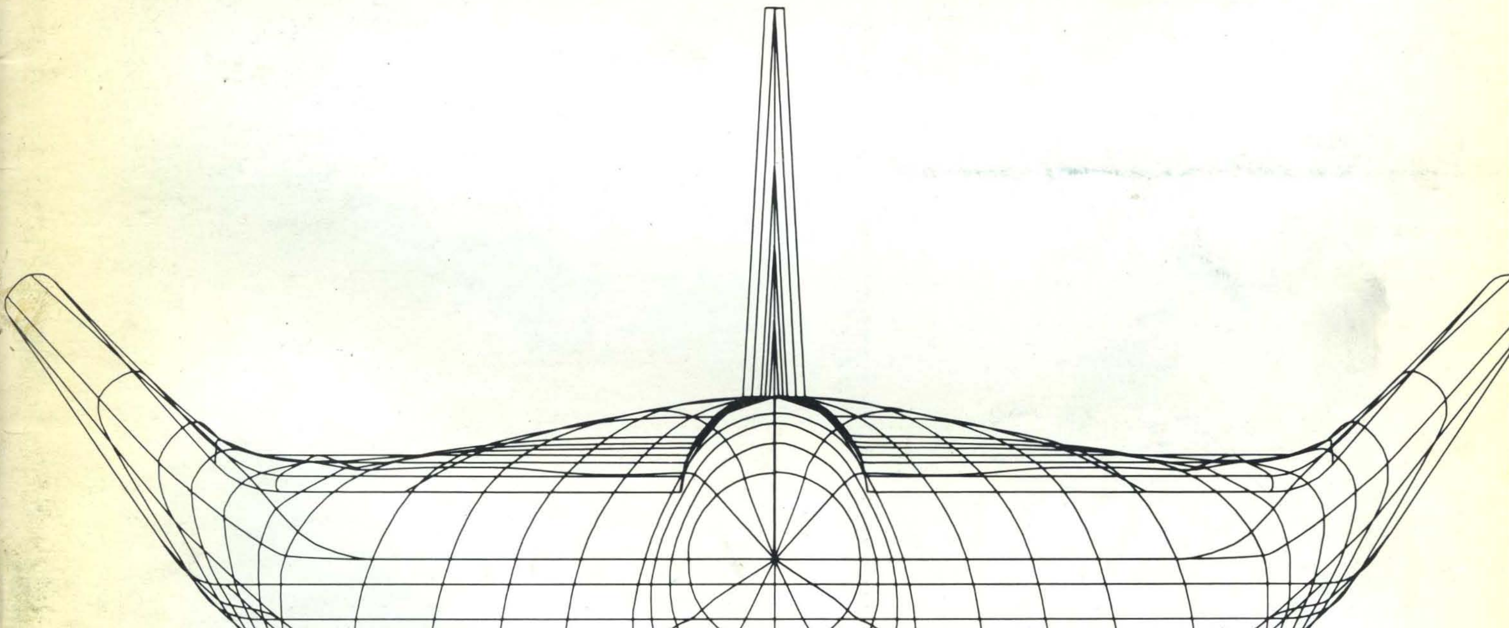
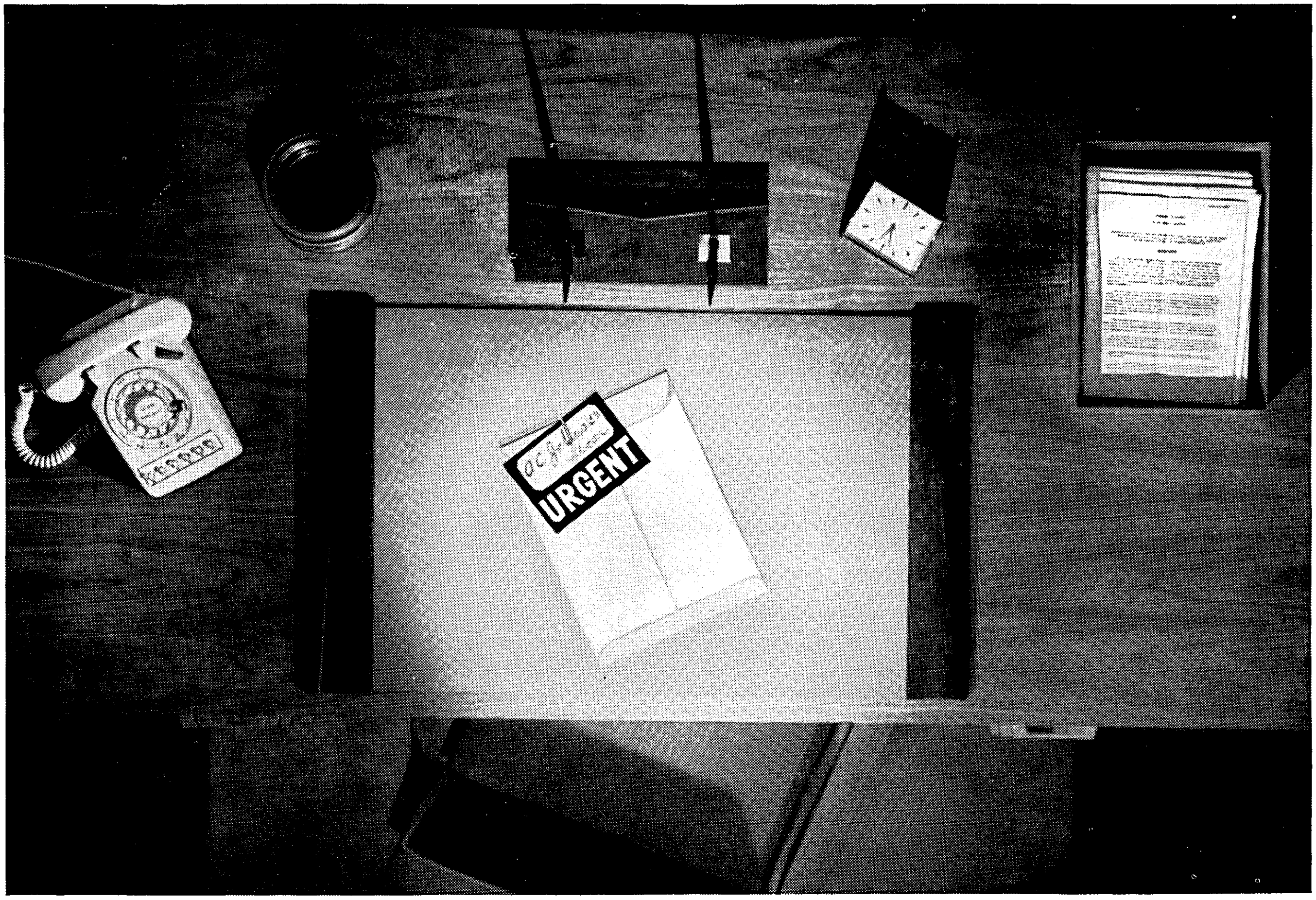
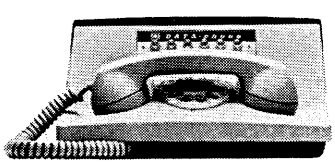
February, 1965

computers and automation

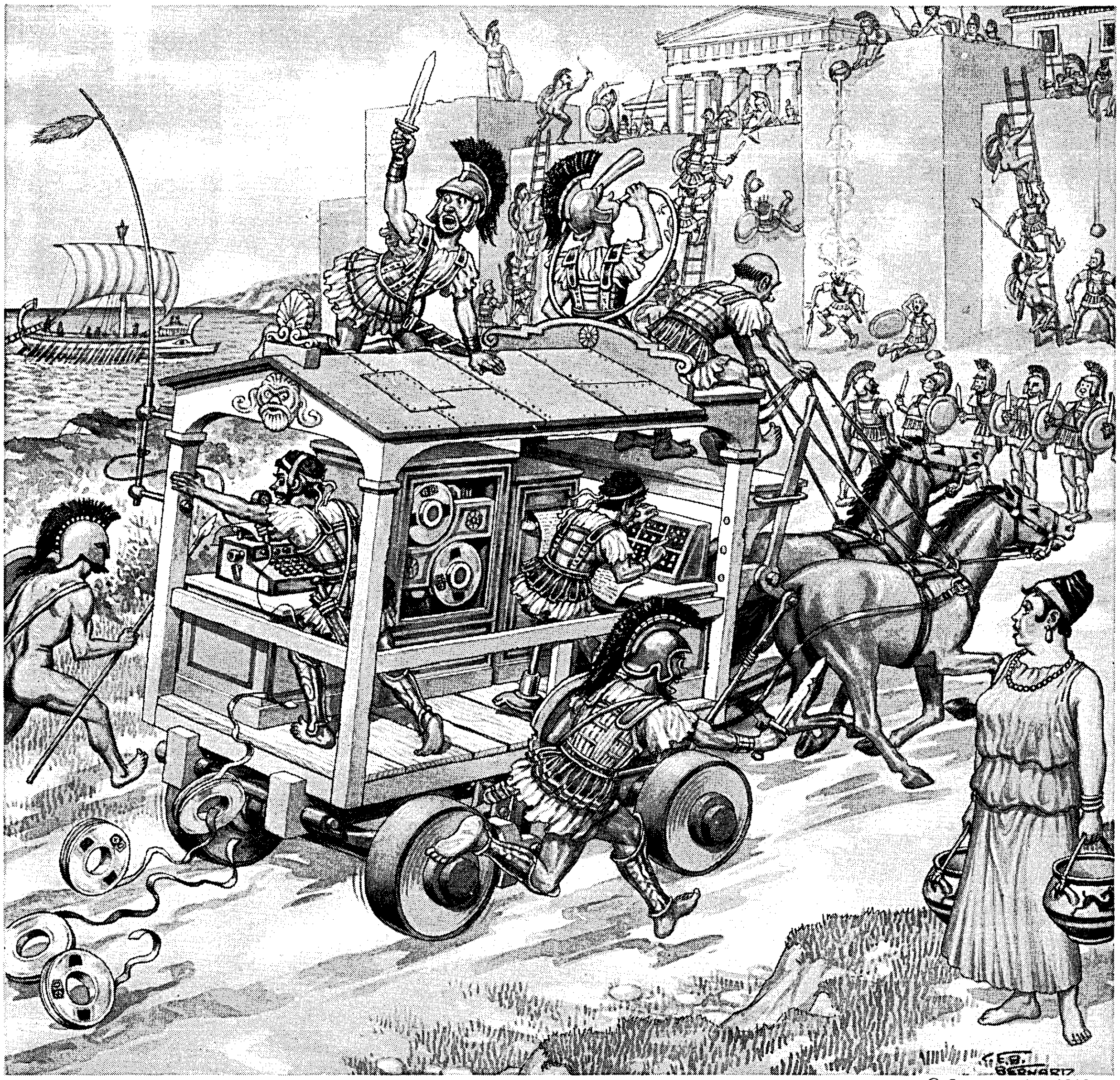


Space Ship Design Drawn by Computer


URGENT



AN OFF-BIT HISTORY OF MAGNETIC TAPE... #4 of a series by Computape



The Trojans were ahead, by virtue of the points Paris had scored with Helen on a completed pass early in the game. But now the Athenians, sparked by their all-star backfield of Ajax, Achilles, Diomedes and Odysseus, had come storming back. The Trojans had their backs to the wall, and to make it worse Hector, Troilus and the rest of the defensive platoon were hobbled with injuries.

On third and goal, Odysseus sent Ajax and Achilles into the right side of the line behind the mobile computer* and it looked to be all over. But Zeus (who doubled as referee and chief mischief-maker) blew the whistle on the play. "The horses were off-side," he said, and the score was called back.

The clock showed time for one more play.

Achilles limped back into the huddle, nursing a bruised heel. "What now?" he grumbled.

"The one we've been practicing all week," Odysseus snapped. "X-97!"

"That old Wooden Horse chestnut? They'll never fall for it . . ."

But you know the rest. The Trojans fell for old X-97 anyway. Which explains why, ever since, they've never trusted a gift bearing Greeks.

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**The Greeks not only had computer tape — they had a word for it: kom-putron — meaning, "works like a Trojan".*

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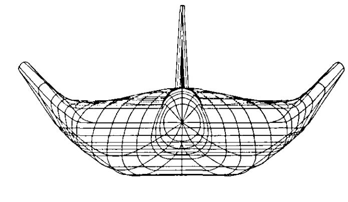

computers and automation

FEBRUARY, 1965 Vol. 14, No. 2

computers and data processors:
the design, applications,
and implications of
information processing systems.

In This Issue

In Every Issue

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Computers, and the Public Sector of the Economy

Do we have to put up with very poor solutions to really important problems in the public sector of our economy, our democratic, capitalistic economy, operated under our government of the people, for the people, by the people?

In the private sector of our economy, in walking around New York, for example, I find amazing, modern new skyscrapers, of glass and aluminum, such as the Chase Manhattan Bank building at Pine and Nassau Sts.—providing for bank customers luxury that seems out of this world. In quantities of office buildings, even old ones, I find gleaming new automatic elevators, working much faster and better than they worked under the vanished human beings that used to operate them. All through the streets I see modern, powerful, good-looking cars.

But in the public sector of our economy, I see cars crawling through the narrow, inadequate sidestreets of New York—and I know that only the narrowness of the sidestreets prevents New York from being far more jammed with far more car traffic. In Brooklyn I see crowds and crowds of young people attending the old public schools *in two shifts*. In the New York subway, the express trains on the East Side Lexington line no longer run all night; the stairs are often much too small for the crowds; quantities of fluorescent lamp holders are filled with dirt; etc. I was born in New York, and went to school and back on the subway every school day from age 11 to age 14; and I used to be so proud of the splendid New York subway, its nickel fare, and its continual, mighty expansion.

In New York on Jan. 7, I rode up the long slow escalator from the subway platform at Lexington and 53rd St., and I looked at the ceiling and tiled walls around the escalator, and saw thick hanging dirt in many places. My thoughts went back to the traveling that I did for myself in the subway of Moscow, U.S.S.R., in six days of September 1962 shortly after the Congress of the International Federation of Information Processing Societies in Munich, Germany. Later I looked up my notes, and found:

"The most interesting part of my visit to Moscow has been, I think, in collecting observations about the people and the way they do things. There seem to be four levels of quality of economic and social behavior: first, the level of the Sputniks and the Moscow subway, which are far beyond anything in the rest of the world which I have seen, and are magnificent by any standards; second, the level of Soviet bread and ice cream and education and some more things, which is just about equal to the good levels anywhere in the world; third, a common everyday normal level, which applies to the elevators in the Leningradskaya Hotel where I am staying, old-fashioned, not very efficient, but they do the job, and they are serviceable; and finally, a bottom level, which is pretty terrible, which applies to the apples in the buffet here, spoiled by worms and accidents, green, small (but not sour), and which also applies to the absence of any plug for the washbowl in my hotel room—so that I have to use as a substitute to keep the water in, a dirty rolled-up cloth.

"But I want to talk most about the Moscow subway. It is not only a clean and beautiful subway, filled with reserved yet friendly people—but a big, efficient, fast subway. It has about 50 or 60 stations, and 7 or 8 lines; and it handles an enormous amount of traffic every day. It has escalators, much longer, wider, and faster than the escalators in the New York subway. The schedules are efficiently adjusted to the crowds of Moscow people who use them. The subway is very well equipped with signs and directions that appear in all the stations so that a stranger, if he will puzzle out the Russian letters, can easily tell which way to go and whether he is on the right platform. The fare everywhere is 5 kopeks (about 5 and ½ cents). The flow of people in the wide escalators, the rapid loading and unloading of trains even in the rush hour, the classic, museum-like quality of many stations with many kinds of marbles and mosaics—but not all stations by any means—, and the cleanliness of the tracks and the trains—are almost too amazing for words. The ventilation of the subway produces always sweet-smelling air. The absence of signs saying "no smoking" or "no spitting" is breath-taking—it is *not necessary*. Only here and there in the subway did I notice lamps out—an indication that at least one department of the subway is not on its toes. I estimate that some of the escalators must be at least 300 feet long, much longer than any I know in New York. In some stations there are four wide escalators together, two to carry people up, two to carry people down. To me the subway is a monument to the desire of the Moscow city government to treat its people like human beings."

I am convinced that the decay, disorder, dirt, and decrepitude in many parts of the public sector of the economy of the United States is *not necessary*. It is a poor solution to some really important problems, and we the people do not have to put up with it.

Why is this true?

This country has been spending fifty billion dollars a year for weapons, for arms, for the capacity to make war, for defense, for military power to deal with situations. So far as any conflicts nowadays can be solved by weapons, by warships, guns, bombs, rockets, missiles, early and late warning systems, etc., and methods of assorted violence, the breadth and magnitude of our current arsenal indicate that

(Please turn to page 24)

RCA'S SPECTRA 70 ANNOUNCEMENT SPOTLIGHTS FIVE MARKET STRATEGIES OF GROWING IMPORTANCE IN COMPUTER FIELD

RCA showed that it was a first-class electronics company, if not yet a front-runner in the office equipment field, with the announcement recently of its Spectra 70 computer series. The announcement also highlighted several of the most important computer marketing trends of the last year, viz.,

(1) Program Compatibility Among Competitive Computers
(2) Stress on Peripheral Equipment
(3) Use of Integrated Circuits
(4) Emphasis on Data Communication Systems
(5) Single-Fee Rental

Spectra 70 itself, as currently announced, consists of four processors, the 70/15, 70/25, 70/45, and 70/55. The two smaller models, the 15 and 25, use conventional circuitry, while the 45 and 55 are built with monolithic integrated circuits...making Spectra 70 the first major computer series to incorporate these third generation circuits as basic components. (For more details, see page 34.)

Price/Performance comparisons between competitive systems is an art replete with pitfalls...for the resulting figures can vary significantly depending on the equipment configuration and applications selected for comparison. However our best calculations to date indicate that the Spectra 70 offers a price/performance improvement of 50-60% in computation speeds and 30-35% in throughput speeds over corresponding models in IBM's System/360. A major reason for the drop in relative throughput advantage is that RCA does not offer the range of small to large capacity random access memory devices offered by IBM...slowing Spectra 70's relative performance on many file processing jobs with low activity ratios.

To offset this, RCA is planning to offer the popular IBM 2311 disk pack unit as an unencouraged option on a Spectra 70 system...especially unencouraged to customers for rented systems now that IBM will no longer make its peripheral equipment available on lease to other computer manufacturers.

Spectra 70 illustrates the five important market strategies outlined above in the following ways:

Program Compatibility: One of the largest potential expenses for an existing computer user in changing-over applications to a new computer system is the cost of rewriting existing programs in the language of the new computer. Since about 70% of new computer orders are now coming from existing computer users, it behooves the computer manufacturer to develop techniques which facilitate this program conversion to its own units from computers currently used by a generous share of its potential customers.

As is true in other computer families, Spectra 70 processors are program compatible in an upward direction. Spectra 70 also offers two methods of program compatibility with other systems...one, direct, and the other via microprogramming.

To achieve the direct compatibility with System/360, RCA designed Spectra 70 with the same data format and character codes as System/360 and incorporated the instruction repertoire of System/360, except for I/O instructions, in the command structure of the model 45 and 55, and subsets of it in the model 15 and 25. This means that after modifying I/O instructions through a special control program Spectra 70 should be able to run System/360 programs on a direct processing basis.

In the microprogrammed method, Spectra 70's model 45 can incorporate a read-only memory which converts instructions written for another computer into microprogrammed instructions understood by the 45...a technique identical to the "emulators" used by IBM in achieving compatibility between System/360 and 1400/7000 series computers. Currently one of four read-only memories can be chosen with the model 45 to convert programs from RCA;s 301, 3301, 501 or IBM's 1401 computer.

Because the read-only memory method requires that each instruction be converted from one sequence of signals to another before execution, the efficiency of the resulting computer operation is reduced...sometimes by up to 1000%. The process is analogous to the reduction in efficiency of a business discussion when all words need to be translated into a foreign tongue. The read-only memory is also expensive to develop and fabricate...costing up to $150,000-$200,000 to develop and produce the first unit, while renting to the user for under $500/mo... so its development is usually justified only for computers of the broadest use...for example, no RCA 601 conversion memory is planned for Spectra 70.

The overwhelming advantage to Spectra 70 users of direct compatibility with System/360 is that the results of the huge investment in program development being put in by IBM and by leading IBM customers to support System/360 applications will also be available to them...provided that program copyright considerations don't prevent this annexing of creative effort.

Stress on Peripheral Equipment: Ten years ago the cost of peripheral equipment as a percentage of the total computing system averaged 30%. This year it was closer to 60%. This is due to the greater number of small-scale systems installed as well as the recognition by the computer user that the flexibility with which he can apply his system is closely related to the number and types of peripheral equipment available with the central processor.

RCA has just over forty peripheral units available with Spectra 70, including data communications equipment. However it is in the "office equipment" type of peripherals where Spectra 70 seems to have its greatest competitive weakness. RCA currently does not make any of its own paper-handling peripherals such as card reader/punches and printers. Their slowest card equipment, an Uptime reader and I.C.T. punch, rents for $1100/mo....38% more than the rental of the 70/15 processor and 30% more than IBM's 1402 reader/punch. This is the principal reason why the 70/15 and 70/25 do not offer a particularly striking price/performance ratio when compared to a small business computer such as the H-200.

We understand that RCA is striving to develop its own card equipment and a non-impact printer in order to claim a larger share of its computer systems. In the meantime they are likely to stress sales to System/360 customers where RCA processors can be used in multi-computer data communication networks with peripherals being primarily supplied by IBM.

New among the RCA peripherals is the 70/237 card reader which also can accept mark-sense cards. The 70/568 mass memory unit, an updated version of the 3488 magnetic card memory, is still one of the most attractive multi-million character storage units currently available.

Use of Integrated Circuits: The monolithic integrated circuits used in the 70/45 and 70/55 are paper-thin silicon chips, no larger than the letter "o" on a typewriter, which are chemically treated to create a gross molecular structure able to perform the logic functions which would require 15 transistors, 13 resistors and the necessary wire connections found on an equivalent conventional solid-state circuit board.

RCA foresees its advantages in using the monolithic circuits as lower manufacturing cost, lower maintenance cost, and smaller size, while lower operating costs (less power) will please the user.

About 70% to 80% of the electronics of the 70/45 and 70/55 are integrated circuits, with RCA's Components Division, Westinghouse and Fairchild being the approved vendors.

The production costs and speeds of integrated circuits have apparently now reached the point where nearly all new computers announced in 1965 will use integrated circuits.

Emphasis on Data Communication Systems: Since Spectra 70 has direct compatibility with System/360, RCA's largest potential market is System/360 users who are seeking a second vendor for data processing systems...but requiring that the computer system be able to work along side, rather than replace their existing equipment. Therefore RCA has been careful to develop a standard I/O interface and data communication terminal equipment which will allow memory-to-memory communications between Spectra 70 and System/360, as well as the 301 and 3301. Spectra 70 also offers a combination of multiplexor channels which can control up to 256 I/O devices at one time.

Single-Fee Rental: Like General Electric on the Compatibles-600, RCA is offering Spectra 70 on a single-fee rental regardless of monthly usage. IBM recently dropped its extra shift rental rate from 30% to 10% of first shift rental...a move which was widely interpreted as evidence of price cutting in the computer industry. However we feel that the trend towards eliminating overtime charges is more correctly due to a shift in the typical use of a computer. In the past most computer jobs were run on a batch basis, with all work grouped to run during a single working shift if possible. However, with the advent of management information systems using data collection/data communication terminals, and scientific computing centers using time-shared inquiry stations, computers tend to be in a "ready to process" state round the clock although the actual net processing time during a day is probably still less than eight hours...therefore the de-emphasis of extra shift charges.

Deliveries begin in the fall, 1965, for the 70/15 and 70/25, and in spring, 1966, for the 70/45 and 70/55...just six months behind the deliveries of corresponding models of System/360. To make these deliveries as numerous as possible, RCA is beefing up its marketing staff 20% in the coming year. To expand their European sales base, and to replace the lost marketing assistance from Bull, RCA recently completed an agreement with Siemens & Halske A.G. for an exchange of patent licenses, technical information and sales agreements which will enable the German firm to manufacture and sell Spectra 70 in the Common Market. An agreement between RCA and English Electric is believed to be in the works for marketing Spectra 70 in England. RCA's existing English market outlet, I.C.T., is currently devoting its attention to getting its own new computer series off the ground.

What's next from RCA? The model 35 may be announced this spring if read-only memory compatibility provides an important sales factor. The 70/35 is expected to have this microprogrammed capability also and when coupled with some lower cost card and printer peripherals currently under development, it should make a very competitive small-to medium-scale computer for business applications. The giant of the line, the 70/65, is expected to use a cryogenic memory which will offer millions of bytes of storage available in usec. speeds. If cryogenic memory development keeps on schedule at RCA's Princeton Labs, the 70/65 should be ready for announcement next fall.

In sum, Spectra 70 has lifted RCA into a vastly strengthened competitive position in the computer industry, and clearly exposed a number of market strategies that have become quite important now that the majority of new computer orders are coming from existing computer users. From the evidence to date, it appears to be selling well...important news to the EDP division who, according to RCA's Chairman Sarnoff, broke into the black for the first time this year with $100 million in revenues, and who rounded out the year with over 140 systems booked and with a 15% growth in revenues projected for 1965.

Associate Publisher

"POOR MAN'S" TIME-SHARED COMPUTER INPUT: THE BUTTON TELEPHONE

Leon Davidson
New York, N. Y.

I should like to call attention to a simple procedure for using the new push-button telephones as alphanumeric computer input devices, for remote inquiry or data entry. The method is so easy and cheap that the regular office or household button telephone of the future, without any modifications or attachments, may be used as the "poor man's computer input terminal." Such usage will not interfere in any way with all the ordinary uses of the telephone.

The essence of the procedure is that one uses the *twelve-button* version of the new telephone dials. The button dial mechanisms are built on a 4 x 3 matrix even in the standard 10-button phone versions, and a full 12-button model is already in limited production. The extra two dial buttons lie on the bottom row on either side of the "zero" button. They are considered to have no digits or other symbols of the character-set showing on them; they will be referred to here merely as the "Left" button and the "Right" button, respectively.

It should be noted that it is not permissible to press any two buttons simultaneously in using the push-button dial, since this would generate a faulty tone. Note also that pressing any buttons after a connection is made does not break the connection; this is what makes it possible to use these phones as data input devices.

The alphabetic input procedure is quite simple. To enter an alphabetic character, one first presses the particular digit button on which that character appears. Thus, for example, to send the letter "D" or "E" or "F," one first presses the "3" button, since the letters "D, E, F" appear on the "3" position of the standard telephone dial layout. One then presses the "Left" button or the "Right" button or both, in some sequential combination, to define which of the three letters is actually wanted, namely the leftmost letter, the rightmost letter, or the middle letter.

It is easy to devise any one of many sets of detailed sequences of use of the "Left" and "Right" buttons to specify the identity of the desired letters (left, middle, or right). In fact, it may be possible to develop an elegant scheme in which one never has to press more than two buttons in all, to define any of the characters.

The numeric input procedure is (quite properly) even simpler than the above alphabetic procedure. If the digit "3" is to be entered, one merely refrains from pressing the "Left" or "Right" buttons after the "3" button is pressed. This situation is defined sufficiently by the fact that the next button to be pressed will necessarily have to be one of the ten "digit" buttons, since all input character entries, whether alphabetic or numeric, must always start with the appropriate "digit" button on which the desired character appears.

Using the above procedures, mixed alphanumeric input, even within the same word, is handled without special consideration being needed. Programmers and systems designers will recognize that the decoding routines to process this type of input string are trivially simple, if they scan from right to left. Special computer input channel hardware requirements are negligible, consisting only of an interface containing the standard telephone-industry tone-decoding circuits and a counter to recognize (say) three or more consecutive taps of the "Left" or "Right" buttons, respectively, as the end-of-message signals.

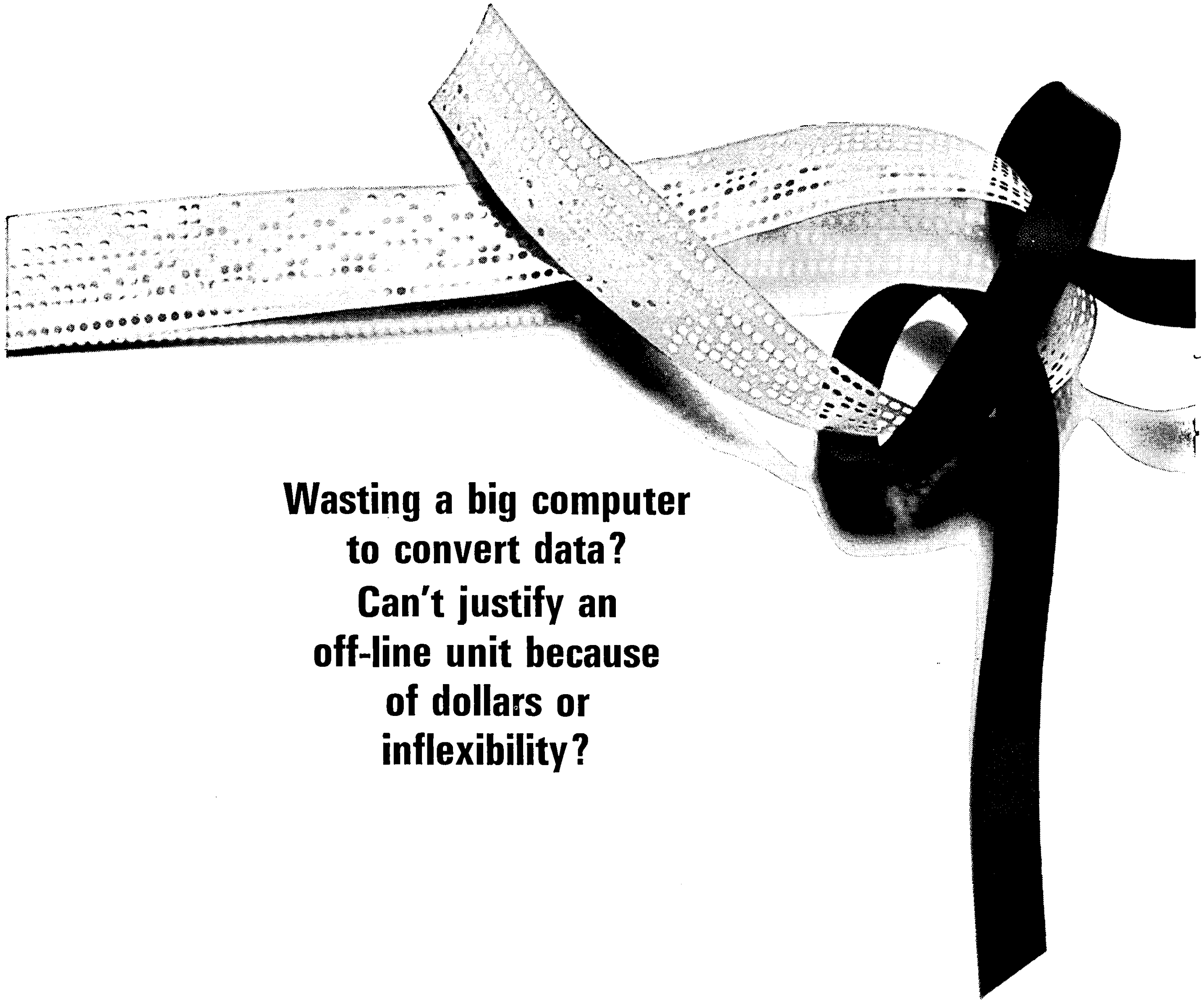
By putting the characters "space," "Q," and "." on the "1" button, which carries no letters on present-day telephones, and by putting the characters "Z," "—," and "+" on the "zero" button, a full 40-character alphanumeric set is provided. This set has the capability of handling arithmetic applications, such as adding machine or calculation services. It also can handle alphanumeric work such as file inquiries based on name or stock ticker symbols, or based on mixed alphanumeric part-numbers for inventory systems. Other symbols are easily provided when needed, such as for example by using the "X" or "M" character as a multiplication sign in doing adding machine work.

Output may be handled by a "voice-answer" system such as started operation at the American Stock Exchange in 1964, sending computer-generated voice reply messages through the user's telephone receiver.

An alphanumeric input scheme such as described above has been actually tested in a large-scale time-shared real-time computer system, and determined to be completely satisfactory and feasible from the viewpoints of human factors, hardware, and programming. With the current spreading of push-button telephone dialing equipment across the country, the computer industry is now in a position to expand into the average home or office with time-sharing "multi-terminal" systems completely accessible through the regular push-button telephone.

Thus a whole new world of service would be provided easily and directly to the average citizen, office worker, professional man, shopkeeper, executive, etc., and last but not least, to the student of any age who will be living in the "computerized" world of tomorrow.

(Please turn to page 26)



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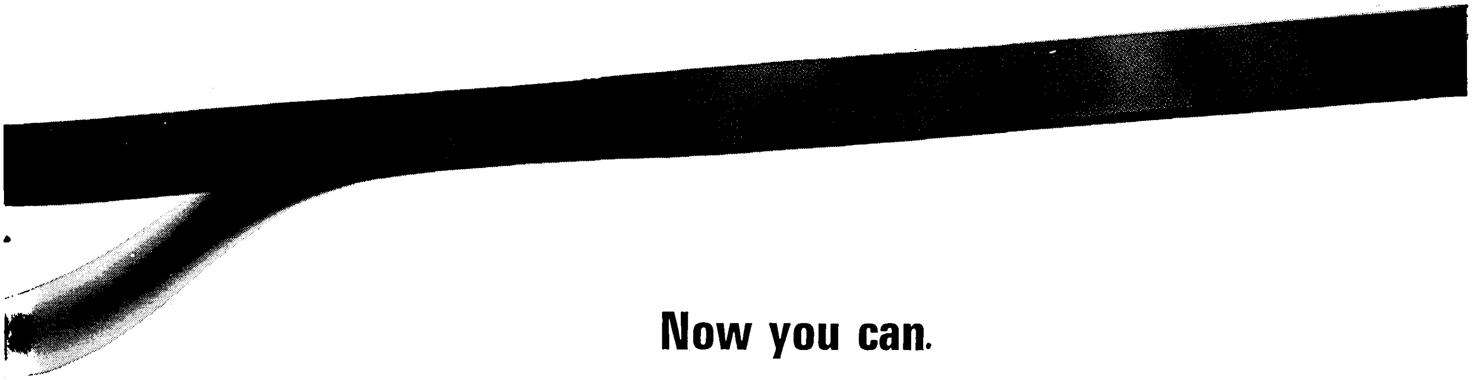

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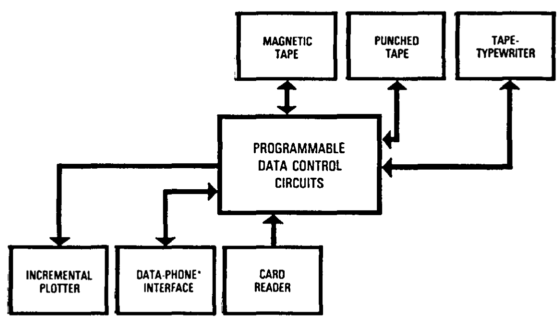

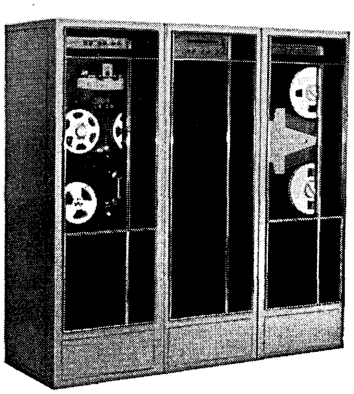

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Programming Languages: Choices, Comparison, and Evaluation

In preparation for this special feature in the February issue of **Computers and Automation,** we wrote to several people in the computer field and put the following questions in front of them:

> "What choices of programming languages would you recommend for what kinds of problems? Why? What are the advantages and disadvantages? For point of view, you might imagine yourself giving advice to the new head of a new large computer installation with a variety of assignments."

We take pleasure in presenting the responses of two distinguished computer people in the following two articles:

> "What Choice of Programming Languages?" by Ned Chapin; and "Comparing Programming Languages," by Jules I. Schwartz.

—The Editor

WHAT CHOICE OF PROGRAMMING LANGUAGES?

Ned Chapin
Data Processing Consultant
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Types of Languages

What is this about a choice of programming languages? Many are the computer users who see the "choice" in very narrow terms. Once a user has picked out his computer—or had it picked out for him—this is the line-up of programming languages provided by the manufacturer with the computer:

1—A *machine* language. This has had its devotees as the language of general choice, but that age is rapidly waning, although all of the computer manufacturers offer a machine language for each computer.

2—A *symbolic* assembly language. For different computers, these range from close to machine language to distant. But given the size and model of the computer and the input-output and storage configuration, generally only one or sometimes two symbolic languages have been made available.

3—An *algebraic* compiler language. In most cases of late, this has looked like a variant of FORTRAN. But in in a few cases, where the manufacturer has not seen a significant computational market for the computer, the manufacturer has made available no algebraic compiler language.

4—A *report* program generator language. Even when the computer manufacturer has viewed the computer as adapted to "business" applications, the manufacturer has often made available no report program generator language. Some manufacturers do not regard a report program generator as a programming language at all.

5—A *business*-oriented compiler language. It is not generally provided for the smaller computers yet, or for the computers the manufacturers aim mostly at the computational market. COBOL is far from being the only business-oriented compiler language provided by the computer manufacturers, but it is becoming more common.

So where does this leave the typical computer user? For his computer, it leaves him a choice of one each of these five types of programming languages. But is *one* each a choice?

Character of Choice

Then just what is this choice being talked about? Is it blue sky talk on the order of "Let's pretend you have a multi-million dollar budget, space, staff, and authorization to acquire and utilize three or four different computers of varying sizes and configurations?" Now here a choice of programming languages means something, for this lifts the major restriction on choice imposed by the model and configuration of the computer. But few indeed are the computer users in this position.

What about the others? The monthly **Computers and Automation** Census shows some 23,000 computers installed. What about the nearly 19,000 of this total that are small in size, or with limited input and output configurations, or for which the computer manufacturer has often not even made available representatives of all five types of languages? About four out of every five computer users find themselves in this boat. This is certainly the case of the users of the four most popular computers today, the IBM-1401, the RR-1004, the IBM-1620, and the IBM-1440, which together account for better than one half of the computers in use. What is the situation for these users?

The situation is that not all of the five types of languages have been implemented for all of these computers. For example, no algebraic compiler language is available for the RR-1004, no report program generator language and no business-oriented compiler languages for the IBM-1620 or the RR-1004, and no business-oriented compiler language for the smaller configurations of the IBM-1401. But two symbolic assembly languages are available for the larger configurations of the IBM-1401.

The choice in short appears narrow, but the user does have a choice among the basic five—for example, should a symbolic or algebraic language be used for the job at hand? Viewed in these terms, a choice certainly exists, but many users are of the view that this is really no choice, because the knowledge of the staff and the type of the job together often dictate unequivocally which available language from the five types to use. The borderline cases are often handed to the programmer who selects to fit his own convenience. (1)*

Actually, the choice is not quite that narrow, for the computer users have in some instances taken the bull by the horns. Faced with the shortcomings of the available languages and by applications that are different to program or run effectively with the computer manufacturer provided languages, they have revised or prepared new ones. But unlike the noteworthy SHARE efforts, these language implementations have often been the result of dedicated work by individual persons. For example, in the San Francisco Bay Area alone, Mr. Ruppert Lissner had made major improvements in the IBM-1401 SPS (8) (a symbolic assembly language) to broaden it, eliminate many of the format restrictions, and incorporate some of the features of the IBM-1401 Autocoder (a symbolic compiler language) (8). And Mr. Robert McAllester has expanded IBM-1401 Autocoder to incorporate debugging aids, improve data editing, provide additional macrocommands convenient for file maintenance work, and improve input and output operations.

On a wider geographic basis, and taking the IBM-1620 as an example, two improved versions of FORTRAN are available, both of which use less storage space, compile faster, and run faster, with little to no loss in the value of the diagnostics. Several augmented versions of FORTRAN for the IBM-1620 have been prepared, as well as some additional subroutines. The IBM-1620 SPS language has also been modified by a user to approximately double the size of the programs that can be compiled, at a cost of some restrictions in the format of some instructions. And other IBM-1620 users have prepared implementations of other programing languages such as ALGOL and IPL-V.

Work such as this increases the scope of choice. But do the users of the smaller computers generally make use of these additions to the supply of programing languages available? By and large, the answer appears to be "no," for several reasons.

First, at the cost of some personnel and machine time, these users have taught their personnel enough about the manufacturer-provided languages they do use to eliminate the obvious inefficiencies that at first arise when working with the new and the strange. Hence, they can give the impression of working efficiently and productively, even when the language they are using is not as well suited to the job at hand as some alternative language.

Second, many of these users apparently do not know of the alternatives available to them for the asking, and they do not know whom to ask. Third, many of these users are not sufficiently inconvenienced by the use of only the manufacturer-provided programing languages to feel motivated to look beyond that choice, and do not sense the gain possible in some situations from changing to some of the other languages.

Factors in Choice

Among the five types of languages provided by the computer manufacturers, among the user-provided versions, and among the user-provided additional languages, what are some of the dimensions of choice open? What are the guide lines or rules for choice? Observation of a selection of computer users suggests that the choice is a matter of judgment, but that it usually reflects at least the majority of the factors listed below, and sometimes others. The importance of each of the factors varies considerably from person to person making the choice, and from situation to situation. These factors are:

First is *personnel competence*. For example, a person skilled in FORTRAN (7) programming can usually produce a workable program using FORTRAN regardless of the nature of the problem or of the other factors. The same is true of persons skilled in machine language programing, in symbolic, etc. For this reason, the language of choice often is the language that is known best at an installation.

Second is the *nature of the job*. When the problem or application can be conveniently expressed in mathematical notation, an algebraic compiler language such as ALGOL or FORTRAN is usually the language of choice. ALGOL (5) is usually favored when the job involves more than iterative computation, especially logic operations. NPL (9) when it becomes available will incorporate features of FORTRAN and ALGOL, and borrow a few from COBOL. When the job involves only minor amounts of computation and considerable amounts of data arrangement, COBOL (6) or a symbolic language is usually the language of choice. In such cases, when good documentation and speed of programing are sought, COBOL may be favored. When a job involves more than routine file and record maintenance and manipulation, symbolic languages (8), report program generator languages,* or tabular decision languages (11)

* References will be found at the end of this paper.

* Information on these is still best available in the manuals put out by the computer manufacturers.

may be more convenient. However, except for the symbolic languages, these, including some sorting capability are in the process of being added to COBOL on an optional basis. The symbolic languages are more general purpose than the others and are usually the languages of choice when operating speed or economy of storage are important. When the job is heuristic or involves primarily lists of data with very little computation, list-processing languages such as COMIT (13) and IPL-V (10) are usually favored. For simulation work, SIMSCRIPT (4) and DYNAMO (12) are sometimes used.

Third is *ease of use*. Conceptually, speed or efficiency factors should probably outrank this factor, but as a practical matter, it is important. The higher-level languages are consistently the easier to use, such as COBOL, ALGOL, FORTRAN, etc. (1, 2, 3). Less convenient are the report program-generator languages, tabular-decision languages, and symbolic languages because of their greater restrictions on the use of mnemonics for identifying the operations to be done and for the data to be operated upon. For convenience in learning, the higher-level languages are favored, because less knowledge of the details of the working of the computer are needed.

Fourth is the *speed of operation* of the object program (the program in its machine language form). Faster speed is worth money in most installations, especially on applications to be run repeatedly. In this regard the higher-level languages have been criticized extensively as being prodigal with machine time, and in some instances the charges have been assuredly true. But not always. For example, some COBOL and FORTRAN produced object programs are as good in speed of operation as would be likely obtained from an intermediate level programer using a symbolic language, although a skilled and experienced senior programer could usually if given time to polish the code produce a faster running program.

Fifth is *speed of compilation* and *speed of programing*. This like the preceeding and following factors is one that varies considerably from one implementation to another of any given programing language. And here again faster speed is worth money, but this speed is most important in installations with a substantial volume of new or revision programing, as in job shop facilities, or in installations where the average operating life of a job tends to be measured in weeks or months. Here the machine time spent in compiling and assembly operations can become a burden if speeds are slow. Although generally slower in compilation speed than the symbolic languages, the higher level languages such as ALGOL and COBOL allow programing work to be done more rapidly than is possible with the symbolic languages, given an equal degree of programer experience. For limited life jobs, the higher level languages on this basis alone may be the languages of choice.

Sixth is *economy of storage*. This economy is a measure of how little storage capacity is used by the object program. Although economy of storage can be gained at the cost of a slower speed of operation, the sought-after balance is a combination of economy of storage and speed of operation. Control over this balance is most easily achieved with the symbolic languages, but only at the cost of considerable programing time. In the larger and more complex computers, this balance may be no more easily attainable in this way than by relying upon the built-in features of the higher level languages.

Seventh is the availability of *macrocommands* to handle common situations. These help make an otherwise indifferent language adequate. For example, square root macrocommands, and input and output macrocommands are features of some symbolic languages. The higher-level languages typically use macrocommands very extensively, even to the point of being founded upon them.

Eighth is the *debugging aid* provided with the programing language. Typically the machine and symbolic languages include no debugging aids, but the higher level languages such as COBOL in particular sometimes provide extensive diagnostic assistance to the programer to catch possible violations in the use of the language as well as in specifying the data to be operated upon. But the value of such aids varies widely from one implementation to another of the various programing languages.

The important point about all of these factors is that the differences between the implementations available of all but the machine languages for each of the various computers, may exceed the differences arising from other reasons. For example, the differences on some factors between the weakest and the strongest of the COBOL compilers available for different computers are for practical purposes as great as the difference between some symbolic and higher level languages. As a practical matter therefore, the characteristics of the implementation of the languages available to a particular computer installation (because of the computer available), have to be examined carefully. These characteristics are in addition to the general factors, such as the eight noted above, that for any given situation may be considered in selecting the programing language of choice.

References

Three general books on programing, selected from among the many available, are:

(1) Dick H. Brandon, *Management Standards for Data Processing* (Princeton, N. J.: D. Van Nostrand Co. Inc., 1963). See also this same author's recent articles in **Computers and Automation.**

(2) Ned Chapin, *Programing Computers for Business Applications* (New York: McGraw-Hill Book Co., Inc., 1961). This book illustrates the use of a variety of different languages.

(3) Herbert D. Leeds and Gerald M. Weinberg, *Computer Programing Fundamentals* (New York: McGraw-Hill Book Co., Inc., 1961). This book illustrates programing for a large computer with emphasis on a symbolic language.

Nine books and one article on specific programing languages, from among the many available, are:

(4) H. M. Markowitz, *et al., SIMSCRIPT* (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1963).

(5) Daniel D. McCracken, *ALGOL* (New York: John Wiley and Sons, Inc., 1962.)

(6) Daniel D. McCracken, *COBOL* (New York: John Wiley and Sons, Inc., 1963).

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(9) Daniel D. McCracken, "The New Programing Language," *Datamation* (V. 10, No. 7) July 1963, pp. 31-36. This is on "NPL."

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(11) Solomon Pollack, *DETAB-X* (Santa Monica, Calif.: RAND Corp., 1963). This is a decision-table language. Several articles by other authors have been carried recently by **Computers and Automation** on decision-table languages.

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COMPARING PROGRAMMING LANGUAGES

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Imponderable Complexities

When one considers the appropriateness of various programming languages for use in the solution of the universe of computing problems, one is generally faced with some highly imponderable complexities. Some reasons for these complexities are:

- *Languages are not standard*
  To compare language A with language B adequately, one would hope to at least be able to define languages A and B precisely. This is usually not possible. Therefore, one must compare language A_i with B_u.
- *Compilers are not standard*
  In those relatively rare cases where a single official document exists to define a language, there is another dimension to the problem. The fact that more than one compiler exists for the language usually implies that more than one version of the language is actually implemented. This is most often true when the compilers are on different computers but is even frequently true when two different compilers for language A run *on the same computer*. Thus, the languages have proceeded from scalars to two-dimensional arrays: A_{ij} vs. B_{uv}.
- *Operating systems are not standard*
  In some cases, the supposed advantages (or disadvantages) of language A_{ij} actually reflect the power of the operating system under which the compiler and compiled program operate. An extreme case is the comparison of a language run in an on-line environment as opposed to one run offline. Even for the same language and the same compiler, the results of this comparison can be striking (but prove very little about the languages). Less extreme variations in the operating system, such as accessibility to libraries and input-output equipment, may influence the results of any comparison of languages.
- *Users are not standard*
  As a fourth dimension in the comparison of languages, one must consider the vagaries of the different users. A language described in glowing terms by one set of users may be disliked or ignored by another set. This can be due to academic or professional background, corporate loyalty, personal animosities, lack of education, or just obtuseness, but in any case, it is a fact of programming life. Result: A_{ijkl} vs. B_{uvwx}.

We have thus far discussed four dimensions of language comparisons. Given adequate motivation, we could possibly extend our array dimensions so that we would run out of lower-case Roman letters for subscripts. However, let us accept the fact that no comparison can be precise. At best, we can present some general statements about some general language systems and (after filtering out the author's biases) discuss the subject on a common, though insecure, ground.

Some Bench Marks

First of all, we can make some basic assertions:

- Machine-language coding (on any computer) produces the "best" code. "Best" here implies less storage space for the program's instructions and generally shorter operating time. Of course, this is somewhat a function of the programmer, but it is normally a fact that today's compilers cannot produce as good a code as can a good machine-language programmer. It is also true that the shorter the program, the better machine language will compare, and programs that tend to be modified quite a bit will begin to lose some of the advantage. However, machine code is still "best" in this sense.

- "Algebraic" languages (e.g., FORTRAN, ALGOL, MAD, JOVIAL, etc.) are generally popular with, and good for, non-programmer, hard-scientist computer users. These languages, despite their individual failings and peculiarities, combine reasonably well the requirements of a stored computer program with the mathematical form of expression generally known to the engineer or mathematician.
- "List-processing" languages are most valuable for programs requiring considerable access to unstructured data. Languages like IPL-V and LISP have been used quite successfully by computer and non-computer experts to program a large number of extremely complex mechanisms, for which associations within the data are more important than any implied association of data to the computer.
- Some languages can be used to program almost anything. It is probably true that, supplied with enough library routines, one can use any language to program anything (although it may turn out in some cases that the basic program is nothing more than calls to subroutines). Some languages, however, were designed with the specific goal of making almost anything programmable with the basic language (i.e., that language defined in the official documents). JOVIAL* is such a language. NELIAC is another. The basic technique used in these languages to allow a wide range of programming capabilities is the provision of reasonably straight-forward access to the computer down to the bit level, while the algebraic flavor of the language is still preserved. This is accomplished with a wide range of structured-data-definition capabilities. It is quite true, however, that certain kinds of routines, particularly those which can be best expressed recursively or which require dynamic changes to data storage allocations, are expressed in a less-then-optimum fashion when these languages are used in their basic form.
- For most kinds of programs, the algebraic languages can produce "better" code than can the list-processing languages. Again, "better" implies faster, shorter code after compilation. Since the algebraic forms of expression tend to approximate the actual computer-storage and instruction hierarchy more than the others, it is easier to "tailor" the program to produce better code. Also, translation from the program statements to machine language is much more direct when the statements are basically arithmetic.
- The initial programming of a problem is not the major obstacle in program production. When one considers the total life of a program including the design, coding, checkout, change, re-checkout, etc., one finds a relatively small percentage of the time devoted to the initial coding. Therefore, the ease with which any language permits the writing of code is not too significant. It is true that the programming language to be used may influence the *design* of the program. For example, some rather intricate processes may be almost immediately available in a language like LISP, making the design of the program much easier and thus faster.
- The main advantage of programs in higher level languages is their capability to be changed. Because of the inherent strangeness, detail, and possibility for tricks in a lower level (machine) language, the ease with which programs in these languages can be reliably modified is considerably less than with higher level languages. Where changes in the data size or form are needed, those languages that deal with unstructured data (e.g., LISP, IPL-V) are modified most easily. Languages that permit little use of the computer-word structure to be reflected in the program (e.g., FORTRAN, ALGOL) also permit, in the trivial sense, relatively easy changes to be made (since not much can be done in the first place without resorting to tricks). JOVIAL is a language that attempts to provide compromise between giving access to the computer and keeping the program relatively free of machine-oriented references. Thus, theoretically, one can take advantage of the computer and modify the data structure without seriously affecting the program. In practice, it works reasonably well.
- No programming language has yet been entirely computer-independent. Although much has been stated and the aims have been high, no language has yet been found to be completely capable of transfer. Some, like FORTRAN, that make very little use of the computer structure, can be relatively easy to transfer, except that, because of some of the lacks in the language, machine language has been utilized to some extent in many large programs. Languages such as LISP and IPL-V also permit relatively easy transfer, but so far, the implementations of them on different computers have varied somewhat. These languages, however, seem to be the closest-to-transferrable, since they are considerably removed from the actual computer. Again, in JOVIAL, an attempt was made to divorce the data structure from the program, so that changes of computer would have an effect only on the data definitions. This has had some success, but as with the others, it has suffered from the normal ills of implementation differences, vast differences in input-output on different computers, etc.

Choices Between Languages

The preceding set of principles ranges from those which are generally acceptable to those on which there are grounds for debate. In any case, they represent some of the conclusions of the author.

In reviewing these conclusions and conceding the earlier remarks admitting that all such comparisons are unreliable, we shall now state which languages are most suitable for a variety of problems. One can assume that qualifications exist in all cases, even where none are stated.

- Numerical programming—where the prime purpose is the input and output of numbers, and where the transformation between input and output can be stated in the terminology of elementary algebra and trigonometry—can be reasonably well programmed in any of the algebraic languages (e.g., FORTRAN, BALGOL, ALGOL, JOVIAL, MAD, NELIAC, etc., etc., etc.).
- Mathematical programming—where the solution of the problem can be expressed considerably better with recursive operations—can probably best be done in "pure" ALGOL (if one can be found). LISP also should be examined in such a case.
- Text manipulation—where the main requirement is the manipulation of strings of symbols—seems to be adequately handled by languages such as COMIT. Also, IPL-V has been successfully used for such problems.
- Control programs—such things as executive routines and time-sharing monitors—usually have a severe restriction on space and time as well as a requirement for access to most of the fundamental machine registers and instructions. Thus, machine language has been most often used for this application. However, where space is not a severe

(Please turn to page 26)

* Disregard any bias on the part of the author.

The New Breed of Software

Contemporary writers in the field of data processing, much like TV writers, apparently firmly believe in the "breeding" of the talent required in the data processing industry. Thus one might take a systems analyst and a programmer of appropriate opposite sexes and hope to create a new "breed" of programmer with an inheritance fit to deal with a total information system.

It is perhaps more reasonable therefore to apply the term new breed to software. There have been many changes in basic software, and the term is perhaps justified. For example, in 1957, the software line-up for the IBM 705 comprised the following:

Languages: A symbolic assembly program
  A simple version of Autocoder
Sorts: A sort for the buffered 705 (TRC)
  A sort for the unbuffered 705 (TCU)
Input—Output: A 300-instruction "package" for error, end-of-file and restart
Utility Systems: A number of simple testing systems, such as Speedtest and Drumtest.
  Memory print, tape print, tape duplicator, drum print, and other simple card programs—the remainder of the package.
Application Packages: None
Subroutines: Miscellaneous contributions from various users and the beginning of a macro-library which most programmers disdained.

The 1965 software line-up is far different. For example, the newly announced RCA-Spectra/70 has an impressive battery of software, with no less than *eight* complete "operating" systems for as many configurations. The new categories of software, as exemplified by the Spectra, emphasize the "executive" or control program. This program monitors system operation, assigns facilities, handles interrupts, communicates with the operator, and in general provides scheduling and control.

The software systems offered for Spectra are:

70/15	Programming System
70/25	16K Tape Operating System
70/25	32K Tape Operating System
70/45, 55	16K Tape Operating System
70/45, 55	32K Tape Operating System
70/45, 55	65K Tape Operating System
70/45, 55	65K Disc Operating System
70/45, 55	262K Disc Operating System

The largest package, the 262K Disc system, contains the following:

Operating Control: The Executive—for supervision of the system's daily use
  The Monitor—a testing system used for sequencing and editing of tests and load-and-go routines.
Languages: The Extended Assembly System
  COBOL
  FORTRAN
  Report Program Generator
Input-Output: File Control Processor—the input-output control system
  Communication Control System—the communications-handling subroutines.
Utility Systems: Sort/Merge
  Peripheral Control System—Tape-to-card, card-to-tape, etc.
  System Library Maintenance Routines—a set of four programs to update the library.
  Random Access File Maintenance Routines—the utility programs for disc loading and maintenance.

The major differences are in emphasis on control, translation, and in general, reducing the *cost* of programming. De-emphasis of sorting and utility programs, as "hardware extensions" has resulted.

New features are the advanced languages, and the "meta"-assembler, the Extended Assembly Program. By allowing procedure statements, the user can make the assembler work on any types of statements which he defines, thereby providing him with some compatibility with his present language. This is an old concept, but renovated to allow the Spectra series to be totally compatible with the IBM 360; privileged instructions can be assembled in the "meta"-language.

Other features important to the user are the complete maintenance routines, and the enforcement of a testing monitor on all tape systems. Although the subroutine library and the application package have not been defined, they can be expected to be substantial, by comparison to 1957.

In seven years, the gains have been substantial, in fact, major—through the recognition of user requirements by the manufacturers.

These gains, however, are by no means as significant as the hardware gains: the 705 handled 6 bits in 17 microseconds; the Spectra 70/55 handles 32 bits in .84 microseconds; almost a 100 to 1 improvement.

A software improvement of 100 to 1 would be of great significance in maintaining the growth rate of the computer and data processing industry which otherwise may well be hampered by a lack of sufficient talented personnel.

CONTRIBUTING EDITOR

DECOMPOSITION – SEVEN LEAGUE BOOTS FOR LINEAR PROGRAMMING

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Over the past five years linear programming has proved to be one of the most useful of the new management techniques made practical by the advent of the electronic computer. LP's acceptance in the business world, however, has been "good" only in a relative sense. Those companies which employ LP extensively in the day-to-day management of their activities have been confined to a few industries, largely those involved in complex industrial processes such as oil, steel, chemicals, and food preparation. The great majority of business enterprises have as yet had no involvement with LP.

The mathematical complexities of linear programming have been a major factor in barring a more general utilization of the technique, but at least as important in preventing its more widespread use have been the size inadequacies of most available LP codes. Until recently, LP codes just did not have the capacity to accommodate many business management problems that were in theory susceptible to solution by LP. The qualification, "until recently," is permitted by the development of a new LP code by C-E-I-R based on the "Decomposition" principle, called "Decomp LP" or "Decomp."

99 Times Better

The development of Decomp LP has increased the number of linear restraint equations that can be included in any given LP problem by a factor of 99. Whereas in the past most codes could accommodate at most 1,024 equations in any one problem, Decomp can handle up to 99,000 equations. The practical effect of this tremendous increment is that many typical linear-type problems encountered in business and industrial situations are now eligible for solution through linear programming. In short, Decomp LP has breached the biggest physical obstacle to greater commercial use of LP as a management tool, although, as will be seen, there still remain formidable psychological and intellectual barriers to its more general employment.

This is not surprising. An understanding of the full significance of Decomp LP presupposes in turn an understanding of basic linear programming. Alas, this is not very often the case, even among those who are professionally involved with computers and their usage. This is unfortunate since linear programming is one of the most functional as well as elegant combinations of mathematics and machines devised by the minds of men.

What Is Linear Programming?

In basic terms, linear programming is a technique whereby a maximum or minimum quantity of some objective function—cost, speed, etc.,—can be derived subject to a set of related linear equations describing the limitations of policy and the physical situation. Working manually, mathematicians can solve sets of linear equations involving a relatively small number of unknowns to optimize whatever objective function they have in mind. For larger linear problems, manual solutions are impractical because no one person, or team of persons, can manipulate the figures and be sure of discovering the true optimum of the objective function that is sought in any reasonable span of time.

Many high school students are familiar with the procedures for solving sets of linear equations in which there are the same number of unknowns as there are equations. In such a set, or problem, only one solution exists, and it is a straightforward process—even if tedious to discover working by hand—to arrive at the solution. A more typical problem situation in the real world, however, is one in

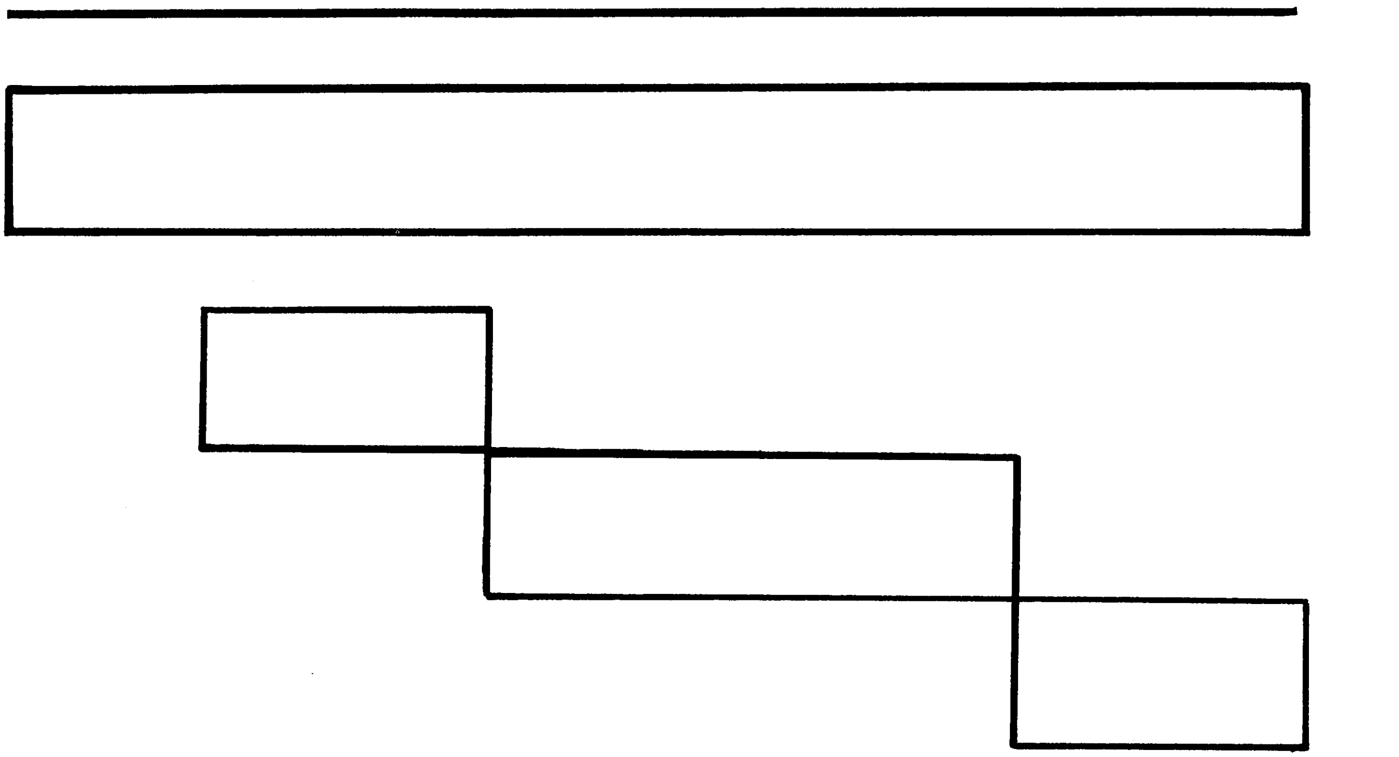


FIGURE 1

which the number of unknowns exceeds the number of equations describing the problem. In these cases, there may be an infinity of solutions that will satisfy the set of descriptive equations. In a situation like this, linear programming comes into its own because it has the capacity to select, of all possible solutions to a complex set of linear equations, that one which is the "best" or optimum answer.

Through linear programming a business user can minimize or maximize some objective function—for example, total cost incurred, or total effort expended on a given project—while remaining consistent with those constraints which exist within the framework of the problem. Constraints, for example, may be the number of machines or workers available in a plant, or the costs of electricity or freight rates, or the total possible market demand for a product.

An Example

Let me give a simplified version of an LP problem. Take, for example, an oil company which has two refineries some 500 miles apart at which some twenty different kinds of petroleum products are produced. At each refinery, costs of producing these products vary. They vary not only because of the different manufacturing efficiencies of the refineries but because of differences in labor costs and the cost of transporting finished products to markets.

Suppose, additionally, the two refineries serve an overlapping geographic area: that is, it's feasible to supply the same geographic region with various petroleum products from either refinery. The products can be transported by tanker, barge, truck, rail car or pipeline, each of which has different rate structures. The oil company's problems include determination of what products to produce at which refinery, in what quantity, to service what geographic area, and through what transportation media? In solving these problems, the company, of course, wants to achieve a balanced condition of minimum cost, maximum profit and best customer service.

This example gives just the bare bones of a typical oil industry problem, but it does suggest the vast number of variables which have to be considered in the decision-making process of a contemporary oil executive. Unaided intuition is not equal to the task of fully assessing the impact of all alternative choices and determining the best one. Some better means is needed if the executive is to cope with complexity of operations on this scale. Such a means does exist in linear programming.

What Is Linear?

Before going any further, I had better first explain the reason for use of the term, "linear." A linear relation exists between two quantities if a change in one always produces a change in the second that is proportional to the change in the first. Thus, if we say $A=f(B)$, where f is a linear function, then any change in A is some constant times the change in B. An example of a linear function is $A=3+.5B$. If $B=20$, then $A=13$. If we double B, making it 40, then $A=23$. If B is 10, then A equals 8. In each case, A changes by an amount of 50% that of the change in B. Expressed in graph form, this relationship is represented by a straight line—hence, linear. In a commercial setting, a linear situation would exist, for example, where an increase in the number of workers or machines increases production, or an increase in advertising expenditures expands product sales.

There's nothing more mysterious to a linear relation than that. Difficulties arise when there are assembled a number of these linear relations encompassing many—not just two—variables pertaining to a physical situation. The trick then is to describe a maximum or minimum condition which does not violate any of the linear relations representing the problem's constraints. Through the use of linear programming codes, the speed and memory capacity of the electronic computer can be utilized to take into account all the linear factors and constraints bearing upon a given problem, check out the ramifications of different possible decisions and determine, for example, the *most* profitable or the *most* rapid or the *least* costly solution.

Effectiveness of Linear Programming

Historically, linear programming has proven to be especially effective in analyzing and optimizing involved industrial processes. These are the processes connected with converting raw materials to a finished product through a series of manufacturing phases, and their subsequent distribution to the consumer. In the production of steel, for example, iron ore and coke are the main raw materials. These are freighted to a central production point and put through a complex manufacturing process, at the end of which various grades and kinds of steel are produced. These products are subsequently shipped to various distribution points and warehouses around the country. Complex questions arise in the course of these activities concerning what, where, how much, and to whom. They can largely be resolved by the use of LP.

That, very briefly, is linear programming. Its potentialities have been known to use for almost 17 years. Professor George Dantzig of UCLA is generally credited with describing the basic ground rules on computer-based LP with his "Simplex" method in 1947, a technique that remains with us to this day, although evolutionary improvements have been introduced. (The Simplex method has close ties to the geometrical theory of convex polyhedra and its algebraic counterpart, the theory of convex sets. It is also imbedded in the allied algebraic theory of linear inequalities.)

The Effect of the Electronic Computer

It was the dramatic emergence of the electronic computer as a practical business tool that permitted implementation of LP theories, but at the same time the computer had built-in limitations that seemingly made it impossible to apply standard LP codes to problems containing more than one or two thousand equations. This was the maximum size of the equation matrix that could be accommodated in the memory of an IBM 7090 and 7094 class computer. With other makes and models of computers, comparable limitations applied.

The need to overcome this limitation set the stage for Decomp. C-E-I-R was among the first companies to market linear programming as a management tool. Since the late 1950's, its proprietary LP codes have been commercially available. They have, of course, been joined by codes developed by other computer service companies and by a number of computer manufacturers. All suffered from the same size defect. While the theoretical possibilities of Decomp were known at an early date, physical and mechanical obstacles prevented theory from being realized in practice.

It was the work of several years to overcome these barriers. At C-E-I-R's Washington Center and at C-E-I-R, Ltd., in London, England, our British affiliate, a cadre of computer-oriented mathematicians and linear programming specialists toiled long and hard on the development of a functioning Decomp LP code. Unlike some mathematical developments which seemingly occur overnight, the Decomp code was the product of a long, painstaking process requiring many man-years of involved and complex mathematical thought. This complexity makes Decomp difficult to describe fully in simple terms, but its broader principles can be explained in non-technical terminology.

The Broader Principles of Decomp

Basically, Decomp is a powerful tool for solving large linear programming problems possessed with a special structure. This special structure can be presented schematically as shown in Figure 1.

The figure suggests how a large linear problem can be segmented into disjoint subproblems. Successful segmentation requires, among other things, the existence of a small number of linking equations, and the appearance of a number of common variables in each of the subproblems. The great utility of the Decomp code is that it permits the computer to determine optimum answers for each subproblem, and evaluate their applicability to the optimum solution for the *total* problem. This ability to compare and evaluate various proposed solutions to each subproblem is critical. The optimum answer to any given subproblem may not necessarily be optimum when considered in light of the total problem. Decomp provides a means whereby many possible answers to subproblems can be compared one against the other and evaluated in total problem terms. This is achieved through a complex process of iteration, which occurs within the computer at the direction of the LP codes.

The basic theory of decomposition reduces to two distinct aspects. The first relates to the way subproblems—the sets of equations involving only a particular subset of the variables of the problem—are fed into the master problem. The second concerns the method of deriving relevant proposed solutions from these subproblems during the course of the computation. Solution is indicated when a condition is arrived at where further proposals from each subproblem to the master problem are not worth introducing.

Controlling the Decomp process can be described as a game, the object of which is to minimize the size of the matrix of the master problem while optimizing the answer for the over-all problem with the greatest speed. One of the rules of this game is to optimize for all the subproblems at as early a stage as possible, without letting them go off on pointless excursions. In each subproblem, a highly composite objective function is used, consisting of all the common rows in the subproblem. Proposals to the master problem are formed and are automatically updated at every iteration for later revision into the master problem. (It is quite within the rules to start a Decomp run with an infeasible master problem in the expectation—or hope—that the infeasibilities will be removed by the addition of proposals from the subproblems.)

Decomp as a management technique is a functional, working product now in use by a number of companies, although additional refinements to the code are being made constantly. The organization of the decomposition code is basically quite simple and takes advantage as far as is practicable of the various special routines and agenda already present in C-E-I-R's standard LP 90/94 code.

An Application of Decomp

One of the first applications of Decomp was made by a major international oil company. Its experience shows how a business enterprise can make good use of Decomp as a tool of top management. The problem concerned the production of oil from several different fields needed to meet a fixed over-all target over a finite span of years. In this oil company's holdings there were seven major oil fields which fed into three refineries. The span of time to be considered was twelve years. The problem was formulated as a linear problem, the object being to set quotas for each field to meet the over-all production target and at the same time to maximize an expression representing the net profit over the time span being considered. This problem decomposed easily into subproblems because the linking equations between the various fields were few in number.

As we've seen, the basic decomposition principle shows how to take advantage of the special structure of linear programming problems that can be considered as separate subproblems with a relatively small number of linking equations. The linking equations are grouped together into what is termed the master problem, while each subproblem contains those constraints and equations that can naturally be grouped together.

In this problem the operations of each oil field under consideration were expressed in separate subproblems. The constraints in the subproblems dealt with the construction of new production facilities in each of the years being considered. These facilities included new oil wells and also plants such as gas/oil separators which are required to handle the oil once it has reached the surface. There were also equations representing the productive capacity of both existing and new wells, and constraints on the upper limits of the capacity of the field. A solution to a subproblem is a way of operating a field, i.e., a set of annual productions with the corresponding investments required to make the productions possible.

The master problem consisted of the linking equations dealing with the supply of oil from fields to the refineries. It also dealt with the possibility of exploring for new oil fields. And, of course, it contained the main supply equations which said that the sum of productions from all the fields must in any year equal the over-all target for that year.

Having defined the problem, we set about introducing the Decomp into the picture. A twelve-year problem could have been solved in undecomposed form, but it was likely that the machine time required would be excessive. Wherever possible, an effort was made to make use of features of our standard LP code. Some of these did indeed prove extremely helpful.

The Decomp program showed a saving in running time for problems of the order of 300 to 500 rows, though the exact point at which the program becomes economic compared with standard LP 90/94 depends entirely on the problem under consideration. A particular 450-row problem which took 40 minutes of 7094 time to solve using LP 90/94 was solved in 37 minutes when decomposed. As the number of rows increased, the advantages of Decomp became more striking.

Before we had the Decomposition program working, we made a ten-year run on the oil field problem in undecomposed form in about 5 hours. Subsequently we solved twelve-year runs on this problem when decomposed in about two hours. With machine time costing perhaps $500 an hour, the savings potential here is obvious. To make a direct comparison of these two times is unduly flattering to the Decomp program. The twelve-year runs, though larger, were "easier" in the sense that the various field productions were more constrained. More importantly, we were able by that stage to specify very good starting bases and sets of trial solutions. We could not, of course, have specified trial solutions to the undecomposed ten-year problems, but we could, in the light of subsequent runs, have specified a better starting basis.

Taken all in all, however, Decomp in this problem and in others of a related nature has earned its spurs. As knowledge of the general over-all utility of LP becomes more widespread in non-technical circles, we may expect to find increased interest to be shown in the potentialities of Decomp.

AN OPERATING SYSTEM WHICH INCREASES PRODUCTIVITY 40%

F. H. Hill, Manager of Business Programming and Systems
Litton Industries
Guidance and Control Systems Division
Woodland Hills, Calif.

When a data-processing staff becomes so busy that it can't handle special requests for service in addition to normally scheduled processing, you either need a larger staff or an operating system. Faced with this problem, we chose the operating system. We now get 40% more productivity out of the computer, and have relieved the staff of many of the details of machine operation.

The Litton Industries Guidance and Control System Division's data processing installation at Woodland Hills, California, processes both commercial and engineering information problems. An IBM 7010 computer is installed for commercial work and an IBM 7040 for engineering work. This article discusses the operating system employed by the 7010.

What is an Operating System?

An operating system is basically a program which supervises the running of other programs. Although an operating system would seem to be primarily for computer operators, it has many other important benefits. It speeds the flow of work on the computer by eliminating much of the between-job delays; it facilitates program writing, program testing, and processing of such jobs as sorts and merges; and it simplifies the transition of programs from one computer to another.

The operating system consists of:

- a supervisor or monitor program (usually installed in the computer's memory), which oversees job-to-job transition and handles interruptions when they occur;
- a standard input-and-output-control program which is used by all other programs;
- standard utility programs for card-to-tape-type operations;
- sort programs, which are also used by other programs; and
- language processors for COBOL, FORTRAN, and Autocoder.

In general, the operating system integrates these various types of programs into a single consistent system. The result is an inherent efficiency which might otherwise be sacrificed for the sake of expediency. Language processors or compilers, for example, are entirely consistent with one another and with the monitor so that each compiler translates a programmer's source statements into the same type of relocatable instructions.

Properties of an Operating System

These processors have several important aspects:

- Translated machine language instructions have relative rather than absolute addresses so that programs can be assigned to any location in memory that is convenient at run time;
- Programs translated by different compilers, or by the same compiler at different times, can be assembled and run as a single program; and
- A single program can be updated and changed quickly both in the source and object versions.

Four major benefits are achieved with the operating system;

- Faster programming of production jobs;
- Two-and-one-half times faster testing of programs;
- Up to 17 times faster compilation of COBOL statements; and
- Up to 50% more production from computer.

The operating system accomplishes about 50% more work by eliminating unnecessary stops between successive computer runs and materially reducing any setup time required between jobs. Moreover, the maze of clerical functions which operators previously performed are eliminated. Operators' tasks are now guided by a single set of standard procedures.

Stacking for Continuous Processing

All 7010 programs handled by our department are stacked for continuous processing. This includes programs to be processed by the compiler, production programs and sort programs.

To stack a sequence of jobs, the operator uses control cards to create an input tape which calls for jobs, assigns tape drives and provides all necessary data. The control cards tell the operating system what to do. They describe the programs being run under the monitor; and indicate what the job is, the location of the necessary files, work tapes, monitor and output tapes, and the sequence of events for those programs using one or more elements of the operating system. The input tape is simply a collection of these control cards plus data to be used by the program.

Control cards can also be fed directly to the processor via a card reader. This method is used when changes in sequence or interruptions are required. In our department, the control cards are transferred to an input tape, along with data, so that processing time is not wasted on a relatively slow-speed task, such as calling data from a punched-card reader.

Litton has developed a 1401 program to keep track of all the tapes, including the input tape, that have to be used. In this way, tapes with programs and data are located rapidly and employed correctly, enabling operators to organize each run efficiently.

When the operating system concept was first considered, we reviewed the benefits hoped for and our own long-term requirements. Four important requirements were applied to the operating system: 1) interchangeability, 2) convertability, 3) training, and 4) efficient performance.

Interchangeability

Interchangeability means that we require a system which permits us to generate programs that run on either of the two computers. With this flexibility, the department can meet most effectively a fluctuating workload for both business or scientific programs. Jobs can be diverted to the processor with the more time available.

Fortunately, the 1410/7010 operating system includes both business-oriented and scientific-oriented language processors. Therefore a programmer can prepare his problem in the more convenient language, FORTRAN or COBOL. Although we primarily use the 7010 for commercial problems, it can handle scientific problems as well.

The key to interchangeability, however, is that the 1410/7010 operating system is quite similar to the 7040/7044 operating system. Commercial problems written in COBOL for the 7010 can be run on the 7040 system with a few program instruction changes. Once a 7010 COBOL program is written, it takes the programmer less than an hour to code the additional set of environmental statements and procedural changes necessary for the problem to be processed on the 7040 system.

Convertability

Convertability is another important consideration because today's data-processing center must anticipate moving into larger or more efficient processing systems. Today's programs should not chain us to today's equipment.

The operating system makes it feasible to keep source programs active and up to date; in other words, programmers don't have to start from the beginning when faced with conversion to a new system. Conversion programs written by the manufacturer can thus be used to make source programs which are valid for a new system.

For example, we were able to use IBM's conversion program for programs written in Autocoder before the operating system was announced. This conversion program took our Autocoder statements and converted them by machine into source statements. These statements, in turn, were then converted to machine language by the operating system's processor.

Conversion required a considerable amount of computer time, but the efficiency gained through use of the operating system for the normal workload provided us with more than enough time to handle it.

With the operating system facilitating source program maintenance, we expect that any future conversion requirements will also be simplified. Future computers will undoubtedly make use of monitor supervision, and our current efforts will provide valuable experience. By organizing our workload to take advantage of elements of operating systems, future systems will not require drastic changes on our growing library of production programs.

Retraining

Retraining is a concern because of the caliber of people required to program and operate almost any data-processing system. Non-productive study time is necessary for systems analysts and programmers, and machine time is lost, while they learn. Also, mistakes are made in programming, system organization, and setup. This makes retraining costly.

The operating system simplifies programmer and operator tasks, and makes training easier. In the first place, compile, test, and go facilities provided by the operating system usually speed the programmer's work back to him on the same day, and also, require less operator supervision.

In the second place, both programmer and operator are guided by more rigid operating-system rules. This means that their work is more consistent, less apt to require on-the-machine debugging, and less apt to be hampered by simple oversights. Programs, for instance, are not dependent on specific tape units; setups are guided explicitly by instructions that match the control card.

The standard input tape contains all the control cards and data required to schedule the machine during the day. Since the Litton-created control for scheduling and tape-library automatically lists tapes required as well as the drives upon which they are to be mounted, the operator makes far fewer mistakes.

Efficient Performance

Efficient performance, streamlining both the preparation and running of programs, is the major advantage in adopting an operating system. We have experienced significant improvement in both areas.

Also, the operating system has made it possible for us to interrupt scheduled processing to do special projects without disrupting the day's work. The computer automatically holds up scheduled work and returns to it when the special project is completed. The only penalty paid is the time required to process the special project.

The operating system also opens the way for new dimensions in the data-processing function. Having an operating system, we can now plan a management information system that can respond to inquiries at any time of day without regard to the batch processing work. Interrupt routines in the monitor enables the machine to temporarily halt work on one job, answer the inquiry, and then return to the batch job—all automatically.

Another advantage provided by the operating system is in sorting. About 60% of the commercial work we do on the 7010 computer consists of sorts. We have improved sort times by 25 to 35%. This represents a significant improvement. A sort that took 3.5 hours when first written for the 1410 can now be done in 1.1 hours on the 7010 with the operating system. (If it were run on an operating system equipped with the 1410, the sort time would have been reduced to 2.5 hours—a 28% time reduction.)

All the sort routines which we use are stored on the system tape or systems operating file. From there, they can be called up as needed by the job cards which a programmer prepares for his work.

Modifications to sorts are quite simple. One of the modifications provides for each sort program employed to use the job number to find control cards in a sort control card library. This library contains some 400 sets of control cards which can be used on the five sort programs.

Another modification permits the operator to indicate the order of a merge, based on the number of magnetic tape units available at any given time, and to tell the system how many reels of tape are to be sorted.

When the department first implemented the operating system, two 1410's were installed. One had 40K of core memory with seven tape units and the other had 80K with nine tape units. Since that time, the 1410's have been replaced with an IBM 7010 with 14 tape units and 100K of core memory.

The tape-oriented operating system puts all major segments of the system on magnetic tape. The operating file, the GO file, and library are on tape. One tape unit takes care of the "standard input," and provides source program and test data when processing a source language. Other tape units hold output for the printer, output for the punch, and a core image file.

An alternate input unit is the 1442 card reader, which is used to reestablish job priorities, to insert a nonscheduled job, or to skip to a job originally scheduled to be run later. To bypass a job, an operator merely enters a code into the console typewriter keyboard.

Two System Operating Files

We have decided to employ two distinct system tapes or system operating files. A single file of all the operating system components would require too many compromises in the arrangement of the elements. By having two, we get maximum efficiency in arrangement based on two approaches. One of the system tapes is organized to run production programs; the other is organized for compile and test operations.

The organization of the system tapes is a critical factor for efficiency in a tape-oriented system. In the interest of saving time we try, as much as possible, to eliminate searching the tape for a required element. Instead, we sequence operating system elements (non-resident monitor, linkage loader, compilers, sort routines, and utilities) in the order in which they will be used. Multiple copies of elements such as the loader and transitional monitor are usually spaced along the tape where they will be needed. We find it is more economical to maintain multiple copies than to execute a long search routine that would include tape rewind.

The importance of arrangement has been shown by the reduction in compile-and-test times brought about by improving system tape organization. Our first compile-and-test jobs were running about 20 minutes. With the elimination of search time, they now average between seven and eight minutes.

The segment of the systems tape arranged for compile-and-test operations indicates how elements are arranged. The COBOL compiler is first, followed by linkage loader, IBM library, tape-file generator, core-dump and tape-print programs. This allows compile-and-test operations to proceed by moving the systems tape in a forward direction only. The tape-file generator program written by our staff automatically produces the files required for program checkout.

Up-Dating

Additional programs as well as program changes may be incorporated into the production-operating file as often as three times a week. This updating process takes about 40 minutes of machine time for each run.

All non-converted programs are recorded in absolute-card-image format on a single reel of magnetic tape. The programs are initiated by a control card which calls for the search program on the input tape. The search program rewinds the input tape, sets up a code in memory so that a rewind won't be started when the operating system is brought back. The search program then locates the desired program on the non-converted program tape and places the "standard loader" program in memory. This program, in turn, loads the non-converted program into memory. The computer then processes the program.

To have the operating system resume control, the operator presses the tape-load key to get the monitor back into memory and types, on the console typewriter, the job number to be selected next from the input tape.

This method of handling these non-converted programs has enabled us to save a considerable amount of reprogramming time and still function in an operating-system environment. Eventually these programs will be redone to incorporate improvements in our data processing applications so that all programs will be dependent on the operating system in a few years.

Our operating system, as it stands today, has given us more than an efficient supervisory program. It has reinforced order and consistency in our data processing efforts. By smoothing the flow of work through the machine and by encouraging the use of rigid standards, it enables us to concentrate on the services for which the department was created in the first place. And that's what we were looking for.

COMPUTERS, AND THE PUBLIC SECTOR OF THE ECONOMY

(Continued from page 6)

this problem is probably more than 99.99% solved. As a result, for example, the Hanford plutonium works of the Atomic Energy Commission are being converted to civilian industries because our nuclear weapon stockpile is far more than overflowing; and overkill is overkill. The Secretary of Defense has begun very sensibly to reduce our expenses for many weapons.

Actually, however we could do very well in defense with less than half of that $50 billion a year. Why?

Because almost everybody knows that big nuclear wars cannot be fought any more without unacceptable destruction. For the United States to "win" such a war means that perhaps 5 to 10 million of our people will be left alive out of 190 million people—and that all our big cities, all our medium-sized cities, most of our small cities, all our forests, etc., will have disappeared in nuclear explosions, radioactive dust, and firestorms.

So conflicts will essentially have to be settled in other ways.

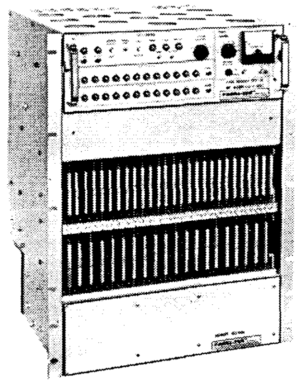
Then there would be at least 25 billion dollars a year ready to be diverted to building up the public sector of our economy: the subways and the schools, the cities and the libraries, the slums and Appalachia, the hospitals and medical services, etc.—the public benefits and advantages of the Great Society.

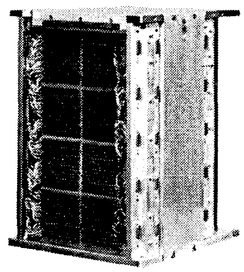
Soon this general idea will get into the heads of enough civilians in this government of the people, by the people, and for the people. Then good solutions to the really important problems in the public sector of our economy will start pouring out of our political, social, and economic studies and research powered by computers.

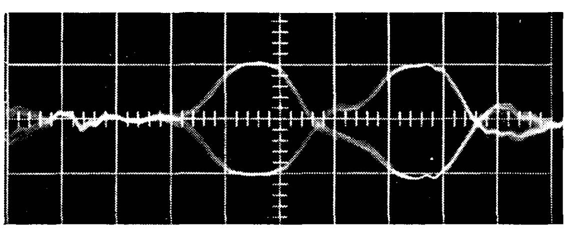
Edmund C. Berkeley
EDITOR

1,500,000-bit "scratch pad"?

Here's a Fabri-Tek memory system approaching "scratch pad" speed but with full memory capacity. It has a 1-usec cycle time and a 450-nsec access time. Coincident-current memory organization takes advantage of all the component economies inherent in this type of system. All silicon semiconductors plus the well-known Fabri-Tek maintenance features result in exceptional reliability and maintenance ease. The Fabri-Tek HIPAC stack is one of the reasons for the high speed and wide operational margins of this system. HIPAC stack density and circuit design result in much higher switching speeds at moderate drive currents. Delay per bit is phenomenally low (approx. 10 psec.). This oscillogram shows all 1's being read and restored. Scale is .1 usec per division. With this new Fabri-Tek Series MF 1-usec Memory System you can do anything you're doing now — but do it faster and more economically! For Radar data processing — cut down the number of components and solve real-time problems with greater savings in time and equipment. Where computer time is money — get more for your dollar! For more information on the Fabri-Tek Series MF 1-usec Memory System, phone, write, or wire Robert E. Rife, Fabri-Tek Incorporated, Amery, Wisconsin. Congress 8-7155 (Area 715), TWX: 715-292-0900.







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READERS' AND EDITOR'S FORUM

(Continued from page 9)

PROGRAMMING LANGUAGES FOR COMMAND AND CONTROL

Theodore Singer
Workshop Chairman
IEEE Computer Programming Committee
Mitre Corp.
Bedford, Mass.

A RAND report issued in January, 1963, considered the question of programming languages and standardization in Command and Control and concluded that it was too early to standardize. But the quantity and kind of work done on and with such languages since that time suggests that the question might well be reopened. In order to bring together people working in this area, the IEEE Computer Programming Committee is planning a workshop at which the problems can be aired, the progress can be assessed, and the different viewpoints can be presented.

To ensure a good representation at the workshop, we are asking for your assistance. Following is a notice we would like to have included in your next issue, and drawn to the attention of any interested persons.

The Computer Programming Committee of the IEEE Computer Group is planning a workshop on Programming Languages for Command and Control. Anyone active in this area interested in participating in such a workshop is invited to send his name, address, and a short resume of his work in this area to the workshop chairman:

Dr. Theodore Singer
The MITRE Corporation
Box 208
Bedford, Mass.

A time and place will be selected, depending on the response, and invitations will be sent to a limited number of persons active in this field.

CERTIFICATE IN DATA PROCESSING

R. Calvin Elliott
R. Calvin Elliott
Executive Director
Data Processing Management Association
Park Ridge, Ill.

Thanks for running the Certificate in Data Processing announcement in you November issue. The results have been overwhelming.

We appreciate your cooperation since the Certificate Program is one that we are very proud of, and we think it will go a long way to assist in professionalizing those in data processing.

COMMENTS ON "PEOPLE WHO DO NOT WORK WELL"

Harry R. Hein
Supervisor, Guidance, Counseling, and Testing
Dept. of Education
State of West Virginia
Charleston 5, W. Va.

Your editorial on "People Who Do Not Work Well" in the October issue is precise and hard hitting.

May I have your permission to reproduce this material, with appropriate credit, in our Guidance Servicer? This publication has a circulation of approximately 1,200 copies. It is read by educators at both the public school and college level.

[Permission was granted.]

COMPARING PROGRAMMING LANGUAGES

(Continued from page 16)

problem, or until it becomes one, a language such as JOVIAL, which permits access to most of the machine, is recommended. It has also been postulated that a language such as IPL-V, or at least the IPL-V Interpreter, which has many of the required control features, could be used almost directly for some control programs.

- "Heuristic" processes—programs that are by nature continually changing and expanding (without human intervention) so that little space allocation can be planned and the relationships among the data are quite "tree-like" —benefit from languages like IPL-V and LISP.
- LISP—a general process-solving language—seems quite powerful for producing programs capable of indefinite integration, symbolic equation solving, predictions of terms in series, and other such processes where manipulation of symbolic variables and mathematical terms is paramount.
- "Large" system programs—where the ultimate program is actually composed of many subprograms and probably written by more than several programmers—require a good operating system for their construction as much as a good language for their programming. However, the language must be amenable to an operating system and permit reasonably complex, yet flexible, data definitions. NELIAC and JOVIAL were designed for this purpose, with JOVIAL having somewhat more flexibility. It has also been recommended that large systems be experimentally implemented with languages like LISP and IPL-V, since these languages permit an extreme degree of freedom in change of data design and, thus, permit observations of proposed system features before "locking" them in with more conventional coding techniques.
- "Business" programs—which usually require vast quantities of data and some (relatively small) amounts of manipulation—can probably be programmed in almost anything, although certain languages, such as COBOL, have gone to lengths to provide adequate input-output as well as internal definitions for implementation of these processes.

Conclusions

The above considerations can almost always be tempered with a number of qualifications, as stated earlier. In any case, it does seem that a language that combines the mathematical capability of ALGOL, the structured-data-definition capability of JOVIAL, the unstructured data and powerful expression capability of LISP, and the ability to express input-output file operations in a general fashion would permit the programming of just about any kind of problem.

Such compilers have been produced (e.g., SLIP, which combines list-processing and algebraic capabilities), and others are being produced now. Perhaps this one grand language is the solution. On the other hand, perhaps with some of the newer techniques for generating compilers (e.g., from the syntex description of the language), one will eventually be able to generate compilers rapidly for any unique program.

It is certainly true that an arbitration board would have a difficult time comparing languages today. Some have been used fairly well for almost every conceivable application, although they weren't intended for all. Other languages that are superb for certain applications on a small scale fail completely when their program's data requirements get large.

One sometimes wonders how long programming languages will be as much a matter of taste as they are matters for careful comparison.

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

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APPLICATIONS

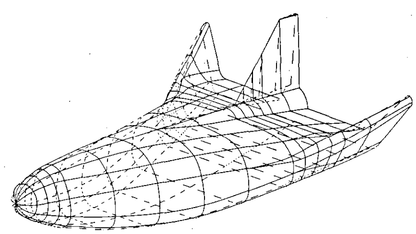
COMPUTER DRAWS SPACE SHIP DESIGNS

Computers now are being used as tools to design space vehicle shapes. Boeing Company's Aero-Space Division applied mathematics organization (Seattle, Wash.) has developed a technique called geometric computing which can design vehicle configurations capable of controlled flight through the earth's atmosphere on a re-entry path, with savings in time, money and material.

Using a computer, Boeing's applied mathematics personnel can develop raw engineering data and prepare it for the computer. It is then fed into the machine which draws a three-dimensional shape of the proposed spacecraft, based entirely on the figures provided by the mathematicians.

This computer-drawn design can take the form of a line drawing for visual study or a tape which, when fed to a machine, dictates what shape will be carved in metal according to the computer design.

These mathematical drawings of spacecraft provide graphic information for engineering evaluation and analysis. Engineers in Boeing's flight technology department, with assistance from the applied mathematics organization, have worked out equations for figuring surface pressures and aerodynamic heating rates in hypersonic flight. When these equations are given to the computer, the lift, drag, and control characteristics of advanced re-entry vehicles also can be calculated, saving many hours of laborious engineering calculations.



— Three-dimensional perspective drawing of re-entry vehicle was drawn by a computer in Boeing's Aero-Space Division. Exact replica of shape can be carved in aluminum by a tape-controlled machine.

Flight technology engineers point out that geometric computing does not eliminate the need for engineering calculation or testing, but it does allow some preliminary design work to be performed quickly and easily.

Geometric computing also can be used to establish the position of major subsystems within a shape. It would have required 35 weeks to design radiation protection systems for deep space vehicles using conventional methods. The computer did the work in two weeks.

Similar computer work is being done by other Boeing divisions aimed at solving design problems for their own product lines. The new Boeing capability is considered a significant advance in engineering design techniques.

RADAR ANTENNA PRECISELY POINTED BY COMPUTER

What is probably the world's most precise antenna point and tracking system is in operation at the Haystack space tracking station in Massachusetts.

The Haystack antenna beam is automatically pointed by a high-speed Univac computer, and begins a tracking operation, as instructed by an operator through a console typewriter. While tracking a target, the operator may instruct the computer to guide the antenna in any of 18 different tracking modes.

Pointing instructions are computed and transmitted to the antenna system once every 4 msec. As reference information in making the calculations, the computer has stored on tape complete ephemeris data from the Nautical Almanac for the sun, moon, 8 planets, and five radio stars. Alternatively, the operator may provide orbital elements of any desired satellite, or a desired direction in space, in radar, or in celestial coordinates.

Four magnetic tape units are used with the computer: Unit 1 stores the master program; Unit 2 stores the Nautical Almanac ephemeris information; Units 3 and 4 alternate storing tracking data. The computer programs themselves use 28K positions of memory out of a total capacity of 32K.

In addition to pointing the antenna, the computer can be used for processing, recording and plotting incoming data, and for monitoring and controlling the performance of electronic equipment; it also can be used to answer such questions as "When will the moon rise on November 27th" or "What will Jupiter be doing for the next three months?", for planning additional experiments.

The antenna structure itself was designed by three independent computer programs which were used by engineers to determine in detail the structure's performance characteristics before it was built.

IBM DEVELOPS 1401 PROGRAMS, EXPERIMENTAL DATA ACQUISITION EQUIPMENT FOR CLINICAL TESTS

IBM's Advanced Systems Development Division has developed a computer program to be used by hospital pathology laboratories. The program is designed to eliminate clerical work performed by nurses and medical technologists during test ordering and processing. Experimental laboratory equipment developed by IBM provides an automatic means to identify and handle specimens through the test cycle. The new IBM program data acquisition and equipment were demonstrated recently at the combined Annual Meeting of the College of American Pathologists and American Society of Clinical Pathologists in Miami, Florida.

Punched cards with pre-scored sections can be used by nurses to order laboratory tests which physicians have requested. Information from this card as well as other identifying facts about the patient are then transmitted to the central computer.

After several tests have been ordered, programming instructions to the computer cause it to print out a specimen collection schedule. This schedule, prepared for each ward, includes the names of patients along with the type of test ordered and other data. As specimens are collected, prenumbered labels from the original requisition card are placed on the speciment containers to assure positive identification.

One computer-produced test card is also prepared for each test ordered. The medical technologist uses the same card to report information about test findings to the computer after the specimen has been analyzed.

Based upon the test results, two reports are printed and relayed to the ward nursing station. The first is a Ward Summary Report which is produced at intervals — usually every two hours. This lists the progress of testing up to that time and is used by the nursing station to give results to physicians during the day and to answer inquiries.

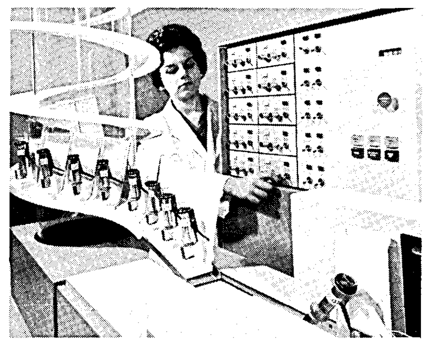
The other report is prepared at the end of the day for every patient tested that day. This Patient Summary Report shows on a single document the chronological results of all tests performed during a patient's hospitalization. Abnormal results are flagged for the physicians.

— Dr. A. E. Rappoport, left, director of laboratories, Youngstown Hospital Association, Youngstown, Ohio, and W. J. Constandse, an IBM engineer, examine a report summarizing tests conducted during a patient's hospitalization.

Three sources of information enter the data acquisition equipment. One of these is the stub portion of an IBM card containing patient and test identification information. The other two are the patient's specimen and prenumbered, pressure-sensitive label taken from the original test requisition card and placed on the specimen container. All of these items are placed in an L-shaped carrier. The card stub rests vertically in a slot along the back of the carrier where it can be read at the time that the test is made. Positive identification of the specimen with the patient is thus assured throughout the handling and processing period.

Up to 50 specimen carriers can be loaded on a cylindrical storage tower which has a spiral ramp.(see picture below). The first two carriers are held in position magnetically, and are released one at a time onto a belt transport that carries them towards the test instrument. The other carriers stored on the tower slide forward one position.

As the released specimen carrier reaches the reading station along the belt feed, the specimen container is upended and its contents are poured into a glass fun-



nel. A colorimeter is used to determine hemoglobin value of blood samples by determining the amount of transmitted light. The resulting voltage signal represents the hemoglobin value of the sample.

In clinical laboratories today, medical technologists read this signal on a dial and perform manually the mathematical calculations to determine the hemoglobin value.

With this experimental IBM equipment, the voltage signal is read by a control device, converted into digital form, and punched in a card. At the same time the specimen was being analyzed by the colorimeter, the specimen and patient identification was read from the punched card stub on the back of the specimen carrier as it passed the reading station. This information is punched in the card along with the digitized voltage signal.

The card, along with other cards with similar information about other tests, is then entered into an IBM 1440 data processing system. A reference curve developed from standards was previously stored in the computer. The computer program uses this reference curve to calculate the hemoglobin value, automatically adjust the computed results for drift, if necessary, and prints out the test findings for review by the pathologist and the patient's physician.

DESK-TOP COMPUTER KEEPS TRACK OF OUR FISH POPULATION

A TR-10 desk-top computer and 1110 X-Y Variplotter (manufactured by Electronics Associates, Inc.) is keeping track of our fish population for the U. S. Bureau of Commercial Fisheries.

According to EAI, the computer uses known facts and statistics on the reproduction ability, weight increase, life span and similar data on fish species to project information about fish population for the Bureau, both under controlled conditions and in cases where information is incomplete. From the information provided by the computer, the Bureau can estimate, by also noting actual commercial fish catches, whether population of a given species are increasing or decreasing.

To learn fish population dynamics when all facts are known, the Bureau is conducting actual tank tests. However, to learn the dynamics of commercial fish population when catch statistics are known, but only limited biological data can be assembled, the Bureau is constructing mathematical population models on the computer, reading out the results on the X-Y plotter.

The computer generates a function representing the life history of each brood. Throughout that history the brood is mathematically subjected to various rates of natural as well as fishing attrition, and the fish grow in mathematical weight to an asymptotic size at a steadily declining rate. Broods present in each year's stock are summed graphically to determine total stock. This factor tells the Bureau biologists the initial sizes of broods entering the commercial fishery X years hence.

Already the method has been used in a pelagic (open ocean) fishery and a demersal (bottom) fishery. Once it is fully developed it will be applied to fisheries where available biological data are scanty. This applies to all but a few of the largest and oldest commercial fisheries.

1964 TAX RETURNS BEING PREPARED BY NEW CSC COMPUTER SYSTEM

The first broad-scale use of computers to analyze, compute and print Federal and State income tax returns for individuals is being undertaken for 1964 filings. An estimated 500,000 taxpayers in New York, New Jersey, Connecticut, and in California, Texas, Washington, Nevada and Arizona are expected to use a new service called COMPUTAX, employing two UNIVAC 1107 computers located in Mineola, N.Y., and Los Angeles, Calif.

COMPUTAX was developed by Computer Sciences Corporation, El Segundo, Calif., and will be available through accountants and tax preparer services. CSC estimates that by 1970 a minimum of 10,000,000 taxpayers throughout the country will have returns prepared by COMPUTAX.

The new service eliminates the need for accountants or tax preparers to make arithmetic calculations. All COMPUTAX returns have been completely free of arithmetic errors. When using COMPUTAX, the accountant or tax preparer completes a group of special forms designed by CSC with basic taxpayer information. These "input" forms are then delivered to local CSC offices where information is keypunched, verified and fed into the magnetic tape system of the Univac 1107 computers.

At this point, the computer begins its operation by reviewing the data it has received, calculating the return several times using different methods and then selecting the most favorable method of computing the return (e.g., by itemizing deductions, taking the 10% standard deduction, or the minimum allowable deduction). The computer performs all of these calculations in less than five seconds and prints completed returns at the rate of 700 lines or 2.3 Federal and State returns per minute. Several printers on each computer are used to speed the printing process following which returns are collated and delivered to the accountant. With both computers operating at full speeds, CSC can produce over 540 returns per hour.

For each taxpayer, COMPUTAX provides three copies of both Federal and State returns including all necessary schedules and attachments, a taxpayer's letter of filing instructions and a special "diagnostic" or audit report for the accountant.

The computer's diagnosis of the taxpayer's return is based on a library of current tax laws and over 45,000 programmed instructions stored in its memory. In preparing this report, the computer checks the return based on current law to determine whether there are inconsistencies or omissions in a return, if deductions exceed tax limitations, and for more advantageous methods of preparation. There are over 100 different diagnostic checks which the computer can relay to the tax preparer.

The COMPUTAX service has been programmed to handle virtually any individual return regardless of the degree of complexity. Similarly, prices vary according to the amount of information which is submitted to the computer. A typical complex return using Form 1040 and including three additional schedules and various lists of itemized deductions, detailed income and capital gains would cost the tax preparer about $8.

Principal advantages of the COMPUTAX service are to reduce the accountant's time in performing many routine clerical tasks and to assure maximum accuracy, neatness and speed in the preparation of returns. The accountant remains as the controlling center of the system since COMPUTAX does not exercise judgment or make discretionary decisions in the preparation of returns. For example, the accountant must tell the computer which depreciation method it must use to calculate the return. Although the computer can perform this function, it cannot foresee the accounting strategy which is most advantageous to the taxpayer.

To supplement marketing of the COMPUTAX program this year, CSC has authorized franchises for four accounting and data processing organizations to service their respective areas. These include CompuStat Systems, San Francisco and Santa Barbara; Electronic Computer Service, Inc., San Diego; Bit, Inc., Sacramento, and Integrated Financial Service, Inc., Seattle. Over 1200 tax preparers will use the CSC service this year.

NEW CONTRACTS

TECH/OPS AWARDED OVER $2 MILLION ARMY RESEARCH CONTRACT

A $2,130,000 contract has been awarded by the Army's Boston Procurement District to Technical Operations, Incorporated of Burlington, Mass., for research and scientific combat development studies.

The award calls for scientific analysis, war games, simulations and field-test for long-range Army planning. Studies under the contract will be conducted through December 1965. The contract, which is the largest ever received by Technical Operations, will be performed at Fort Belvoir, Va., and Fort Benning, Ga., by the company's Combat Operations Research Group (CORG) under the direction of Martin N. Chase.

LEEDS & NORTHRUP TO SUPPLY COMPUTER SYSTEMS FOR MINE-MOUTH POWER STATION

Leeds & Northrup Company, Philadelphia, Pa., will supply two digital computer systems and boiler control equipment totaling more than $1,000,000 for the new 1,800,000-kilowatt Keystone power station — the world's largest mine-mouth power plant — now under construction near Elderton, Pa.

The two LN4000 digital computer systems, ordered by Gilbert Associates, Reading, design engineers for the project, will be used for performance monitoring, alarm scanning, data logging and efficiency studies on the No. 1 and No. 2 generating units at Keystone. Additionally, the systems will provide sequence monitoring and operational guides for starting and shutdown of the units.

The boiler control system, ordered by Combustion Engineering Inc., Windsor, Conn., utilizes the L&N Direct-Energy-Balance (D-E-B) method of control. With this technique, automatic regulation of combustion and feedwater supply to the boiler is coordinated with the turbine governor to provide the desired electrical output.

CTI RECEIVES STUDY CONTRACT FROM NASA

Control Technology, Inc., Long Beach, Calif., has received a study contract from the National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Texas. CTI is to provide an error analysis of hybrid computer simulation of six-degree-of-freedom equations of motion. This study is for a period of six months and will take place at CTI's Long Beach Facility.

The prime object of the study is to determine the optimum use of the digital differential analyzer computer at MSC when used in combined operation for aerospace applications, with particular attention directed to man-in-the-loop studies. A prediction of the accuracy to be expected from such a combination operation is a major part of this study.

EMR TELEMETRY TO MONITOR LARGEST MOBILE STRUCTURE FOR NASA

The National Aeronautics and Space Administration has awarded a contract to Electro-Mechanical Research, Inc. (EMR), Sarasota, Fla., for FM telemetry equipment worth over a million dollars. Over 1000 voltage-controlled oscillators and 70 discriminators will be supplied to NASA for two Mobile Launcher Vibration Data Acquisition Systems. These systems will monitor the Mobile Launcher while it is being moved to the launch site and during the launch of the Apollo-Saturn V rocket.

The Mobile Launcher, the largest mobile structure in the world, weighs 11.5 million pounds unloaded and is approximately 100 feet taller than the Statue of Liberty. It will hold the 360-foot-tall Apollo-Saturn V in the huge NASA Vehicle Assembly Building, under construction at Merritt Island, during rocket assembly and checkout and then will be moved three miles to the launch pad by a crawler-transporter, a 7600-hp tractor device.

EMR's equipment forms part of the ground support equipment, considered the most advanced ever built. It will measure and code over 1000 vibration points on the enormous structure. EMR will supply the first system to NASA for installation at Kennedy Space Center, Merritt Island Spaceport, by April 1965 and the second by October 1965.

DSI WRITING ASI 6020 DIAGNOSTIC PROGRAM

Decision Systems, Inc., Teaneck, N.J., has received a contract from Advanced Scientific Instruments Division of Electro-Mechanical Research, Inc., Minneapolis, to write the diagnostic program for the new ASI 6020, a medium-scale digital computer for scientific, engineering, and on-line systems applications.

Thomas A. Wood, president of DSI, said the program will be designed with a view toward making the arithmetic unit portion modular, so that the same program can be modified for use with the ASI 6040, a computer in the same series.

A diagnostic program is used for regular maintenance checks on computers, and for spotting the cause of specific malfunctions.

CONTROL DATA DIVISION RECEIVES CONTRACT FROM DEFENSE ATOMIC SUPPORT AGENCY

The System Sciences Division of Control Data Corporation has received a contract from the Defense Atomic Support Agency to provide systems design, systems engineering, and a real-time systems programming effort in support of a large data processing requirement. The contract award includes all of the analysis, design, and demonstration of techniques necessary for the implementation of the ultimate system.

COMPUTER APPLICATIONS WINS NASA CONTRACT

Computer Applications Inc., New York, N.Y., has received a contract approximating $1 million in value from the National Aeronautic and Space Administration's Goddard Space Flight Center, Greenbelt, Md.

According to John A. DeVries, president of CAI, the three-year agreement will cover a variety of computing services associated with programs conducted at Goddard Space Flight Center. The work under the contract actually will be performed, Mr. DeVries said, by Computer Concepts, Inc., a wholly-owned subsidiary of CAI located in Silver Spring, Md.

NEW INSTALLATIONS

KELLOGG-CITIZENS NATIONAL INSTALLS IBM SYSTEM

Kellogg-Citizens National Bank, Green Bay, Wis., has installed an IBM system which is being used in all departments of the downtown financial center to handle demand deposit accounting, savings, installment loans, mortgage loans, trust, proof and transit, payroll and customer service functions.

The new system consists of an IBM 1440 computer with random access disk storage, card reader and punch, printer and a magnetic ink reader-sorter capable of processing 950 checks per minute.

BROKERAGE HOUSE INSTALLS NCR COMPUTER SYSTEM

Shields and Company, New York, N.Y., has announced the installation and purchase of a half-million-dollar computer system from the National Cash Register Company.

The system will eventually link Shields' branch offices and headquarters with stock exchange floors for immediate and direct processing of securities transactions. Shields expects to be the first brokerage house to be operational "on-line" when it inaugurates a remote inquiry system among its departments and branches and an NCR 315 computer next July.

MOBIDIC SYSTEM DELIVERED TO PRATT & WHITNEY

Systems Engineering Laboratories, Inc. of Fort Lauderdale, Fla., has delivered to Pratt & Whitney Aircraft's Florida Research and Development Center, West Palm Beach, a Mobile Data Acquisition System called MOBIDAC III. The system is a 50-channel Data Acquisition System that accepts low-voltage signals that represent temperatures, pressures, straines, etc., and produces a computer compatible magnetic tape. The system will be used by Pratt & Whitney Aircraft engineers in testing engines which are being developed for the United States defense and space programs.

KASSLER & CO. USES H-400 TO PROCESS LOANS

Kassler & Co., Denver, Colo., one of the nation's leading mortgage banking firms, has installed a Honeywell 400 data processing system to process mortgage loan data for more than 90 banks and institutional investing firms.

The computer, which is located at Kassler & Co.'s headquarters in Denver, consists of a central processing unit with 3072 words of memory, five high-speed magnetic tape units, a 900 line-per-minute printer, and a card reader-punch.

SMITHSONIAN OBSERVATORY ORDERS CONTROL DATA COMPUTER SYSTEM

The Smithsonian Astrophysical Observatory, Cambridge, Mass., has ordered a Control Data 3200 computer system for use in connection with satellite tracking and its broad program of scientific studies of celestial phenomena, the upper atmosphere, and the earth.

The Smithsonian Astrophysical Observatory maintains a world-wide network of 12 photographic tracking stations for satellites, under a grant from the National Aeronautics and Space Administration. It will use the Control Data 3200 computer system in connection with scientific analysis of data obtained by these tracking stations.

BULLOCK'S TO INSTALL SECOND NCR 315 COMPUTER SYSTEM

Bullock's-Magnin Company, a division of Federated Department Stores Inc., Los Angeles, Calif., plans to install a National Cash Register 315-100 computer as a satellite to an NCR 315 system already in use.

The additional system will share the same site at Bullock's Downtown Los Angeles data processing center. It will be used initially to convert the company's chain of I. Magnin & Co. specialty shops to electronic processing. The larger system is already on a two-shift-plus-Saturday basis and averaging 90 to 110 hours per week.

Additional programming scheduled for the over-all system includes accounts payable, payroll-personnel, improved buyer's reports and staple stock control. The processing center is currently handling accounts receivable, direct mail advertising, and sales reporting for print punch ticketed departments.

ELECTRONIC DATA CORP. INSTALLS HONEYWELL 200

Electronic Data Corp., an affiliate of Administration, Inc., Boston, Mass., has installed a Honeywell 200 business computer at its service center. EDC will be using the H-200 to provide an integrated data processing service for local business and industry, according to Harold Symington, President of EDC, and to increase the effectiveness of administrative backup being provided clients of Administration, Inc., which is one of the leading business advisory firms in the Boston area.

Among the more unusual assignments to be handled by the H-200 are: the purchase and sale of trust fund holdings for Boston law firms having their own trust departments; projecting for colleges their requirements for development funds; and documenting case histories of patients for hospitals. The computer also will be involved in all of the more normal data processing activities required by EDC's clients.

NEW YORK CITY DEPT. OF TRAFFIC INSTALLS UNIVAC 1004

A modern data processing system has been installed in the New York City Department of Traffic to handle operational and maintenance records. One of the principal tasks of the new system will be to keep installation, control and maintenance records for traffic lights at approximately 9000 signalized intersections and 60,000 parking meters located throughout New York City's five boroughs.

Heart of the new data processing system is a UNIVAC 1004 Card Processor, designed and built by the Sperry Rand Corporation's UNIVAC Division.

The new system will provide detailed records of every traffic signal light, pole, controller, detector, parking meters and other associated equipment on the city's streets. It will also record reports of defective equipment and the time of repair in order that the department will have assurance of prompt repairs by its maintenance contractors.

In addition, the equipment will keep a complete record of traffic accidents in the city. These data will help the department's traffic engineers to pinpoint dangerous and potentially dangerous intersections requiring corrective traffic control measures. Future applications include inventory records for its sign and signal shops, motor vehicle records, payroll, time keeping, budget operations, personnel and accounting operations.

WABCO ORDERS DDP-116 FOR FREIGHT CAR SORTING

The Union Switch and Signal Division of the Westinghouse Air Brake Company (WABCO) has ordered a DDP-116 digital computer from Computer Control Company, Inc., Framingham, Mass. The DDP-116 will be installed at the Southern Pacific Company's Classification Yard in Eugene, Oregon. The computer will be the central control element of an Automatic Classification Yard System which will apply the latest technical developments for sorting railroad freight cars.

The Automatic Classification Yard System provides automatic retardation and automatic switching of freight cars so that they can be assembled into trains for common destinations. The DDP-116 will be programmed to control the alignment of track switches so that cars will be routed to the proper classification track. Detecting devices (field transducers) feed information to the computer which in turn determines the proper retardation required in order to deliver the freight car to its classification track at a safe coupling speed.

NYU ORDERS CONTROL DATA 6600

New York University's Courant Institute of Mathematical Sciences has ordered a Control Data 6600 Computer System. The new computer, scheduled for delivery early this year, will provide New York University students and faculty with a system capable of processing more than 3 million instructions per second. It will be installed in Warren Weaver Hall, a new building now being completed near Washington Square to house the Courant Institute of Mathematical Sciences.

The Courant Institute, one of the nation's most important research facilities, operates both as a graduate mathematics department for NYU, and as a Center for Advanced Training and Research supported by government agencies, private foundations, and corporations. It will use the Control Data 6600 to develop methods for using very high-speed digital computers for applied mathematics and mathematical physics, through numerical and non-numerical techniques.

ORGANIZATION NEWS

C-E-I-R BUYS RCA DATA CENTER

C-E-I-R, Inc. has purchased the Radio Corporation of America's Electronic Data Processing Center in Washington, D. C. The acquisition became effective January 1, 1965. Although the sale price was not disclosed, the original value of the equipment installed at the Center exceeded $1 million.

The Center employs some 40 people and operates a large RCA 501 data processing system and a smaller 301 computer. The facility has been in operation more than four years, providing data processing services for banks, associations and a wide range of business enterprises.

WASHINGTON, D.C. FIRM ACQUIRES PHOTO MAGNETIC SYSTEMS

The William C. Allen Corporation of Washington, D.C. has acquired Photo Magnetic Systems, a research and development firm specializing in the areas of information storage and retrieval, data displays, and optical character recognition. The acquired firm consists of research, engineering, and management experts in the application of advanced graphic information processing technology to the solution of commercial and government information handling problems.

The William C. Allen Corporation is a Management Consulting firm providing services in the areas of manufacturing, information processing, and economic progress. It conducts studies for commercial and government users as well as for major equipment manufacturers.

RCA AND PRENTICE-HALL NEGOTIATE MERGER

David Sarnoff, Chairman of the Board of Radio Corporation of America, and Richard P. Ettinger, Chairman of the Board of Prentice-Hall, Inc., have announced that negotiations for a merger of RCA and Prentice-Hall are taking place.

The negotiations are still in the preliminary stage and are subject to approval by the Boards of Directors of both companies; final agreements will be submitted to the stockholders of both companies at a later date.

CONTROLS, INSTRUMENTATION AND AUTOMATION GROUP FORMED BY ITT

International Telephone and Telegraph Corporation has announced the formation of a Controls, Instrumentation and Automation Group (CIA) to direct the activities of four ITT units, with combined annual sales totaling approximately $50 million. These sales involve a variety of valves, meters, counters, relays, switches, actuators and similar process and control devices, and the instrumentation associated with these products.

The organizations comprising the group are: ITT General Controls, Glendale, Calif.; ITT Hammel-Dahl, Warwick, R.I.; ITT Process Systems, Lawrence, Mass.; and Barton Instrument Corporation, Monterey Park, Calif.

ITT's vice president and group executive, John C. Lobb, stated, "The CIA group gives ITT a much wider coverage and a deeper penetration into the process control and instrumentation field. The new organization encompasses a broad coverage of the residential, commercial, industrial and process markets for automatic controls...."

EDUCATION NEWS

DAVENPORT AREA TECHNICAL SCHOOL

The Davenport Area Technical School (Davenport, Iowa) last February initiated a two-year training program which includes 2820 hours of instruction in punched card and computer principles.

This "hands on" EDP training program is centered around a GE-225 electronic computer with a card reader, card punch, high speed printer, magnetic tape equipment and disc storage device. It is under the direction of Richard Livingston, coordinator of the school's EDP Division and is geared to male and female students, 16 years of age and over, who have a high school diploma or the equivalent. The course includes an intensive, four-semester training schedule.

Students are introduced to the principles of flow-charting, symbolic coding, English language programming, and such supporting subjects as the principles of accounting and cost accounting. Computer applications to receive particular attention in the program are payroll, accounts receivable, accounts payable, invoicing and billing, and inventory control. Emphasis is on business data processing applications. However, the basic concepts of scientific data processing will be introduced in the second year of this two-year college level program. Upon satisfactory completion of the course, diplomas are presented.

The school "laboratory" contains 11 pieces of punched card equipment for student use, including a verifier, an interpreter, a sorter, a collator, a reproducer, an accounting machine and five keypunches.

Classes meet from 8 a.m. to 3 p.m. daily, with an additional hour each day devoted to individual conferences and instruction. Class enrollment is limited to 20 students per class, with a class starting each September. Each student must pass a standard programmer's aptitude test prior to acceptance.

The entire EDP curriculum has been developed with the assistance of the U. S. Department of Education, the State Department of Education and the local advisory committee. Each instructor is qualified by education and experience to teach data processing subjects, and each is approved by the Iowa State Department of Public Instruction.

Iowa schools are among the most advanced in the nation in recognizing the need for more educational programs centered around the electronic computer. Computer training programs are being offered at the secondary level in Des Moines and at the post-high school level in Ottumwa. A fourth city in Iowa, Cedar Rapids, is planning a course at both levels.

FSU STUDIES COMPUTER POTENTIAL IN HELPING PUPILS LEARN

An experimental program to examine the potential of the electronic computer in meeting the individual learning needs of students — from kindergarten through graduate school — has been started at Florida State University (Tallahassee). The project is being undertaken by FSU with the cooperation of the Florida State Department of Education and IBM Corporation.

The project uses a typewriter-like keyboard terminal linked by telephone wire to an IBM computer some 1200 miles away at the company's Thomas J. Watson Research Center in Yorktown Heights, N.Y.

FSU's experiment will use computer assisted instruction, a system developed by IBM which enables an educator to enter instructional material, questions and guidance into a computer for presentation to students on typewriter consoles or other equipment. The course unfolds at a pace and in a manner determined by a student's demonstrated ability.

Instructional material used in the computer project is organized, edited and sequenced by the actual teachers of the courses, who are doubly qualified in knowing both their subject matter and the ways in which students learn. The responses made by each student on the typewriter terminal are compared by the computer with the correct answers stored in its memory. This, together with the fact that the computer also keeps stored a record of each student's performance, enables the presentation of the material to be tailored to the individual's capacities.

In addition to testing the potential value of computer assisted instruction, the project will furnish University faculty members with specific data on student learning processes. This information will enable educators to investigate the characteristics of individual instruction and its best use by the classroom teacher.

The study also will serve to measure student acceptance of the computer as an instructional aid, and its relation to other instructional techniques. FSU educators also are seeking to discover any differences in the effectiveness of the computer technique at all grade levels, from reading readiness in kindergarten to course work for graduate degrees.

HIGH SCHOOL STUDENTS OFFERED SPECIAL COURSE BY MSU

"Learning computer language is like learning a foreign language," according to the director of the Michigan State University Computer Institute for Social Science Research. "It requires no prerequisites, it is on about the same level of difficulty, and it is easier to learn early in life."

Confirming his statement are 30 Lansing-area high school students who have been taking a special Evening College course on computer programming which he arranged. The decision to offer a special course for high school students was made after a number of them showed up for a course open to the general public last summer.

"The proper time to learn computer programming is in high school", says Dr. Charles F. Wrigley, a professor of psychology at MSU. "It would be a good thing if high schools could teach computer programming but unfortunately they cannot afford the computer. This is why universities should offer the opportunity."

Students enrolled in the MSU course have been taught to use the Control Data 3600 to solve a number of simple problems. The course has included a Monday evening lecture-discussion class and a Saturday morning laboratory session. A similar evening course for adults is being offered during the winter term on Tuesday and Thursday evenings.

NEW PRODUCTS

Digital

BUNKER-RAMO 335

A new small, fast, low-cost control computer system for industrial applications has been announced by Milton E. Mohr, vice president and manager of The Bunker-Ramo Corporation's Industrial Systems Division, Canoga Park, Calif.

The system, called the Bunker-Ramo 335, will be offered to industry for process control and optimization, direct digital control, data logging and alarming, control and recording for industrial analyzers, control for automatic warehousing, packaging, and accounting systems, and sequence control for automated systems.

The 335 is a fully parallel machine with 4096 to 16,384 16-bit words of directly addressable core memory. The machine has a 1.7 microsecond memory cycle, with a 3.4 microsecond execution time for the majority of instructions. Other features of the 335 include: memory protection against power failures; program interrupt; multi-level indexing and indirect addressing; double length accumulator; extensive shift, skip branch, logical and control instructions; and a Teletype 33 automatic send-receive unit.

Among optional equipment available with the basic 335 system are: card input/output station with manual card preparation capability; flexible process input/output controller; an analog input system; an operator station; and logging typewriters.

A comprehensive process control software package is available with the Bunker-Ramo 335.
(For more information, circle 41 on the Readers Service Card.)

CONTROL DATA 6000 SERIES

"Because of industry's demands for total management information systems, and the scientific users demands for the means to solve larger and larger problems, Control Data is bringing out its 6000 Series of super-scale computers", William C. Norris, President of Control Data Corporation (Minneapolis, Minn.), said in announcing the new 6000 Series.

The 6000 Series consists of three computers — the 6400, 6600, and 6800. They provide business, industry, science and government users the most comprehensive range of software and system compatibility announced in the computer industry. In addition to serving routine data processing and computational needs, the 6000 Series has been specifically designed to handle multi-processing and multi-programming, time-sharing, and management information systems.

The 6000 Series represents a new concept of concurrent operation in three areas: memory, input-output, and functional units (of which there are ten).

The central processor for the 6400 has a unified arithmetic section, operating in a sequential manner. In the 6400 computer, the concept of "distributive computers" is readily implemented. This means that more than one central processor can be used with the same bank of memory. It is particularly useful for those who emphasize multiple access where many people want to use the system for large groups of related small problems.

The 6600 and 6800 have arithmetic sections that include ten functional units (Add, 2 Multiplies, Divide, Long Add, Shift, Boolean, 2 Increments, and Branch), thus making possible the execution of instructions simultaneously within the same program.

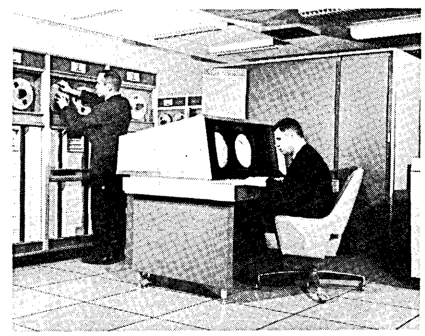
While the 6400 has an instruction buffer register supply a continuous stream of instructions into the unified arithmetic section, the 6600 and 6800 use an instruction stack. Instructions are fed into the stack containing up to eight 60-bit words of instruction contents.

All three computers in the 6000 Series achieve processing efficiency without operator intervention by switching programs in current execution during input-output delays, whenever a higher priority requirement is encountered, or upon reaching a time limit.

A disk storage unit, a requisite to the Systems' multi-programming capabilities, provides mass random access storage increments of 500 million bits. By accumulating portions of a given program's output during generally scattered periods of execution, the disk permits program switching without loss of previous partial results whenever switching is advantageous or necessary.

The disk also is used for storage of the System Library, the source language job stack, and previously compiled programs for which execution has not been initiated. Because of a request table in one of the peripheral processors and because the position of the disk is known at all times, information is transferred in an optimum manner which greatly reduces the access time normally associated with disks.

With the same basic design concept common to all three computer systems, fantastic speeds are achieved. These range from execution speeds of one million instructions per second on the 6400 to twelve million instructions per second on the 6800.



— Control Data 6400 Computer System

The 6400 is now in production, and Control Data will take orders for delivery in less than 12 months. Delivery of the first 6800 is scheduled for 1967. The 6600 is presently being delivered and increased production is now being implemented.

Purchase prices for typical systems will range from less than $1 million to several million. Rental prices will vary from $25,000 per month to $150,000 per month or more depending upon the system configuration.
(For more information, circle 42 on the Readers Service Card.)

SPECTRA 70 SERIES

The Radio Corporation of America, New York, N.Y., has announced the first of a new generation of electronic computers, designed to meet the total information processing requirements of science and industry well into the 1970's.

The new computer series — called Spectra 70 — comprises four compatible electronic data processors identified as the 70/15, 70/25, 70/45, and 70/55. The four provide all of the elements needed for total information systems, including an extensive array of data storage, communications, and input-output equipment.

Memory cycle speeds range from two microseconds for the smallest processor, the Spectra 70/15, to 840 nanoseconds for the largest, the Spectra 70/55. Memory sizes range from 4096 bytes to 524,288 eight-bit bytes, respectively.

The new processors provide multi-lingual compatibility, real-time processing, and the capability to utilize more than 40 kinds of peripheral devices. Standard interface units allow interchange of Spectra 70 input, output, storage or communications units with other Spectra 70 processors.

The multi-lingual capabilities enable the Spectra 70 to "speak" the language of many other computers, including the recently announced IBM 360 as well as the RCA 301, 3301 and 501 systems. The "native tongue" of the systems is the Extended Binary Coded Decimal Interchange Code (EBCDIC), and each of the new computers can generate and work with the American Standard Code for Information Interchange (ASCII).

An additional innovation, is the use in the two larger computers, of monolithic integrated circuitry. Each of the circuits is formed of a silicon chip so small that it would barely cover the letter "o" of a typewriter, yet large enough to contain two complete electronic circuits with 15 transistors and 13 resistors. The new integrated circuits are described by RCA engineers as faster, more reliable and more economical than any such circuit technique now in commercial use or so far announced.

Design of the new series itself was aided by extensive automated design techniques, in which circuit and system layouts were produced by an electronic computer.

Customer deliveries will begin in the fourth quarter of the year. (For more information, circle 44 on the Readers Service Card.)

Software

FORTRAN IV AVAILABLE FOR DDP-116 COMPUTER

Computer Control Company, Inc., Framingham, Mass., has announced the availability of the FORTRAN IV Algebraic Compiler for its low-cost DDP-116 computer. FORTRAN IV, generally not available for most present day computers, is particularly not available for low-cost, high-speed computers in the DDP-116 class.

The DDP-116 computer (see Computers and Automation, October 1964, p. 43) is designed for both open-shop scientific applications and real-time data processing. The new FORTRAN IV software package greatly enhances the DDP-116 capability for open-shop computations.
(For more information, circle 45 on the Readers Service Card.)

"CART" FOR MOTOR CARRIERS

Honeywell's electronic data processing division (Wellesley Hills, Mass.) has developed a new computer application package for the trucking industry called CART (Computerized Automatic Rating Technique). CART, designed for use with the Honeywell 200 and 2200 business computers, automatically applies proper freight rates to shipments and transmits rated bills to the terminals responsible for final delivery of shipments to consignees.

Key to the application is a computer program, which when used with a Honeywell 200 or 2200 tied into a data communications network, will: automatically rate all shipments; notify terminals of deliveries; trace lost shipments; facilitate collection of accounting and statistical data; monitor all freight loading and routing; accumulate data for vehicle maintenance and operating reports; and perform personnel scheduling.

The CART rating method also will maintain and update tariffs as approved by state governments and the ICC, and allows for inventory control and scheduling.
(For more information, circle 46 on the Readers Service Card.)

Information Retrieval

VIDEOFILE SYSTEM

Ampex Corporation, Redwood City, Calif., has developed a new system, called Videofile, that replaces file folders with television recordings that may be viewed and kept up to date electronically.

The Videofile system records documents on magnetic video tape of the same kind used in television broadcasting. As a document is needed, file users dial the appropriate location number and the file is displayed page-by-page on a conventional television receiver. If copies of any portion of the file are required, they may be electronically printed in seconds.

A basic Videofile system consists of a Videotape television recorder with built-in electronic editing capabilities, a television camera, an indexing unit, television receiver and/or an electrostatic printer. With large and more complex files additional basic and supplemental equipment is necessary.

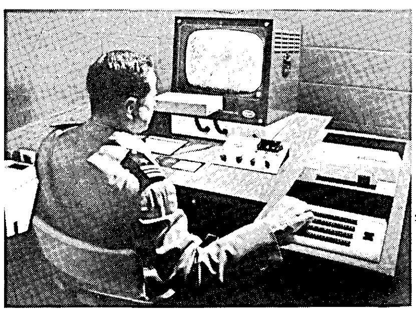
The first Videofile system will be delivered in mid-year to the National Aeronautics and Space Administration, Huntsville, Ala., under an $875,000 contract, for use as a technical library filing system. It will permit storage of more than 250,000 document pages per 14-inch reel of standard video tape. Users at a variety of locations will have immediate and simultaneous access to any part of the file.
(For more information, circle 47 on the Readers Service Card.)

PARD (PRECISION ANNOTATED RETRIEVAL DISPLAY)

GPL Division of General Precision, Inc., Pleasantville, N.Y., has developed a system that allows microfilm to be up-dated and corrected without film reprocessing. Only a standard pencil and eraser is needed to add or delete updated information.

The new system, PARD (for Precision Annotated Retrieval Display), stores up to 500,000 management information items on 5000 EAM-cards, automatically selects any one card within six seconds, then magnifies it up to 250 times for television viewing, while providing continuous up-dating capability.

In the PARD/120 system, the 5000 EAM-size cards, containing one to 100 microfilm images, are first coded according to a master organization plan, then stored in an automatic storage/retrieval file. To select any one of 5000 back-



ground cards, a PARD operator punches four coded buttons, shown at right in the picture. Within six seconds the correct card is located and popped up. The operator removes the card and inserts it in the Microteleviser (to operator's left in the picture) which enlarges the microfilm image up to 250 times. This image appears on a television screen in front of the operator, as well as on any number of large and small screen television displays.

When the image appears on television, another code number is shown on the background image to locate more information or later data available in the file. By punching keyboard buttons, the correct card with the most recent up-dating material is located and popped up. The PARD operator takes out the card and places it in front of him on an annotation platen which is being scanned by a closed television camera. Information from the first card selected (the background card) and the up-dated card are electronically mixed to provide one television picture with basic background and current updated material.

This television picture can be sent to any number of large and small screen television displays, providing commanders or managers and their staffs with an overview of various tactical, strategic and management operations.

When the PARD/120 operator is through with the cards, he drops both the background and annotation cards in the storage drum where they are randomly filed automatically.

Initially designed to meet new Defense Department command and control requirements, PARD/120 systems are expected to find wide acceptance by commercial companies facing an increasing volume of paperwork and greater need for rapid management decision information.
(For more information, circle 49 on the Readers Service Card.)

VIDEO-IR SYSTEM

A video tape information storage and retrieval system has been developed by Dixon Industries, Inc., Gaithersburg, Md. The VIDEO-IR System uses video tape in place of conventional microfilm to record printed data. A single 3600 foot video tape reel can store nearly 400,000 standard-size pages of information. When a particular page of information is desired, it may be viewed immediately on a display television screen. If required, the system will automatically print out the information.

The VIDEO-IR System has many advantages over conventional microfilm storage and retrieval systems, including: 1) no film processing — the material is filmed on video tape and can be played back instantly; 2) faster acquisition time — a particular segment of information can be selected from among the nearly 400,000 segments on the storage reel practically immediately by pushing a button, and 3) the VIDEO-IR file may be interrogated from any distance, and the desired information displayed to the interrogator in a matter of seconds, using regular telephone lines.

A specially developed coding system permits instantaneous access to individual portions of information on the reel. In addition to storing data on tape reels, a unitized VIDEO-IR card also is available, in the shape of a standard computer punch card, which will hold 150 pages of information.

Although the basic components of the Dixon VIDEO-IR System are standard, each individual system is custom-designed to specifically suit the special requirements of the user.
(For more information, circle 50 on the Readers Service Card.)

IBM ANNOUNCES FOUR MICROFILM PRODUCTS

IBM Corporation, Dayton, N.J., has announced four microfilm products that give the company's line of Micro-Processing equipment a new systems capability for automating information handling. The system combines the space saving method of storing documents on microfilm with the advantages of processing and retrieving data on punched cards.

Key to IBM's microfilm systems is the Micro-Processing Aperture Card. The cards enable easy reference to and retrieval of a variety of documents. They may be used to project information onto screens of viewing devices or to obtain paper copies as required. The cards can be used repeatedly. They also are economical enough to be discarded after use.

The four products that provide IBM with the new systems capability are: (1) a copier/reproducer — this machine enables the transfer of both punched holes and microfilm images from one punched card with a microfilm frame to another in a single operation; (2) a diazo copier — this device copies images from roll microfilm to punched cards as well as from one card to another, in one step; (3) a viewer/printer — this device projects images from Micro-Processing cards, acetate jackets, microfiche or roll film onto an 18-inch by 24-inch screen, and also, at the press of a button, makes a high-contrast, paper copy of the image in a variety of sizes, and (4) a planetary camera — this is designed to simplify the microfilming of large as well as small documents.

The Micro-Processing product line now enables a company to microfilm source documents, produce multiple aperture card copies for reading of the filmed images, and

— Three of the microfilm products are shown above. At left, girl removes keypunched, imaged Micro-Processing card from the new diazo copier. The other machine operator scans the Micro-Viewer/Printer before making a paper copy of the image. At extreme right of photo is the planetary Micro-Camera which simplifies the microfilming of source documents.

return to paper copies of the documents from the aperture card copies.

IBM's Supplies Division manufactures the copier/reproducer and the diazo copier. The viewer/printer is manufactured by Itek Business Products. The camera is a product of Photo Devices Inc. (For more information, circle 48 on the Readers Service Card.)

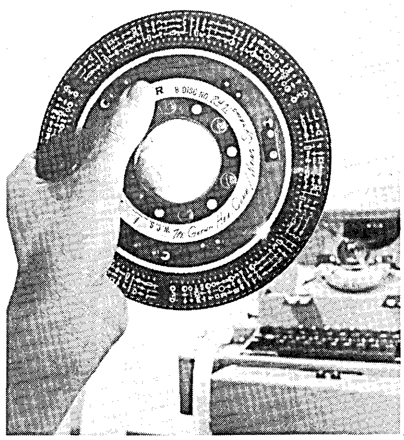
Input-Output

"PHOTO-DRAFT" SYSTEM

A design engineer's finished electrical or electronic circuit diagrams can be "photodrafted" automatically at speeds up to ten times as fast as they can be drawn manually, using new equipment developed by the Keuffel & Esser Co., Hoboken, N.J. The new system, called "Photo-Draft", is being offered by K&E for use in electronic, utility, architectural, and other diversified design engineering work.

A trained typist can take an engineer's rough diagramatical sketch and process it through the Photo-Draft system to obtain a finished schematic on drafting film within an hour's time. This schematic is then available for reproduction by standard processes such as diazo for similar-size copies, or microfilming for enlargement.

A unique design aspect of the Photo-Draft equipment is the use of a light beam to make exposures on the drafting film through any combination of 168 different transparent schematic symbols, lines, letters, or numbers contained on a revolving disc. The disc resembles a standard-size 45 RPM victrola record. It is positioned by commands from coded, 8-channel paper tape to make light exposures at the rate of approximately 200 a minute.

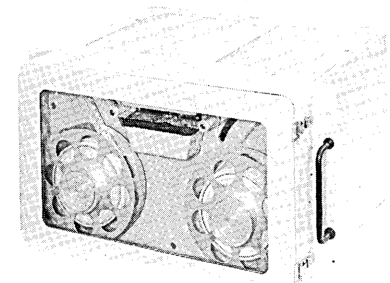


— Victrola-like disc is inserted in photographic unit (background) which contains 40 feet of tightly rolled photosensitive drafting film. Disc revolves and is positioned by commands from coded, 8-channel paper tape. As it does so, a light beam passes through selected symbols making exposures on the film.

Virtually all engineering symbols, letters or numbers can be incorporated on the revolving light-exposure disc. Discs can be prepared for any type of schematic drafting merely by incorporating whatever combination of 168 symbols are required for the drafting work involved.
(For more information, circle 51 on the Readers Service Card.)

TYPE 422 MILITARIZED TAPE READER

The Militarized solid-state paper tape reader Type 422 was developed by Ferranti Electronics, A Division of Ferranti-Packard Electric Ltd., Toronto, Ontario, Canada. It has a new magnetic disc drive unit and photoelectric sensing system for rapid processing of standard 5, 6, 7 and 8 channel tape at 300 and 600 characters per second. The new disc-drive system eliminates the need for adjustments during the life of the device.



— Type 422 Militarized Tape Reader

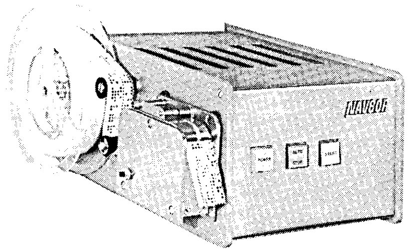
A picture showing the drive unit and reading platform only, of the Type 422, was shown in the December 1964 issue of Computers and Automation, Input and Output Equipment, page 41. The illustration caused some confusion and to clarify this we are glad to print the above picture supplied by the manufacturer. (For more information, circle 52 on the Readers Service Card.)

NAVCOR TAPE READING SYSTEM

A new tape reading system, developed by the Navigation Computer Corp., Norristown, Pa., uses many unusual design features. Model 1291 table-top tape reading system is so compact (about 12" long and 6" high) it can be used on a desk or a work table. It is so light (only 14 pounds) it can be carried easily from work area to work area.

This is a completely self-contained system, capable of reading 8-channel paper or mylar tape asynchronously at any rate up to 30 characters per second. Model 1291 uses sufficient power and card space to permit a wide variety of optional functions, such as gated and buffered outputs, parity checking, detection of special tape codes to generate command signals, and sequential data phone outputs.

Since the system uses NAVCOR "System Function" digital logic modules in its all-solid state circuitry, it requires only one or two cards for complete operation. One card controls the entire system, while just one other card will operate all optional functions.



A new patented reel servo system substantially reduces tape stress and power consumption. The new system also provides built-in automatic rewind capabilities. The device has a full set of output timing and blanking signals, which can be set easily to special voltage levels.

Model 1291 can be used on-line or off-line and integration into a larger system requires a minimum of special mechanical or electrical design. Maintenance is virtually non-existent — only a routine cleaning of the reader head every 10 million operations is required.
(For more information, circle 53 on the Readers Service Card.)

EAI ANNOUNCES TWO NEW LOW-COST RECORDERS

Electronic Associates, Inc., West Long Branch, N.J., has introduced two new low-cost X-Y recorders — the EAI VARIPLOTTER 1120 (8½" x 11") and the VARIPLOTTER 1130 (11" x 17"). The former marks EAI's entry into the 8½" x 11" market.

The new recorders have an unusual direct drive tape that is used in the instruments' linear ball-bearing drive systems. This 1/8-inch stainless steel tape prevents backlash and replaces the complex pulley and string system found in other recorders. Both devices are designed for use in a wide variety of electronic and analytical applications, and both can be used without extensive intermediate equipment.

The two recorders combine static accuracy of ±0.1% with a dynamic accuracy of ±0.2% and repeatability of ±0.05%. They include 18 calibrated d.c. ranges from 1 millivolt per inch to 20 volts per inch; and have continuously variable scale factor and a built-in time base with 6 calibrated ranges.
(For more information, circle 54 on the Readers Service Card.)

"MINIATURE" MILITARIZED PRINTER

Potter Instrument Company, Inc., Plainview, N.Y., has developed a new high-speed militarized printer capable of printing up to 10 lines per second in a 26-column format with 64 characters available per column in a parallel mode. Serial, character-at-a-time printing allows a minimum print speed of 10 characters per second. A typical message will provide an average speed of 80 characters per second.

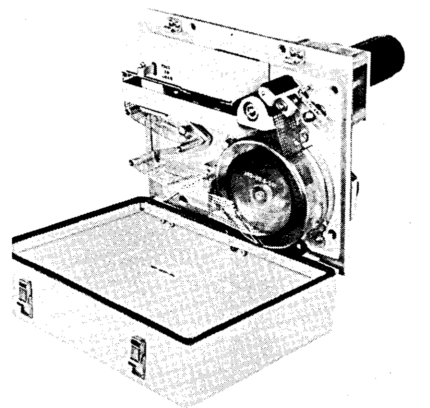
A new drum design permits the use of only 13 print hammers and associated driving circuitry, increasing reliability and reducing system costs. The drum is replaceable quickly (less than 30 seconds) to facilitate various drum formats. New elastomeric torsion bearing print hammers are used to provide long life expectancy.

The device will accommodate up to 4-part paper. The paper advance system is active only during the paper feed cycle. There is immediate view of the last line printed at all times. Facilities for storage and supply of pressure-sensitive fanfold paper are contained within the printer. The printer, identified as Model HSP-3604, and its associated basic electronics is packaged for mounting in a container only 5.4" in width, 8.8" in height, and 15.8" in depth. Inclusion of basic electronics allows the flexibility of either a serial or parallel print mode.
(For more information, circle 55 on the Readers Service Card.)

COOK ELECTRIC PAPER TAPE READER

A new paper tape reader has been designed and built by Cook Electric Company's Data-stor Division, Morton Grove, Ill. It has been developed as a program loader and malfunction testing device for the control computer of a new tactical missile system.

The device requires less than a cubic foot of space and weighs only 25 pounds. It is 8 5/16 inches high, 10 inches wide, and 13 inches deep. Functioning inside the missile vehicle with the operational control computer, the reader uses a continuous-loop tape cartridge with up to 150 feet of perforated tape stored in a magazine. Tape movement is simplified by means of a clutched capstan assembly.



The new tape reader, unusually good for repetitive program playing in general usage, operates unidirectionally at 15 ips (150 cps) stop on sprocket hole and at 100 cps stepping character to character. It uses .003-inch-thick, 1-inch-wide mylar tape. All components of the reader are modular construction. The reader uses no lenses and has a throwaway light source. No electrical adjustments are necessary.
(For more information, circle 56 on the Readers Service Card.)

Components

PRINTING TECHNIQUE BY BERRY GRANTED PIONEER PATENT

A pioneer patent has been granted to Theodore M. Berry and assigned to the General Electric Company, Phoenix, Ariz., on a high speed printing technique especially useful with computers. The U. S. Patent Office awarded patent number 3,161,544 dated December 15, 1964 on the Berry technique. The original patent application was filed on April 27, 1951.

One form of the Berry process employs what is known as ferromagnetography — a technique of printing characters on paper from a latent image magnetized onto a metal sheet or drum. Magnetic iron particles applied to the image are transferred to the paper during the printing process. The process makes possible reproduction of virtually an unlimited number of copies without destroying the latent image on the original sheet or drum. The latent image also can be stored for future use. (In electrostatic printing, a method of office copy reproduction now in common use, the image is destroyed each time a print is made from the negative. The image must be reproduced for each additional print desired.)

Most computer systems today use an impact printer which produces characters on paper by the use of electromagnetically driven hammers. The print elements are located in lines and columns usually around a drum which revolves at high speed during use. Such equipment is capable of producing 1500 lines of 160 characters every minute.

The Berry process uses a drum possessing rows and columns of character elements similar to the conventional high speed printer and revolves in a similar manner. In the ferromagnetic form of the Berry invention, it prints characters, however, without impact with the paper. Timed electrical pulses energize selected electromagnets associated with the character elements and magnetize the corresponding ones of these character elements. Latent magnetic images of the magnetized character elements are recorded on a print drum or belt adjacent to the character drum. When magnetic particles, acting as "ink", are applied to the drum, they are attracted and held magnetically by the recorded images. The visible images produced by the process are transferred to paper by the rolling action of the drum.

Claims in the Berry patent apply to both impact and impactless types of high speed line printers. Multiple copies may be made by simply recycling the drum using the same latent images during each cycle. This releases electronic control equipment in the computer for other uses during the reproduction cycles. Officials at GE's Computer Department forsee use of the technique to aid the retrieval and reproduction of information from computers whose abilities are now in part limited by the performance of its printers.

Theodore M. Berry, a native of Jewell, Kansas, was a top-level engineer at GE's General Engineering Laboratory in Schenectady, N.Y., until his death in 1953. He joined the General Electric Company in 1925. The present award represents Berry's 22nd patent.

MAGNETIC TAPE REHABILITATION CENTER

A new magnetic tape rehabilitation center has been introduced by Cybetronics, Inc., Waltham, Mass. The device, called Cybetronics CS-1, has high speed tape signal testing, buffing, cleaning and repair — all in one unit. It also has automatic test and certify modes of operation. The CS-1 center certifies tape at 556 and 800 bpi with signal levels adjustable from 20 to 80% of full signal voltage.

The new system is considered to be an economy model, although it contains most of the key features of equipment costing considerably more. Options include noise testing, additional density selections, testi-record mode operations.

The CS-1 is designed for use by magnetic tape manufacturers or for organizations with large tape libraries.
(For more information, circle 57 on the Readers Service Card.)

KEYBOARDS FOR USE WITH INPUT/OUTPUT DEVICES

A line of keyboards designed for electrical connection to card punches, printer-punches, computers, and other electronic input/output devices has been announced by the Industrial Products Division of IBM Corporation, White Plains, N.Y. The products include the Numeric Keyboard PE 707, the Alpha-Numeric Keyboard PE 708, and the Coded Output Keyboard PE 709.

The PE 707 contains 20 keys — ten numeric and ten function or control keys. In addition, there are three switches for automatic functions such as automatic feed, automatic skip, automatic duplicate, and print control.

The PE 708 contains 45 keys. Eighteen keys operate only when the keyboard is in alphabetic shift, 15 in either alphabetic or numeric shift, and 12 are function or control keys. This keyboard includes features of both a typewriter and a numeric key punch. The letter keys are arranged for operation by the standard typewriter touch system, while the digit keys are placed so that a rapid three-finger touch system can be used.

The PE 709 contains 53 keys, including seven function keys for space, backspace, line feed, carrier return and line feed, tab, shift, and shift lock. In appearance and operation, this keyboard resembles the standard IBM typewriter keyboard.
(For more information, circle 58 on the Readers Service Card.)

JOBS & OPPORTUNITIES

NEW EXAMINATION ANNOUNCED BY CIVIL SERVICE

The U. S. Civil Service Commission has announced a new examination for persons experienced in the fields of automatic data processing. The examination covers the positions of Digital Computer Programmer, Digital Computer Systems Analyst, and Digital Computer Systems Operator which pay between $6,050 and $10,250 depending on the length, quality, and type of experience shown by the applicant.

Interested persons should consult Announcement No. 348 for a detailed explanation of the experience requirements. The announcement and appropriate application forms may be obtained from many post offices throughout the country or from the U. S. Civil Service Commission, Washington, D. C. Applications will be accepted until further notice by the U. S. Civil Service Commission, Washington, D. C. 20415.

PERSONNEL EVALUATION SERVICE

Brandon Applied Systems, Inc., New York, N.Y., has announced a new service to assist users in the recruitment and selection of qualified data processing personnel.

The service, called Personnel Evaluation Service, is designed to provide its users with a convenient, central source of personnel; with screening and evaluation by professional analysts with extensive data processing experience.

The service comprises two parts: (1) recruitment and screening and (2) evaluation and ranking.

Recruitment and screening allows the user to participate in a pooled advertisement in major media at a low cost. The user submits his requirements; the ad is inserted and resumes received are screened by Senior Analysts of Brandon Applied Systems, Inc. to determine which meet the stated requirements.

Evaluation and ranking, the second step of the plan, independently allows the user access to Senior Consultants to evaluate and rank applicants for positions. The evaluation includes testing, when appropriate, and two independent interviews by Brandon Applied Systems, Inc. staff members. A confidential report is submitted to the client evaluating each applicant.
(For more information, circle 59 on the Readers Service Card.)

NEW LITERATURE

MOORE OFFERS BOOKLET ON DATA PROCESSING FORMS

A catalog of data processing forms and related forms handling equipment is available from Moore Business Forms, Inc. The seventy-three page spiral-bound book contains complete information on Moore marginal punched data processing forms and Moore forms handling equipment for every "after-writing" operation. The four-color book is divided into nine sections covering, in addition to forms facts and forms handling equipment, sections on custom-printed forms, MCR and OCR forms, stock and standard forms, government forms, duplicating forms, labels, binders, and special purpose forms.

The booklet is available free of charge under the title "Data Processing Forms".
(For more information, circle 60 on the Readers Service Card.)

USE OF MAGNESIUM IN RANDOM-ACCESS DISC FILE MEMORY SYSTEMS

Bryant Computer Products is offering a two-part, fully-illustrated, 42-page paper discussing the use of magnesium in random-access disc file memory systems. The paper provides an overall physical and functional description of a disc file and then discusses the advantages of using magnesium in disc file design.

This paper was presented at the Magnesium Association's 21st Annual Convention and Technical Meeting held last fall in New York City. The first part of the paper was presented by Frank Lohan, Bryant's Disc File Product Manager; the second part of the paper was presented by George Cheney, Bryant's Research and Development Manager.
(For more information, circle 61 on the Readers Service Card.)

AVAILABLE FROM NCR

"NCR 315 Computer System for Demand Deposit Accounting" is the title of a 32-page booklet available from The National Cash Register Company. This booklet traces the flow of data in an automated demand deposit system using Card Random Access Memory (CRAM) units for the storage of account data.
(For more information, circle 62 on the Readers Service Card.)

LITERATURE AVAILABLE ON THE SERIES 4000 DISC FILE RELIABILITY PROGRAM FROM BRYANT

A fully-illustrated, 65-page paper, discussing the reliability program Bryant Computer Products has initiated in the manufacture of their Series 4000 Disc Files, is available from the company. The paper was presented at the Disc File Reliability Seminar held during the 1964 Fall Joint Computer Conference.

The paper provides an introduction to the requirements for establishing an effective reliability program; a detailed mathematical analysis of the reliability of Bryant's Series 4000B Disc File including a discussion of the steps Bryant is taking to continuously improve this reliability; and a concluding comment of the benefits customers can ultimately receive if they actively participate in this reliability program to the extent requested by Bryant

Introductory and concluding statements of the talk were presented by Donald Merry, Bryant's Product Assurance Manager; the analysis portion of the talk was presented by his assistant Joseph Novak, Reliability Engineer.
(For more information, circle 63 on the Readers Service Card.)

BUSINESS NEWS

COMPUTER INDUSTRY TO BE $5 BILLION-A-YEAR BUSINESS BY 1970 EXPERTS PREDICT

Two computer industry authorities predicted that the value of commercial computers installed in the United States would increase from $6.4 billion in 1964 to over $17 billion in 1970. The prediction was voiced at a special all-day briefing session on the computer industry for security analysts held recently in New York.

The briefing session was sponsored by the EDP Industry and Market Report, a semi-monthly newsletter on the computer industry edited for the financial community. The session was conducted by Patrick J. McGovern, Associate Publisher of Computers and Automation and Editor of the EDP Industry and Market Report, and Dick H. Brandon, President of Brandon Applied Systems, Inc., a data processing consulting firm.

Trends expected in the computer field as outlined by Mr. McGovern and Mr. Brandon include:

1. The increasing shift toward program compatibility between computers of competing manufacturers, with the command structure of IBM's new System/360 being adopted as the de facto standard.

2. The elimination of much of the $2.5 billion worth of punched card and tabulating equipment with its replacement by low cost computers and newly developed forms of data capture devices that convert data directly into a form which can be processed by a computer.

3. A strengthening in the market for general purpose com-

puters in the process instrumentation field where such firms as Computer Control Co., Digital Equipment Corp., Raytheon Corp., and Scientific Data Systems can provide productive computers at a low cost because they need not spend the heavy programming and marketing expenses required of the other computer manufacturers.

4. A lightening of the shortage of computer programming and systems personnel as the growth of programming compatibility between computers allows more and more standard application programming packages to be available to the majority of users.

The briefing session on the computer industry, held at the Lawyers' Club in New York, was attended by over 40 security analysts and institutional investors. It was the first in a series of semi-annual briefing sessions sponsored by the EDP Industry and Market Report for the financial community.

1965 'BIGGEST YEAR' YET FOR EDP, FINKE PREDICTS

Walter W. Finke, president of Honeywell's EDP division, in a year-end statement noted: "The past year has been one of transition in the EDP industry, in which the rate of obsolescence of existing equipment was hastened by introduction of a large number of new systems. As a result, there has been a dramatic increase in the size of the replacement computer market."

Finke said the replacement market has been recognized as a large and growing share of the total EDP market by many manufacturers who introduced new equipment this year. This factor has also accelerated development of several trends which will become more apparent in 1965, according to the Honeywell executive.

Most significant of these is the trend towards program compatibility. "Nearly every major producer has introduced techniques of varying competence to translate, simulate, emulate or in other ways convert programming languages of competitive systems during 1964."

Use of program conversion techniques "can potentially open at least half of the total data processing market to more competitive selling, since 'locked-in users' — those bound to a particular computer model because of the prohibitive costs of rewriting programming languages for a competitive model — will tend to disappear," he said. "This will be reflected in increased intensity of sales efforts throughout the industry next year."

Technology was "shaken out" in 1964, and will not play a major role in computer developments in 1965. Microcircuitry, particularly integrated monolithic circuitry, appeared in some computers introduced in 1964, and will become standard in virtually all new equipment announced next year, Mr. Finke predicted.

The development of real-time data processing systems, which imply the presence of a variety of remote transmission terminals and quickly accessible mass information storage devices to permit immediate, "on-line" data processing, will continue to be the area of greatest emphasis during the next several years.

Remote terminals capable of performing document scanning, printing, communications, audio-answer-back, and other specialized functions will begin to play a prominent role in data processing equipment. Many such units already in existence will begin to go into use in user organizations next year.

"We have reached a new age in the computer industry, The Age of the Integrated System. As a result, we are seeing a de-emphasis of the central processor in favor of a balanced emphasis on systems design, special-purpose peripheral equipment, and the processor units. The Age of the Integrated System is cost- and applications-oriented, and these facts have shaped the plans and activities of manufacturers for the next few years," Mr. Finke stated.

He indicated that the shipment value of peripheral equipment in 1964 approximately equalled the value of central processors. Within several years, processors will represent only about one-third of the dollar volume of the industry, he said, with peripheral and special-purpose devices making up the remaining two-thirds.

Mr. Finke also reported that Honeywell's growth in 1964 was the greatest in its history. Record orders for its newest computer line, the Honeywell 200 system, and its large-scale computers, the Honeywell 800 and 1800, helped Honeywell raise shipments to more than $100 million this year, and its annual revenues to the highest in its 10-year history.

"We expect new orders to continue at near record levels, and shipments to continue at present rates — the highest in our history. By the end of 1965, we will have more than 1,000 data processing systems in operation throughout the Free World," he said.

3C REPORTS INCREASED EARNINGS IN 1964

Computer Control reports net earnings for Fiscal 1964 of $525,907, compared with $436,076 in 1963. Sales were $19,049,683, a 72% increase over the $11,081,415 of 1963. Company sponsored and expensed R&D rose to $2,181,255, or 11.4% of sales in 1964, compared to $974,267, or 8.8% of sales in 1963.

Unfilled order backlog October 31, 1964, was approximately $6,500,000. A significant portion of this backlog was in orders for the company's DDP computer line which was expanded during the year with the introduction of the DDP-224 and DDP-116 computers.

EXECUTIVE PREDICTS $1 BILLION SIZE FOR SOFTWARE FIELD

Services of independent computer software firms to industry and government are expected to reach — or exceed — $1 billion a year by 1970.

This was predicted recently by Vernon D. Walker, president of Mesa Scientific Corporation, one of the nation's largest computer software firms.

He said that during the last five years the field of computer software — including everything from real-time programming to complete software package development — has been growing four to five times faster than the computer hardware industry. He said that the services of independent computer software firms in 1964 would probably reach over $300,000,000. These services should rise to "well over $400,000,000 by the end of 1965 and exceed half a billion dollars by the end of 1966," he predicted.

MONTHLY COMPUTER CENSUS

The number of electronic computers installed or in production at any one time has been increasing at a bewildering pace in the past several years. New vendors have come into the computer market, and familiar machines have gone out of production. Some new machines have been received with open arms by users — others have been given the cold shoulder.

To aid our readers in keeping up with this mushrooming activity, the editors of COMPUTERS AND AUTOMATION present this monthly report on the number of general purpose electronic computers of American-based companies which are installed or on order as of the preceding month. These figures included installations and orders outside the United States. We update this computer census monthly, so that it will serve as a "box-score" of progress for readers interested in following the growth of the American computer industry, and of the computing power it builds.

Most of the installation figures, and some of the unfilled order figures, are verified by the respective manufacturers. In cases where this is not so, estimates are based on information in the market research reference files of COMPUTERS AND AUTOMATION. The figures are then reviewed by a group of computer industry cognoscenti.

Any additions, or corrections, from informed readers will be welcomed.

AS OF JANUARY 10, 1965

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	11	1
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	21	1
	ASI 2100	Y	$3000	12/63	7	1
	ASI 6020	Y	$2200	4/65	0	3
	ASI 6040	Y	$2800	7/65	0	2
Autonetics	RECOMP II	Y	$2495	11/58	60	X
	RECOMP III	Y	$1495	6/61	19	X
Bunker-Ramo Corp.	TRW-230	Y	$2680	8/63	11	3
	RW-300	Y	$5000	3/59	40	X
	TRW-330	Y	$5000	12/60	30	X
	TRW-340	Y	$7000	12/63	13	16
	TRW-530	Y	$6000	8/61	24	3
Burroughs	205	N	$4600	1/54	61	X
	220	N	$14,000	10/58	41	X
	E101-103	N	$875	1/56	118	X
	E2100	Y	$535	8/64	130	1250
	B100	Y	$2800	8/64	17	28
	B250	Y	$4200	11/61	96	11
	B260	Y	$3750	11/62	107	135
	B270	Y	$7000	7/62	92	24
	B280	Y	$6500	7/62	100	38
	B370	Y	$8400	7/65	0	22
	B5000	Y	$16,200	3/63	24	14
	B5500	Y	$35,000	10/64	13	6
Clary	DE-60/DE-60M	Y	$525	2/60	281	3
Computer Control Co.	DDP-19	Y	$2800	6/61	3	X
	DDP-24	Y	$2500	5/63	50	61
	DDP-116	Y	$900	2/65	0	22
	DDP-224	Y	$3300	1/65	0	14
Control Data Corporation	G-15	N	$1000	7/55	328	X
	G-20	Y	$15,500	4/61	28	X
	160*/160A/160G	Y	$1750/$3400/$12,000	5/60;7/61;3/64	414	10
	924/924A	Y	$11,000	8/61	28	2
	1604/1604A	Y	$38,000	1/60	60	X
	3100	Y	$7350	12/64	1	13
	3200	Y	$12,000	5/64	32	48
	3300	Y	$15,000	7/65	0	17
	3400	Y	$25,000	11/64	3	15
	3600	Y	$58,000	6/63	32	16
	3800	Y	$60,000	5/65	0	15
	6400	Y	$40,000	12/65	0	1
	6600	Y	$110,000	8/64	2	6
	6800	Y	$140,000	4/67	0	0
Digital Equipment Corp.	PDP-1	Y	$3400	11/60	57	2
	PDP-4	Y	$1700	8/62	54	6
	PDP-5	Y	$900	9/63	85	7
	PDP-6	Y	$10,000	10/64	2	8
	PDP-7	Y	$1300	11/64	3	14
	PDP-8	Y	$525	4/65	0	21
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	24	X
Friden	6010	Y	$600	6/63	195	110
General Electric	205	Y	$2900	10/64	9	21
	210	Y	$16,000	7/59	57	X
	215	Y	$5500	11/63	34	9
	225	Y	$7000	1/61	120	2
	235	Y	$10,900	12/63	30	14
	415	Y	$5500	5/64	23	103
	425	Y	$7500	7/64	12	46
	435	Y	$12,000	10/64	3	23
	455	Y	$18,000	6/65	0	6
	465	Y	$24,000	6/65	0	3
	625	Y	$50,000	2/65	0	11
	635	Y	$65,000	12/64	1	15
General Precision	LGP-21	Y	$725	12/62	143	35
	LGP-30	semi	$1300	9/56	430	3
	RPC-4000	Y	$1875	1/61	98	1
Honeywell Electronic Data Processing	H-200	Y	$6000	3/64	230	560
	H-300	Y	$3900	7/65	0	11
	H-400	Y	$8500	12/61	105	5
	H-800	Y	$22,000	12/60	64	16

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Honeywell (cont'd.)	H-1400	Y	$14,000	1/64	9	4
	H-1800	Y	$30,000	1/64	5	8
	H-2200	Y	$12,000	10/65	0	26
	DATAmatic 1000	N	$40,000	12/57	4	X
H-W Electronics, Inc.	HW-15K	Y	$490	6/63	3	1
IBM	305	N	$3600	12/57	400	X
	360/20	Y	$1800	12/65	0	1000
	360/30	Y	$4800	5/65	0	2100
	360/40	Y	$9600	5/65	0	800
	360/50	Y	$18,000	7/65	0	390
	360/60	Y	$35,000	8/65	0	115
	360/62	Y	$50,000	9/65	0	45
	360/70	Y	$80,000	10/65	0	145
	650-card	N	$4000	11/54	280	X
	650-RAMAC	N	$9000	11/54	55	X
	1401	Y	$4500	9/60	7650	750
	1401-G	Y	$1900	5/64	500	300
	1410	Y	$12,000	11/61	550	110
	1440	Y	$3500	4/63	1350	280
	1460	Y	$9800	10/63	925	600
	1620 I, II	Y	$2500	9/60	1510	18
	701	N	$5000	4/53	1	X
	7010	Y	$19,175	10/63	57	36
	702	N	$6900	2/55	8	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	39	X
	7040	Y	$14,000	6/63	70	22
	7044	Y	$26,000	6/63	45	12
	705	N	$30,000	11/55	70	X
	7070, 2, 4	Y	$24,000	3/60	500	5
	7080	Y	$55,000	8/61	71	2
	709	N	$40,000	8/58	11	X
	7090	Y	$64,000	11/59	45	2
	7094	Y	$70,000	9/62	235	10
	7094 II	Y	$76,000	4/64	60	40
ITT	7300 ADX	Y	$18,000	7/62	9	6
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	155	X
	Monrobot XI	Y	$700	12/60	450	155
National Cash Register Co.	NCR - 304	Y	$14,000	1/60	26	X
	NCR - 310	Y	$2000	5/61	46	1
	NCR - 315	Y	$8500	5/62	265	115
	NCR - 390	Y	$1850	5/61	775	160
Philco	1000	Y	$7010	6/63	15	0
	2000-210, 211	Y	$40,000	10/58	19	2
	2000-212	Y	$52,000	1/63	5	2
	2000-213	Y	$68,000	6/65	0	1
Radio Corp. of America	Bizmac	N	$100,000	-/56	3	X
	RCA 301	Y	$6000	2/61	540	75
	RCA 3301	Y	$11,500	7/64	17	35
	RCA 501	Y	$14,000	6/59	99	2
	RCA 601	Y	$35,000	11/62	4	1
	Spectra 70/15	Y	$2600	11/65	0	40
	Spectra 70/25	Y	$5000	11/65	0	15
	Spectra 70/45	Y	$9000	3/66	0	25
	Spectra 70/55	Y	$14,000	5/66	0	10
Raytheon	250	Y	$1200	12/60	160	15
	440	Y	$3500	3/64	8	10
Scientific Data Systems Inc.	SDS-92	Y	$900	2/65	0	20
	SDS-910	Y	$2000	8/62	107	30
	SDS-920	Y	$2700	9/62	70	6
	SDS-925	Y	$2500	12/64	1	8
	SDS-930	Y	$4000	6/64	12	22
	SDS-9300	Y	$7000	11/64	1	7
UNIVAC	I & II	N	$25,000	3/51 & 11/57	29	X
	III	Y	$20,000	8/62	78	15
	File Computers	N	$15,000	8/56	22	X
	Solid-State 80, 90, & Step	Y	$8000	8/58	320	X
	Solid-State II	Y	$8500	9/62	42	2
	418	Y	$11,000	6/63	9	7
	490	Y	$26,000	12/61	37	17
	1004	Y	$1900	2/63	2200	450
	1050	Y	$8000	9/63	125	220
	1100 Series (except 1107)	N	$35,000	12/50	13	X
	1107	Y	$45,000	10/62	21	5
	1108	Y	$50,000	7/65	0	12
	LARC	Y	$135,000	5/60	2	X
				TOTALS	24,220	11,165

X = no longer in production.

* To avoid double counting, note that the Control Data 160 serves as the central processor of the NCR 310. Also, many of the orders for the 7044, 7074, and 7094 I and II's are not for new machines but for conversions from existing 7040, 7070 and 7090 computers respectively.

CALENDAR OF COMING EVENTS

Feb. 2-4, 1965: Symposium in On-Line Computing Systems, Schoenberg Hall, UCLA Campus, Los Angeles, Calif.; contact UCLA Engineering Extension (GRanite 8-9711, Station 3721), Los Angeles, Calif. 90024.

Feb. 17-19, 1965: International Solid-State Circuits Conference, 12th Annual Meeting, Sheraton Hotel and Univ. of Pa., Philadelphia, Pa.; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

Mar. 22-25, 1965: IEEE International Convention, Coliseum and New York Hilton Hotel, New York, N. Y.; contact IEEE Headquarters, E. K. Gannett, 345 E. 47th St., New York, N. Y.

Apr. 13-15, 1965: National Telemetering Conference, 15th Annual Meeting, Shamrock-Hilton Hotel, Houston, Tex.; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

Apr. 15-16, 1965: First International Conference on Programming and Control, U. S. Air Force Academy, Colorado Springs, Colo.; contact Prof. G. B. Dantzig, Operations Research Center, Univ. of Calif., Berkeley, Calif.

Apr. 21-23, 1965: 16th Semi-Annual Meeting of Philco 2000 Users Group (TUG), El Tropicana Motor Hotel, San Antonio, Tex.; contact Omar Phipps, Philco Western Development Laboratories, Palo Alto, Calif.

May 3-8, 1965: Symposium on the Numerical Solution of Partial Differential Equations, Inst. for Fluid Dynamics and Applied Mathematics and the Computer Science Center, Univ. of Md., College Park, Md.; contact Inst. for Fluid Dynamics and Applied Mathematics, Univ. of Md., College Park, Md. 20742

May 10-12, 1965: National Aerospace Electronics Conference (NAECON), Dayton, Ohio; contact IEEE Dayton Office, 1414 E. 3rd St., Dayton 2, Ohio.

May 13-14, 1965: Symposium on Signal Transmission and Processing, Columbia Univ., New York, N. Y.; contact Dr. L. E. Franks, Bell Tel. Labs., No. Andover, Mass.

May 18, 1965: SWAP Conference, Marriott Motor Hotel, Twin Bridges, Washington, D. C.; contact Gordon V. Wise, Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55420.

May 18-21, 1965: GUIDE International User Organization Meeting (Users of Large Scale IBM EDP Machines,) Statler-Hilton Hotel, Detroit, Mich.; contact Lois E. Mecham, Secretary, GUIDE International, c/o United Services Automobile Association, 4119 Broadway, San Antonio, Tex. 78215

May 19-21, 1965: 15th CO-OP Conference, Marriott Motor Hotel, Twin Bridges, Washington, D. C.; contact Gordon V. Wise, Control Data Corp., 8100 34th Ave. So., Minneapolis, Minn. 55420.

May 19-21, 1965: Power Industry Computer App. Conference (PICA), Jack Tar Hotel, Clearwater, Fla.; contact G. W. Stagg, American Elec. Power Serv. Corp., 2 Broadway, New York, N. Y. 10008.

May 24-29, 1965: IFIP Congress '65, New York Hilton Hotel, New York, N. Y.; contact Evan Herbert, Conover Mast Publ., 205 E. 42 St., New York 17, N. Y.

June, 1965: Automatic Control in the Peaceful Uses of Space, Oslo, Norway; contact Dr. John A. Aseltine, Aerospace Corp., P. O. Box 95085, Los Angeles 45, Calif.

June 10-12, 1965: Annual Southeastern Regional Conference of Association of Computing Machinery, Palm Beach Towers, Palm Beach, Fla.; contact Donald J. Beuttenmuller, Gen. Chairman, 243 Russlyn Dr., W. Palm Beach, Fla.

June 17-18, 1965: 3rd Annual Conference of The Computer Personnel Research Group, Washington University, St. Louis, Mo.; contact Prof. Malcolm H. Gotterer, Program Chairman, 120 Boucke Bldg., Pennsylvania State University, University Park, Pa. 16802

June 21-25, 1965: Information Sciences Institute, Seminar I: Image Processing, Univ. of Maryland, Computer Science Center and University College, College Park, Md.; contact Div. of Institutes, Center of Adult Education, Univ. of Md., College Park, Md. 20742

June 21-25, 1965: San Diego Symp. for Biomedical Engineering, San Diego, Calif.; contact Dean L. Franklin, Scripps Clinic & Res Found., La Jolla, Calif.

June 22-25, 1965: Sixth Joint Automatic Control Conference (JACC), Rensselaer Polytechnic Institute, Troy N. Y.; contact Prof. James W. Moore, Dept. of Mechanical Engineering, Univ. of Va., Charlotteville, Va.

June 28-July 1, 1965: Information Sciences Institute, Seminar II: Pattern Recognition, Univ. of Maryland, Computer Science Center and University College, College Park, Md.; contact Div. of Institutes, Center of Adult Education, Univ. of Md., College Park, Md. 20742

June 29-July 2, 1965: Data Processing Management Association 1965 International Data Processing Conference and Business Exposition, Benjamin Franklin Hotel and Convention Hall, Philadelphia, Pa.; contact Data Processing Management Association, 524 Busse Highway, Park Ridge, Ill.

Aug. 14-Sept. 6, 1965: National Science Foundation Conference on Digital Computers for College Teachers of Science, Mathematics and Engineering, Univ. of Southwestern Louisiana, Lafayette, La.; contact Dr. James R. Oliver, Director, USL Computing Center, Box 133, USL Station, Lafayette, La. 70506

Aug. 23-27, 1965: 6th International Conference on Medical Elec. & Biological Engineering, Tokyo, Japan; contact Dr. L. E. Flory, RCA Labs., Princeton, N. J.

Aug. 24-26, 1965: Association for Computing Machinery, 20th National Meeting, Sheraton-Cleveland Hotel, Cleveland, Ohio; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

Aug. 24-27, 1965: WESCON, Cow Palace, San Francisco, Calif.; contact IEEE L. A. Office, 3600 Wilshire Blvd., Los Angeles, Calif.

Sept. 8-10, 1965: Industrial Electronics & Control Instrumentation Conference, Sheraton Hotel, Philadelphia, Pa.; contact Lewis Winner, 152 W. 42 St., New York, N. Y. 10036

Sept. 20-23, 1965: Second Systems Engineering Conference & Exposition, McCormick Place, Chicago, Ill.; contact Clapp & Poliak, Inc., 341 Madison Ave., New York, N. Y. 10017.

Oct. 4-7, 1965: 20th Annual ISA Instrument-Automation Conference & Exhibit, Sports Arena, Los Angeles, Calif.; contact Public Relations Dept., Instrument Society of America, Penn-Sheraton Hotel, 530 Wm. Penn Pl., Pittsburgh, Pa. 15219.

NEW PATENTS

RAYMOND R. SKOLNICK
Reg. Patent Agent
Ford Inst. Co., Div. of Sperry Rand Corp., Long Island City 1, New York

The following is a compilation of patents pertaining to computer and associated equipment from the "Official Gazette of the U. S. Patent Office," dates of issue as indicated. Each entry consists of patent number / inventor(s) / assignee / invention. Printed copies of patents may be obtained from the U. S. Commissioner of Patents, Washington 25, D. C., at a cost of 25 cents each.

September 29, 1964

3,151,316 / Andrew H. Bobeck, Chatham, N. J. / Bell Telephone Labs., Inc., N. Y. a corp. of N. Y. / Magnetic Data Storage System.

October 6, 1964

3,152,263 / Paul J. de Fries, Bloomington, Ill., General Electric Co., a corp. of N. Y. / Semi-Conductor Logic Circuit With Voltage Dividing Base Channels.

3,152,264 / Harold L. Ergott, Jr., Apalachin, Stathis G. Linardos, Vestal, and Richard T. O'Connell, Owego, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Logic Circuits With Inversion.

October 13, 1964

No applicable patents

October 20, 1964

3,153,776 / Harold S. Schwartz, White Plains, N. Y. / Potter Instrument Co., Inc., Plainview, N. J., a corp. of N. Y. / Sequential Buffer Storage System For Digital Information.

3,153,778 / Arthur W. Lo, Elizabeth, N. J. / Radio Corp. of America, a corp. of Delaware / Magnetic Core Binary Devices.

3,153,781 / Virgilio J. Quiogue, Princeton, N. J. / Burroughs Corp., Detroit, Mich., a corp. of Mich. / Encoder Circuit.

October 27, 1964

3,154,675 / Merle E. Homan, Poughkeepsie, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Asynchronous Logical Systems for Digital Computers.

3,154,676 / Leonard Roy Harper, San Jose, Calif. / IBM Corp., N. Y., a corp. of N. Y. / Change Adder.

3,154,677 / Jean Borne, Saint-Maur (S), and Jacques Golfier, Paris, France and Herman Jacob Heijn, Geldrop, Netherlands / Laboratoires d'Electronique et de Physique Appliquees L. E. P. (Societe Anonyme), Paris, France / Magnetic Core Matrix Adder and Subtracter.

3,154,691 / Harold Fleisher, Poughkeepsie, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Transistor Exclusive Or Logic Circuit.

3,154,697 / Albert X. Widmer, Peekskill and Paul Abramson, Yorktown Heights, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Data Transmitting Apparatus Employing Switches and Diodes to Selectively Transmit Pulses of Desired Polarity.

3,154,698 / Thomas J. Lynch, Phila., Pa. / by mesme assignments, to United Aircraft Corp., a corp. of Delaware / Shift-Register Stage Employing Pair of Cascade Connected Transistors to Discharge Storage Capacitor to Thereby Set Flip-Flop.

3,154,765 / Rexford G. Alexander, Jr., Norristown, Pa. / Burroughs Corp., Detroit, Mich., a corp. of Michigan / Thin Film Magnetic Storage.

3,154,768 / Albert J. Hardwick, West Chester, Pa. / Burroughs Corp., Detroit, Mich., a corp. of Michigan / Magnetic Device for Nondestructive Data Storage.

3,154,769 / John D. Blades, Strafford, Pa. / Burroughs Corp., Detroit, Michigan, a corp. of Michigan / Helical Wrap Memory.

3,154,770 / Helmut Schwab, Altadena and Robert E. Sandiford, Arcadia, Calif. / by mesme assignments to Consolidated Electrodynamics Corp., Pasadena, Calif., a corp. of Calif. / Digital Data Processor.

November 3, 1964

3,155,816 / Robert E. Bible, Burbank, Edward L. Braun, Los Angeles, James L. Cass, Burbank, Robert L. McIntyre, LaCrescenta and Robert R. Williamson, Sunland, Calif., / General Precision, Inc., a corp. of Delaware / Digital Computer.

3,155,818 / Frank M. Goetz, Franklin Square, N. Y. / Bell Telephone Labs., Inc., N. Y. / Error-Correcting Systems.

3,155,819 / Frank M. Goetz, Franklin Square, N. Y. / Bell Telephone Labs., Inc., N. Y. / Error Correcting System.

3,155,821 / Edwin Shain, DeWitt, N. Y. / General Electric Co. / Computer Method and Apparatus.

3,155,834 / Robert M. MacIntyre, Newport Beach, Calif. / Fort Motor Co., Dearborn, Mich. / Multiple Level Logic System.

3,155,846 / D. Parham, Downey, Calif. / Hughes Aircraft Co., Culver City, Calif., Digital Computer Gaiting Device.

3,155,942 / Martin L. Hoover, Downey, Calif. / The National Cash Register Co., Dayton, Ohio / Method and Apparatus For Threading Core Memory Arrays.

3,155,943 / Seymour Markowitz, Los Angeles, Calif., by mesme assignments to Ampex Corp., Redwood City, Calif., Magnetic-Core Memory Driving System.

3,155,944 / Paul E. Oberg, Bloomington, and Robert W. Olmen, White Bear Lake, Minn., Sperry Rand Corporation / Photo-Magnetic Memory Devices.

3,155,945 / David E. Keefer, Houston, Tex., Sperry Rand Corp., / Parallel Interrogation of Computer Memories.

3,155,947 / Taro Yoshida, Nagoya, Japan / Mitsubishi Denki Kabushiki Kaisha, Tokyo, Japan / Flip-Flop Circuit.

November 10, 1964

3,156,897 / Ralph J. Bahnsen, Cambridge, Mass. and Jules F. Dirac, Sea Isle City,

N. J. / IBM Corp., N. Y. / Data Processing System with Look Ahead Feature.
3,156,905 / Oscar B. Stram, Paoli and Edward V. Trocky, Phila., Pa. / Burroughs Corp. / Magnetic Storage Arrangement.
3,156,906 / Richard E. Cummins, Saratoga, Calif. / IBM Corp., N. Y. / Transducer Positioning Mechanism in a Random Access Memory System.

November 17, 1964

3,157,778 / Munro K. Haynes, Poughkeepsie, N. Y. / IBM Corp., N. Y. / Memory Device.
3,157,779 / Harry W. Cochrane, Poughkeepsie, N. Y. / IBM Corp., N. Y. / Core Matrix Calculator.
3,157,782 / Jean C. Lejon, Paris, France / Controle Bailey, Paris, France / Analog Computer Amplifier with Transformer Input.
3,157,791 / Rene H. Terlet, Ossining, N. Y. / IBM Corp., N. Y. / Multi-State Photoconductive Logic Circuits.
3,157,794 / Allan A. Kahn, Bronx, N. Y. / IBM Corp., N. Y. / Magnetic Core Logical Circuits.
3,157,857 / Charles H. Stapper, Jr., Fishkill and Lawrence E. LaFave, Poughkeepsie, N. Y. / IBM Corp., N. Y. / Printed Memory Circuit.
3,157,858 / Charles J. Barbagallo, Needham, Mass. / Honeywell Inc. / Electrical Storage Apparatus.
3,157,860 / James V. Batley, Kingston, N. Y. / IBM Corp., N. Y. / Core Driver Checking Circuit.
3,157,861 / Jons Kurt Alvar Olsson, Sundyberg and Sven Arne Olsson, Hagersten, Sweden / Telefonaktiebolaget L. M. Ericsson, Stockholm, Sweden, a corp. of Sweden / Method and Device in Magnetic Memory Matrices.
3,157,862 / Joseph J. Eachus, Cambridge, Mass. / Honeywell Inc., a corp. of Delaware / Controller for a Computer Apparatus.
3,157,863 / John Bernard James, Stevenage, England / International Computers and Tabulators Ltd., London, England / Read Out of Bistable Memory Elements by Resetting From a Further Element.
3,157,864 / Robert W. Hoedemaker, Princeton, N. J. and Charles Molnar, Somerville, Mass. / Gulton Industries, Inc., Metuchen, N. J. / Control for Magnetic Memory Matrix.
3,157,866 / Dallas H. Lien, Indianapolis, Ind., Western Electric Co., Inc., N. Y. / Ring-Type Magnetic Memory Element.

November 24, 1964

3,158,839 / Richard R. Anderson, Berkeley Heights, N. J. / Bell Telephone Labs., Inc., N. Y. / Data Translating System.
3,158,842 / John R. Anderson, Los Altos, Calif. / The National Cash Register Co., Dayton, Ohio, Memory Devices Using Ferroelectric Capacitors and Photoconductors.
3,158,844 / Raymond R. Bowdle, Los Altos, Calif. / IBM Corp., N. Y. / Data Processing System.

BOOKS AND OTHER PUBLICATIONS

Moses M. Berlin
Allston, Mass.

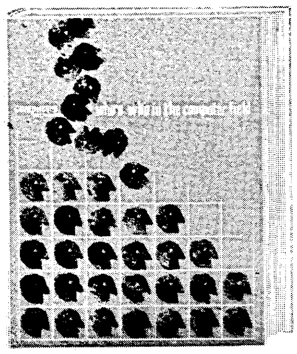
We publish here citations and brief reviews of books and other publications which have a significant relation to computers, data processing, and automation, and which have come to our attention. We shall be glad to report other information in future lists if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning **Computers and Automation.**

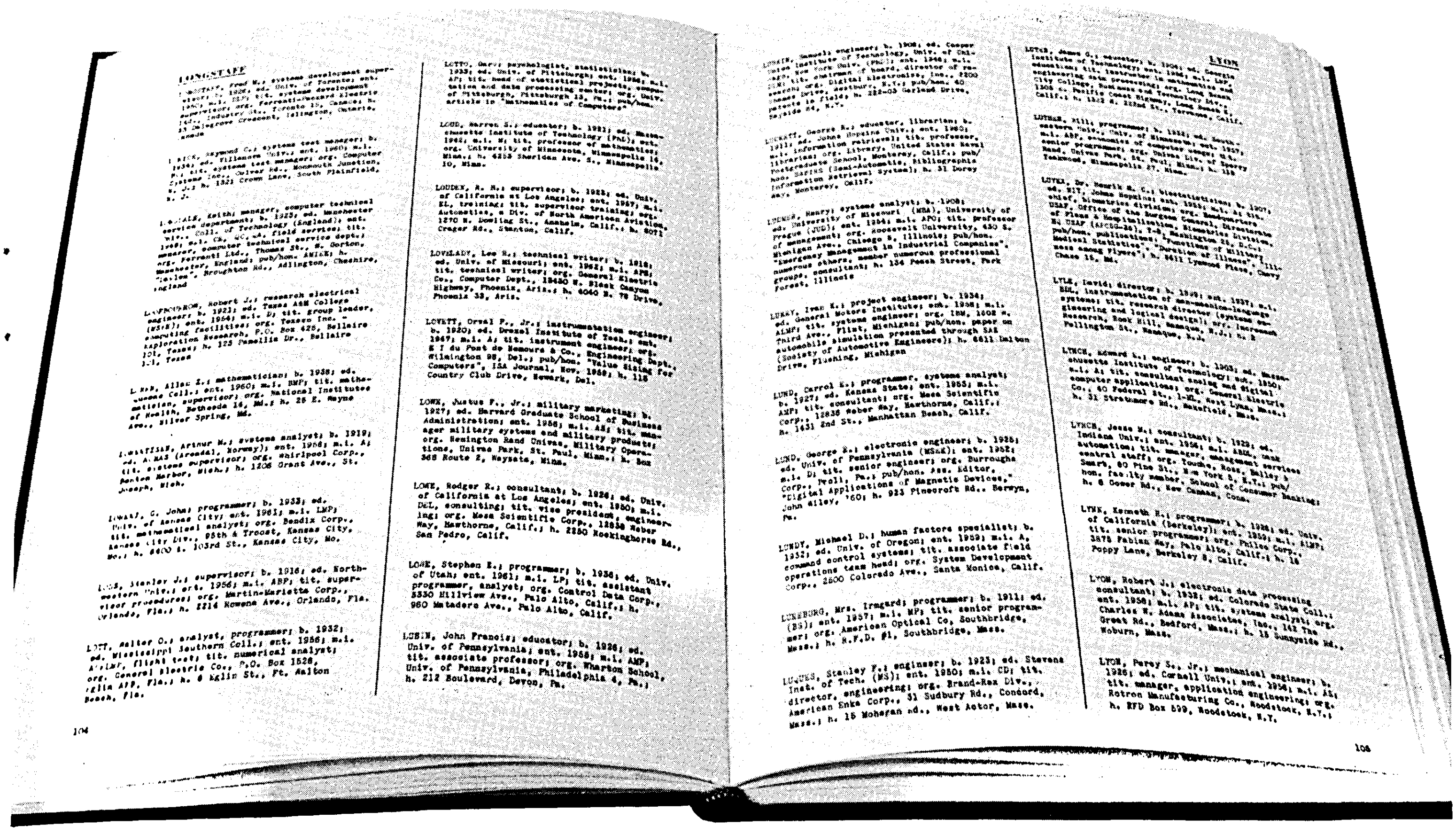
Kovach, Ladis D. / Computer-Oriented Mathematics: An Introduction to Numerical Methods / Holden-Day, Inc., 728 Montgomery St., San Francisco, Calif. / 1964, printed, 98 pp, $3.95 ($2.95 paperbound)

The purpose of this book is to present, for high-school and beginning college students, ideas and techniques of numerical methods and computer mathematics. Some facets of numerical analysis not related to computers are also discussed. The ten chapters include: "Characteristics of Digital Computers," "Various Number Bases," "Interpolation, or Filling in the Gaps," "Iteration: Repetition with a Purpose," "Monte Carlo Methods," and "Computer Applications—Present and Future." Many examples are given to show that computer-oriented mathematics can be used to solve problems even though no computer is used. Bibliography and index.

Enslein, K., Editor, and 53 authors / Data Acquisition and Processing in Biology and Medicine, Volume 2, Proceedings of the 1962 Rochester Conference / The MacMillan Co., 60 Fifth Ave., New York 11, N. Y. / 1964, printed, 367 pp, $11.50

Twenty-five papers on the application of computers to medical research and diagnosis, and to biological laboratory processes are here presented. In addition, a general discussion of various medical data processing subjects, and the conference keynote address, "Medical Implications of Data Processing and Computing" are included. Sessions I and II, "Analysis in Medical Research," include the papers: "Automatic Data Processing and Experimental Design in Medical Research," "Frequency Analysis of Responses from the Olfactory Bulb of Unanesthetized Mammals," and "Patient Monitor System for Critically-Ill Hospital patients." Session IV includes four papers relating to "Analog-Digital Approaches and Relationships," and ses-





sions V and VI, nine papers on "Diagnostic Procedures and Treatment." No index.

Ginsburg, Seymour / An Introduction to Mathematical Machine Theory / Addison-Wesley Publishing Co., Inc., Reading, Mass. / 1962, printed, 148 pp, $8.75

This is a technical introduction to selected topics from the literature about the behavior of mathematical data processors from the point of view of terminal characteristics. The book is developed from notes used in courses at UCLA and System Development Corp. The three types of sequential "machines" discussed are the sequential machines of Huffman-Moore-Mealy, the author's own abstract machines, and tape-recognition devices popularized by Rabin and Scott. The four chapters, following the section, "Preliminaries," which reviews set-theoretic concepts and properties, are: "Complete Sequential Machines," "Incomplete Sequential Machines," "Abstract Machines," and "Recognition Devices." An appendix offering a proof of an earlier stated theorem, a bibliography, and an index are included.

Stein, Sherman K. / Mathematics: The Man-made Universe; An Introduction to the Spirit of Mathematics / W. H. Freeman & Co., 660 Market St., San Francisco 4, Calif. / 1963, printed, 316 pp, cost ?

This book, developed from the thesis that "mathematics is completely the work of man . . . therefore mathematics is concrete," introduces and interrelates various mathematical subjects. The information is intended as a text for an introductory college course for nonmathematicians. Seventeen chapters include; "The Weaver," which discusses arithmetic concepts such as "odd" and "even" in terms of woven thread; "The Primes"; "Rationals and Irrationals"; "The Highway Inspector and the Salesman," which discusses topology in terms of highways and routes; "Strange Algebras"; "Infinite Sets"; and "A General View." Three appendices are: "The Rudiments of Algebra," "The Geometric and Harmonic Series," and "Space of Any Dimension." The text includes many exercises and references, and an index. It accomplishes the author's purpose "to give students in many fields an appreciation of the beauty, extent and vitality of mathematics."

Markuson, Barbara Evans, editor, and 24 authors / Libraries and Automation: Proceedings of the Conference on Libraries and Automation / Supt. of Documents, Govt. Printing Office, Washington, D. C. 20402 / 1964, printed, 268 pp, $2.75

The proceedings of the conference held at the Airlie Foundation, May, 1963, sponsored by the National Science Foundation, the Council on Library Resources, Inc., and the Library of Congress, are here published. The book's seven sections represent the seven topics covered at the conference. Each section includes a state-of-the-art paper and related discussions. The topics are: "The Library of the Future," "File Organization and Conversion," "File Storage and Access," "Graphic Storage," "Output Printing," "Library Communications Networks," and "The Automation of Library Systems." A number of data processing techniques and concepts, some conflicting, are introduced in each section. They represent the thinking of current leaders in the field of computer applications, and reflect the unresolved questions of how best to accomplish certain processing requirements. Two appendices give biographical data on conference participants and fifty-six illustrations are included. No index.

Starr, Martin K., and David W. Miller / Inventory Control: Theory and Practice / Prentice-Hall, Inc., Englewood Cliffs, N. J., 07632 / 1962, printed, 354 pp, $11.35

A comprehensive discussion of major inventory problems and methods for solving them is here presented. The emphasis is placed on understanding the problems in the context of decision theory and practice. Part I, "Inventory Theory," includes six chapters. Among the titles: "The Analytical Structure of Inventory Problems," "Static Inventory Pro-Problems Under Uncertainty," and "Dynamic Inventory Problems Under Uncertainty." Part II, "Implementation Phase: The Theory of Practice," includes the three chapters: "The Evaluation Study: Design of the Inventory Study," "The Inventory Study: Design of Decision Procedures," and "The Data Processing Study: Design of Operating Procedures." An appendix, which gives equations relevant to the text, tables, a glossary, a bibliography, and an index are included.

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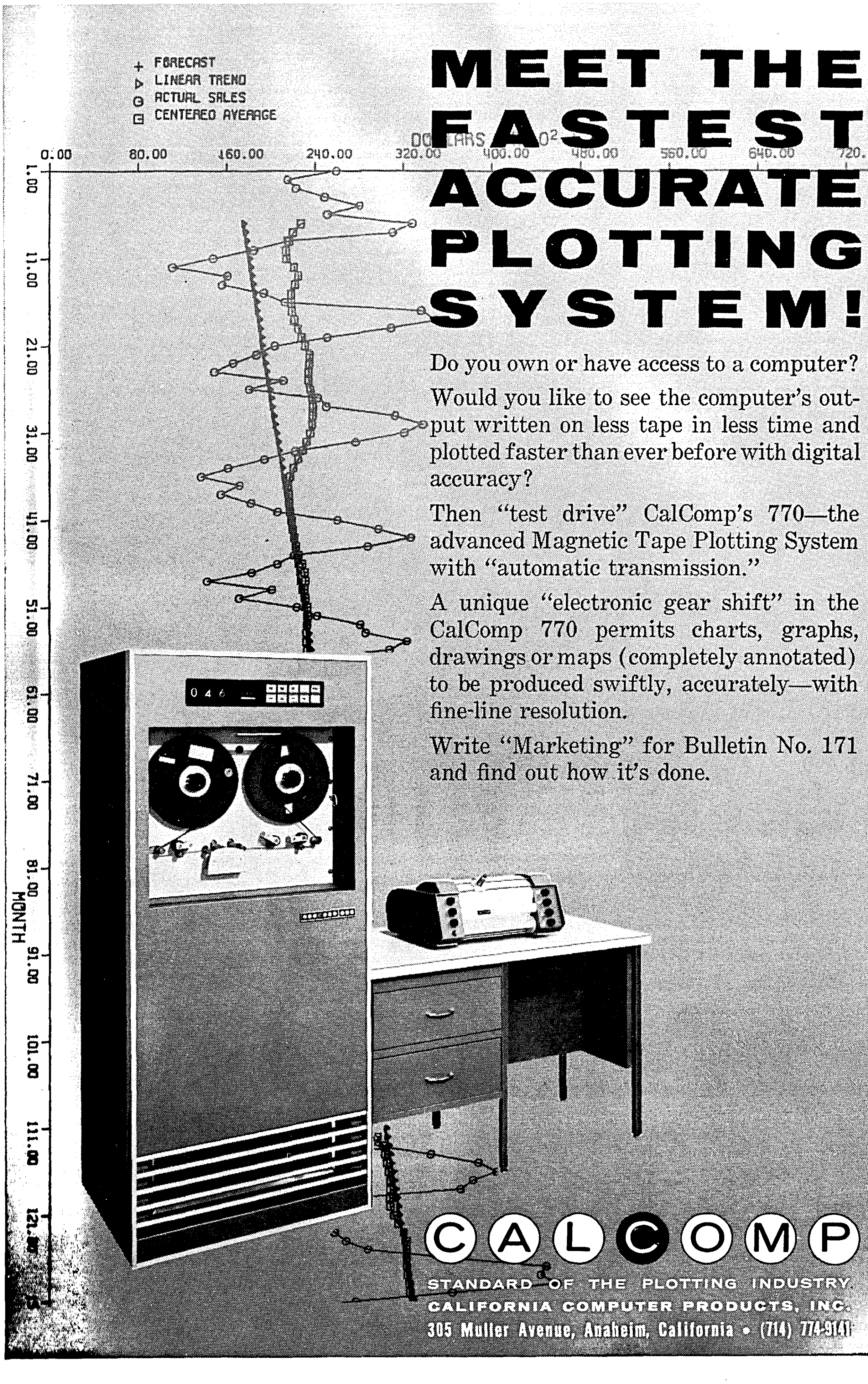
ADVERTISING INDEX

Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.



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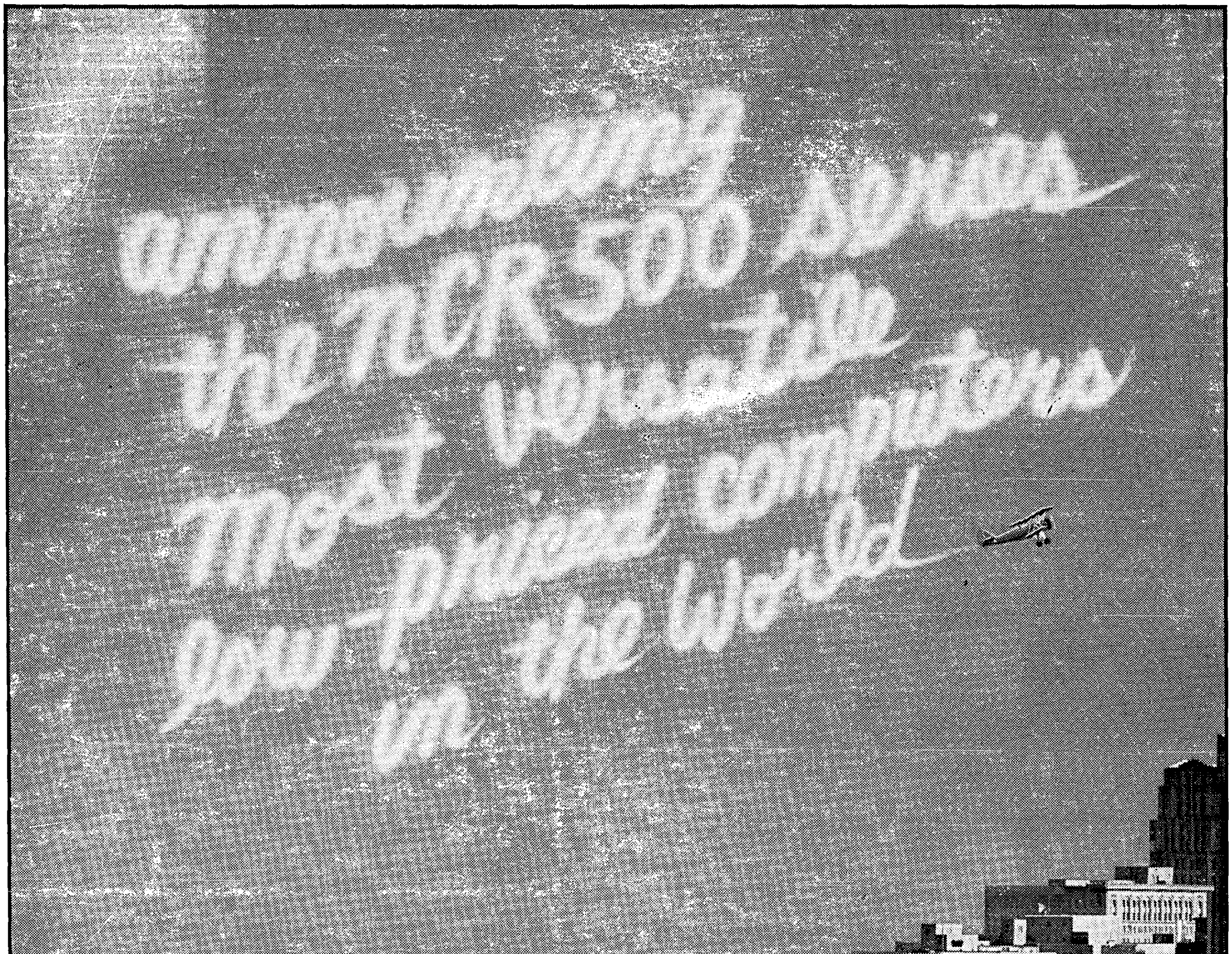

A Modest Announcement

It's hard to be modest about a new electronic computer system that has more input, output and processing capabilities than any other system in its price range. It's actually a family of completely compatible systems. NCR's new 500 series handles all machine languages: punched cards, punched paper tape, magnetic ledger cards; it even optically reads machine printed figures. Its "modular" design means you can add to the system as your needs and requirements grow. Buy or rent only what you need . . . expand when you're ready. Complete NCR 500 Computer Systems start as low as $765 a month. To find out more about this unique computer system, and what it can do for you, write for our free brochure SP-1588. NCR, Dayton, Ohio 45409.

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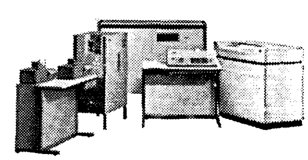

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