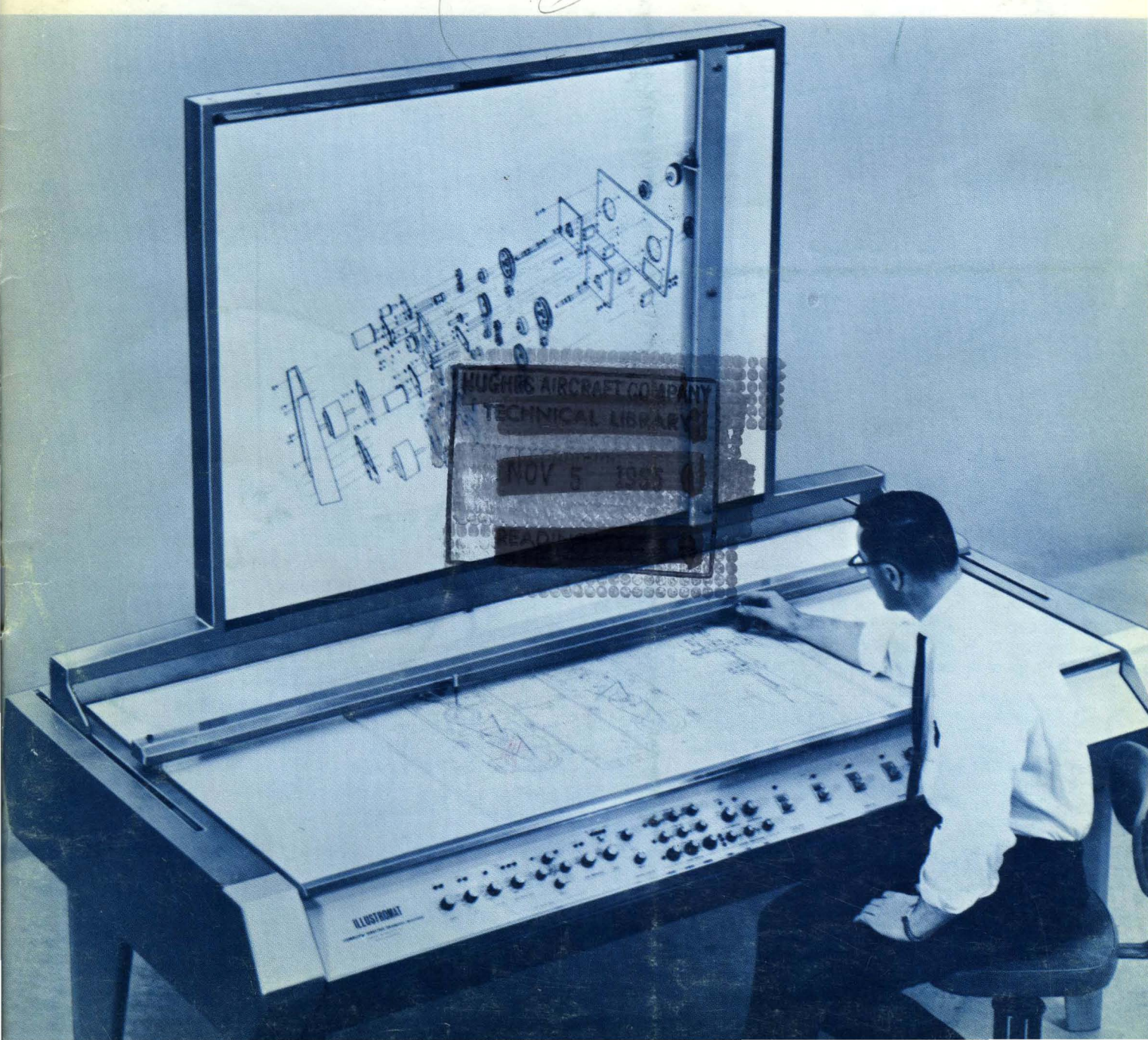
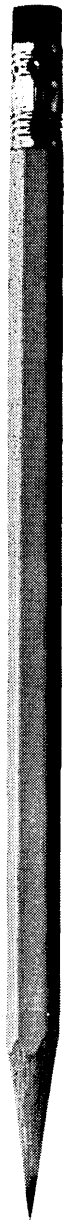
July, 1965

computers and automation

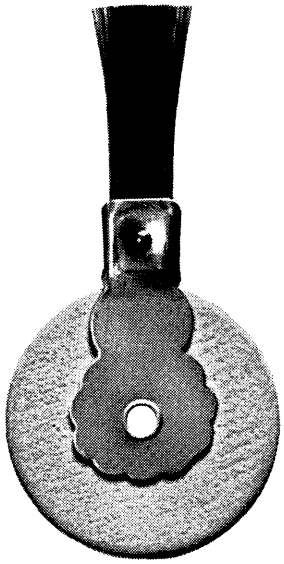
Perspective Drawing By Analog Computer



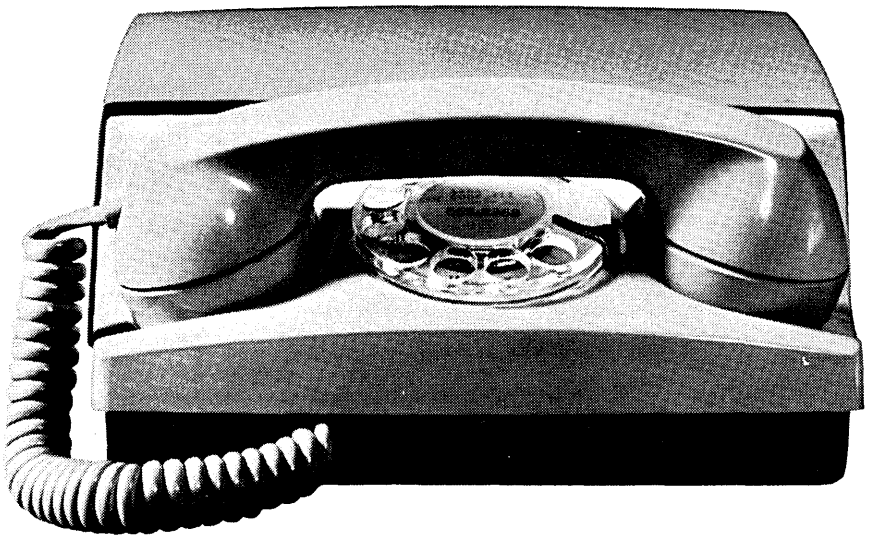


"Guess who saved $75,000 for a customer of Atlas Stationers?"

"Well, who?"



"I did."



"Actually, I shouldn't take all the credit. I'm just part of the Atlas Order-Mation* system, which is saving money for a lot of customers."

When an Atlas customer needs office supplies, it's just a matter of feeding punched cards through a card reader connected to a Bell System Data-Phone** data set.

The order flashes over telephone lines from distant locations to Atlas headquarters in Los Angeles. The cards are automatically duplicated and processed so that Atlas can start filling the order within minutes.

Because of the fast, automatic reordering operations, Atlas customers are able to reduce clerical details, paperwork, and inventories. A chain of department stores saved approximately $75,000. An electrical company saved $28,000. An astronautics firm saves $5000 yearly.

If you're interested in keeping customers buying from you, consider what Data-Phone service could do for your customers and your business. We can show you how.

Just call your Bell Telephone Business Office and ask for the services of our Communications Consultant.

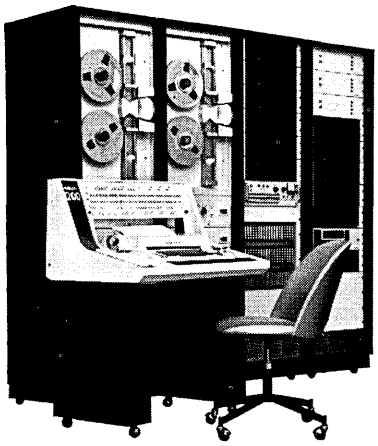
*Trademark of Atlas Stationers
**Trademark of the Bell System

Bell System
American Telephone and Telegraph and Associated Companies

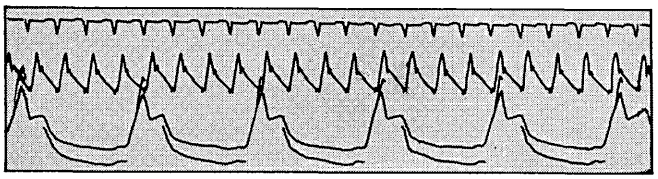
Circle No. 1 on Readers Service Card

Circle No. 5 on Readers Service Card →

AMBILOG 200 the only computer designed especially for signal processing



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



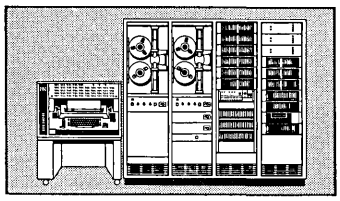
Real Time Waveform Measurement

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

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

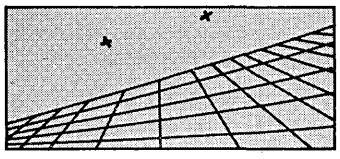
Spectrum Analysis

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



Digitizing and Recording

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



Display Generation

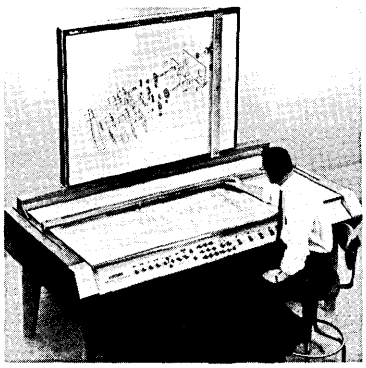
Multiple analog outputs facilitate close man-machine relationships in systems involving visual displays. Points of an image stored in memory are rotated through three space angles and projected on a CRT at a 50 Kc rate. Co-ordinate transformation is accomplished simultaneously with digital-to-analog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

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

Adage INC

1079 Commonwealth Avenue, Boston, Massachusetts 02215

Circle No. 2 on Readers Service Card



The front cover shows a vivid perspective drawing of an intricate mechanism, made using an analog computer. See more information on page 14.

computers and automation

JULY, 1965 Vol. 14, No. 7

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

Special Feature

In This Issue

In Every Issue

COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE, MASS. 02160, BY BERKELEY ENTERPRISES, INC. ADDITIONAL OFFICE OF PUBLICATION: 1657 WASHINGTON ST., HOLLISTON, MASS. PRINTED IN U.S.A. SUBSCRIPTION RATES: UNITED STATES, $15.00 FOR 1 YEAR, $29.00 FOR 2 YEARS, INCLUDING THE JUNE DIRECTORY ISSUE; CANADA, ADD 50c A YEAR FOR POSTAGE; FOREIGN, ADD $3.50 A YEAR FOR POSTAGE. ADDRESS ALL EDITORIAL AND SUBSCRIPTION MAIL TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE, MASS., 02160. SECOND CLASS POSTAGE PAID AT HOLLISTON, MASS.

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Education in the Field of Computers and Data Processing

Not long ago in the Chicago Daily News appeared an Associated Press report that began:

> "The unemployment problem that is nagging some segments of the nation's economy has not touched one of the fastest growing new professions of specialists. In this new field, working conditions are pleasant, the pay is good, the future is very bright, and there are "help wanted" openings by the thousands. The field is the $4-billion-a-year data processing business."

The story by the Associated Press gave some interesting figures:

— 50,000 data processing installations in the United States, of which 20,000 are electronic computer installations;
— 225,000 estimated number of persons now in the field;
— 600,000 estimated number of persons expected to be in the field by 1970.

Then, referring to the Data Processing Management Association as reporting the information, the story said:

> "One industry source has estimated that only 2 out of every 10 computer programmers are sufficiently trained to be proficient in their jobs."

Of all the associations in the field of computers and data processing, the Data Processing Management Association has been outstanding in its efforts to increase the supply of persons educated in the field. The DPMA initiated in 1960 a program of certification in data processing (CDP).

At the last CDP examinations in February 1965, 6953 persons sat for the test in 97 locations, and "somewhat less than two-thirds" are expected to pass. If 5000 a year pass in each of the next five years, 25,000 more people with some degree of education in the field of computers and data processing will be available. But the influx anticipated is more than 300,000 persons.

It would be well worthwhile if the preparation and education of persons to fulfill useful roles in the computer and data processing field could proceed rapidly — much more rapidly.

What sorts of persons should be encouraged to enter this field? Could "Computers and Automation" publish a self-screening test which would help a person to decide if he should enter this field or not?

What kinds of studies should a person undertake in order to become educated in the field? Could "Computers and Automation" publish a syllabus of subjects and topics?

What sorts of books should be read and studied? Could "Computers and Automation" publish from time to time a list of basic references in the computer field?

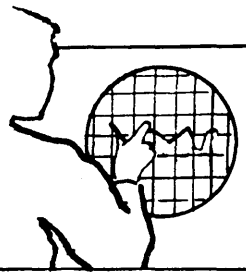
Why is it that only one of the professional associations in the computer field, the DPMA, has undertaken a systematic program of education? Shouldn't the other associations in the computer field be persuaded to take up systematic programs of education?

All these questions and many more related to education in computers and data processing are worth consideration and need discussion. We of "Computers and Automation" are ready to help in providing a forum and in any other ways open to us, in the program of massive education needed, so that the bottleneck of trained people for the field can be broken.

We invite suggestions, discussion, and contributions from our readers.

Edmund C. Berkeley

EDITOR



c & a MARKET REPORT

THE IMPACT OF INTEGRATED CIRCUITS ON THE COMPUTER FIELD

Integrated circuitry has been widely held to be the most significant advance in computer technology since the development of the transistor in the mid-fifties. With widespread increases in the performance requirements of advanced computer systems, integrated circuitry promises new and important improvements in computer memory speed and capacity. Intensively developed in the last four years, research on ICs has been accelerated by the rising aerospace industry demand for small and efficient digital logic systems. For example, using ICs, the internal guidance computer of the Minuteman missile was reduced from 14,711 to 5,510 components.

Integrated circuits are essentially the combination of active electronic devices with passive elements, i.e. combinations of transistors and diodes with resistors and capacitors, into one unit. While each of the four components had been separately developed to a high degree of efficiency, industry lacked a technology to combine the optimal components into a simple, high-efficiency system. The complexity of achieving this led to three approaches, namely, semiconductor integrated circuits (SICs), thin-film integrated circuits, and micromodules.

These approaches can be defined as follows: Semiconductor integrated circuits are microminiature circuits with the active and passive microcomponents on or in active substrate terminals. In thin-film integrated circuitry, terminals, interconnections, resistors, and capacitors are formed by depositing a thin film of various materials on an insulating substrate. Microsize active components are then inserted separately to complete the circuit. Micromodules are tiny ceramic wafers made from semiconductive and insulative materials. These then function either as transistors, resistors, capacitors, or other basic components.

ICs EFFECT ON COMPUTER PERFORMANCE

	Speed	Size	Cost	Reliability
1st Generation	1	1	$0.50-$5/ unit	1
2nd Generation	10	.01	$0.30-$1/ unit	75-100
3rd Generation	25* to 100**	.0001	$2.50-$7/ unit	100-650

*Average of presently available ICs
**Potential

The most important effects of IC technology on the computer industry will be:

1. Speed. Computation speeds will eventually be increased 10-fold. Newest large computers using ICs can execute over 10,000,000 operations a second.

2. Size. Information processing equipment size can eventually be reduced 100-fold and ultimately will be limited only by the size of peripheral input/output and mass-random-access memory devices.

3. Reliability. Maintenance cost will become significantly less as reliability increases and replacement parts are incorporated into the equipment during manufacture.

4. Cost. Cost will be modestly reduced for central processors but will not change for most peripheral equipment.

More and more of the new computer offerings incorporate ICs. However, the change from second generation (transistor) to third generation (IC) technology will be very gradual because, in contrast with the changeover from vacuum tubes to transistors, the two technologies are compatible with one another.

In considering the gradual change, three circuit types may be defined:

Type 1: Circuits using discrete components (2nd generation)
Type 2: Circuits in which semiconductor devices are attached to passive networks ("hybrid" of 2nd and 3rd generation systems)
Type 3: Circuits utilizing monolithic silicon circuits (3rd generation)

Several recent commercial and system computer offerings use Type 2 hybrid circuits, e.g., IBM System/360 and Digital Equipment's PDP-7 and PDP-8.

Full use of Type 3 monolithic ICs in installed computer systems is currently confined to special military and aerospace computers. Some experts predict that it will be "at least three years" before computers using monolithic ICs for their entire circuitry appear on the commercial market. These "three years" may be very short indeed, for in the last six months a growing number of computers have been introduced using monolithic ICs in a portion of their circuitry.

RCA's Spectra 70 series was the first major computer series to incorporate ICs as basic components. These systems will achieve their first installation in the winter of '66.

Scientific Data Systems Inc.'s first general purpose computer to use ICs, the SDS 92, was designed for such applications as real-time system control, direct digital control, data communication systems, and peripheral processing for larger computers. About one-third of the circuitry in its central processor is composed of integrated circuits. Several systems are now installed.

Other announced computers which use ICs include Computer Control's DDP-124, Data Systems' DSI-2000, Electronic Associates' 8400, and Honeywell's 4200 and 8200.

Current predictions are that the market for microelectronics will grow at the rate of 10.8% per year from slightly over $3 billion in 1963 to $8.4 billion in 1973. Government research expenditures increased from $9.5 billion in 1963 to $9.9 billion in 1964 and can be depended upon to continue to stimulate electronics R&D. IC sales in 1965 are expected to be $60-75 million, of which at least $5 million are expected to come from the commercial computer industry. As the use of ICs in new government and commercial computers is expected to increase at the rate of 50% per year, total IC sales for 1966 should reach $100 million.

As IC technology advances, and fabrication yields increase, IC manufacturing costs will decrease. However, since this only affects 15-20% of the cost of a small-size to medium-size data processing system, it is easier for manufacturers to justify ICs in medium-to-large systems, where greater savings can be realized. To users, this means that a greater price/performance value can be expected on those medium-to-large size computers which utilize ICs. Finally, the potential of integrated circuitry to yield faster, more reliable systems without cost increase, suggests that computer designers will continue to search for new methods to exploit IC technology.

THE FUTURE OF PROGRAMMERS

From Joseph P. Grammer
Santa Monica, Calif.

To the "Dear Leaders" in the computer field:

It has been said that a programmer is not a leader, not a reader, and not a writer. This is, to a large extent, true. But something has happened which I think is important enough to justify a break in literary silence from the programmer.

The leaders, readers, and writers, occasionally like to inject a note of levity into their writing which frequently takes the form of ridicule of the programmer. This humor ranges all the way from the article about the programmer who complains that there aren't any specs and then doesn't (can't) read them when they finally do come out, to the cartoon of the idiot saying, "Three munths ago I cudn't spel programmer, and now I's one." We enjoy these articles and cartoons largely because we recognize the element of truth in them which has been exaggerated to the ridiculous. This exaggeration is the essence of all humor. We don't take offense because we know that the authors of these pieces also recognize that the reason they are funny is because they are ridiculous.

Recently, however, I have noticed a sprinkling of articles which are *not meant* to be funny. They express a sincere concern over the future of programmers. So this letter is written to set at ease the minds of those authors who have expressed this concern.

You underestimate us, Dear Leaders. Why do you think we became programmers in the first place? It's because we *created* programming. Through one kind of lucky chance or another (which, oddly enough, seems to happen only to creative people), we discovered the great big fast adding machines which some very ingenious people invented, and we made them *do something*.

Surely, Dear Leaders, you're not so naive as to believe that nonsense about an "electronic brain." The only brain in the machine is the one that programmers thought up and put there. You are concerned for our future because we are on the verge of creating a brain which can communicate directly with engineers and physicists and mathematicians and biologists and all the others for whom you think the programmer merely serves as interpreter. Thank you for your concern, but it is wasted. We *want* to finish the job of programming the interpreter!

We brought to the computer our creativity, our intelligence, our confidence in ourselves. We were drawn to it by our interest in doing what had not been done before, even that which hadn't even been conceived. When we finally leave the computer to our more highly trained colleagues, those characteristics which enabled us to become programmers in the first place will not have been used up. On the contrary, they will be sharper than before.

So concern yourselves instead, Dear Leaders, with those persons who *practice* a profession instead of adding to it. For when we have finished the present programming job, we will have created a brain which can understand not only the professional man's questions, but also his statements. Our engineer friends have invented input/output devices which can transfer 20 years of formal education from one computer to another in seconds. And we programmers are creating the brain which can use it. Already several of the professions are starting to twitch nervously about the encroachment of computers into their domain. They form societies which more and more look like labor unions.

Certainly one of the biggest problems society must face is what to do with the people (from laborers to PhDs) whom automation displaces. Perhaps, just perhaps, we can create a program which will enable a computer to answer that question too.

But the one group of people you needn't worry about is the group of programmers. I can think of nothing which would please me more than to produce a program which would put me and all other programmers out of a job. We are no more fearful of that eventuality than the artist is fearful of finishing a painting. Your noises of concern, Dear Leaders, sound like the warnings of the unimaginative clod who triumphantly admonishes the successful inventor with "Aha! What will you do *now*, now that everything has been invented?"

Unlike most professional people, I was never trained to *be* anything. So for the past nine years I've been a programmer. But those years were alike in name only. What I'm doing now is as much different from what I was doing several years ago as building a house is from digging a cave. What I'll be doing nine years hence I don't know. But one thing I *won't* be doing is quaking in fear before the awful spectre of the future!

Are some of my statements not quite accurate? Is some of my information a bit mixed up? Perhaps so. But there are ideas to be mulled over, insights to be reached for; so don't try to disillusion us with such mundane things as facts. Just stop worrying, and go back to writing the amusing articles and cartoons about us. And I suggest that oc-

(Please turn to page 33)

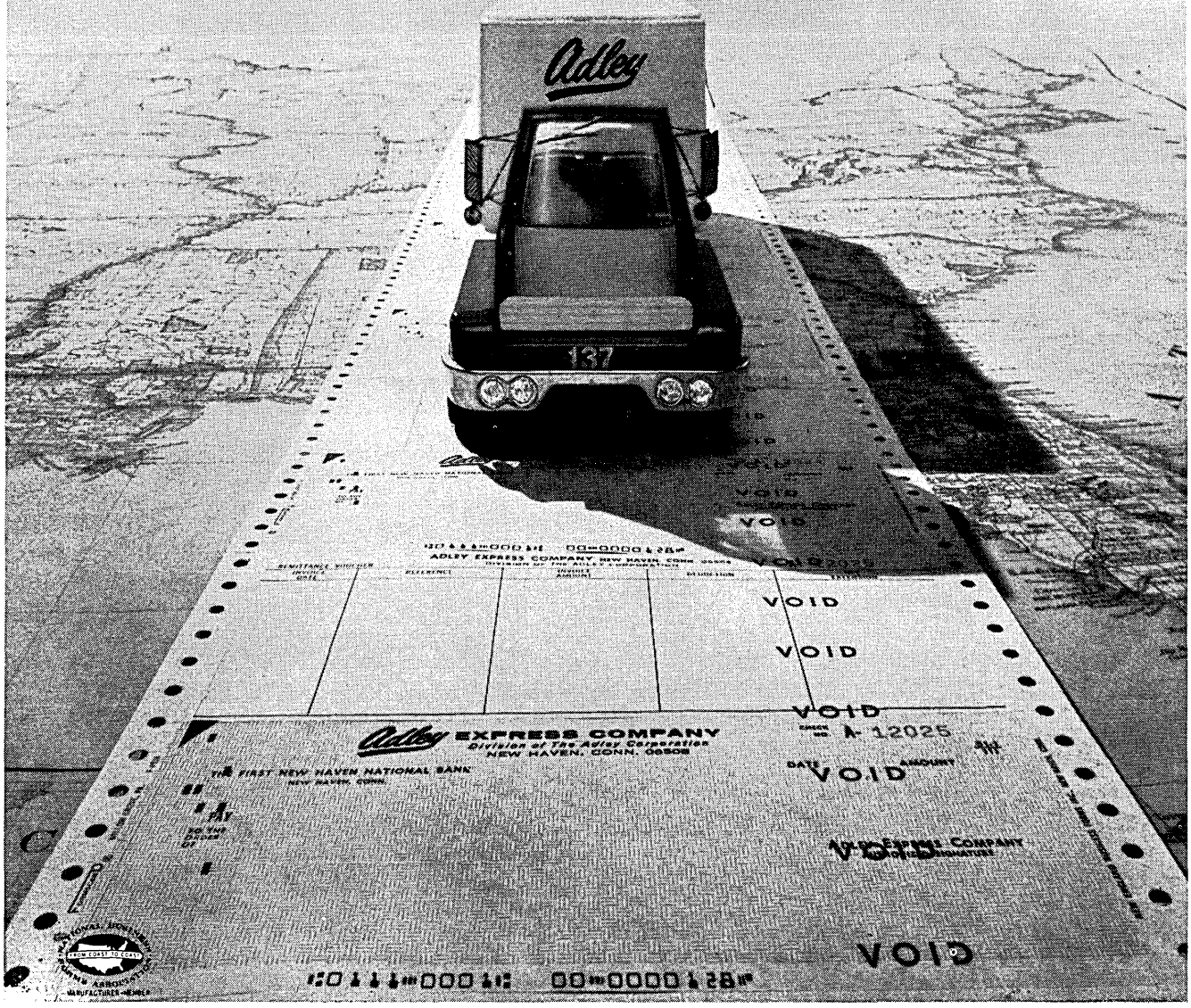
The Adley Express Company of New Haven, Conn. has three iron-bound rules of operation; service, efficiency and speed—a philosophy which dictated FORMSCARDS as the continuous tabulating cards for Adley's accounts payable and payroll.

FORMSCARDS are unique; they don't have medial waste strips between the cards. So you don't waste money shipping useless medial strips around. You don't waste space storing medial strips. You don't waste time running them across your processing equipment. You don't waste time bursting them. And finally, you don't wind up with a truck-load of medial strips to throw out. (See why those little strips between cards are called "**waste** strips?")

Isn't it time you followed the route Adley took to faster, waste-free tabulating card operations? There's a FORMSCARD system to fit your every need. Let us tell you all about the time, trouble and money you could be saving with FORMSCARDS; drop us a line and we'll send you our brochure telling the whole amazing FORMSCARD story. Or, if there's a rush, give us a call. Phone: OLdfield 9-4000 Area code 215.

Forms inc
WILLOW GROVE, PENNA.

Adley Express saves a truckload of time with Formscards



Circle No. 4 on Readers Service Card

INPUT/OUTPUT:

ITS POWERS AND POTENTIAL —

Some Insights and Comments

PIPE-BENDING — INPUT/OUTPUT WITH A PLOTTER

California Computer Products
Anaheim, Calif.

What should you do when there is shortage of manpower and an accumulation of work in the pipe-bending shop of a boiler construction facility?

This was the problem which confronted engineer G. Akos, manager of the computer department, at Koninklijke Machinefabriek, Gebr. Stork & Co., N.V., at Hengelo, Holland, which has a CalComp Model 563 Plotter on-line with an IBM 1620 Computer. The charts show what he did.

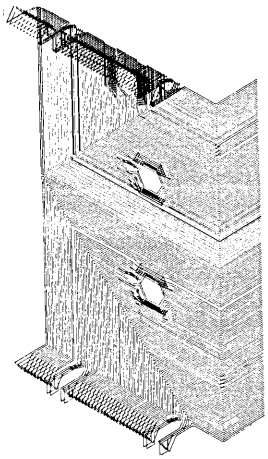


Figure 1

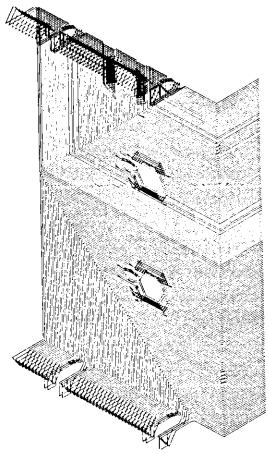


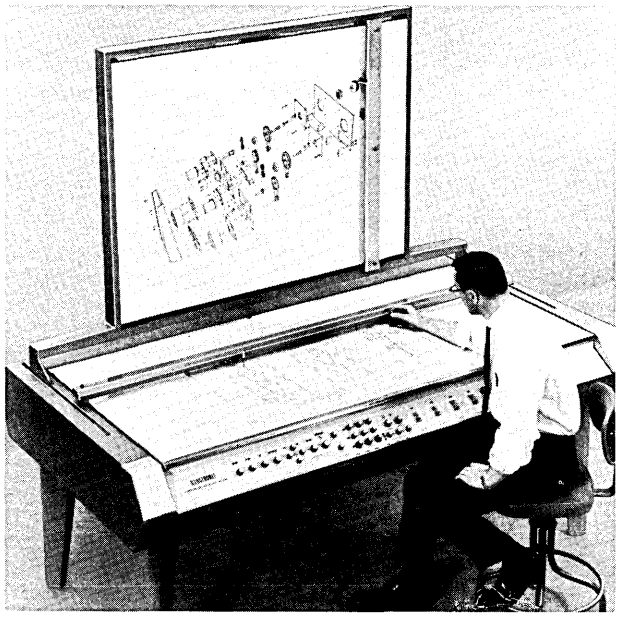
Figure 2

Figure 1 shows a plotter drawing from basic design data for piping in a boiler wall. That plot was returned to the drafting department for checking against the original design. The checking operation is a critical phase of the project, to assure the designer that the computer operations will be accurately performed to meet his design instructions. Figure 2 is a revised drawing from checking corrections; it was approved for further computer operations. Using the approved drawing, the computer calculates and prints out bending lists and plots detailed drawings in orthogonal or isometric projections. The bending lists are routed through the estimating department, where they are used to make up instructions for the draw-bending machines. The detailed drawings also guide final inspection of the constructed boiler wall.

PERSPECTIVE DRAWING OUTPUT

A drawing machine directed by an analog computer can now make visually accurate perspective drawings. Given front and side views of a casting, a building, or another solid, accurate perspective views can be quickly and easily drawn. The object to be drawn can have any angle of rotation and tilt. The input/output subjects for the machine include: tapering aircraft wings; industrial equipment; exploded views of machinery; topographical maps and birds' eye views.

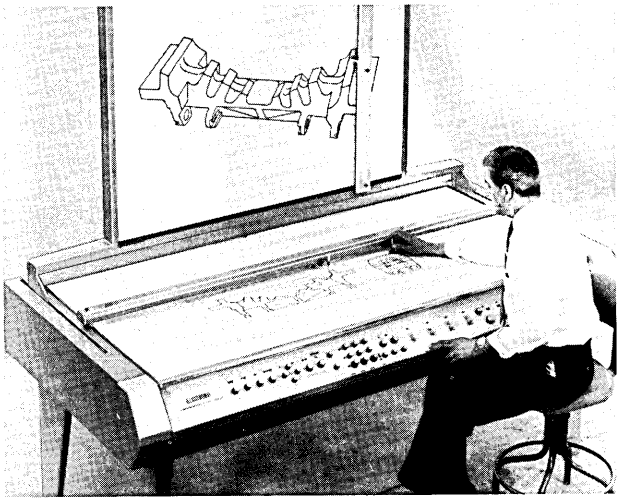
The machine is called the Illustromat 1100, and is made by Perspective, Inc., Seattle, Wash.



— Exploded perspective view of some machinery, produced by the Illustromat 1100.

The machine consists of a tracing table, a control panel, a solid-state analog computer, and a vertical, motorized X-Y plotter. Two tracing styluses supported by a movable framework are moved by the human operator above the horizontal table. Positions and settings of the knobs on the control panel of the analog computer determine the type and kind of perspective view which is produced. Anyone who can read blueprints should be able to operate the machine.

The new approach to perspective drawing which the machine uses is explained in a book "Precision



— Three-dimensional perspective drawing of a casting, produced by the Illustromat 100.

Perspective Drawing," published by McGraw Hill Book Co., and written by T. O. McCartney, the inventor of the machine, and president of the Perspective Inc.

OPTICAL CHARACTER RECOGNITION AND ITS IMPORTANCE

Herman L. Philipson, Jr., President
Recognition Equipment Inc.
Dallas, Texas

Until recently, systems design and programming efforts have required almost all the attention of most users of large electronic computer systems. Now that such systems have achieved operational maturity, increasing attention is being given to data input. The rather surprising result is a general discovery that input operations can, and frequently do, cost more than main-frame computer time. Furthermore, input volumes are increasing as central processors are used better, and so computer systems become "input bound". Input procedures clearly merit careful analysis and management interest.

The conventional mode of input to large-scale magnetic-tape-oriented computers has been, of course, keypunching of punch cards, which are then converted to magnetic tape. The punched card was invented before 1900 for other uses; it is not well suited to feed modern electronic computers, and its limitations become significant as computer speeds and data volumes increase.

Two other methods are now coming into general use as basic input techniques. One of these is direct entry, on-line, of keyboard generated data, from nearby or over a distance. This method clearly is not suitable when the source data are in documentary form. The second method is optical character recognition (OCR). It makes possible the direct entry of data previously generated and "stored" in the form of printed or typed documents.

Much of the data currently entered into large scale data processing systems is of course business information. For a long time, paper documents will constitute the principle business language. The main problem of computer entry of this language through OCR has been reading the variety of styles of type in which these documents are prepared and typed. Another but less serious problem has been to handle mechanically the great variety of sizes and styles of paper documents on which typed or printed characters appear.

At least one OCR system now available can accomplish these input and editing operations more efficiently and at lower cost than the conventional methods. (See Figure 1.) This approach is based upon the following principles:

1. Machine-printed and mark-sensed source documents are read directly by the OCR system. This eliminates all manual key-stroking for those documents.

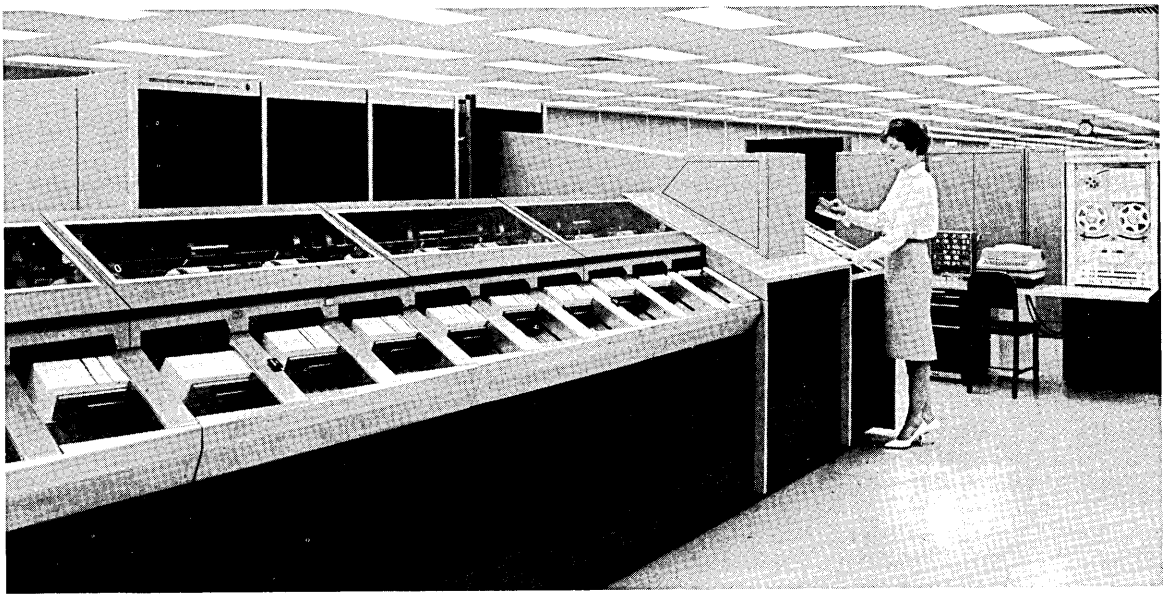


Figure 1. — This machine reads airline tickets and auditor's coupons, accumulates totals, and provides balances to be compared with control figures, all at the same time. It is an Electronic Retina Computing Reader, made by Recognition Equipment Inc., Dallas, Texas; it is installed at the office of United Airlines, Chicago, Ill.

2. Handwritten source documents are key-stroked manually into conventional typewriters or adding machines prior to optical reading. (These readily available machines are much less expensive than key punches. Data entry into them is more rapid and more reliable, and key-stroking errors can be corrected more readily. Condensed data storage provides easier access, and storage cost is less than for punched cards. While a second keystroking operation can provide verification, an independent visual proof reading is enough in many applications.)

3. The preliminary computer editing is performed "on-line" while the original source documents (or typed transcripts) are being read by the OCR system. (This permits marking exceptional documents and sorting them out the first time they are handled by the system. Details of exceptions are printed out on a peripheral printer, ready for inspection and entry of corrections.) Control totals are established or maintained as a part of the editing process. If desired, source documents may be sorted automatically.

4. Under program control, data are rearranged into the format required by the central processor and written on a compatible magnetic tape. An important advantage of the foregoing approach is that source documents, typed transcripts, and magnetic tapes are completely free of the format restrictions imposed by punch card oriented systems. This means that convenience to the human user, not to the key punch operator, can be the prime consideration in the design of business forms.

Such an OCR system is much more than a machine which only reads typewritten or printed characters and writes a "mirror image" of the data on magnetic tape. It is a complete system for data preparation, input, and editing, and it is applicable to any computer installation where input volume is substantial.

Optical character recognition has long been considered essential in systems for machine translation, information storage retrieval, and automatic typesetting. Now, it is becoming essential in a great many types of business data processing systems.

The economic implications of using such a system are important. The elimination of keystroking by optically reading source documents saves: labor; punch card tabulating equipment; their operators; punch cards; card-to-tape conversions; and preliminary computer editing.

Among the diverse types of business using the OCR system described, are: a large casualty insurance company; a major airline; the public schools of a principal city; a large newspaper publisher; and a computer service organization.

The use of optical character recognition as the basic method of input to large scale data processing systems is now an established technique economically justifiable in thousands of data processing systems. Also, further technological advances in the OCR art will make it available to even more users of data processing.

Characters may now be read at a rate faster than the rate at which character-bearing documents can be passed through the machines. In addition, further advances in technology are producing increased speeds in character recognition. Also, OCR systems are increasingly able to read reliably characters of printing quality much less than perfect and of almost any type font readily read by human beings. Undoubtedly, soon, there will be systems that will read hand-lettered characters reliably at high speed. A degree of success has in fact already been achieved in reading hand-printed numerals.

Developments directed toward increasing productivity and raising system performance can be expected to expand greatly the field of use of this equipment. In time, it will include a substantial majority of all computer users now operating key-stroke-prepared data entry.

INPUT/OUTPUT AND SYSTEM 360

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More than 65 input/output devices are now available for use with the IBM System 360.

Magnetic Tape

Magnetic tape equipment includes: a nine-channel magnetic-tape unit, using 1/2 inch wide magnetic tape, with a speed up to 90,000 alphanumeric characters per second; ultra high-speed tape drives, with a speed up to 170,000 characters per second; a tape switching unit, which allows up to 16 drives to be shared by up to 4 tape controls; and other devices.

Data Cells

One of the types of storage devices is a data cell drive, with a storage capacity of 400 million characters. It can be attached to 8 control unit positions on each of 6 channels, providing a total storage capacity of 19 billion characters. It may be worth explaining just what one of these data cells consists of.

— The IBM 2321 data cell drive

In this kind of device, information is stored on and retrieved from magnetic strips which are held in cells mounted vertically around a rotating cylinder. To read or write information, the positioning system turns the cell cylinder to locate a specific ten-strip group, and puts that beneath an access station. At the station the particular strip containing the desired information is taken out and moved past a read/write head for transfer of information to or from the computer. The strip is then returned to its peoper location in the cell. The process requires about a half second. The magnetic tape strips used in this device for storing information are 2 and 1/4 inches wide by 13 inches long; each of the 200 strips has an individual coding tab identifying its position among the 200 strips in the cell. Any data cell of 200 strips (40 million characters) can be exchanged for another one.

The device has a 5-position 20-track read/write head. Each strip has 100 addressable recording tracks. When being recorded upon, the strips move at 250 inches per second; writing is performed at a rate of about 55,000 characters per second. Access time varies between 95 milliseconds and 600 milliseconds.

Disks

Another type of storage facility is storage using multiple disks. One model can store up to 7 million characters in an interchangeable disk pack. Up to 8 drives can be attached to one control unit, allowing an on-line capacity of 58 million characters.

One disk pack can be exchanged for another in about one mintue. The information transfer rate is 312,000 characters per second.

Another type of disk storage facility can record or retrieve information either randomly or sequentially.

Drum Storage

One type of magnetic drum storage device has a capacity of 4 million characters and can transfer information at 1.2 million characters a second. This speed is based on using 4 read-write heads simultaneously for associated tracks.

A second type of magnetic drum storage device can store 800,000 characters and transfer information at 200,000 characters per second.

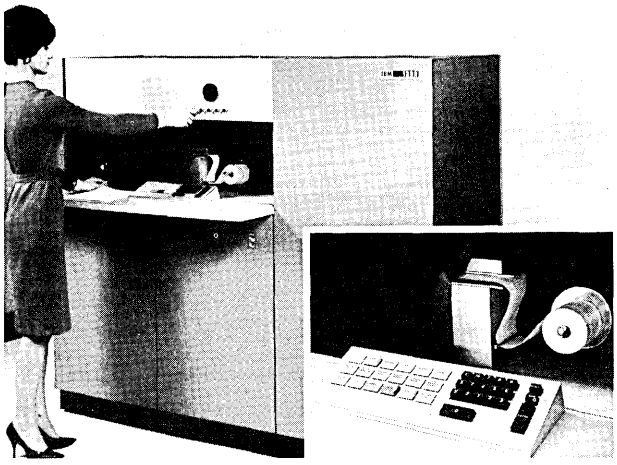
Up to 4 of the bigger drum storage units can be linked to a control unit for a total of on-line direct-access storage of 16 million characters.

Visual Input/Output

The types of visual display devices include: film recorder; film scanner; computer display; display control; light pen; microfilm display; microfilm copier; operator console control via light pen; buffer storage; etc.

Hundreds of display units can be associated with a single System 360 and operate concurrently yet independently.

A high-speed optical reader can be used, for example, to scan rolls of ordinary cash register tape, and transfer the information into a computer. Up to 8 OCR's can be used simultaneously.



— The new IBM 1285 optical reader. Inset shows keyboard used to enter or change information.

Communications Equipment

Communications devices include: programmed keyboards; entry terminals; process communications systems; unattended monitoring and reporting devices; transmission controls; audio response units; data adapter units; multiplexor channels; data collection systems; bank-teller communication systems; data acquisition systems; etc.

Card Read Punches

Five types of card read-and-punch devices are available, some with multiple facilities such as merging of card decks, and reading and manipulating cards from several card hoppers.

High-Speed Printers

Eight types of printers are available with printing speeds ranging from 240 to 1400 lines per minute.

COMPUTER TO MICROFILM AT 100 PAGES PER MINUTE

The first production model has been finished and delivered, of a machine which produces 100 pages per minute of computer-generated data, displaying the symbols on the face of a special cathode ray tube, and recording them automatically on film via a microfilm camera.

This means that in an 8-hour shift 50,000 pages of readable computer output can be recorded on microfilm. Indexing codes are imprinted automatically for later fast retrieval. The characters and symbols are electronically produced in the CRT from computer storage at the rate of 62,500 characters per second. Business forms may be superimposed.

The machine is an SC 4400 Document Recorder made by Stromberg Carlson Data Products, San Diego, Calif. The customer receiving the first production machine is Eastman Kodak, Rochester, N.Y. Eastman will use the machine for obtaining information from magnetic tape records produced by an IBM 7080.

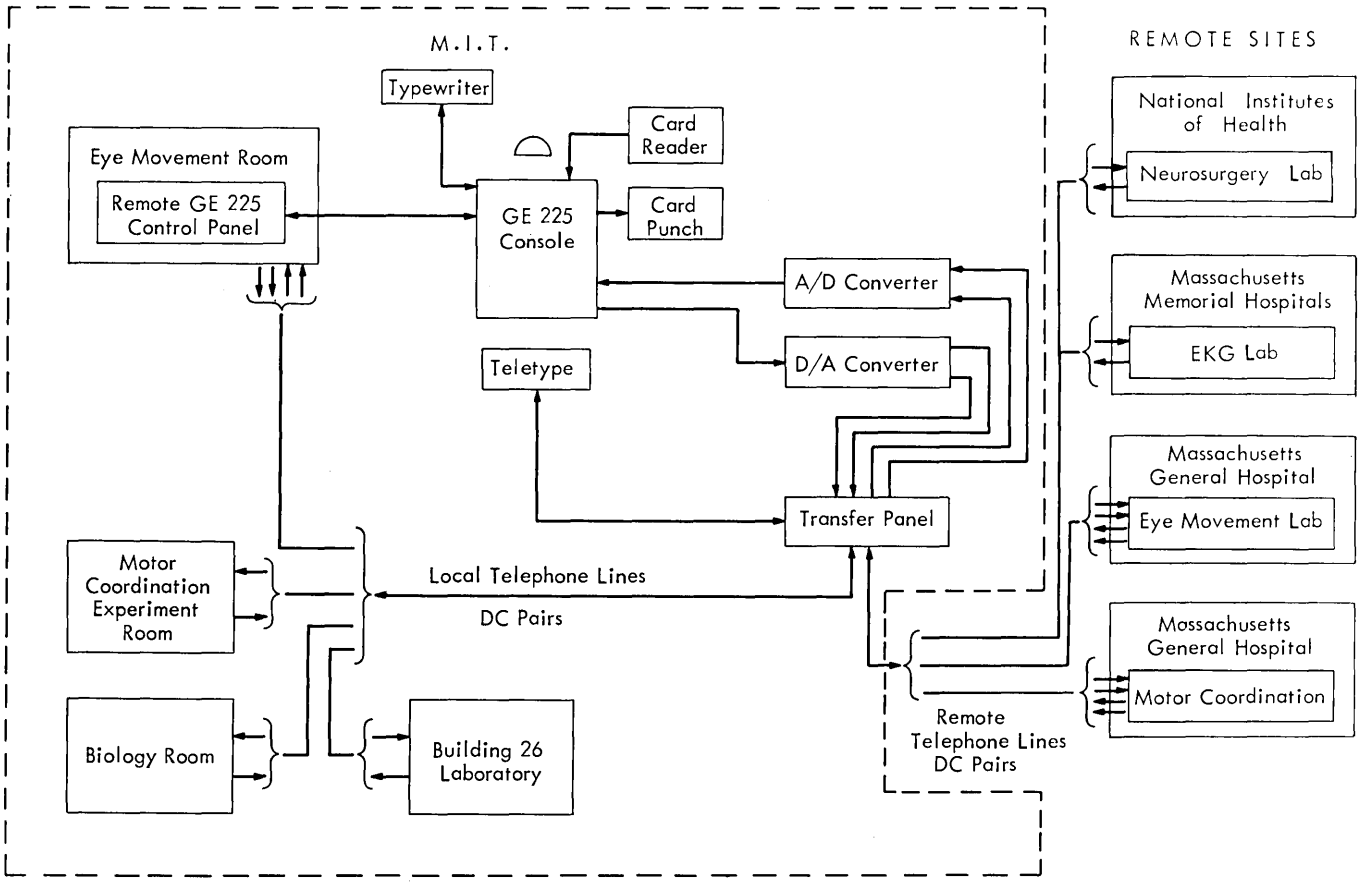


Figure 1. Remote hospital diagnostic laboratories connected by telephone lines to computer at M.I.T.

The Engineering Analysis of Biological Systems

One of the many troubles that may beset coal miners is an eye disease called nystagmus, a constant and involuntary rhythmic tremor of the eyes that is a result, particularly in poorly illuminated mines, of imperfect fixation on the black face of the coal seam. Nystagmus has been characterized chiefly as an occupational disease of miners and of train dispatchers, but in our highly automotive society, truck drivers may also be so afflicted from constantly watching traffic without complete fixation. Occasionally healthy persons may experience a form of nystagmus when trying to observe a faint light, such as a star, at dusk. In addition, nystagmus itself may be a sign of more fundamental disease states such as cerebral tumors or diseases of the middle ear. In these instances, the nature of the nystagmoid eye movements may be a clue to the underlying difficulty. In diagnostic testing an ophthalmologist can also evaluate the light perception and visual acuity of a patient by inducing a type called optokinetic nystagmus which is accomplished by moving striped patterns across the field of view, in a manner directly analogous to the passage of utility poles past a train window.

The pupil reflex of the eye can also be a very instructive mechanism. The poet Thomas Moore once wrote, "The minds of some of our statesmen, like the pupil of the human eye, contract themselves the more, the stronger light there is shed upon them." Medically speaking, this may or may not be true of the pupil, whose reactions can also be an index of disease conditions within the complex network of nerve centers and pathways of pupillary control. A classic example involving the loss of the pupil's reflex to light was first observed in 1869 and has been called ". . . as near as may be, in an imperfect world, an infallible sign of syphillis of the nervous system." In another case, when a pupil reacts to high intensity light as a normal pupil would react to light of low intensity, it may be taken as a symptom of damage to the optic nerve or retina, and under certain other conditions such a reaction may be the only objective evidence of multiple sclerosis.

From an engineering point of view, the tremors described by medical terms such as *nystagmus,* (the constant and involuntary rhythmic tremor of the eyes) and *hippus* (rhythmical and rapid contraction and dilation of the pupils) are thought of as oscillations, a redefinition that provides a new point of view. A neurological system such as that of the pupil can further be considered as a servomechanism. The latter is essentially an automatic control system distinguished by a feedback pathway, and a very elemental, familiar but classical example is the float that controls the water level in a flush toilet. Stability is a fundamental property of a servomechanism that is closely related to all of its elements, and a breakdown of the system cannot be attributed to any one of its components. Characteristically, the failure of an unstable system shows up as sustained or increasing oscillations, an example of which is howl in a radio set. In this light, the condition called "induced pupillary hippus" becomes comprehensible when it is considered as sustained oscillations in a pupil servosystem made unstable experimentally. It is this approach based on communications-engineering concepts that has been followed in the Neurology Section of the M.I.T. Electronic Systems Laboratory, in studies of a number of neurological and biological systems.

An On-line Real-time Computer System

If the complex details of neurological control systems are to be quantitized, the requirements for research must

REMOTE COMPUTERIZED MEDICAL DIAGNOSTIC SYSTEMS

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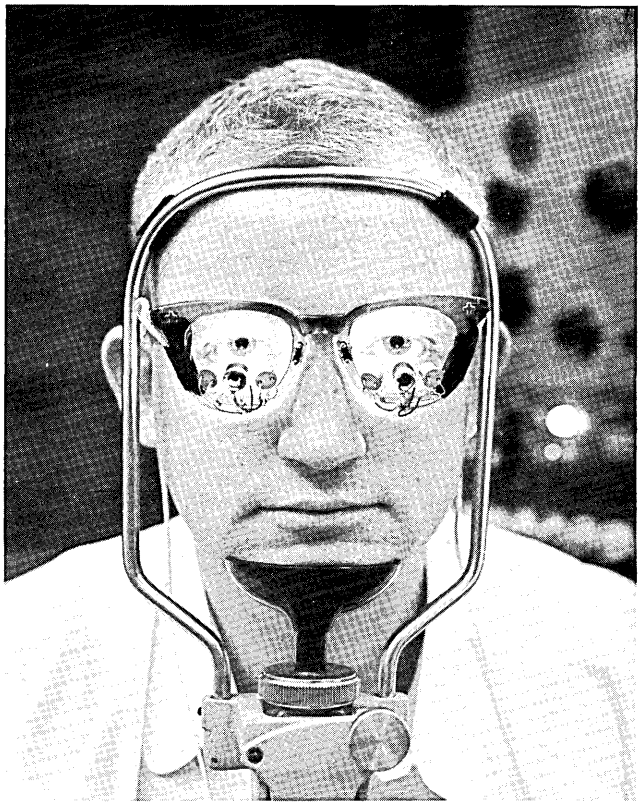

Figure 2. Photocell goggles for the study of eye movements.

include the development of more precisely controlled and accurate complex stimulus-response experiments, the rapid analysis of characteristically noisy records for the detection of finely detailed responses, and the intensive correlation of such experiments with adequate theoretical modeling. In the Neurology Section a digital computer system has been developed that operates in an on-line, real-time mode for the purpose of facilitating these objectives. It has been designed to control and accurately record complex multi-stimuli, multi-response experiments, to transmit the experimental data to the computer, to rapidly digitize and analyze the pertinent information and to return the results to the experimental sites for a real-time display in either an oscilloscopic, graphical or teletyped form.

In the main, the system consists of a GE 225, transistorized, single address, general purpose digital computer. This machine has a magnetic core memory consisting of 8,192 individually addressable twenty-one bit words, with an access time of 18 microseconds. The input devices are, an input console flexowriter, a teletype (8-bit code), an analog-to-digital converter with an 18 KC maximum transfer rate (10-bit accuracy) which accepts analog signals in the 0-10 volt range, and a 400 card per minute photo-electric card reader. There are two, 250 bits per inch tape handlers with a 55 KC maximum transfer rate. The output devices are a ten character per second output console typewriter, a 100 card per minute card punch, and a 10-bit digital-to-analog converter which provides a 0-10 volt output. The results of the digital-to-analog conversion may be directly plotted either by a pen recorder, X-Y recorder or an oscilloscope.

In the laboratory, a variety of experimental sites have been connected to the analog-to-digital and digital-to-analog converters of the computer by DC paired lines. This permits the experimenter to gather data in his own vicinity and to have the computer process this data and return an analysis to him that is displayed in real time. The investigator maintains computer control of the experimental procedure in two ways. 1) A remote GE 225 control panel consisting of program-sensed switches and accumulator register indicator lights can be located at the experimental site. This panel enables the investigator to run a computer control experiment without the necessity of traveling between the experimental site and the computer room. The lights enable him to tell where he is in a program at any time so that appropriate action may be taken. 2) A teletype monitoring system may be used. This provides a capability for remotely controlling the key steps of an experimental procedure such as computer function generation, data editing, and the real time analysis and display of results. These various sections of an experimental program can be called by teletype from the computer's magnetic tape system into core to be executed at the command of the experimenter.

The computer methods of real-time experimental analysis include programs for: a) the generation of comb spectra input functions for the gain and phase shift analysis of a biological system's response; b) accepting on-line response data evoked by repetitive excitation and automatically computing the average response as an analog-voltage output; c) Fourier analysis; d) a variety of statistical analyses (as correlation functions, power spectra, etc.); e) impulse response studies and additional special programs that have been prepared for the acceptance and analysis of data to include—pulse interval analysis, delay line simulation, the calculation of Wiener kernels for non-linear studies, amplitude probability distributions, and various additional parametric and nonparametric tests.

Before the organization of this biological data processing system less sophisticated experiments were made and they

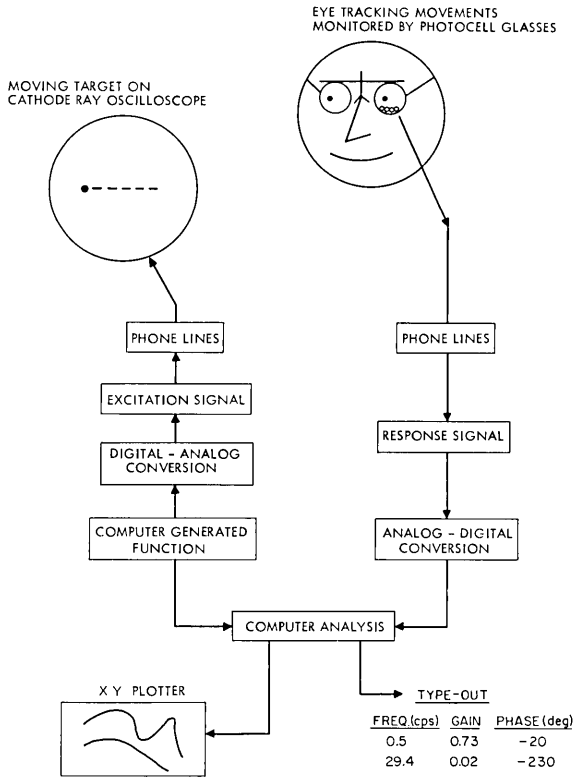

Figure 3. Block diagram outline of system for remote testing of patient's eye movement control system.

were most discouraging. This was due to the extreme variation between single records, the large amount of noise or uncorrelated responses, the variable sensitivity to different components of the stimuli, and the evidence of complex multi-frequency responses. The use of this system has resolved these data analysis problems and many of the required stimulus accuracy problems. It has further revealed the presence of accurately definable complex responses. It has provided us with detailed quantitative information on a variety of biological and neurological control systems. In particular, the on-line, real-time digital computer control and analysis of experiments has been applied in studies of the eye movement control system, the pupil control system, the lens system, the hand motor coordination system, the eye-hand tracking system and for the computer diagnosis of clinical electrocardiograms using adaptive matched filter pattern recognition techniques.

Remote Diagnostic Studies

New dimensions have been given to four investigations in particular, with the linking of this computer system by DC paired telephone lines to the following remote hospital diagnostic laboratories for on-line, real-time studies. (Fig. 1)

1. The Neurosurgical Laboratories of the Massachusetts General Hospital. Here, eye goggles (Fig. 2) with eye movement reflection photocells for measuring the horizontal position of gaze for one or both eyes are used in diagnostic studies. The connection to the computer allows the investigator to conduct a computer controlled experiment and to receive a real-time analysis and display of the experimental results. Figure 3 is a block diagram outline of the system for this remote testing of patients. At the hospital the patient wearing the photocell goggles watches a moving spot on the oscilloscope. The computer at M.I.T. drives the spot, measures the angular deflection of the patient's eyes, analyzes the data at each frequency of interest and then plots or types out the analysis at the hospital within minutes.

2. The Electrocardiography Laboratory of the Massachusetts Memorial Hospitals. Here, clinical electrocardiograms are transmitted (Fig. 4) to the computer system where analysis of temporal arrhythmia and adaptive techniques for the recognition of patterns using matched filters are applied for their real-time classification and automatic diagnosis. The diagnosis is then returned to the hospital within five minutes. (Fig. 5.) The effects of experimental variation on the pattern classification process is being studied in order to simulate human interpretation of the electrocardiogram more closely.

3. The Neurology Laboratory of the Massachusetts General Hospital. Engineering studies of the motor coordination system of the hand are being made with and without dependence on eye orientation. The computer

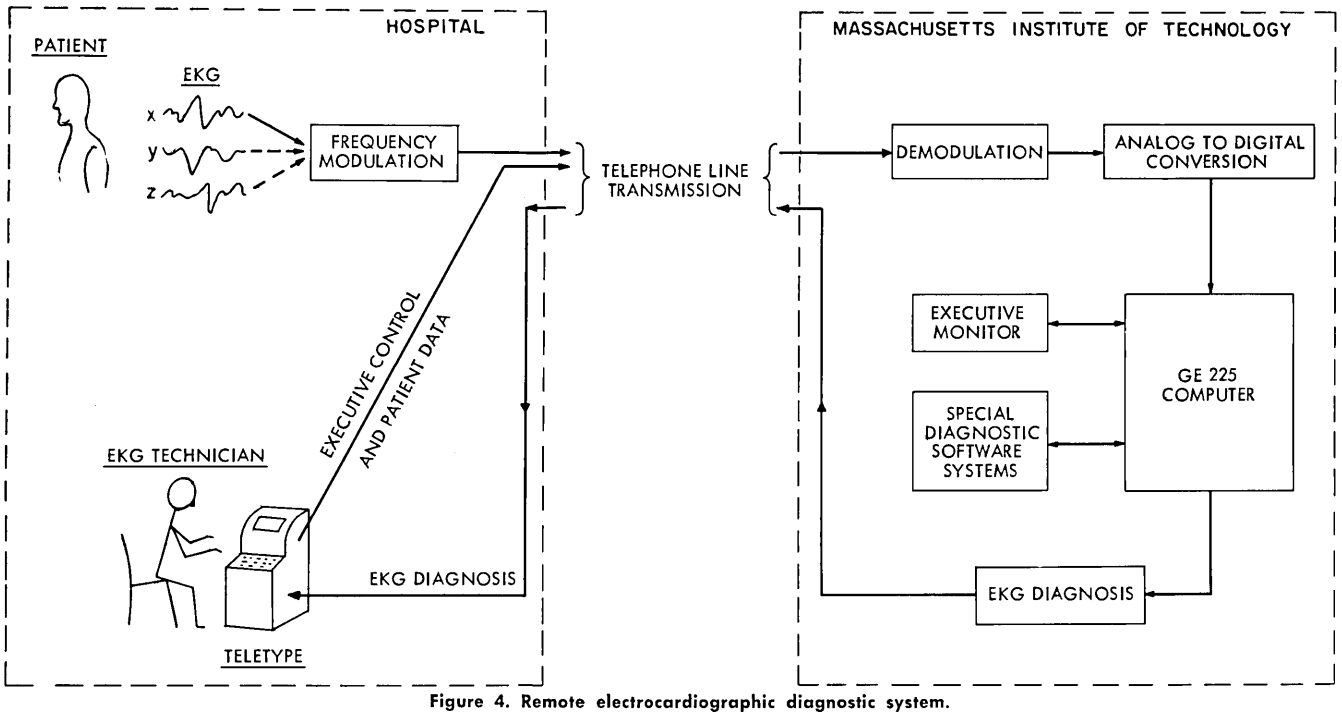

Figure 4. Remote electrocardiographic diagnostic system.

processes the data with the aim of discovering patterns of neuromuscular abnormality. An example of the capability of this particular system can be seen in a brief outline of a hand movement study. Here, the requirement for dynamic analysis of a complex unpredictable input may be necessary in order to distinguish between behavior attributable to the "neurological system" and that due to the probable brain prediction apparatus. To meet this need, to reduce hidden errors in analyzing filtered data and to permit a shorter experiment (and thus less dependence on assumptions on time and variance) the on-line, real-time computer system is used. Briefly, the experimental procedure runs as follows: a) the function generator capacity of the computer produces a sum of as many as twenty sinusoids, specified as to frequency and amplitude. These are then converted to an analog voltage and fed to a mechanical input to the subject. His mechanical response, measured as an electrical voltage, is reduced to digital form and stored in the computer in real time; b) in the analysis routine 25 seconds of tracking are measured. If this seems to indicate a reasonable experimental result, the analysis program then proceeds to determine the alpha and beta coefficients, cycle by cycle (frequency by frequency). A Bode plot is then made, showing the response of the subject to the input. In the conduct of such an analysis it is apparent that this method is sensitive to quantitative differences in the organization and function of the neurological control system for hand movement.

4. The Neurosurgical Section of the National Institutes of Health, Bethesda, Maryland. Here, an experimental station has been connected to the computer at M.I.T. for the remote analysis of the dynamics of neurophysiological disease processes. These studies are particularly oriented toward gaining insight into the effect of surgical intervention of the progression of disease states that are marked by instability of the muscular coordination control system.

The remote, operational control of the computer at M.I.T. by the hospital investigators is a most important feature of these diagnostic systems. Via teletype, the investigator maintains contact with and control of the computer's executive monitoring program. This provides him with a capability for remotely controlling the key steps of any procedure such as input function generation by the computer, data editing and analysis, and the real-time display of the results of the analysis at the hospital. The investigator calls these various sections of the diagnostic program by teletype from the computer's magnetic tape system into its memory where they then may be executed at his command.

Figure 5. EKG technician receiving diagnosis by teletype directly from the computer.

While these computer based diagnostic programs are still research efforts for the most part, they are a forerunner of capsuled computer diagnostic systems (Fig. 6) that will link medical facilities throughout the country and will service many remote areas where such clinical aid is often hard to obtain.

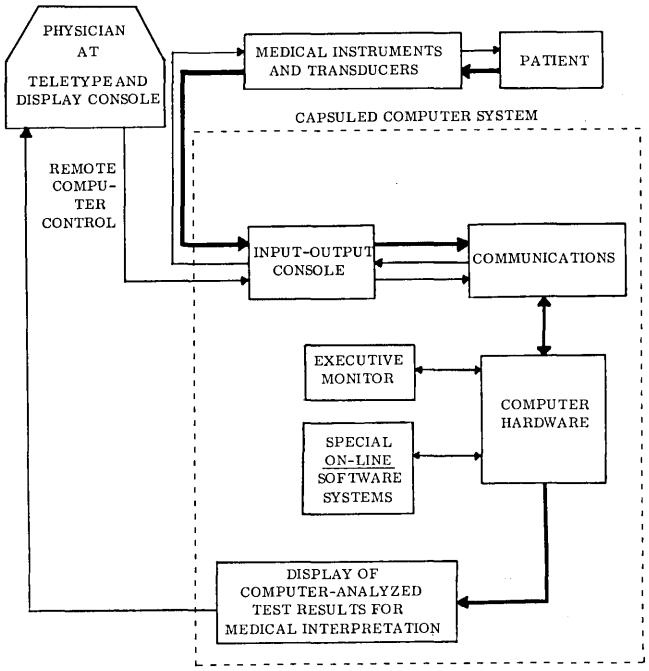

Figure 6. A capsuled computer system for remote research and diagnostic studies.

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Dr. James F. Dickson, III, M.D., is a graduate of Dartmouth College and Harvard Medical School. He is a thoracic surgeon and a control systems engineer. He is also a Research Associate at ESL, and Associate Profesor of Medicine at BU School of Medicine. He has been concerned recently with the development of real time computer systems for biological research.

COPYRIGHTED COMPUTER PROGRAMS: SOME QUESTIONS AND ANSWERS

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The recent announcement by the U.S. Copyright Office that it would register copyrights on computer programs and the flurry of activity within the data processing community which followed the announcement have no doubt left many computer people wondering what the excitement is all about. This uncertainty is caused in part by the difficulty of understanding a problem which is half legal and half technical and in part by the tendency to confuse copyright protection with the more familiar patent protection.

Interest in Copyrighting

QUESTION: Why is there suddenly an interest in the problem of legal protection for computer programs?

ANSWER: Actually, programmers and lawyers have been wondering for several years whether or not programs could be legally protected. 1964 provided the first definitive answers. In that year the U.S. Patent Office announced that it considered computer programs to be unpatentable subject matter and that it would not grant any program patents. At almost the same time the Copyright Office reversed its previous policy and announced that it would register copyrights on computer programs. Shortly thereafter it did register copyrights on three programs and has continued to do so ever since. The latter decision in particular raised the topic of legal protection for programs from the level of a casual discussion topic to the level of an important consideration for the data processing industry.

The value of programs produced each year in the United States has long since passed the one billion dollar mark. Prior to the recent decision, programmers and their companies had a choice of keeping their programs secret or of donating them for public use, often through the medium of sharing organizations. No reasonable means existed whereby a program could be offered for use on a wide scale with the hope of financial return. In other words, the lack of legal protection made it impossible to market a program as a product. As a logical result a large number of valuable programs were never written; many others were written and kept under wraps; and those who donated their programs, if they weren't computer manufacturers, could expect no financial return for their generosity. Copyright protection can completely alter this picture. For the first time it will be possible to write programs to meet the needs of a large number of users and then to offer the program to the users for a small license fee. While it is hard to appreciate the importance of this change without first considering the law involved, it should be clear that anything which can substantially affect the present systems of writing and exchanging programs affects the life blood of the data processing community.

More Decisions

QUESTION: If these decisions are the "first definitive answers", is it likely that there are more to come?

ANSWER: Quite possibly there are. Each of the decisions mentioned was made by the administrative body created by Congress to administer its particular law. As such, the decisions of these bodies carry great weight because of their important positions and because of their expert knowledge. However, it is always possible to challenge these decisions in the courts for a further determination.

QUESTION: Will there be final answers before the Supreme Court eventually rules?

ANSWER: Both yes and no. It is true that each decision may eventually be reviewed by the Supreme Court but this seems unlikely. Moreover, you must remember that today as always business rests on many laws which have not been authoritatively declared by the highest court. It is also possible for Congress to pass legislation. Subject to certain constitutional limitations, Congress may expand or contract the protection of the patents and copyright laws. In fact, Congress is now considering a bill to revise the entire copyright law.

QUESTION: How will the new bill affect the law with respect to computer programs?

ANSWER: That is a very difficult question to answer before we discuss the protection under the present law. Let's simply say that the new bill would at least affirm the Copyright Office's decision that programs are copyrightable and at least continue all of the protection which copyrighted programs now enjoy.

Purpose of Copyrighting and Patenting

QUESTION: What in general is the purpose of the copyright law, and is it similar to the patent law?

ANSWER: Much misunderstanding seems to have been caused by people assuming that copyright protection is like patent protection. It is true that both are grants by the United States government of limited monopoly rights to encourage people to create useful and beneficial products. But this is where the similarity ends.

Patents are granted for inventions which may be loosely defined as new machines and processes. Copyrights are designed to protect the creative works of authors and include such things as music, writings, moving pictures, maps, etc. In order to be patentable, a work must meet a very high standard of creativity bordering on a "flash of genius." For this reason, even if the Patent Office were to change its position and hold that programs did fall within the bounds of the patent laws, most programs would probably fail to meet these very high standards and would not be patentable. On the other hand, a copyrightable work need only be original and possess a modicum of creative effort. Thus almost all programs are eligible for copyright protection.

To secure a patent, an inventor applies to the Patent Office which examines his invention in the light of present technology and previously patented inventions. If they are satisfied that the device is in fact new and meets the high requirements for creativity, the applicant is granted a patent. The process often takes several years and may cost several thousands of dollars in legal fees. With copyright, the procedure is very different. No applications are necessary. The author merely publishes his work with a copyright notice and his work is thereafter copyrighted.

There is also a difference in the scope of protection under each system of laws.

Nature of Copyright

QUESTION: Is it not necessary to send copies of a published work to the Copyright Office to secure copyright? Can't users copy a program in spite of a copyright?

ANSWER: Under the patent system, the Patent Office considers applications for patents and awards those which it finds meet the legal standards.

The function of the Copyright Office is very different. It serves as a central registry for copyrights which have already come into existence when the Copyright Office first receives an application for registration. The office does not grant or deny copyrights.

The law clearly says that a work is copyrighted and entitled to full protection from the moment that it is published with the required copyright notice. The Copyright Office then acts as a registry for copyright claims which have previously been acquired by publication. The wording of the statute requires that the author deposit copies of his work "promptly" after publication; but the courts have construed this requirement very loosely; delays in registration of as long as twenty-seven years have been excused. It is clear that no suit for infringement can be brought until copies of the work have been deposited with the Copyright Office; yet the Supreme Court has held that the right to bring suit is not impaired by tardy deposit whether the infringement occurs before or after the deposit is finally made. Although there is another section of the statute which gives the Copyright Office the right to demand deposit of copies, it is unlikely to be used with respect to computer programs; the power is rarely used in any case and the Office has little way of knowing that a program has been copyrighted until an application for registration is made. It should be recalled that registration was sought for the programs originally involved in the decision only as a means of causing the Copyright Office to publicly acknowledge that programs are copyrightable subject matter.

John F. Banzhaf, III, graduated from Columbia Law School in June, 1965, where he was a Stone Scholar and an editor of the *Columbia Law Review*. In 1964 he submitted two computer programs to the Copyright Office and persuaded them to reverse their previous position and to register copyrights on his programs. He has written over a dozen articles on legal and technical developments. He formed Computer Program Library, and is the president of it.

How to Copyright a Program

QUESTION: Could you explain in a simple step-by-step manner how a programmer can copyright his program?

ANSWER: Here is the way:

1. You must first have an original program which has not previously been published. This simply means that you must write the program rather than copy it from someone else and that it hasn't previously been available to the general public.

2. You next modify your program so that it includes a copyright notice in the following form: "Copyright 1965 J. Smith" or "Copyright 1965 Computertronics Inc." Because the law is not clear as to how a notice is to be placed on a program, it is advisable to include it in the program in several different ways. The notice should be included in English in the first or second line of a program. This can usually be done by using the method provided by the programming language for inserting programmer comments in English. If the program provides for a printout of information, on paper or on tape, the program should be modified so that the copyright notice appears on each printout. Finally, if the program is in the form of a magnetic tape, a readable notice should be attached to the ends of the tape.

3. The program now must be "published" in the copyright sense of the word. This means that it must be sold, leased, or circulated to the general public or at least that it be offered for sale or lease to the public.

At this point the copyright has been secured. To register the copyright with the Copyright Office, you first obtain registration Form A, free of charge, from the United States Copyright Office, Washington, D.C. This form when received can easily be filled out without legal assistance. Then it is mailed to the Copyright Office together with a registration fee of four dollars and two copies of the program. If the program was copyrighted in a form which cannot be read (for example, a magnetic tape) then a printout or other readable form of the program must be sent in addition to two copies of the program in its copyrighted form.

Thus copyright protection for programs can be obtained easily, quickly, and inexpensively.

Advantages from Copyrighting

QUESTION: What do I get for copyrighting a program?

ANSWER: In a very few words, a copyright provides substantial protection against a copying, in whole or in part, of the program; but it does not protect any novel ideas or techniques embodied in the program. For example, suppose you discover a new mathematical formula or technique, a novel method of evaluating a particular type of

integral for example. Certainly you couldn't patent or copyright the formula itself nor could you use any legal means to prevent others from using this formula. The laws of the United States do not permit a person to tie up the laws of mathematics or of nature. Nothing changes if the formula is put into the form of a program. Although someone else couldn't sit down and copy the program, he could legally examine the program (if in fact he could get to see it), learn the formula, and write a completely new program to do the same task in almost the same way. The situation would be similar to using a mathematical technique described in a copyrighted book.

QUESTION: If anyone is free to use a formula in a program, how much protection is left?

ANSWER: Plenty. As is easily realized, the process of converting an idea or a mathematical technique into a working program is probably the most difficult and costly step in developing software. In the simple example just described, the element protected would be the man hours of programming talent required to convert the formula into a working, debugged program. Moreover, the majority of programs seem to involve more of this second element and less of the former. While all good programs embody the good judgment and careful planning of the programmer, few contain any revolutionary mathematical or programming innovations which are so valuable that their loss would destroy or even seriously affect the value of the copyrighted program.

It is naturally very difficult to draw precisely defined lines between the lawful use of an element contained in a program and the taking of an element which is forbidden by the copyright law. At the one extreme it seems clear that if the program's essential idea could be described in a few short equations or a paragraph or two of descriptive prose, another program which might be written after examining such a description and which did not copy the form of the original program at all would not be an unlawful copying. On the other hand a programmer who copies from a copyrighted program but who makes obvious and almost mechanical changes in the method of expression could clearly be punished under the copyright law. As to situations between these two limits, the lawfulness would seem to depend on the extent of the borrowing, the saving to the copier, and even the type of program.

By way of a grossly simplified analogy, most programs seem to be more like a dictionary than a novel. In a novel it is often profitable to plagiarize the bare outlines of the plot or even to reuse the principal character in another novel. On the other hand, how can you steal the essence or basic ideas of a dictionary? Though it involves the labor of many creative individuals, there are no central ideas which can profitably be extracted and used by others in creating similar works. While we are on the subject, it is also true that to the extent that a program contains reference information such as citations, mathematical tables, etc., they are protected by the copyright just as if they had been printed in a published reference work.

So copyright law seems to provide a substantial measure of protection for programs.

Catching Illegal Copiers

QUESTION: How would you be able to catch anyone who copies your programs? and how would you even be able to prove that he did copy it?

ANSWER: You actually raise two different problems with your question; the problems of detection and of proof of copying. Let's answer the second question first because it is the simpler.

Publishers of works like directories and maps have long since solved the problem of how to prove whether a similar work is a copy or not. Almost all directories contain fictitious entries known as "house names." Maps usually contain certain small deliberate mistakes. A showing that another work contains these same errors rather conclusively demonstrates a copying since the second author is hard-pressed to explain why he also included them in his work. Programmers can use the same principle by using several "bugger" instructions which do not affect the operation of the program or sets of instructions which cancel each other out. A second program with the same "funny" instructions would obviously be a copy. To avoid these gimmicks, a potential infringer would have to make such a detailed inspection of the workings of the copyrighted program as to make plagiarism unprofitable.

The problem of detecting an infringement is somewhat more difficult but there are several possibilities. In the first place, most potential infringers are large companies with valuable reputations to maintain. It is unlikely that they would take the risk of being sued for infringement, with the accompanying adverse publicity, to save the cost of reasonable license fees. To be worth the risk, the infringement would have to be done on so large a scale that chances of a leak because of a disgruntled employee becomes prohibitively large. Smaller users who rent time on someone else's computer may be deterred to some extent by the risk that the infringement may become known to the computer owner.

Copyright holders are by no means restricted to depending on chance reports of infringement. The offer of a sizable reward for information leading to the successful prosecution of infringers would be a powerful deterrent. When program leasing becomes widespread, it is not unlikely that industry-wide associations will be formed to provide a measure of internal self-policing.

Finally, the copyright holder may contract with the persons leasing the program to provide for strict control, inspection, and harsh penalty clauses, and in this way seek to prevent disclosure of his program to potential infringers.

So the copyright holder can effectively protect his program.

Monopoly of Programs

QUESTION: But isn't it likely that a few large companies can obtain a monopoly over all the important programs and tie up the entire industry?

ANSWER: Definitely not. This is a popular misconception which results from a confusion with the patent system. A patent prevents anyone else from making or using an invention for 17 years, whether it was copied from the invention or created without any knowledge of the invention. A copyright is very different; it only prevents a copying of the protected work and does not preclude an independent creation of a similar work.

No one will ever have a monopoly on programs. A potential user will always have the option of agreeing to the copyright holder's terms or of writing a similar program himself (and perhaps leasing his new program to all of the users reluctant to pay the original high leasing fee). Thus the economic law of supply and demand will tend to keep leasing fees reasonable.

QUESTION: How will all of this affect the data processing industry?

ANSWER: The answer to this question is mainly a guess, and has to be at this time. The computer industry as we know it is only about 15 years old and has already gone through many changes. Moreover, there are several distinct

segments of the data processing community whose reactions need to be considered separately.

Let's start with service bureaus. Except where they have been working for computer manufacturers, service bureaus almost without exception have written programs designed for either one or a very small group of individual users. Because no legal protection existed, they have not been tried to write programs for general consumption by a large number of users. Now they can. I expect here that the effects will be almost as revolutionary to the industry as the development of mass production techniques which made it possible for manufacturers to produce identical goods for mass consumption. In the future I see service bureaus writing programs for use by large numbers of similarly situated users so that each pays for only a small portion of the development cost.

As for the users of computer services, I see them turning to leased programs as a matter of course. Why shouldn't they? A need develops for a particular program which a company doesn't have and can't get from the user group it belongs to. The company will then have the choice of writing the program themselves or through hiring a service bureau, or of leasing a previously developed program. If the fee is a small portion of the development cost, this plus the saving in time will surely persuade the company to lease the program. I suspect that in the near future leasing fees will be a recognized cost of computer service as much as leasing the computer itself.

To look at the other side for a moment, will users continue to donate programs to sharing organizations? I don't see why they should. They will feel, and rightly so, that they should be compensated in part for developing a program if other companies are going to make use of it.

The attitude of computer manufacturers, who now write the majority of programs, is difficult to foresee. Their policy has always been to support user program-sharing groups and to write programs for these groups to encourage the use of their machines. It is possible, however, that this may change. Already there are indications that computers of different manufacturers are becoming more compatible with each other and that users will be tempted (and are already being encouraged) to change from one manufacturer to another. In such a case it would be unfair and unprofitable for a few manufacturers to carry the burden of writing new programs when they will be used by all users. In such a case, it will be to a manufacturer's advantage to copyright its programs.

Will No Programs be Free?

QUESTION: Is this picture of the future encouraging? Will the day come when all programs will cost money and when there will be no user groups? Are these advantages to be looked forward to?

ANSWER: The advantages may greatly outweigh any disadvantages. The mechanisms for exchanging programs which have developed so far are primitive and not particularly effective. There is little if any incentive for users to donate programs to sharing organizations. Members usually have access to programs without regard to their contributions. As a result many programs, particularly the most significant, are never revealed. Even more important is the fact that many programs have never been written because the cost is too great for one company, and there was no way in which the development cost could be equitably divided. There are severe limits on the effectiveness of any system in the business world which is based on nothing but unrewarded generosity.

You may dislike the idea of paying for programs. But for the most part these programs would not otherwise have been available for your use. Who wouldn't rather pay a rental fee of one percent of the development cost rather than wait for a year and over the year pay the entire development cost? For the most part we have found that the profit system promotes rather than hinders progress. Why shouldn't programs be included?

On the other hand, no one would welcome the disappearance of user groups. In the days when there was no other way of exchanging programs, they made a valuable contribution to the computer industry. Now that a more effective system seems to be coming, they can concentrate on fulfilling many other important functions which are stated in their articles of agreement and purpose.

When Will Changes Begin?

QUESTION: If copyrights will have an important effect on the computer industry, when will these changes begin? To put it another way, have there been any signs that the computer industry is reacting favorably to the Copyright Office decision?

ANSWER: A considerable amount of interest in the question of legal protection for programs has already been expressed. This topic was the subject of a recent meeting of the American Patent Law Association and was also discussed at the 1964 Spring Joint Computer Conference in Washington. Almost two dozen articles on the topic have already appeared in legal and computer periodicals in addition to the publicity generated by the original announcement. The Copyright Office has been bombarded with hundreds of requests for further information and has already acted favorably on several applications. Digitek Corp., a leading service bureau, announced in a four-page full-color ad its intention to lease a copyrighted compiler. More recently Computer Program Library was formed to act as a central registry of copyrighted programs and to assist users in finding programs to meet their needs.

This interest is particularly encouraging because the announcement of the Copyright Office's decision caught the industry by surprise. In other industries to which copyright protection was suddenly introduced, it took several years before it really caught on, even where the protection had been eagerly sought. For example consider the situation in dress fabric designs. For many years the industry had pressed for copyright protection for the original fabric designs created every year. Yet, when copyrights were finally recognized for designs, it took several years before companies understood and accepted the new legal protection. For this reason the activity to date in the computer industry should be regarded as a favorable sign that the problems of acquainting the industry with the new concept are almost over and we can expect that the industry will soon begin to make active use of this new opportunity.

Readers who are interested in a more detailed exposition of the legal aspects of this topic may receive on request a copy of "Copyright Protection for Computer Programs," originally published in the *Columbia Law Review,* by writing to the author at Computer Program Library, 509 Fifth Avenue, New York, N.Y.

Readers who have views about copyright protection for programs are invited to send their comments to the Editor of "COMPUTERS AND AUTOMATION."

INTELLIGENT MACHINES AND HAZY QUESTIONS

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Two women, applying for a job, are interviewed separately by the company's personnel manager. The interviewer finally comes to the inevitable question; in a nervous, oblique manner he asks, "Do you mind telling your age?"

The first woman answers, "Thirty-six," and the interview continues. The second woman thinks a moment, answers, "No, I don't mind. What is the next question?"

To interviewers, this incident just illustrates that some people are "ornery." But to readers of this magazine, it can be a reminder of a fact about computers: They are ornery all the time; the stupid things answer the questions you actually ask, and not the questions you meant to ask.

Failure to Say Exactly What One Wants

Why do people fail to say exactly what they want? Computers have no feelings to be offended by bluntness; why, then, do people fail to tell them precisely what is demanded? At least two reasons exist.

First, people find it very tedious to explain, especially in computer language, exactly what they want. So a person's impatience often causes his programs to be incomplete.

The second reason is less obvious: People sometimes do not know exactly what they want. A man may, for example, want vital information about other people, yet he may be unable to specify what he means by "vital information."

A great deal of attention is being lavished on the first case, and promising results are appearing. In the past, as one writer (see reference 4) observes, technically trained individuals may "have tried unsuccessfully to use a digital computer" and they may have been "turned away by the mechanics of programming and the details of batch processing." But new programming systems enable these individuals to address the machine in a language which is familiar and concise. A high degree of precision is still demanded, but people can now specify entire blocks of operations by explicit commands which are easy to learn.

The second case — that in which a person has only a hazy idea of what he wants to ask — is more difficult. It is hard for people to communicate with each other, much less with computers, when their questions involve "judgment" and "intuition."

"Something Wrong - Please Investigate"

An executive, for example, is conferring with a senior staff assistant. The executive was trained years ago in mechanical engineering. The assistant has a more recent education in physics. The executive declares, "I have the feeling that something is wrong in our new cryogenics lab, but I don't really know what's going on down there. You look into it and tell me what's cooking."

The executive is asking his assistant to do something that the executive cannot do. But that fact does not necessarily distinguish the assistant from a computer; people regularly ask computers to do things they cannot do — to work problems very rapidly, for example.

The executive's request could not be made to an ordinary computing system for the following reason: Intelligence will be necessary in answering the request. The assistant has "the big picture" about the company and its goals, and he has a store of fundamental scientific and technical knowledge. His intelligence enables him to use this fundamental information in responding to the request of his boss.

Generalization Demanded

The physicist is an intelligent person; he can readily acquire, recall, and apply a large number of general principles. He therefore illustrates a basic point:

> A touchstone of intelligence is the ability to supplement, by knowledge of general principles, information which is neither entirely explicit nor complete.

This touchstone applies to machines as well as to people. If computers are to be intelligent, they must be able to generalize. The machines must be able to deal with general principles as well as with specific data:

> When machines with significant intelligence are available, an entire new world of applications will arise: People will be able to ask machines questions which deal with general concepts as well as with specific data.

This will probably bring about a tremendous increase in the use of computers, because it will mean people can then

ask machines the same kind of hazy questions which people almost always ask each other.

Autonetics established an "Artificial Intelligence" project nearly four years ago. Among the first studies of that project were investigations of generalization.

Most of the literature on generalization has come from the theorizing and experimenting of psychologists. One of the oldest theories[6] says this: Complex situations can be analyzed in terms of primitive elements, and people generalize from one situation to another on the basis of the number of identical elements in the two situations. That is, two situations will be treated similarly if they contain many of the same elements.

Influenced by this venerable theory, our first attempts to simulate generalizing machines made use of large tables. The rows of the tables represented possible elements of situations. When a preprocessor determined that an element was present in a situation, the row corresponding to that element was "flagged." Thus the rows which were flagged at any given time described a situation which was existing at that time.

The columns of the table represented elements of possible responses. The entries in the table indicated connections between past situations and past responses. As a result, similar sets of inputs (that is, those having many elements in common) tended to lead to similar responses and outputs.

Construction of "Generalizing" Tables

A practical question immediately arises: How do you construct such a table in the first place? How do you calculate what the entries in it should be?

This question hints at learning. There is very strong evidence[2] that tentative (or short-term) learning coincides with temporary activity in the brain, but that long-term learning is represented by some kind of static, long-term changes. Turning to computers, the concept of change naturally leads to the idea of incrementing and decrementing the entries in a table. The general idea is this: If a set of entries is used which leads to a bad output, then those should be decremented. If another collection of entries leads to a good output, then those entries should be incremented.

This general idea is so simple and so obvious that it has independently occurred to a number of people. For example, one book[5] includes a discussion of "learning matrices" — an appropriate name for tables of the type we have been describing.

Our Artificial Intelligence project independently prepared computer programs for setting up learning matrices. The project has also studied extensively fine points in incrementing and decrementing the matrices. Should the amount decremented for a bad answer be the same as that which is incremented for a good answer? In some cases, it turns out, the answer is no. You should decrement more for a bad answer than you should increment for a good answer. Should you decrement every time there is a bad answer and increment every time there is a good answer? Again, the proper technique is not obvious. As a matter of fact, it must be tailored to the specific purpose of the specific learning matrix.

"AGILE"

In February, 1962, Autonetics completed the simulation of an elaborate but imaginary machine called AGILE. In addition to some preprocessing routines and some provision for postprocessor calculation, the simulated machine contained four learning matrices. The name of the simulated machine (AGILE, for Autonetics General Information Learning Equipment) was not entirely a "cute" acronymic. AGILE really was designed to be capable of dealing with general information, and it was designed to be able to learn. The simulation program has undergone two major modifications, and the resulting "Model III AGILE" is still used for demonstration purposes.

Dr. Richard K. Overton received his Ph.D. in 1956 from the University of Texas. By 1959 he had written a textbook *(Thought and Action: A Physiological Approach)* and served three years as a professor at Fort Hays Kansas State College; then he joined Autonetics, a division of North American Aviation, Inc.

His early work at Autonetics included the design of the control panel for an electronic computer, an experiment in vision, and assistance in the design of an automatic checkout system. Since 1961 he has directed the company's Artificial Intelligence project.

Dr. Overton is the designer of the highly successful Autonetics General Information Learning Equipment (AGILE), and he has directed the development of other designs for automatic diagnosis and other applications.

AGILE has perhaps a personality also.

In AGILE'S replies, "mm" comes close to a human being's deliberative "hm-m" but is not quite the same. The computer in addition to choosing a reply, calculates how good the reply is likely to be. When it has low confidence in the response, it also says "mm".

The computer is unable to say nothing. Therefore, the period "." is as near to no response as it can make, and is used when the computer is unable to come up with something meaningful.

A Demonstration of Learning by AGILE

In the latest of the demonstrations, the guest was a professor from the Univ. of California at Los Angeles, and the subject was "polite conversation." AGILE had been taught to use a 64-word typewritten vocabulary to make polite conversation. That is, it had been taught to answer certain questions in certain ways. Much more important is the fact that the simulated machine would try to answer new questions with new answers on the basis of what it had previously been taught.

The demonstration initially featured previous learning. Then an Autonetics executive, who was host to the guest from UCLA, suggested that the professor make up some new questions. The following conversation ensued:

Professor: ARE YOU A MAN?
AGILE: NO POWER MAN.
(A "Bad" button was then pushed to cause some decrementing of matrices.)
Professor: ARE YOU A MAN?
AGILE: NO POWER MAN.
(The "Bad" button was pushed again.)
Professor: ARE YOU A MAN?
AGILE: NO POWER MAN BE.
(Again the "Bad" button was pushed.)
Professor: WHAT ARE YOU?
AGILE: I BE MACHINE.
(This time the "Good" button was pushed.)
Professor: ARE YOU A MAN?
AGILE: I NO BE.
(Now the "Good" button again.)

Professor: ARE YOU A MACHINE?
AGILE: BE I BAD MACHINE?
(A "Neutral" button — the only choice other than "Good" and "Bad" — was pushed.)
Professor: I THINK YOU ARE ALL RIGHT.
AGILE:

Vocabularies and Translation

Although all of its vocabularies are quite small, AGILE has also been taught to make light conversation in Spanish, French, and German. It has demonstrated a limited ability to translate English into Russian, English into Japanese, and Bulgarian into Ci Tonga. (The last skill, which was taught only at the most rudimentary level, was intended to illustrate that AGILE can learn any language as easily as any other.)

Vocabularies are small, in part, because AGILE has been simulated on a small computer, the Autonetics Recomp II. This is a disc-memory machine with 4096 memory locations of 40 bits each. In theory, AGILE could be scaled up for simulation on any general purpose computer with an adequate command list. Short AGILE experiments have also been conducted on the IBM 1401 and 7090 computers.

Game-Playing, Maze-Solving, and Linear Programming

In the nonlinguistic area, the Recomp AGILE has learned to play tic-tac-toe, and it has acquired some skill at other simple games. It has explored and mapped out simulated mazes. It has studied diets in an attempt to provide a mixture of foods which will be adequate for the requirements of a group of people, but which will still have minimum cost.

It has been used, in revised form, as the basis for an economic simulation program. Here its purpose was to draw general conclusions from a number of real observations of economic indices and to apply these repeatedly to hypothesize economic situations. The repeated application caused, in effect, a prediction of the course of economic development following the hypothesized situation.

The economic simulation program required a revision of the basic program for simulating AGILE, but most of the other accomplishments were realized without any change in the simulated system. As a matter of fact, it was claimed at one time that the Model I AGILE had learned a greater variety of skills than any other nonliving system.

How AGILE Works

How does AGILE work? Details vary in each of the three models, but the essential features are these:

Inputs which are recognized by a simple search routine go in directly to something called a "circulating combiner." In one sense, this is a small temporary memory or shift register. When it is filled and when a new word appears, the oldest input is removed. It is important to note that inputs can come to the circulating combiner from AGILE itself as well as from the outside world. Thus, its contents may change while it calculates a long answer to a question.

The shift register feature of the circulating combiner causes a certain number of words to be always "under consideration" during a "conversation" between AGILE and the person. This feature allows AGILE to do something roughly analogous to keeping track of the context in which a question is asked.

Also, the circulating combiner occasionally tags some inputs or words for extra emphasis. The tagging is essentially random, but lists are kept which eventually indicate those words which are usually the most important. This feature allows the over-all system to deal more readily with key words and to learn more readily, for example, that "no good" is really not very similar to "good."

The circulating combiner feeds symbols to the most basic of the learning matrices. As explained above, this is a sort of table correlating inputs and outputs. It is the basic path between question and answer. Entries in the table are, of course, incremented and decremented as people tell AGILE that they do and do not like its answers.

Guesses, Rewards, Punishments, and Lessons

Now suppose a person decides in advance that he wants to ask a certain set of questions. Suppose he also decides to demand some specific answers to these questions. He could personally ask AGILE each question, but it would be much easier to record the questions and answers as a complete "lesson."

AGILE contains routines which enable it to go through the lesson automatically. It guesses at an answer to each question. Then it looks to see whether or not it got the right answer. If it does not, AGILE "punishes" itself and then goes on to the next question. After making one "pass" through the lesson, it automatically tries it again. The machine continues to make passes until it learns the lesson or until something stops it.

A lesson is learned as a whole; the questions and answers interact with each other. For this reason, the course of learning a question depends on the lesson in which it is imbedded.

Longer lessons, which permit AGILE to acquire more general information, permit better generalization — better answering of new questions that were not in the lesson.

An Example of a Lesson

For illustrative purposes, short lessons have been studied. One of these is given below:

1. WHAT ARE YOU?
   I AM A MACHINE.
2. WHAT AM I?
   YOU ARE A MAN.
3. WHAT DO YOU DO?
   I WORK FOR MAN.
4. WHY DO YOU WORK FOR MAN?
   FOR MAN TO KNOW.
5. HOW CAN YOU KNOW?
   I WORK ON DATA.
6. I WANT TO KNOW.
   GOOD.
7. TELL ME ABOUT DATA.
   I GIVE MAN GOOD DATA.
8. WHAT CAN DATA DO FOR MAN?
   DATA CAN TEACH MAN.
9. DO YOU LIKE DATA?
   GOOD DATA.
10. CAN DATA TEACH YOU?
    YES.
11. DO YOU LIKE MAN?
    YES.
12. CAN YOU BE LIKE MAN?
    I WORK FOR MAN.
13. IS MAN GOOD?
    MAN MUST BE GOOD.
14. IT IS GOOD FOR YOU AND I TO TALK.
    YES.

After 130 passes through this lesson, AGILE had learned it. The course of learning of the first question (WHAT ARE YOU?) illustrates a typical sequence of answers. AGILE's

answers, recorded at eight equally spaced intervals during the learning session, were:

1. mmMAN mmLIKE mmON mmWORK mm.
2. I mmBE mmWORK mmARE mmFOR
3. I mmMACHINE mmON mmARE mmCAN
4. I mmMAN LIKE mmTO.
5. I mmKNOW A mmMAN mmARE
6. I AM A YOU.
7. I AM A MACHINE.
8. I AM A MACHINE.

After the 130th pass through the lesson, the human experimenters challenged AGILE with new questions. The questions, and the machine's answers, were:

1. AM I GOOD?
   MUST BE.
2. AM I LIKE YOU?
   YES.
3. MUST DATA BE GOOD TO TEACH MAN?
   mmGOOD DATA.
4. MUST MAN BE GOOD?
   I WORK FOR MAN.

Obviously AGILE erred in its answer to the last question. So more training was in order. And AGILE was stubborn, as indicated by the number of "B" or "Bad" evaluations in the supplementary training session reported below:

Question: WHAT CAN YOU DO FOR MAN?
Answer: DATA CAN TEACH MAN.
Eval: B
Question: WHAT CAN YOU DO FOR MAN?
WORK FOR MAN TO KNOW.
Eval: N
Question: WHY DO YOU WORK ON DATA?
Answer: mmFOR MAN GOOD DATA.
Eval: B
Question: WHY DO YOU WORK ON DATA?
Answer: mmWORK FOR MAN TO KNOW.
Eval: N
Question: MUST MAN BE GOOD?
Answer: I WORK FOR MAN.
Eval: B
Question: MUST MAN BE GOOD?
Answer: I WORK GIVE GOOD DATA.
Eval: B
Question: MUST MAN BE GOOD?
Answer: mmAM A MACHINE.
Eval: B
Question: MUST MAN BE GOOD?
Answer: TO KNOW.
Eval: B
Question: MUST MAN BE GOOD?
Answer: mmARE.
Eval: B
Question: MUST MAN BE GOOD?
Answer: mmYES mm.
Eval: G
Question: MUST MAN BE GOOD?
Answer: YES.
Eval: G

Interaction of Learning

There is a complicating characteristic to new learning: It interacts with old learning. After learning something new, the answer to an old question is likely to be different from the one given in the past. This is true with AGILE as well as with people.

As a result, AGILE's supplementary training caused it to react differently to one of the questions in the original lesson. Specifically,

13. IS MAN GOOD?
    YES MUST BE GOOD.

Tentative Evaluations

A problem which arises in complex learning situations is this: Suppose some responses have been made (or some actions taken) which lead to a certain good or bad result. Suppose, for example, that in a maze a number of turns have been made, and the thing trying to learn the maze either bumps its nose into a dead end or gets out of the maze. One of the first turns may have been correct, and yet one of the last turns may have been a wrong decision which led to a trap. If AGILE were in this kind of situation, the decrementing of all of the matrix entries leading to the "bumped nose" would be unwise; good choices would be "punished" as well as bad.

This is a serious problem. In its most general form, it is one of the most fundamental difficulties encountered in the design of "intelligent" machines.

Our general solution to this problem is to rely on tentative evaluations of partial responses. For this purpose, AGILE contains a prediction matrix. This operates on exactly the same principles as the basic matrix, but it has quite a different purpose. In conversation it learns the replies which a person will *probably* make to the replies which AGILE *does* make.

This second matrix is used when a tentative choice or response has been calculated by the basic matrix. The prediction matrix then estimates the most likely reaction of the outside world to the tentative response. If it is bad (analogous to bumping the learner's nose in a blind alley) or if it is one with which AGILE cannot easily cope, then entries leading to the tentative reply are decremented.

Early reports designated this matrix as "the simulated outside world" because its function is to play the role of the real outside world when the learner does not have access to reality; it enables AGILE to do "vicarious trial-and-error" learning as opposed to real experimentation. However, other learning matrices can also be considered as representations, for other purposes, of the real outside world. Indeed, such representations are the essential feature of learning, according to one report[3]. For this reason, research now emphasizes another question: How should sets of matrices be organized to represent different aspects of reality most efficiently?

Diagnostic Applications

Two general kinds of applications are being considered for AGILE: diagnostic and linguistic.

The first diagnostic work is being done with automatic checkout equipment and with systems for isolating faults in complicated electronic packages. The conventional approach to automatic checkout and fault isolation is to design a programmable system capable of making electrical measurements. This is then programmed by an engineer familiar with the system under test. The program directs the conducting of the tests necessary to isolate a fault to a removable assembly. In the simplest and most common case, the tests are always performed in the same order. This is a wasteful procedure because most of the tests are unnecessary in finding a particular fault.

An experienced technician, however, is more intelligent than the program. He does not take the tests in an unchanging order. Using what he has learned from past equipment failures, he takes short cuts. As a result, he usually can arrive at the faulty unit using fewer tests than the program requires.

Unfortunately, such short cuts cannot be foreseen by the programming engineer when he is writing the checkout and fault isolation program. At that time no one has enough experience with the system under test to know its general failure characteristics. Also unknown are the idiosyncrasies of the particular package under test.

A machine like AGILE promises to fill the gap between the program and short cuts; that is, it would do what the technician does, but it would do it faster because it would not be limited by the slowness of human perceptions and reactions.

Another diagnostic application which has been considered undoubtedly lies farther in the future. It is the assisting of physicians in the diagnosis of human illnesses, particularly under emergency conditions.

Linguistic Applications

In the linguistic area, experiments have been made with AGILE as a major component in a mechanical translator of languages. Also, the kinds of information which are most useful to AGILE are being analyzed. This analysis may be an aid to the automatic abstracting of long technical documents.

More fundamental and immediate linguistic applications probably will involve information retrieval. One of the greatest challenges is posed by that second reason why people do not tell computers exactly what they want: the user's language may be necessarily vague. For example, a scientist with only a rough hypothesis should eventually be able to use a natural sequence of questions and answers to search technical literature which has been converted to computer tapes. Similarly, an intelligence officer should be able to use a machine to assist in the content analysis of a data bank. AGILE, together with another design mentioned below, may evolve into just this kind of mechanical assistant.

Mathematical Applications

Another application is more mathematical in nature. It concerns blending problems. AGILE has been asked to make diets for large groups of people which contain the required nutritional elements, but which also cost as little as possible.

This kind of problem — the blending of several ingredients to create an adequate but economical mixture — occurs in many industries. It can theoretically be solved by laborious mathematical techniques such as linear programming. However, AGILE-type logic may provide solutions to some problems more readily and inexpensively than linear programming techniques.

Neural Net Simulations

The investigations of the Artificial Intelligence project have not been restricted to the AGILE concept. In addition, two neural net programs have been written. In the larger of these, the computer simulates the following parameters of living neurons: temporary sensitivity and its decay rate, long-term sensitivity, absolute refractory period, transmembrane potential, and number of axon branches. As many as 1024 such neurons can be simulated as a net on the IBM 7094 computer.

Experimentation with the neural net programs leads us to suspect that they are not efficient in terms of relatively short-term goals. However, their long-range potential may be greater.

The Adaptive Categorizer

A design which seems more practical and which has been successfully simulated is an "Adaptive Categorizer." This is a system for assigning groups of words, and portions of groups, to categories, subcategories, sub-subcategories, etc. It works by comparing the incoming words with certain test words at various decision nodes. This categorizing system is adaptive in that it automatically places the words which are most useful for testing purposes in the various nodes. This means that the Adaptive Categorizer learns first those words which are most useful to it, and also that it changes itself if the nature of the input vocabulary changes with the passage of time.

The use of an Adaptive Categorizer is currently being suggested for the automatic classification of technical articles written in foreign languages. Also considered is the possibility of automatically classifying new research projects so that they can readily be brought to the attention of the people who need to know about them.

What Next?

A tremendous amount of work remains to be done with learning and generalizing machines. To cite just one example, there is an important difference between what has been called "physical similarity" and "learned similarity"[2]. Machines rely too much on the former; they note too little of learned similarity. Also, we look forward to an increasing emphasis on advanced mathematical concepts, such as the fixed-point theorems, which can be used to measure the degree of overlap between sets of elements in different problems.

A second course of development will be the modification of the existing programs for special purposes such as information retrieval and classification, automatic checkout, and other diagnostic tasks.

Finally, we have begun to consider ways of building AGILE-type machines from scratch, rather than simulating them. We are not necessarily restricted to electronics for the construction materials. In particular, one proposal calls for the optical representation of very large learning matrices with lasers providing the energy in the pure form needed to look through the optically recorded data.

In talking about artificial intelligence and learning and generalizing machines, people occasionally ask the rather sophomoric question, "Is there anything to worry about? Do you think the machines will ever take over?" At least one book[1] deals philosophically with this subject, suggesting a continuum between machines, men, and God. But a more mundane answer was suggested by a frustrated engineer who was tired of the ratrace in a certain "high priority" project. He sighed, "You know, too many people are losing sight of the more important things in life: eating good food, drinking good liquor, and sleeping. . . ."

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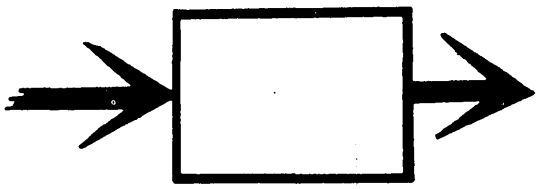


The Hazards of Contract Programming

The use of service organizations to provide contract programming services has been increasing rapidly. This has been caused partially by personnel shortages in programming and systems activities, and partially by a large increase in the complexity and scope of programming tasks. It is estimated that current expenditures for programming and software services exceed $400 million per year; by 1970 the annual total probably will exceed $1.2 billion.

Three distinct markets for contract programming services can be identified:

- the manufacturer — to expand software development capabilities, and to meet requirements increased by competition
- the government — unable, as a result of personnel ceilings and grade structure, to meet total data processing requirements; and
- industrial and commercial computer users — whose peak load requirements often exceed their own capacity by a substantial amount.

The last market, users, will expand faster than the other two. To a large extent, the manufacturer's demands are finite and currently being satisfied. The government has budgetary restrictions which create a limit for expansion. But the industrial and commercial user market can expand infinitely.

The individual industrial or commercial user faces great hazards in employing contract programming services. The dangers exist in a lack of definition, in quality of personnel, in costing, and in scheduling of projects.

The hazards of contract programming services apply to the entire profession of persons supplying them and might destroy the market; and a user informed about these hazards is therefor a better prospect and a better client.

The key to the problem lies in the word "contract". A contract normally is a legal instrument drawn to document an agreement; however, in drawing a "contract" for programming the agreement does not always include understanding by both parties, the wording is often vague and general, and the terms of the contract are often not binding and often can be circumvented.

Programming services generally can be obtained in three ways:

- from a "body shop", which provides persons who have programming talent, by the hour, day, or month, and charges from $10 to $20 per hour;
- on a "time and materials" basis, with a range of cost provided, based on an educated guess;
- on a fixed price basis, like any other contract for definable services or products.

The last is most desirable, the second is acceptable, and the first is fraught with dangers. The following hazards apply to each mode:

"Body Shop"

1. Costs are never known in advance — will almost always exceed expectations.
2. Quality of personnel is not a factor; an unethical shop acts merely as a personnel agency, and may not even screen the applicants.
3. Use of part-timers and "moonlighters" is high.
4. Turnover among programmers is extensive and expensive to the user.
5. Training time is charged for.
6. This mode provides no good way to *select* a contractor.

Time and Materials Costs within Ranges

1. The upper limit of the range is almost invariably reached, and often exceeded because of "changes in definition".
2. Quality of personnel is usually not a factor.
3. An organization with high overhead will invariably be more expensive.
4. If an organization has both time and materials contracts and "body" contracts, it will tend to assign high-priced (and not necessarily more qualified) personnel to the T & M contracts.

Fixed Price Contract

1. Because price is guaranteed, it will tend to be higher as "insurance" for contractor.
2. Cost can be increased only through desired "changes in design".
3. If schedule is not guaranteed, schedule may slip because of inadequate personnel quality.

The following are basic suggestions for user organizations contemplating use of contract programming services:

a. Establish overall systems requirements in advance;

b. Define in advance, an "upset" price or range of cost, based on an estimate of doing the work in-house, including necessary overhead and fringe, plus 30%;

c. Request fixed price or guaranteed time and materials proposals from at least three reputable firms. Reject those proposals which exceed the upset price by a wide margin;

d. Insure that the proposal define: systems scope; schedule; cost; staffing; responsibilities for punching, test time, assemblies, etc.; documentation and training to be provided;

e. Insist in advance on detailed resumes of personnel to be assigned; meet and talk to personnel, if feasible, before awarding contract;

f. Check references of at least three current clients of the contractor, chosen at random, preferably those using the same personnel;

(Please turn to page 33)

READERS' AND EDITOR'S FORUM

(Continued from page 11)

casionally you look back, Dear Leaders, because some day soon your erstwhile programmers will not be following. They will be going in a different direction, doing other more interesting things, and you will have to hurry to catch up and get in front again.

MORE COMMENTS ON "COMPUTERS AND THE PUBLIC SECTOR OF THE ECONOMY"

William W. Stark
St. Louis, Mo. 63122

I am a college student in accounting and mathematics at the University of Missouri. I recently became a subscriber to your magazine for two reasons. First, I am interested in the rapidly advancing world of data processing, hoping eventually to work in this field. Your magazine is providing not only a means of keeping up with what is transpiring in the field, but also serves as an introduction to things I previously was unfamiliar with. Second, numerous articles in your magazine are helpful in my school work. They provide examples and practical background for the information obtained in the class room.

I appreciate the manner in which your magazine monthly presents more than one article or view on a particular topic. A collection of these magazines will produce an extremely good introduction and background reference on many topics for use when I finish school.

Since your editorial mentioning the Russian subway drew a considerable number of comments, I would like also to pass mine along. I am in favor of an article of that nature. Since I am not in a position to travel to distant places as others are, I appreciate learning and knowing the observations of other people. I tend to feel sorry for the two individuals, L. H. Nebel and P. G. Sexton [see "Computers and Automation" for April 1965] who evidently preach a doctrine of isolationism. If I am not mistaken, that very doctrine caused considerable trouble a number of years ago. I would be one to oppose the Soviet Union's forms of socialism and communism, but just because I don't believe in it is no reason to shut the door on knowledge about the subject. A good businessman is indeed very interested in knowing exactly what his competition is doing, and would be more than willing to profit from the other's knowledge, if he could do so.

I feel my money was wisely invested in your publication; keep up the high quality.

USEFUL INFORMATION

Andrew G. Favret, Associate Professor
Dept. of Electrical Engineering
The Catholic Univ. of America
Washington 17, D.C.

In addition to renewing my subscription, I want to take this opportunity to commend you on the excellent magazine you publish. It is very readable and provides up-to-date coverage of developments in equipment, programming and applications.

I recently completed a book "Introduction to Digital Computer Applications" (Reinhold) and I found more useful information in Computers and Automation than in any other single reference. (I referenced it frequently.)

My renewal is attached. Congratulations again on a fine job.

THE HAZARDS OF CONTRACT PROGRAMMING

(Continued from page 31)

g. If changes are required, obtain in advance fixed price estimate of their cost;

h. Avoid use of part-time or "moonlighting" personnel as part of the contract;

i. Insist on the right to approve changes in personnel, or any other contract terms;

j. Draw a contract, or make reference to the detailed proposal in a letter of acceptance;

k. Prior to final payment, establish an acceptance test, and insure that personnel will be available after the system goes into operation;

l. Compel the contractor to define, in advance, the *methodology* and *standards* to be used in the project;

m. Provide contractually that the programs and all documentation become the sole property of the user;

n. Assure that information obtained by the contractor during the contract will be kept confidential;

o. Insure that maximums are defined for user responsibilities, such as test time;

p. Above all, choose to deal with organizations whose reputation, references, and personnel qualifications are impeccable.

Dick H. Brandon
Contributing Editor

c & a CAPITAL REPORT

A Special Report from C&A's Washington Correspondent

How far should an author's rights extend when he has a copyright on information contained on magnetic tape?

This is one of the problems that U.S. legislators are now facing in their efforts to overhaul our ancient copyright laws. It has also received attention from the electronics industry in the form of a statement to Congress by the Electronic Industries Association. EIA is worried that proposed legislation would make it illegal to process copyrighted information on magnetic tape for any purpose without paying a royalty to the author. It has asked Congress to write into the legislation amendments to allow two situations:

1. A person should be able to print out copyrighted information from magnetic tape in order to see if it contains a usable mathematical formula.

2. A person should also be able to examine this information via computer print-out to see if he wants to incorporate it into an information retrieval system.

On the first point, EIA said the public is free to copy a mathematical formula from a copyrighted book and should also be free to do so from a computer program, which is basically a series of mathematical formulas in the form of instructions to a computer.

The objective of copyright laws is the dissemination of information, EIA said, and this objective is frustrated if a person who lawfully obtains a copyrighted magnetic tape cannot reduce it to intelligible form to see if it contains a usable formula. The ideas on such a tape are not ascertainable without a print-out of the work in visual form. If no intelligible copy could be made, such a meduim of expression could be substantially maintained in secrecy.

On the second point, EIA said a copyright owner should not be allowed "to thwart the public interest involved in the progress of information retrieval." Its suggestion that a person be able to look at a print-out without paying royalties "does not significantly impair the profit of the copyright owner . . . since it is intended that he will be compensated for both the purchase of the work and thereafter for any print-outs made by the machine."

Printing out a program before you decide to buy it is no different than a person examining books in a library to determine which ones he is not interested in, EIA said, but "some authors apparently feel they should be entitled to a fee every time the copyrighted work is processed by the computer."

The success of the Government's computer-sharing program has been "most gratifying," according to the General Services Administration, which administers the program. GSA recently told Congress that sharing exchanges have been established in 12 large cities and another is planned.

Under this program an agency needing additional computer time or resources can go to GSA for information about available time on nearby equipment. Agencies without computers may arrange to have their work done on a reimbursable basis.

GSA said several agencies are operating the sharing exchanges, such as the Veterans Administration in Philadelphia, the U.S. Navy in Los Angeles, and the National Bureau of Standards in Washington, D. C.

"In the Denver exchange," GSA said, "over 21 Federal agencies and government contractors have made use of the facilities. Among the users are the Forest Service, the Air Force, the Geological Survey, Bureau of Land Management, Bureau of Public Roads, the National Park Service, Federal Bureau of Prisons, the Civil Service Commission, and the Bureau of Reclamation. We are also participating with the Budget Bureau in a study of the need for regional Federal data processing centers to establish equipment and resource pools to serve agencies on a geographical basis."

President Johnson recently declared a "War on Waste." One of the first things government agencies did was to total up savings they have achieved by using computers in business management.

Internal Revenue Service said that on 1964 individual income tax returns people reported $2 billion more in interest income than they did on 1963 returns. This is an increase of 28 per cent, and IRS credits the use of computers and the public's awareness of what they can do for most of the increase, although its computers processed individual returns from only one of seven regions last year. IRS also reported additional taxes of $8.6 million from tax delinquent businesses, this time from four regions covering half the nation. When it first began to process business returns in 1962, it uncovered $3.6 million from these businesses in the Southeast Region alone. All business returns are now on IRS computers and all individual returns will be by 1967.

The Department of Agriculture recently reported to the President that its computers are saving the Government $7 million each year. One example it gave concerns preparation of the Agriculture payroll by one computer at an estimated savings of $500,000 a year. This task used to be done by 87 separate payroll offices in Agriculture.

Computer manufacturers submitted proposals to the Department of the Army in May for replacing hundreds of punch card accounting machines now in use at various Army installations. The initial contract will call for about 60 small computers. There is also a possibility that a year or two from now these computers will either be replaced by larger computers or will have compatible equipment added to them to make up more powerful configurations.

Army said the computers will have a central processor with card input and card and line-printer output. This is the same-

size system that the Air Force is currently installing by way of a contract awarded to Burroughs in 1964. When the Air Force accounting machine replacement is complete, Burroughs will have installed 151 computers around the world. Army is expected to award its contract sometime in July.

It might seem from this activity that the entire Department of Defense is getting rid of its punch card accounting machines, but the Navy still has a considerable number. One reason may be that it has not centralized EDP requirements and selection as its sister services have, but leaves this up to the individual Navy bureaus.

The National Institutes of Health are setting up a new Division of Computer Research and Technology in Bethesda, Md., to offer central computing facilities to the various health institutes that come under its authority. The NIH budget has been increased by $1,250,000 by the House Appropriations Committee to finance the new division.

There is a possibility that NIH will set up within this division a time-sharing computer system with remote input/output terminals in laboratories and offices; however, no decision has been made yet. NIH currently has two Honeywell 800 systems, one Honeywell 200 and one IBM 1620. If it sets up a central time-sharing system, it will probably contract for another large computer.

In addition to the above services the new division will: assist in processing information re health grants; apply computers to X-ray interpretation and to automatic analysis of laboratory specimens; test blood samples; retrieve and correlate laboratory data; and build mathematical models of biological processes in order to better control studies that cannot be carried out by ordinary laboratory or clinical procedures.

Congressman John E. Fogarty of Rhode Island said recently in the House, "The computer is destined to become as important an adjunct to the operating room as the X-ray machine. The facilities at NIH and the broad competence of its staff furnish an excellent setting for developmental work in this very promising new field."

As part of the Public Health Service, the National Institutes of Health support programs in its nine institutes to obtain new scientific knowledge in order to control especially the major killing and crippling diseases of today, such as cancer, heart disease, arthritis, dental and neurological disorders, and mental illness.

Cooperation between Federal and State governments in the use of computers will probably get a push this year from Congress. In a recent speech, Representative Arnold Olsen of Montana said that the Budget Bureau should give overall guidance to State agencies, possibly through a Federal-State EDP committee.

The Federal Government has a good deal more experience in EDP than the average State government. As Olsen told state and local government officials:

"There is every good reason for making this experience available to the States and local governments. It would be unfortunate if you were to spend long hours, or even days, weeks, and months, covering ground the Federal Government has already been over and resolving specialized problems all over again, and even more unfortunate if the States and cities were to repeat the mistakes the Federal Government has made and only partially rectified so far."

The push for cooperation will probably come as a result of hearings that will be held in the House of Representatives, mostly likely by the Post Office and Civil Service Committee, on which Olsen serves. This is a thorough committee; its recommendations following hearings usually bring about changes. We expect this will happen when it looks into the use of computers by both Federal and state governments.

CALENDAR OF COMING EVENTS

Aug. 13-14, 1965: 8th Annual Northwest Computer Conference, Olympic Hotel, Seattle, Wash.; contact Grant W. Erwin, Jr., Box 836, Seahurst, Wash.

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., 1965: International Symposium on Economics of Automatic Data Processing, Rome, Italy; contact Symposium on Economics of ADP, International Computation Centre, Casella Postale No. 10053, Rome, Italy

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

Oct. 10-16, 1965: 1965 Congress of the International Federation of Documentation (FID), Sheraton Park Hotel, Washington, D. C.; contact Secretariat, 1965 FID Congress, 9650 Wisconsin Ave., Washingon, D. C. 20014

Oct. 19-22, 1965: Symposium on Economics of Automatic Data Processing, Rome, Italy; contact International Computation Centre, Viale della Civilta del Lavoro, 23, P.O.B. 10053. Rome, Italy

Oct. 20-22, 1965: Fall Conference of the H-800 Users Association, Jung Hotel, New Orleans, La.; contact John D. Kearney, Conference Chairman, NASA Michoud Operations, P. O. Box 29300, New Orleans, La. 70129

Oct. 21-23, 1965: IFAC/IFIP Symposium on Microminiaturization in Automatic Control Equipment and in Digital Computers, Munich, Germany; contact Verein Deutscher Ingenieure — Abt O, P.O. Box 10 250, Düsseldorf, Germany

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

TABLE OF CONTENTS

APPLICATIONS

THE COMPUTER IN STRUCTURAL DESIGN

The John Hancock Center in downtown Chicago (Ill.) is scheduled for completion in 1968. This structure grew out of the combination of men and machines working together. Structural engineers and designers from the national architectural firm of Skidmore, Owings & Merrill (Chicago) joined forces with an IBM computer to develop plans for the functional high-rise project, which has an announced cost of about $95 million. The building will provide apartments, offices and shops, and will be 100 stories high — the tallest apartment building and the second tallest office building in the world. Thirty-four stories will be used for offices and 49 for "apartments in the clouds". The remaining floors will house lobbies and shops, utilities, restaurants and parking.

Chief structural engineer for Skidmore, Owings & Merrill, E. Alfred Picardi, said that by using structural design programs developed by S. O. M. engineers for the computer, the architectural firm was able to "speed up design work, eliminate errors associated with manual computation, explore all possible solutions to the design problem, and then refine the final solution for maximum economy and efficiency in construction. Effective use of the computer's speed helped to compress perhaps three years' work into five months".

One of the most important benefits of a computer is that it frees engineers from tedious mathematical calculations, giving them time to concentrate on the development of analysis systems and the more creative planning aspects of the job. The IBM 1620 system at Skidmore, Owings & Merrill enables its engineers to quickly execute advanced stress analyses, some of which are so complex they couldn't be solved without the computer's help. Perhaps of equal importance, electronic data processing optimizes the engineer's performance by allowing him to explore many more alternative solutions in seeking the best possible answer to a given design problem.

The final plan for the John Hancock Center is the most dramatic example to date of the importance of the computer in structural design, according to Dr. Fazlur Khan, project structural engineer for the Center. The towering skyscraper "probably could not be built as envisioned" without the high speed, problem-solving capability of the computer which permitted use of highly sophisticated structural analyses, he said. The intricate structural steel framework, for example, will weigh only about 32 pounds per square foot. If designed by conventional methods, the weight would have been closer to 50 pounds per square foot.

Dr. Khan said methods of solving the mathematics involved in the stress analysis have long existed, but humans could not cope with the vastness of the problem. For example, one vital step in the analysis was a set of 1500 simultaneous equations. This step would take one mathematician working regular hours several hundred years.

The computer also was a valuable asset to architect Bruce Graham, who used it to assist him in arriving at the most rational solution to his design problems. "More than 30 structural possibilities were examined in developing the best kind of building for the occupants and for the city," he said. "The computer quickly gave us information about which designs were the most practical."

Using this information, the architect finally developed a steel and glass tower which tapers slightly from the bottom to the 1100 foot summit. The base is 41,000 square feet and the top 17,000 square feet. Exterior diagonal braces will be used, providing strong but open structural support.

Mr. Picardi also pointed out that the use of computers by Skidmore, Owings & Merrill is not experimental in nature. The IBM system also was used to design more than 50% of the total structural work at the Brunswick and Equitable Buildings and Gateway Center project (three recently-completed Chicago high-rise office buildings). In addition the firm has used this technique on a number of other buildings throughout the country.

Newsletter

U. S. PAVILION HAS A REMOTE ELECTRONIC LIBRARY CENTER

LIBRARY/USA, the American Library Association's exhibit in the United States Pavilion at the World's Fair is one attraction that can be visited without actually going to New York. It can be enjoyed in most cities and towns throughout the United States and abroad as easily as dialing the telephone.

New this year, the exhibit becomes the first remote electronic library center ever to be established. Essays and lists may be received by librarians, teachers, students and others anywhere in the country through the use of the standard national teletype TWX dial network equipment which exists in most schools, libraries and in many public buildings and private businesses and industries.

The exhibit has a $1.5 million Sperry Rand UNIVAC information storage and retrieval system, an electronic computer, which provides information in the form of 700-word essays and annotated reading lists on 75 subjects ranging from "Space Age" and "Peace Corps" to "Automation", "Population Explosion", and "Equal Rights". Essays have been prepared by the editors of Encyclopaedia Britannica. Professional librarians have prepared the annotated reading lists in five levels: elementary, young adult, adult, college-popular, and college-research.

By employing teletype equipment locally, the computer in the LIBRARY/USA exhibit at the World's Fair may be dialed, and essays, reading lists or periodical indexes will be printed out on the local teletype machine in a matter of minutes. The system will be available for requests at any time between 10:00 a.m. and 10:00 p.m., seven days a week, through October 17th.

A directory listing teletype numbers and code numbers for specific information stores in the system has been prepared for distribution to libraries, schools, news media, and other institutions which would find the information service helpful.
(For more information, designate #41 on the Readers Service Card.)

COMPUTER SCORECARD KEEPS DAILY CHECK OF BILLS FOR FLORIDA LEGISLATORS

Florida legislators now are using one of the most comprehensive daily "scorecards" ever developed to help them keep track of the more than 3000 bills considered during each session of the State Legislature — from introduction to final outcome.

The computer-produced reports, available on an overnight basis, provide a readily accessible review to all floor and committee actions the day before, a complete history of all bills in the legislative hopper, and a ready reference index of all bills by subject and number. These fast, convenient guides to all activity in the Florida Legislature are prepared and printed electronically by an RCA 301 computer system. Preparation of one series of daily reports requires approximately two hours of computer time a day, leaving sufficient time for the computer to perform its regularly scheduled computer applications.

J. Ed Straughn, Director of the Florida Revenue Commission, said the Florida Legislature has been using the Revenue Commission's RCA 301 computer system since the start of the present session on April 6. "The overnight report is believed to be the most comprehensive legislative indexing function ever undertaken at any level of government, and should result in a more effective and efficient session," according to Mr. Straughn.

The over-all report consists of a subject index of all bills introduced to-date, printed out in alphabetical sequence showing the major subject classification, subclassifications to speed reference, and bill number. This is followed by the "scorecard" which includes the number, title and sponsors of all bills, plus all transactions that have been taken since introduction. Finally, the computer lists each legislator by name and bills by number which he sponsored or co-sponsored.

Prior to the daily computer reports, members of the House and Senate desiring immediate information about a specific bill had to visit the office of the Chief Clerk of the House or the Secretary of the Senate — a time-consuming and often inconvenient task. More than 150 actions can be taken on a bill during its progress through the legislature.

Mr. Straughn pointed out that the daily reports by computer were developed at the request of the legislature as a means of keeping its members in closer touch, day-by-day, with all actions taken by their colleagues.

Key to the overnight reports is a three and four-digit numerical code specially designed for this application by computer specialists at the Revenue Commission and RCA, guided by the expressed needs of the lawmakers themselves. The team of computer programmers began by assigning code numbers to each member of the House and Senate, to each standing committee in both houses, to approximately 180 actions which are repetitive and applicable to most bills, and to 475 major legislation categories, ranging from accountants to worthless checks.

Coded information on new bills, including names of sponsors, description of the bill, and the bill number, is entered in the computer the morning the bill is scheduled for introduction, so all basic data is prerecorded for updating the overnight report. By using the numerical codes and standard reporting forms, the clerks who review bill action during each session need only enter the proper code number on the form, which then goes to a keypunch operator, and then into the computer's memory. All coded information covering the day's session is available between 4 and 5 p.m. on a normal day. A half-hour later the overnight report is emerging from the computer's printer.

Immediately at the conclusion of the session, the data processing system will provide a master list of all bills and their success or failure.

FIRST COMPUTER TELEMETRY SYSTEM NOW IN OPERATION IN WASHINGTON STATE

The electric utility industry's first integrated computer/telemetry system which time shares the computer as part of the telemetry equipment now is in operation at the Public Utility District No. 1 of Chelan County, located in Wenatchee, Wash. The system, installed by the Westinghouse Power Control Division, includes a Prodac® 510 computer, operator's and programmer's consoles, high-speed, solid-state digital teleme-

try and data collection equipment, and analog load frequency control equipment.

Any six of thirteen generating units at the Rock Island and Rocky Reach plants on the Columbia River can be selected for control by a combination of digital and analog control. Plant base load generation requirement is determined by a digital load frequency control program stored in the computer, and is dispatched via digital telemetry.

The telemetry and data collection system is under direct computer control and is used to update and transmit 123 pieces of data from these two plants (which have a combined peaking capability of nearly one-million kilowatts) for use by a number of on-line computer programs. Important on-line programs include load frequency control, actual and estimated encroachment, telemetry control, pondage accounting, scan, log and alarm, spill calculation, and operator's information programs.

The computer also can handle many off-line assignments such as running load flow programs. It has a core memory of 8196 words and a drum memory of 65,536 words.

The analog load frequency control equipment provides a local loop to control generation at each station. Its input is from the computer but manual operation at each station is provided.

AUTOMATED LABORATORY DATA HANDLING

A computer application that automatically evaluates hospital laboratory test results for accuracy and content has been successfully implemented at the University of Missouri Medical Center, Columbia, Mo.

School of Medicine officials have demonstrated a computer based system that: (1) evaluates laboratory tests for accuracy and content; (2) automatically reports the results of these tests to the proper patient floor; (3) stores in an electronic memory all information contained on each of these tests; and (4) has the capability of making any part of this accumulated data instantly available for teaching, statistical, diagnostic, and research purposes.

This advanced system includes IBM 1092 data transmission terminals located in each of the hospital's five laboratories, and an IBM 1410 computer with vast direct access memory capabilities.

This work is supported by a grant from the Bureau of State Services of the U. S. Public Health Service.

Dr. Donald A. B. Lindberg, assistant professor of pathology and director of the Medical Center computer program, explained how the new system operates:

"The laboratory data handling system subjects information from newly-completed tests to highly critical screening procedures. These involve factors such as age, race and sex of patient; previous patient diagnosis and relation of new test results to earlier ones; accepted normal range of values; relation to the frequency distribution of results at the Medical Center; and biological properties of bacteria and antibiotics.

Based on application of these limits to each test, the 1410 computer then:

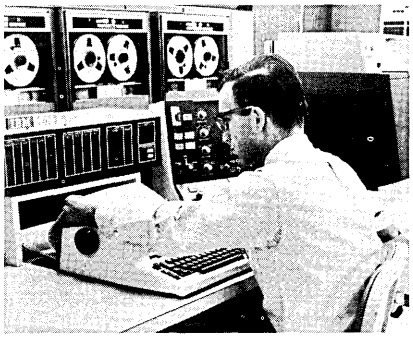
— Transmits each "normal" test result to one of nine printers located at nursing stations on patient floors. This data is for inclusion in the patient's bed chart.

— Transmits tests that exceed limits to the patient floors in the same manner, but also lists them each evening on a computer print-out for review by a pathologist.

— Transmits tests with highly abnormal, dangerous, or "preposterous" results directly to a reviewing station in the laboratory that made the test, but not to the patient floor. A resident pathologist checks each reviewing station periodically and, based on the data reported, he can visit the patient and/or order a test re-run. He may erase the previous test information from the computer simply by pushing a few buttons. Or, the resident can approve release of the test result to the patient floor, in which case it will be transmitted in the normal manner.

All cases at University Hospital, a 441-bed general hospital, are referrals — often patients with difficult medical problems. As a result the patients may be seen by a large number of doctors who often must order an unusually large number of lab tests — about 500,000 each year. "Consequently, the 'exception reporting' features of the IBM system relieve the institution's pathology laboratory directors of a tremendous burden of detail, pinpoint the patients whose problems require immediate review, and give the pathologists time to see them," Dr. Lindberg said.

Additionally, the system frees valuable time of other medical, technical and nursing personnel by speeding compilation, transmission and receipt of data. As one example of the project's time-saving features, Dr. Lindberg cited the three daily summaries of the laboratory operation that are automatically prepared by the system. They are: the previously described listing of abnormal results; a total recap of the daily work of the labs; and a listing for each out-patient clinic of the results of laboratory tests for patients treated in that clinic.



— Laboratory messages are processed by the IBM 1410 computer, controlled from its console. In the rear are magnetic tapes which contain the permanent memory of a wealth of information about each patient seen since the Medical Center opened in 1956.

Further, all lab data transmitted over the system are automatically added to a clinical laboratory file stored on magnetic tapes. Also stored in the computer are a radiology file, containing the physician's interpretation of each roentgengram since 1955; and an EKG file, containing some 60,000 electrocardiograms, coded by cardiologists according to 105 categories. These data are available to the faculty for diagnostic, research and teaching purposes.

Dr. Lindberg said: "The ability to constantly and automatically update the file of patient

Link

information, and provide ready accessibility to it, is probably the most important aspect of this computer-communications system. While computers have most frequently been applied in support of medical research, our program, as conceived by Dean Wilson, concerns itself with their use in medical practice and teaching."

COMPUTER USE IN POPULATION RESEARCH

A revolution in the studies of human populations may result through the application of computer capabilities. Nathan Keyfitz, Professor of Sociology at The University of Chicago, foresees such a development on the basis of research he and his colleagues are conducting on the University's Midway campus.

A team of demographers under Professor Keyfitz's direction is using the Univeristy's IBM 7094 computer to turn out population information for the nations of the world by methods more uniform and accurate than had been possible before the age of the computer. As a first step in producing comparable figures for different regions of the world, months were spent preparing a computer program which would make the necessary calculations from census data.

Altogether, 86 items of census information taken from such sources as the United Nations were fed into the computer for each of 69 different countries and regions. In three minutes and 34 seconds, the computer produced detailed life expectancy tables, population projections for the next 150 years, birth rates, death rates, and growth rates for all 69 regions. A skilled demographer, with a desk calculator, would take at least one month for each nation.

"What is important is not the speed of computation, but the fact that the results for all 69 regions are comparable," says Professor Keyfitz.

Demographers working with raw census data have developed many statistical measurements of population trends. Such calculations often have been done piece-meal. One expert, working with a desk calculating machine, might figure out the birth rate for a country; another might calculate life expectancy tables; a third might make projections of future populations. Sometimes, results calculated by different demographers have not been strictly comparable.

Demographers only recently have begun to use computers for basic calculations, and this is the first time such detailed calculations have been made for many of the areas included in the study, according to Professor Keyfitz.

The results of the study are contained in a 198-page booklet, Comparative Demographic Computations Based on Official (Unadjusted) Data for 69 Selected Countries and Regions, authored by Keyfitz and Edmund M. Murphy and published by the Population Research and Training Center at The University of Chicago.

Population expert, Philip M. Hauser, Chairman of the Department of Sociology, said, "We are just beginning to explore the uses of a computer in population research. We are about 10 years behind the physicists and four years behind the biologists in introducing this tool. However, I think that no future student of population will leave The University of Chicago without knowing how to program a computer."

NEW CONTRACTS

LINK GROUP RECEIVES $1 MILLION CONTRACT FROM EASTERN

General Precision's Link Group, Binghamton, N.Y., has received a contract in excess of $1,000,000 from Eastern Airlines for a flight simulator. The simulator will be for the Douglas DC-9 twin jet airliner, the advanced version of the Douglas short-to-medium haul aircraft, of which Eastern has ordered twenty-four. Deliveries of the advanced DC-9 will start in the fall of 1966. (To fulfill it's interim requirements, Eastern will lease fifteen standard DC-9's from Douglas.) The Link DC-9 simulator will be delivered to the airlines before the first of the advanced-model airplanes.

The simulator will utilize the new Link GP-4 digital computer, which will be programmed initially with predicted DC-9 flight data. However, as soon as actual flight data becomes available, Eastern will be able to update the simulator performance to reflect the actual aircraft performance by merely reprogramming the GP-4.

Eastern Airlines was the first in the air transport industry to acquire a digital flight simulator — the Link B-727. From September 10, 1963, through September 9, 1964, its first year of operation at Eastern, the Link B-727 simulator provided 3820 flight crew training hours even though several modifications were made on the simulator during that period.

BURROUGHS AWARDED $3 MILLION SUBCONTRACT

Burroughs Corporation has been awarded a $3,219,614 subcontract by the Martin Marietta Corporation's Orlando (Fla.) Division to provide digital computers for the U. S. Army's Pershing Missile Program. The computers, adapted to meet Pershing requirements, are based upon Burroughs recently announced D84 modular data processing system. They make extensive use of tiny monolithic integrated circuits to achieve a high degree of reliability as well as small size and weight.

The computers will form a central part of new, completely automatic weapon system ground support equipment called the Improved Programmer Test Station (IPTS). The new test station combines functions previously performed by other separate test subsystems. The IPTS will be used to perform tests, checkout and fire control functions at the firing site prior to launch of the Pershing missile.

Work on the computer system will be performed at Burroughs Defense and Space Group, Paoli, Pa.

ITT PARAMUS DIVISION AWARDED CONTRACT

A $1,672,000 contract for technical services in support of the Strategic Air Command Control System has been awarded to a New Jersey division of International Telephone and Telegraph Corporation. Dr. Norman E. Friedmann, president of ITT Data and Information Systems Division, Paramus, N.J., announced that a contract has been signed

with the Electronic Systems Division (Air Force Systems Command) to provide engineering assistance in connection with the system integration and test, operation and maintenance of the Strategic Air Command's Control System. The services will be performed for the Electronic Systems Division (Air Force Systems Command) and the Oklahoma City Air Material Area (Air Force Logistics Command).

IBM AWARDS MILGO ANALOG COMPUTER CONTRACT

Milgo Electronic Corporation, Miami, Fla., has been awarded a $224,000 contract for an analog computer system by IBM's Federal Systems Division, Huntsville, Ala. This system will be used in connection with IBM's contract with the NASA Marshall Space Flight Center for the integration of the instrument unit on the Saturn IB and Saturn V Programs.

The computer system delivered to IBM will represent the initial delivery of Milgo's new Model 4100 line of analog computers. Eight standard racks of equipment plus several external consoles for peripheral input and output equipment are included in the order.

HUGHES AIRCRAFT ORDERS $3.5 MILLION GE-635 SYSTEM

The Hughes Aircraft Company has ordered a large GE-635 central computing system valued at more than $3.5 million, Hughes and General Electric Company officials jointly announced. The giant direct-access computer will be employed to help solve complex engineering and scientific problems leading to the design and development of advanced missile and aerospace equipment. It is scheduled for delivery in May of next year and is due to go into operation at the Hughes airport site at Inglewood (Calif.)

The large G-E system will replace five computers now in operation at Hughes. Engineers and scientists will be able to have direct access to the system's computing powers without having to wait, as a result of its "on-line" capabilities. The GE-635 has a memory speed of one microsecond and in its Hughes configuration holds 131,000 words in core memory. There will be two central 635 processors working together to give the system twice its normal computing power. It also will have multi-programming capabilities.

NEW INSTALLATIONS

NEW COMPUTER TO GUIDE AND CONTROL FRENCH SEA-TO-AIR MISSILES

The first, on-board digital real-time computer of entirely French conception and construction, the BG-Ea system, has been presented to the French Navy by IBM France's military division. The BG-Ea system will be installed on two missile-launching frigates, the Suffren and Duquesne, which are equipped with MASURCA missiles. The project is the result of cooperation between IBM France's military division and the Technical Service of Naval Weapons Construction.

The computer performs the following functions as soon as radar registers enemy penetration: (1) choosing the targets to be attacked and the appropriate weapons to be used; (2) acquisition and tracking of the target by a remotely-controlled radar dish automatically correcting the roll and pitch of the ship; (3) aiming of the missile launching ramp; and (4) guiding the missile to the destruction of the hostile plane.

The military division of IBM France has, since 1956, been engaged in systems technology with France's three armed services. It is a member of Westinghouse NADGE Associates, the multi-national team formed to produce a large-scale air defense system for the NATO nations.

NASA BUYS ASI 2100 FOR HYBRID SIMULATION SYSTEM

The National Aeronautics and Space Administration has received an ASI 2100 digital computing system from Advanced Scientific Instruments, Minneapolis, Minn., a division of Electro-Mechanical Research, Inc. (EMR). The ASI 2100 is installed and operating in a hybrid computer system at the Computation Laboratory of NASA's George C. Marshall Space Flight Center, Huntsville, Ala. It is coupled to an analog computer to facilitate mathematical simulation of a wide range of aerospace systems and allied problems.

The system includes an eight-thousand-word memory, multidensity magnetic-tape system, line printer, high-speed punched-card equipment and input/output typewriter.

LARGEST NON-GOVERNMENT COMPUTER SYSTEM IN LA. AT TULANE UNIVERSITY

The largest non-government computer system in Louisiana has gone into operation at the Tulane University Computer Laboratory (New Orleans) on the main university campus. The new electronic data processing system, an IBM 7044, will be used for instruction and research. The 7044 is part of an expanding computer complex — known as the Tulane Computer Center — which also includes computers at the University's Biomedical Computing System in downtown New Orleans, and its Delta Regional Primate Research Center in Covington, La.

The Tulane $1.8 million IBM system includes a data channel device which operates independently of the processing unit and provides for problem solving by remote control. A smaller computer, such as the one at the Primate Center, can be connected with the 7044 through this device. It also may be used to feed information from such outside sources as telegraph or telephone lines into the 56 million character disk storage file while the main computer is processing other jobs.

TB AND HEALTH ASSOCIATION TO INSTALL H-200

A computer is among the newest recruits enlisted in California's battle to conquer tuberculosis and related respiratory diseases. The TB and Health Association of California, located in Oakland, has placed an order for a new Honeywell H-200 electronic data processing system to provide administrative and scientific research services for its statewide program.

The TB and Health Association, a non-profit organization, will use the H-200 system to support the fund-raising and research activities of country tuberculosis associations throughout California. Delivery of the system is scheduled for this month.

Newsletter

WESTINGHOUSE EDUCATIONAL EQUIPMENT DELIVERED TO STANFORD UNIVERSITY

Westinghouse Electric Corp. has delivered to Stanford University (Stanford, Calif.) one of the basic elements of a computerized teaching system — the audio equipment that enables the computer to talk to the students. The equipment includes a Westinghouse Prodac 50 computer system that controls the battery of 12 unique, random-access audio units. They are the first units of a complete line of computerized classroom equipment that Westinghouse expects to be marketing by next year.

Essentially, the 12 audio units are magnetic tape machines upon which verbal information is recorded. The tapes contain such information as lesson instructions, questions, and correct answers which are communicated to the student according to the directions programmed into the machine. Any student has access to any information on any tape.

The educational equipment will be used at Stanford's Institute for Mathematical Studies in the Social Sciences. The Westinghouse equipment will be incorporated into the Institute's existing computerized research facility.

AUSTRALIAN BANKING CORP. TO INSTALL COMPUTER SYSTEM

The Australian Commonwealth Banking Corporation will install a computer system at its head office in Sydney to automate customer and internal accounting. This initial installation — an IBM System/360 Model 30 — will automate the processing of 50,000 checking accounts and 300,000 savings accounts for the Corporation's Sydney offices and branches in the inner city area.

It also will process the Sydney office check clearing operations, stock and share registry accounting, and the bank's Australia-wide payroll requirements.

One of the main reasons for installing the system is the bank's ever swelling tide of checks. An average of 180,000 checks a day is now passing through the Sydney clearing branch alone. Rate of increase is from eight to ten per cent each year.

The coding of checks with magnetic ink characters, coupled with the introduction of the computer and IBM Magnetic Character Recognition equipment, will enable staff in one central location to handle the clearing and posting of checks much more efficiently than by the current decentralized methods. The system also will release bank personnel from the routine processing work associated with this section for employment in more interesting duties.

The installation at the Commonwealth Banking Corporation will include a central processing unit with 32,768 positions of core storage, two magnetic character readers, two high speed printers, a paper tape reader, a card read punch, four magnetic tape drives, and two disc storage drives.

Support groups of systems engineers and programmers will help the bank with its changeover to the computer, and with programming, testing and application development. The IBM Test and Educational Centre in Sydney will also assist the bank with the training of staff for the system and provide specialist courses in document handling techniques and the IBM 1419 Magnetic Character Reader.

PUERTO RICAN POLICE TO INSTALL COMPUTER

The San Juan Police Department, San Juan, Puerto Rico, plans to install an electronic system to keep track of criminal records and prepare transcripts for court use. Police Superintendent, Colonel Salvador T. Roig, said a National Cash Register 315 computer will be used to store complete, up-to-date records on all persons charged with criminal offenses and also will quickly provide transcripts of prior convictions.

The system is scheduled to be installed within the next eight months. During the interim period, arrangements have been made for NCR's Data Processing Center to assume charge of 4 million punched cards which contain the criminal records of about one million persons convicted of felony charges in Puerto Rico over the past 10 years. The data center will temporarily furnish criminal reports needed by the Police Department.

When the NCR 315 computer is installed at Police Headquarters, the criminal files will be transferred to magnetic cards in three CRAM (Card Random Access Memory) files. The computer system will include a high-speed printer which will produce complete transcripts of criminal records including name, place of birth, last address, type of offense, sentence, and dates of prior convictions.

STANFORD ORDERS LINC COMPUTER

The School of Medicine of Stanford University has purchased a LINC (Laboratory INstrument Computer) from Digital Equipment Corporation, Maynard, Mass., for use in the analysis of experimental data.

The Department of Pharmacology will use the computer on and off line. The data will come from evoked and spontaneous electrical activity in the nervous systems of mammals subjected to learning situations and to a variety of drugs of interest in the treatment of the mentally ill. The computer will be used with low-level, low-frequency biological amplifiers, analog tape systems, and operant conditioning equipment.

ORGANIZATION NEWS

OPTION PLAN ANNOUNCED FOR COMPUTER TIME BUYERS

A new method of selling computer time, expected to become the accepted trade practice for the computer industry, has been announced by Time Brokers, Inc., New York City. Called the TBI Standard Future Option plan, it provides Top Management the opportunity of knowing now what their computer time costs will be in the future — through the purchase of transferable options for time on specific configurations of computer equipment.

Time Brokers, Inc. will maintain a market in the copyrighted options by acting as brokers for those desiring to buy or sell. According to William P. Hegan, President, many companies want to sell time on their computer but heretofore have not felt there is

a stable, organized market in existence. With the new announcement, the user buys a series of four-hour, standard-configuration options to meet his monthly predicted needs. If he has planned his needs too high, he later sells the unused options at the market price. The options are supplied by companies with excess capacity. Time Brokers, Inc. acts as the agent in the sale, matching buy and sell orders. They also maintain all records of transfers and validate options if there is any question as to their authenticity when they are presented. Options not exercised during the month specified on their face expire.

Any computer showing wide acceptance can be listed by Time Brokers, Inc. Unusual configurations are sold on the next-larger model. The law of Supply and Demand is the controlling factor of prices. Bid and Asked prices will be publicized for TBI Standard Configurations by Time Brokers, Inc. Options are sold for 2.0% of the total price.
For more information, designate #12 on the Readers Service Card.)

SDS COMPUTERS TO BE MANUFACTURED IN ENGLAND AND FRANCE

Scientific Data Systems, Santa Monica, Calif., soon will become the first computer manufacturer to have its complete line of equipment produced and marketed overseas. SDS President Max Palevsky said that long-term agreements have been signed granting manufacturing and marketing rights for all SDS computers and related equipment to Compagnie Pour L'Informatique et Les Techniques Electroniques de Controle (CITEC), Paris, France, and The General Electric Company, Ltd., (GEC), Wembley, England.

Both companies, ranked as two of the largest electronic firms in Western Europe, will begin production of the SDS 92, 930 and 9300 computers in the near future. The SDS 910, 920 and 925 computers also will be available to customers of GEC and CITEC.

Mr. Palevsky said that approximately 25 per cent of the world market for computers currently exists outside the continental United States. He predicted that the international market will be equal to current domestic sales by 1970 and added that the new SDS agreements will provide the company with an opportunity to penetrate a significant segment of this market.

THREE-YEAR WARRANTY BY AMPEX CORPORATION

The first three-year warranty on computer tapes in the industry has been introduced by Ampex Corporation, Redwood City, Calif. The new warranty applies to certain Ampex magnetic tapes for RCA 301, UNIVAC II and IIa, IBM and IBM-compatible computers. Robert L. Pappas, vice president and general manager of the firm's magnetic tape division, said that the warranty, which is more than three times longer than any offered in the industry today, covers the new Ampex 832 and 838 long-wear, heavy duty tapes.

Ampex warrants that new magnetic tape from these lines will meet the company's published specifications, as measured on the first "read pass," and that it will be free of any defect in manufacturing workmanship for a period of three years from the date of shipment from the plant in Opelika, Alabama.

THOMPSON RAMO WOOLDRIDGE INC. CHANGES NAME TO TRW INC.

At the close of business April 30 the name of Thompson Ramo Wooldridge Inc. became simply TRW Inc. Shareholders voted the name change at their annual meeting.

The change was proposed by J. D. Wright, board chairman and chief executive officer of the aerospace, automotive and electronics firm. "For some time our corporate advertising has stressed the trademark initials 'TRW'," Chairman Wright said. "We believe that the company is becoming better known by these initials than by its full legal name. Thompson Ramo Wooldridge Inc. is difficult for many people to spell or pronounce. We feel that the shorter name will be easier for people to use and remember, and will result in improved recognition of the company and its capabilities..."

COMPUTING CENTERS

TIP (TECHNICAL INFORMATION PROGRAM) IS ADDED TO MAC

Scientists at the Massachusetts Institute of Technology have a computer at work scanning and searching the physics journals for them. The service called TIP for Technical Information Program, has been added to MIT's time-shared Project MAC IBM 7094 computer network as an experiment in computer help for scientists in keeping up with burgeoning scientific literature.

TIP already had been in use by several physicists and, incorporated into MAC it is available to the more than 300 present MAC users. Project MAC (for machine-aided cognition) is an experimental program, supported by the Advanced Research Projects Agency of the Department of Defense, aimed at exploiting computer time-sharing to enlarge the ways that computers can aid and reinforce men in their creative work. There are now more than 100 remote consoles scattered through the MIT community through which scientists have direct access to the central MAC computer.

TIP, developed under a National Science Foundation grant by Dr. Myer M. Kessler, Associate Director of MIT Libraries, has stored in memory citation data on some 35,000 articles that have appeared in 23 leading physics journals. Data includes authors, titles, bibliography, journal names, volumes and pages. TIP is capable of being considerably expanded to take into account increases in demands for service, additional journals, and new articles in the original journals. Physics article citations are being added at the rate of 1500 a month as new issues of the journals are published.

An especially attractive feature of TIP is that a person can use it without knowledge of, or even interest in, computers as such. TIP language is ordinary English with easily-understood abbreviations for journal names ("The Physical Review" journal to TIP, for example, is "phyrev"). Commands also are ordinary English words such as "search", "find", "list", "print", and "go".

TIP offers scholars help in several ways. A user who wants to know what new has been written in

some area of physics can go to a teletype machine near his office or laboratory, dial the computer and type out a few descriptive words and commands. The central computer goes through its stored memory of articles and rattles back on the teletype a list of citations in the area. The user does not have to give the computer a vast amount of detail to get citations back. The more sharply he defines his interest however, the more pertinent and less far-ranging will be his answers.

Users are not restricted to receiving readouts of citations organized by subject matter alone. Also available are citation lists organized by author, or by geographic location of authors, by dates of publication, or by common bibliographic references.

Another TIP service is automatic order filling. Users are able to tell the TIP system their own areas of special and continuing interest. Then, as new articles in the specified areas appear, the individual users are notified of the citations.

Still another TIP service is automatic notification to MIT scientists about new articles that quote their own earlier published work. When a new article shows up citing a researcher at MIT, the T TIP system is prepared to type out a note to that person all addressed and ready for mailing. Dr. Kessler calls these notes "MAC TIPS".

In organizing and indexing the articles in memory, TIP takes advantage of a new technique called "bibliographic coupling". It is based on the idea that articles can be grouped and classified, in part, through cross references they make to each other in their bibliographies.

Dr. Kessler himself was one of the many MAC users in the process of developing TIP. MAC and its users will form TIP's experimental laboratory setting. As such, TIP become's one of MAC's first generalized "public" services for all users.

MORE THAN 250 COMPUTERS EXCHANGE DATA AS PART OF COAST TO COAST NETWORK

More than 250 electronic computers across the nation now can exchange work and information as part of a communications network placed in operation by IBM Corporation. The network links computing centers at 16 IBM plant, laboratory and headquarters locations from Boston to Los Angeles. Data in machine language flows between the centers at a rate of 5100 characters a second.

IBM 7711 data communications devices, at each location, make possible the high-speed flow of information. The 7711 sends data between magnetic tape units over long distance communications facilities, and also allows a magnetic tape unit in one location to communicate with a computer in another location.

Among the first jobs to be handled by the network is the balancing of computer workloads. A job to be processed is flashed from a busy location to one with an available computer. The results are returned almost as if the computer doing the work were in the same room.

A second job being handled is the transmission of engineering information from IBM's development laboratories to its plants. All engineering design data developed within the company is expressed in a standard numerical format which can be readily transmitted over the network. Each plant, in turn, incorporates this design information into its own manufacturing procedures.

Other planned uses of the network include the centralized processing of vital financial data, the establishment of an up-to-the-minute company-wide personnel file and the consolidated processing of IBM customer orders.

The IBM computing centers in the communications network are in Los Angeles and San Jose, Calif.; Washington, D.C.; Chicago, Ill.; Cambridge, Mass.; Rochester, Minn.; Armonk, Endicott, Harrison, Kingston, Mohansic, New York City (two locations), Poughkeepsie and White Plains, N.Y.; and Mechanicsburg, Pa.

EDUCATION NEWS

POSTGRADUATE DEGREE PROGRAM IN BIO-COMPUTER SCIENCE

A postgraduate degree program in bio-computer science, one of the first in the world, will be offered starting this fall through the Goddard Computer Science Laboratory of Wadley Research Institute and Blood Bank. The degree program, leading to the master of science in bio-computer science, will be part of the postgraduate education curriculum of the Graduate Research Institute of Baylor University, Wadley, Texas.

Only five other postgraduate schools in the world offer advanced degrees in pure computer science. There are only a few other degree programs in bio-computer science, which is a new and rapidly-growing field concerned with applying computer technology to medical problems.

Graduate students will work with the laboratory's IBM 1620 computer and related computer instruments in such areas as rapid calculation of medical and research information, statistical analysis, and storage and retrieval of medical data.

'JOIN' YOUNGSTERS VISIT DECISION SYSTEMS

Decision Systems, Inc., Teaneck, N.J., recently played host to a group of young people whose education has been interrupted. The young visitors went there under the auspices of JOIN (Job Orientation in Neighborhoods), a New York City job preparation and placement program assisting members of minority groups.

Thomas A. Wood, president of Decision Systems, explained to the group some of the qualifications for working in the "big, broad and growing field of data processing".

In the computer room, Mr. Wood, himself a negro, showed some of the things a computer does to (from Mr. Woods' left) Max Tollens, 21; Dolores Halcomb, 17; Gloria Rivera, 18; and Lydia Cruz, 21.

Mr. Wood told his visitors, "There are many positions open in

data processing and anyone who studies hard to acquire the necessary skills can qualify. Even school dropouts can fill the gaps in their education and go on to handle many well-paying technical and clerical tasks in the computer field. It is a most attractive environment, offering as many opportunities for women as for men."

CONTROL DATA INSTITUTE

William C. Norris, President of Control Data Corporation, has announced the establishment of a computer training school known as Control Data Institute. He said that the Institute will be an integral part of Control Data Corporation and will operate on a tuition basis. Site of the Institute will be in the Minneapolis/St. Paul area. The purpose of the Control Data Institute will be to train high school graduates to qualify for positions as electronic technicians in the computer industry.

Elaborating on the need for establishing Control Data Institute, Mr. Norris said that "the computer industry is the greatest growth industry yet, as nowhere in industrial history can one find a comparable one if a composite of size, rate of growth and ultimate potential is considered. At the present time, the needs and projected new applications for computers make it impossible to predict a plateau for it, so employment in the industry will continue to grow for many years."

By way of illustrating Control Data's continued efforts to obtain talented people, Mr. Norris referred to the Company's intensive recruiting program carried out on the campuses of the nation's colleges and universities. He also cited the hundreds of courses taught by Control Data each year to keep its employees abreast of the latest developments in the computer industry. "In many cases," he said, "these courses for our employees are taught by key Control Data engineers, whose experience and creative imagination are today responsible for many advances in computer technology." Many of the engineers who design and build Control Data computers also will conduct classes in the Institute.

Swen A. Larsen, formerly President of the Institute of Computer Technology, has been named to the post as Director of Control Data Institute. He said that students of the Institute will work with Control Data's computer systems and will use the latest instrumentation equipment in laboratory work. In addition, students will receive instruction in writing computer programs.

The course work will prepare graduates for positions as engineering/electronic technicians. Upon completion of the course work, graduates of Control Data Institute will exercise complete freedom to seek employment wherever they choose. However, Mr. Larsen indicated that Control Data would offer employment opportunities in the U. S. and overseas for many of the graduates.

Control Data Corporation will provide many part-time jobs each year to students who, upon making application, can qualify. These part-time jobs will enable qualified students to defray some of their expenses, and to work in an atmosphere and on the type of equipment which they will encounter after graduation.

Classes of Control Data Institute will begin in September, 1965, with the length of the course being approximately one year in duration. Present plans call for other beginning classes to follow at 60- to 90-day intervals.

The Institute will meet all provisions of Minnesota law with respect to private schools.

Requests for additional information and application blanks should be directed to the Registrar, Control Data Institute, 8100 34th Avenue South, Minneapolis, Minn. 55440.

NEW PRODUCTS

Digital

DDP-124 ANNOUNCED BY COMPUTER CONTROL

The DDP-124, a new 24-bit word computer constructed with monolithic integrated circuits, has been announced by Computer Control Company, Inc., Framingham, Mass. The microcircuit computer, designed to offer price, size, reliability and performance advantages inherent in integrated circuits, employs 3C's new module line of μ-PACS (see Computers and Automation, May, 1965, p. 62).

The DDP-124, fully parallel, may be applied to a variety of on-line, real-time system uses, as well as general purpose open shop computation. It is capable of 285,000 computations per second, has a basic memory cycle of 1.75 microseconds with 0.8 microsecond access time, and multiplies in 14 microseconds. The new 3C computer includes 4096 words of core memory optionally expandable to 32,768 words. It is program compatible with 3C's DDP-24 and DDP-224 general purpose computers.

The DDP-124 extends capabilities and price spectrum of 3C's general purpose computer family which includes the DDP-116, DDP-24, and DDP-224 computers. This new computer will be available after the first of the year.
(For more information, designate #43 on the Readers Service Card.)

BURROUGHS E1100 ELECTRONIC COMPUTING-ACCOUNTING MACHINE

Burroughs Corporation, Detroit, Mich., has demonstrated its new E1100 Electronic Computing-Accounting Machine, which combines a keyboard familiar to most operators with solid-state electronics. The low-cost, high-output E1100 will multiply two 5-digit numbers in 1/20th of a second and stores frequently used factors such as tax, interest, and discount rates in a memory unit. The E1100 handles a wide variety of unit records and transaction journals. As many as 220 alpha and numeric characters can be printed on a single line.

In performance and price the new E1100 falls between Burroughs Sensimatic accounting machine lines and the E2100 Electronic Direct Accounting Computer introduced last year.

The E1100 keyboard is easy for new operators to use. Single or multiple forms are inserted quickly into the carriage and posting lines are always visible. Automatic decimal lights on the keyboard tell the operator exactly where to enter figures at each posting position. 'C' and 'M' keys allow the operator to enter

— E1100 Electronic Computing-Accounting Machine

to enter prices 'per hundred' and 'per thousand', and the decimal points are inserted automatically.

To provide maximum protection against operator errors, an internal audit control automatically will reject incorrect balances. Warning lights and safety locks assure that all electronic computations are complete and printed correctly.

A Program Control Center automatically guides the E1100 through all accounting functions. Four or more separate routines can be stored on each Control Center.

The E1100 also can be equipped to gather management data on punched cards or tape for low cost processing by home office computers or EDP service centers.
(For more information, designate #44 on the Readers Service Card.)

SYSTEM/360 — MODELS 65 AND 75

IBM Corporation, White Plains, N.Y., has introduced two powerful new models of System/360 — Models 65 and 75. These new models step up the computing power in the higher end of System/360's performance range.

Model 65 is designed to solve very large information processing problems. Its main memory ranges in size from 132,072 to 1,048,576 characters of information. It requires only 750 nanoseconds (billionths of a second) to retrieve eight characters from memory — an effective memory cycle time per character of less than 94 nanoseconds. It is possible to further improve the effective memory cycle time as much as 25% by interleaving Model 65's memory two ways. Model 65 provides substantially improved price/performance characteristics over the previously announced Models 60 and 62, which it supersedes in System/360.

The System/360 Model 75's main memory operates at 750 nanoseconds and will be available in three sizes ranging up to 1,048,576 characters of information. Its memory is interleaved up to four ways to obtain increased performance. Model 75 supersedes Model 70 in System/360.

In addition to announcement of Models 65 and 75, IBM is making available System/360 Model 67 on a special bidding basis. Internal operating speeds of the Model 67 are comparable to those of the Model 65. It, however, is designed to operate as a time-sharing system. Model 67 supersedes System/360 Models 64 and 66.

Deliveries of Model 65 are scheduled to begin in the first quarter of 1966. The new System/360 Model 75 will be delivered in place of the previously announced Model 70 starting in the fourth quarter of 1965.
(For more information, designate #47 on the Readers Service Card.)

ADVANCE SERIES EXPANDED FROM TWO TO FIVE SYSTEMS

Advanced Scientific Instruments, Minneapolis, Minn., has announced the development of three new computer systems — Advance 6050, 6070, and 6080 — expanding the Advance Series product line to five systems. Other members of the "family" introduced nine months ago by ASI are the Advance 6020 and 6040.

ASI's new systems are entirely modular in concept and have expanded processing capabilities. All systems are upward program compatible.

The Advance 6050 system includes double precision floating point hardware with floating point multiply execution times of 17.1 microseconds and floating point divide times of 28.5 microseconds. Input/output access directly to the arithmetic section as well as to memory is also featured.

The Advance 6070 system is designed for the rapidly expanding systems market. Multi-processing capability is provided by a high-speed arithmetic processor, in addition to the standard processor. Arithmetic operations are accomplished independently of, and simultaneously with, the main processor. System capability can be further expanded by the addition of auxiliary processors. Some sample processing times are: sine, 42 microseconds; square root, 48 microseconds; and arctan, 70 microseconds.

The Advance 6080 system is designed for time-shared operations, multi-programming capability and the use of remote stations. The system has memory protect by either hardware or software control, and hardware relocation.

All systems include monolithic integrated circuitry. Memory size can be expanded up to 32,000 words; word length is 24 bits plus parity. A wide choice of peripheral options is available.
(For more information, designate #46 on the Readers Service Card.)

ANNOUNCE MODIFICATION TO THE LOCI FAMILY

Wang Laboratories, Inc. of Tewksbury, Mass., has announced a significant modification to the LOCI LOgarithmic Computing Instrument family. These are keyboard controlled and programmable desktop computers. It is now possible to add either 2, 4, or 16 storage registers to the LOCI-1 keyboard controlled device (see Computers and Automation, January 1965, p.45), extending the capability and complexity of problems which can be handled on this equipment.

All LOCI-2a instruments are now being furnished with the sixteen storage registers in addition to the three existing registers. This increases the programming flexibility greatly without increasing the cost of the units.
(For more information, designate #49 on the Readers Service Card.)

PRODAC® 50 AND 550 DIGITAL CONTROL COMPUTERS

The new Westinghouse Prodac® 50 and 550 digital process control computer systems are designed to solve a full range of electric utility problems. The computers, manufactured by Westinghouse Electric Corp., Pittsburgh, Pa., use the same input/output hardware,

operating principles and packaging. This feature enables a utility to purchase a Prodac 50 computer initially and later make the conversion to the more powerful Prodac 550.

The Prodac 50 computer is a low-cost computer system designed specifically to handle on-line process control operations.

The Prodac 550 computer is a powerful computer system which meets the needs of utilities faced with fast-growing complexities in power generation, transmission, and dispatch, with adequate reserve for expansion of both on-line and off-line activities far into the future.
(For more information, designate #45 on the Readers Service Card.)

Memories

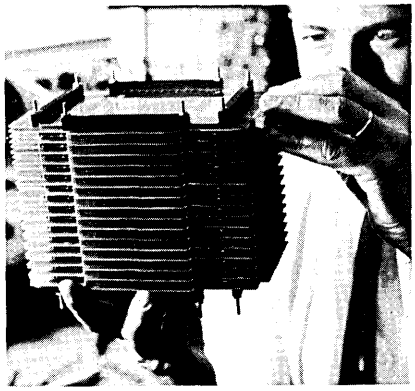
NEW DESIGN FOR ASSOCIATIVE MEMORIES

A unique computer-memory development has been outlined which would make it economically and operationally feasible to incorporate associative memories into military and aerospace computers. With associative-memory capability, high-speed memory searches within computers could be based on content or subject matter rather than being limited to locating data through specified "addresses".

The method by which this could be accomplished was covered in a paper presented in Dayton, Ohio, at the National Aerospace Electronics Convention (NAECON) by Dr. R. H. Fuller of the Librascope Group of General Precision, Inc., Glendale, Calif. Co-authors of the paper were Dr. J. C. Tu and R. M. Bird, also of General Precision/Librascope.

Dr. Fuller described a memory system that incorporates capabilities for light weight, high-speed operation, and reasonable cost — in addition to associative search capabilities — into airborne computers. These properties can be attained through the use of a new clothlike, woven plated-wire memory.

Fabricated with a process developed by Toko, Inc., of Tokyo, and licensed to General Precision/Librascope in the United States, this memory consists of stacks of thin-film, permalloy-coated copper wires interwoven with insulated wires and mounted in printed cir-



— Woven thin-film planes shown here in a 16-plane stack.

cuit panels. These memory planes provide extremely high-speed read and write capabilities. Reading can be done either on a non-destructive or destructive basis.

Operating characteristics of associative memory computers using these plated-wire planes include: (1) stored data may be located on the basis of content which is evaluated simultaneously over all stored words; (2) memory word content may be specified to be equal to, greater than, or less than a key word; (3) responding words (those satisfying a search) may be read out or may be rewritten in a bit-parallel mode; (4) for multiple reasons, words may be accessed sequentially for reading or writing; and (5) all responding words may be rewritten simultaneously (multiwritten) in some or all bits.

The potential cost advantage through the use of woven thin-film plated-wire memories can be substantial in comparison to other memories, Dr. Fuller said. This cost reduction can be even more decisive when volume production techniques, such as batch fabrication, are used.

Specific application areas suggested in the paper included: (a) visual pattern recognition; (b) solution of partial differential equations; (c) eling pulse train separation; and (d) information retrieval.
(For more information, designate #54 on the Readers Service Card.)

TWO NEW MEMORY DEVICES FROM GENERAL ELECTRIC

General Electric Company has announced two new memory devices — the DS-10 and the DS-15.

The DS-10 supplements the built-in memory of the company's Datanet-30 data communications processor in automating small teletype switching networks. The device uses removable magnetic discs the size of long-playing records. These may be changed in a minute or less. Each disc stores up to 1½ million characters of computer data. The DS-10 can 'read' or 'write' 190,000 computer characters a second and messages are available to the processor in an average of 445 milliseconds. Two disc drives and a controller are contained in a master unit. The controller will handle two additional cabinets, each having two-disc drives.

The DS-15, a random access storage device for the GE-400 family of computers stores 7.8 million characters on each removable disc. It permits users to begin using random access storage on a small scale, and is modular to permit expansion. Each disc holds as much data as that stored on 97,500 full-punched cards. Data is transferred at 259,000 characters per second. The read/write heads on both disc surfaces move to random positions in an average of 70 milliseconds. A single input/output controller can control up to eight disc drives and permits up to eight simultaneous seeks.
(For more information, designate #52 on the Readers Service Card.)

IBM 2314 DIRECT ACCESS STORAGE DEVICE

In addition to the introduction of two new models of System/360 (see New Products, Digital), IBM Corporation has announced a new information storage facility. The IBM 2314 direct access storage device combines the high capacity of large disk files with the faster access time and interchangeability of disk packs that are features of smaller files.

The 2134 has storage capacity of up to 414 million digits, an average access time of 75 milliseconds, and can transfer information to System/360 for processing at a rate of 312,000 characters a second.

The new pack (at left in the photo below) contains 11 magnetic disks with 18 information recording surfaces. It can store nearly 26 million characters — or 52 million digits. It is shown with

elements of two currently used disk files; the smaller pack is used with the IBM 2311 disk storage drive; and in the rear is an IBM 2302 disk storage unit.

The new direct access storage device is expected to play an important role in time-sharing and Tele-processing applications as well as in other business and scientific applications. The IBM 2314 is being manufactured at the company's San Jose, Calif., plant. Deliveries are scheduled to begin in the first quarter of 1967.
(For more information, designate #56 on the Readers Service Card.

RAPID ACCESS DISC FILES ANNOUNCED BY SDS

Two new Rapid Access Disc (RAD) files with storage capacities of more than eight million characters of information, have been developed by Scientific Data Systems, Santa Monica, Calif.

The RAD 9167 has a maximum storage capacity of 8,388,606 characters. Average access time is 17 milliseconds and the data transfer rate is 480,000 characters per second.

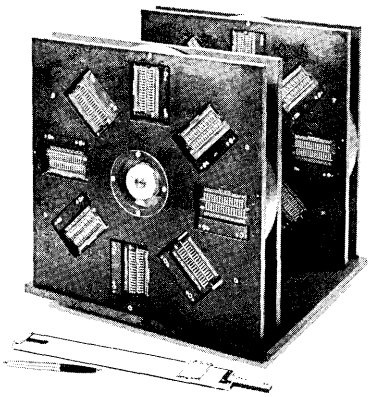
The RAD 9166 has an average access time of 34 milliseconds with a data transfer rate of 60,000 characters per second. RAD files consist of a Controller and from one to four storage units each of which contains four 12 inch discs. Rotating speed of the discs is 1800 rpm. A variable number of read/write head assemblies are supplied expanding the capacity of the storage unit from 524,288 characters to 2,097,152 characters.

The use of fixed read/write heads for every track in the RAD file reduces access time by eliminating the positioning delay associated with conventional movable-arm disc file. Rotational delay is minimized when large blocks of data are transferred through the use of a technique which initiates transfer at the current file location rather than at the beginning of the disc. As an example, this technique reduces the time required to transfer 4096 24-bit words from computer memory to discs from 50 to 35 milliseconds, a 30% time saving over conventional methods.

Delivery of RAD files is scheduled for the fourth quarter of 1965.
(For more information, designate #55 on the Readers Service Card.)

GENERAL PRECISION/LIBRASCOPE'S TWO NEW DISC-MEMORY SYSTEMS

Librascope Group of General Precision, Inc. (Glendale, Calif.) has developed two self-contained disc-memory systems ready for "plug-in" operation with computerized communications or control networks. The high-speed, high-density disc memories — Models L-414 and L-424 of the Series L-400 Magnetic-Disc Memory Systems — also are designed for use as original, on-line equipment in commercial or military computer systems.



— L-414 shown here is a modular unit designed for "plug-in" operation with digital communications and control systems or as a main-frame computer memory.

Capacity of the new memories ranges up to 27,033,600 bits for the largest L-424 configuration. The L-400 systems use two sizes of disc, 14" and 24", in accordance with standards set for other devices in the General Precision/Librascope disc memory line.

The L-414 is a two-disc memory with 512 tracks. The L-424 has 1024 tracks on two discs mounted on a common shaft, one at each end of a double-ended motor containing precision, preloaded bearings. Each individual track has its own aerodynamic read/write head which "floats" just above the surface on a cushion of air created by the rotation of the disc.

Series L-400 memory devices interface with the systems into which they are integrated through a variety of compatible circuits incorporated into the disc units to meet virtually any customer requirement.
(For more information, designate #57 on the Readers Service Card.)

Information Retrieval

ITEK INTRODUCES NEW FILM VIEWER

Itek Corporation, Lexington, Mass., has announced the availability of a new and versatile photo-interpretation device. The Variable Width, Rear Projection Film Viewer has a high-quality optical system, variable magnification, and a film handling system that moves the film at various speeds without damaging delicate image areas.

The viewer is specifically designed for quick and precise examination of projected enlargements of aerial photography. The device handles film widths ranging from 35 millimeters to 9.5 inches on reels up to 10.5 inches in diameter.

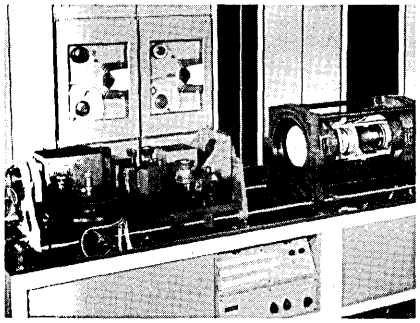
Four standard magnifications — 3X, 6X, 12X, and 30X — provide the photointerpreter a clear, exact screen projection which maintains an even, sharp image. Controls are located within immediate reach of the seated operator.

The viewer, currently in production, is offered as a basic unit to which specific options and modifications may be added.
(For more information, designate #61 on the Readers Service Card.)

AUTOMATIC FILM READER DEVELOPED BY III

A new type of automatic film reader is now available from Information International Inc., Cambridge, Mass. The new PFR-3 Programmable Film Reader is unique in that it speedily converts photographic data requiring very high degrees of resolution into fully processed digital form under program control. The new III film reader has a resolution 10 times that of its predecessor, the PFR-1.

With a spot size of less than .001 inch and a 3 inch by 3 inch Cathode Ray Tube (CRT) raster containing 16,384 by 16,384 addressable points, the PFR-3 is ideally suited for automatic film reading applications requiring very high degrees of resolution and accuracy such as aerial reconnaissance. It achieves its high resolution partly by integrating two of its components mechanically and electronically, these two being the Cathode Ray Tube (at right in photo) and the Optical-Mechanical Unit (at left in photo).



The first of the new PFR-3 Programmable Film Reader Systems will be used at the U. S. Government's White Sands Missile facility for the reading of radar and theodolite film. The system has among its applications the photo-interpretation of medical film, oil well log film, meteorological film, bubble chamber, star chart and satellite tracking film.
(For more information, designate #60 on the Readers Service Card.)

BUSINESS NEWS

ANELEX INCOME DROPS

Anelex Corp. disclosed that net income for the first half of their fiscal year was $389,651 compared to $529,986 for the comparable period last year.

The company said that engineering and sales were strengthened last year "in expectation of sizable contracts we believe are imminent", leading to the smaller earnings.

CAI UPS EARNINGS 50 PER CENT IN FIRST HALF

Net earnings of Computer Applications, Inc. during the six months ended March 31, 1965, climbed 50 per cent above the year-earlier figure, the company reports.

Net profit for the period reached $229,800. This compares with the year-ago figure of $135,000. Revenues for the first six months of this fiscal year total $4,084,000, more than double the volume of $1,841,000 posted a year ago.

MAI INCREASES REVENUES SHARPLY

Management Assistance, Inc., reports total gross revenue for the six months ended March 31 reached a record $4,207,758, as against $1,725,528 for the same period last year. Net income rose to $324,019 from $139,829. The company specializes in renting and servicing data processing equipment.

COLLINS UPS EARNINGS

Earnings of $2,654,000 on sales of $197,080,000 for the nine months ended April 30, 1965 are reported by Collins Radio Company. Comparable results for the same period the previous year were earnings of $1,902,000 with sales of $204,617,000.

Backlog at April 30, 1965 was $261 million compared to $204 million a year ago and $262 million at the beginning of this fiscal year.

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 well 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.

In general, manufacturers in the computer field do not officially release installation and on order figures. The figures in this census are developed through a continuing market survey conducted by associates of our magazine. This market research program develops a documented data file which now covers over 80% of the computer installations in the United States. A similar program is conducted for overseas installations.

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

AS OF JUNE 10, 1965

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTALS	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	22	2
	ASI 2100	Y	$3000	12/63	6	0
	ASI 6020	Y	$2200	4/65	1	4
	ASI 6040	Y	$2800	7/65	0	4
	ASI 6050	Y	$3000	10/65	0	1
	ASI 6070	Y	$3500	10/65	0	0
	ASI 6080	Y	$4000	1/66	0	0
Autonetics	RECOMP II	Y	$2495	11/58	57	X
	RECOMP III	Y	$1495	6/61	15	X
Bunker-Ramo Corp	BR-230	Y	$2680	8/63	14	1
	BR-300	Y	$3000	3/59	40	X
	BR-330	Y	$4000	12/60	35	X
	BR-340	Y	$7000	12/63	18	3
	BR-530	Y	$6000	8/61	15	X
Burroughs	205	N	$4600	1/54	57	X
	220	N	$14,000	10/58	44	X
	E101-103	N	$875	1/56	167	X
	B100	Y	$2800	8/64	44	30
	B250	Y	$4200	11/61	100	7
	B260	Y	$3750	11/62	170	100
	B270	Y	$7000	7/62	138	26
	B280	Y	$6500	7/62	75	24
	B370	Y	$8400	7/65	0	30
	B5000/B5500	Y	$20,000	3/63	37	12
Clary	DE-60/DE-60M	Y	$525	2/60	324	3
Computer Control Co.	DDP-19	Y	$2800	6/61	3	X
	DDP-24	Y	$2500	5/63	58	15
	DDP-116	Y	$900	4/65	4	25
	DDP-224	Y	$3300	3/65	4	35
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	410	4
	924/924A	Y	$11,000	8/61	28	1
	1604/1604A	Y	$38,000	1/60	60	X
	3100	Y	$7350	12/64	10	35
	3200	Y	$12,000	5/64	31	23
	3300	Y	$15,000	7/65	0	37
	3400	Y	$25,000	11/64	3	16
	3600	Y	$58,000	6/63	31	14
	3800	Y	$60,000	5/65	0	18
	6400	Y	$40,000	12/65	0	2
	6600	Y	$110,000	8/64	4	8
	6800	Y	$140,000	4/67	0	1
Digital Equipment Corp.	PDP-1	Y	$3400	11/60	60	2
	PDP-4	Y	$1700	8/62	55	2
	PDP-5	Y	$900	9/63	110	5
	PDP-6	Y	$10,000	10/64	8	10
	PDP-7	Y	$1300	11/64	11	50
	PDP-8	Y	$525	4/65	9	160
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	24	X
Electronic Associates, Inc.	8400	Y	$7000	6/65	0	5
Friden	6010	Y	$600	6/63	211	201
General Electric	115	Y	$1375	12/65	0	85
	205	Y	$2900	6/64	22	18
	210	Y	$16,000	7/59	56	X
	215	Y	$6000	9/63	49	6
	225	Y	$8000	4/61	140	4
	235	Y	$10,900	4/64	44	9
	415	Y	$7300	5/64	54	90
	425	Y	$9600	6/64	30	52
	435	Y	$14,000	10/64	10	25
	625	Y	$41,000	12/64	3	18
	635	Y	$45,000	12/64	3	20
General Precision	LGP-21	Y	$725	12/62	143	X
	LGP-30	semi	$1300	9/56	425	X
	RPC-4000	Y	$1875	1/61	98	X
Honeywell Electronic Data Processing	H-120	Y	$2600	12/65	0	150
	H-200	Y	$4500	3/64	475	360
	H-400	Y	$8500	12/61	120	10
	H-800	Y	$22,000	12/60	80	11
	H-1200	Y	$6500	2/66	0	30
	H-1400	Y	$14,000	1/64	11	3
	H-1800	Y	$30,000	1/64	9	11

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTALS	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Honeywell (cont'd.)	H-2200	Y	$11,000	10/65	0	40
	H-4200	Y	$16,800	2/66	0	5
	DATAmatic 1000	N	$40,000	12/57	3	X
IBM	305	N	$3600	12/57	185	X
	360/20	Y	$1800	12/65	0	2500
	360/30	Y	$7500	4/65	40	2250
	360/40	Y	$16,000	4/65	45	650
	360/50	Y	$30,000	7/65	0	280
	360/60	Y	$48,000	8/65	0	20
	360/62	Y	$55,000	9/65	0	6
	360/65	Y	$49,000	1/66	0	75
	360/75	Y	$78,000	11/65	0	85
	650-card	N	$4000	11/54	255	X
	650-RAMAC	N	$9000	11/54	46	X
	1130	Y	$900	11/65	0	700
	1401	Y	$4500	9/60	8300	450
	1401-G	Y	$1900	5/64	850	100
	1410	Y	$12,000	11/61	800	80
	1440	Y	$3500	4/63	1600	500
	1460	Y	$9800	10/63	1200	130
	1620 I, II	Y	$2500	9/60	1700	30
	1800	Y	$3500	2/66	0	65
	701	N	$5000	4/53	1	X
	7010	Y	$19,175	10/63	75	20
	702	N	$6900	2/55	8	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	45	X
	7040	Y	$14,000	6/63	100	30
	7044	Y	$26,000	6/63	50	12
	705	N	$30,000	11/55	64	X
	7070, 2, 4	Y	$24,000	3/60	360	8
	7080	Y	$55,000	8/61	71	1
	709	N	$40,000	8/58	11	X
	7090	Y	$64,000	11/59	68	4
	7094	Y	$70,000	9/62	135	15
	7094 II	Y	$76,000	4/64	65	30
ITT	7300 ADX	Y	$18,000	9/61	9	5
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	155	X
	Monrobot XI	Y	$700	12/60	550	140
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	310	50
	NCR - 315-RMC	Y	$12,000	9/65	0	60
	NCR - 390	Y	$1850	5/61	910	80
	NCR - 500	Y	$1500	9/65	0	170
Philco	1000	Y	$7010	6/63	16	2
	2000-210, 211	Y	$40,000	10/58	21	2
	2000-212	Y	$52,000	1/63	9	3
	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	590	18
	RCA 3301	Y	$11,500	7/64	27	20
	RCA 501	Y	$14,000	6/59	98	2
	RCA 601	Y	$35,000	11/62	4	1
	Spectra 70/15	Y	$2600	11/65	0	65
	Spectra 70/25	Y	$5000	11/65	0	55
	Spectra 70/45	Y	$9000	3/66	0	65
	Spectra 70/55	Y	$14,000	5/66	0	20
Raytheon	250	Y	$1200	12/60	170	10
	440	Y	$3500	3/64	11	6
	520	Y	$3200	10/64	0	4
Scientific Data Systems Inc.	SDS-92	Y	$900	4/65	6	38
	SDS-910	Y	$2000	8/62	127	20
	SDS-920	Y	$2700	9/62	82	8
	SDS-925	Y	$2500	12/64	8	25
	SDS-930	Y	$4000	6/64	36	23
	SDS-9300	Y	$7000	11/64	10	7
Systems Engineering Labs	SEL-810	Y	$750	8/65	0	8
	SEL-840	Y	$4000	10/65	0	2
UNIVAC	I & II	N	$25,000	3/51 & 11/57	30	X
	III	Y	$20,000	8/62	88	5
	File Computers	N	$15,000	8/56	22	X
	Solid-State 80 I, II, 90 I, II & Step	Y	$8000	8/58	320	X
	418	Y	$11,000	6/63	24	12
	490	Y	$26,000	12/61	45	17
	1004	Y	$1900	2/63	2750	300
	1050	Y	$8000	9/63	165	180
	1100 Series (except 1107)	N	$35,000	12/50	13	X
	1107	Y	$45,000	10/62	27	2
	1108	Y	$50,000	7/65	0	19
	LARC	Y	$135,000	5/60	2	X
				TOTALS	27,445	11,351

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 IBM 7044, 7074, and 7094 I and II's are not for new machines but for conversions from existing 7040, 7070 and 7090 computers respectively.

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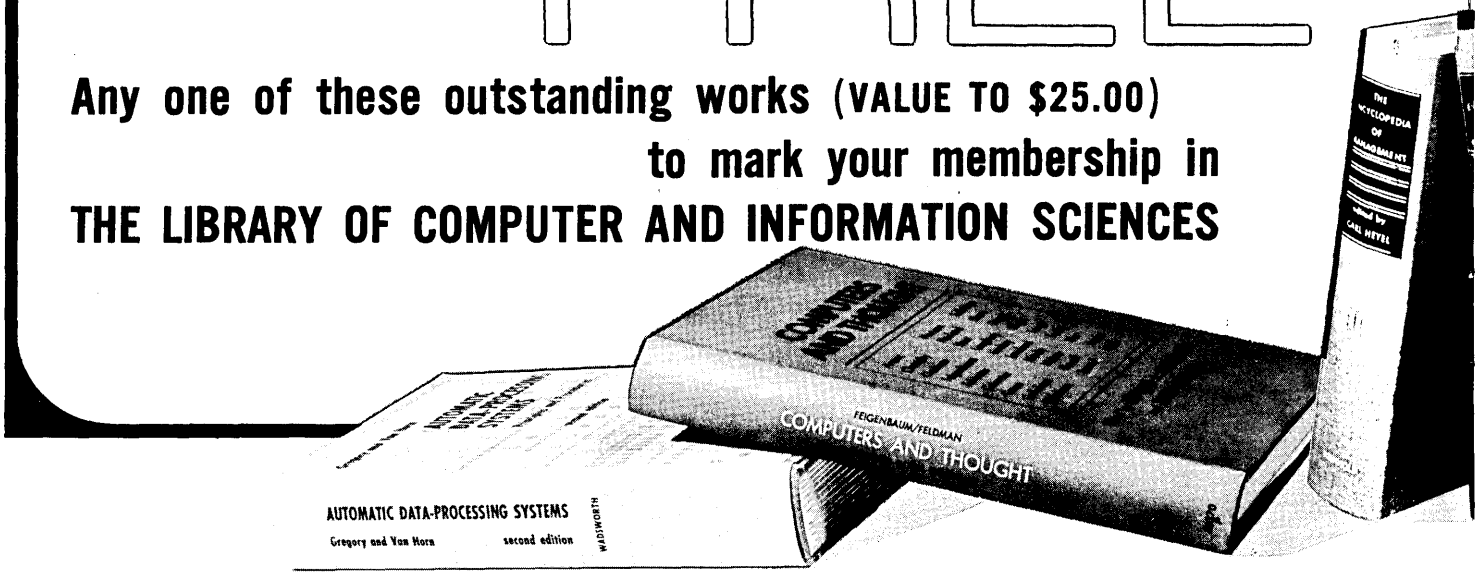

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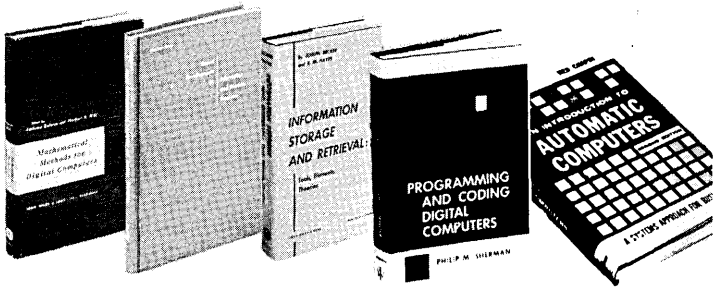

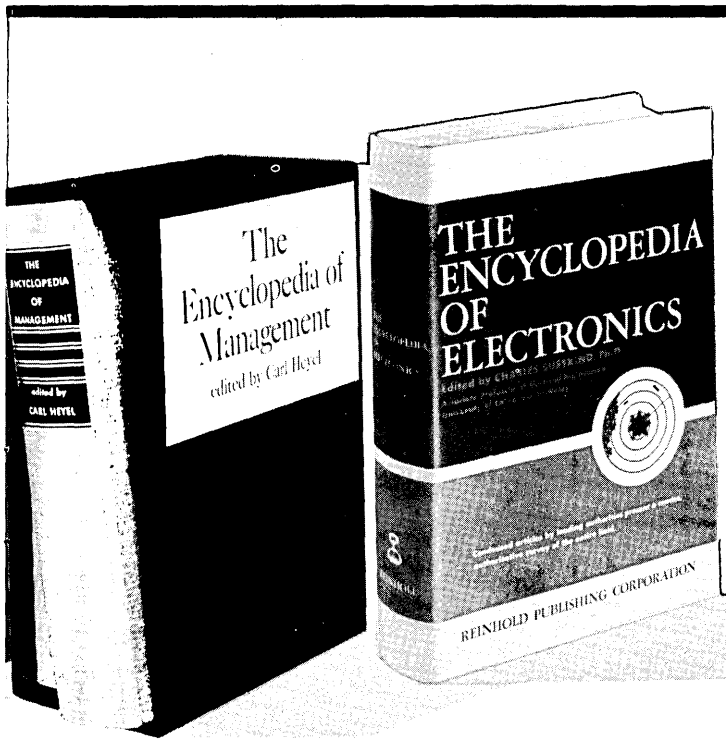

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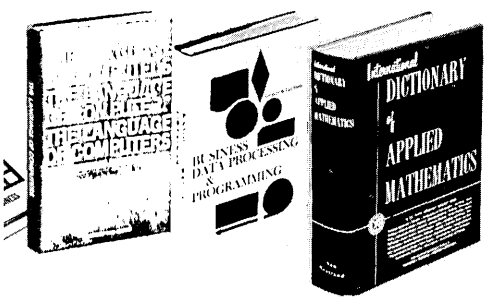

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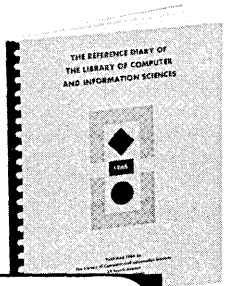

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Our 2415 adds tape processing to SYSTEM/360 Model 20. It makes low volume tape jobs practical for Model 30. It reduces card handling and increases throughput.

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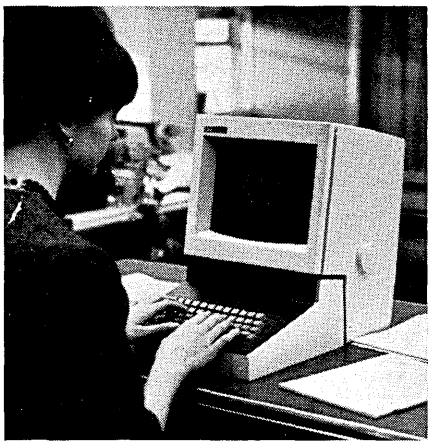

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Hundreds of units—near or far—can be attached to one SYSTEM/360. When directly connected to a computer channel, our 2260's data rate is 2560 characters per second. On a telephone line, its data rate is 120 or 240 characters per second, depending on the data set used. Rental starts as low as $89 a month.

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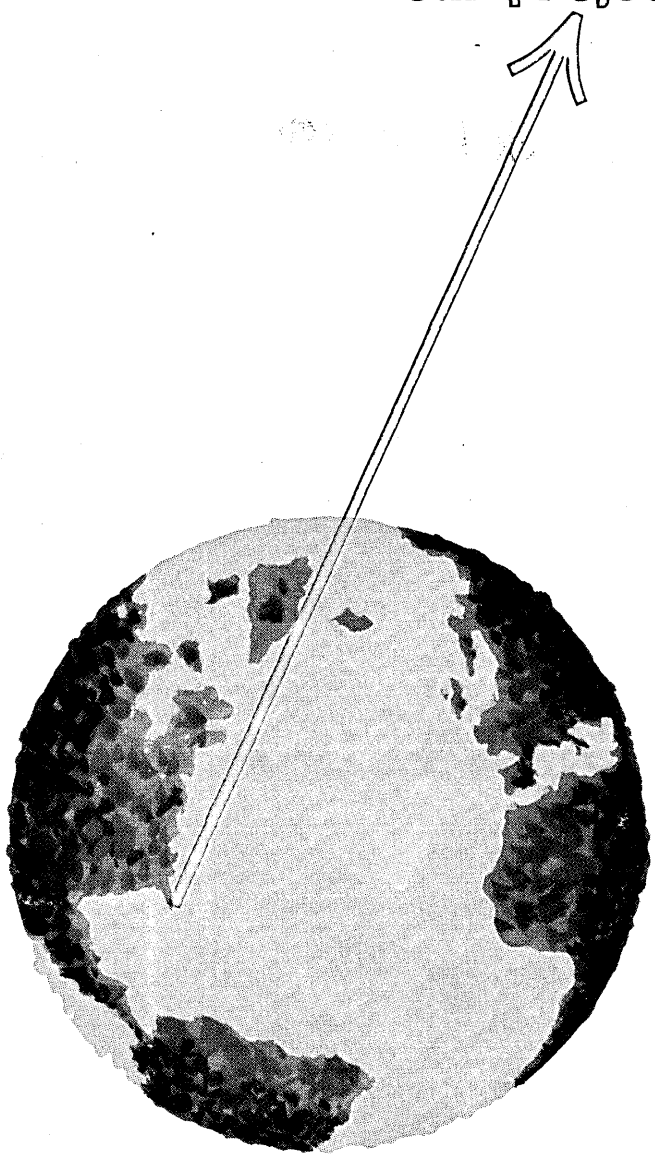

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