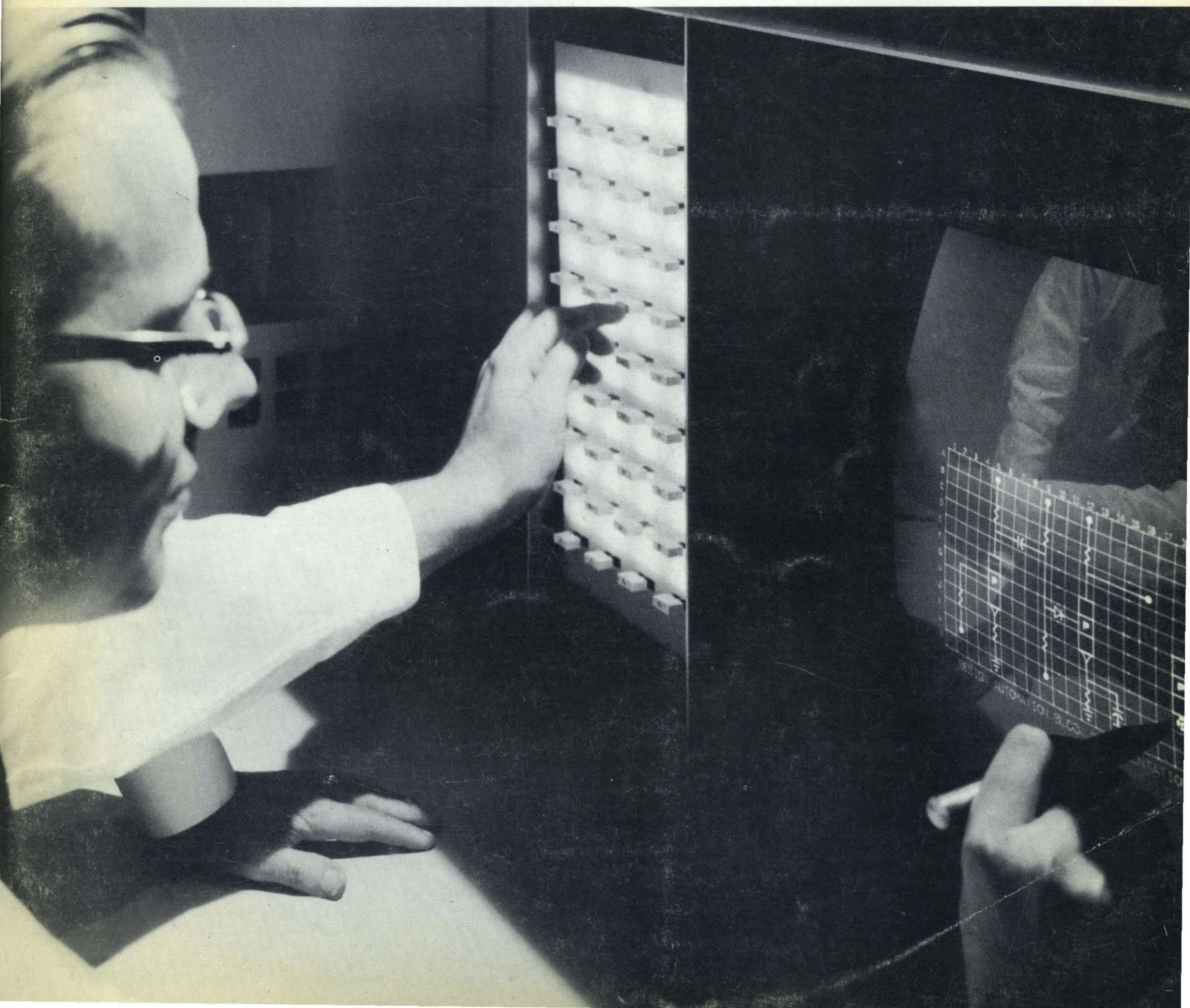
November, 1965

computers and automation

Graphic Data Processing: A New Frontier for Computers



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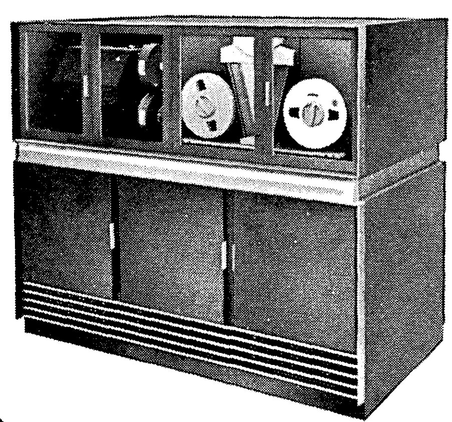

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AN OFF-BIT HISTORY OF MAGNETIC TAPE... #9 of a series by Computape*

There were mutterings at the Round Table that Merlin the Magician was growing absent minded, not to say daft. The Knight of the Silver Spoon was sure of it. And the Knight of the Iguana agreed.

"Absent minded am I? Ready for Medicare am I?" cackled Merlin. "I'll show them!"

And so he collared the noble Galahad. "Watch this, Gal old boy!" he crowed.

And without so much as an abracadabra — lo! The two were suddenly in a strange room, where a damsel pecked absently at a typewriter and musicians played Greensleeves from the balcony.

"And what do you think those are?" Merlin whispered to Galahad, pointing a warty finger at a bank of computers that had suddenly materialized along the far wall.

"Computers," Galahad replied promptly. "As for the tape, it's heavy duty Computape. Magnetic. 556, or 800, or 1000 bits per inch with no dropout, if I recall."

Merlin sighed. "Then I've shown you this before?"

"At least 25 times," said Galahad. "But fear not, Merlin. None shall ever be the wiser."

And none ever was. After all, would you have the heart to tell on a poor old man?

Galahadn't either.

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

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*Reg. T.M. Computron Inc.

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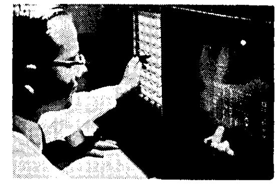
Our front cover shows a graphic data processing system which can scan graphic information recorded on microfilm, store it in a computer, process it, and display it on a screen in the form of diagrams, drawings, graphs, and management reports. For more details, see the article by C. F. Smith beginning on page 14.



computers and automation

NOVEMBER, 1965 Vol. 14, No. 11

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

Special Feature: Graphic Data Processing

In This Issue

In Every Issue

COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE, MASS. 02160, BY BERKELEY ENTERPRISES, INC. 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 BOSTON, MASS.

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Intelligent Operations and Their Performance by Computers

Proposition: "Every defined intelligent operation can be performed by a computer."

Is this true?

In Cedar Rapids, Iowa, on September 25, I listened to two excellent illustrated talks given at the 13th Annual Conference of the Cedar Rapids section of the Institute of Electrical and Electronic Engineers.

One was a talk by R. P. Noonan of Honeywell Corporation about the new computer-controlled Kitchens of Sara Lee, Deerfield, Ill. This is a $25 million dollar plant for automatically making frozen cakes of very high and uniform quality; they are stored automatically in a warehouse 4 stories high, larger than a football field, and maintained at 10° below zero; and the cakes are drawn automatically from the inventory to fill orders. He showed movies of the automatic cranes in motion — a non-human world of metal dinosaurs. This automatic factory and warehouse is operated by a combination of data processing computers and control computers.

The other talk was by T. D. Robertson of IBM, on the automation of engineering design. Formerly, a human engineer would take a customer's order, a book of rules, etc., and make the design of a motor, transformer, pump, voltmeter, etc., to meet the customer's requirements. Now this is accomplished by a program. The customer's requirements, the tables, standards, and formulas, and the design logic of the engineer, are put together in a program using a technique called "decision tables." The program produces product specifications so that the factory has the precise specifications for making the particular product the way the customer wants it. A computer program may, for example, express 250 decision tables, leading to 200 billion different possible designs. The same technique can be applied in other areas such as producing the product. The decision tables summarize the conclusions about what choices should be made in view of given circumstances.

Across my desk on September 18 came a Release of which the following is an excerpt:

"Students applying for Pennsylvania college loans and scholarships are getting a fair hearing from a computer, which is screening student requests to the Pennsylvania Higher Education Assistance Agency for funds. The aid may total $2000 per student during each year of undergraduate study. There are 190 checkpoints in each application, and 12 to 15 thousand student applications. The computer impartially reviews each application and judges it on its merits. Safeguards have been built into the system that guarantee every student a fair hearing. The computer processes an application in seven seconds compared to the 45 to 50 minutes it takes a professional evaluator. Though the computer determines an applicant's needs, its decision is not necessarily binding, since an applicant may have a review of his case by an evaluator, if he so requests."

Here is the work of a factory manager, the work of a design engineer, the work of a judge — all summarized and performed by a computer, and performed better, faster, and more reliably than the professional man who used to do the work.

These examples make more and more evident the long reach of the capacity of a computing machine. There is no question that a computer can perform arithmetic, mathematics, logic, reasoning, proving, controlling, guiding, communicating, filing, classifying, sorting, investigating permutations and combinations and making the "best" choice, puzzle-solving, game-playing, etc., etc. It has been demonstrated repeatedly that defined intelligent operations can be reduced to sequences of logical steps. It has been demonstrated repeatedly that sequences of logical steps can be performed by a computer.

What sorts of intelligent operations might be outside the power of a computer to perform? At any rate, what sorts of intelligent operations show hardly any signs yet of being performed by computers? Examples are:

— driving a bus, and stopping to pick up passengers and let them off (a bus driver)
— diagnosing and repairing a motor car (a repairman)
— identifying decayed places in teeth, and drilling and filling them (a dentist)
— recognizing the ideas conveyed by sequences of words in a booklet of motor vehicle driving regulations, and applying them subsequently in driving a motor car (a driver)
— investigating the occurrences surrounding a news event, and writing a report about it for a newspaper (a reporter)

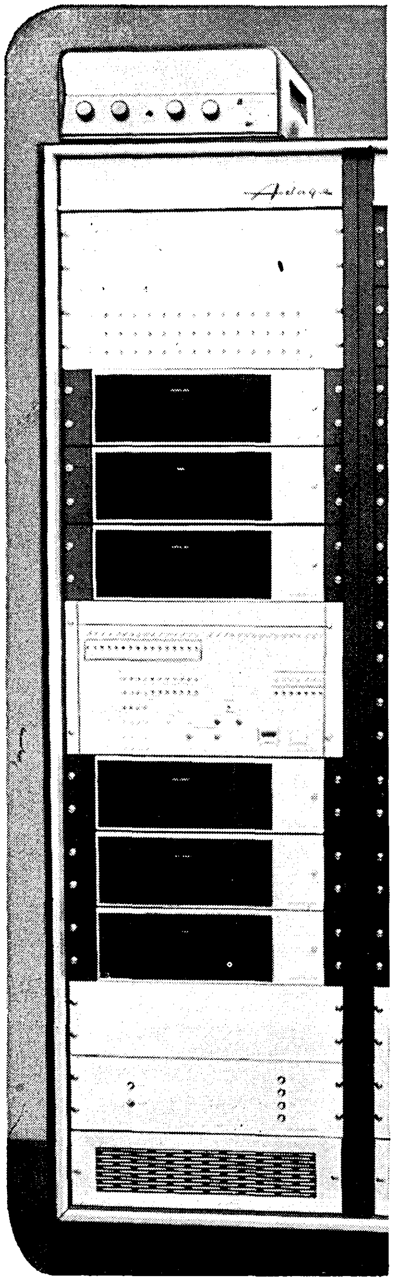
All of these types of intelligent operations depend on a highly trained way of perceiving a complex environment, distinguishing parts of it, and then acting appropriately in response.

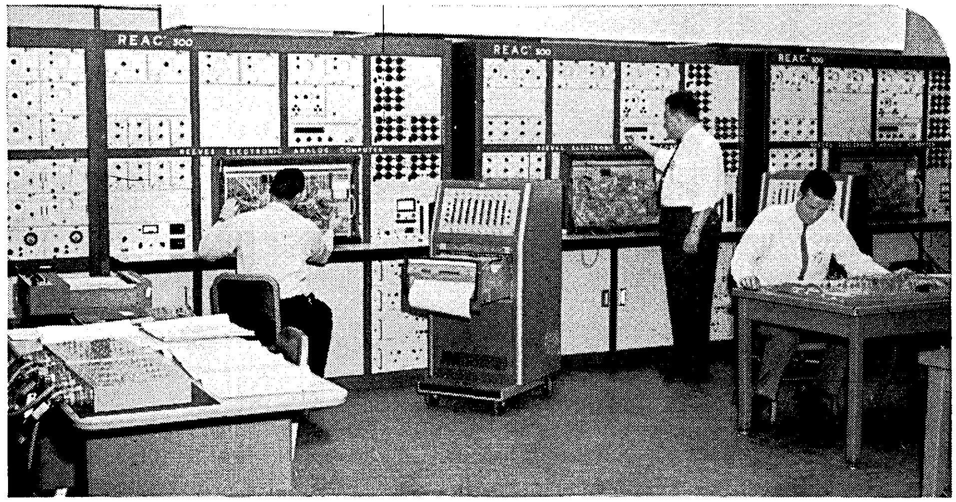
And yet even for these operations, it seems clear that over the next quarter century equipment that observes, analyzes, and classifies the environment will develop greatly. We already have optical scanning of characters, reading of films by programmable computers, and other graphic devices. Once the parts of an environment are recognized and defined, the intelligent operations to be performed are often simple; for example, the dentist's mission after finding a decayed area, is simply to excavate and put in a filling.

So we can conclude that it is mainly our limited capacity to imagine the probabilities and the possibilities in the future that may prevent us from agreeing completely with the proposition:

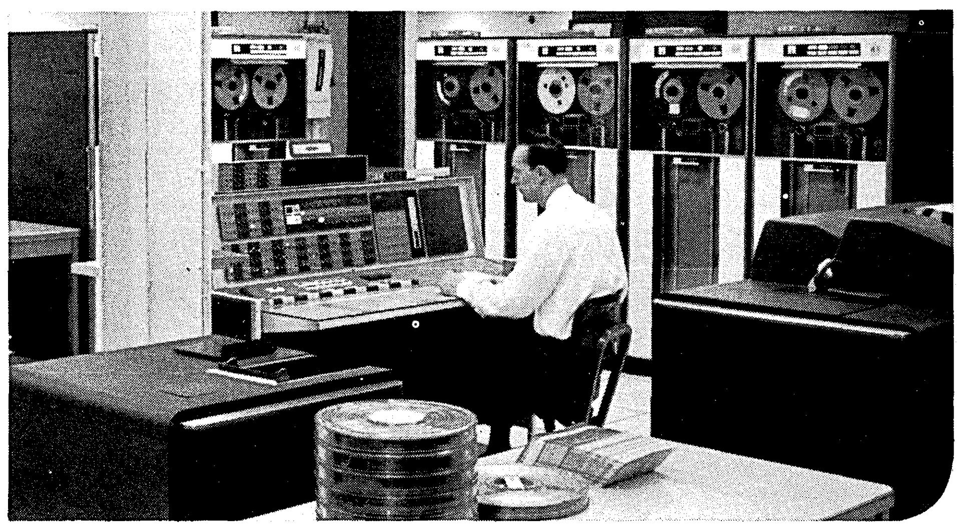
"Every defined intelligent operation can be performed by a computer."

Edmund C. Berkeley
EDITOR





computer specialists



At Grumman, our highly sophisticated digital facility is comprised of two IBM 7094 II systems, two IBM 360/30's and one IBM 1460. Parallelling this is our modern analog facility with 1700 operational amplifiers. Modern linkage equipment between the two facilities providing one of the largest hybrid installations in the U.S., makes Grumman an ideal vehicle for computer specialists who find up-to-the-minute equipment can materially speed their professional progress. Positions are immediately available in the following fields:

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c & a MARKET REPORT

UNCLE SAM'S COMPUTER CHEST: WHERE THE DOLLARS WENT

The Federal Government, the nation's largest computer user... employing just over 10% of all computers in use in the U. S.... spent an estimated $1132 million for data processing in the Fiscal Year ending June 30, 1965. Of this amount, $441 million, or 39% of the total, is estimated as the cost for the rental or purchase of computers ($203 million for rental and $238 million for purchase).

These figures, and scores of others, are reported in the publication, "Inventory of Automatic Data Processing Equipment in the Federal Government", issued recently by the U. S. Bureau of the Budget. This is the third consecutive year that such an inventory has been prepared and published through the efforts of the Management Improvement and Research Branch of the Bureau of the Budget's Office of Management and Organization. This year's edition, 365 pages long, is available for $2.00 from the U. S. Government Printing Office, Washington, D. C. 20402.

A selection of other significant statistics about the computer industry provided by this publication are:

* 2188 computers were in use in the Federal Government by the end of June, '65, compared to 1767 at the end of June, '64... an increase of 24%. This number is expected to rise to 2451 by the end of June, '66... an increase of 12% during the year.

* IBM supplied 999 of the computers in use in the Federal Government as of June, '65, accounting for 46% of the total. In June, '64, their share of installed computers was 53%. By next June, '66, it is expected to decline to 36%.

* Control Data, benefiting from the addition of some 33 installed computer systems acquired from General Precision, has moved into a secure second place in the government market with 243 systems installed... 11% of the total. NCR, which was in the second place in June, '64, slipped to third place this year with 196 systems installed, 9% of the total.

* Total costs for data processing in the Federal Government are expected to rise to an estimated $1148 million in Fiscal '66... an increase of less than 2%. However previous government projections of DP costs have usually proven to be conservative.

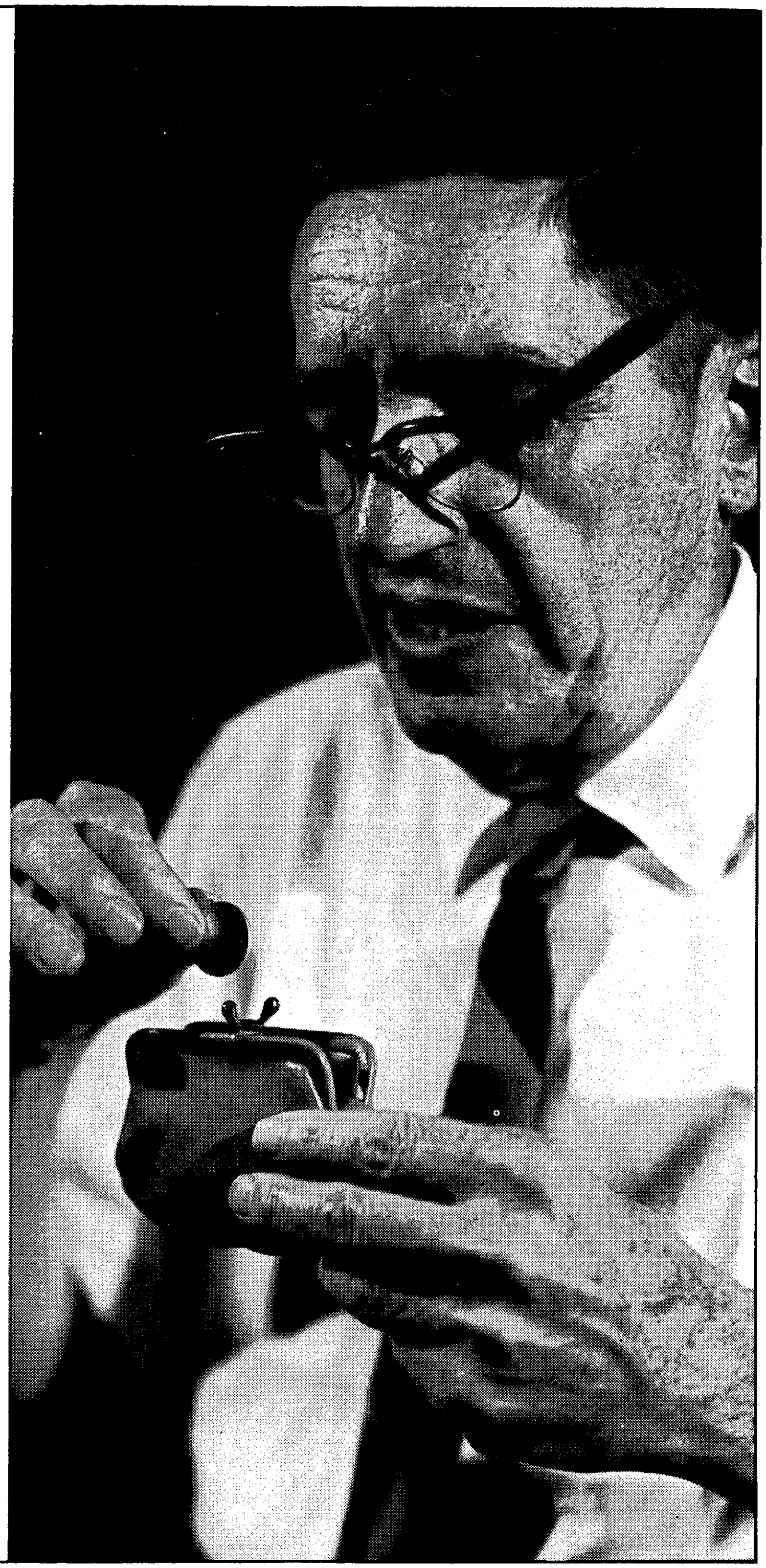
* The percentage of purchased computers in use in the Federal Government rose from 39.7% as of June, '64, to 45.2% as of June, '65. By June, '66, the percentage of purchased computers is expected to rise to 49.2%.

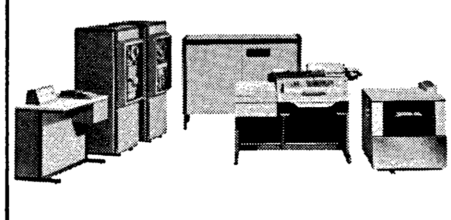
* By June, '66, 37 government agencies will be using computers at some 923 computer units... each computer unit being defined as a separate administrative site for a computer installation.

* The Department of Defense operates 1497 computers, or 68% of the current government total. It accounts for 60% of the total government bill for data processing. NASA is the next largest user, using 11% of government computers and accounting for 17% of DP spending. In third place is the AEC, using 8% of government computers, and accounting for 7% of the DP spending.

The chart below gives a breakdown of the number of systems installed, or expected to be installed, in the Federal Government, and the number and percentage of currently installed equipment which is purchased.

	Number of Computers Installed In Federal Government				
Manufacturer	June '64	June '65 (Est.)	June '66 (Est.)	Est. No. Computers Purchased, June '65	% Computers Purchased
IBM	940	999	888	370	37%
Control Data (includes General Precision)	195	243	243	148	61%
NCR	190	196	197	5	3%
Univac	96	187	330	126	67%
RCA	97	132	132	70	53%
Burroughs	30	98	164	22	24%
Honeywell EDP	25	66	90	35	53%
General Electric	36	53	44	21	40%
Scientific Data Systems	18	40	43	33	83%
Digital Equipment	20	31	35	31	100%
All others	120	143	286	127	89%
TOTALS	1767	2188	2451	988	45%





EDUCATION IN COMPUTERS AND DATA PROCESSING

E. J. Haga
Editor, Education Edition,
Business Automation
Livermore, Calif. 94550

In response to your editorial in the July issue on education, I heartily commend your long-standing efforts in the field of computers and automation education. I think it would be highly beneficial for all publications in the field to devote more attention to this vital topic. You may know that *Business Automation* Magazine now has an Educators Edition, published as an insert in the October, January, March and May issues. This is sent free to all qualified educators.

With regard to DPMA's Certificate in EDP, I have given some attention to this topic in my monthly column, "Understanding Automation," which appears in *The Journal of Business Education.* I too think that other groups should join in this effort; I would like to see *Computers and Automation,* and all magazines in the field, publish more educational material, both of a factual and of a critical nature (the latter is essential, in my opinion, for good programs to be developed).

Generally, I am opposed to testing, or screening of any other kind, to determine entry qualifications. I believe that it is far better to let an individual try to do the actual course work, or actual job, than it is to try to tell him in advance that he can't succeed. Just consider events in your own life: did things turn out in a way that anyone could earlier have predicted? But I do believe that the safest place to print such a test would be in a magazine such as *Computers and Automation.* The self-screening test should caution individuals to explore the field, and tell them that no test can measure all the factors that potentially make for occupational success.

The biggest drawback to the furtherance of education in computers and data processing areas is political: namely, our outmoded and uneconomic system of 29,000 school district organizations. When this condition is ameliorated, the attendant economic problems of financing such education will be far more easily solved. As a partial solution, I believe in and propose state control of education. Local school district organization has too often and far too long fostered tyranny in the name of democracy, for there is nothing democratic about a handful of local professional people governing in the name of 5% or 10% of the people, as is often the case. As a substitute, I would have regional boards of education, elected by all the people at large, on a statewide ballot. These people would be educators probably, but wouldn't have to be, and they would be on full-time status on the state payroll. The result would be democratic education, with far more administrative and financial efficiency (teachers, for example, would receive pay based on a uniform state salary schedule).

For more information on education in computers and data processing, I would like to refer readers to my book "Understanding Automation — A Data Processing Curriculum Guide and Reference Text," published by The Business Press, 1965.

"THE COMPUTER FIELD AND BANDWAGONS" — SOME COMMENTS

I.

From Roger G. Gilbertson, President
Electronic Management, Computerology Corp.
Washington, D. C.

In your editorial "The Computer Field and Bandwagons" you hit the nail right on the head — I agree with you!

II.

From James C. Reilly
Information Manager
The Service Bureau Corporation
New York, N.Y.

Congratulations on your "bandwagon" editorial in the September issue. The points you raised needed saying for a long time and coming as they do from the editorial page in *Computers and Automation,* I'm sure that many businessmen will pause to take a hard look at their own "wagons."

May we have permission to reprint your editorial and distribute it internally to our sales force?

III.

From Sam Wyly
President
University Computing Co.
Dallas, Tex.

May I congratulate you on your "Band Wagon" editorial? You expressed most clearly a thought which has been buzzing about in my head for a couple of years.

TIME-SHARING — SOME COMMENTS

Gordon R. Carlson
The Flint Journal
Flint 2, Michigan

I would like to take exception to the following articles, "The Small Computer Versus Time-Shared Systems" and "A Time-Shared Computer System — The Disadvantages," which were published in the September issue, for the following reasons:

1. These articles used only the university and engineering lab environment as a basis for judging against time-

sharing. The commercial environment, which makes up a very large share of our industry, was completely overlooked.

2. The techniques (such as multi-programs, multiprocessors, operation and hardware organization philosophy) which can make time-sharing more effective and less costly, were given so little room that an informed stand can not be made against time-sharing on the basis of these articles.

I would like to see a thorough thought-provoking discussion regarding the use of multiple small computers vs. a computing system operating in a multi-user mode. Our quest for improved computer usage should not be based on one technique vs. another; but on what is the problem as it really faces us and what blend of techniques and philosophy will help us solve the problem.

1966 IEEE COMMUNICATIONS CONFERENCE — CALL FOR PAPERS

The 1966 IEEE Communications Conference has issued a call for papers on the subject of electrical communications as applied to the government and the military, business, education, and industry. Topic sessions include satellite systems, optical (laser) technology, analog versus digital transmission, data systems and error control, software for communication systems, and display systems. Abstracts (35 words) and condensed versions of contributed papers are due on or before March 4, 1966 to: A. E. Joel, Jr., Bell Telephone Laboratories, Inc., Room 2G-330, Holmdel, N.J. 07733. The '66 IEEE Communications Conference will be held June 15-17, 1966, at the Sheraton Hotel, Philadelphia, Pa.

"PERSONNEL PROBLEMS IN DATA PROCESSING SYSTEMS" — SOME COMMENTS

I. From Dick H. Brandon

Brandon Applied Systems, Inc.
New York, N.Y.

In regard to the article "Personnel Problems in Data Processing Systems" by H. W. Protzel, August, 1965, I must take exception. The data processing industry needs boosters; articles which reflect unwarranted assumptions are misleading and destructive.

The following statements are harmful or incorrect:

1. The opening sentence: "A good percentage of the personnel doing work in data processing and systems today should not be in those fields." This is assumption, unsupported, and if "good" means "majority," totally false.
2. "Only a relatively few executives have taken advantage of IBM's test for selection." If this means P.A.T., this statement is absurd. We know of no installation using trainee personnel which did not use P.A.T. or its equivalent for selection.
3. "Psychological testing, if used properly by management, can only help." The controversies surrounding this topic are far too deep for simple and inaccurate generalizations.
4. "Many current machine supervisors and systems department supervisors are performing inadequately." So are many consultants, TV repairmen, furniture salesmen, actors and even editors. But how many, and how inadequate? Certainly the article offers no solution.

The industry faces complex problems which do not lend themselves to simple solutions borrowed from Personnel Theory I.

II. From Harvey W. Protzel

H. W. Protzel and Co., Inc.
St. Louis, Mo.

I appreciate Mr. Brandon's letter regarding my article.

1. Based upon 25 years of experience in the field (14 as a consultant to management) and discussions with other experienced consultants, I have become convinced that "a good percentage," though not "a majority," of the personnel doing work in data processing and systems today should not be in those fields. Of course, no statistical information is available on this point about *all* data processing installations; and it is not possible to state the percentage exactly.

There are many people going into data processing because of its growth and future potential. A percentage of these people will not perform adequately because data processing should not be their field. Better selection methods could discourage them early and possibly direct them toward something more suitable for them.

2. I have been asked into numerous installations, because of existing problems, and found that the personnel were "given" their jobs because their former jobs had been eliminated. This was considered the "humane" thing to do, or else it was done for "morale" purposes. Quite often the problems are found to be a result of this practice. In fact, I was just called into a company this week which is seriously concerned about certain key personnel that were moved into their new computer operation as described.

Mr. Brandon's last sentence, I assume, refers to his clients who have acted correctly because of his capable direction. This is probably a good example of the value of using experienced consultants.

There are some fine data processing schools who determine aptitude prior to accepting students. But other schools will take anyone with the fee. This adds to the percentage of people who should not be in the field of data processing.

3. It is true that psychological testing is a controversial subject. However, so is medical practice, and the performance of many other professions and functions. It is clear that psychological testing is not 100% correct at all times just as a physician or lawyer is not. But it reduces the gamble considerably and offers management an additional tool to work with. Like any tool, it must be used properly to be helpful. I have found psychological testing to be extremely helpful. The extent of aid to management depends upon how it is used and this depends mostly upon the psychologist's training in regard to management's use of test results.

4. The rapid growth of the data processing industry and the extensive need for personnel has created the problem with which I am concerned. The article intended to offer a solution by recommending better methods of selection and training. This recommendation could be applied to and could be of value to "consultants, TV repairmen, furniture salesmen, actors, and even editors," etc. However, I see no reason not to remind the data processing industry that selection and training are important factors even though other industries could also be reminded. We must all remember that the success or failure of any endeavor is most dependent upon the personnel involved. Therefore, better selection and training of people provides an opportunity for greater success.

The next time somebody asks you why the talent is moving to the Independent Software Houses, quote him Bauer's Second Law.

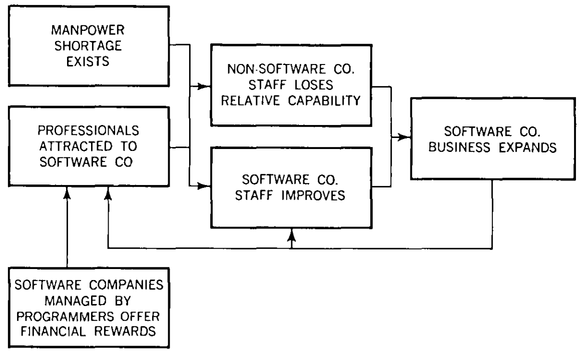


Fig. 1

Fig. 2: Dr. Bauer

Bauer's Second Law: Talent migrates from areas of well defined and stratified responsibility to areas of expanding activity at a rate proportional to the rate of expansion. Or, stated more simply: *talent goes where the action is.*

COROLLARY

Independent software companies, those not associated with a manufacturer or user group, are attracting an increasing percentage of available programming talent.

MANPOWER SHORTAGE EXISTS

Our basic premise is that talent, especially top talent, is in limited supply in any field. In the software industry the demand for top-rated specialists exceeds the supply. Consequently, software experts have a choice as to where they work. At present, and with increasing frequency, they choose to work for independent software companies. This is not to say that you can't find very talented people employed by computer manufacturers or user organizations. You certainly can. But more and more of them concentrate in independent companies.

SOFTWARE COMPANIES, MANAGED BY PROGRAMMERS, OFFER FINANCIAL REWARDS

It is true that part of the attraction is financial. Independent software companies depend on talent for their livelihood and consequently are willing to pay for it in several ways. Empiricists please call.

PROFESSIONALS ATTRACTED TO SOFTWARE COMPANY

But specialists are attracted to the independent company by more than money. A professional, given his choice, would rather work among his fellows. It is always best to work where your contribution is essential to the success of the enterprise, a place where you feel yourself in the mainstream of the business. Furthermore, when a man and his management are of the same discipline his needs are understood, his accomplishments rewarded, and his individual worth appreciated. Finally, working among top talent, a man can improve his own skills. This is especially true where people who have relatively narrow specialties within the basic discipline have a chance to exchange ideas and to learn from one another.

SOFTWARE COMPANY STAFF IMPROVES

For these reasons the staff of the independent software company improves, both in quality and in quantity. Since the talent pool is limited, it follows that the increased capability of the independents results in a decrease in the relative capability of non-independent software groups.

SOFTWARE COMPANY BUSINESS EXPANDS

This increase in capability brings more business to the independents. This in turn, makes it possible for the software company to offer more challenging work, more responsibility and more rewards. All this attracts still more talent. Thus the whole process repeats itself and becomes self-propagating.

IS THE INDEPENDENTS' GROWTH GOOD FOR YOU?

In five short years the independent software industry has grown from a meager $5,000,000 annual business, to $70,000,000 last year. And this year the figure is expected to double. Such growth must have sound economic reasons. There must be something the independents have to offer. There is. Stated in the simplest terms, the independent software firm can offer a pool of specialized talent which few users could afford to maintain for themselves. You can buy all this expert know-how, and use it for just as long as you need it to solve a given problem. And you will pay less than if you tried to solve the problem yourself. Furthermore, you will get the results on time.

HOW DOES INFORMATICS FIT IN?

Within our own organization (you knew the commercial was coming, didn't you?) we can call upon systems specialists, language specialists, experts in artificial intelligence, in data retrieval, in PERT, and many more. Without even leaving the building. Now, this kind of talent doesn't come cheap. (Look at our payroll and at our salary incentive plan, unique in the software industry.) We're always busy working on the latest problems. Right now, about 80% of our work is in the new field of on-line computing systems. We sponsored the first national symposium on the subject together with U.C.L.A. (We'll be happy to send you some of the papers presented in return for the coupon, below.)

THE MORAL:

If you have read this far, you might be interested in talking to us further about our services, capabilities, and opportunities. Simply call (213) 872-1220 and ask for me, for Frank Wagner, for Bob Rector or for anyone else on our staff. If more convenient call Werner Frank at our Washington office (301) 654-9190.

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P.S. IN CASE YOU'RE WONDERING, BAUER'S FIRST LAW IS: IF THE PROGRAM HAS A BUG, THE COMPUTER WILL FIND IT.

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GRAPHIC SYSTEMS FOR COMPUTERS

Christopher F. Smith
Manager, Graphic Data Processing Development
IBM Data Processing Division
White Plains, N. Y.

With the arrival of working graphic systems in computers, the concept of direct communcation between man and machine has taken on a new dimension. In the short space of two years, computer components which can process both graphic and alphanumeric information have emerged. They have the potential for a wide range of commercial and scientific applications involving graphic information.

Much of graphics today, however, is in process of development. On the one hand we have a set of devices whose effect on engineering, research, and business is expected to be revolutionary. On the other hand, we are faced with the realization that all new advances are really evolutionary in nature, and a great deal of application, hard work, and testing is required before our expectations can be fulfilled.

Design Engineering

Particularly in design tasks, graphic systems will be useful in shortening the cycle time and in making changes easily. Graphic data processing will remove many present-day procedures in the review of designs, their modification, and recording, and provide faster and more accurate designs than were possible previously.

In a typical design task of the future, an engineer might make a simple sketch on the face of a cathode-ray tube with a light pen; then he might use program function keys at the display unit to activate computer subroutines. Using an alphanumeric keyboard, the engineer would then enter parameter values, then the prestored programs (written by the engineer) would compute values and make the results immediately available. In this way, the engineer could arrive at essential specifications or constraints.

The design and the specification could then be retransmitted automatically to the computer, which would compute the desired characteristics, such as weight, strength, and power. These values would then be displayed with the sketch so that the engineer could make any desired changes. These changes, in turn, would again be transmitted to the computer, and new values of the characteristics displayed. This procedure would be repeated until the engineer was satisfied with the design. A great deal of programming, of course, will be needed before such a system could operate satisfactorily.

Other Applications

Graphic systems of the future will be used not only for design but also for a variety of information-handling activities in business, science and industry. These might include:

Graphic File Maintenance, for updating and maintaining microfilm files of blueprints and working drawings, construction plans or public utility distribution network drawings;

Graphic Data Reduction, for conversion of graphically recorded information, such as electrocardiograms, into digital form for computer processing;

Graphic Documentation, for recording business statistics represented in graphs and charts on film while making the information available for computer processing; and

High-Speed Recording, for transferring to film, at rates up to 20,000 lines a minute, information stored on magnetic tape.

Because graphic systems can translate between graphic and alphanumeric information, graphic systems can process words, tables, and equations as well as graphs, drawings, and charts. These elements, until recently, seemed beyond the capabilities of the computer.

Graphic Systems

A complete graphic system will link input/output units, such as film scanners, film recorders and display units to a computer, and will provide integrated graphic input, manipulation, and output. Such a system would accept information in graphic form, convert it to digital form, and then store it on disk or tape. It would make the stored information available in graphic form for handling modifications while the information is still retained in the system. It will convert the information from digital form back to graphic, displaying or recording it as required.

A planned graphic system is to provide these capabilities through advanced programming and time-sharing techniques

Since joining IBM in 1959, Christopher F. Smith has been active in the development of advanced computer applications with emphasis on the engineering and scientific areas. These have included design automation, inventory management simulation, scientific inventory management, forecasting techniques, piping design and layout and information retrieval.

Prior to joining IBM, Mr. Smith served as an engineer with utility companies. He holds bachelor degrees in electrical engineering and English from Union College, Schenectady, New York.

to permit graphic communication between engineers, scientists and businessmen and a computer through devices such as:

— a display unit;
— a display station;
— a film recorder; and
— a film scanner.

The display unit is a programmable, free-running device which will permit graphical computer input and output. It makes use of an electronic light pen to enable the operator to modify or update images which have been called from computer storage or from microfilm and displayed on a 21-inch, direct view cathode ray tube located on the console.

The user will be able to draw lines, modify a curve, change a physical dimension or identify a piece of information directly with the light pen, or point to a section of the image with the light pen and make the desired manipulation by using an alphanumeric or program function keyboard. This link to the computer will give the user the opportunity to see the results of his decisions immediately and to obtain the data in the desired output form, when he is satisfied with the results.

Display Stations

Multiple displays from 2 to 8, depending on the application, and a film recorder and scanner, may be used with the computer. Multiple control units can be linked to a central processing unit, depending on the application.

Some display stations may be used to display alphanumeric images. Executives, for example, may review current operating data at their desks or in conference rooms to make decisions. Engineers will describe a problem on the screen, enter new variables, and receive solutions. Computer programmers will be able to use the unit to "debug" and update programs.

Many display stations may be linked to a central computer over regular communications lines, time-sharing the computer's central processing unit and making available to each user a completely different set of facts.

Users will transmit messages to other display stations or to the central computer from either an alphanumeric or numeric keyboard. These messages will be composed in their entirety, displayed for verification and editing, and then transmitted for computer processing and possible display at other locations.

Symbols

Sixty-four different symbols, including letters and numbers, may be displayed. One of these symbols, called a "cursor," identifies the location at which each character of information will be displayed on the screen and will give the user the ability to edit and correct alphanumeric charts or listings on the screen and update information stored in the computer.

Film Recorder

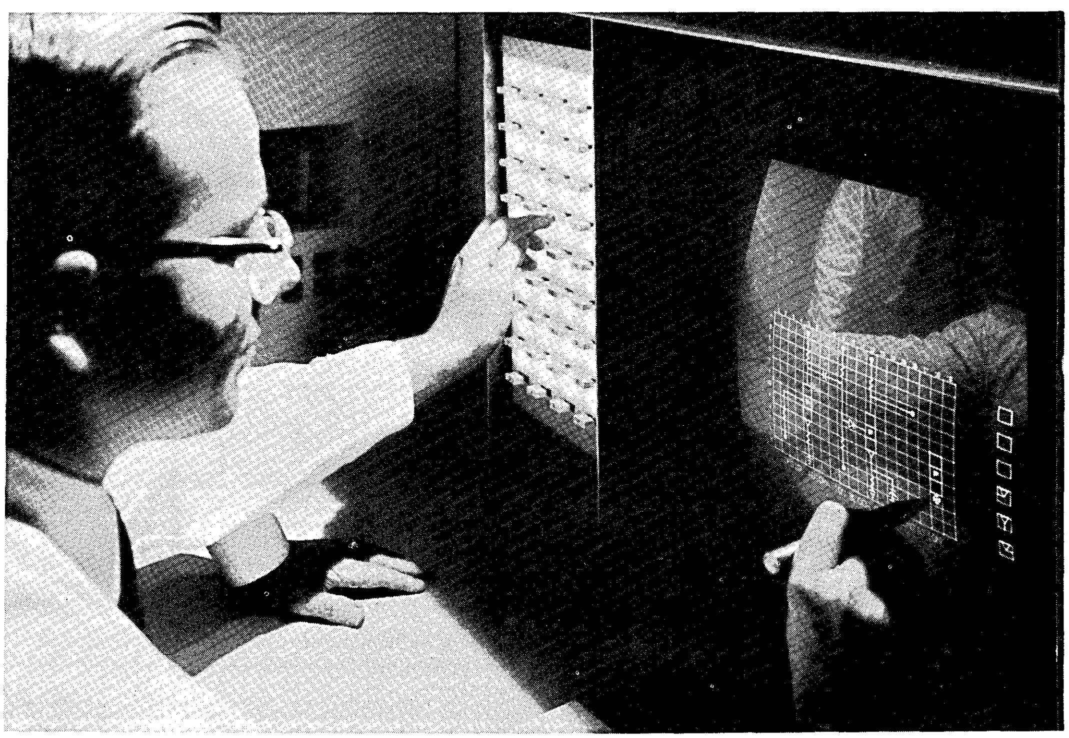
A film recorder will record images generated by its cathode ray tube onto unsprocketed 35 mm film (1.2 x 1.2 inch frame) from information stored digitally in the computer. Once the film is exposed, if processing is desired, the film is moved through various chemical solutions. The processed images may be magnified 19 times actual size for viewing on the unit's rear-projection screen.

Film Scanner

A film scanner uses a cathode ray tube to convert lines and curves recorded on microfilm to digital form for storage in the computer. The information may de displayed. A new microfilm recording of the material may then be made on a film recorder.

Programming Routines

Programming routines for the graphic system will include:
— an input/output routine for the displays;



A graphic data processing system can scan graphic information recorded on microfilm, store it inside a computer and display it on a screen in the form of diagrams, drawings, graphs or management reports. The image can be changed on the screen with a light-sensitive pen, and automatically recorded in corrected form on microfilm.

— problem-oriented routines which provide the display and the film recorder with the facility for defining grids, scaling coordinates, plotting lines and labeling graphs; and
— an input/output routine which enables information to flow between the computer and the peripheral equipment.

A programming package, designed for use with one or more display units connected to a processing unit via a selector or multiplexor channel, will include three types of modules to assist the programmer in reducing his graphic programming time and effort. These will include macro-instructions, problem-oriented routines (PORs), and operating system modules.

Macro-instructions and PORs will reduce required programming by offering a set of generalized "building blocks" that are pretested and debugged, and which will be used directly to support a wide range of applications.

Operating System Modules

The operating system modules will function as part of the Input/Output Supervisor (IOS). They will relieve the programmer of much handling of input/output functions. They will also provide error-correction techniques.

Macro-Programming

The functional advantages of macro-programming are widely recognized. A macro-instruction statement is one that is translated into a group of machine instructions, input/output commands, communication assembler instructions, etc.

Initialization macro-instructions provide for monitoring buffer allocation and current beam position during the generation of graphic orders at assembly time. Monitoring is accomplished by initializing and updating the symbolic buffer-location and beam-position counters. Macro-instructions in this category are also used to specify the limit or maximum value of the buffer-location counter. Initialization and special macro-instructions may also be used throughout the problem program to reset, interrogate and store the contents of the counters.

The input/output command macro-instructions are used to construct channel programs. Each macro-instruction in this category fulfills two functions: generating channel commands to control transfer of data between the processing unit and the graphic display unit and to start and stop execution of the display unit program; and inserting instructions into the problem program to request execution of input/output commands.

Order macro-instructions provide a convenient means of generating the graphic orders that become part of the device program, including conversions from one scale of notation to another.

Expansion

The capacity and complexity of a graphic system can vary over a wide range, from small to large, and from single location to many interlinked locations. It is reasonable to expect that in another half dozen years computer graphics will expand so far that the handling of information graphically in computer systems will then be as normal as the handling of characters is today.

PROGRAMMING GRAPHIC DEVICES

Roger L. Fulton
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Gardena, Calif.

The physical tools required for effective input, processing, and output of graphic data are available. In many instances they are capable of considerable improvement and could be marketed profitably at well below current prices. Nevertheless, the rapid application of graphic data processing to a host of problems is both physically possible and economically desirable with currently available and priced devices.

The barriers to more rapid development of graphic data processing are essentially lack of communication with potential users and the failure to fully utilize existing devices through the development of computer programs for graphic devices.

Applications

Graphic data processing can be effectively applied to problems in engineering, education, astronomy, law enforcement, advertising, entertainment, biology, printing, medicine, seismology, meteorology, oil exploration, missile landing, and many other fields. Weather satellites transmit infrared and cloud cover information which is displayed on scopes and recorded on film. Extensive studies of the fundamental nature of weather require this data in digital form, and even short range predictive programs utilize this data. The medical field produces encephalograms and electrocardiograms; they can be studied more completely in digital form. The engineering and architectural fields are showing great interest in computer-aided design, using a suitably programmed computer, a cathode-ray tube (CRT), and a light-pen to generate and manipulate designs displayed on the CRT. The Bureau of Internal Revenue, credit card offices, and many commercial operations require conversion of handwritten numbers. Even the analysis of natural phenomena such as blood cells, fingerprints, and fish scales can be accomplished if they can be suitably recorded on film. Both seismologists and oil companies have extensive stylus traces to be digitized and processed. Circular charts of temperature, humidity, and pressure are maintained during many experiments and must be processed. Statistical studies of star density are possible from existing film records. Bubble chamber film can be examined for events; spectrograms can be examined for density and band width under computer control. In each of these areas extensive efforts are being made to implement existing graphic I/O devices and develop graphic data processing techniques applicable to the particular problem.

Engineering

An examination of one area, engineering, should serve to illustrate the extensive hardware available for the solution of graphic problems as well as the nature of required programming support to effectively utilize this hardware.

Scanner

The first essential in the application of computers to engineering problems is rapid input of engineering drawings. The most practical method of mass input is by means of a computer-controlled scanner. This device inputs data at 100,000 points a second and can be programmed to automatically read the lines on an engineering drawing, and even recognize alphanumerics generated by a lettering device. IBM has announced a computer-controlled scanner for the System 360. Computer Graphics has constructed a computer-controlled scanner utilizing Digital Equipment Corporation equipment. The device reads either drawings or film records of drawings. The computer-controlled scanner can advance automatically from one drawing to the next, and recognize shades of gray by internally controlled sensitivity.

Computer Programs

Needless to say, the programs necessary to fully exploit this capability are demanding and highly specialized. They include: routines to follow the interface between two gray shades until return to point of departure or until the edge of the drawing is reached; routines that vary sensitivity in order to maintain line width in spite of drawing variations; dendritic search routines; and routines that can read and store a character set and then identify members of the set. The basic programs used by the computer-controlled scanner are a probe and an edge follower that automatically follows an interface between two shades of gray until it returns to its starting place or leaves the screen area. The probe is used to locate information on the film and the edge follower performs the actual reading. Although there are automatic scanners that read at electronic speeds, they flood the computer with unorganized responses. The programs to order this data in memory are the same as those used *directly* by the computer-controlled scanner in reading the drawing. The probes of areas of uniform shade performed by an automatic scanner are unnecessary and wasteful, since areas of uniform shade contain no information. Computer control greatly reduces the number of probes by adhering to gray shade contours.

Following a Line

To follow a line it is necessary to apply the edge follower program to both sides alternately. It is advisable to let one side lead the other and connect each point with the closest point on the opposite side to find the centerline. This produces a differential effect on curves, yielding more points just where they are usually desired. An intersection is detected by the widening of the distance between the sides. The routine should then probe across the intersecting line and back toward the intersection to establish its location accurately.

Following a Tree

It is possible to follow a treelike pattern by making left turns at each intersection until a dead end is reached and then backing up to the last intersection and making the next left turn until all branches of all intersections have been followed. When two curves merge, it is sometimes impossible to identify them on separation. By reserving judgment the routine can usually establish identity later when one curve exceeds limits possible to the other.

The edge of a line is rough even if photographically reduced from drawings on vellum. This can be observed by an operation using a microscope program under light pen control to scan and display to successively greater detail. The light pen is used to select the center of interest at each level and switches indicate whether to go up a level, down a level, or center around a new point at the same level. The light pen can also be used to add to or delete from a particular read.

Macro-Instructions

Once the major input has been accomplished, the engineer requires a man-machine interface to permit modification of existing data and introduction of new data. Graphic compilers can be designed to permit macros such as "rotate," "translate," "scale," dimension" etc., but these entail the mastery of a new language by the engineer or the intervention of a programmer. Devices are available which permit the engineer to communicate directly and graphically with the computer. These devices include stylus sensitive tablets such as the Rand tablet and pressure plates. Rapid responses can be obtained with a light pen (photodiode or flexible light fiber connected to a photomultiplier) which writes on the CRT face. Programming should eliminate the need for any drafting instruments. Generation of straight line connectors, parallel lines, required angles, conic sections, etc., should be provided by program. The console must provide a function keyboard to indicate desired functions and an alphanumeric keyboard to indicate desired lettering. Since varying applications require different utilization of the function keys and they must be properly labelled, alternate function keyboard overlays should be provided for each application. The overlays themselves can depress keys to call the associated programs into memory.

Dr. Roger L. Fulton developed software for one of the earliest computer controlled scanners at Lawrence Radiation Laboratory, Livermore, California. Since then he has been continuously engaged in the application of visual I/O to computers, including projects such as software for the IBM Graphic System and a computer generated motion picture on quantum mechanics at Computer Sciences Corporation. Recently, he has been appointed director of the technical staff of Computer Graphics, an organization which develops hardware and software for applications of graphic data processing.

The programming support should provide manipulative functions such as translation, rotation, scaling, dimensioning, storage, and retrieval of standard parts drawings and adjacent sub-assemblies. Generation of isometric drawings from input views should be provided for the user.

Output Devices

A wide variety of output devices are available, including mechanical plotters and printers. The fastest output method employs the CRT already present in the display system as the source and the pulse-operated camera already present in the film input device as the recorder. It offers the additional advantages of compact storage and excellent reproduction by photographic or electrostatic processes.

Output Programming

Graphic output presents programming problems as severe as those encountered in graphic input. There are many "packages" intended to provide the user with an effective language for graphic output comparable to the processing capability afforded by Fortran or Algol. Some of these are designed for use with an on-line CRT such as Data Display's DD80. Others are intended for mechanical plotters such as the Cal-Comp, or off-line CRT recorders such as General Dynamic's SC4020.

There are certain standards which should be met by all such programs. First, they should provide a rapid versatile alphanumeric output. Often the output device supplies a standard upper-case character set, but lower-case, punctuation and user-designed symbols should be provided by program if necessary. It is probably not important to enable the user to print upside down, but vertical as well as horizontal printing should be permitted. In most cases a sacrifice of "typewriter mode" speed is entailed by such programs, and this aspect should be stressed in the documentation. It is interesting to note that the computer-controlled scanner permits the rapid input of *any* character set for output use, obviating the necessity for expensive programming.

Graphs

The engineering user, like many others, requires more than alphanumeric output. He wants performance graphs and drawings he can give to his shop superintendent as well as parts lists and specifications. Whether the program support consists of a graphic compiler or graphic Fortran subroutines, it must enable the user to output graphs and drawings with a minimum of programming. The graph options should include output of curves composed of connected or unconnected data points, or alphanumerics at data points that both define and label the curves, and the ability to output curves in segments and still retain connectivity. Rectangular or polar grids with linear or logarithmic divisions clearly labelled should be provided.

Drawings

The programming to output drawings is fairly straightforward, although storage limitations may require that bit patterns or vectors rather than full X-Y coordinates be stored. Repetitive backgrounds can often be produced by rear-window CRT projection less expensively than by program. Occasionally the graphic output must take the form of motion pictures and a premium is placed on concise graphic-output programs in these instances. It is possible to utilize multiple film frames for each output frame and generate color film, adding a dimension to graphic capability. It is also possible to generate offset views for stereographic viewing. Color and stereo output each require programming capabilities not widely available at present.

Feasibility

Three relatively recent developments make the solution of graphic problems economically feasible. The first is time-sharing: the utilization of a single computer by a number of users virtually simultaneously.

The second is the development of remote data terminals, which permit installations to enjoy many of the advantages of an in-house computer through joint usage.

Finally, the cost of the smallest computers has been reduced while their speed has increased to match that of far larger computers. These small computers can solve many graphic problems entirely. They can be used off-line to control graphic I/O devices of very high speed. They can also be used as terminals in a time-sharing environment or as remote graphic data terminals. Although the smallest computers are fast and reliable, they require compact programs. Fortunately, graphic data processing lends itself to modularly constructed programs using quite small elements.

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COMPUTER-GENERATED THREE-DIMENSIONAL MOVIES

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Animated movies for educational presentations of scientific concepts are increasingly interesting a small but dedicated number of scientists, engineers, educators, and animators. The value of animated movies for presenting complicated concepts has long been recognized. Now a new method for producing animated movies has been devised, and has led to the present renewed interest.

Previously, animated movies were made a single frame at a time — a time-consuming and tedious process. Now, however, special photo-optic equipment under the control of a high-speed digital computer is being used to generate animated movies. For example, such computer-generated movies have been used at the Bell Telephone Laboratories to demonstrate the effects of different gyroscope constraints on an orbiting satellite.[1] Also, an ingenious computer-programming language has been devised for producing computer movies.[2]

In a previous issue of *Computers and Automation,* I described a computer technique for the production of three-dimensional pictures.[3] This technique utilized the same equipment that others had also been using to generate movies. Since a movie is essentially a series of related still pictures, the extension of my previous work to produce three-dimensional movies was quite obvious. This extension is described in this article along with a few examples of some computer-generated three-dimensional movies.

Computer-Generated Movies

Digital computers are very adept at manipulating numerical data under the control of a program. If this numerical data consisted of the coordinates of points which when connected by straight lines would produce some desired object, then the computer would in effect be able to calculate and specify a numerical representation of a picture. These points could be printed-out on paper by the computer; then they could be connected together manually; but this procedure would be far too tedious. Instead, the coordinates are used to position the electron beam of a cathode-ray tube and in this way trace out the desired picture on the face of the tube. A 16-mm camera, also under control of the computer, photographs the tube face while the picture is being traced out. In this manner, the coordinates computed by the computer are automatically connected together to produce the desired movie.

Although the computer is fast enough to compute the coordinates for most movies at a rate of about 20 frames per second, the plotting equipment is unfortunately not so fast. Hence, the coordinates of the points and the camera control instructions are more efficiently all written by the computer on digital magnetic tape, and then the tape is later used as input to the plotter.

Three-Dimensional Pictures

A three-dimensional effect can be created by presenting two slightly different pictures separately to each eye. These two pictures are the perspective projections of some object as seen from two slightly different positions. Although the two perspectives are quite similar, the human brain translates their minute differences into a very realistic depth effect.

The mathematics for producing a perspective drawing is quite straightforward and is easily derived from simple geometric relations. The analytic approach results in formulas

A. Michael Noll has been a Member of the Technical Staff of Bell Telephone Laboratories, Inc. since June, 1961. His initial work at the Laboratories involved determinations of the subjective effects of peak-clipping distortion and sidetone on telephone communication. Last year, he was transferred to the Acoustics Research Department where he is investigating new methods for vocal pitch detection.

Mr. Noll is a Member of the Acoustical Society of America, the Audio Engineering Society, Tau Beta Pi and Eta Kappa Nu. His education includes degrees from Newark College of Engineering (BSEE) and New York University (MEE).

that give the two-dimensional coordinates of a three-dimensional point viewed from any specified position. These formulas were incorporated into a computer program so that the computer could calculate the points for the left and right perspectives of the three-dimensional coordinates specifying the desired object. The program also generated instructions for the plotter to produce a single frame of 16-mm film containing both the left and right perspective drawings.

Computer Method

The computer method for generating a three-dimensional movie is first to calculate, at some particular instant in time, the three-dimensional coordinates of the points in a line-drawing representation of the desired object. The three-dimensional movie program then calculates the points required for the two perspectives and also generates the instructions for drawing the perspectives with the plotter. The three-dimensional coordinates of the object at a small time increment later are then computed, and the three-dimensional program generates the instructions for another frame of the movie. This procedure is repeated on a frame-by-frame basis until the desired movie sequence is completed. The movie then exists on magnetic tape which is used as input to the plotter. The plotter decodes the instructions on the tape and repeatedly advances the film and deflects the electron beam until the entire movie is completed. Figure 1 is a simple block diagram of this process.

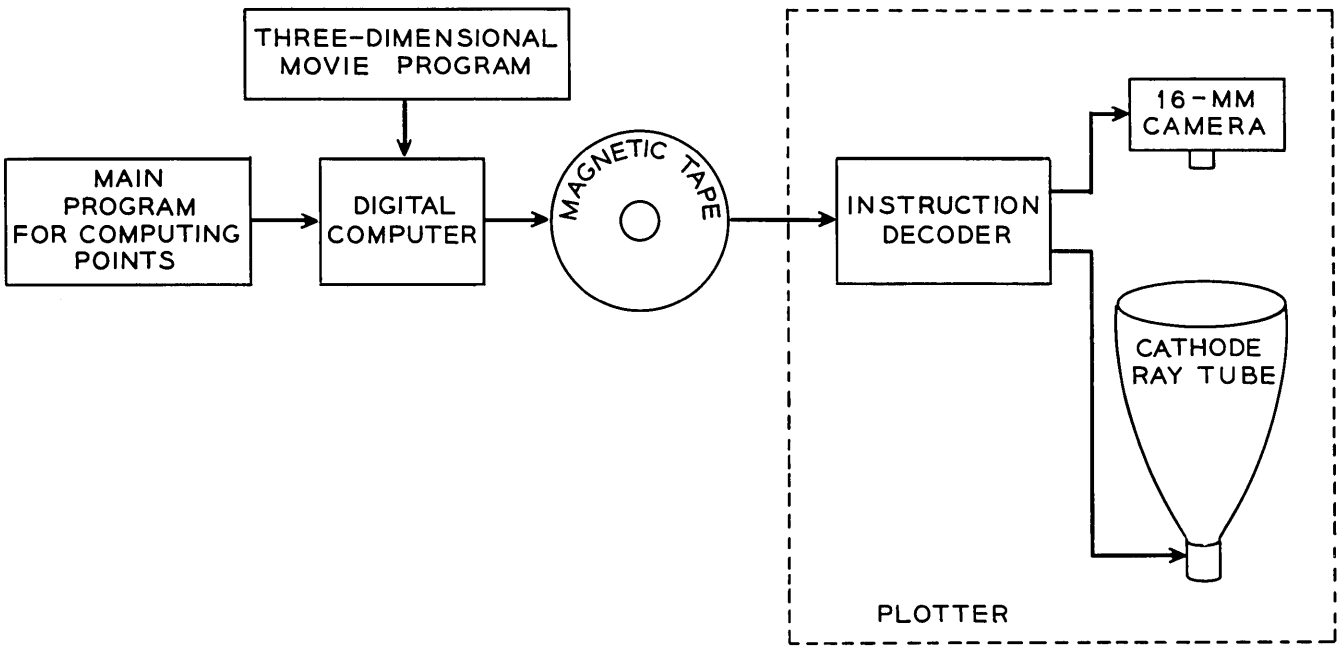


Fig. 1. Block diagram of computer technique for producing three-dimensional movies.

Since the three-dimensional projection calculations are somewhat lengthy, the projection program has been written so that only the lines which have changed from the previous frame are recalculated. The program notes any line changes and automatically recalculates only the coordinates of that line. All the points for the projected two-dimensional patterns are then connected by line segments.

The distance between the two viewing positions, the distance of these positions to the origin, and their angles of inclination and rotation with respect to the object are all easily varied so that the object can be viewed from any position and distance. The program also has provisions for plotting single characters (such as *, +, or .) at specified three-dimensional points.

Kinetic Sculpture

Most practical problems can usually be represented by only two spatial dimensions, so that any time variation can be introduced as the third dimension; a single three-dimensional plot is thus sufficient.

Any three-dimensional problems that do require time as a fourth variable can be adequately displayed by a two-dimensional perspective movie in which monocular depth clues provide a pseudo-depth effect. However, three-dimensional random objects have no monocular depth clues and therefore must be presented three-dimensionally. If the pattern changes with time, then a three-dimensional movie is required. For these reasons, the first three-dimensional movie was of a randomly-changing abstract design — a form of "kinetic sculpture."

Figure 2 shows a few frames from a computer-generated three-dimensional movie of a "kinetic sculpture." The object consists of 39 line segments sequentially connecting 40 points chosen at random to fall uniformly within a cube. At random times, one of the points is changed to a new random location within the cube, and the two lines attached to this point are instantaneously twisted to produce the new shape. These jumps occur very slowly at the beginning and end of the movie but at the relatively fast rate of one jump per frame during the middle portion.

The left and right perspectives are shown adjacent to each other in Figures 2, 3, and 4. A depth effect can be obtained by decoupling one's eyes sufficiently to produce double images. This task is made easier by first gazing beyond the page and then dropping the eyes to the page without refocusing; sometimes a piece of paper placed between and perpendicular to the two perspectives may be helpful. The third image usually is blurred, but if one focuses his attention on this center image, it will become clear and look remarkably solid.

Rotating Objects

Rotating objects can be displayed very effectively by three-dimensional movies, particularly if the object is geometrically

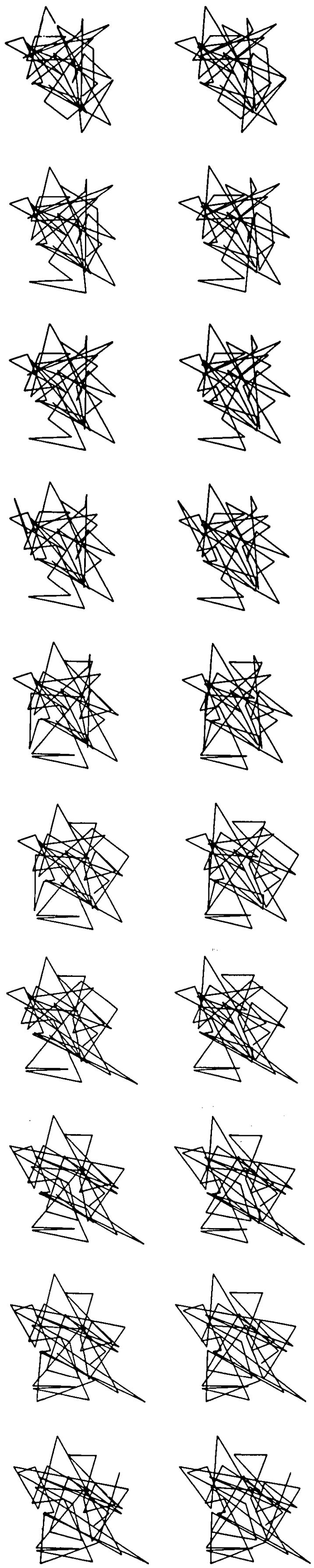


Fig. 2. Sequence from three-dimensional movie of a random line pattern.

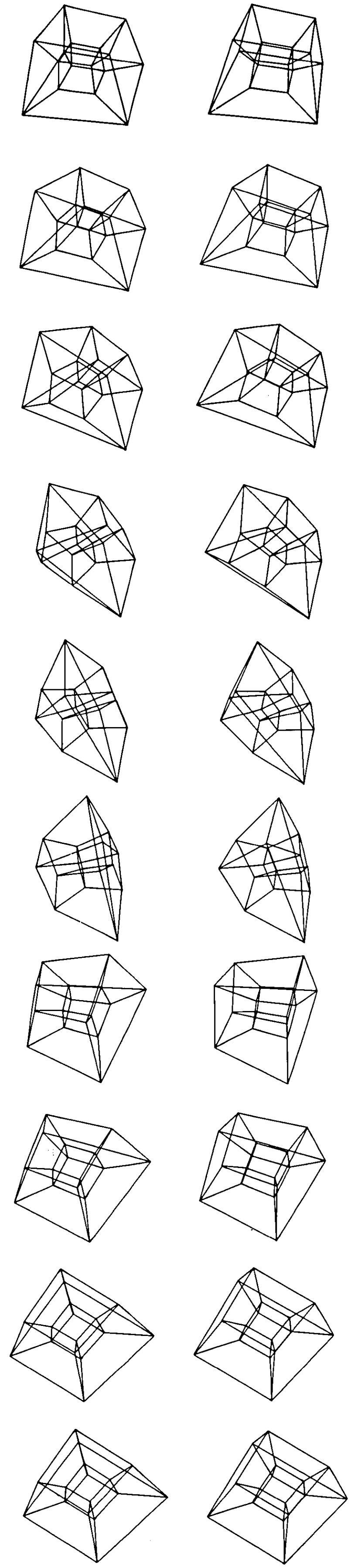


Fig. 3. Selected frames from movie of the three-dimensional projection of a rotating four-dimensional hypercube.

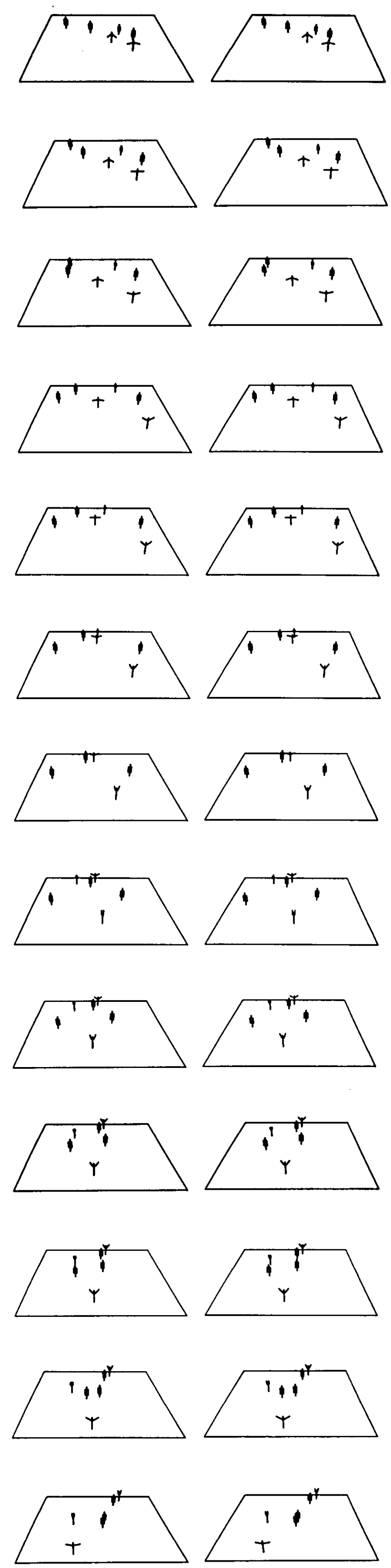


Fig. 4. Example of stick figure representation of human motion.

complicated as in Figure 3. This cube within a cube is the three-dimensional perspective projection of a four-dimensional hypercube. The hypercube is specified mathematically and is rotated in four dimensions by a matrix operation. The program and technique, incidentally, are very general; other four-dimensional objects can be similarly displayed. Extensions to even higher dimensions are also quite simple.

Motion of Stick Figures

The last example, Figure 4, is a simple attempt at stick-figure motion on a stage. The stage positions of the stick figures are chosen at random, and the figures move at uniform rates. Arm motion has also been programmed into the figures. The real goal of this project is to draw a complicated stick figure which can then be used in computer investigations and optimization of human movement.

Motion of a Membrane

Three-dimensional movies are presently being used to show simulations of the motion of the basilar membrane of the ear in response to an acoustic pulse. Such applications are being used by scientists in their explorations of the hearing mechanism.

The movies just described were generated with an IBM 7094 digital computer in association with a General Dynamics SC-4020 microfilm plotter equipped with a 16-mm camera.

Increase of Speed

The preceding examples indicate several possible applications of computer-generated three-dimensional movies in both the sciences and the arts.

Unfortunately, a time lag of a few hours exists between the actual running of the computer program and the final 16-mm movie. Most of this delay is contributed by the slowness of the plotter itself and the time required for processing the film.

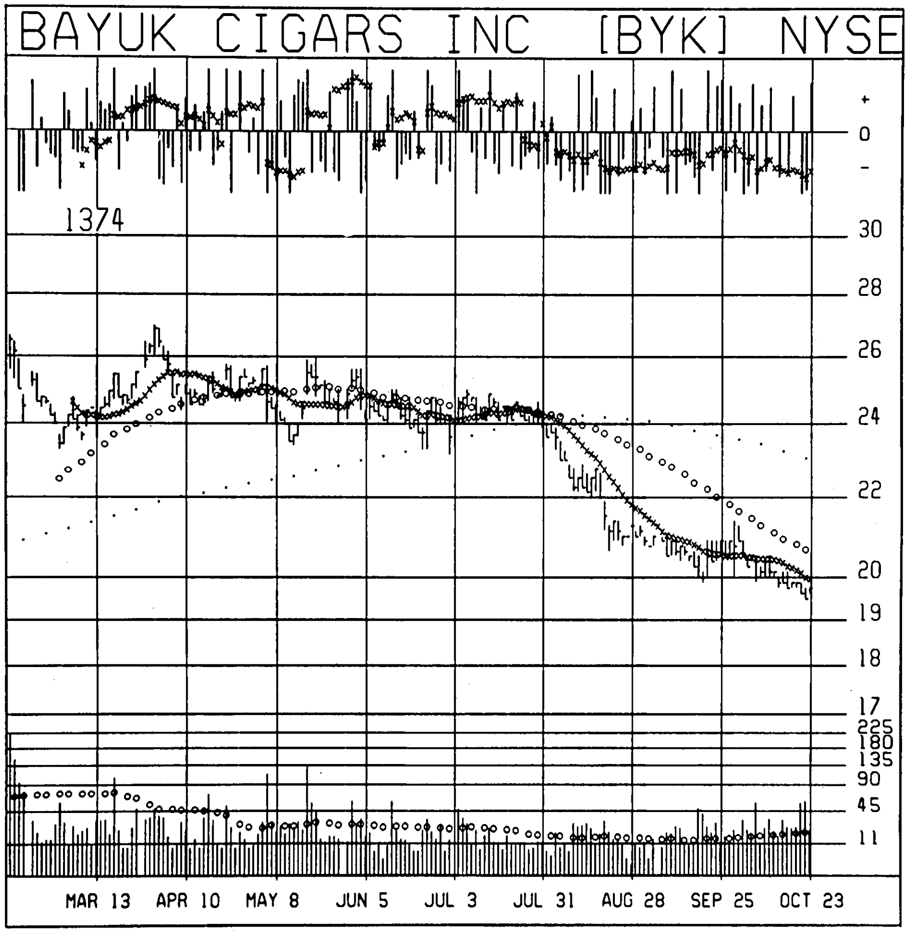
Ideally, the programmer-user should see the results while the program is running. Equipment has recently become available for immediate real-time visual displays of computer-generated data. This equipment usually uses a large cathode-ray tube to display the data, and provides light pens and other facilities for interacting with the computer while the program is running. Then, when the final desired results are obtained, a hard copy can be made with a conventional film plotter.

As the technology progresses, increasing numbers of scientists, animators, artists, and others will use the graphic capabilities of computers coupled with devices for producing visual output. Completely new approaches to presenting complicated concepts will become possible. The computer-generated three-dimensional movies described in this article are only a small glimpse at what the future may bring.

References

1. Edward E. Zajac, "Computer-Made Perspective Movies As A Scientific And Communication Tool," *Communications of the ACM,* Vol. 7, March, 1964, pp. 169-170.
2. Kenneth C. Knowlton, "A Computer Technique For Producing Animated Movies," *AFIPS Conference Proceedings,* Vol. 25, 1964, pp. 67-87.
3. A. Michael Noll, "Stereographic Projections By Digital Computer," *Computers And Automation,* Vol. 14, No. 5, May, 1965.

SOME APPLICATIONS OF GRAPHIC DATA OUTPUT



N. Waddington
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The computer recorder we discuss here is a microfilm printer-plotter which translates computer-generated data into visual forms. Its applications are steadily expanding. It is the S-C 4020 manufactured in San Diego, by the Data Products Division of the Stromberg-Carlson Corporation.

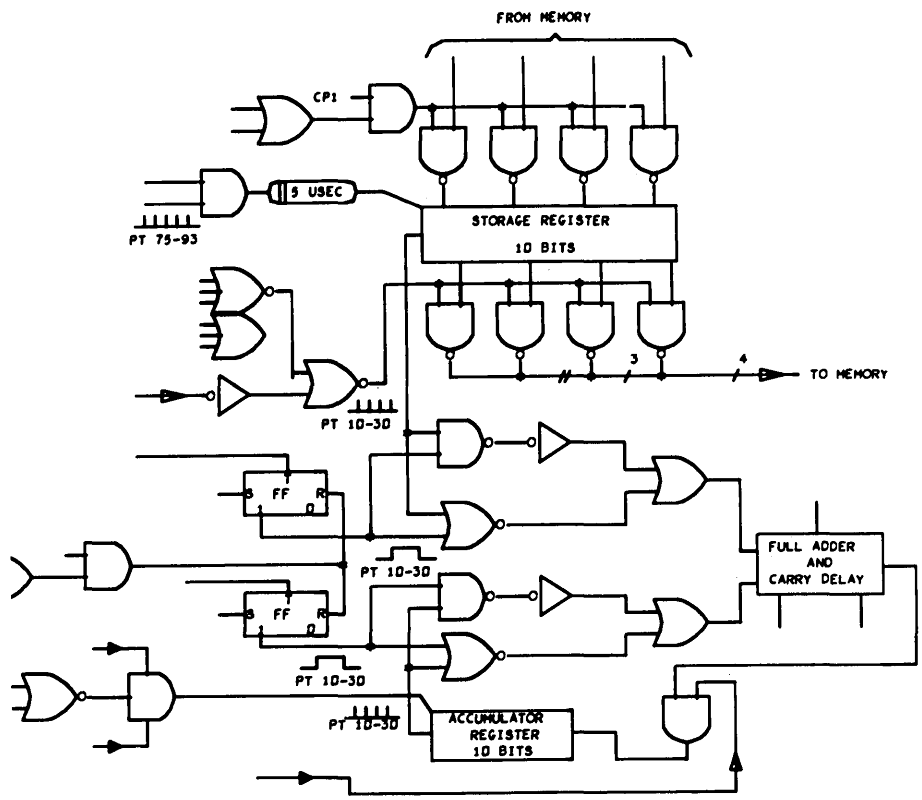
Although originally conceived as a one-of-a-kind type of equipment, the unit has received wide acceptance by industry, government agencies, and universities as a versatile output tool for computer users. More than 40 of the systems are now in use translating computer-generated data into drawings, annotated graphs, etc. The capabilities and applications of the system have grown continually during the five years since the first installation.

Requirements

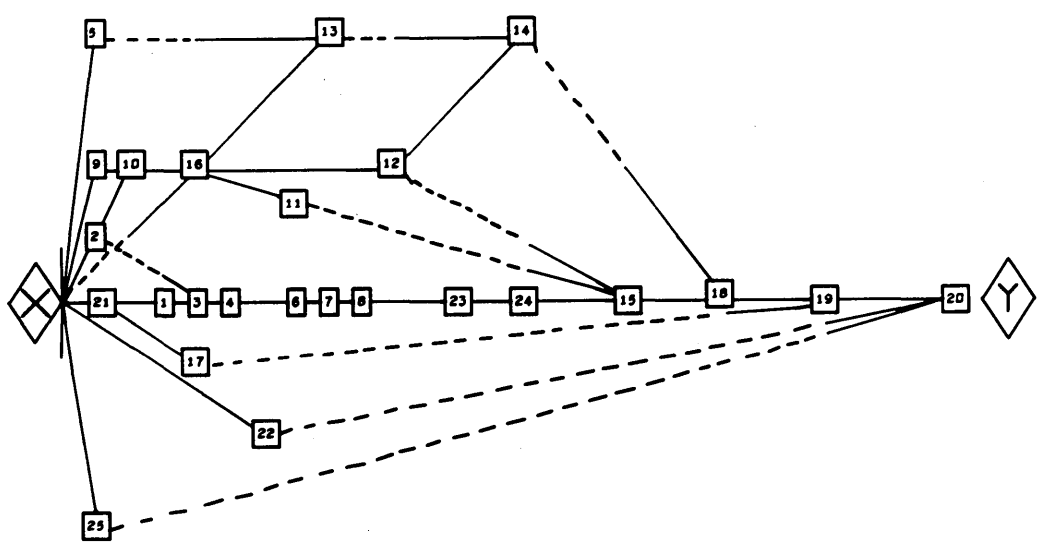
As the number of systems in operation grew over the past five years, requirements defined by users or potential users often preceded the capabilities of the equipment. In all cases, equipment modifications have satisfied these needs. Whenever a new application proved to have general usefulness, the added capabilities were incorporated into all leased equipment and made available to all users of sold equipment. The first two systems, delivered in the first quarter of 1961, remain in operation today after a combined usage in excess of 60,000 hours. During these 60,000 hours, the users of the equipment have enjoyed a useful realization (actual availability in hours/required availability in hours) of over 98 percent.

Machine Description

The unit accepts binary-coded inputs and converts these inputs into images that are recorded either on microfilm or photographic paper. The binary-coded input signals may come directly from a computer interface, or indirectly from a magnetic tape unit. In the system these binary codes are converted into images on the face of a shaped-beam tube. The images are alphanumeric, special symbols, plotted curves,

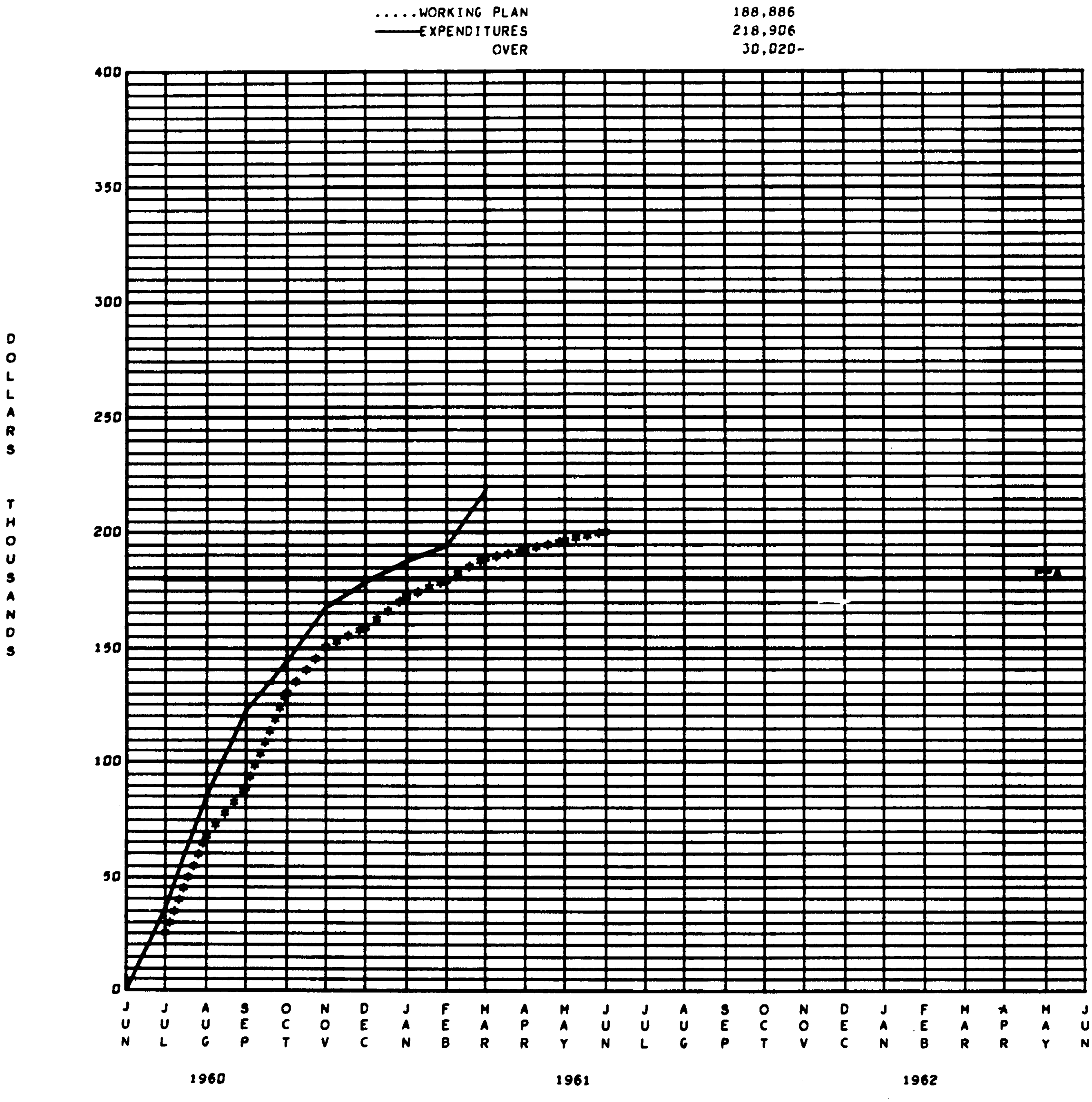


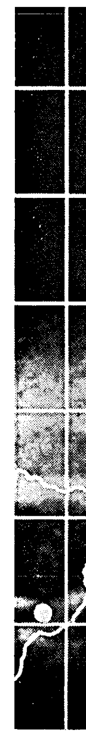
FEAS. STUDY GRAPHICAL SYMBOLS FOR LOGIC DIAGRAMS NO. 1
Y32.14 PAGE 16
THIS DRAWING MADE ON SC-4020 IN LESS THAN 1 SEC



A TYPICAL PERT SCHEDULE NETWORK

0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
TIME ~ WEEKS



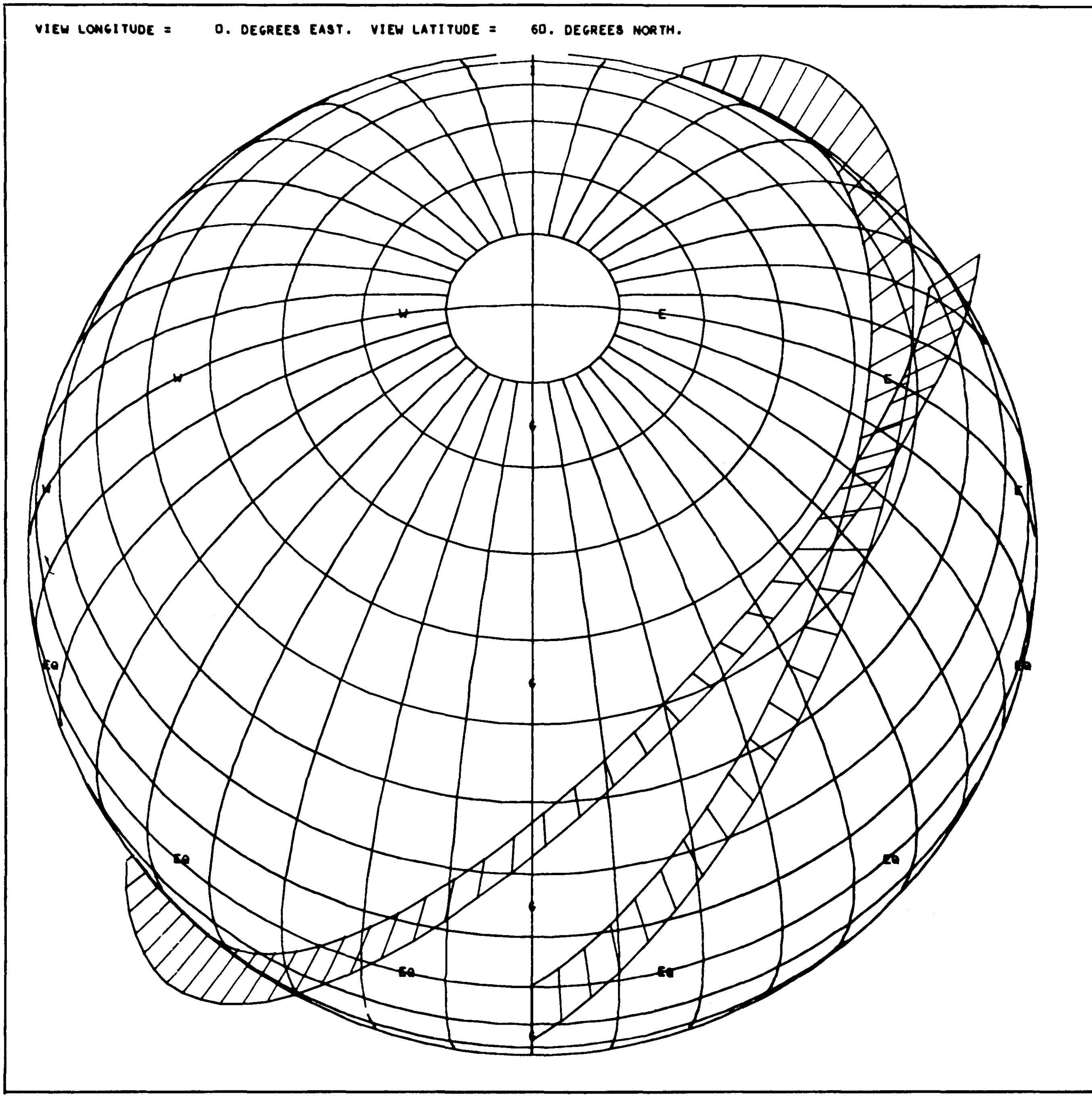


axis vectors, etc. These images on the tube face are permanently recorded on film or on photographic paper as hard-copy output.

Applications

Some of the types of output obtained from the system include the following:

1. Construction of PERT charts.
2. Orbital plotting of space vehicles.
3. Stock lists.
4. Computer-generated block diagrams.
5. Tool path drawings.
6. Business graphs.
7. Text in foreign language.
8. Movies.
9. Multiframe-length charts (using butted-frame techniques).



10. Polar plots and graphs.
11. Trajectory analysis.
12. Special and standard grids, with plotting points scaled to fit properly.
13. Automatic drafting.
14. Electron gun pictorial design.

Virtually anything that can be programmed can be recorded.

Samples of some of these types of output illustrate this article.

Users' Group

In 1961 the first meeting of users was held, and a year later UAIDE, "Users of Automatic Information Display Equipment," was formally organized. 25 papers were presented at the August 1964 meeting; and the proceedings of UAIDE contain a very large number of applications for the equipment.

COMPUTER PROGRAMMING: THE DEBUGGING EPOCH OPENS

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Throughout the history of electronic computing, some component of the total computing system has by its relative backwardness kept users from realizing the potential power of the rest of the system.

Until sometime in the later '50's, the limiting factor for most applications was hardware. Much of a programmer's effort during those early years was spent on planning how to squeeze a useful program into 4K of core, and how to time the reading of data so that it would be called for just as the drum brought it under the read head. The epoch of hardware-limited computing was brought to a close when machines in the class of the IBM 709, with its million-bit core, overlapped input/output, and 12 microsecond cycle time became common.

With King Log deposed, King Stork arrived in the shape of software-limited computing. FORTRAN was still having teething troubles, COBOL was as yet but a gleam in the eye of the Dept. of Defense, and the rest was assembly-language coding and hand-punched binary patches. We are now nearing the end of this second epoch. FORTRAN is as reliable and taken-for-granted as the machine it resides in. COBOL has not only been implemented but has occasionally even been well implemented. There are special application languages for every human activity this side of truffle-hunting. We have, then, machines big and fast enough to execute most useful programs, and software varied and reliable enough to get those programs written; what now? Now: debugging.[1]

Mistakes

That tendency to err that programmers have been noticed to share with other human beings has often been treated as if it were an awkwardness attendant upon programming's adolescence, which like acne would disappear with the craft's coming of age. It has proved otherwise. The satisfactory disposal for most purposes of the hardware and software problems promises to reveal the debugging problem as the new limiting factor in extending the computer's domain of application. Compilers have been so successful that they have brought back on a higher level one of the chief problems they were designed to solve. Compiler languages cut by an order of magnitude the number of statements to be written for the production of a given amount of machine-language coding; they substitute application-oriented vocabulary and format for machine jargon.

The Bug Rate

Many of us expected compiler languages to eliminate all bugs except those so glaring as to leap to the first fresh eye cast on the faulty program. We overlooked our species' trait of extending every new tool to the point where it is as strained and abused as the old one was when applied to its smaller tasks. An unfriendly behaviorist studying programmers might conclude that we deliberately elaborate our tasks so as to keep the bug rate constant. And we have, in fact, begun producing programs that contain as many compiler statements as there used to be instructions in the biggest machine-language programs, and whose field of application is so far removed from the notion of the language's designers that the mnemonics are useless or even misleading.

The Debugging Problem

But the debugging problem is not merely, as these observations suggest, as bad as ever; it is far worse. While programming bugs have learned to survive and even thrive in the compiler environment as staphylococcus aureus has in an environment of penicillin, the tolerance of our programs to their toxin has decreased markedly.

Two factors make bugs both harder to find and harder to tolerate: time-constrained programming and closed-loop applications. The requirement that program segments fit into arbitrary time periods introduces the timing bug, which is not just another category but rather a whole new dimension of error compounding, obscuring, and aggravating all other debugging problems. In the closed-loop computer applications, especially when human life is directly involved, it is imperative that bugs be gotten rid of before the computer goes on-line.

Lay Users of Computers

The greatest force making bugs less tolerable even as they grow harder to root out, though, is the increasingly lay character of the computer-using population. Another human trait which mechanization is forcing on our attention, is to refuse to extend any tolerance toward machine imperfections. This is most marked in the non-programmers, for whom the

M. I. Halpern entered programming in 1957 with IBM's Programming Research Department. He moved to Lockheed Missiles & Space Company (LMSC) in 1961 as Head, Computer Application Research. At LMSC, Mr. Halpern supervises a group working in the production of a meta-language compiler and in experimentation in areas of natural-language programming and debugging.

computer is merely a means to an end and not an object of interest in its own right. Reports on pilot experience with computer-controlled blind landing systems frequently note that pilots demand higher performance from such systems than they do from themselves. Similar reactions have been found in another area of man-machine interaction that is growing in importance, that of information retrieval. Drew and his co-workers, reporting on user reaction to an operational library reference retrieval system, write

> "An interesting remark was made by several users to the effect that it made them impatient to wait 60 seconds while their catalogue cards were being teletyped, even though they felt they were saving hours or days of manual search."[2]

It appears that people simply refuse to be kept waiting by machines even when they know they are being well served during the waiting period. (The historical and psychological roots of this attitude would be fascinating to explore, and might have some lessons for machine builders. It may be that humanoid robots, however impractical from a narrow engineering viewpoint, can be justified as a means of winning a necessary measure of tolerance from human users; robots may be more easily forgiven for error and delay than black boxes, on the grounds that they're "only human.")

The Memory Dump

Such is the nature of the epoch of computer usage we are moving into, armed with debugging tools inadequate even for today's problem — children with Flit guns about to meet the army ants. There has been talk for years about "source-language debugging," and even some claims that it had been realized in this or that system; but the distance we have yet to go to make good this boast is sufficiently indicated by the frequency with which we have recourse to the core-memory dump. The dump, still the major debugging tool for all but formal errors in the use of source language, represents a reversion to the more primitive machine-oriented level that is due to bankruptcy on the application-oriented level. In writing his program the programmer was dealing with (say) FORTRAN, not with a 7094, and when something goes wrong he wants to continue dealing with the familiar system. We give him a complete report on the state of the machine and leave him — or the systems programmer he will turn to — to infer the state of the processor. And as a final measure of futility and frustration, the dump will all too often prove useless because the program, running on after the bug had taken effect, has destroyed the evidence.

Systematic, Reasoned Approach

We are going to have to take the same kind of reasoned and systematic approach to debugging that we have been accustomed to give to mechanisms for producing coding, and the effort necessary before we learn how to do the job may be no less than was needed to teach us how to write translators. The procedures to be suggested here will seem over-elaborate to some; in five years' time they will seem as rudimentary as an octal assembly system would to today's meta-compiling, time-sharing, on-lining superprogrammer.

Three distinct phases of the debugging process can be identified, none adequately provided for in typical present-day processors:

1. Bug arresting
2. Bug identifying
3. Bug correcting

Bug Arresting or Rip Stopping

"Bug arresting" means becoming aware that something is amiss with a faulty program in time to preserve the evidence that will permit "bug identification," the pinning down of the specific fault. A great part of the conventional debugging chore lies in back-tracking from the point where a bug manifests itself unmistakably (by transferring control into data, for example) to the point where it originated. All too often, as noted earlier, a bug will have destroyed enough information to wipe out its own trail and make a number of cut-and-try runs necessary before we have even a meaningful dump. What is needed to deal with this problem is something analogous to the airplane designer's rip-stopper. The rip-stopper is a reinforcing member installed at regular intervals along panels of stressed sheet metal such as fuselage skin. It is there to ensure that a rip occurring anywhere in that skin cannot propagate itself beyond a certain line — namely, the nearest rip-stopper — and thereby to guard against disasters like sudden depressurization at altitude.

Debugging Mode

To build rip-stoppers into programs it will be necessary first to provide processors with two distinct modes of operation, a Debugging and a Production Mode. In Debugging Mode, which would be used until a program was considered satisfactorily checked out, the processor would expect from the programmer two kinds of information not conventionally provided. These are (1) upper and lower limits — and, where appropriate, step size — for every numeric variable in the program, and (2) limits within which transfers were legitimate. The compiler operating in Debugging Mode would cause all computation and transfer of control to be executed interpretively, with a programmer-specified error action taken as soon as any attempt to transgress one of these limits was detected. Neither deductive proof nor substantial experimental results are available to support the contention that these two stoppers would suffice, but it is clear they would go far toward the goal, and that they constitute a necessary minimum.

The Timing Bug and Timing-Constraints

The control of the timing bug more than any other requires that the programming system of the near future do a great deal more than any does today. A more detailed sketch of the kind of processor required has been offered elsewhere[3]; briefly, it should upon demand generate coding that is interpretively executed, like that produced by Debugging Mode, but with the purpose of computing the execution time of the compiled instructions rather than of checking their validity. The programmer would be able at any point to have recorded the exact execution time elapsed since some datum point, either for the built-in worst-case condition or for such data as he provided.

Ambitious though this may seem, it may well be that really firm control over time-constrained programming can be achieved by nothing less than what we have called (in the study cited above) the Synthetic Timing Mode of compilation. In this Mode, the timing-constraints are given as parameters to the processor, which then assumes full responsibility for their observance, just as a dynamic memory allocation algorithm does (or would do) for space constraints.

The implementation of such a processor is going to need the kind of programmer celebrated by old-timers in the yarns they spin about the CPC, Mark I, and the like, but these must somehow be found. Experience with time-constrained programs so far suggests that as a general rule it is nearly impossible to debug them in the usual sense of removing embedded bugs; the approach must be prophylactic rather than curative — which means the problem must be taken out of the application programmer's hands and put in those of the system he will employ. The subject of time-constrained programming, its problems, and their management is much too rich to be dealt with in any except the most rudimentary and suggestive fashion here, and it is only because of the impossibility of dealing adequately with it in these few pages that we revert in what follows to a consideration of the mere logical bug.

The Logical Bug and System Dumps

With bugs arrested by means of the devices described and such extensions as experience dictates, the problem to be faced is that of bug identification. Here we draw on the notion of the dump — but a dump of the system, not of the machine. As suggested earlier, the fact that we revert with any but the most trivial bug from being FORTRAN programmers to something like customer engineers is due to the unspoken but widespread idea that some day programmers will learn not to make mistakes. There are even traces of a feeling that to provide programmers with better tools for debugging would only encourage them in their disgusting habit. More power to those who want to get at the root of the problem by reforming programmers or by creating "systems so perfect no one will need to be good"; but until that breakthrough it will be worth risking the charge of being soft on bugs to get programming systems to tell the programmer what they can of his troubles.

What a programming system should offer is a print-out of its own contents, fully structured, interpreted, and captioned, and ordered so as to correspond to the steps of a standard bug-investigating procedure. Tables should be tabular, character strings linear, and so on; numbers should be represented in the appropriate external format and radix, and English-language labels, reminders, and warnings used freely. Where bits and pieces of what is logically a single item or package of information are scattered throughout the machine (as they will be, for example, when stored in threaded lists), they must be gathered and printed in unified form.

XRAY

The detailed list of what must be displayed and in what order will, of course, vary from system to system. But the general principles to be observed in implementing the XRAY (as I have dubbed it) are clear: show the programmer the system, not the machine, and do so in his language, not octal or hexadecimal.

The XRAY feature is bound up with Debugging Mode, in that the production of an XRAY will generally be one of the actions a programmer will order to be taken in the event that any of the limits he laid down is overstepped at execution. The experience accumulated so far with the XRAY feature suggests not only that non-professional programmers can debug their own programs with much less help from systems or other machine-language programmers, but also that they can occasionally identify bugs in the system and point them out to systems programmers.

The Trace Routine

The XRAY should largely displace as a major debugging tool not only the dump but the trace routine. Traces embody the good idea of catching a bug the first time it manifests itself, but they also commonly embody several shortcomings: they will record the history of only a few explicitly specified cells, and print their contents at certain arbitrary moments such as executions of transfers. What is wanted, and what the combination of Debugging Mode and the XRAY supplies, is a silent checking of all key variables, with print-out of all needed information when any anomaly is found.

Bug Correction

Bug correction is less a problem than the two phases of the debugging process already touched on, but even for this phase a little more can be done, at least for some programmers. Broadly speaking, the two paths open today to the programmer who has identified a bug in his program are re-compilation and load-time patching. The trouble with the former is that, given a large program and a trivial bug, it involves an expense far out of proportion to the change that is to be made. The latter has the fault of failing to provide a listing, and thus of leading to the nasty situation of the deck that doesn't correspond exactly to its documentation. Both methods have the shortcoming of providing only for unconditional load-time change to the program to be altered.

Symbolic Language Patching

For the programmer who knows only compiler language, of course, there is no real choice; he re-compiles. For the programmer who knows assembly language and has a listing of the program to be patched the load-time correctors are a real option and, for him, a third possibility is now open. This is a miniature assembly program, packaged as a closed subroutine, that is loaded along with the object program to be corrected and resides in memory ready to be called on whenever the programmer chooses. The programmer must activate the routine by telling it where the input and output buffers are, and what cue-words it is to search the input stream for as signals that a patch is about to enter or is complete. When it sees the cue-word that signifies that a patch follows, it diverts the input stream to its own work area, where it assembles the symbolic-language patch. When the cue word for the end-of-patch is found, it will transfer control to the patch or back to the object program, as directed.

The special advantage of this method over re-compilation or re-assembly is that it is faster. The special advantage over load-time correctors is that it produces integral documentation; while assembling, the subroutine produces a listing on the system output tape. A record of all patches in both symbolic and absolute form is printed along with the output of the patched program, in a position that corresponds to the points where those patches were introduced.

The general advantage that the subroutine described offers over both conventional correction methods is that it is not limited to unconditional load-time changes. It may be called upon to modify the object program with which it shares memory at any time during a run; and the carrying out of any of these modifications may be made contingent on any condition the programmer can test for. Where several different versions of some procedure are to be tried, the constant availability in core of an assembler means that all of them can be tested during one run, with a saving in turn-around time that can be an important consideration.

Confronting the Debugging Problem

The adequacy, even the desirability, of any of the debugging measures proposed here may be open to question. What is certain is that the debugging problem must be confronted squarely and soon if the computer is to take on some of the critical roles it is presently being cast for. A dismal end would come to the many splendid elaborate plans being made everywhere with the computer as their cornerstone, if it turned out that we simply could not trust the programs that will have to animate and control these elaborate systems. The danger is real and imminent. The remedy will require the commitment of the programming community's full resources.

Notes and References

1. This seems to be the viewpoint taken also in W. S. Brown, "An Operating Environment for Dynamic-Recursive Computer Programming Systems," *Comm ACM,* VIII (6), June 1965, pp. 371-77, where we read (p. 371), "OEDIPUS [the system described in the paper] is based on the premise that debugging is a central problem, perhaps *the* central problem, in the implementation and in the operation of any large programming system." Brown goes on to discuss some uncommon system debugging aids in a paper well worth reading.
2. See D. L. Drew, R. K. Summit, R. I. Tanaka, and R. B. Whitely, *An On-line Technical Library Reference Retrieval System,* Lockheed Missiles & Space Company Technical Report 6-75-65-17, Palo Alto, Calif., May 1965. A summary of this report will appear in Vol. II of the IFIP 65 Congress *Proceedings.*
3. See M. Halpern, *A Programming System for Command and Control Application,* 2nd ed., Automatic Programming Information Bulletin No. 23, Brighton, England (October 1964), pp. 23-25.

CALENDAR OF COMING EVENTS

Nov. 29, 1965: Annual Fall Symposium of the Digital Equipment Computer Users Society (DECUS) Stanford University, Tresidder Union Hall, Stanford, Calif.; contact Ken Gold, Digital Equipment Corp., Maynard, Mass.

Nov. 30-Dec. 2, 1965: Fall Joint Computer Conference, Convention Center, Las Vegas, Nev.; contact W. D. Orr, S.F. Assoc., Thousand Oaks, Calif.

Nov. 30-Dec. 3, 1965: Four-Day Institute on the Impact of the Computer Revolution on Law and the Administration of Justice, sponsored by American University's Center for Technology and Administration, Twin Bridges Marriott Motor Hotel, Washington, D. C.; contact Paul W. Howerton, Director, Center for Technology and Administration, The American University, 2000 G St., N. W., Washington, D. C.

Dec. 3-4, 1965: 6th International SDS Users Group Meeting, Dunes Hotel and Country Club, Las Vegas, Nev.; contact Dr. Robert J. Stewart, Jr., Cyclone Computer Center, Iowa State University, Cedar Falls, Iowa

Jan. 31-Feb. 4, 1966: International Symposium on Information Theory, UCLA, Los Angeles, Calif.; contact A. V. Balakrishnan, Dept. of Engrg., Univ. of Calif., Los Angeles, Calif. 90024

Mar. 21-24, 1966: IEEE International Convention, Coliseum & New York Hilton Hotel, New York, N. Y.; contact J. M. Kinn, IEEE, 345 E. 47 St., New York, N. Y. 10017

Mar. 24-26, 1966: 4th Annual Symposium on Biomathematics and Computer Science in the Life Sciences, Shamrock Hilton Hotel, Houston, Tex.; contact Office of the Dean, Div. of Continuing Education, Univ. of Texas Graduate School of Biomedical Sciences at Houston, 102 Jesse Jones Library Bldg., Tex. Medical Center, Houston, Tex. 77025

May 3-5, 1966: British Joint Computer Conference, Congress Theatre, Eastbourne, Sussex, England; contact Public Relations Officer, Institution of Electrical Engineers, Savoy Place, London, W.C.2, England

May 10-12, 1966: National Telemetering Conference, Sheraton-Boston Hotel at Prudential Plaza, Boston, Mass.; contact IEEE, 345 E. 47 St., New York, N.Y. 10017

May 16-20, 1966: Australian Computer Conference, Canberra, A.C.T., Australia; contact S. Burton, Honorary Secretary, P.O. Box 364, Manuka, A.C.T., Australia

May 18-20, 1966: 29th National Meeting of the Operations Research Society of America, Los Angeles, Calif.; contact Dr. John E. Walsh, System Development Corporation, 2500 Colorado Ave., Santa Monica, Calif. 90406

May 30-June 1, 1966: National Conference of the Computing and Data Processing Society of Canada, Banff Springs Hotel, Banff, Alberta, Canada; contact Mr. K. R. Marble, Mgr., Systems and Computer Services Dept., Western Region, Imperial Oil Ltd., Calgary

June 15-17, 1966: 1966 IEEE Communication Conference, Sheraton Hotel, Philadelphia, Pa.; contact Lewis Winner, 152 W. 42nd St., New York, N.Y. 10036

June 20-26, 1966: 3rd Congress of the International Federation of Automatic Control, London, England; contact American Automatic Control Council, c/o Dr. Gerald Weiss, Electrical Engineering Dept., Brooklyn Polytechnic Institute, 333 Jay St., Brooklyn 1, N. Y., or IFAC Secretary, Postfach 10250, Düsseldorf, Germany

CHARACTERIZING DOCUMENTS— A TRIAL OF AN AUTOMATIC METHOD

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The purpose of this short article is to report on the results of an experiment in which a completely automatic method of deriving the significant words in a text was used. The method, which involves only a word frequency analysis, is shown to lead to a simple procedure for retrieving significant information.

Elaborate vs. Simple Techniques

Much effort has been spent in devising rather elaborate methods for establishing the technical content of documents. But here we seek to illustrate the virtues of an extremely simple technique for characterization and to show how it worked in one particular case. The main value of the method lies in the fact that it requires no human inspection of the document and is well suited to computer operation.

The Method

The method consists in having a computer: (1) make a word-frequency analysis of the whole of the input document; (2) sort the words into a list in descending frequency of occurrence; (3) compare the frequency of the words with a standard frequency; and (4) apply a test to determine unusual frequency.

The frequency of each word in the list for the input document may be compared with its frequency of occurrence in one of the standard lists of word frequencies—e.g., Dewey's. [1] Any word which occurs more than five times as frequently as in normal usage is regarded as significant; the machine then puts out a frequency-ordered list of such words.

The factor five in frequency is an arbitrary one and may be varied according to the amount of detail which is required in the output.

A Practice Trial

For a test in a sample case, the method has been applied to a paper by Stiles[2] with results as shown in Table 1. This table shows the sort of situation which is encountered.

If discrimination based on 5 times the standard frequency is applied, the resulting list of selected (abnormally frequent) words, in descending order of frequency is:

> Terms, request, documents, term, document, association, generation, list, indexed, used, profiles, number, each, where, second, related, information, index, collection, system, profile, relevance, expanded, thin, step, statistical, friction, film, factors, exposure, called, appear, synonyms, retrieval, language.

"Noise"

Anyone who is familiar with the paper by Stiles is likely to agree that the list of words just given provides a very good description of its contents. Yet there is a certain amount of "noise", particularly the words: *used, each, where, second, called, appear.*

Some of this "noise" could have been removed by increasing the selection factor to, say, 10. In this case the list of characteristic words would have become:

> terms, request, documents, term, document, association, generation, list, indexed, used, profiles, number, second, related, information, index, collection, system, profile, relevance, expanded, thin, step, statistical, friction, film, factors, exposure, appear, synonyms, retrieval, language.

It may well be that the words *used* and *appear* which are still in the list may, in fact, be relevant.

As may be seen, the use of this technique is simple and automatic.

A Measure of Relevance for Retrieving Related Papers

This method also makes possible an easily mechanized retrieval technique. Thus, assume that we know that a certain important paper is highly relevant to the subject being retrieved. Suppose the foregoing analysis is performed upon this paper and produces a table of words with frequencies. Then this set of word frequencies may be used as a standard in place of the Dewey (or some other) standard. Then a "criterion of relevance" for another paper could be defined based on a measure of the amount of the differences between the word frequencies for that paper and the new standard. For example, such a measure could be that:

the sum of the squares of the differences of the relative frequencies should be less than some agreed value.

Using this method it is not necessary for the user of a file of information to formulate a question to the file; he need only know one paper relevant to his field of inquiry.

Finding Papers Frequently Using Special Topic Words

Suppose that even one relevant paper is initially unknown. Then the searcher attempts to formulate a question to the file in the form of a list of topic words in descending frequency of importance. This list is then used to retrieve documents in the way just discussed. The documents are then examined by the questioner; and the frequency analysis of any relevant documents is used to produce an improved question.

The method may thus become a self optimizing one between man and machine.

This technique can be generalized still further so that, quite apart from using selected document analyses to improve the procedure, the frequency lists derived from these documents may be modified by the human questioner so as to bring retrieved material into closer relationship with that desired. In our example, for instance, it could be concluded from an examination of Stiles' paper that the words *friction, film* and *exposure,* were not relevant to the subject of association factors in information retrieval and that therefore these words should be given zero frequency in the list of criterion words and frequencies.

The potential applications of this system are considerable. It is hoped to conduct some large-scale tests of its validity in connection with large sets of documents.

Dr. Andrew D. Booth is Dean of the College of Engineering at the University of Saskatchewan. Previously, he was Director of the Computation Laboratory at Birkbeck College, University of London, London, England. He is the author of many books and over 100 papers in the field of computers, and is well known as a contributor to the design, construction, and programming of computers.

References

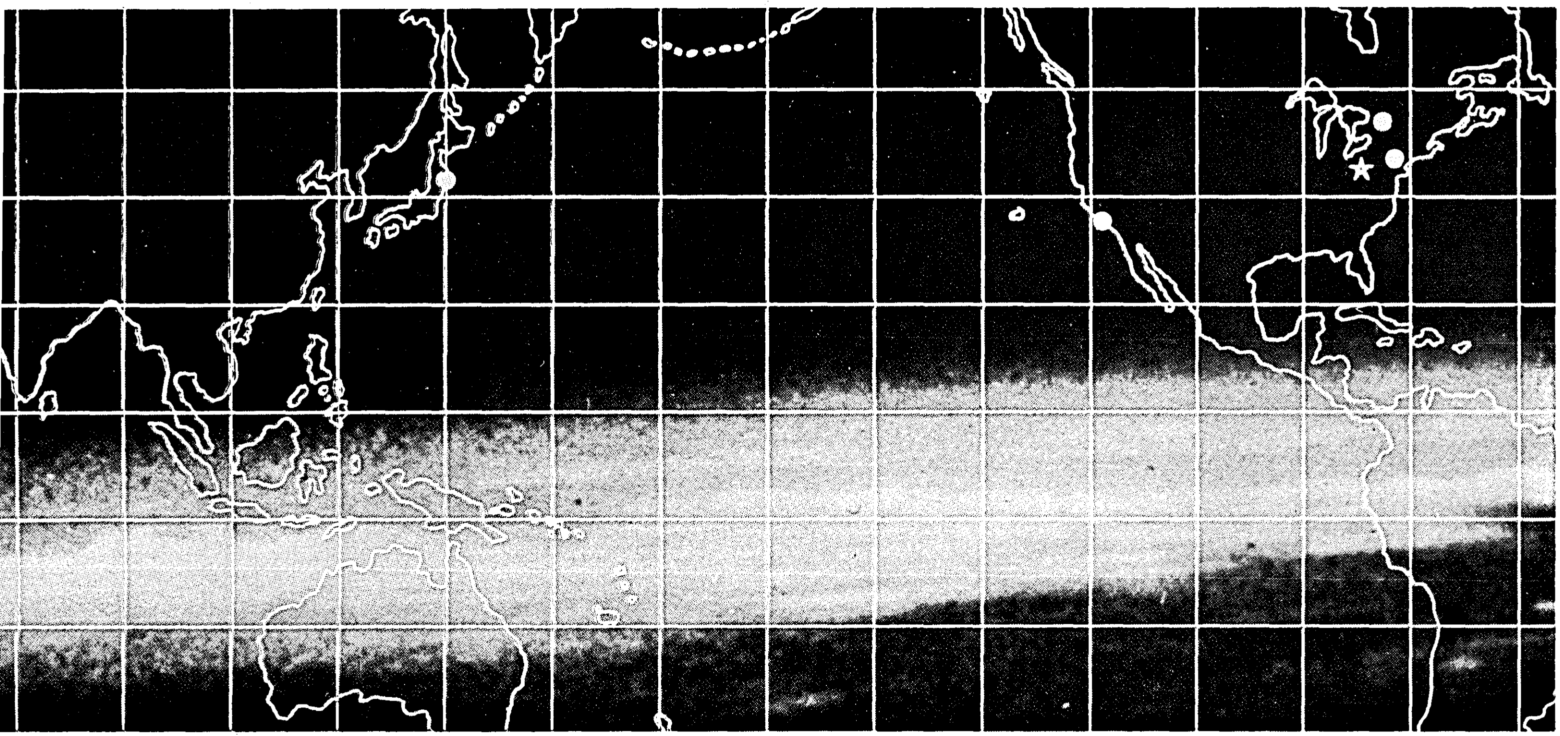
1. Dewey, G., "Relation Frequency of English Speech Sounds", Harvard University Press, 1923.
2. Stiles, "The Association Factor in Information Retrieval," in the "Journal of the Association for Computing Machinery", vol. 8, (1961), pp. 271-279.

Table 1 — COMPARISON OF WORD FREQUENCY IN SAMPLE ARTICLE WITH STANDARD WORD FREQUENCY

In the table, column (1) shows Frequency Rank, column (2) is Word Occurring, column (3) shows Relative Frequency, column (4) shows Standard Relative Word Frequency (Dewey), and column (5) indicates with an "x" Is Difference Significant? (Test: more than five Times as Frequent).

(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
1	the	1	1	-	30	first	.082	.018	-	59	relevance	.037	.0015	x
2	of	.56	.55	-	31	been	.078	.045	-	60	expanded	.037	.0015	x
3	terms	.40	.0023	x	32	list	.074	.0029	-	61	thin	.033	.0015	x
4	to	.33	.40	-	33	indexed	.074	.0015	x	62	their	.033	.043	-
5	a	.26	.29	-	34	used	.069	.0062	-	63	than	.033	.027	-
6	and	.25	.45	-	35	profiles	.069	.0015	x	64	step	.033	.0019	-
7	in	.22	.29	-	36	number	.069	.0044	-	65	if	.033	.036	-
8	we	.21	.072	-	37	each	.065	.0086	-	66	has	.033	.053	-
9	request	.20	.0015	x	38	will	.061	.061	-	67	when	.029	.032	-
10	documents	.16	.0015	x	39	where	.057	.011	-	68	statistical	.029	.0015	x
11	by	.16	.082	-	40	these	.057	.021	-	69	no	.029	.044	-
12	is	.14	.17	-	41	all	.057	.064	-	70	friction	.029	.0015	x
13	be	.14	.12	-	42	or	.053	.063	-	71	film	.029	.0015	x
14	that	.13	.18	-	43	only	.053	.026	-	72	factors	.029	.0015	x
15	term	.13	.0015	x	44	had	.053	.056	-	73	exposure	.029	.0015	x
16	for	.13	.14	-	45	an	.053	.045	-	74	can	.029	.027	-
17	are	.13	.075	-	46	they	.049	.063	-	75	called	.029	.0044	-
18	document	.12	.0015	x	47	second	.049	.0033	-	76	appear	.029	.0015	x
19	with	.114	.10	-	48	related	.045	.0015	x	77	use	.025	.0087	-
20	which	.106	.062	-	49	it	.045	.161	-	78	synonyms	.025	.0015	x
21	association	.098	.0015	x	50	information	.045	.0033	-	79	such	.025	.018	-
22	our	.094	.045	-	51	index	.045	.0015	x	80	same	.025	.0091	-
23	not	.094	.081	-	52	collection	.045	.0015	x	81	retrieval	.025	.0015	x
24	on	.090	.088	-	53	system	.041	.0026	-	82	other	.025	.0094	-
25	have	.090	.085	-	54	profile	.041	.0015	x	83	most	.025	.014	-
26	this	.086	.078	-	55	one	.041	.050	-	84	more	.025	.029	-
27	generation	.086	.0015	x	56	new	.041	.014	-	85	may	.025	.022	-
28	as	.086	.11	-	57	from	.041	.059	-	86	language	.025	.0015	x
29	would	.082	.035	-	58	those	.037	.014	-					

NCR is moving fast in worldwide business automation.



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ADVANCED PRODUCT PLANNING SPECIALISTS
To work in advanced product planning group responsible for determining and analyzing requirements of new product markets, recommending product development programs needed to promote new ideas, formulating and specifying new products based on state-of-the-art and beyond-the-state-of-the-art hardware, software, and application concepts.
Ability to deal with "total systems" concept in a business data processing environment is essential. Specific experience in such areas as time sharing systems, multi-processing, data transmission technique, programming language design, list processing, and information retrieval is desirable.
Requires a broad background in business data processing systems with a minimum of eight years of hardware and software systems design experience. Advanced engineering or science degree desirable.

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For analysis and design of complex computer mechanisms. Must have knowledge of applied mechanics and high-level mathematical ability. PhD required.

MAGNETIC RECORDING SPECIALISTS
Senior and intermediate positions for men with experience in advanced magnetic recording techniques. Knowledge of media, circuitry and magnetic head design necessary. Requires BS in engineering or physics.

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Positions require a BSEE degree with experience in designing digital computer equipment and in maintaining liaison with manufacturing.

PACKAGING
Positions entail layout and design of packaging for computer systems. Applicants must have previous experience with electronic computers or electro-mechanical devices. Background in miniaturization utilizing thin films and integrated circuits is desirable. BSEE required.

SOFTWARE PROGRAMMING
Positions entail development of software for various computer input/output routines, operating systems and monitors. Applicants must have previous programming experience with machine language on a large file computer.

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Positions require previous experience in programming for design automation, good understanding of engineering and hardware problems, and BS degree in math, engineering or related field.


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trace
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curves

c&a CAPITAL REPORT

A Special Report from C&A's Washington Correspondent

The second session of the 89th Congress will convene sometime in January. It should prove to be a busy time for Government people involved in computer management and policy matters. As mentioned in this column last month, H. R. 4845, a bill to streamline management of Government computers, has passed the House of Representatives. It must now be considered by the Senate, but the busy schedule of the Senate Committee on Government Operations, which is now responsible for the bill, will push its consideration into the session beginning January. Government agencies and departments will be asked to testify at hearings before this committee, which is chaired by Sen. John McClellan.

In addition, the House Post Office and Civil Service Committee may take another hard look at EDP matters during the same session. Under the guidance of Rep. Arnold Olsen, its Subcommittee on Census and Government Statistics held extensive hearings a few years ago and precipitated many changes in the management and selection of computers. Rep. Olsen indicated recently that he is interested in holding further hearings, probably early in the session, with particular emphasis on the effect of computers on manpower. For example, he pointed to the current shortage of programmers in the Government. This subcommittee may also delve into the area where Federal and State governments overlap in EDP matters.

More than 2,000 leading figures in international law met in Washington in September to attend the Conference on World Peace Through Law. Automation of law was one of the major topics they considered.

The Conference's Automation of Law Committee, chaired by John R. Dere, believes that automation is one of the means of securing a peaceful world. Formed in May 1965, it is studying many aspects of automation and considered the following at the conference:

(1) The impact a national information center would have on law.
(2) Automation of space law.
(3) International cooperation through automated national networks.
(4) Problems in indexing international law for better retrieval.

On the fourth point, Prof. W. T. Mallison, Jr., of George Washington University Law School, told a special session of the Committee that there is a drastic need for the automatic retrieval of international law because lawyers today are confronted with an exponential increase in the number of cases, treaties, relevant municipal enactments, and other source materials they must work with.

"The amount of this material confronts the lawyer with a dilemma," he said. "The material is indispensable to the development and improvement of the law, as well as to thorough research and professional workmanship, but at the same time its quantity makes it more and more difficult for the lawyer to obtain access to it."

By automatic retrieval methods, Prof. Mallison said, such material as "The United Nations Treaty Series," "The Foreign Relations of the United States," or diplomatic papers of other countries would be made readily accessible to lawyers.

Methods of selecting computers are being studied currently to arrive at the best, most objective analysis of each computer proposed to the Government.

The Department of Defense, largest user of computers in the world, held an inter-service meeting at Hanscom Field, Mass., this fall to exchange information among the military services on how they choose computers. In addition, the Bureau of the Budget solicited computer manufacturers this summer for their thoughts about selection procedures. How many manufacturers responded or how their opinions will be put to use is not known at this time, but some manufacturers have been waiting for such an opportunity for a long time; it is certain their opinions were readily available.

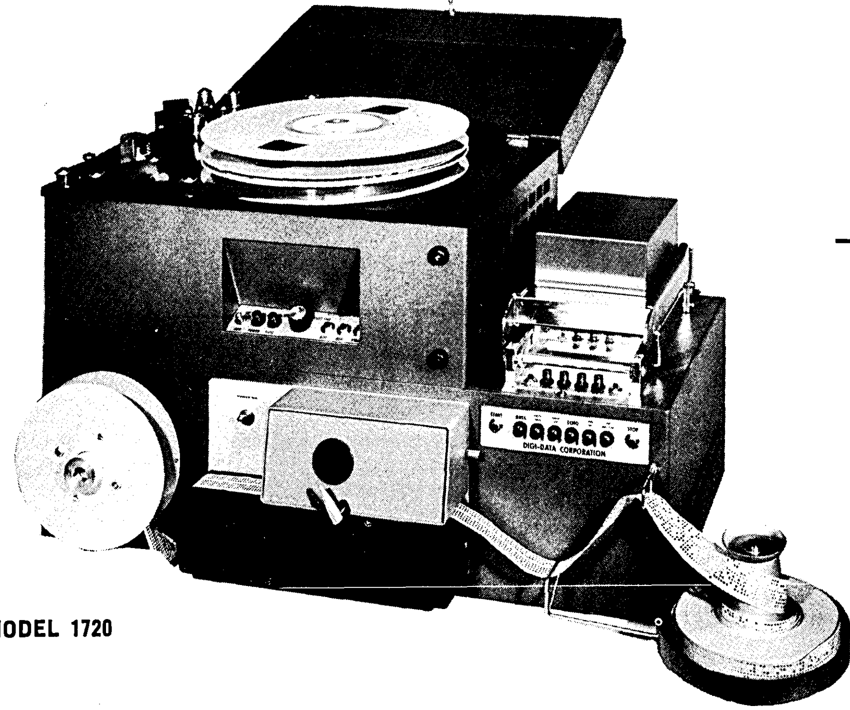
The Department of Defense meeting, "EDP Equipment Selection Methodology and Selection Data Exchange," was called by the Air Force Electronic Systems Division. This was the first of a series of regular one-day conferences to be held each quarter by the Air Force, Army, Navy, Marine Corps, and Defense Supply Agency.

Col. Edward McCloy, head of the Air Force EDP Equipment Office and chairman of the meeting, said, "Our joint efforts will provide the means through which the military services will benefit mutually in the computer area, and at the same time we will assist in advancing the equipment selection state-of-the-art."

James Titus

JAMES TITUS

SOME THINGS ARE BETTER DONE OFF LINE —



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— Paper Tape to Magnetic Tape Conversion for example;

- Virtually any paper tape reader will limit the speed of your computer, but now your computer can run at full speed.
- The Model 1720 uses center tape unwind for simplest possible tape loading and handling.
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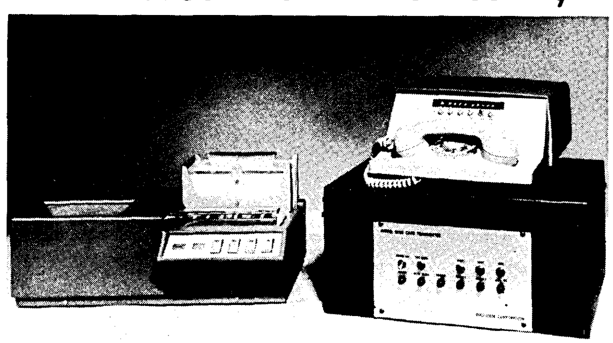
- Minimizes computer scheduling problems.
- Broad programming capability handles virtually all code conversion or format conversion requirements.
- Minimal space required; any table or desk will serve the purpose.
- Easy on tape—mangled tapes are unheard of.
- Nationwide service.

— Low-cost Data Transmission;



In addition to our line of converters, Digi-Data Corporation manufactures card and paper tape Data-Phone® transmission units such as the Model 2120 Magnetic Tape Receiver and the 2020 Card Transmitter shown here.

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"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

TABLE OF CONTENTS

APPLICATIONS

NEW YORK STATE'S INTERNATIONAL TRADE PROGRAM AIDED BY COMPUTER

New York State's International trade program now is using a computer to help match overseas buyers with Empire State sellers. New York's "where-to-buy-it" service, which is free, uses an IBM 1410 computer to match buyers to sellers.

State Commerce Commissioner Keith S. McHugh said the four-year program — the only one of its kind in the nation — has generated $125 million in new business for New York State companies. In 1964 alone, the sales produced by the program resulted in 7900 jobs. Since the start of the program in 1961, an estimated 20,000 man-years of work has been generated.

Inquiries from abroad pour into the State's Division of International Commerce in New York City at the rate of some 60 a day. Most of them result from "where-to-buy-it" advertisements that the Division places in 70 newspapers in 40 countries. Most are channeled through New York State's permanent European trade office in Brussels, Belgium, which serves as a direct link between buyers in Europe and New York sellers. (New York is the only State which maintains a permanent commerce office in Europe.)

All inquiries are translated where necessary, then classified. Ten international trade experts, each a specialist in several areas of commerce, interpret and code each inquiry for processing to selling firms. After being sorted, the coded inquiries are sent to the computer, which sorts them by category, lists them on 21 different bulletins, and addresses them for mailing. "It used to take us several weeks," said Howard D. MacPherson, director of the department's Division of International Commerce. "Now it's down to days."

The Foreign Trade Opportunities bulletins, issued every week, contain the prospective buyers' name, address, bank reference and products desired. During an average month, from 50 to 60 thousand bulletins are sent to selected New York State firms that have indicated an interest in exporting their products.

"Without the help of IBM's computer, this program would be completely impractical at the rate we are now going," said Mr. MacPherson. "Speed of service to prospective foreign buyers is very important and pinpointing the New York firms that might be interested in any given inquiry from abroad is equally important. Obviously, if we had to handle these thousands of inquiries manually, it would be a slow, tedious business and overseas buyers would be apt to look elsewhere for the products they require."

EKG ANALYSIS BY CONTROL DATA SYSTEM

The use of a Control Data 160-A computer system to aid physicians in screening community populations for the presence of heart disease was demonstrated at the Meeting of the County Officers Association of New York State held in New York City in mid-September.

Electrocardiograms (EKGs) taken from participants and guests attending the annual meeting were transmitted via telephone lines to the Instrumentation Field Station in Washington, D.C. There, the EKGs were analyzed on a Control Data 160-A computer. Without human intervention the results were relayed back to New York and printed on a line printer in less than a minute after the electrocardiogram had been taken.

The electrocardiogram records the biological electrical voltages which cause normal contraction of the heart muscle. The impulses produce characteristic waveforms which can be analyzed to determine heart abnormalities.

The demonstration at the meeting showed the type of computing and data processing equipment used, the number of subjects (or patients) that can be screened, and the rapidity with which results can be returned to physicians using computer techniques.

In effect, the Control Data 160-A computer system is an electrocardiographic reader that rapidly and consistently interprets recordings continuously, day and night. Because the EKG may be transmitted by telephone to the computer, interpretations can be made accessible to virtually all physicians, no matter how remotely located they are from the computer system. The resultant information can be returned directly over the same telephone lines.

Through the use of the electronic computer system, the physician may obtain measurements of the waveforms of electrocardiograms, as well as an interpretation suggesting the abnormality, if any.

According to Public Health Service officials, provisions for automating the means of obtaining such information could relieve the physician of routine aspects of screening for heart disease. "Use of computer techniques", they said, "can also sharpen the physician's diagnostic capabilities, provide more time for personal attention and interpretation to patients, and thus lead to improved medical care for an ever-growing population".

CRIMINAL INVESTIGATION-IDENTIFICATION NETWORK BEING SET UP BY CALIFORNIA

The California Department of Justice, in a program to build a state-wide criminal data gathering network, has ordered an RCA 301 computer system including two mass storage and retrieval units. The system, to be delivered by the Radio Corporation of America, will be one of the first such electronic data processing installations in the country for centralized storage and retrieval of criminal information.

Initial application of the system will be to take over the record-keeping of criminal activities, storing information, and making it immediately available to authorized inquiry. The equipment will be located in Sacramento with California's Bureau of Criminal Identification and Investigation (CI&I), which has the over-all responsibility for coordinating police information in California, and the Bureau of Criminal Statistics.

To be stored in the system for immediate recall will be data on all registered firearms; miscellaneous lost, stolen or pawned property; assorted statistics on narcotics and other criminal activities, and information concerning modus operandi of criminals.

Eventually it is planned to centralize all information in the CI&I files in this data bank, including fingerprint files, the alphabetical listing and identification of all known criminals and their aliases in the State, and selected statistical information.

According to Dr. John P. Kenney, Deputy Director, Department of Justice, CI&I is the largest state bureau of its kind in the nation, its files being second in size only to the Federal Bureau of Investigation in Washington, D.C.

HOT STRIP MILL TO BE UNDER COMPLETE COMPUTER CONTROL

General Electric has begun shipment of components for a computer-controlled electrical system to drive the new 84-inch hot strip mill at United States Steel Corporation's Gary Sheet and Tin Works, Gary, Indiana.

Under complete computer control from the reheat furnace to the coilers, the new mill will deliver strip at high speeds, possibly the fastest in the world. It also will mark the first application of computer control to the reheat furnace, where slabs are brought to 2300 degrees before entering the rolling mill.

A single 40-foot slab entering the new 84-inch mill will be reduced to a weld-free coil with enough steel to produce more than 30 automobiles.

Electrical equipment for the mill will include drive motors totaling 181,000 horsepower; automatic gage control on all seven finishing stands; automatic crop shear; silicon-controlled-rectifier (SCR) power supplies on all main and auxiliary motors, and a process computer.

COMPUTER TAILORING

A computer-created garment recently was demonstrated at a press conference held in New York City. Participants were a machine called a Curve Follower-Plotter developed by California Computer Products, Inc. of Anaheim, Calif., and the new Miss Universe, Miss Apsara Hongsakula of Thailand.

Miss Universe modelled a swim suit specifically custom proportioned for her by the CalComp equipment. The computer-originated swim suit is part of a joint CalComp-Catalina, Inc. project initiated this year.

The CalComp Curve Follower-Plotter traces the designer's original pattern electronically and records it in computer language on magnetic tape. When processed by computer, the recorded data automatically commands the plotter to draw the original pattern in all required sizes of a particular style in an apparel line.

Lester L. Kilpatrick, president of CalComp, said that among the advantages of computer tailoring were more direct control of style features from design through finished production; significant reduction in "reject" garments; speed-up of the production cycle bringing actual production closer in time to actual orders, and important reduction in fabric wastes.

EXTENDED COMPUTER APPLICATIONS FOR THE MISSOURI PACIFIC RAILROAD

A far-reaching development of quality control in railroading, built around a large complex of computers scheduled for completion in mid-1966, has been announced by the Missouri Pacific System, St. Louis, Mo.

The program represents "a concentrated effort to establish a new level of performance and cost control".

It is based on three new IBM System/360s. A Model 50 and two Model 40 computers will give the railroad additional speed and flexibility to expand its current computer operations into all areas of the business.

The major extensions of the new computer-center system will be: traffic and marketing analyses, equipment control, accounting and inventory control, and car and consignment tracing. In less than one hour after a car move on the Missouri Pacific is reported. the computer facility will be able to locate a shipment anywhere on the 12,000-mile railroad system.

RETAIL PHARMACISTS RECEIVING COMPUTERIZED ASSISTANCE

Computer assistance to retail pharmacies is being introduced by the Louis Zahn Drug Co., Melrose Park, Ill., a large wholesale drug firm in the Chicago area. The company services 1300 drugstores and has annual sales of $18 million.

Zahn is making its IBM 1401 computer available to the corner drugstore to take over some of the druggists' most tedious chores such as inventory control, accounting, bookkeeping and billing for charge customers.

Zahn's computer also will provide druggists with up-to-date records of tax deductible pharmacy purchases for the druggist to give his customers.

More than 10,000 drug items are deductible for income tax purposes. By April 15, 1966, the next deadline for income tax returns, Zahn expects to be handling more than 200,000 consumer charge accounts for pharmacists who subscribe to the new plan, called Tip-Top. Tip stands for tax information plan and Top for totally owed purchases.

The automated assistance program being introduced by Zahn Data Service Corp. will be enlarged to provide customers of retail druggists with proof of purchase of Medicare prescriptions, which may double after July 1, 1966.

UPI USING RCA 301's FOR DELIVERY OF NEWS REPORTS

United Press International has placed an RCA electronic data processing system in operation for the computerized delivery of its news report for newspapers. The system is a new concept in production of news in type, using a dual system of on-line computers.

An operator punches news dispatches on a teletypesetter machine, without justifying the lines. The signal from the machine is picked up by an RCA 301 computer which automatically justifies for column width and performs the other typesetting functions. The computer signal is transmitted on a teletypesetter circuit and reproduces the dispatch on a monitor in the newspaper office. It also produces a perforated tape which operates the linecaster.

This on-line, direct signal input and output with the computer does away with any handling of paper tape or manual work at the computer.

Mims Thomason, UPI President and General Manager, said the system has been under development for more than two years by the company's communications specialists working with C-E-I-R, a Washington consulting firm, and RCA. The system is engineered to eventually handle as many as forty input and forty output lines, simultaneously, operating at various speeds and capable of producing justified tape for a variety of column widths and type sizes.

UPI uses two RCA 301 computer arrays, located in its world headquarters. The second machine provides backup in the event of trouble and is used under normal conditions for accounting and business office work. Future plans call for the computer to store and maintain morgue material for rapid access and for the system to handle typesetting of local copy for individual newspapers.

COMPLETELY COMPUTERIZED AIRCRAFT PART PRODUCTION SEEN BY LATE 60's

Completely computerized aircraft part production — from design to manufacture — is a distinct possibility in the late 1960's, Boeing engineer A. L. Pickrell told the national meeting of the Society of Automotive Engineers in Los Angeles last month. Mr. Pickrell machining and numerical control developmental supervisor for Boeing, said he envisions a system where numerical-control machine tapes would be produced by a team of manufacturing and design engineers communicating directly with a computer. The tapes then would be fed to a machine, as they are at present, to manufacture the final part.

Boeing now has many numerical definitions which enable a computer to translate a surface design to numerical-control machine tape. However, not all engineering drawing details can be described with the present library of such definitions. Some new numerical drawing definitions, particularly of inner structures, still must be worked out manually.

"Boeing is now developing a computer-aided design technique to simplify and speed up the programming operation," Mr. Pickrell said. The first phase of this technique is for two-dimensional parts. After that, a three-dimensional system may be considered.

To reach the lowest numerical-control tape programming cost and avoid all duplication of definition, complete computerization of N/C part manufacture is almost inevitable, he said.

HONOLULU KEEPS VOTER REGISTRATIONS ON PUNCH CARDS AND MAGNETIC TAPE

In Honolulu a punch card, instead of handwriting, serves as the record for each registered voter — at a considerable saving of time and money. The city is among the first to systematize the ponderous and costly voting record job by using data processing.

In January 1965 it became apparent that manual voter registration techniques were wholly inadequate. They were slow, cumbersome, and subject to the errors of hand posting and hand processing. Something had to be done.

The first step was to punch all existing voter registrations into cards. With overtime and extra help the conversion was completed at a cost of $20,000 — about equal to the cost of preparing one set of voter lists under the old system.

The most important advantages of the new system are speed and accuracy. As an example, purging the lists of those who failed to vote, or of preparing re-registration notices used to take six months or more to accomplish. Handling transfers and name changes was also a slow process. No longer.

Once the new voter registration cards are punched, the next step is to feed them into an IBM 1401 computer located at a nearby state facility and create a master tape record of all registrations. This information, once on tape, is easily kept up to date by feeding in cards for new registrations and changes as they occur.

TWA COMPUTER "FLIES" ATLANTIC 10,000 TIMES BEFORE EACH JET TRIP

Trans World Airlines, New York, plans and tests two million flights a week across the Atlantic to assure maximum schedule dependability and the smoothest ride for passengers.

Applying the advances of computers to flight planning, TWA "flies" the Atlantic 2,100,000 times a week by computer preparatory to dispatching its Boeing 707 jets on 210 weekly transatlantic flights.

The computer's job is to plot the fastest fairest-weather route in advance of each flight departure. It flies the Atlantic 10,000 times in the process.

TWA in late August will apply computerized flight planning to its nonstop polar operations between the West Coast U.S.A. and Europe.

The computer (an IBM 1620) analyzes every mile of weather, radio aids, air traffic control procedures, aircraft performance, payload and a host of other factors. Several minutes later, it prints a detailed flight plan which assures the speediest trip in the greatest comfort for passengers.

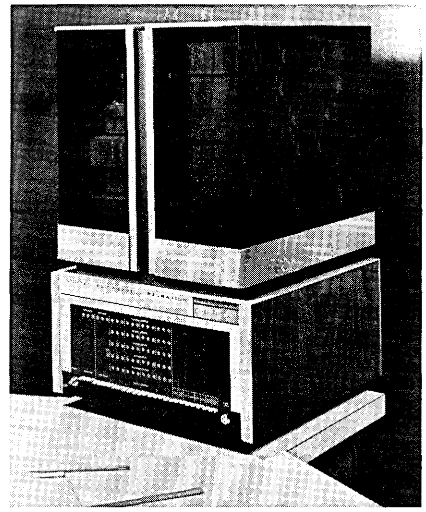
Here's how it works: The computer is continually "informed" by TWA's Meteorological Winds Analysis Group of present and forecast weather across North America, the North Atlantic, and Europe. Dispatchers feed into the computer operational data, such as aircraft weight, fuel capacity, payload, and Air Traffic Control instructions. After analyzing all its data through as many as 10,000 electronic trials across the Atlantic, the computer determines the optimum weather track for a specific scheduled flight, avoids turbulent areas, and prints a detailed flight plan.

It shows how much fuel should be on board; it indicates route and altitudes leg by leg, rate of fuel consumption, flight time and distance between radio check points, and temperatures aloft. It even tells the crew how many ground and air miles they will have flown, the weight of their aircraft, the amount of fuel and the time upon arrival at destination — all this before take-off.

COMPUTER TESTS AND CLASSIFIES TRANSISTORS

At the Western Electric Show and Conference, San Francisco, Calif., in August, a PDP-8 computer of Digital Equipment Corporation, Maynard, Mass., was in control of Teradyne, Inc.'s automatic system for testing and classifying electronic components being exhibited there.

The Teradyne system logs the data for each parameter. An automatic handler bowl-feeds transistors, positions them for a sequence of tests, and files them into one of 14 bins at the rate of 4,000 devices per hour.



— Digital Equipment Corporation's new general purpose, integrated circuit PDP-8 computer is compact, fast, easy to use and versatile; it has simplified programming systems — all at the price of $18,000, with 4096 words of 12-bit core memory.

The PDP-8, with its store of complex classification programs, controls the Teradyne Test Instrument for each individual test — and on the basis of the test result — reprograms the instrument for the next test. In this way, a minimum path for the entire testing and classification sequence is established, and former testing times can be cut by a factor of three.

Without interrupting the testing sequence, the PDP-8 prints out a complete analysis of the performance of the product line being tested.

NEW CONTRACTS

FROM	TO	FOR	AMOUNT
United States Department of State	International Telephone and Telegraph Corp., Data and Information Systems Division, Paramus, N.J.	A computer-based terminal system to handle State Department record communications. The Automated Terminal Station will replace equipment which currently terminates State Department telegraph and communications lines in Washington, D.C.	$3 million
Northern Indiana Public Service Company (NIPSCO), Michigan City, Ind.	Leeds & Northrup Company, Philadelphia, Pa.	Two LN4000 digital computer systems, boiler control using the Direct-Energy Balance (D-E-B) concept, and associated instrumentation and panels. One computer system is for existing Unit 7 of NIPSCO's Bailly station; the second one and the boiler control system will be installed in the new 400,000 kw. Unit 8, now under construction.	Over $1,250,000
National Science Foundation	System Development Corporation, Santa Monica, Calif.	Development of a computer-based system designed to improve the teaching of statistics and the training of future research workers. The system will employ computer time-sharing, natural language communication between user and computer, and programmed instruction.	$90,980 two-year grant, supplemented by an additional $47,487, funded by SDC
Town of Niskayuna, Niskayuna, N.Y.	General Electric Information Processing Center, Schenectady, N.Y.	Tax bill processing	$2080 annually
National Institutes of Health, Bethesda, Md.	IBM Corporation, White Plains, N.Y.	First of a planned three-phase installation of a time-sharing computer system on the 48-building, 350 acre NIH "campus". System/360 Model 40 scheduled to be installed January, 1966; Model 65 as a second-step replacement in August, 1966; ultimate expansion to an IBM System/360 Model 67 time-sharing system.	$1.8 million
Holly Stores (a division of S.S. Kresge & Company)	Electronic Business Services Corporation (EBS), New York City, N.Y.	Data processing service contract to process all sales information from Holly's more than 150 outlets across the nation.	Over $750,000 during next two years
Burroughs Corporation, Detroit, Mich.	Stromberg-Carlson Corp., San Diego, Calif.	15 S-C 3070 Electronic Printers for use with five data processing systems Burroughs is manufacturing for the U. S. Navy Bureau of Ships.	$287,000
Sperry Rand Corp. UNIVAC Division, St. Paul, Minn.	Potter Instrument Co., Plainview, N.Y.	Potter M906II digital magnetic tape transports to be integrated into computer equipment being produced by UNIVAC for the Dept. of the Navy's Mobile Management Program. They will be part of a shipboard logistics complex.	Over $1.2 million
Pan American	General Precision, Link Group, Binghamton, N.Y.	Two more dual-cockpit flight simulators — one to simulate Pan Am's Boeing 707-321B (advanced) aircraft while the other set will duplicate the Boeing 727-21 aircraft.	Over $4 million
Naval Command Systems Activities (NAVCOSSACT)	C-E-I-R, Inc., Arlington, Va.	Programming and analytical services relating to construction of a mathematical model on the Navy's readiness posture. Model will be used for war gaming.	—

NEW INSTALLATIONS

AT	OF	FOR	FROM	AMOUNT
Ohio State University, Columbus, Ohio	Two GE-636 computers, 8 GE-115 computers; a number of GE Datanet 760 data display terminals	Generalized time-sharing and remote-access computing for each of the university's 40,000 students, faculty and researchers	General Electric Co., Phoenix, Ariz.	About $5.5 million
Swedish State Power Board, Stockholm, Sweden	Control Data® 3200 computer system	Data processing applications now being performed on an IBM 1401. Also will be used to solve engineering and scientific problems and different kinds of economic management sciences	Control Data Corporation, Minneapolis, Minn.	—
The Duisburg Copper Works, Duisburg, Germany	Control Data® 3100 computer system	Commercial applications in accounting, payroll, production processing and control	Control Data Corporation, Minneapolis, Minn.	—

AT	OF	FOR	FROM	AMOUNT
Department of Public Works, New York, N.Y.	B5500 computer system including standard processor, input/output components and random access disk files providing a record storage memory of 19,200,000 alphanumeric characters	Engineering design, management control and highway planning research	Burroughs Corporation, Detroit, Mich.	Almost $1.5 million
Swedish Postal Bank, Stockholm, Sweden	Electronic Retina® Computing Reader System	Automatic processing of part of daily banking transactions for 500,000 account holders	Recognition Equipment Inc., Dallas, Texas	Leased for about $15,000/month
General Dynamics, Pomona, Calif.	DDP-116 computer	Use in conjunction with an existing analog computing facility for a wide spectrum of engineering studies in the area of aerospace science	Computer Control Co., Inc., Framingham, Mass.	—
Carnegie Institute of Technology Computation Center, Pittsburgh, Pa.	Computer-driven visual display system consisting of a controller and three display consoles and based on Philco's READ system	Programming and program debugging; problem solving in engineering, mathematics and science; and classroom instruction	Philco Corp., Willow Grove, Pa.	—
Coalite and Chemical Products Ltd., Bolsover, Derbyshire, England	NCR 315 system including 5 magnetic tape handlers and a high-speed printer — input will be by punched paper tape	Processing of orders (solid smokeless fuel) and shipping labels, employers documentation and material control	National Cash Register Co., Dayton, Ohio	—
California Department of Motor Vehicles, Sacramento, Calif.	Spectra 70/45 and 70/55 plus 20 RCA Mass Random Access Storage devices	First step in long-range plan for extensive computer-communications network. By 1970 it is expected that a complex of RCA Spectra 70's will process paperwork for 15 million vehicles and be connected with computers in other State and Federal agencies	Radio Corporation of America, New York, N.Y.	—
Pacific First Federal Savings & Loan Assoc., Tacoma, Wash.	25 electronic Teller Machines and associated transmission equipment	System will enable all tellers in the Association's eight offices to use a central Univac 490 computer on a time-sharing basis	The Bunker-Ramo Corp., New York, N.Y.	—
United States Savings Bank, Newark, N.J.	Two NCR 315 CRAM (Card Random Access Memory) computers; 51 NCR window machines	Use in a new "on-line" computer network serving six savings institutions in five New Jersey cities — each will remain entirely independent under the on-line system	National Cash Register Co., Dayton, Ohio	$1 million
The Dow Chemical Co., Midland, Mich.	SDS 925 computer system and special communications hardware	Directing programs and data transmission between the Midland headquarters and the research laboratories and operating departments both in Midland and throughout the country	Scientific Data Systems, Santa Monica, Calif.	—
Marshall Space Flight Center, Huntsville, Ala.	SEL Model 810	Use as part of a system for simulating space vehicle instrumentation	Systems Engineering Laboratories, Inc., Fort Lauderdale, Fla.	—
Veterans Administration Data Processing Centers in St. Paul, Minn.; Hines, Ill.; and Philadelphia, Pa.	Four off-line media-conversion systems: 2 Ampex Card-to-Tape Systems and 2 Paper Tape-to-Magnetic Tape Systems	Speeding the processing of veterans' pension payments, insurance records and related data	Ampex Corporation, Redwood City, Calif.	$80,000
Chemstrand Company, Div. of Monsanto Co.	Advance Series 6020 computer system	Technical and scientific computation associated with fiber development	Advanced Scientific Instruments, Minneapolis, Minn.	About $175,000
Mass. Institute of Technology, Civil Engrg. Systems Lab, Cambridge, Mass.	IBM System/360, Model 40	Use in the ICES (for Integrated Civil Engineering System) program of R&D, which is concerned with systems research on command-structured and problem-oriented languages for man-machine communications, remote computing and time-sharing, graphical input-output, and advanced systems programming techniques	IBM Corporation, White Plains, N.Y.	—
Munitype, Inc., New York, N.Y.	GE-215 computer and a Datanet-30 communications processor	On-line time-sharing municipal bond data-processing services offered initially to municipal bond underwriters, dealers and dealer banks	General Electric Co., Phoenix, Ariz.	$350,000
Varo Optical, Chicago, Ill.	SDS 910 computer system	Designing high quality lenses and optical systems	Scientific Data Systems, Santa Monica, Calif.	—
United Air Lines	Electronic Retina® Computing Reader	Expansion of its automatic accounting operation	Recognition Equipment Inc., Dallas, Texas	—

ORGANIZATION NEWS

ANNOUNCE FORMATION OF PROGRAMMING SERVICES, INC.

Two employees of what once was the Bunker-Ramo process computer business have announced the formation of a new company to provide a full range of programming services to computer manufacturers and users.

The company is Programming Services, Inc.; Donald F. Ford is president and Paul A. Quantz vice president. Ford had been manager of programming at Bunker-Ramo's Industrial Control Systems and Quantz manager of product development.

The company is now performing work for 10 companies in seven states, covering process control, engineering, scientific, business and special application areas of data processing. Mr. Ford said that the new firm emphasizes basic programming services that are vital to EDP efficiency, but too often have been slighted.

Programming Services, Inc. has headquarters offices in Tarzana, Calif.
(For more information, designate #41 on the Readers Service Card.)

COMPUTER USAGE COMPANY ENTERS EDUCATION FIELD

Elmer C. Kubie, President of CUC, has announced the formation of a new subsidiary, Computer Usage Education, Inc. (CUE). CUE will conduct classes on timely subjects, offer advanced seminars to the computing profession, and engage in a broad range of activities in the field of computer education. Other activities will be announced later.

CUE will be a wholly owned subsidiary of CUC. Mr. Kubie will serve as President of the new organization and Ascher Opler, will be Executive Director.

On-site classes at a basic and advanced training level will be offered to industry and government. A series of advanced seminars to be given in principal cities of the U. S. will be announced shortly.

DIGITRONICS ESTABLISHES FACTORY SERVICE CENTER FOR PAPER TAPE READERS AND SPOOLERS

Richard W. Sonnenfeldt, President of the Digitronics Corporation, has announced the establishment of a factory service center for the company's photoelectric paper tape readers and spoolers customers.

"There are many thousands of Digitronics paper tape readers and spoolers operating in the field today, with unmatched performance", Mr. Sonnenfeldt stated. "The fact is that less than 1% of these are returned annually for overhaul and maintenance. To offer its customers guaranteed completion of repairs in a minimum time, we have set up this new factory service center...the first in the industry."

The new factory service center, located in one of the three separate plants of the company in Albertson, L.I., New York, is staffed by a team of service experts, under the direction of the Manager of Factory Services. Units will be completely processed in five working days. Rigid incoming inspection and quality control standards ensure that equipment, regardless of age, will be restored to original performance standards.
(For more information, designate #42 on the Readers Service Card.)

CORNING GLASS WORKS FORMS FLUIDIC PRODUCTS DEPARTMENT

Corning Glass Works has elevated the status of its fluid amplifier effort by forming a Fluidic Products Department. The action contributes to what Corning believes is the world's most mature marketing operation in the still-young technology of fluid amplification.

Corning made its first fluid amplifiers in 1960. The firm now makes integrated fluid devices and systems to customer specifications and also manufactures a line of 15 standard products.

Fluid devices utilize the flow of fluids — usually air — to recognize and act upon instruction signals for counting and switching. Chief uses are logic and industrial control applications.

NEW FIRM IN COMPUTER LEASING FIELD

A new company, North American Computer Corporation, has entered the computer leasing field. According to John M. Randolph, the company's president, NAC has an initial capital and debt structure that will permit it to acquire up to $40 million of computer equipment. "The company will concentrate on the newest computing equipment as typified by IBM's System/360", Randolph said.

North American intends to capitalize on the industry-accepted habit of computer rental. A major innovation developed by the management of NAC is the short-term lease under which the computer is rented only for a period tailored to suit the customer's requirements.

Although rental of computers is the basis of the company's major activity, NAC expects to build a future consulting service related to the computer field. The new company is located in New York City and is prepared to service all corporate and government computer users throughout the country.
(For more information, designate #43 on the Readers Service Card.)

URS CORPORATION OPENS NEW SYSTEMS CENTER

URS Corporation has established the California Systems Center, Burlingame, Calif., to perform electronic data processing, operations research and related computer services for URS clients on the Pacific Coast.

The new systems center supplies private industry and the Government with such services as computer simulation, management information development, programmed instruction, scientific and engineering computation, logistics research and computer systems consultation.

URS Corporation, in addition to systems centers in Burlingame and Sierra Vista, operates a data processing center in Tucson, Ariz. The corporation was founded in 1951 and also has physical science research facilities in Burlingame and San Carlos, Calif.

Newsletter

CONTROL DATA TO ACQUIRE HOWARD RESEARCH CORPORATION

William C. Norris, president of Control Data Corporation, and James H. Howard, president of Howard Research Corporation, have announced that an agreement has been reached, subject to approval of Howard Research Corporation's stockholders, whereby Control Data Corporation will acquire the assets and business of Howard Research Corporation. The acquisition would be in exchange for shares of Control Data common stock.

Howard Research, located in Arlington, Va., is an electronic systems engineering company which specializes in underwater systems, missile systems, fire control systems, facilities engineering, and information systems. The company provides a variety of engineering support services and numerous management services. Howard Research is serving as system engineer for the U. S. Navy's Polaris Fleet Ballistic Missile Training Facilities.

Control Data's reason for acquiring Howard Research, Mr. Norris said, is to expand Control Data's total systems capabilities in electronic military and weapons systems programs. The newly acquired organization would continue to be known as Howard Research.

MONSANTO DONATES 3700 TRANSLATIONS TO SLA TRANSLATIONS CENTER

The Information Center of Monsanto Company, St. Louis, recently has centralized the company's 3700 in-house translations and has arranged to have microfilm copies of the entire collection sent to the SLA Translations Center at The John Crerar Library in Chicago. This is the largest and most impressive single donation ever made to the Center by private industry.

The SLA Translations Center is a cooperative, non-profit depository and information source for unpublished translations from all languages into English. Its collection now totals over one million items, but it is anxious to continue expanding its holdings by receiving a continual flow of contributions from industrial, business, research, and scientific organizations. Copies of unpublished translations should be sent to Mrs. Ildiko Nowak, Chief, SLA Translations Center, The John Crerar Library, 35 West 33rd St., Chicago, Ill. 60616.

NEW COMMERCIAL SERVICE OFFERED BY DESIGN AUTOMATION, INC.

Design Automation, Inc., Lexington, Mass., offers computer analysis of electronic circuit performance as a new commercial service. Any circuit topology can be accepted, with any set of component values. Computed results are normally ready within one day of receipt of the problem.

With computer analysis, the usually difficult and time-consuming worst-case analyses for design reviews are accomplished quickly and easily. Computed results have been accepted by Government agencies for design reviews.

In most cases, computer analysis is less expensive than building and testing breadboards; in all cases it is faster. Data obtained are far more extensive, and are free of instrumentation difficulties and human errors in recording instrument readings.

To use this new service, the customer submits his circuit schematic, specifying component values, supply voltages and signals. Free pickup and delivery at the customer's office are provided in the Boston area. Outside of the Boston area, communication is via Air Mail Special Delivery, telephone, or TWX. Application engineering service is available.
(For more information, designate #44 on the Readers Service Card.)

ITT SUBSIDIARY ANNOUNCES U.S. — RUSSIA TELEX LINK

Another "curtain" in Russian-American relations recently was lifted with the opening of telex communication between the two countries. ITT World Communications Inc., a subsidiary of International Telephone and Telegraph Corporation, inaugurated the service in mid-September, thus permitting telex subscribers in the United States and USSR to "talk" to each other by teleprinter for the first time.

Opening of the new service marks the successful culmination of repeated efforts to establish this new channel of communication. Until now, the only telex service with Russia has been confined to European countries. The cost to communicate by teleprinter is $3.00 a minute for a 3-minute minimum.

Government, press and business agencies are expected to be the principal users initially, although the service can be employed by any subscriber of the international telex network.

In the United States, subscribers to both domestic telex systems (Western Union Telegraph and the Bell System's TWX) will have access to the new service via ITT Worldcom's international cable circuits.

EDUCATION NEWS

NEW TECHNICAL HIGH SCHOOL STRESSES COMPUTER TRAINING

The first self-contained technical high school in Pennsylvania, which opened in late September, is placing heavy emphasis on training in electronic data processing. The school, called Lenape Vocational Technical School, is serving students from throughout Armstrong County.

A National Cash Register 315-100 computer plus various types of NCR peripheral equipment has been installed in the school. Ninety per cent of the computer time is used for training purposes, with the remainder reserved for school administrative work. All 31 school districts in Armstrong County are contributing toward the purchase of the 315 system.

Students totaled approximately 350 at the outset. Although the school is specializing in vocational training, officials stress that those receiving EDP training will receive a college preparatory course. "The idea is not to turn out professional programmers," said Robert Kifer, director of the school. "Rather, it is to provide general programming background and the kind of basic training in electronic data processing that will enable our students to take advanced EDP work after graduation." Many are expected to continue their EDP and business studies at the college level.

Students will use the NCR system for homework and research problems. In addition to learning NCR programming languages, they will be instructed in COBOL and FORTRAN.

AMERICAN CAN CONDUCTS SPECIAL COMPUTER COURSE FOR HIGH SCHOOL SENIORS

The American Can Company has offered its Systems Development & Programming Section equipment and personnel to the Woodbridge, New Jersey, high schools for the creation of a special course for qualified seniors.

American Can's Finance Department has made 23 programmers and analysts available to conduct a course in systems and computer programming twice a week during the school year.

Seniors enrolled in the 72-hour course will learn how the machines are programmed to react to different conditions and direct calculations in fractions of a second. At the conclusion of the course, students should be capable of developing their own computer programs.

Class material, developed in cooperation with the IBM Education Center, will involve the use of the IBM 1401 and 1460.

According to Vincent W. Renz, Manager of Systems Development & Programming, American Can Company made the course available to encourage potential drop-outs to continue their education and become eligible for this course in their high school senior year. Also, Also, recognizing there are more college applicants than available openings each year, American Can hopes this course will afford those students not going to college an opportunity to learn useful and productive skills.

NEW PRODUCTS

Digital

CONTROL DATA ANNOUNCES HIGH-SPEED INDUSTRIAL & REAL-TIME COMPUTER

Control Data Corporation has announced its fast and versatile 1700 small-scale computer system. The Control Data® 1700 is a low cost, small-scale computer featuring a 1.1 microsecond memory and an average execution rate of over 400,000 instructions per second.

The 1700 computer system has been designed for four main classes of applications. These include on-line, closed-loop industrial control; high-speed data acquisition; stand-alone engineering/scientific computing; and communications systems. It is the only computer to provide such high speed, computing power, reliability and system versatility for less than $30,000.

The 1700 uses the same all-silicon circuit modules found in Control Data's 6600 computer. "With these high-speed, field-proven circuits, the 1700 is the fastest computer available for real-time operating systems and on-line industrial control, with arithmetic execution times and data transfer rates comparable to, if not faster than, many recently announced large scale computers," said William R. Keye, vice president of Control Data's Industrial Group.

Packaging and environmental characteristics of the 1700 have been derived from the requirements of the industrial system user. For example, the 1700 takes up a minimum of floor space: size of the main frame is only 74" long, 28" deep, and 41" high. The main frame and peripheral control elements operate at ambient temperatures ranging from 40° to 120°F, and thus do not require special air conditioning, which is a significant cost factor in factory and remote environments.

Program support for the 1700 system includes a large array of programming systems: basic assembly and utility programs, A.S.A. Fortran compiler, macro assembler control operating system, and modular process control package. The Fortran system for the 1700 is specifically designed for real-time, time-sharing, and on-line applications.

A program protect system built into the 1700 protects the execution of the continuous real-time programs, while allowing the operator to perform other functions, such as debugging new programs.

A wide variety of standard peripheral devices, all designed and manufactured by Control Data, are available in the 1700 system.

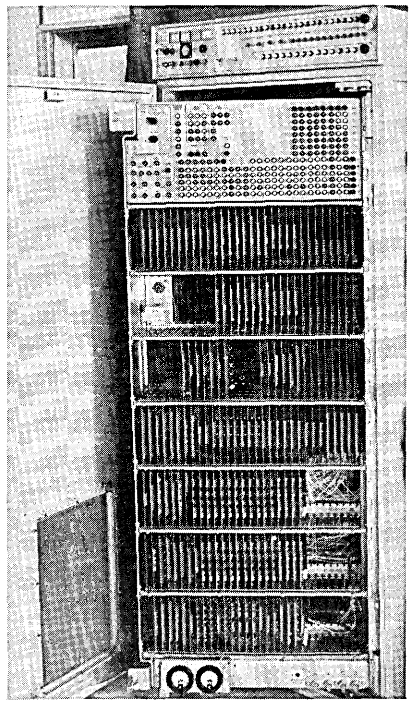
Customer shipments of 1700 systems are scheduled to begin in the second quarter of 1966.
(For more information, designate #45 on the Readers Service Card.)

MILITARY DATA PROCESSOR BY WESTINGHOUSE SURFACE DIVISION

A general purpose digital data processor, the DPS-2402, has been developed by the Surface Division of the Westinghouse Defense and Space Center. The device was specifically designed to meet military requirements.

The DPS-2402 has a response time of two microseconds. It uses 24-bit words and a stored program. Unlike commercial models three times its size, usually operated under closely controlled environmental conditions, it is capable of withstanding unusual shock, vibration, temperature extremes, salt spray and humidity.

Molecular electronic circuits are used in the new data processor to achieve high speed, high reliability, low power consumption and small size. The unit is a parallel, 24-bit-per-word, binary, single-address, stored-program machine capable of retaining from 4000 to 32,000 words of memory. Modular design features and a wide variety of options or input-output signal levels permit tailoring the DPS-2402 to specific applications.



A complete software package is available including FORTRAN, NELIAC, a symbolic assembler and a comprehensive library of routines. Field maintenance service is available anywhere.

The DPS-2402 is designed for real-time applications such as tactical control, communications switching, weapon control and guidance, navigation and air traffic control and display.

The first DPS-2402 data processor will be installed aboard the Royal Canadian Navy's new high-speed antisubmarine hydrofoil, the FHE-400. It will provide split-second processing of information for the complex electronic equipment which controls the ship's weapon system.
(For more information, designate #46 on the Readers Service Card.)

SDS ANNOUNCES 940 TIME SHARING COMPUTER

Scientific Data Systems, Santa Monica, Calif., has announced the SDS 940, the computer industry's first low cost, high performance computer designed specifically for time sharing. All aspects of time sharing are featured in the SDS 940 including multi-programming; real time processing; on line, remote data processing; and simultaneous access by several users of the central computer.

The SDS 940 is compatible with all SDS 900 series computers. It was designed in conjunction with researchers at the University of California at Berkeley and is based on the SDS 930 computer.

The new SDS 940 computer can provide up to 32 simultaneous users with response times of two to three seconds each. For up to six simultaneous conversational users, the response time is less than one second. Users may be individuals, machines, or a combination of the two, but each is able to obtain access to the computer without affecting the others. Memory protection is provided to prevent one user from accidentally destroying or gaining access to the programs or data of another user.

Another important feature of the computer is its ability to continuously load programs in any available portion of core memory so that users do not have to wait for a specific memory location. In effect, the 940 provides each user with his own central processor containing up to 16,384 words of core memory, selected as random blocks from an available core memory pool which may contain as many as 65,536 words.

The flexibility of the 940 system allows it to be used either by untrained operators in a conversational mode or by highly skilled programmers. The system is delivered with a complete set of programming languages. All of the languages are under control of a special time sharing executive program that allows users to call for the language that best suits their problem and ability to operate the machine.
(For more information, designate #47 on the Readers Service Card.)

FOXBORO

PCP-88 MULTIPLE COMPUTER SYSTEM

Multiple-computers for direct digital control — a new concept in industrial computer applications — have been introduced by The Foxboro Company, Foxboro, Mass.

The system features two significant breakthroughs in computer control: reliability approaches 30 years' mean time between failures (MTBF); and the system allows a

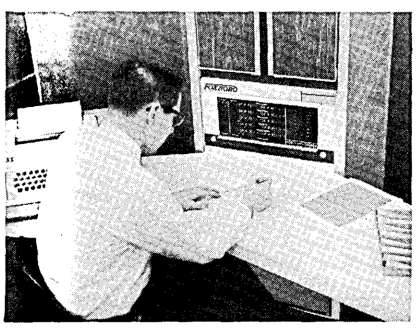
Newsletter

plant programmer to change supervisory programs without any possibility of accidentally erasing or affecting the direct digital program.

The system, called PCP-88, employs Parallel Cascade Processing which organizes the computers in a master-slave arrangement. The master computer performs total process supervision, while the slave computer, operating simultaneously, provides direct digital process control. Should the slave computer temporarily fail, the master computer assumes direct digital control of the process without interruption.

PCP-88 provides separation between supervisory and direct digital control programs for chemical and petro-chemical applications. This separation permits proprietary, "do-it-yourself" programming in FORTRAN language without the risk of accidentally changing direct digital control programs.

In the steel, non-ferrous and power industries, the PCP-88 supervisory computer can be programmed to manage inventory accounting, production scheduling and load dispatching, while the slave-like, direct digital computers adjust process conditions.



Computer facilities available with PCP-88 include teletype networks, logging typewriters and operator consoles which enable a process supervisor to exert finger tip control over an entire plant.

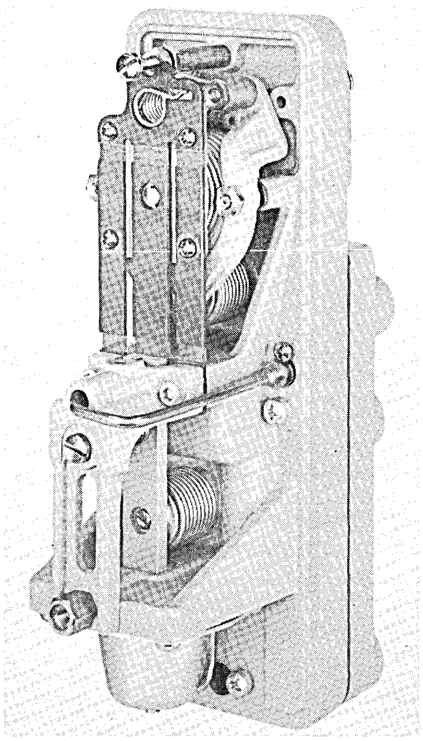
Data Phone Communication Links can be provided to make PCP-88 compatible with a variety of business management computers where multiple plants need to be co-ordinated by a single headquarters.
(For more information, designate #48 on the Readers Service Card.)

Analog

FOUR-FUNCTION ANALOG COMPUTER

The Foxboro Company, Foxboro, Mass., has developed a pneumatic analog computer called the Model 556. The computer can be converted in the field to perform any of four computing functions: multiplication, division, square root extraction and squaring.

The M/556 has an accuracy of ±0.25 percent of span for the multiplier and squarer. Square root extractor accuracy is ±0.25 percent of span from 1 to 100 percent of input. Divider accuracy is ±0.5 percent of span from 10 to 100 percent of denominator input. Sensitivity and repeatability are 0.1 percent of span.



— Four-function, pneumatic analog computer.

All four computing functions are built into the M/556. Conversion from one function to another may be performed in the field by simply rotating a switch plate. Because of this feature, one standby unit can back up many computers in the field.
(For more information, designate #49 on the Readers Service Card.)

Software

COMPUTER PROGRAM FOR POLITICAL REAPPORTIONMENTS FROM C-E-I-R

Problems concerning reapportionment of state legislative and congressional districts can now be resolved rapidly and inexpensively through the use of a new computer program for "redistricting". The program is being made available by C-E-I-R, Inc., Washington, D.C. computer services and research firm.

The program was developed by Stuart S. Nagel, professor of political science at the University of Illinois, to aid in resolving the political deadlock over reapportionment in the State of Illinois. Besides its political application, it can also be modified for use in related fields such as school redistricting and territorial assignments for salesmen.

A principal advantage of the program is its ability to produce districting patterns which accurately reflect whatever political judgments are "fed" into the computer and at the same time meet court imposed criteria of "one man, one vote" and compact, contiguous districts.

The program, written for a large-scale computer, is capable of accepting eight distinct conditions of redistricting, including the number of current districts, number of districts to be formed, and the percentage by which a district may be permitted to deviate from the average district population.

By adjusting these eight conditions, program users can adjust the relative weight given to three prime political considerations: 1) the equality of population between districts, 2) the territorial contiguity and compactness of the districts, and 3) the influence of any proposed redistricting on the political balance of power. The ease with which weights can be varied and new redistricting plans produced, lends itself to the give-and-take of political negotiation.
(For more information, designate #50 on the Readers Service Card.)

NEW PROGRAMS FOR IBM SYSTEM/360

Eleven computer programs which enable System/360 to handle such diverse jobs as blending foods and milling machine parts have been announced by IBM Corporation, White Plains, N.Y. These programs provide System/360 with detailed instructions and give it the ability to solve problems in fields ranging from medicine to banking.

The programs in the group are termed applications programs, and bear such titles as the "Scientific Subroutine Package" and "Advanced Life Information System". They are oriented to specific jobs in specific industries or to problem-solving techniques that cut across many fields.

For example, System/360's "demand-deposit accounting program" is industry-oriented. It enables the computer to handle accounting procedures basic to all commercial banks — but stays within the banking field.

On the other hand, the "mathematical programming system" is oriented to linear programming: a technique using the computer to determine how best to allocate resources. This program can be used for blending gasoline or investing money.

The common element within this group of programs is that they all are problem-solving — they save the computer user from having to write programs that are generally common to his industry. These programs can be (and often are) modified, but at a fractional investment of the time and effort that would be required to write them from scratch.

System/360 applications programs are considered by IBM to be part of the complex product that is today's computer, and are provided without cost.
(For more information, designate #51 on the Readers Service Card.)

SBC COMPUTER PROGRAM AIDS IN VEHICLE SCHEDULING

A computer program designed for the businessman who maintains a fleet of vehicles for delivery of his products has been announced by The Service Bureau Corporation of New York.

The new service, called "Vehicle Scheduling", is aimed at minimizing fleet mileage and determining optimum loads. The program can be used either as an aid in planning new distribution networks, evaluating existing ones, or in determining day-to-day or weekly delivery schedules.

In solving a typical problem, where a businessman wants to make deliveries within a 25-mile radius from his warehouse, SBC's IBM computers produce a list of suggested vehicle routes, showing vehicle capacity required, time and mileage of each journey, and incorporating unusual, out-of-sequence drop-off times when requested by customers.

The Vehicle Scheduling system can process 5,000 deliveries per schedule and a maximum of 1,000 zones. True road distances are used throughout, with time allowances made for traffic congestion on certain road sections. Up to 15 different types of vehicles with varying capacities may be processed. Total number of vehicles is unlimited and vehicle journeys may be restricted to a maximum time or a maximum number of deliveries, as specified by the user. Allowances also can be made for loading and unloading times and parking restrictions.
(For more information, designate #52 on the Readers Service Card.)

Memories

MORE COMPACT COMPUTER MEMORY DEVELOPED BY IBM ENGINEERS

A computer memory about the size of a baseball has been developed by engineers at IBM Corporation for aerospace computers. It is seven times smaller but holds four times more information than existing memories of its kind.

It is designed to store and then give information to computers that guide missiles, rockets, or aircraft to their targets. The 2½ pound device also is highly reliable because it has only one moving part — a small cylinder on which data is stored magnetically.

Several experimental models of the memory have been built at IBM's Space Guidance Center in Owego, New York. Engineers there have subjected the compact unit to vibration, temperature and other conditions that it would experience on aircraft and missile flights.

The memory is the next step beyond the larger memory built by IBM for the Titan II ICBM, Titan III and Saturn I launch vehicles. To date, this earlier model has guided successfully over 50 rocket flights.

— Baseball size experimental computer memory

Unlike its predecessors, which have several hundred moving parts, the spinning drum is the only moving part in the new miniature memory. The drum is a hollow 1-7/8 inch diameter cylinder, on which guidance data is recorded magnetically. It can spin as fast as 12,000 revolutions per minute.

"Because there is just this one moving part and fewer components and devices associated with the memory, it promises very high reliability", said Donald L. Carter, the IBM engineer who led development of the drum.
(For more information, designate #53 on the Readers Service Card.)

CONTROL DATA ANNOUNCES OWN DISK MEMORIES

Control Data Corporation, Minneapolis, Minn., has announced five new disk memory systems — two large capacity Disk File Systems and three versatile Disk Storage Drive Systems. These have been designated the CONTROL DATA® 6607 and 6608 Disk File Systems, for use with CONTROL DATA 6400, 6600, and 6800 computing systems; and the CONTROL DATA 852, 853, and 854 Disk Storage Drives, for use with CONTROL DATA 3000 and 6000 Series computing systems.

The 6608 Disk File System contains a double-actuator 72-disk unit with over one billion bits capacity (more than 168 million characters of 6-bit length); transfer rate is 1,680,000 characters per second; minimum access time is 34 milliseconds; maximum access time is 100 milliseconds. Over 5,250,000 characters are available at one actuator position. The two actuators operate independently to provide simultaneous seeking and read/write operations. Thus, the software operating systems can overlap access time to further increase system throughput.

The 6607 Disk File System has a single-actuator 36-disk file unit with a capacity of 84 million characters. There are over 2,625,000 characters available at one actuator position.

The 854 Disk Storage Drive contains a removable/storable disk pack consisting of six disks and ten recording surfaces with one dual-gap head per surface. Storage capacity is 9,666,000 characters of 6-bit length; transfer rate is 208,333 characters per second; and maximum access time is 145 milliseconds.

The 853 has a storage capacity of 4,833,000 characters; otherwise it is the same as the 854.

The 852 Disk Storage Drive has a storage capacity of 2,980,000 seven-bit characters in the full-track mode and 2,000,000 seven-bit characters in the sector mode. The transfer rate is 77,730 characters per second. Maximum access time is 145 milliseconds.

Deliveries of the new Disk Memories will begin in mid-1966.
(For more information, designate #54 on the Readers Service Card.)

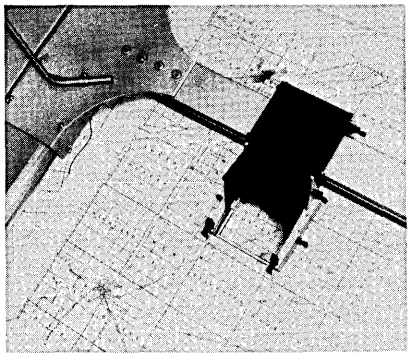
Data Transmitters and A/D Converters

DIGITIZER — CONVERTS DATA FROM GRAPHIC TO DIGITAL FORM

A new instrument which quickly and easily converts data from graphic to digital form and can be used for data storage and retrieval has been developed by Electronic Associates, Inc., West Long Branch, N.J.

This device, called the model 1,092 Digitizer, is designed to digitize and x-y coordinate point over a 30" x 30" surface as depicted by photographs, maps, graphs and strip charts.

The device consists of two primary components: the input coordinatograph and a control unit. The coordinatograph, shown below in a close-up view, is a portable



device which is clamped onto a drawing board and easily movable. It instructs the control unit to measure, digitize and transfer the point coordinate data to the output unit. The control unit contains a digitizer, which converts the analog voltages received from the input coordinatograph to digital form and transfers it to an output card punch or tape unit. The digital data, together with 20 different labels or headings, are recorded automatically on 80 column punched cards or 5 to 8 channel punched paper tape.

The accuracy of the Digitizer is ±.015-inch. Repeatability is held to within ±3 counts at a scaling of 400 counts per inch and is directly proportional to the scale used. Scales are continuously variable from 40-counts to 1000-counts per inch. Speed of the device is 10 millisecond without sign change and 35 millisecond with sign change. Punched card output is 13 columns per second, and paper tape output is 15 characters per second.

The instrument has broad application for such diversified areas as oil and mineral explorations, civil engineering computations, cartography, photogrammetry, numerical control and bio-medical research.
(For more information, designate #55 on the Readers Service Card.)

Components

MAC's 3200 FCI TAPE NOW AVAILABLE

MAC Panel Company, High Point, N.C., has announced the availability of high-density 3200 FCI magnetic tape. This new, heavy-duty computer tape is compatible with the new IBM 2400 Series magnetic tape units, which record and read data at 1600 bits per inch. It is also compatible with present half-inch tape drives.

According to George L. Athanas, president, special manufacturing and testing equipment and procedures have been designed for the production of this new tape. The development of a new testing technique was the primary requirement before marketing this tape, Mr. Athanas said, since the phase encoding method of recording at 3200 flux changes per inch calls for a more critical test covering the complete surface of the tape. Increased character densities and accelerated processing speeds demand more accurate and reliable magnetic tape. The physical and magnetic properties of MAC's new 3200 FCI tape more than meet these requirements, he added.
(For more information, designate #57 on the Readers Service Card.)

CONTROL DATA ANNOUNCES EXPANDED LINE OF MAGNETIC TAPE CERTIFIERS

Control Data Corporation, Minneapolis, Minn., has introduced the CONTROL DATA® 680 and 685 Magnetic Tape Certifiers. With the addition of full-width ½-inch and 1-inch certifiers, complementing the widely used Control Data 690 Certifier, Control Data now offers a family of versatile off-line tape testing, inspection and cleaning devices. These units are designed specifically to serve the needs of data processing installations and magnetic tape manufacturers.

The versatile 680 provides 7-track, 9-tract or full-width testing of ½-inch tape. It can retest 7-track tape for use on both 7-track and 9-track tape transports. The 685 model is a 16-track, 1-inch unit; the 690 is a 7-track, ½-inch unit. Since a complete rehabilitation of tape can be accomplished by one machine in one pass, these certifiers offer both economy in use and ease of operation.

Control Data's magnetic tape certifiers detect tape flaws which may otherwise cause loss of data, program reruns, and lost time due to needless error subroutines. The operational capabilities of the Control Data 680,685, and 690 Certifiers include automatic error detection and tape cleaning. Several optional features are also offered.
(For more information, designate #58 on the Readers Service Card.)

MICRONETIC 404 COMPUTER TAPE

Robert H. Twyford, president of Micronetic Corporation, Alexandria, Va., has announced that the same scientists who developed high resolution ferro magnetic oxide for computer tapes have now introduced a superior binder system which will eliminate most of the magnetic recording errors which can still frustrate a multi-million dollar computer system.

According to Twyford, the ferro magnetic oxide particles in almost all computer tapes now on the market are bonded together by a thermoPLASTIC system which expands when heated, permitting particles to drop out or to become rearranged. The new Micronetic 404 thermoSETTING binder system has optimum flexibility yet does not stretch or soften with heat thus holding the magnetic particles firmly in place despite changes in temperature or extended use.

Micronetic sales manager, Michael Cetta, added that the superiority of the new Micronetic 404 tape could introduce new guarantees to the computer tape field with the possibility of certifying tapes to be completely free of errors for a period of ten years or more of continuous use. The half-inch wide computer tapes have a recording capacity of 800 bits per inch stored on seven separate tracks. A nine track, full width tested tape required for the new IBM 360 system also is available.
(For more information, designate #59 on the Readers Service Card.)

MONTHLY COMPUTER CENSUS

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

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

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 85% 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 OCTOBER 10, 1965

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	24	1
	ASI 2100	Y	$3000	12/63	6	1
	ADVANCE 6020	Y	$2200	4/65	4	5
	ADVANCE 6040	Y	$2800	7/65	1	5
	ADVANCE 6050	Y	$5000	10/65	0	2
	ADVANCE 6070	Y	$10,500	10/65	0	7
	ADVANCE 6080	Y	$7000	1/66	0	0
Autonetics	RECOMP II	Y	$2495	11/58	51	X
	RECOMP III	Y	$1495	6/61	12	X
Bunker-Ramo Corp.	BR-130	Y	$2000	10/61	160	6
	BR-133	Y	$2400	5/65	8	7
	BR-230	Y	$2680	8/63	14	1
	BR-300	Y	$3000	3/59	39	X
	BR-330	Y	$4000	12/60	35	X
	BR-340	Y	$7000	12/63	19	1
	BR-530	Y	$6000	8/61	14	X
Burroughs	205	N	$4600	1/54	54	X
	220	N	$14,000	10/58	44	X
	E101-103	N	$875	1/56	160	X
	B100	Y	$2800	8/64	80	30
	B250	Y	$4200	11/61	105	5
	B260	Y	$3750	11/62	220	40
	B270	Y	$7000	7/62	152	16
	B280	Y	$6500	7/62	92	20
	B300	Y	$8400	7/65	7	70
	B5000/B5500	Y	$20,000	3/63	42	11
Clary	DE-60/DE-60M	Y	$525	7/60	330	3
Computer Control Co.	DDP-19	Y	$2800	6/61	3	x
	DDP-24	Y	$2500	5/63	66	8
	DDP-116	Y	$900	4/65	12	45
	DDP-124	Y	$2050	2/66	0	2
	DDP-224	Y	$3300	3/65	12	17
Control Data Corporation	G-15	N	$1000	7/55	328	X
	G-20	Y	$15,500	4/61	26	X
	160*/160A/160G	Y	$1750/$3400/$12,000	5/60;7/61;3/64	438	2
	924/924A	Y	$11,000	8/61	28	1
	1604/1604A	Y	$38,000	1/60	60	X
	3100	Y	$7350	12/64	33	38
	3200	Y	$12,000	5/64	84	32
	3300	Y	$15,000	9/65	2	34
	3400	Y	$25,000	11/64	16	20
	3600	Y	$58,000	6/63	44	11
	3800	Y	$60,000	11/65	0	23
	6400	Y	$40,000	1/66	0	8
	6600	Y	$110,000	8/64	6	9
	6800	Y	$140,000	4/67	0	3
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	112	3
	PDP-6	Y	$10,000	10/64	8	6
	PDP-7	Y	$1300	11/64	28	44
	PDP-8	Y	$525	4/65	53	302
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	22	X
Electronic Associates, Inc.	8400	Y	$7000	6/65	2	6
Friden	6010	Y	$600	6/63	210	180
General Electric	115	Y	$1375	12/65	0	140
	205	Y	$2900	6/64	35	12
	210	Y	$16,000	7/59	55	X
	215	Y	$6000	9/63	52	3
	225	Y	$8000	4/61	141	2
	235	Y	$10,900	4/64	55	6
	415	Y	$7300	5/64	75	70
	425	Y	$9600	6/64	38	55
	435	Y	$14,000	10/64	14	22
	625	Y	$41,000	12/64	8	35
	635	Y	$45,000	12/64	9	38
General Precision	LGP-21	Y	$725	12/62	100	X
	LGP-30	semi	$1300	9/56	310	X
	RPC-4000	Y	$1875	1/61	65	X
Honeywell Electronic Data Processing	H-120	Y	$2600	12/65	0	180
	H-200	Y	$5700	3/64	630	250
	H-400	Y	$8500	12/61	124	6
	H-800	Y	$22,000	12/60	86	5
	H-1200	Y	$6500	2/66	0	38

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Honeywell (cont'd)	H-1400	Y	$14,000	1/64	12	2
	H-1800	Y	$30,000	1/64	13	7
	H-2200	Y	$11,000	10/65	0	45
	H-4200	Y	$16,800	2/66	0	8
	H-8200	Y	$35,000	3/67	0	1
	DATAmatic 1000	N	$40,000	12/57	4	X
IBM	305	N	$3600	12/57	175	X
	360/20	Y	$1800	12/65	0	3600
	360/30	Y	$7500	5/65	240	3100
	360/40	Y	$16,000	4/65	200	800
	360/44	Y	$12,000	9/66	0	250
	360/50	Y	$30,000	8/65	5	350
	360/60	Y	$48,000	10/65	0	13
	360/62	Y	$55,000	10/65	0	5
	360/65	Y	$49,000	1/66	0	105
	360/67	Y	$49,000	9/66	0	18
	360/75	Y	$78,000	11/65	0	75
	650	N	$4800	11/54	260	X
	1130	Y	$850	11/65	0	1400
	1401	Y	$4500	9/60	6800	240
	1401-G	Y	$2000	5/64	1100	100
	1410	Y	$14,200	11/61	750	40
	1440	Y	$3500	4/63	2350	350
	1460	Y	$9000	10/63	2100	275
	1620 I, II	Y	$2500	9/60	1720	20
	1800	Y	$3700	12/65	0	105
	701	N	$5000	4/53	1	X
	7010	Y	$22,600	10/63	148	50
	702	N	$6900	2/55	8	X
	7030	Y	$160,000	5/61	7	X
	704	N	$32,000	12/55	42	X
	7040	Y	$18,000	6/63	110	12
	7044	Y	$35,200	6/63	64	12
	705	N	$30,000	11/55	61	X
	7070, 2, 4	Y	$27,000	3/60	345	7
	7080	Y	$55,000	8/61	75	X
	709	N	$40,000	8/58	11	X
	7090	Y	$63,500	11/59	51	2
	7094	Y	$72,500	9/62	138	10
	7094 II	Y	$78,500	4/64	82	28
ITT	7300 ADX	Y	$18,000	9/61	9	6
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	150	X
	Monrobot XI	Y	$700	12/60	570	120
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	360	50
	NCR - 315-RMC	Y	$12,000	9/65	3	50
	NCR - 390	Y	$1850	5/61	1030	45
	NCR - 500	Y	$1500	10/65	0	510
Philco	1000	Y	$7010	6/63	20	0
	2000-210, 211	Y	$40,000	10/58	18	1
	2000-212	Y	$52,000	1/63	9	1
	2000-213	Y	$68,000	9/66	0	1
Radio Corporation of America	Bizmac	N	$100,000	-/56	3	X
	RCA 301	Y	$6000	2/61	620	8
	RCA 3301	Y	$11,500	7/64	40	20
	RCA 501	Y	$14,000	6/59	99	2
	RCA 601	Y	$35,000	11/62	5	X
	Spectra 70/15	Y	$2600	11/65	0	70
	Spectra 70/25	Y	$5000	11/65	0	65
	Spectra 70/35	Y	$7000	4/66	0	12
	Spectra 70/45	Y	$9000	3/66	0	75
	Spectra 70/55	Y	$14,000	5/66	0	20
Raytheon	250	Y	$1200	12/60	170	7
	440	Y	$3500	3/64	13	5
	520	Y	$3200	10/65	0	10
Scientific Data Systems Inc.	SDS-92	Y	$900	4/65	21	40
	SDS-910	Y	$2000	8/62	147	18
	SDS-920	Y	$2700	9/62	94	13
	SDS-925	Y	$2500	12/64	9	28
	SDS-930	Y	$4000	6/64	70	30
	SDS-9300	Y	$7000	11/64	15	8
Systems Engineering Labs	SEL-810	Y	$750	9/65	2	12
	SEL-840	Y	$4000	10/65	0	3
UNIVAC	I & II	N	$25,000	3/51 & 11/57	29	X
	III	Y	$20,000	8/62	88	2
	File Computers	N	$15,000	8/56	19	X
	Solid-State 80 I, II, 90 I, II & Step	Y	$8000	8/58	300	X
	418	Y	$11,000	6/63	37	25
	490 Series	Y	$26,000	12/61	64	48
	1004	Y	$1900	2/63	3100	250
	1050	Y	$8000	9/63	220	135
	1100 Series (except 1107)	N	$35,000	12/50	12	X
	1107	Y	$45,000	10/62	29	1
	1108	Y	$50,000	9/65	2	16
	LARC	Y	$135,000	5/60	2	X
				TOTALS	29,501	14,629

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.

NEW PATENTS

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

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

July 6, 1965

3,193,672 / Victor Azgapetian, Santa Barbara, Calif. / Servomechanisms, Inc., Hawthorne, Calif. / Solid State Computer.

3,193,799 / Arthur W. Holt, Silver Spring, Md., / by mesne assignments to Control Data Corp., Minneapolis, Minn. / Reading Machine With Time-Spatial Data Extraction.

3,193,800 / Donald P. Shoultes, Owego, N. Y. / International Business Machines Corp., New York, N. Y. / Method And Apparatus For Verifying Location And Controls In Magnetic Storage Devices.

3,193,802 / Alan J. Deerfield, Franklin, Mass. / Honeywell Inc. / Data Handling Apparatus.

3,193,806 / Arthur V. Pohm, Ames, Iowa and Richard M. Sanders, St. Paul, Minn. / Sperry Rand Corp. / Search Memory Array.

3,193,808 / Richard M. Sanders, St. Paul, Minn. / Sperry Rand Corp. / Digital Shift Circuit.

July 13, 1965

3,194,974 / Eugene J. Rymaszewski, Poughkeepsie, N. Y. / International Business Machines Corp. / High Speed Logic Circuits.

3,194,981 / Jack Saul Cubert, Haddonfield, N. J. / Sperry Rand Corp. / Tunnel Diode Logic Circuit For Performing The Nor Function.

3,194,983 / Brian Elliott Sear, Oreland, Pa. / Sperry Rand Corp. / Logic Circuit Employing Current Selectively Controlled For Switching Tunnel Diode.

3,195,053 / Terry A. Jeeves, Penn Hills Township, Allegheny County, Pa. / Westinghouse Electric Corp. / Nor Shift Register.

3,195,108 / Abraham Franck, Richfield, Minn. / Sperry Rand Corp. / Comparing Stored And External Binary Digits.

3,195,113 / Ames F. Giordano, Newark, N. J. / International Telephone and Telegraph Corp. / High Density Data Storage System.

3,195,114 / Robert O. Gunderson, Torrance, Edmund F. Klein, San Pedro, and Paul Higashi, Los Angeles, Calif. / The National Cash Register Co. / Data-Storage System.

3,195,115 / Edward Michael Bradley, Stevenage, England / International Computers and Tabulators Ltd. / Magnetic Data Storage Devices.

3,195,116 / Robert S. Weisz, Pacific Palisades, Los Angeles, Salvadore J. Zuccaro, Santa Monica, and Mario Semeraro, Sherman Oaks, Calif. / Ampex Corp. / Nondestructive Readout Memory.

3,195,117 / Douglas C. Engelbart, Palo Alto, Calif. / AMP Incorporated / Bipolar Magnetic Core Circuit.

July 20, 1965

3,196,260 / John M. Pugmire, Poughkeepsie, N. Y. / International Business Machines Corp. / Adder.

3,196,261 / David H. Schaefer, Oxon Hill, Md. / USA Administrator of the National Aeronautics and Space Administration / Full Binary Adder.

3,196,402 / Arthur J. Gehring, Jr., Haddonfield, N. J., and Lloyd W. Stowe, Broomall, Pa. / Sperry Rand Corp. / Magnetic Computer.

3,196,410 / Paul M. Davies, Manhattan Beach, Calif. / by mesne assignments, to Thompson Ramo Wooldridge Inc., Cleveland, Ohio / Self-Searching Memory Utilizing Improved Memory Elements.

3,196,413 / Michael Teig, Yonkers,

N. Y. / International Business Machines Corp. / Non-Destructive Magnetic Memory.

3,196,414 / Edward P. Stabler, North Syracuse, N. Y. / General Electric Co. / Magnetic Core Logic Circuits Employing Coupled Single Path Core Structures.

3,196,415 / Alfred E. Brain, Menlo Park, Calif. / Stanford Research Institute, Palo Alto, Calif. / Magnetic-Core Logic And Storage Device.

3,196,416 / Michael Williams, Watford, England / The General Electric Co., Ltd., London, England / Data Stores.

3,196,417 / John T. Franks, Jr., Akron, Ohio / Goodyear Aerospace Corp. / Magnetic Circuits.

3,196,419 / Andrew Gabor, Port Washington, N. Y. / Potter Instrument Co., Inc. / Parallel Data Skew Correction System.

July 27, 1965

3,197,737 / Joseph Patrick Conklin, Fairfield, Conn. / Pitney-Bowes, Inc., Stamford, Conn. / Electronic Memory Device.

3,197,738 / Edward J. Raser, Rhinebeck, and Walker H. Thomas, Poughkeepsie, N. Y. / International Business Machines Corp. / Data Processing System.

3,197,740 / Joseph M. Terlato, Bronx, and Bruce M. Updike, Endwell, N. Y. / International Business Machines Corp. / Data Storage And Processing Machine.

3,197,741 / Charles F. Kohler, Parma, Mich. / by mesne assignments, to Hancock Telecontrol Corp., Jackson, Mich. / Means For Recording Registered Data.

3,197,745 / Joseph P. Sweeney, Harrisburg, Pa. / AMP Incorporated, Harrisburg, Pa. / Magnetic Core Circuit.

3,197,760 / Marius Cohn and Richard Lindaman, Minneapolis, Minn. / Sperry Rand Corp. / Data Processing System.

August 3, 1965

3,198,939 / Walter A. Helbig, Woodland Hills, and Ronald J. Woldrich, Northridge, Calif. / Radio Corporation of America / High Speed Binary Adder-Subtractor With Carry Ripple.

3,198,955 / David H. Schaefer, Oxon Hill, Md. / USA as represented by the Administrator of the National Aeronautics and Space Administration / Binary Magnetic Memory Device.

3,198,957 / Kazuo Husimi and Tsuneori Koshiba, Tokyo, Japan / Nippon Telegraph and Telephone Public Corp., Tokyo, Japan / High Speed Memory Bistable Dynatron Circuit.

3,198,959 / Brian Elliott Sear, Oreland, Pa. / Sperry Rand Corp. / Logic System Employing Tunnel Diode That Is Both D.C. And Clock-Pulsed Biased.

3,198,960 / Joseph F. Kruy, West Newton, Mass. / Honeywell Inc. / Shift Register Utilizing A Holding Pulse To Obviate Interstage Signal Storage Means.

C&A CLASSIFIED COLUMN

Use economical C&A Classified Ads to buy or sell your computer and data processing equipment, to offer services to the industry, to offer new business opportunities, to seek new positions or to fill job vacancies, etc.

Rates for Classified Ads: 90¢ per word — minimum, 20 words. First line all capitals — no charge.

Blind Ads: Box Numbers acceptable at $4.00 additional to cover costs of handling and postage.

Send copy to: Computers and Automation, 815 Washington Street, Newtonville, Mass. 02160. Telephone: 617-332-5453.

Deadline for Classified Ads is the 10th of the month preceding issue.

ADVERTISING INDEX

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