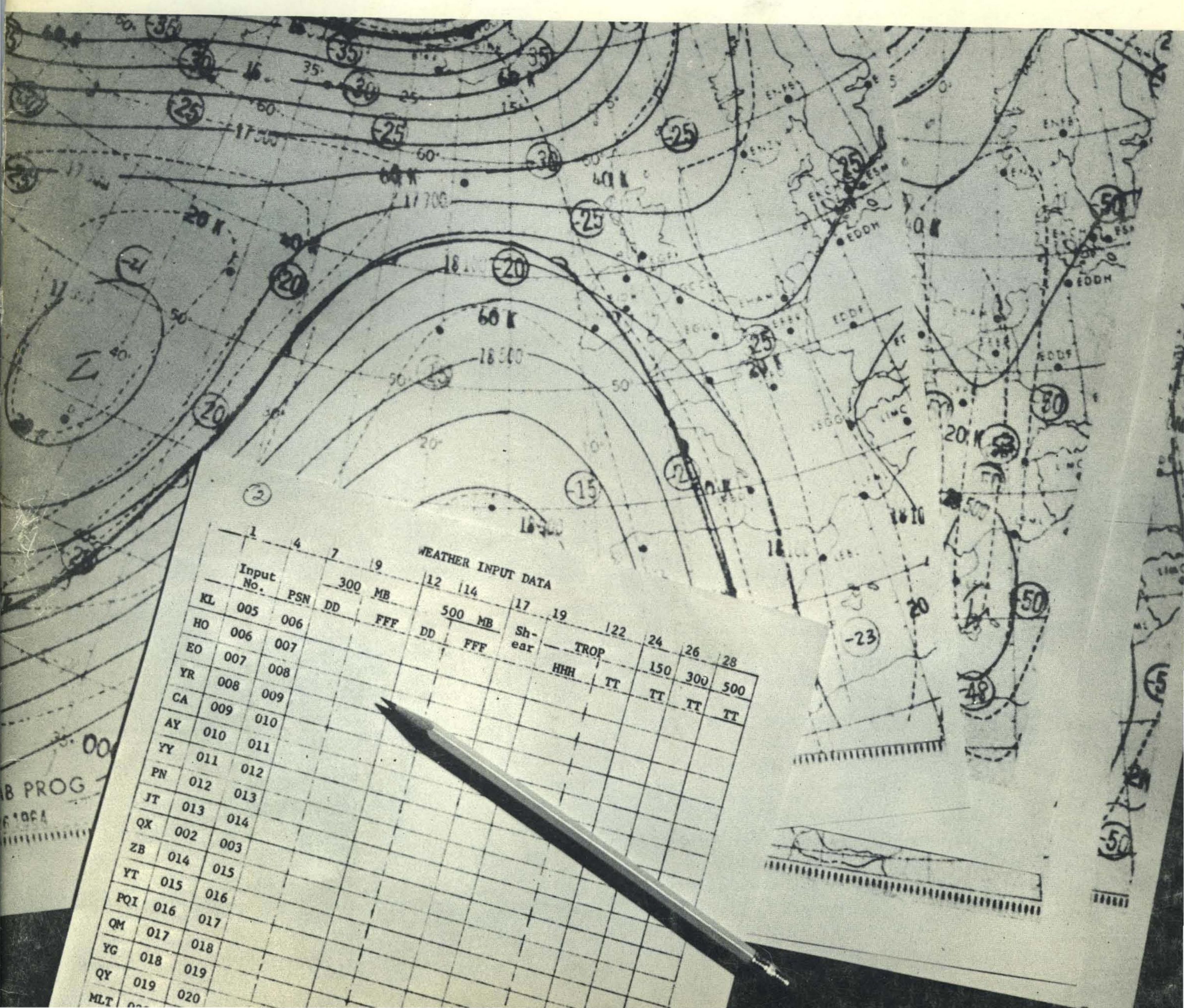
January, 1965

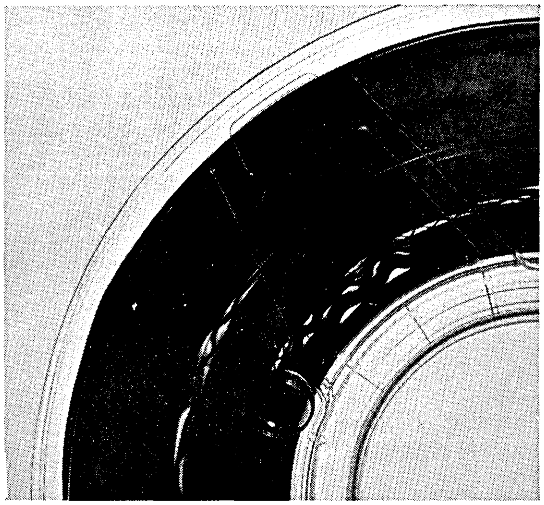
computers and automation

Computer Flight Planning



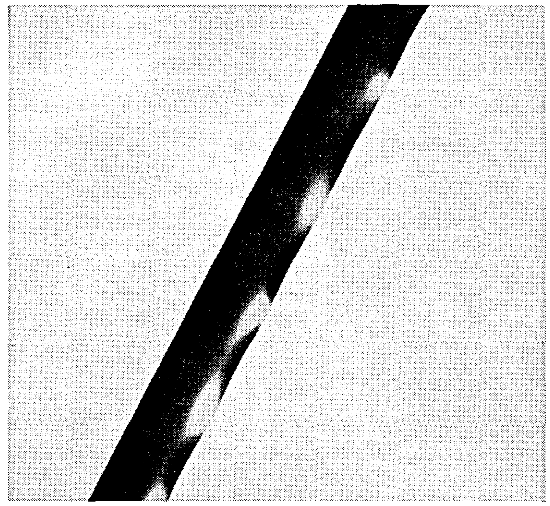
4 COMPLAINTS ABOUT COMPUTER TAPE

(And how Memorex solves them!)



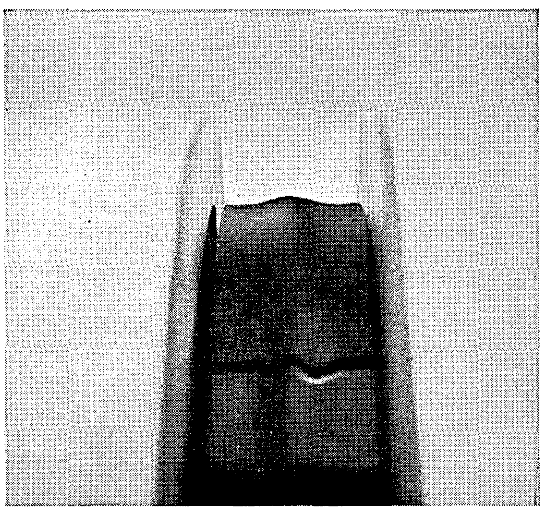
Complaint. Cinching during shipping, use or handling results when reel is wound under improper tension or exposed to temperature extremes.

Solution. Precision winding, special packing and careful shipping are examples of attention to detail that insure cinch-free delivery every time.



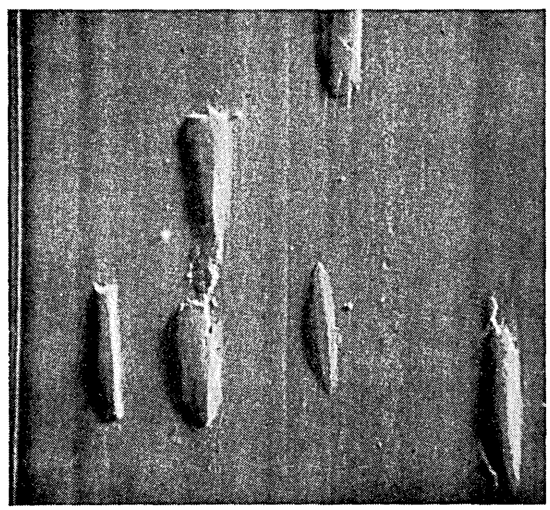
Complaint. Wavy edge caused by improper slitting.

Solution. Specially designed Memorex slitters and microscopic edge inspection of every reel prevent wavy edges. Fifty-one other quality control checks (many performed only by Memorex) guarantee every Memorex reel pre-test perfect.



Complaint. Semi-permanent ridging and loss of contact caused by microscopic scratches produced in manufacturing or use.

Solution. Memorex-designed manufacturing facilities include equipment unique to the industry which eliminates all fixed friction surfaces that potentially produce scratches.



Complaint. Dropout-causing clumps of redeposited coating (50X magnification).

Solution. Memorex has developed coating formulations and processing methods to achieve superior bond between coating and base, extra toughness, high flexibility, and a smoother surface. Result: Memorex tape is essentially redeposition-free.

Memorex tape is premium tape. No need to pre-check it. You can place Memorex computer tape directly in service— reel after reel.

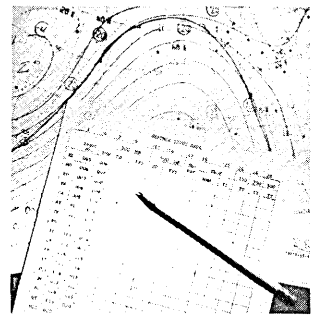
Memorex certification means what it says: Memorex computer tape is error-free. Extra care, extra steps and scrupulous attention to every detail make it that way. We know the importance to you of having a tape you can depend on.

Are you on our mailing list to receive the Memorex Monograph Series of informative technical literature? Write 1176 Shulman Road, Santa Clara, California

MEMOREX

PRECISION MAGNETIC TAPE

Circle No. 6 on Readers Service Card



The front cover indicates the application of computers in up-to-the-minute flight planning for commercial airlines. For more information see page 39.

computers and automation

JANUARY, 1965 Vol. XIV, No.1

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

In This Issue

In Every Issue

THREE STARS *** ON YOUR ADDRESS IMPRINT MEANS: "YOUR SUBSCRIPTION HAS EXPIRED" — PLEASE RENEW AT ONCE TO KEEP C&A COMING

COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE, MASS. 02160, BY BERKELEY ENERPRISES, 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 $1.50 A YEAR FOR POSTAGE. ADDRESS ALL EDITORIAL AND SUBSCRIPTION MAIL TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE, MASS., 02160. SECOND CLASS POSTAGE PAID AT HOLLISTON, MASS.

POSTMASTER: PLEASE SEND ALL FORMS 3579 TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE, MASS. 02160. CHANGE OF ADDRESS: IF YOUR ADDRESS CHANGES, PLEASE SEND US BOTH YOUR NEW ADDRESS AND YOUR OLD ADDRESS (AS IT APPEARS ON THE MAGAZINE ADDRESS IMPRINT), AND ALLOW THREE WEEKS FOR THE CHANGE TO BE MADE.

c & a

EDITORIAL

A National Computer Facility

Among the ideas unofficially discussed at the Second Congress of the Information System Sciences at Hot Springs, Va., in November, was the idea of a national computer facility for the United States.

The proposal in one of its forms is that there should be a national facility centrally located where the best and most modern in both hardware and software would be gathered together, along with an adequate and competent staff, and managed by an association of universities. It would be a laboratory in the computer field like the Brookhaven National Laboratory in the nuclear energy field. Professors, researchers, students, and other qualified persons could go there for temporary periods to carry out research beyond the reach of even well-supported computer facilities at single universities. Access to the national computer facility would also be provided to qualified computer scientists, through remote consoles and rapid communication links anywhere in the country. U. S. government support would need to be on the order of $10 million a year. The facility would not teach undergraduate students though it would reasonably investigate the best ways of teaching them, so as to help forestall the anticipated huge shortage of trained computer people in years to come.

A number of great advantages could accrue from a national computer facility.

We know much less than we would like to know about the structuring of information so as to make retrieval systems feasible—yet expensive retrieval centers are being proposed which are very likely to fail, without the prior basic research that a national facility could support.

In addition, at the present time, hardware and software research are concentrated in commercial and industrial laboratories; for them computation is an auxiliary activity and one which is subject to overriding requirements of other kinds. This is undesirable. At least some (though of course not all) hardware and software research should be under the direction of a national computer facility.

Besides, although important funds for research become available from defense-oriented contracts in which computers are vital, yet computers have wider applicability in our national scene. Instead of seeking to meet nearly all our future requirements through programs inspired by the military, we would be better off to try to meet some of our future requirements through programs planned and carried out by a national computer facility.

Some of the projects which a national computer facility could pursue, and which are probably out of reach by existing organizations, would be these:

- —the provision of a rapid core memory of 50 to 100 million words;
- —the exploration and testing of important concepts in large-scale heuristic programming;
- —compilers that will improve themselves;
- —large-scale research in artificial intelligence;
- —a beginning on war safety control, as put forward by Howard Kurtz;
- —the application of computers on a large scale to increase the prosperity of the United States and its geographic regions, and bring closer to reality President Lyndon B. Johnson's "great society."

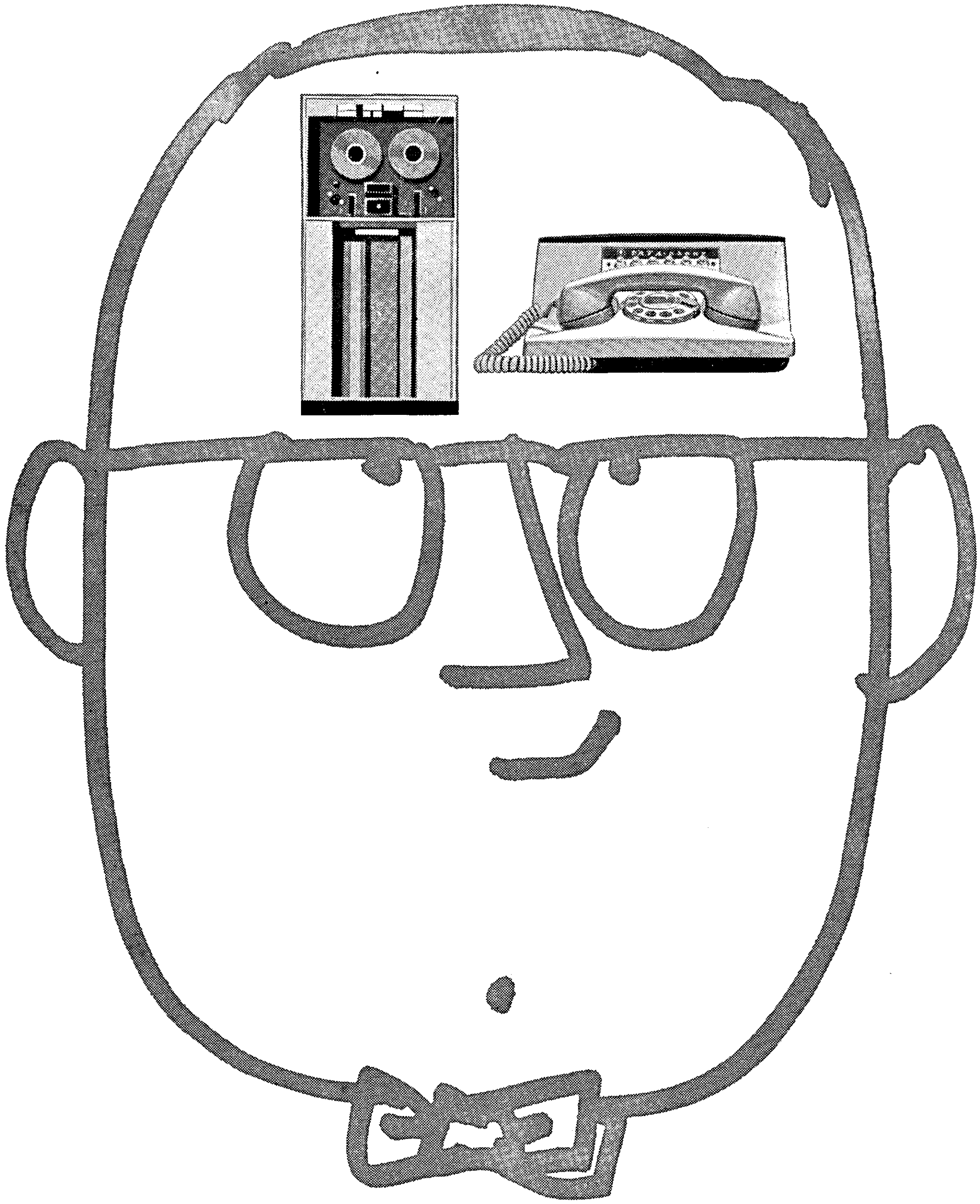
The computer and data-processing industry has reached an annual volume of $5 billion a year, and will in a few more years become $10 billion a year. The contribution of the industry to the prosperity and security of the United States is enormous. The cost of the national computer facility would be only about one fiftieth of the recent Defense Department saving eliminating approximately 95 military bases in the United States.

Computing has enough importance and potential so that it deserves to be supported on its own, entirely apart from the support that it receives (which is considerable) as an aid to physics, chemistry, and other specific subject-oriented fields.

It would be desirable to start planning promptly for a national computer facility. It would seem that one of the logical groups to initiate the planning study would be a committee of the American Federation of Information Processing Societies.

Edmund C. Berkeley

EDITOR



Think both

Let's say your business is bogged down with paperwork and clerical details—and it's costing you time and money.

Naturally, you think of data processing—of those amazing machines that reduce mountains of information to neat stacks of punched cards or reels of tape.

Good thinking. But hold everything.

Data processing is just *half* of an effective information-handling system. The other half is data *transmission* —moving the information crosstown or cross-country, while it's still timely and useful.

That's where Bell System DATA-PHONE* service belongs in your thinking. It converts business-machine data into a tone language that can be *telephoned.* Swiftly. Accurately. Economically.

So when you think data processing, think DATA-PHONE service, too. Think both. Then talk with our Communications Consultant. He's thoroughly trained and experienced in the data communications field. Just call our Business Office and ask for his services.

*Service mark of the Bell System

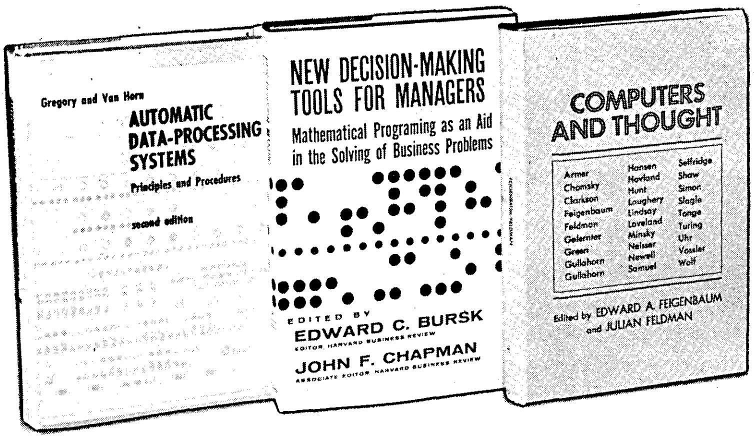
Bell System

American Telephone and Telegraph Co. and Associated Companies

Circle No. 9 on Readers Service Card

THE LIBRARY OF COMPUTER AND INFORMATION SCIENCES

Invites You to Accept Three Extraordinary Volumes a $30.25 Value for only $5.95



To Mark Your Nomination to Charter Membership

No field in recent years has made as rapid strides as the computer and information sciences: Real-time responses, market simulation, stochastic systems control, programming languages such as LISP — these are now exciting new realities with enormous implications for science — for business — for your *personal* participation in the "computer revolution."

But how do you keep up with developments? How do you cut through the maze of published materials to pinpoint the approaches that will help you move ahead in pace with the new concepts in the computer sciences? *How do you make these revolutionary ideas work for you?*

The Library of Computer and Information Sciences has been created to help you answer these urgent questions by selecting and bringing to your attention those publications that are most *directly useful* to you. And to inaugurate your membership in this unique new program, we should like to send you three books that represent the Library's value and scope. These three volumes, purchased separately, would cost you $30.25. But we are making them available for only $5.95 — a savings of $24.30.

Do you know how the information sciences are currently revolutionizing business and industry? In NEW DECISION-MAKING TOOLS FOR MANAGERS, a group of leading researchers and specialists give you a brilliantly lucid review of the techniques that are playing a major part in increasing profits and improving the marketing picture for many organizations. They discuss every major type of mathematical programming used in operations research, planning and controlling with PERT, advanced techniques for capital budgeting, long-range forecasting, quality and inventory control, etc. And in AUTOMATIC DATA-PROCESSING SYSTEMS, Robert Gregory and Richard Van Horn show how these systems have been used to make more effective and profitable business decisions. You will find intensive, step-by-step coverage of every aspect of business data flow and control, from punched-card equipment through high-speed hardware.

Are you concerned with the almost limitless applications of the computer and information sciences? COMPUTERS AND THOUGHT, edited by Edward A. Feigenbaum and Julian Feldman, will bring you to the forefront of current research in the field. It brings together twenty outstanding and often difficult-to-find reports on the use of computers to simulate human thought processes and to perform tasks previously only within the range of human intelligence. Concentrating on milestones in achievement of intelligent behavior by machine, the book describes a series of remarkable computer programs that play chess or checkers, prove theorems in logic and geometry, and even communicate in natural language.

We should like to send all three of these valuable books to you for only $5.95 to mark your membership in The Library of Computer and Information Sciences. *By accepting this unusual offer, you join with other forward-looking executives and specialists in a program that is surely the most reliable, most economical way to keep you moving ahead in the forefront of the computer and information sciences.*

Circle No. 10 on Readers Service Card

RETROSPECT

AND

PROSPECT

IN THE COMPUTER FIELD

INVITATION TO OUR READERS

From the Editor
Computers and Automation

Our January issue is the New Year issue marking 20 years since the first automatic digital computer (the Harvard IBM Mark I Automatic Sequence-Controlled Calculator) started operating.

The special feature in our January issue is "Retrospect and Prospect in the Computer Field."

We think you might have something interesting and important to say on this subject. Here are some remarks from people in the computer field (or close to it). You may want to comment on these remarks—you may want to express your ideas independently.

As we stand here 20 years after the beginning of our new era, what should we remark? What should we notice? What should we focus on?

Your comments will be most welcome—for us to put in the continuation of a roundup of views in the April issue. For length: something like 500 to 1000 words; for deadline: Tuesday, March 2.

May we hear from you?

THE COMPUTER'S IMPACT ON THE FUTURE

David Sarnoff
Chairman of the Board
Radio Corp. of America
Camden, N. J.

(Excerpts from "The Promise and Challenge of the Computer," talk given at Fall Joint Computer Conference, San Francisco, Calif., October, 1964.)

As the shape of tomorrow's technology takes form, the volume and accessibility of data stored in the computer will play a decisive role. All information as to what to do, how to do it, and what data to do it with, resides in the memory of the machine. With larger and faster memories there are few limits to the tasks that can be solved or the speed with which they are completed. . . .

By these means we can hope to store all of the information that is presently contained in all the world's libraries.

Tomorrow's standard computers and their peripheral equipment will instantly recognize a handwritten note, a design or drawing which they will store and instantly retrieve in original form.

The computer of the future will respond to commands from human voices in different languages and with different vocal inflections.

Its vocabulary will extend to thousands of basic words in the language of its country of residence, and machines will automatically translate the speech of one country into the spoken words of another.

The computer itself will become the hub of a vast network of remote data stations and information banks feeding into the machine at transmission rates of a billion or more bits of information a second.

Laser channels will vastly increase both data capacity and the speeds with which it is transmitted.

Eventually, a global communications network handling voice, data and facsimile will instantly link man to machine —or machine to machine—by land, air, underwater and space circuits. . . .

It will be possible eventually for any individual sitting in his office, laboratory or home to query a computer on any available subject and within seconds to receive an answer—by voice response, in hard copy, or photographic reproduction, or on a large display screen.

We will see the emergence of national and global information processing utilities, serving tens of thousands of subscribers on a time-sharing basis. These utilities will accommodate the specialized needs of researchers and engineers, lawyers, medical men, sociologists, or the general needs of the public. . . .

A scientist will be able to discuss a problem by two-way television with a colleague anywhere on the globe, and both of them will be able to query a computer at another terminal point for assistance in finding the solution. . . .

Private corporations, many of which will be international in ownership and operation, will have instant access to production and market information from data stations positioned around the globe. . . .

This emerging pattern inevitably will set in motion forces of change within the social order, extending far beyond the present or presently predictable applications of the computer. It will affect man's ways of thinking, his means of education, his relationships to his physical and social environment and it will alter his ways of living. . . .

As computers become amenable to simple commands, they will become as indispensable to education as the reference library. Indeed they will become tomorrow's reference library, used by every student from the upper elementary levels through university.

Far from eliminating the need for intense intellectual effort, they will permit young people to undertake mental explorations far beyond the boundaries of the present classroom world. . . .

The ultimate implication of the computer is that it provides a means of releasing the productive powers of the human brain to an almost limitless degree. Yet the computer imposes as a precondition the sternest discipline to which the mind has yet been subjected. . . .

SOME UNORTHODOX PREDICTIONS

Dr. Franz L. Alt
National Bureau of Standards
Washington 25, D. C.

Retrospect and prospect in the computer field? Everyone knows that hindsight is safe and that predicting is impossible. Yet we all are forced not only to make predictions all the time, and on the flimsiest grounds, but to base important actions on them. It is moot to complain about the unpredictability of the computer field (other fields are no easier) and foolish to believe firmly in one's own predictions; the reasonable course is to weigh all alternatives. Thus, some alternatives are presented here, not in the belief that they are necessarily right, but because they are likely to be overlooked. For some reason or other, they are not the kind that are apt to occur to us.

1. Are there any revolutionary new applications of computers ahead? With the exception of organized crime (where the potentialities are truly staggering) practically every field of human activity has already been talked and written about as a candidate for automation. Crime fighting has been mentioned relatively little—like crime itself it is not well served by publicity. In these activities computers enjoy one great advantage over humans—over both their users and opponents: While it is becoming more and more apparent that computers do indeed *think,* they do not engage in *wishful* thinking. Never jumping to conclusions, never failing to follow up a line of reasoning no matter how implausible, computers can come up with solutions overlooked by a human Sherlock Holmes. (They have shown this ability also in proving mathematical theorems and playing games.) Yet, while a few instances of such mechanized crime hunting are known and others probably exist without being publicized, we shrink from further progress: the threat to privacy and personal freedom, the specter of Big Brother in 1984 is too high a price to pay for improved police protection and internal or external security.

2. What revolutionary changes in computer design are ahead? Unorthodox answer: None. (Remember again that this is not presented as a true or even likely forecast, but as a possibility which we tend to forget.) Indeed, the speed gain of recent computers over the earliest ones, a factor of less than 1,000 obtained in almost 20 years of intensive development at a cost of billions of dollars is unimpressive compared to the accomplishment of the first electronic calculator. Our logical design is still based on von Neumann's concept of a stored-program machine. We still use core storage and the still older external storage on tapes, drums and discs. "Superspeed" computers introduced a few years ago (Stretch, Larc) were no commercial success and gave way to more conventional designs. Certainly there are changes going on, but they look bigger to us then they really are, merely because of their proximity, in comparison with those of the more distant past; just as we tend to overestimate the "computer revolution" of today, compared with the far more fundamental changes caused by the invention of fire, the wheel, and the printing press long ago.

3. How far will the number of computers increase? There is a theory which holds that the rate of growth of a population depends both on the size of the existing population and on the "growing potential," i.e., the difference between the actual population and a hypothetical maximum or saturation level. More precisely, the rate of growth of the population of size P is said to be proportional to the product $P(M-P)$, where M is the saturation level. This theory has been applied to a wide variety of cases, including biological organisms, human populations, automobiles and many others. There are obvious reasons why it should not be valid for computers; but there also were obvious objections to many of the applications which did, in fact, prove successful. Let us at least give it a try and consider the result as one alternative to be considered along with others.

Populations which have the property stated before can be described as follows. From the time the first few individuals are introduced, the size of the population grows exponentially; the *relative* or *percentwise* growth is the same each year. Gradually, however, this relative growth rate declines, until a point is reached at which the *absolute* year-to-year growth is stationary; the population now grows only arithmetically. Soon even the absolute growth rate declines, the population grows more and more sluggishly, and gradually approaches a constant level, which is the saturation level M previously mentioned. (In practice this level need not remain constant forever; in the case of economic series, for instance, like automobiles or computers, it may change up or down with national income, prices, new technical developments, new markets; but these changes are slow and small compared to the explosive growth of the early stages.) Such a population is characterized by three numbers: the initial rate of relative growth, the saturation level, and the time at which saturation is reached. Only the first of these three numbers is known at an early time, and the prediction of the other two is the crucial problem. More precisely, the time of reaching saturation is not well defined, since saturation is approached gradually; but the time of reaching the halfway point in the development of the population is clearly marked. At this point, the size of the population is just half of the ultimate saturation level, the relative rate of growth is just half of its initial value. Can we predict this point before we are actually there? In the very early stages of development this is made difficult by the fact that random influences, including inaccuracies in the compiling of statistics, tend to mask the regular features of growth. But after a while—normally well before the halfway point is reached—refined statistical methods should lead to usable extrapolations. (Technically speaking, one fits a growth curve to the given date on population size by the method of least squares; some complication is caused by the fact that these growth curves are strongly nonlinear functions of their parameters.)

The other day the writer happened upon a set of statistics on computers bought or rented by the Federal Government.* Chart 6 in this booklet shows the year-by-year growth from 2 computers in 1950 to 1,767 (estimated) on June 30, 1964. It occurred to him to try to subject these figures to the kind of analysis just outlined. The results suggest that, *if the indicated theory of population growth applies in this case,* we passed the halfway point some time in 1963 or 1964. If this were true, the number of computers in Government would not go beyond twice its present value. As stated at the outset, there are enough reasons for doubting the hypothesis on which this finding rests, and we hold no brief for it other than that it deserves to be considered as one argument among others.

Since the Government led the way in the early stages of the introduction of computers, it is likely that the industrial market for computers is farther from maturity than the

*1964 Inventory of Automatic Data Processing (ADP) Equipment in the Federal Government. Prepared by the Bureau of Budget . . . July, 1964. U. S. Government Printing Office, Washington, 1964.

Government market. It has, however, probably arrived at a stage where a careful analysis of carefully compiled market statistics would be a promising undertaking.

PROSPECTS AND PROBABILITIES

Dr. Andrew D. Booth
Dean of Engineering
University of Saskatchewan
Saskatoon, Canada

During the past year we have seen the announcement of a new, third generation system of computers, claimed to revolutionize thinking in the field. This is by no means the first such claim which has been made and without doubt will not be the last. It is thus salutary to consider what has been achieved in the light of history.

In the mid 1940's the group working with John van Neumann at Princeton had laid down a logical structure of computing machines based entirely on a reasoned deduction from desiderata in problem-solving. The structure of the computer envisaged was such that a store of not less than 4,096 words, each of about 12 decimal digits was needed; and that this store should have an access time of about 1 microsecond. An arithmetical unit should be provided in which the operations of addition and subtraction would take not much longer than the cycle time with the store. The main computing structure thus projected was to be accompanied by a comprehensive set of input-output equipment based both on magnetic drums for large volume medium access storage, and on magnetic wires (tapes not then being in a sufficiently reliable state for consideration) for the backing store.

The actual achievements of the 15 years which followed provide a singularly unsatisfactory view of advertising ethics and of the self deception of so-called scientists. The computing systems of the present time often barely realize the design objectives of the mid 1940's and certainly in no sense of the word constitute anything which might be called third generation except insofar that they are the third generation of remarkably watered-down images of the concepts of the early designers.

The only real revolution which has been effected in the computer art has been the introduction of the transistor, and of the solid-state diode. These seem really to make possible the type of reliability which was considered to be essential by the early pioneers, a thing which the hot thermionic tube certainly did not.

The future of machines from the present time onward seems likely to depend largely on the adequate development of the sciences of microelectronics and of thin-film data processing. Whether or not such things as cryogenic computers will be of use seems extremely speculative. There is no doubt whatever, though, that integrated microelectronic circuits are here to stay and that these will make possible speeds of an order of magnitude considerably greater than those at present in use.

In my own laboratory at Saskatchewan, for example, we have in current operation solid-state shifting registers whose speed is well in excess of 100 megacycles per second. We have also under development logical elements to accompany these shifting devices so that, whatever else may be said, in the quite near future machines with addition times of well under a microsecond will be available, whose structural complexity is no greater than that of, for example, our M.3 transistor machine.

The key to the future is almost certainly going to be the storage medium which comes out at the head of the field. Speaking at this instant of time, it seems probable that thin-film magnetic storage may fill this space. It has the advantage of satisfying one of the dicta of the pioneers, namely that no form of storage is acceptable if it involves microscopically distinct elements, which must be individually fabricated.

The thin-film store has the advantages firstly that the actual medium, the film itself, can be continuous, and secondly that the elements of storage, if they need to be generated, can either be produced automatically by a sort of photographic process, or alternatively can be generated as the intersection of a set of 2_n conductors for the production of n^2 elements.

This type of logic for the acceptability of a store was well known to von Neumann and his group. It is, however, just coming to the point of technical realizability having made relatively little progress over the past decade.

It is possible that the direct reading of documents, and the direct interpretation of speech sounds may go some way to providing adequate input but I have been maintaining for some years that the only really satisfactory method of using computers is to have them in direct communication with each other so that, for example, we shall receive no salary in the form of a check, but a communication will go from our employer's computer to that in the bank. Likewise the presentation of an embossed credit card for payment of goods will cause automatic deductions to be made from our bank account via the computer of the supplier of our goods and services. By this method the world will rapidly become highly computerized and, with the use of computers for the control and operation of industrial automation, it seems quite likely that in the next decade we shall have gone some way to a computer-controlled world.

What is perhaps less satisfactory is the thought that something like half of the human race will not only be unemployed but will be unemployable. Some use must be found for these people, or they must be bred out of the system by suitable eugenic procedures. Assuming that the latter thought is unacceptable to the majority of the race, it follows either that the unemployed 50% must be permanently regarded as a liability on the state or, more desirably, that the present tendency to de-nigrate manual activities of all sorts must be removed by a suitable education programme. There is nothing in the least bit undignified in domestic service and a return to some Victorian notions of this sort would produce nothing but good for the human race.

BOON OR BANE TO CAPITALISTIC SOCIETY?

Dr. Alston S. Householder
Oak Ridge National Laboratory
Oak Ridge, Tenn.

Those of us who can remember the days when there were no electronic computers must all view the present scene with a wonder and astonishment that can never be felt by the youngsters to whom the computer is as natural as the radio, the telephone, and the airplane. Who among us could have had twenty years ago even a glimmering of a notion of the volume and the diversity of the uses of computers today? With a base from which to extrapolate, perhaps one can make better predictions for the next two decades than had been made for the past two, but it seems unlikely. For one thing, the acceleration in the rate of scientific and technological development makes prediction difficult. For another, the computer represented a qualitative novelty that is still only poorly understood. It is easy to get used to riding in an airplane, and anyway the airplane has a speed advantage over the oxcart of only about three orders of magnitude. But the computer—!

Any computer man will admit readily that the computer has created a much more fundamental social and intel-

(Please turn to page 54)

RETROSPECT — 1941: "A TREMENDOUS FIELD"

"A TREMENDOUS FIELD FOR THE ANALYSIS, STUDY, AND TRANSFORMATION OF IDEAS AND RELATIONS OF ALL SORTS, BY MEANS OF A BLENDING TOGETHER OF THE TECHNIQUES OF SYMBOLIC LOGIC, ELECTRICAL RELAY CIRCUIT THEORY, MATHEMATICS, PUNCH CARD OPERATIONS, ETC."

Edmund C. Berkeley
Editor, Computers and Automation

In looking back from 1965 to the beginnings of the field of computers and data processing, I came across some of my notes in the year 1941, when I was working in the home office of the Prudential Insurance Company of America, in Newark, N. J.

In June, I had passed the last of 12 examinations to become a Fellow of the Society of Actuaries, and I had been transferred from the actuarial divisions to the Methods Division, which was charged with working out improved methods and procedures for use in the company, which even then had over 10,000 employees in the home office. One of the assignments I had proposed and had been given was "Applications of Symbolic Logic" to problems of the Prudential.

In August, I went to see the recently finished "Complex Computer," a machine made out of telephone company relays by Dr. George L. Stibitz of Bell Telephone Laboratories, New York, which would multiply and divide complex numbers having eight decimal digits.

On September 29, Dr. Stibitz and Dr. Claude E. Shannon, then of Bell Telephone Laboratories, came to the Prudential home office to discuss possible developments and applications. On October 8, 1941, I reported to my enthusiastic and imaginative vice president, Mr. Harry Volk, in the following memorandum (some unessential omissions are marked by four dots and two explanatory insertions are marked with square brackets):

Application of Symbolic Logic, Report No. 6

October 8, 1941

Electrical Relay Computing Machine for Insurance Company Calculations

On September 29, Dr. G. R. Stibitz, inventor of the Complex Computer calculating machine of the Bell Telephone Laboratories (described in Report No. 3 "Analysis of the Operation of the Complex Computer"), and Dr. Claude E. Shannon, author of "Symbolic Analysis of Relay and Switching Circuits" (referred to in Report No. 3) and now of the Bell Telephone Laboratories staff, spent several hours at the Prudential, in discussion with the undersigned, chiefly in regard to the possibilities of adaptation of electrical relay computing to the calculation of insurance company tables and individual policy calculations. In order to make clear to Dr. Stibitz and to Dr. Shannon the nature of calculation problems occurring in the rates and values sections of an insurance company, a sample revival charge on a Weekly Premium Industrial policy was explained. This calculation involves, at the present time, reference to some eight tables, some of them being entered for two or more values. Also there was some discussion of application of a modified Boolean algebra in electrical circuit theory.

1. Possible Operations

Certain arithmetical operations have now been proved possible with electrical relay computing equipment, as expressed in the Complex Computer. These operations include the following: addition, subtraction, multiplication, division, storing of a value, taking a value near or high or low. Other operations which are crucial to the success of an adaptation of electrical relay computing to insurance company calculations, and which according to Dr. Stibitz and Dr. Shannon, are all possible under the principles of the electrical relay computer are: comparing two values and selecting one, storing a table of values, entering a table, reading a value, plugging in a table, plugging in a formula or series of operations, plugging to compute a set of values to be stored in "metal storage leaves," preparing storage leaves automatically from punch cards, preparing storage leaves by hand punching, preparing tables in written form from storage leaves, and preparing punch cards from storage leaves.

In addition, it would be possible to considerably condense existing tables for clerical use, because automatic interpolation by the machine would be possible. The storage leaf would contain (1) some of the information enabling the selecting of the leaf, (2) the tabular entry, and (3) the tabular difference. The machine would be plugged to perform the interpolation needed to secure a desired value, or to use it in a calculation. Two-way interpolation would also be possible. Consequently, if, for some table, age and duration changes were both approximately linear in an interval of five years, each storage leaf would need to contain only one out of every twenty-five annually spaced values together with two tabular differences. Indeed, it would be possible to dispense with the tabular differences and have the machine determine interpolated values by using (1) neighboring given values, and (2) a formula depending only on the relative position of the interpolated value.

In fact, the existence of this machine, which would be able to perform arithmetical calculations in long chains with reliable accuracy, would open an entirely new field of possibilities in the layout of insurance company calculations. In the same way, the modern computing machine [desk calculating machine] has put logarithms into relative disuse for purposes of multiplication.

Of course, long distance control of the electrical brain would be entirely possible; the equipment doing the operations could be stored in an inexpensive part of the Company, and the computing rooms would be wired to the computing machine. To reduce idle time, provision could be made for storing electrically the given data for a calculation at any time, and the machine would then attend to its demands in order, publishing its results as it worked.

In wiring up the machine for a given series of operations to be performed for a certain kind of calculation, it was Dr. Stibitz' opinion that the complex wiring necessary for IBM [punch card machine] plug boards, would be avoided. Instead, it would be possible to connect up the machine to perform a series of algebraic operations in a straight-forward algebraic way.

2. Spaces, Times, Costs, and Development

The essential element in the proposed expansion of electrical relay computing is a unit which will store a value of a table. On talking to Dr. Stibitz, it appears that the Bell Telephone Laboratories have already begun development of a unit occupying only a small amount of space which will successfully store information. Furthermore, this unit, which has been referred to as a storage leaf, will probably be cheap, and made either of metal or plastic. It will be able to be individually inserted and removed from a bank of such units with relative ease; it will be inexpensive to produce and to throw away. In this respect, the Bell Telephone Laboratories appear to be approaching the punch card facility. Furthermore, in Dr. Stibitz' opinion, it may be possible to proceed along the line of Bell Telephone Laboratory facilities, without infringing on International Business Machines patents, and without delays in order to get these two large concerns to agree with each other. There is, of course, an essential difference in design necessary in order that any storage leaf in a bank may be selected and read by electricity, a process which is not directly possible in a drawer of punch cards.

As to space, it seems it will be possible to commence research work figuring on the basis of 1000 entries, of 6 decimal digits each, all in the space of one-sixth of a cubic foot. This is considerably better than Complex Computer capacity, but then these units are relatively permanent storage. The space then required to store 20 tables of 50,000 entries would be in the neighborhood of 100 to 150 cubic feet. The time necessary to select one of these million entries would be in the neighborhood of one-half a second.

The cost of the duplication of the existing machine, the Complex Computer, would be on the order of five or ten thousand dollars. It contains in the neighborhood of 800 relays and the cost, accordingly, would be in the neighborhood of $10 a relay. This, for ownership of a machine, compares favorably with the IBM tabulator renting at an annual rate of from two to five thousand dollars.

It would take considerable time to work out the final details of the electrical relay computer; probably it would take two or three years to work them all out, especially since Dr. Stibitz is likely to be called by the National Research Defense Council for a year's service in an advisory capacity, and since the circuit construction department of the Bell Telephone Laboratories is rather heavily loaded with national defense work. Nevertheless, in Dr. Stibitz' absence, there are a number of Bell Telephone Laboratories' people available for cooperation. Dr. Claude E. Shannon is an expert in the field of abstract circuit analysis, while Mr. S. B. Williams is an expert in the concrete design of circuits and standard practice. . . . From a large point of view, the Bell Telephone Laboratories are custodians, for the people of the United States, of a vast amount of priceless information and devices in the field of electrical communications, and so it should be possible to convince them to push forward to some extent with development of electrical relay computing. . . .

3. Implications for the Future

It is becoming clear that there is a tremendous field for the analysis, study, and transformation of ideas and relations of all sorts, by means of a blending together of the techniques of symbolic logic, electrical relay circuit theory, mathematics, punch card operations, etc. After all, a great many mental operations are repetitive. They should be able to be analyzed by symbolic logic and other techniques, and codified into correct sequences using "If X, then" and "If no-X, then" and other extremely basic ideas. Then the sequences should be able to be translated into chains of electrical relays which will make use of electrical energy to activate still other chains, and so on, until we reach a final chain representing the answer. As soon as one chain of relays is released from momentary use, it should be able to be used again for another step in the progress of the solution. This happens in the Complex Computer; and also in the field of attention in the human brain. Thus it should be possible to plug into an electrical relay calculating machine (1) the data for any problem in a certain definite but vast range, (2) the problem in question, and (3) the channels along which a solution is to be successively sought; and then press a button for the solution!

As E. T. Bell says:

> "The expert user of mathematics is a general commanding perfectly trained armies he never sees. Unforeseen combinations, inherent in the planned co-ordination, but not themselves deliberately planned, appear as if by fate in the engagement with the unknown."
>
> E. T. Bell, *The Handmaiden of the Sciences,* page 3.

But there is nowadays little reason to restrict this idea to one social creation alone, mathematics; or to one social invention of four thousand years' vintage, written symbols on paper (or papyrus). A person using the dial telephone and some other edifices of modern society has similar powers. New inventions and new levels of social coordination create new possibilities.

In order to pursue this line of investigation, we must look for (1) the elements of any thinking, and (2) their parallel in electrical relay chains, and we must recognize (3) the time element in "coming to a conclusion," which is equally necessary for the operation of electrical relays and for actually solving a problem by mental processes.

....

EDMUND C. BERKELEY
Assistant Mathematician

October 8, 1941
ECB:EEC

Looking back at this memorandum from a day 23 years later, it is remarkable that George Stibitz and Claude Shannon could have seen so clearly the basic essentials of automatic digital computing and the prospects in the field.

We did not see electronics. We did not see modern storage of information. We did not see the immense reliability and fantastic speed that has been achieved. Of course, we did not foresee the nomenclature in use today.

But we did see the machine choosing for itself its path through an unlimited sequence of instructions. We did see the machine modifying its own instructions according to information revealed as the calculation proceeded. We did see the machine as resembling the automatic dial telephone system. And we did see the versatility and the generality and the dimensions of "a tremendous field."

THE FUTURE OF PROGRAMMING AND PROGRAMMERS

Dr. John W. Carr, III
Moore School of Electrical Engineering
University of Pennsylvania
Philadelphia, Pa.

There is a need for an objective evaluation of the future of the digital computer programmer and what he does, programming. A need has suddenly, beginning about 1950, grown for persons who are identified by these terms. This need is, superficially, at least, so great that a general consensus has arisen that good computer programmers are "born, not made," and that they are irreplaceable by either man or machine. On the one hand, there is a giant rush to develop courses in high schools, colleges, and universities that relate to the field, on the other a belief by many academicians that such material has no place except in a purely vocational training. The salary of competent men and women with experience in using machines is higher today in this field, relative to an individual's formal education, than almost any other (except movie stars and "pop record" artists); and yet many competent practitioners have a feeling of unease about their own personal future.

In this discussion we will avoid too much emphasis on the present and future mechanics of programming, to concentrate on the relation of man to machine, now and in the future, from the point of view of those persons working directly with machines. We will thus concentrate on a future set of goals and needs which it appears to us will in some way have to be carried through before the problems that disturb digital computer user-practitioners can be allayed.

The future of programs and programming are tied up, crudely, with three areas of effort and three classes of people. The same person may appear in more than one class simultaneously.

(a) *Practice of the art* of programming, carried on by the *practitioner*.
(b) *Education* of the future machine user as a problem solver, by the *teacher*.
(c) *Research* into how to solve problems on machines, not specific problems oriented toward any one area, but generic classes of problems, and the development of operating machine-programmed systems (combinations) to solve a particular task, to be done by those persons working in research and development.

For the past 10 years many of us have preached (and we use the term advisedly) the usefulness of the problem-oriented language as the most important element (at this moment) of the man-machine computer combination. To a certain extent that promotional job has been completed, and the tenets of the faith agreed to, so that the present-day practitioner makes use of one (or sometimes more) stylized languages to solve problems in his field of usage. These languages, with some salient exceptions, are aimed at numerical manipulation using the terminology of algebra and analysis: $+$, $-$, $>$, $=$, $<$, $\times$, $/$, . . . These, in fact, are the standard symbols in most computer languages and the corresponding external languages. The work of Gorn on Mechanical Languages [1] is one example of an attempt at a unified theory of those languages which are involved in solution processes.

There has also been a marked growth in data-manipulation languages. Here, because there was no general body of mathematical formalism to draw upon, there has been an intuitive growth of terminology, algorithms, processors, etc., that certainly so far at least have almost no cohesive structure. There has been work done on trying to organize this area, with some initial success. The book of Iverson [2] is an example.

At any rate, after ten years, the programming practitioner, it would appear, stands at the following position: Certain forward strides have been made:

1. The recognition that the languages available for use need not be machine languages *only*.

(Reprinted with permission from "The Computer Bulletin," vol. 8, no. 1, published by the British Computer Society, London, England.)

2. The recognition that more than one "type" of language will be needed to solve the broad array of problems that machines can solve.
3. The recognition that some sort of universality of language, or language conventions, or interchangeability of programs easily among machines is needed.
4. The recognition that in a dynamic problem solving situation, programs must be easily changed, and that this is the most important part of the automatic problem-solving process that was neglected by the pioneers in the field.

On the other hand, the following very important concepts are far from broadly recognized or accepted or utilized:

1. Practitioners in general still do not accept the possibility of general logical non-numerical symbol manipulation as a primary problem solving use of computers. They do not understand the basic idea; they have not been taught the techniques; and they are not furnished by their machine and program sources with languages they can use that will allow them to manipulate symbols as casually as they manipulate numbers today.
2. Moreover, the practitioner (as well as the designer, both of control programs and equipment) does not recognize that programming is equivalent to (not "analogous to" or "similar to") building a machine, and not only that, to building a machine in a certain orderly fashion. There are very few large installations—that we know of, at least—where the concept of what would technically be called "automatic assembly" is being practised where each program is considered as a unit in itself, a subassembly, and is stored away as a unit for *automatic* recomposition into a larger subassembly. It is interesting to note that those centres where this sort of structure is beginning to be evolved are those where there is a common *discipline* (such as nuclear physics) and a common goal (such as design of nuclear reactors) to make the need for such a project urgent.
3. Along with this the practitioner has not realized in general that a computing facility must be considered as (again) an *automatic* information retrieval system, in which past data, kept in the same storage medium and the same general operational form as the programs, and the programs themselves, are stored and retrieved by information retrieval systems that must be as sophisticated as those developed for any other application.

These last comments lead one to make what will probably be considered some quite controversial remarks about the practitioner of the future.

He will have to be a *disciplined* worker, in both the past traditional and scientific sense of the word "disciplines." He will have to have a combination of engineering and scientific knowledge like none that is present today among any of us in one individual. He will have to have a technological knowledge of how the system he is using works. He will have to have a liberal education to relate his revolutionary tool to the rest of the world in which he lives.

Or alternatively, he can become what would be analogous to a practising librarian or file clerk today, handling and manipulating information that he does not understand, add to, or basically use.

The latter alternative seems to become more nearly possible in the large, first because there are many persons called "programmers" today who, through no fault of their own, fill this description. Moreover, the development of combined machine-program systems that take in problems or classes of problems described in an implicit non-command, descriptive language, and by some decidable or undecidable process produce either

(*a*) *an* or *the* answer to the problem,
(*b*) an algorithm or approximate algorithm in command language form,

means that much of the relatively straight-forward coding, problem layout, etc., will be done by machines. The skilled labour portion of programming will become relatively smaller. Such machine program systems in their most trivial form, when they first came out, were called "generators." There exist today working programs which, taken in the large, do all of the work once considered to be of importance by the programmer.

For example:

1. Various ALGOL processing systems carry out large parts of storage assignment dynamically during execution of the program, as do, of course, such programs as LISP, IPL, and others.
2. Various "compiler constructors" accept, not yet completely efficiently, simple linguistic descriptions of well-formed strings in two languages plus a dictionary, and produce a program system for translation.
3. Various compilers have efficiency and optimization algorithms that often work better at producing "optimised sequences" of computer instructions than can the average human coder.

Another speaker on today's program, Tom Steel, has pointed out the paradox involved in attempting to develop programmed algorithms that will produce programs tailored for efficiency. That is a difficult task, at least in the early stages; and once completed it may be very wasteful as far as machine storage and running time are concerned.

There are several obvious solutions:

(*a*) In some cases build these efficiency procedures into the equipment itself.
(*b*) Rethink and rebuild the machines so that what are problems now no longer will be problems (e.g., the use of indirect addressing, multi-use machine registers, built-in push down lists, etc.)
(*c*) Construct the machines so that the "inner guts," the detailed interconnection of equipment, can be changed under program control,
    (1) first by the programmer, based on static decisions.
    (2) secondly by the running program, dynamically during the performance of programs.

These encroachments by designers and systems programmers on common human "programmer prerogatives" lead one to question whether discussions of "professionalism" among programmers in the classical context has any but historical meaning. What is a professional? The following definition is immediately due to S. Gorn.

A professional is a worker who translates information into action. (For example, one has physicians, lawyers, engineers as opposed to scientists, novelists, etc.)

On this definition, most programmers fail to qualify. The reason is obvious. They neither create information in their area or use information provided by others. First, up until recently, there has been no recognition of any portions of information that would be called "theory of programming." Secondly, there has been no development or creation of an ordered body of knowledge that can serve to be acted upon.

On this definition, for professionalism to exist, there must be a body of knowledge, there must be communication between practitioner and this body of knowledge, and there must be a well organized program of education in such a body of knowledge.

A physician, before he is allowed to *practice,* will have had between 8 to 12 years of class room, laboratory, and on-the-job experience which is all considered part of his education.

Attorneys may need less—6 or 7 years total—education.

Today, so-called "professional engineers" are generally expected to have had 5 years of education beyond the high school.

On the other hand, if one evaluates programmers on the level of novelists or poets (who must at least learn English, French, Russian, etc., grammar) then the evaluation of the output that they produce is not an "aesthetic" one based on artistic consideration, but rather one of empirical evaluation based on results—philosophers use the word "ethical." Programmers may consider themselves artists, without the restriction of being judged on their output results but rather on its aethetic qualities, but they are not judged on this basis by their employers and the persons who ask them to solve problems. Programmers are trained like artists (mostly intuitively self-taught) but judged like physicians and engineers.

One should note that physicians, attorneys, etc., do not protect themselves and their work by patents, although they do have such protective devices as the AMA, the various bar associations, the State Bar and Professional Engineering Exams, etc. On this ground, one should not expect, if a programmer is to be a professional, that he may copyright his programs or patent his subroutines. We cannot decide today whether or not programmers will become "professionals," but if they do, their training and attitudes will have to change.

Education

These relatively trivial examples only point towards what may become a clash between "haves" and "have-nots" residing not in New York and Afghanistan, but in neighbouring computation centres, or in neighbouring offices of the same computation centre. There are just growing to be cleavages into classes of educated and uneducated computer users. What will be the criteria that will divide these programmer "sheep" from "goats"? The answer appears to me possibly this: if a human is to be a computer user, he must be

(*a*) highly educated in some scientific, engineering, or managerial discipline, with a knowledge of computer problem solving, or

(*b*) a computer scientist, educated to work with computers, or

(*c*) a semi-skilled although important labourer working on the level of the present-day performance of mechanics, technicians, and clerks, or

(*d*) a manager.

One danger, it has been pointed out to me, is that of mechanization of the humans involved, on the one hand, and the complete divorcement of the computer scientist from any of the reality of what is going on, on the other. This latter extreme is possible if the university atmosphere is to dominate the situation. The latter, under present-day economic demands, would appear highly unlikely.

Instead, the alternative extreme is more likely. Education may in fact become merely training. Under this direction of the future, computer science would rather fall into the traditional programming trap and end up with a curriculum similar to that alleged of many schools of education. By carrying to the extreme some of the concepts of what programming should be one could foresee a curriculum composed of titles similar to the following:

1. The History of Programming.
2. The Philosophy of Programming.
3. Practice Programming Laboratory.
4. Programming Psychology.
5. Programming the IBM 650.
6. Introduction to ALGOL.
7. Introduction to FORTRAN.
8. Programming Monitor Systems.
9. Programming Input-Output.

The similarity of any course titles to recently announced courses or published documents is not necessarily purely coincidental.

Alternatively, if such a debasement of the education process is to be avoided, the computer scientist or engineer will have to take over that portion of the present programming job about which other speakers here have given two sides.

Should one include the *art* of programming in the Computer and Information Science curriculum? From our own experience in teaching advanced courses in the C.I.S. area, those persons who have had actual experience in constructive problem solving are most strongly motivated. In many cases, because they are on the "firing line," they realize the end goal most clearly. However, most such students (and unfortunately not just undergraduates) have a very thin understanding of the inter-relationship of the problem-solving components. To them a machine stands at one side of a line, computer programs on another, and they match them together. Moreover, the nature of problem-solving as a growing process is not understood, perhaps has not been taught. The understanding of the truly explosive nature of problem-solving, both theory and practice, as developed by science, is not helped, in most cases, as a result of either a classroom, laboratory, or industrial computer experience. In some cases these students can see the relationship between logic and problem-solving, or between switching theory and algorithms, or between programming and certain portions of logical design, but they cannot see the area as one organic whole. Until this is presented to them, the future of the man-machine relationship will be the result of localized, rather than global, understanding and progress.

Future Programming Research and Development

One of the more important problems that has been posed, and which has not really been faced, is: How will the intermixture of stored algorithms (programs) and equipment algorithms (machines) be combined into one whole? It has already been emphasized that those persons learning about and using machines must be helped to realize the organic nature of this structure. At present this realization occurs relatively infrequently within a single human being, or common to a single research or development organization.

We have, over the past few years, spent time with both computer users and manufacturers. The following appear to be appropriate comments:

There is not necessarily a lack of intercommunication between programming practitioners on the one hand, and the logic designers and computer system engineers on the other. There is, however, a marked gap between all these groups and the area of research in programming. There is communication between logic designers and persons studying the theories of machine structure and design, but there is a major gap between both practitioner programmers and system programmers on the one hand, and the formal theorists in programming and algorithm theory, mechanical languages, formal systems, combinatorial analysis, etc.

There is a gap between practicing programmers and mathematicians, not to say mathematics. The fault is obviously not one-sided, but the gap will be crossed only by the programmer, who today is the only person, as yet, who needs to care about the existence of this gap.

There is a gap between the programmer and the biologist, the physiologist, the psychologist, and all those persons who work in areas related to living organisms. Many scientists believe that the development of "artificial intelligence," that is, machine systems that duplicate portions of the intellectual activity of human beings, will come from dupli-

(Please turn to page 54)

AUTOMATED METHODS IN PERT PROCESSING

Norman B. Solomon
Sylvania Electronic Systems
A Division of Sylvania Electric Products, Inc.
40 Sylvan Rd.
Waltham, Mass.

PERT stands for "Program Evaluation and Review Technique," a network analysis method developed by the U. S. Navy for managing the Polaris program. It represents an advance in the state of the art of planning and control of large projects in large organizations, particularly research and development projects.

This article deals with PERT as it relates to processing on a computer. The need for computer programs is identified; a brief description of the basic elements of such programs is presented. A sampling of various programs and their hardware requirements is given. Finally, some statistics on the automatic preparation of networks are presented.

The computer continues to grow in importance as an aid to the process of management. PERT programs, in particular, have now become an integral part of many computer-based management information systems.

Why is there a need for computer programs to perform PERT processing? Here are some of the answers.

1. Evaluation of Large Complex Networks. It is not uncommon to find today, complex, multi-million dollar defense systems with sub-tasks requiring 3,000 to 5,000 activities in their detailed networks. Costs in terms of time, effort, and accuracy, preclude the manual processing of such networks.
2. Simulation. One of the primary advantages of building a model of any physical situation is to permit multiple evaluations for different sets of input parameters; this is often called simulation. Simulation requires quick response, and computer programs can provide this response. A network as small as 200 events can become unwieldy if four or five re-evaluations are attempted manually.
3. Network Integration. It is usually desirable to subdivide large, complex networks into smaller, manageable sub-nets; the National Aeronautics and Space Agency, for example, refers to these as "frag-nets." In this process, many interface events are created, thus posing a severe problem in network integration, i.e., determining the over-all effect of processing the networks together. Computer programs can handle this problem easily.
4. Rapid Response Updating. The dynamic nature of large R&D (research and development) efforts re-

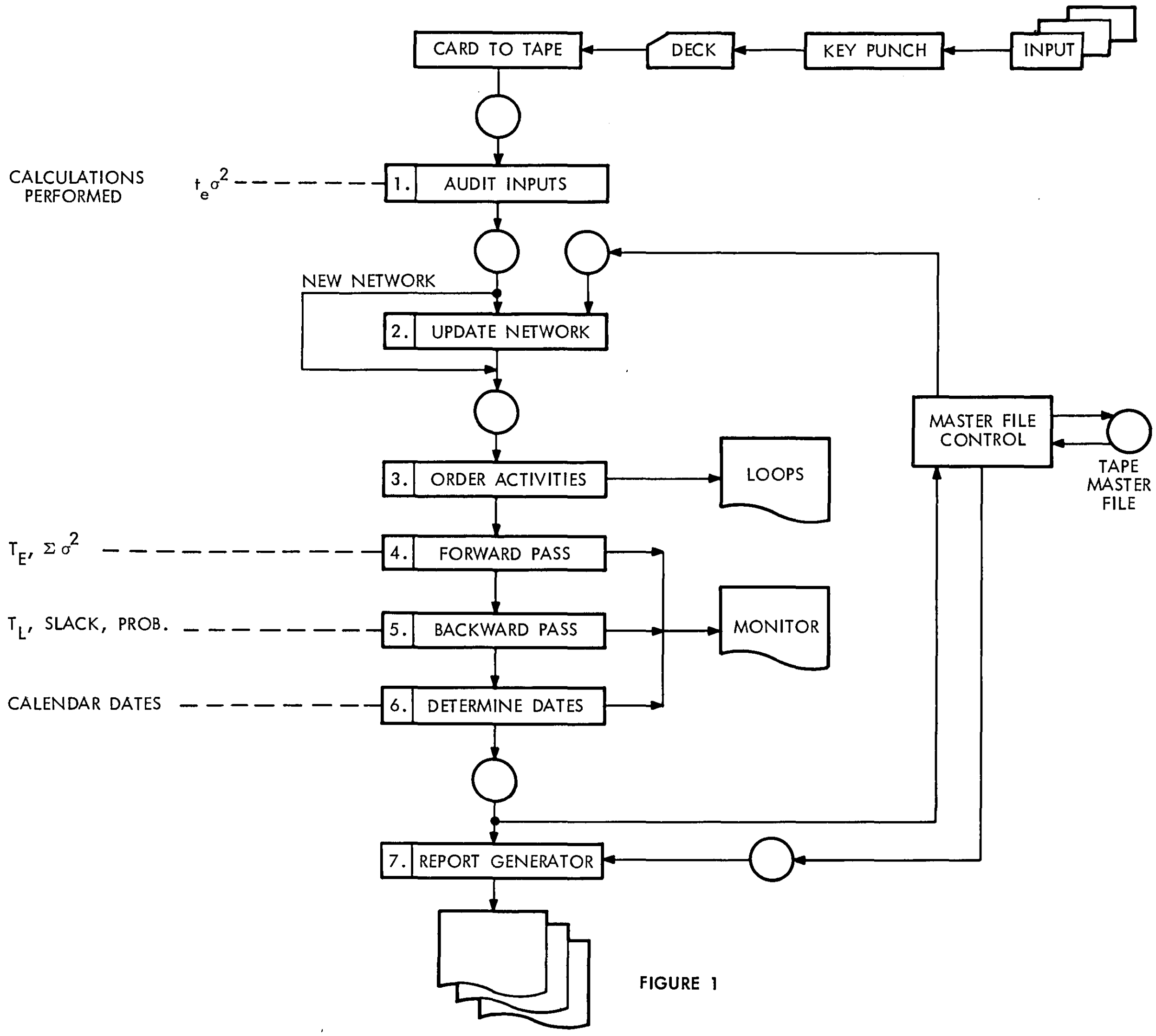


FIGURE 1

quires network updating over relatively short intervals of time. A computer program can maintain a large number of networks, accurately, rapidly, and effectively.

5. Input to Management Information Systems. Many companies have developed computer-based management information systems for planning and control of all major R&D contracts. PERT information as it relates to task progress is a necessary input to such systems. PERT/COST, for example, requires an input from a PERT/Time program. Thus computer processing of PERT data permits generation of timely and direct inputs to such a system.
6. Exception Reporting. Finally, computer processing of PERT data provides an effective means for management by exception. By supplying the computer with a set of decision criteria it is possible, automatically, to call to the attention of management certain tasks in the schedule which exceed established tolerance limits. Thus the computer program alerts management when a potentially critical situation is detected.

Elements of a Basic PERT Program

The seven basic steps of a standard PERT computer program are shown in Figure 1, describing the complete process from submission of initial inputs to generation of final outputs. An input card deck is produced through key punching of the input documents. The deck is then converted to tape for input to step (1). A brief description of each step is given below.

1. Audit Inputs

   In order to ensure the processing of meaningful input data, a preliminary examination of these data is made, thus reducing the number of undetected errors. Both quantitative and qualitative checks are performed, e.g., more than one schedule date given for an event or perhaps an unacceptable relationship between the input time estimates a, m, and b. In general, a complete assessment of the reasonableness of inputs is performed. Certain errors prevent processing through subsequent operations until adequate corrections are made; other errors merely identify questionable inputs which may or may not require

SAMPLE PERT AND COMPUTER STATISTICS
FOR SIX PROGRAMS

COMPUTER MONTHLY RENTAL (AVERAGE)	$67,000	$45,000	$28,000	$22,000	$14,500	$7,000
COMPUTER	IBM 7090/1401	UNIVAC 1107	PHILCO 212	HONEYWELL 800	IBM 1410	HONEYWELL 400
PROGRAM NAME	AF PERT III	AF PERT III	AF PERT III	PERT 800	AF PERT III	PERT 400
HARDWARE CONFIGURATION REQUIREMENTS: 1. INTERNAL MEMORY 2. TAPE UNITS 3. CARD READER AND PRINTER 4. OTHER	7090-32K WORDS 1401-16K CH 16 1	16K-64K WORDS 6 1 1 DRUM UNIT	8K-32K WORDS 8-11 1	4K-28K WORDS 5-8 1	10K-80K CH 1 1 1 1301 DISK UNIT	2K-4K WORDS 4 1
CAPACITY (ACTIVITIES)	12,000	6,000 WITH 16K 12,000 WITH 32K 24,000 WITH 64K	14,000	UNLIMITED	5,000W/INTERRUPT 12,000 W/ NO INTERRUPT	1,100 WITH 2K 2,000 WITH 3K 3,000 WITH 4K
MASTER FILE	MAGNETIC TAPE	MAGNETIC TAPE	MAGNETIC TAPE	CARD OR TAPE	MAGNETIC TAPE	CARD
RUNNING TIME:	5 STANDARD REPORTS Activities / Minutes	NOT AVAILABLE	4 STANDARD REPORTS Activities / Minutes	5 STANDARD REPORTS Activities / Minutes	8 STANDARD REPORTS Activities / Minutes	5 STANDARD REPORTS Activities / Minutes
PROCESSING TIME:	1,000 4 3,000 6 5,000 9 7,000 11		2,500 1.5 4,000 3.3 1. SET-UP NOT INCLUDED	1,000 16 3,000 50	7,000 156 --------- 9 STD REPORTS 1,572 26	1,000 50 3,000 150
PRINTING TIME:	1,000 9 3,000 25 5,000 42 7,000 70 1. INCLUDES SET-UP 2. PRINTER=600 LPM		1. INCLUDES SET-UP 2. PRINTER=900 LPM	1,000 7 3,000 15 1. SET-UP NOT INCLUDED 2. PRINTER=900 LPM	8 STD REPORTS 7,000 84 --------- 9 STD REPORTS 1,572 28	1,000 7 3,000 15 1. SET-UP NOT INCLUDED 2. PRINTER=900 LPM
COMMENTS	AF PERT III NOW AVAILABLE AT AFSC. IBM PERT ALSO AVAILABLE	PROGRAM AVAILABLE 2ND QUARTER 1964			PROGRAM AVAILABLE 1ST QUARTER 1964 AT ESD	

FIGURE 2

correction. This processing is often referred to as data purification, consistency checking, input auditing, or input diagnostics.

Some calculations may be performed during the audit, such as the calculation of elapsed time and variance of each activity.

2. Update Network

Following the audit process, the inputs may be used either to modify an existing network, or for direct processing as a completely new network. Thus, step (2) is by-passed when a network is to be processed for the first time. A magnetic tape master file is shown in the diagram containing a complete record reflecting the most recent evaluation of all networks. Any of these networks may be updated by step (2) and then re-evaluated by steps (3) through (6).

3. Order Activities

To compute the values of a PERT network properly, the effect of each activity must be determined in a logical sequence. However, it is usually desirable, from the user's standpoint, to have the flexibility of numbering events in a random fashion. This flexibility is consistent with the dynamic nature of a PERT network and reduces the processing problems which are encountered when updating networks or merging together sub-nets or portions of networks.

The computer programs, therefore, must have the ability to re-order or re-arrange the activities for processing. This operation is referred to as a ranking or topological ordering process. As a by-product of the activity ordering process, step (3) will detect and list network loops resulting from errors introduced in event numbering or in the transcription of input data. (A loop exists when a path may be traced from an event, through the network back to the same event. This process disturbs the normal path tracing operation and must be detected by the computer program.)

4. Forward Pass

Once the activities are properly ordered for processing, a forward pass through the network, starting with the begin events, generates the "T_E" values, i.e., the earliest expected completion time for each activity. At the same time, event variance (the square root of the sum of the deviations) is also computed.

5. Backward Pass

Directly following the forward pass, objective dates for end events are determined and a backward or reverse pass through the network is made. This pass generates T_L values, i.e., the latest allowable completion time for each activity required to meet the objective dates. During this pass, slack and statistical probabilities are computed.

6. Determine Dates

Since the activity time inputs to the program are given in terms of work weeks, the values of T_E and T_L computed in steps (4) nd (5) are also in terms of work weeks relative to the earliest event in the network. For purposes of computation the earliest event is assumed to have a start time of zero. It now remains to convert T_E and T_L from work weeks to actual calendar dates. Step (6) performs this conversion by referencing all work week values to an actual calendar date assigned to the earliest event in the network. This date is called the network start date. The computed T_E and T_L dates reflect any delays encountered by non-working days such as holidays or plant shutdown. (Note that a printed output from steps 4, 5 and 6—referred to as a MONITOR output in the diagram—keeps the computer operator informed as to program status.)

7. Report Generator

A report generator is capable of producing any of the various output reports in response to the user's requests. This program can produce reports for previously evaluated networks stored in the master file, or for the network currently being processed through steps (1) through (6).

The tape master file shown may be used as the PERT/TIME input to an integrated, computer-based management information system.

Survey of PERT Programs

How do organizations within industry select a particular computer program? How many different PERT programs are available and what are the relative costs and hardware configurations required for these programs? To assist in answering these and other related questions, several comprehensive surveys are available to the potential user. (See Appendix 1.) In general, almost every major computer manufacturer has one or more PERT-type programs available to his users. Furthermore, many government and industry computer users have written special and general purpose programs, many of which are available on request.

Computer and PERT Program Statistics

What range of hardware configurations is available for PERT processing? To answer this question, a sampling of six computer systems is presented in Figure 2, ranging from the $67.5K average monthly rental down to the $7K average monthly rental.

Although not shown on the chart, PERT and CPM programs with limited capabilities do exist in the IBM 1620 and 1401 class or the $2K to $3.5K monthly rental range. It should be noted that the particular program shown is not necessarily the only program that can run on the computer listed. For example, at least fifteen PERT programs exist for the IBM 7090 alone, of which AF PERT III is one. However, AF PERT III has been established as the current standard within the Air Force and will form the basic PERT/TIME module for the Air Force PERT/COST program.

The AF PERT III for the 7090 and for the Philco 212, and the Honeywell 400 and 800 programs are available to users on request. The IBM 1410 program currently being tested at the Air Force Electronic Systems Division, Hanscom Field, will be available in the near future. UNIVAC's 1107, AF PERT III program is not expected to be available for distribution until the second quarter of 1964.

Of particular interest is the IBM 1410 program with two operating modes. Mode 1, with a processing capacity of 5,000 activities, permits interruption or suspension of the PERT processing to permit initiation or continuation of a higher priority computer program. Upon completion of the higher priority programs, PERT processing will resume, automatically. Mode 2, with a processing capacity of 12,000 activities, does not permit automatic interruption.

Note that most of the programs shown allow maintenance of a magnetic tape master file to permit rapid updating of networks.

Considerable interest has been expressed within government and industry for standardization and coordination of PERT concepts and computer programs. The most noteworthy effort in this area has been under the direction of the Department of Defense Inter-Agency PERT Coordinating Group. Within industry, the National Security Industrial Association had devoted much of its time to PERT and PERT/COST matters.

The use of a common computer-programming language has been considered by the PERT Coordinating Group. Although not shown in Figure 2, it should be mentioned that an operational PERT program written in the COBOL language does exist. It was developed by Sylvania and is being used on their S-9400 computer in Needham, Mass.

Buying Computer Time for PERT Processing

Many organizations which do not maintain an in-house computer facility and would like to utilize PERT computer programs may do so either through service bureaus or through computation centers in industry which sell time to other organizations. In general, buying time at computer centers not operating primarily as service bureaus requires that the user be oriented in regard to computer programming, whereas utilizing an established service bureau greatly reduces this requirement. Furthermore, service bureaus generally supply input forms with explicit instructions and maintain the tape or card master files for the networks being processed. Service bureaus that specifically sell a PERT processing capability train their operators to become familiar with the program in order to minimize delay time in determining what actions to take in the interpretation of various standard audit checks.

Advanced techniques in long-distance data transmission provide new opportunities for remote processing of PERT data when potential users do not maintain a full-scale data processing center or are not located close to such a facility.

Automatic Generation of PERT Networks

Preparation of evaluated PERT networks for visual presentation at various management levels is an extremely tedious, time-consuming, and costly task. This is especially true when the networks are large and the updating cycle is short, i.e., re-assessment of progress is made every two weeks. Since a PERT network is a model of a dynamic situation, it is expected that the model will continue to change its shape, particularly during the early development stages where many of the tasks are not fully defined. Furthermore, with complex networks, it is often impossible manually to arrange the presentation of activities and events in the most desirable manner, e.g., time-phased by expected completion dates or grouped by performing organization.

To resolve this problem, several automatic systems have been or are being developed. (See Figure 3).

Most of these systems fall into two general categories: (1) high speed photographic process producing a microfilm output and (2) mechanical graph plotting process producing a chart output.

In both categories, a computer program is necessary to

(Please turn to page 55)

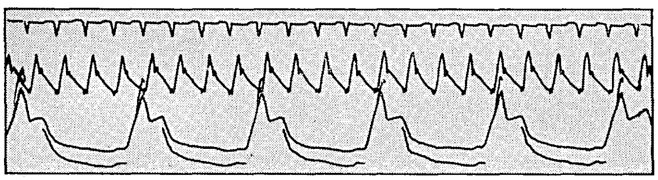
AUTOMATIC GENERATION OF PERT NETWORKS

SYSTEM	DD-80 SYSTEM	ADMA AUTOMATIC DRAFTING MACHINE	ELECTROPLOTTER II PERT SYSTEM
MANUFACTURER	DATA DISPLAY CORP. ST. PAUL, MINN.	HUGHES AIRCRAFT, AEROSPACE GROUP CULVER CITY, CALIFORNIA	BENSON-LEHNER CORP. SANTA MONICA, CALIF.
EQUIPMENT TYPE	CATHODE RAY TUBE – HIGH SPEED CAMERA SYSTEM	TAPE CONTROLLED PLOTTING BOARD (BENSON-LEHNER ELECTROPLOTTER II–MODIFIED)	MAGNETIC TAPE ELECTROPLOTTER II SYSTEM
OPERATIONAL STATUS	SERIAL NO. 1, 2, 3, AND 4 NOW OPERATIONAL.	OPERATIONAL	FINAL SYSTEM CHECKOUT
INPUTS	SERIAL NO. 1, NO. 2, DIRECT FROM COMPUTER SERIAL NO. 3, DIRECT AND OFF-LINE (IBM TAPE UNIT)	IBM 729-IV COMPATIBLE MAGNETIC TAPES	1/2" IBM FORMATED TAPE, PUNCHED CARDS, PAPER TAPE
OUTPUTS	1. MICROFILM, 16MM, 35MM, 70MM 2. 16-INCH ON-LINE CATHODE RAY TUBE MONITOR 3. ON-LINE FINISHED HARD COPY (OPTIONAL)	CONTINUOUS ROLL OF 30-INCH VELLUM FOR OFF-LINE REPRODUCTION	CONTINUOUS ROLL OF 30-INCH VELLUM FOR OFF-LINE REPRODUCTION
PROCESSING TIME	1. MICROFILM ON LINE 33 MS/FRAME 2. SECONDARY CAMERA (DEVELOPED) 6 SEC/FRAME 3. ON-LINE FINISHED HARD COPY 6 SEC/FRAME	2 TO 3 FEET OF VELLUM/MINUTE 25 TO 50 ACTIVITIES/MINUTE 66 ACTIVITIES/MINUTE (PLANNED)	7090 COMPUTER: PROGRAM: 625 ACTIVITIES/MINUTE PLOTTER SPEEDS: 225 ACTIVITIES/HOUR
PROCESSING COSTS	1. ON-LINE FINISHED HARD COPY $.20/PAGE 2. ON-LINE MICROFILM OUTPUT	COMPLETE SERVICE (INCLUDING 7090 PROCESSING) .50-.70/ACTIVITY DRAWING ONLY (CUSTOMER 7090) .25-.40/ACTIVITY DRAWING ONLY (PLANNED) .15-.20/ACTIVITY	PACKAGE COST FOR COMPLETE SYSTEM: COMPUTER PROGRAM, TAPE INPUT ELECTROPLOTTER] $85K
COMPUTER PROGRAMS FOR PERT NETWORKS	FORTRAN 7090/7094 PROGRAM AVAILABLE TO DD-80 USERS	FORTRAN 7090/7094 PROGRAM. ACCEPTS PERT INFORMATION FROM OUTPUT OF AF PERT III, NASA PERT, HUGHES-PERT, LOCKHEED. 1500 ACTIVITY CAPACITY. COST: $20,000	FORTRAN IV (7090, 3600, 7044) 3000 ACTIVITY CAPACITY PER SUB-NET. NO LIMIT ON SUB-NETS.
SERVICE BUREAUS	NONE CURRENTLY THREE PLANNED FOR BOSTON AREA BY 3RD QUARTER 1964.	CULVER CITY, CALIF. (TWO SERVICES AVAILABLE:) 1. 7090 PROCESSING PLUS DRAWING 2. AUTOMATIC DRAWING ONLY	MARTIN DATA CENTER BALTIMORE, MARYLAND 48 HOUR TURN-AROUND TIME. OWN PROGRAM REQUIRED.
MONTHLY RENTAL	$6,510/MONTH	$6,200 (1 MACHINE PLUS COMPUTER PROGRAM)	NEGOTIATED
COMMENTS:	MOSAIC TECHNIQUE CAN BE USED WITH OUTPUT	1. NETWORKS TIME PHASED BY T_E OR T_L 2. VERTICAL PLACEMENT (BANDING) POSSIBLE, (21 BANDS) 3. 65 CHARACTERS FOR EVENT BOX DATA (5 ROWS) 4. ACTIVITY DATA POSSIBLE	COMPLETE SYSTEM AVAILABLE IN 2ND QUARTER 1964. NETWORKS MAY BE TIME PHASED AND BANDED.

FIGURE 3

DO YOU HAVE A **SIGNAL PROCESSING** PROBLEM?
AMBILOG 200 IS DESIGNED TO SOLVE IT!

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



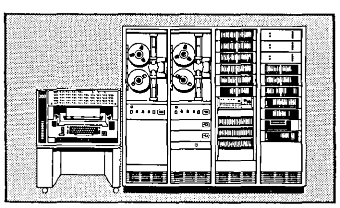
Real Time Waveform Measurement

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

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

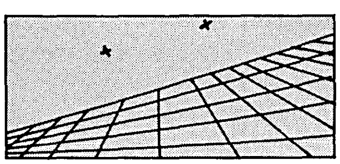
Spectrum Analysis

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



Digitizing and Recording

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



Display Generation

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

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

Adage INC.
292 Main Street, Cambridge,
Massachusetts 02142

Circle No. 13 on Readers Service Card

CALENDAR OF COMING EVENTS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Nov. 10-16, 1965: INTERKAMA (International Congress and Exhibition of Measuring Instruments and Automation); contact Nordwestdeutsche Ausstellungs-und Messe-Gesellschaft mbH - NOWEA -, Düsseldorf, Messegelände.

June, 1966: Third Congress of the International Federation of Automatic Control, London, England (Deadline for papers from the U. S. is March 1, 1965); contact Dr. Theodore J. Williams, Chairman, AACC Applications Committee, R & E Div., Monsanto Chemical Co., 800 N. Lindbergh Blvd., St. Louis 66, Mo.

computers and automation

1964 ANNUAL INDEX

Volume 13, 1964

Published by
BERKELEY ENTERPRISES, INC.
815 Washington Street
Newtonville, Mass. 02160

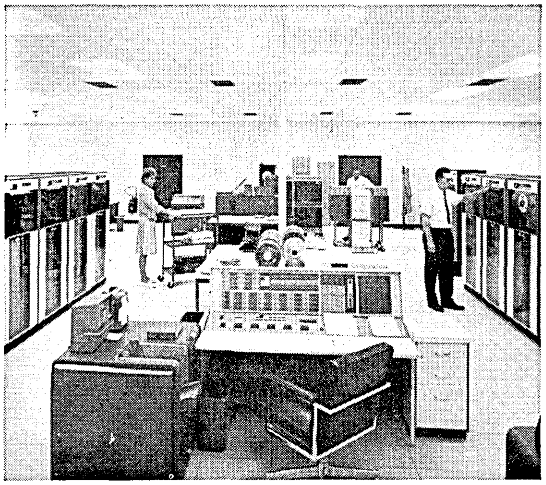
ANNUAL INDEX
for
VOLUME 13, 1964
of
COMPUTERS AND AUTOMATION

Published by Berkeley Enterprises, Inc.
815 Washington St., Newtonville, Mass. 02160

---

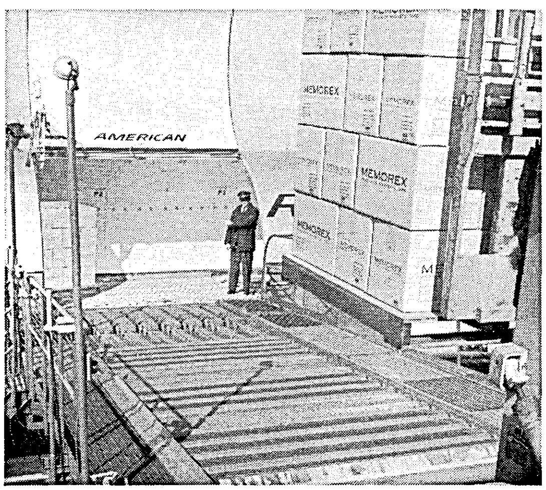
4 REASONS WHY MEMOREX LEADS IN COMPUTER TAPE

(And what it means to you!)



Premium Quality Ask the most demanding computer centers whose tape is used for their ultra-critical applications. You'll find a multi-million dollar vote of confidence placed in the integrity of Memorex products — the result of uncompromised and unvarying product superiority. With Memorex precision magnetic tape you always benefit from measurably longer tape life, freedom from rejects, greater reliability.

Extra Technical Support Authoritative technical backing is the hallmark of Memorex marketing. Manufacturing engineers and tape specialists with experience born of years solving digital recording problems offer help for the asking. Other aids to users include the Memorex Monograph series of informative literature; the Memorex tape slide rule; and technical liaison, of course. Next time you face recording problems, call Memorex!

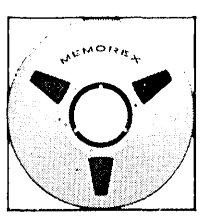


Added Service Close attention to a customer's needs is the rule at Memorex. But not all are technical. It is important to have the right product at the right time and in the right condition. To assure timely delivery and extra care in transportation, Memorex routinely ships via air carrier at no extra cost. What is more, specially designed containers and material handling methods keep tape error-free and pre-test perfect throughout shipment.

Continued Research Memorex Computer Tape is scientifically designed (not the result of cut-and-try methods) to meet highest standards of consistency and reliability. Intensive research in oxides, binders, and process innovations assures continued quality advances. Some results are subtle (an increase in coating durability); some are obvious (the super-smooth surface). But all improvements pay dividends in better performance to Memorex tape users.

Memorex tape is premium tape. No need to pre-check it. You can place Memorex computer tape directly in service — reel after reel.

Memorex certification means what it says: Memorex computer tape is error-free. Extra care, extra steps and scrupulous attention to every detail make it that way. We know the importance to you of having a tape you can depend on.



Are you on our mailing list to receive the Memorex Monograph Series of informative technical literature? Write 1176 Shulman Road, Santa Clara, California

MEMOREX

PRECISION MAGNETIC TAPE

Circle No. 18 on Readers Service Card

"ACROSS THE EDITOR'S DESK"

Computing and Data Processing Newsletter

TABLE OF CONTENTS

APPLICATIONS

COMPUTER FLIGHT PLANNING

Announcement of a new airline service industry — computer flight planning — recently was made by Frederick G. McNally, Chairman of the Board of Aero Performance, Inc., Manhasset, N.Y. The first operational flight that actually followed a plan developed by API's IBM computer was Swissair's Flight 801 to Europe last July 1. Since then, more than 1000 jet airliners have crossed the North Atlantic from the U. S. to Europe faster and more economically because of API's computer.

At present there are four airlines — Swissair, SAS, KLM, and Seaboard World — using the API Service for their jet flights to Europe. Routine operations provide daily service for such major terminals in North America as New York, Chicago, Boston, Montreal, and Charleston to the European destinations of Copenhagen, Frankfurt, Zurich, Amsterdam, London, Paris, Rome, Lisbon, and Geneva.

The computer's advantage over standard flight planning methods lies in the fact that it can blend last-minute weather information with a multitude of other factors and come up almost instantly with the best possible flight plan, which may shave minutes — and hundreds of dollars in cost — off every flight.

The average time saving realized on Europe-bound flights, McNally said, is about five minutes. This reduces the aircraft's fuel consumption by 1000 pounds for a savings of $50. Also, there is a savings of $50 to $75 in operating costs through cutting the time the aircraft is in flight. Even more importantly, however, the aircraft's payload potential is increased substantially. Here every minute saved may be worth $100 to $200.

Not only airlines, but passengers also benefit directly from computer flight planning, McNally pointed out. "The last man aboard a jet flight may owe his seat to a savings in fuel load made possible by our computer-planned flight route."

The IBM 1620 computer used by API maps out North Atlantic air routes by using a combination of fixed and variable data. Permanently stored in the computer are the individual airline's specifications for the maximum fuel capacity of the aircraft involved; operating weight empty; climb time, fuel and distance; aircraft altitude capability as limited by gross weight and air current characteristics; fuel flow for a variety of cruise schedules; speed capabilities for these situations; and the descent time, fuel, and distance. The system currently handles such data for a variety of models of Boeing 707 and Douglas DC-8 passenger and cargo jets with both straight jet and fan engines.

For each individual jet flight the computer will review detailed primary route and alternate route data; maximum allowable gross weight as dictated by various conditions; estimated arrival time; required fuel reserve and planned payload. Special U. S. Weather Bureau forecasts of upper air conditions over the Atlantic, obtained every six hours, are analyzed by the computer to produce a precise determination of wind directions and velocities and temperatures. After all of the variable data is entered into the computer, its high-speed card punch turns out the flight plans in the form of IBM cards at the rate of 125 cards per minute. The cards then are entered into an IBM telegraphic card reader which converts the data on the cards into telegraphic code for direct teletype transmission to the airlines.

Both an optimum route and alternate routes can be given with the comparative advantages of each. Routes also can be tailored to meet the airline's objectives for each flight — maximum payload or minimum time, distance, or fuel consumption.

The Computer Flight Planning System has been tested by TWA and other carriers. Several airlines have asked for extension of the Service to cover westbound flights to the U. S. from Europe. Already under study are the prospects for expansion of the service to air operations in the domestic U. S., Pacific Ocean Region, and the "polar routes".
(For more information, circle 41 on the Readers Service Card.)

COMPUTER USED TO PICK BEST SITES FOR WATER

A new computer method for evaluating the water supply in any area and determining where to drill new wells has been developed by Profs. Robert B. Johnson, Purdue University School of Civil Engineering, and H. Grant Goodell, Florida State University Department of Geology. The new method was demonstrated to the Geological Society of America at a recent meeting in Miami Beach, Fla.

Their method is a statistical analysis of ground-water movements. They provide the computer with thousands of statistics about a specific area — the water levels of a great number of wells at many different times, and the day to day rainfall — and the computer, following their mathematical instruction, creates a map showing zones of unusual water accumulation — that is, places where surface and rain water may be trapped in the earth, as compared with places where it runs off and is lost. By inference, they are able to picture the soil and rock formations beneath the surface.

With such a map, the geologist or water-supply engineer can determine the future water resources in the area, whether they are diminishing or increasing, and the immediate as well as long-term effects of water use and of local rainfall. In the area investigated for illustration (Jefferson County, Fla.), during a two and a half year period, they found that the earth formation is not open to the surface, and most of the local rainfall runs off into the Gulf of Mexico. But the regional rainfall, over a long period of time, does eventually raise the underground water level.

Comparison of computer-made maps with maps drawn manually reveal that the computer provides far better and more reliable information about underground water than has been previously possible. Profs. Johnson and Goodell said that the method also could be useful in selecting the safest places for waste water disposal.

COMPUTER GAINS SKILL IN DECIPHERING HANDWRITING

An IBM 7090 computer at Purdue University has been "learning" to read handwriting and hand-printing ranging in legibility from the efforts of grade-school children to the fast scribbles of college professors. Recognition of machine-printed letters is relatively easy; investigators in the field have already developed such computer programs for research projects. But to get the computer to recognize and act on a wider variety of visual patterns, none precisely alike and none completely predictable (as in handwriting, weather maps, or targets in space), requires a system of far greater complexity.

Prof. King-sun Fu and graduate student C. H. Chen, of Purdue's School of Electrical Engineering have taken a long step in that direction. With the system they have developed, the computer learns from each new handwritten or hand-printed sample it "sees", changing its programmed instructions so it can recognize still more varieties of the same letters. They have accomplished this by applying a sequential decision procedure, not previously used in practical problems of pattern recognition. It means the computer makes a series of decisions in sequence; the result of each calculation governs the next. As the final step it prints out the letter it recognizes.

Fu and Chen worked with the written and printed samples of 10 people at a time — 30 people altogether, at all levels of education. Each subject was asked to write and print 20 samples of each letter of the alphabet. To translate the letters into the mathematical expressions understood by the computer, the samples were magnified and placed on a photocell grid, which made it possible to describe the characteristic pattern of each letter in a set of measurements. They could also be measured by an electronic scanner.

From all the measurements, which the computer analyzed statistically, it arrived at an average set of characteristics (or numbers) for each letter. Any type of writing or printing of the letter, when so measured, would approximate the average measurements for that letter. At the same time, the computer was learning to recognize the patterns made by these sets of measurements.

Although Fu and Chen began with the complete statistical description, comprising hundreds of measurements, for each letter, they report that continuing analysis has reduced the number of descriptive measurements required as prior information for the computer, to 18 measurements to describe any written letter, and only eight for a hand-printed letter.

While reducing the amount of prior information the computer needs, they have also increased its skill at recognition. With the present program, it is accurate 93.1% of the time in reading hand-printed characters, and 88% with written characters.

NEW CONTRACTS

CONTROL DATA CORPORATION PLACES LARGEST DEVICE ORDER IN FAIRCHILD HISTORY

Fairchild Semiconductor, Mountain View, Calif., has received from Control Data Corporation of Minneapolis, Minn., what is believed to be the largest single commercial order ever placed for silicon transistors and diodes. Initial shipping release on the order calls for delivery of 10 million transistors and 2½ million diodes. Approximate value of this first increment against the purchase order is $5 million.

According to Robert N. Kisch, vice president and general manager of Control Data's computer division, the components will be used in the CDC 6600 computer system. The 6600 design calls for more transistors in relation to other components than have been used in any computer before — more than a half-million transistors in each computer.

Delivery of transistors and diodes in this order, began during the fourth quarter of 1964 and will carry through 1965 and part of 1966, when other shipping releases of similar magnitude are expected against the purchase order.

CSC AWARDED $1 MILLION NASA CONTRACT

Computer Sciences Corporation, El Segundo, Calif., has been awarded a new contract of up to $1,000,000 for computer programming services from the National Aeronautics and Space Administration's Goddard Space Flight Center, Greenbelt, Md.

The NASA contract covers a three-year period during which CSC will provide such services as mathematical and physical analysis, systems analysis, scientific programming, operational analysis and documentation.

NAVY AWARDS BUNKER-RAMO HYBRID COMPUTER STUDY

The Navy Bureau of Ships has awarded Bunker-Ramo's Defense Systems Division, Canoga Park, Calif., a $95,000 contract for a hybrid computer study that may define the standard Navy computer of the future.

The nine month study will define in detail a variety of Navy computational requirements from routine "housekeeping chores" of EDP bookkeeping to sophisticated, on-line control of guns and missiles. A preliminary design of a hybrid computer, geared to meet this broad variety of tasks, will be produced.

AUERBACH RECEIVES CONTRACT FROM RADC

Auerbach Corporation, Philadelphia, Pa., has been awarded a $70,000 contract by the Rome Air Development Center to design the storage and retrieval system for what will be the largest store of computer-processed reliability information in the world. It will be part of a facility called Reliability Central, which eventually will manage and analyze all of the reliability information developed on Air Force systems and their components.

The file structure of the Reliability Central system will have to meet unusual requirements in terms of expansibility and accessibility. The system will be used by both military personnel and contractors on a time-shared multi-access basis from remote locations. Consequently the file structure will have to facilitate the retrieval and analysis of many different and changing types of reliability information.

RCA AWARDS CONTRACTS TO PROGRAMMATICS INC.

Programmatics Incorporated, Los Angeles, Calif., has been awarded two contracts by the Radio Corporation of America involving the production of a meta-assembly program and various utility programs.

The meta-assembly process is a Programmatics development which permits one computer to assemble programs for numerous other computers. This award calls for the production of such an assembly system for the RCA 110A computer. The meta-assembler will be used for assembling programs used in the SATURN checkout system.

MITSUBISHI ORDERS DATA PRODUCTS DISCfILES

Mitsubishi Ltd. of Japan has placed an order in excess of one-half million dollars for DISCfILES® to be used in their computer product line. The order was negotiated by the Nissho Company Ltd., Japanese representatives for Data Products.

Raymond Stuart-Williams, vice president of the Data Products DISCfILE Division, stated that Mitsubishi is the third major Japanese computer manufacturer to select Data Products DISCfILES as standard components in their computer lines. The Nippon Electric Company and Fujitsu Ltd. have used DISCfILES in Japan for more than a year.

CONSOLIDATED EDISON ORDERS CONTROL SYSTEM FROM LEEDS & NORTHRUP

Leeds & Northrup Company, Philadelphia, Pa., will manufacture a $1,300,000 computer directed control system for Consolidated Edison to dispatch and regulate the electric power supply for nearly 9,000,000 people in New York City and Westchester County.

The new system is scheduled to begin operations in 1966, and will be housed in Con Edison's Energy Control Center in Manhattan. It will allocate electric generation to any of 23 single or groups of generators in Con Edison's 12 power plants serving the five boroughs of New York and Westchester County.

In addition, the system will provide automatic interchange scheduling between Con Edison and cooperating systems; will apportion power to key areas during peak load periods; and indicate reserve units to be used in case of emergency.

The control system combines the advantages of digital and analog techniques. Supplied under sub-contract by General Electric, the digital computer system provides memory and logic, while the analog system manufactured by Leeds & Northrup provides the qualities of simultaneous control, continuous monitoring and backup facilities. Leeds & Northrup has been given complete system responsibility for design, engineering and installation.

GP's LINK GROUP RECEIVES $7 MILLION CONTRACT

General Precision's Link Group, Binghamton, N.Y., has received a $7 million contract to design, develop and produce a Lunar Excursion Module (LEM) mission simulator. The contract was awarded by the Grumman Aircraft Engineering Corp. which is producing the LEM vehicle for NASA's Project Apollo.

The LEM mission simulator will be an exact replica of the LEM internal configuration including all instruments, displays and operational modes. Through an intricate combination of optics, mechanics, and electronics, it will accurately simulate the lunar approach, landing, stay, and lunar launch.

Link is now in the process of producing Apollo mission simulators which will provide the means for simulating the journey to the vicinity of the moon. The LEM mission simulator will complete the trip by simulating the manned lunar landing. Through use of both the LEM and the Apollo mission simulators, astronauts will be able to prepare for the entire, two-week Apollo mission.

Two LEM simulators will be produced for installation at NASA's Manned Spacecraft Center, Houston, and Cape Kennedy.

NEW INSTALLATIONS

BOWDOIN INSTALLS IBM 1620

Technicians have completed installation of a new IBM 1620 computing system at Bowdoin College, Brunswick, Me. Housed temporarily in the College's Searles Science Building, the $100,000 computer and its components will be moved into Hubbard Hall, Bowdoin's present Library, when work on its new Library building is completed late this year.

The new computer will be used in teaching, research, and administrative functions. Professor Robert A. Walkling, Chairman of the College's Computing Center Committee, said several courses now being taught at Bowdoin will be enhanced by use of the new system, among them Advanced Analytical Chemistry, Statistics, and Psychological Measurements.

So that they will be able to make fullest use of the new equipment, members of the Faculty and Staff at the College are attending a series of lectures to learn its uses and operation. At the invitation of the Computer Center Committee, a representative of the IBM Corporation is conducting the once-a-week meetings.

1000TH NCR COMPUTER SYSTEM INSTALLED AT FIDELITY MUTUAL LIFE

The National Cash Register Company disclosed that its 1000th computer system has been installed at Fidelity Mutual Life Insurance Company, Philadelphia, Pa.

The system is an NCR 315 which will process insurance records for Fidelity Mutual Life's more than 200,000 policyowners. It will compute policy valuations including dividends, reserve and cash value, prepare premium notices and provide actuarial statistics. Future applications will include actuarial studies, investment analysis and general accounting.

EVANGELISTIC ASSOCIATION TO INSTALL GE-415

The Billy Graham Evangelistic Association, Minneapolis, Minn., has placed an order with General Electric Co. for a GE-415 computer. The machine will be used in the distribution of the association's magazine, "Decision", and in maintaining files of names and addresses for the organization's fund raising activities.

The Billy Graham Evangelistic Association is a "support" organization, created to administer much of the paperwork associated with Rev. Graham's world-wide religious activities.

The new GE-415 data processing system, scheduled for delivery in February, replaces two IBM 1401 computers.

PHYSICISTS TO USE PDP-5 FOR COSMIC RAY STUDIES

The Physics Department of the University of Arizona has ordered a Programmed Data Processor-5 computer from Digital Equipment Corporation of Maynard, Mass., for use in studying cosmic ray phenomena.

The PDP-5 will perform on-line scanning of wire spark chambers. The chambers will function with particle detectors to record the passage of each particle. The computer will make a permanent record of all the events and will be used to perform kinematic analyses seeking to identify the particles.

The University of Arizona system includes a 4096-word core memory, an additional equipment bay, and a console tape-teleprinter.

INSTITUTE OF TEXTILE TECHNOLOGY EXPANDS COMPUTER FACILITIES

The Institute of Textile Technology, Charlottesville, Va., has installed an IBM 1620 computer as part of an effort to enlarge the scope of its research, academic, and information programs.

The Institute of Textile Technology, founded in 1944, has continued as a privately-owned organization providing research, education, and informational services to member textile companies. The Institute offers a Master of Science degree in Textile Technology and is the research and information arm for 150 mills representing over 6,000,000 spindles in the textile industry, located from Canada to Texas.

The new 1620 computer will enable the school to expand its classes in advanced management techniques, and will enable them to probe areas of research that would be impossible without the calculating and processing speed of a computer.

TRAVELERS INSURANCE RECEIVES FIRST SHIPMENT OF NEW COMPUTER SYSTEM

Delivery of a UNIVAC 490 Real-Time computing system has been made to The Travelers Insurance Companies, Hartford, Conn., by Sperry Rand Corporation's UNIVAC Division. The equipment will be housed in the north wing of The Travelers Data Center. Within the next several years additional UNIVAC 490 systems will be added to complete the system.

The recently delivered system is part of what is believed to be one of the largest single commercial computer installations in the country. It will be a message handling as well as a data processing system and will be installed over a period of several years. Delivery of the next UNIVAC 490 system is scheduled for mid-1965.

UNIVERSITY OF CALIFORNIA INSTALLS SDS 930

An SDS 930 Computer with 16,384 words of memory has been installed at the University of California at Berkeley. The 930 is used on a time-sharing basis by scientific researchers located throughout the campus. Each remote station is equipped with a Teletype Keyboard/Printer. The 930 also communicates with a previously installed SDS 910 computer and an IBM 7094.

PROVIDENT SAVINGS INSTALLS NEW COMPUTER

Provident Savings Bank of Baltimore, Md., which recently passed the $200 million mark in volume of deposits, has announced the installation of a new IBM 1460 computer to handle its growing business.

The IBM 1460 system contains information concerning some 180,000 savings accounts, 16,000 mortgages and 22,000 consumer loans — and room for more to accommodate future growth.

Provident was the first savings bank in the country to establish branches, and in 1961, was the first savings institution in the Baltimore area to install a computer.

AMERICAN CAN COMPANY INSTALLS COMMUNICATIONS CONTROL SYSTEM

The American Can Company has inaugurated a computerized communications relay system which is expected to handle 1,640,000 messages annually, involving automatic routing of more than 106 million words.

Heart of the new automatic system, located in suburban Oak Brook, Ill., is an IBM 7740 communications control system which links together more than 100 American Can Company plants and offices for almost instantaneous reception of messages.

The message relay center will use more than 45,000 miles of wire circuits leased from the American Telephone and Telegraph Company. A total of 150 American Can Company installations will eventually be served by the automatic message relay equipment.

INVESTMENT FIRM TO HANDLE COMMODITIES SERVICES BY COMPUTER

E. F. Hutton & Company, Inc., New York, N.Y., a leading nationwide investment firm, has announced that with the addition of a fourth RCA computer system it will become the first firm electronically handling commodities transactions.

The new RCA 301 computer will be installed at Hutton's data processing center in New York, which already utilizes two of the 301's and a larger RCA 501 computer system.

With the addition of the new computer system, E. F. Hutton plans to add new services for its more than 77,000 active securities and commodities customers in the U. S. and Europe. Present tasks being performed at Hutton's data center include bookkeeping, stock record and statements, interest and dividend computation, payroll and security margining.

FURNITURE SALES TO BE ANALYZED BY H-400 SYSTEM

Kroehler Manufacturing Company, Naperville, Ill., internationally known furniture manufacturer, has recently installed a computer at its headquarters to keep track of sales and to spot areas where sales need bolstering.

Each day, sales information from the firm's 15 plants throughout the U. S. and Canada will be processed through a Honeywell 400 computer, which will analyze the data and help Kroehler management pinpoint locales and product lines that require sales emphasis. The company also will provide sales analyses for its major customers to aid them in forecasting demands in their marketing areas.

In addition, the computer will perform scheduling, production and material control, labor distribution and general accounting functions for the home office, furniture plants, fabric warehouses, saw mills and cotton blending plants maintained by the company.

The System includes a central processor with 2048 words of memory, five magnetic tape drives, a high-speed printer, card reader-punch and a paper tape reader.

BANK OF DELAWARE INSTALLS IBM 1410-1301

The Bank of Delaware (Wilmington) has announced installation of an IBM 1410-1301 computer system which provides answers to customers questions regarding checking, savings and installment loan accounts — in as little as 45 seconds.

Within the next six months, an IBM audio response unit will be added which literally will speak out the answers to questions, right at the teller's window, within 10 seconds after the inquiry.

The bank now handles some 600 inquiries per day, half of which occur within a two-hour period. Formerly, these were handled manually through separate departments and response could take as long as five minutes. Bank employees now can make a customer inquiry directly to the computer center. There, two IBM 1014 operators query the computer for the desired information. The computer types out a reply on a card which then also serves as a record of the inquiry.

ARTIFICIAL FLOWER COMPANY INSTALLS COMPUTER

Zunino Altman, Inc., a subsidiary of Revlon, and the world's largest manufacturer and importer of artificial flowers, has installed a Honeywell 200 data processing system at its Ridgefield, N.J., distribution headquarters; it is the first company in its field to install a computer for the sole purpose of handling artificial flower data processing tasks.

The computer will help Zunino Altman keep track of orders from 20,000 chain stores, department stores, retailers and florist jobbers, and to forecast seasonal demands for more than 2000 different artificial flower styles, ranging from asters to zinnias. In addition, the system will also keep track of an inventory of millions of individual flowers, plants and trees in transit from 50 manufacturing plants in Hong Kong, or located at three regional warehouses in Ridgefield, Baltimore and Los Angeles.

The Honeywell 200 consists of a central processor with 12,288 characters of memory, five magnetic tape transports, a card reader-punch and a high-speed printer.

WEST VIRGINIA UNIVERSITY INSTALLS COMPUTER SYSTEM

West Virginia University, Morgantown, W. Va., has completed installation of a new computer system. Dr. Paul A. Miller, president of WVU, said the equipment provides the university with data processing capabilities comparable to other major universities. Prior to installation of the IBM 7040 and 1401 computers, these needs were met by two medium-size computers operating 24 hours a day.

In addition to use in research projects, WVA's Computer Center is used annually by more than 400 students in their studies.

ORGANIZATION NEWS

BUNKER-RAMO, 3C ANNOUNCE INTERNATIONAL COMPUTER AGREEMENT

The Bunker-Ramo Corporation and Computer Control Company, Inc. have announced the conclusion of arrangements making available to Bunker-Ramo 3C computer hardware and technology on a worldwide basis. The arrangements cover both present and future computer developments by 3C and contemplate long term contractual cooperation between the two companies. These arrangements permit Bunker-Ramo to supplement its own hardware developments so as to market a broad line of computer systems.

As an immediate result of the arrangements with 3C, the present Bunker-Ramo computer line, including the new BR340, will be expanded by the addition of a smaller, low cost computer to be marketed as the BR 335. This will have applications to small process control systems, as well as more general applications in manufacturing operations and in scientific and engineering uses.

3C is a leading manufacturer and marketer of general purpose computers. Bunker-Ramo is a major supplier of process control systems.

COMPUTRON INC. JOINS BASF

Computron Inc., Waltham, Mass. (USA), and Badische Anilin- & Soda-Fabrik Aktiengesellschaft, (BASF) Ludwigshafen/Rhein/Germany, have jointly announced that Computron Inc. has become a wholly-owned subsidiary in the BASF-Group.

Computron Inc., manufacturers of magnetic tape, will continue operations in their Waltham facilities under present management. BASF, a producer of dyestuffs, chemicals and plastics, was also the producer of the world's first magnetic recording tapes in 1934. Computron Inc. markets its products in the United States and throughout the world.

CONTROL DATA, DATATROL PLAN MERGER

William C. Norris, President of Control Data Corporation, and Hugh P. Donaghue, President of Datatrol Corporation, recently issued the following joint statement:

"The officers of Control Data Corporation and Datatrol Corporation have been negotiating and have reached a preliminary understanding, subject to final agreement, regarding the acquisition of Datatrol Corporation by Control Data Corporation. The merger is subject to final approval by shareholders of Datatrol and by the Board of Directors of both firms."

The acquisition will involve the exchange of approximately five shares of Datatrol stock for one share of Control Data stock.

PLANNING RESEARCH CORP. ENTERS NUMERICAL CONTROL FIELD

Planning Research Corp., Los Angeles, Calif., announced that it has extended its capabilities into the field of numerical control. A new section has been created within PRC's Information Systems Division to handle the work.

Though many major manufacturers have employed their own parts programmers to institute automated systems, most smaller shops retain independent consultants such as Planning Research to implement their systems. Dr. Robert W. Krueger, president of PRC, reported that the company's initial efforts will be made in the Southern California area, where it already has several contracts for numerical control systems. It will gradually expand throughout the U. S.

TECHNICAL ASSOCIATION FORMED FOR NAVIGATION SYSTEM SALES IN CANADA

Joseph B. Heimann, Division President, announced that the Systems Division of General Precision's Aerospace Group and de Havilland Aircraft of Canada Limited have formed a technical association to market, in Canada, General Precision's Vertical Azimuth Reference System (VARS). VARS is the central element in a navigation system for long range aircraft. The agreement between the two companies calls for the marketing, field support and overhaul, and possibly the manufacture of the VARS system.

Particular significance was given to the agreement, and the possible use of VARS by the Canadian Armed Forces, by Mr. D. B. Annan, Vice President of de Havilland. The VARS is used presently in the navigation of aircraft engaged in anti-submarine warfare, radar picket flights and similar long-range missions. Currently, it is being manufactured for installation in the Brequet 1150 "Atlantic", a maritime patrol aircraft used by NATO.

ELECTROPHOTOGRAPHY, SUBJECT OF AGREEMENT

Agreements have been signed between IBM Corporation, Harris Intertype Corporation and the Mead Corporation in the field of electrophotography. The agreements, which had been under negotiation for some months, could facilitate IBM's entry into the office copying field.

Under the contracts, IBM will obtain from Harris Intertype an option for a non-exclusive license under certain Harris electrophotographic developments and patent applications. If IBM exercises its option with Harris and markets office copying machines utilizing the Harris technology, the Mead Corporation will supply the copying paper.

Harris Intertype has developed electrostatic map printers for the U. S. Government in addition to office copying developments. Mead has carried out a joint research project with Harris on electrostatic printing papers and currently manufactures paper for the Harris Intertype electrostatic map printers.

COMPUTER USAGE COMPANY OPENS OFFICE IN HOUSTON

Computer Usage Company, Inc., specialists in computer programming and problem analysis, have opened a new sales and operations facility in Houston, Texas. CUC also maintains offices in Washington, New York, Boston, Los Angeles and San Francisco.

COMPUTING CENTERS

COOPERATIVE COMPUTER CENTER FOR DELAWARE HOSPITALS

A cooperative venture in electronic data processing, linking three independent hospitals to a central IBM computer, has been initiated in Wilmington, Del. The new computer center, known as EDCO (Electronic Data Coordinated Operations), is the result of a movement in the Wilmington area to unify the accounting operations of Delaware Hospital, Wilmington General Hospital and Memorial Hospital, representing a total of over 1000 beds.

Here is how the system works: When a patient is admitted, all relevant information is transmitted to the computer center where the individual record is entered into the memory disks of the computer. Each of the memory disk files can hold over two million digits or characters of information. Subsequently, whenever a service is performed — such as a laboratory examination — the information is transmitted through a terminal to the computer where the record is updated. When the patient leaves, the computer is queried and the complete bill is typed out, automatically, at the outgoing desk.

The new computer system relieves hospital personnel of routine paperwork, allowing them more time for professional duties. Furthermore, instead of receiving an incomplete, often unintelligible bill for 35 to 40 services performed, the patient receives a complete bill clearly indicating the services performed and the cost for each.

Additionally, important statistical information will be readily available to hospital management. With this kind of information retrieval ability, hospital management will be able to evaluate where services can be improved, where resources should be allocated and where costs can be cut.

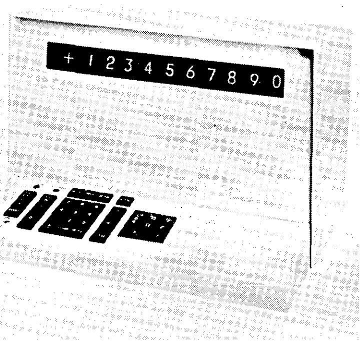
NEW PRODUCTS

Digital

LOGARITHMIC COMPUTING INSTRUMENT

Wang Laboratories, Inc., Tewksbury, Mass., has announced their new LOCI (LOgarithmic Computing Instrument), a compact electronic computer which can be used on desk tops or tables. LOCI-1 has been designed to extend the personal computing power of the scientist and the engineer.

With its storage registers and keyboard, it performs all of the operations found in ordinary calculators. However, LOCI's logarithmic principle of operation enables it to function with unusual flexibility and unparalleled power, reducing the number of steps needed for many types of complex calculations.



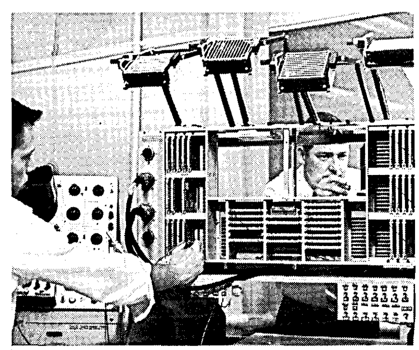
For example, square roots and reciprocals of square roots may be computed with one-key strokes. Exponential and logarithmic operations are accomplished with equal ease. Briefly, the logarithmic register accumulates the logarithms of numbers much as an ordinary accumulator stores the result of additions and subtractions. The logarithms are automatically generated when the appropriate function keys are pressed. The antilog of a number in the logarithmic register is also obtained upon a single key command.

Answers of eight- to ten-digit precision are available at electronic speeds upon the clearly legible Nixie display. The LOCI-1, although simple to operate, is more flexible than a slide rule and more accurate than most mathematical and engineering tables. (For more information, circle 42 on the Readers Service Card.)

SPACE COMPUTER DEVELOPED BY IBM FOR MOON ROCKET

One of the most reliable computers ever developed for a space system has been described by Glenn C. Randa, design engineer from the IBM Federal Systems Division, Rockville, Md. The suitcase size computer is to steer 30-story-high Saturn V rockets and their Apollo spacecraft during the first leg of the manned trip to the moon. According to Randa, the computer is three times faster and sixty times more reliable than the guidance computer that steered an unmanned Saturn I rocket into orbit last September. Both the Saturn I and Saturn V digital computers were developed for NASA's Marshall Space Fligh Center by engineers at the IBM Space Guidance Center in Owego, N.Y.

IBM has also designed a data adapter for the Saturn moon rocket. This 176-pound box of highly compressed and advanced electronics ties the computer with all the other on-board systems that feed data into the computer and use its calculations.



— IBM engineers test a prototype of the 77-pound computer that will help guide the six-million-pound Saturn V launch vehicle with its Apollo spacecraft into earth orbit and, when all is ready, out of that orbit towards the moon.

The computer holds information that has been stored in its memory before launch, plus electronic circuits that perform guidance and checkout calculations at speeds measured in millionths of a second. The data adapter acts as the computer's communications link with other parts of the Saturn V, and with ground equipment.

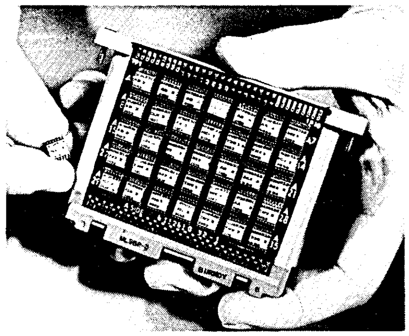
The work of the computer and data adapter was described in the following way:

The equipment's duties begin before launch when ground monitors use it to check out itself in a complete simulated mission. Then, starting at liftoff, the computer navigates and steers the six-million-pound vehicle towards orbit. During the ascent, the computer receives raw information on speed and attitude from the data adapter, which has collected the information from sensors elsewhere in the rocket. The computer processes this raw data into steering commands to equipment that keeps Saturn on course. The computer also issues the commands to drop off the first and second stages when they have burned out.

After the Saturn and its Apollo payload get into orbit about Earth, the computer shuts off the S-IVB third stage rocket stage engine and checks it out as the vehicle coasts around the earth. It sends this test data to the ground where it is analyzed. If all tests are satisfactory, the computer is radioed to restart the S-IVB rocket engine at the exact moment that will send the Apollo towards the moon. When the Apollo and the Saturn are on the final course for the moon, the computer issues the signal to separate the third stage from the manned moon vehicle, and the burned out stage with the IBM system then falls behind as the Apollo spacecraft flies on to the moon on the course the computer has navigated for it.

The computer and data adapter designed to perform these tasks will ride near the top of the 360 foot-high Saturn V. Both units will be in the launch vehicle's Instrument Unit — a three-foot-high, 22-foot-diameter slice of the vehicle located between the upper stage and the Apollo payload.

A triple modular redundancy design is used in the space computer to get a 20-fold increase in reliability over a completely non-redundant system. When a problem is presented to one module, the



— The microminiature circuit package shown here was used in the Saturn V computer. There are a total of 8918 tiny unit logic devices in each computer and data adapter in the guidance system (single device shown held at left). ULDs are mounted by infrared solder reflow on interconnection boards, which, in turn, are interconnected back to back to form page assemblies (right). Each Saturn computer has 150 page assemblies, each with an average of 500 components. There are more than 50 types of ULDs in the IBM computer, each containing up to 17 components including transistors, diodes, and resistors.

same problem is presented simultaneously to two other identical modules. If one module has failed and issues an incorrect signal, a majority "voter" circuit only passes on data from the two other circuits that agree with each other. Still another circuit, called a "disagreement detector", signals ground equipment whenever voter circuit inputs are not identical. Without this booster-to-ground signal, ground monitors would not know there had been a failure in the guidance system because the TMR feature insures that the system will operate accurately even if an individual part should fail. A reliability of over 99% is predicted for a 250 hour operation.

PHILCO 213

The latest and most powerful electronic data processing system in the Philco Corporation's 2000 series is the Philco 213. The 213 has multi-processing capabilities for simultaneous computation of related or independent problems. It is compatible with the earlier Philco models. All programs developed by Philco and Philco 2000 users over the past seven years, can be run on the 213 without reprogramming.

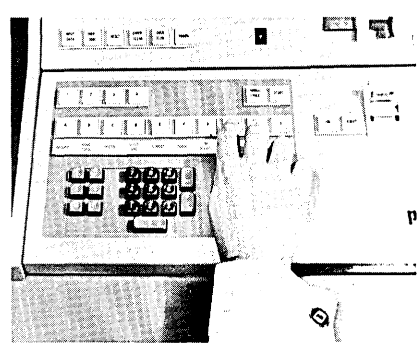
As many as four processors may be included in a 213 system. Each processor is able to address any character or word in up to two million words of memory. A memory protect system precludes inter-processor interference.

The key software element is an Executive System Program. This is being designed to control all processors and peripheral units in the system.

The Philco 213 Information Handling System also provides: memory access time of less than 900 nanoseconds; expanded command field providing future growth capability; mass random access storage, shared by any processor, providing transmission speeds up to two million characters per second and storage of more than 665 million characters; magnetic tape units with transfer rates of 120,000 6- or 8-bit characters per second; and multiple remote input-output stations and long-range Data Communications Terminals.
(For more information, circle 45 on the Readers Service Card.)

SURVEYING COMPUTER

Pacific Data Systems, Inc., a subsidiary of Electronic Associates, Inc., Santa Ana, Calif., has announced the PDS 1020 SUPR computer with which common surveying problems can be easily computed. No formal computer training is required, and proficient operation can be learned within an hour.



The simplicity of its operation is best illustrated by the ease of data entry. Bearing and distances are keyed in from an adding machine type keyboard. The type of calculation is selected merely by pushing the desired button: traverse, horizontal curve, inverse, supersine (including criss-cross and angle-cross), square root, angle conversion and others.

In addition to checking closure, the SUPR will compute the area of a traverse in square feet and in acres; the traverse area including or excluding curved areas; and the area, delta angle, arc, chord and semi-tangent of a curve when given radial and two bearings. It will also provide the error of closure and type out the correction course with bearing and distance required to correct the error of closure.
(For more information, circle 43 on the Readers Service Card.)

IBM INTRODUCES LOW-COST IBM SYSTEM/360

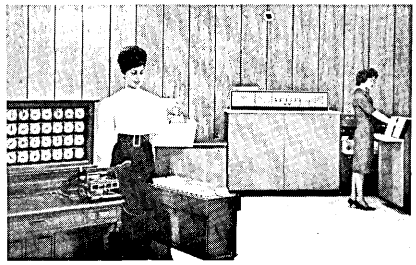
A low-cost version of IBM System/360 now makes the use of an electronic computer practical for many companies which could not previously afford one. The computer, known as the IBM System/360 Model 20, includes major advances over traditional punched-card accounting methods.

IBM Corporation said this is the culmination of an international product development program. Elements of the new system were developed at the Boeblingen, Germany, laboratory of the IBM World Trade Corporation, and at IBM facilities in San Jose, Calif.

A new peripheral unit, the IBM 2560 multi-function card machine, enables the system to perform many card-handling jobs which previously required four off-line machines. The result is a drastic reduction in processing time. For example, a billing operation handling some 5000 bills each cycle, would take nine separate punched card steps and seven hours of accounting machine time. With the new system it can be done in one step and two-and-a-half hours.

The IBM 2560 can read, manipulate and punch cards from two separate card hoppers. The device reads up to 500 cards a minute, punches up to 90 cards a minute, and prints up to 100 cards a minute. Cards are fed into five common output stackers to permit merging as well as sorting.

Other changes include advanced programming techniques. The plugboards required to control punched-card machines have been replaced by stored programs called forth by control cards.



— The first punched card tabulating machine, invented in 1890 by Dr. Herman Hollerith, contrasts with new IBM System/360 Model 20. Hollerith's machine was designed to automate tabulation of the 1890 U.S. census — at a speed of 10 cards a minutes. System/360 can read up to 1000 cards a minute while simultaneously performing high-speed computations.

The new System/360 configuration also has data communications capability, making possible its use in widespread information systems. For efficient operation, the system uses overlapped processing to permit several activities to take place simultaneously.

The System/360 punched card processor contains logic and control circuits as well as memory and eight 16-bit registers. Its magnetic core storage has a capacity of 4096 eight-bit characters, or 8192 packed decimal digits. Memory speed for a read-write cycle is 3.6 microseconds. Data is accessed from memory one eight-bit character at a time.

The Model 20 processing device uses the same instructions and instruction format as other System/360 processors. In addition to the 2560 multi-function card machine, the user has an option of several input-output devices.
(For more information, circle 44 on the Readers Service Card.)

Software

DATA PROCESSING SYSTEM SIMULATOR (DPSS)

A computer program which simulates and evaluates the pre-operational design of an information processing system — including both hardware and software elements, was described at the 1964 Fall Joint Computer Conference. The program, called the Data Processing System Simulator (DPSS), was originally designed by System Development Corp., Santa Monica, Calif., for analysis and development of the information processing requirements of the Strategic Air Command Control System (SACCS). The DPSS has been adapted to permit application to other systems in various stages of design and development.

Through the use of the DPSS, the total system design can be subjected to a rigorous analysis and evaluation early in the design process so that key decisions can be made in the areas of: the kind of equipment to be used; the number of each type of equipment; the kind of data processing discipline and strategy required; the projected performance of the system under varying loads; the system's maximum capacity; the system's ability to respond as a function of loading, capacity, and environment.

It is pointed out that DPSS is not regarded as a cure-all for the problems of system design. Its designers feel, however, that it is a powerful analytic tool, which, if properly used, can be of invaluable aid to the user and designer in studying systems under development and making better design decisions.
(For more information, circle 46 on the Readers Service Card.)

SPECIFICATION VISIBILITY AND CONTROL

Business Technicians, Inc., Anaheim, Calif., has announced the development and implementation of a new computer program designed to provide the Government and Government contractors with Specification Visibility and Control to any desired level of reference. The system was developed to provide defense contractors with the specification visibility necessary to keep abreast of current Government procurement practices and requirements.

Basically, in the matter of but a few hours, BTI can provide a specification tree listing all possible military and Federal specifications and their applicable amendments to any Government contract, proposal request, model spec, end-item spec, etc., for any specified date. The program is very flexible and has been designed to accommodate contract peculiar information such as superseding company documents; interpretation of certain specifications, applicable paragraphs, deletions, and waivers.

The program is not only economical but provides a substantial risk reduction in Government contracts, thereby improving a company's competitive position. (For more information, circle 48 on the Readers Service Card.)

COMPUTER PROGRAM AIDS SAVINGS AND LOAN MANAGEMENT

A new package of computer instructions called Program for the Allocation of Resources of Savings and Loan Associations has been developed by the IBM Corporation. The program enables savings and loan executives to use IBM 1401 or 1440 computers as an aid in making financial policy decisions.

Under control of the resource allocation program, a computer can compare the effects of a large number of key financial decisions. The program also enables the computer to consider an unlimited number of variables and 46 restrictions. Variables would consist of all sources of funds and allocation possibilities; restrictions include those imposed by law as well as those an association may set for itself as a matter of policy.

To use the resources allocation program, a savings and loan institution enters into the computer a description of its financial status, its legal requirements and association policies. These are translated by the program into a set of concise mathematical equations which reflect the economic environment within which the association must operate.

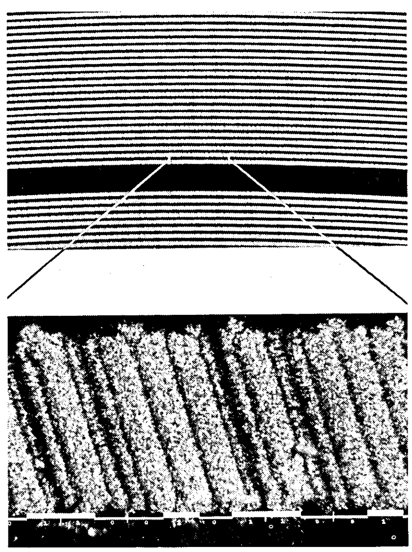
The resources allocation program is available without charge to users of IBM data processing systems. (For more information, circle 47 on the Readers Service Card.)

Memories

NEW BRYANT DISC FILE

A new random-access mass memory — designated the Mod 2 Series 4000 Disc File — has been developed by Bryant Computer Products, Walled Lake, Mich.

The Mod 2, designed to be competitive with the IBM 1302, includes three important design improvements over the Bryant Series 4000 Disc File, namely: (1) a dual-positioning system; (2) 600 bit-per-inch recording in all zones and for all file sizes; and (3) an exceptionally wide range of operating capability in terms of insensitivity to temperature/humidity environments. These new disc files also will incorporate a modular styling option — wherein the front panels of the Mod 2 file can easily be modified to be compatible in appearance with the equipment with which it is being used.



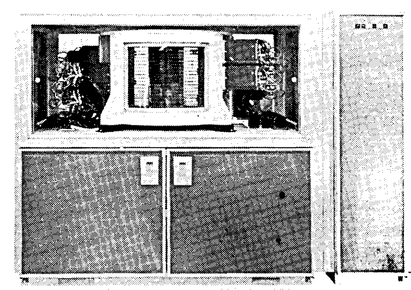
— 600 BPI Recording. The upper photo shows an enlarged view of tracks recorded in two zones; the large black horizontal bar is the zone-to-zone guard band; the smaller black horizontal bars are the track-to-track guard bands. The lower photo shows a magnified section of the innermost track of a zone; the original track width is 0.010 inch. The bit pattern of ONES and ZEROES representative of data which have been recorded by a phase-modulation technique is indicated by the scale along the bottom of the photo.

The Mod 2 files will include three basic machine sizes, each modularly designed to accommodate from one to its maximum complement of discs. The Mod 2 Series 4000A will contain up to 6 data discs with a single head positioning system; the Mod 2 Series 4000B and Series 4000C, up to 13 data discs and 25 data discs, respectively, with the option of one of two head positioning systems. Each Mod 2 file will contain an extra disc for clocking data, additional data storage and fast accessing capability.

All Mod 2 models will have self-contained environmental control and the capability of providing packing densities of 600 bits per inch across all zones of the recording discs. (For more information, circle 49 on the Readers Service Card.)

DATA PRODUCTS ANNOUNCES LOW-COST DISCfILE SYSTEM

The low-cost Model dp/f-5022 DISCfILE® is now available from Data Products Corporation, Culver City, Calif., for special purpose computer makers or data systems builders. This latest model of the 5000 Series DISCfILE product line is offered in capacities ranging from 8 million to 32 million characters in a single 16-disc system with up to 128 million characters possible in special configurations. The 5022 can be conveniently and quickly field-expanded at low cost as system complexity grows.



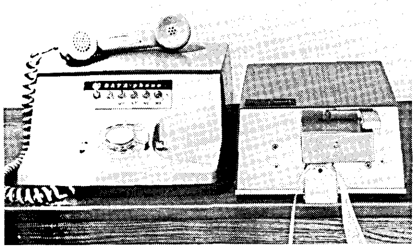
Of particular advantage to the system builder is the simple interface provided by a specially designed logic unit which includes all data electronics and is an inherent part of the 5022 system. (For more information, circle 50 on the Readers Service Card.)

Data Transmitters and A/D Converters

DATA TRANSMITTER WITH UNATTENDED ANSWERING

A low cost data transmission terminal featuring unattended answering service has been developed by Tally Corporation, Seattle, Wash.

The new terminal, the Mark 10 UA, is the latest in the firm's line of low cost data transmitters for use in sending business and scientific data over the telephone. Data is transmitted on perforated paper tape at 60 characters per second using Bell System Model 402 Data-Phones. Size is only 8½" wide x 4" high x 11" deep.



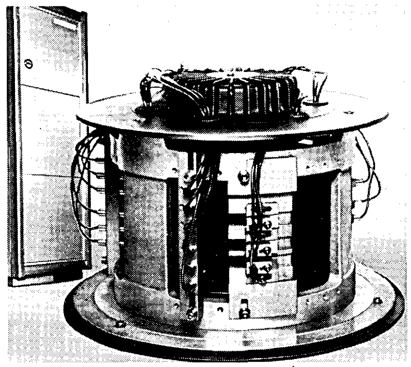
The Mark 10 UA can be used to solve data gathering problems whenever collection from multiple points for processing by central computer or other EDP equipment is required.
(For more information, circle 51 on the Readers Service Card.)

CREDAC CONTROL SYSEM

CREDAC, developed by CREDAC, a Division of Mechanical Enterprises, Inc., Alexandria, Va., is an electronic system which automatically verifies credit in ten seconds. Although similar to a computer in appearance, engineers explained that CREDAC performs a different function and is designed to work with or without computer systems now in operation.

Only one employee is needed to operate the CREDAC central unit. Sales personnel need no special training, and check stations are easily installed at any point-of-sale — including those in branch stores.

The CREDAC memory unit, located in a store's accounting department, is the "heart" of the



CREDAC control system. The device (shown above) is capable of holding up to 30,000 ten digit account numbers. In operation, the memory device holds a complete list of customer charge accounts which are "overdue", "over-the-limit", discontinued, or reported lost or stolen.

The CREDAC check station (shown below) will be used near each cash register to authorize customer credit purchases without delay. With every charge purchase, a salesperson enters the customer's

account number at the check station. If that account number is in the memory unit, an amber light flashes instantly and the purchase is stopped until the account is cleared. If the account is in order, a green light okays the customer's purchase.
(For more information, circle 52 on the Readers Service Card.)

Input-Output

INCREMENTAL TAPE TRANSPORT INTRODUCED BY POTTER

A new magnetic incremental tape transport has been introduced by Potter Instrument Company, Inc., Plainview, N.Y. The device provides a writing capability in a character-at-a-time mode using an IBM 200 bpi tape format, with 556 bpi optional.

The Model MT-SW Transport uses a simple magnetically positioned drive motor and provides 300 character-per-second recording. Bit positioning accuracy (pulse spacing jitter) is ±0.0005". The device has a single capstan tape drive, vacuum-column slack loops with photoelectric loop sensing, and handles standard 10½" reels of ½" tape. Solid-state circuits are included for controlling all operations by means of standard logic signals.

In addition to the incrementing mode, a continuous drive mode providing 7.5 ips steady running speed permits interrecord and file gaps to be generated with a minimum of lost time. A "step-off beginning of tape" (BOT) is provided as part of the manual load procedure. All controls are on the front, and printed circuit cards are inserted and removed from the front.

Magnetic incremental stepping recorders are finding widespread use in the fields of data logging, digital data transmission and data processing.
(For more information, circle 53 on the Readers Service Card.)

FAIRCHILD CAMERA ANNOUNCES ADVANCED DIGITAL DATA RECORDING SYSTEMS

Two major advances in solid state systems for the recording of digital data were reported by Fairchild Camera and Instrument Corp. scientists at the Symposium on Optical and Electro-Optical Information Processing Technology, held in Boston, Mass.

In a paper presented at the Symposium, L. J. Kabell of the Fairchild Semiconductor Division and C. J. Pecoraro of the Fairchild Space and Defense Systems Division described an all solid state data annotation system designed to service multi-sensor reconnaissance equipment.

Using a unique silicon light pulser matrix, the system records digital data on photographic film without optics through controlled spacing of silicon avalanche light sources. Its small size, light weight and reliability combined with the geometric fidelity of the recorded data pattern make it particularly useful in defense applications in extreme environments.

In a second paper, R. K. Agarwal of Fairchild Space and Defense Systems discussed a new digital microtape recording system. Using sprocketed 35mm mylar with a thin layer of aluminum as the storage medium, the system is capable of controlling five times more operations in a single row reading than is possible with paper tape.

An electric current passing through an air gap generates a spark which evaporates the metallic coating and forms a transparent hole or bit on the mylar tape. Forty-nine bits can be written serially across the tape at rates up to 10 kilocycles. Packaging density is 2450 bits per inch of tape. A photoelectric diode array can read the bits at 1000 inches per second.

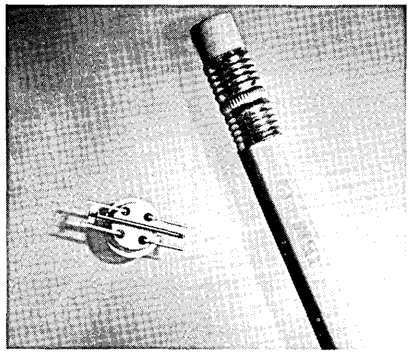
In both military and commercial applications, the microtape reader can provide memory storage to a digital computer or to any automatic control processor with greatly increased speed and reduced size and weight.
(For more information, circle 56 on the Readers Service Card.)

IBM DEVELOPS EXPERIMENTAL SCANNING DEVICE

An experimental solid state optical scanning device, which converts images into electrical signals, has been developed by IBM Corporation, White Plains, N.Y. The dime-sized device, called the Scanistor, combines high resolution and fast response with other advantages of solid state electronics.

The Scanistor differs significantly from earlier solid state light-sensitive devices such as the photocells used in electric-eye cameras. Because these cells sense only the total amount of light falling on their surface, detecting a pattern requires many cells, arranged in-line or in a mosaic pattern, and a corresponding number of output amplifiers.

In contrast, the Scanistor provides on a single output wire an analog voltage that represents both the amount and position of light shining on its surface. Or, with different operating voltages, the device can provide a series of corresponding electrical pulses for entry into a digital computer.



The Scanistor shown in the picture above is one-half inch long. It contains 100 light-sensitive diodes paired with 100 switching diodes. These diode-pairs are spaced 0.005 inch apart to give a resolution of 200 image elements per inch.

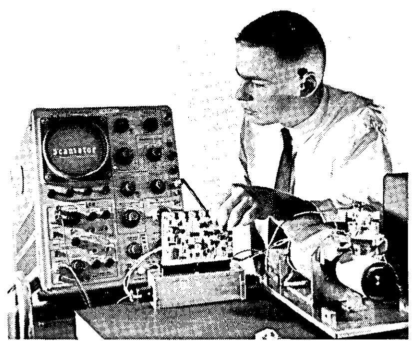


Image transmission capability of the Scanistor is shown in the above picture. A card bearing the typed word "Scanistor" has been placed on the rotating drum at the right. Above the drum is a light source and a lens that focuses an image of the text onto a Scanistor. IBM Technician Robert J. Lynch, co-inventor of the Scanistor, is adjusting the simple circuitry that supplies bias and scanning voltages to the device, and differentiates its output to obtain an oscilloscope display of the original text.

Although the Scanistor is experimental and not commercially available, IBM has tested sample units in such applications as document and film scanning, character recognition, and reading punched and mark-sense cards.

A few of the possible future uses for Scanistors that engineers of IBM's Advanced Systems Development Division have suggested are: a hand-held "reading" device which could be passed over a line of printed text to enter data into a computer; a simple position sensor requiring no standby electrical power to relay the readings of thermometers or other instruments to a central location; a memory read-out device for mass memories which store information in the form of optical patterns; and compact, infrared scanners for battlefield surveillance.

Components

EXPERIMENTAL SELF-ACTUATED READ/WRITE HEAD

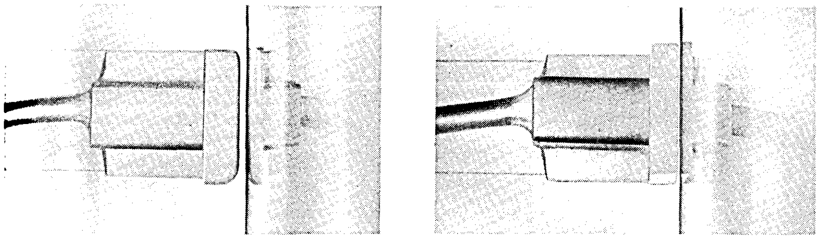
A prototype model of what could become the flying magnetic read/write head for use with drums and disc files of the future has been demonstrated by Bryant Computer Products, Walled Lake, Mich.

The experimental head is a self-actuated, fail-safe device which automatically provides its own exactly correct loading force to assure that the desired stable flying attitude and small-gap magnetic coupling are obtained. Although Bryant has been building self-actuating heads for several years, this head is different in that it operates on a non-Bernoulli principle, does not require a different head pad configuration to accommodate varying drum or disc speeds, and will cost less to manufacture.

During inoperative periods, the head is spaced a safe distance from the recording medium. When the rotating memory approaches its operating speed, a vacuum is created between the head pad and the surface causing ambient air pressure to push the head toward the surface. The head pad is shaped so that it will ride on an air bearing extremely close to the drum surface — but never touch it.

After shut down of the memory device, the head remains in the flying mode until the recording surface speed is reduced sufficiently to bring the head/surface pressure back to ambient. At this point, the head is spring returned to its original starting position away from the drum surface.

Bryant reports that this type of head appears to possess superior performance characteristics; could potentially read and write at pack-



-- The left-hand photo shows the head spacing before the head is pulled into its operating attitude; the right-hand photo shows the head spacing once the head has achieved its proper flying mode.

ing densities of up to 1500 bits per inch; and exhibits extremely good stability under severe environmental conditions. It is considered likely that this type head will first see service in custom-built commercial and military drums and disc files used in difficult-to-control environments such as exist in submarines, surface vessels, aircraft and land vehicles. (For more information, circle 57 on the Readers Service Card.)

BUSINESS NEWS

C-E-I-R REPORTS INCOME GAIN

C-E-I-R, Inc., reports net income and special gains totaling $1,574,197 for its 1964 fiscal year ended September 30. This compares with a loss of $1,858,537 in fiscal 1963.

Dr. Herbert W. Robinson, board chairman and president, also revealed that during 1964 the company's net income from operations totaled $235,504, as against an operating loss of $692,277 a year earlier. Special gains for the year were $1,338,693, compared with special expenses of $1,166,260 for 1963.

C-E-I-R sales during the year were $16,359,955, approximately the same level as reported for 1963. Sales of the company's British affiliate, C-E-I-R, Ltd., of which a 60 per cent interest was sold to British Petroleum Company, Ltd. last spring, totaled $2,231,600. Together, these total $18,591,555 for 1964, compared with total sales of $18,007,916 for both companies in 1963.

FABRI-TEK REPORTS INCREASED SALES

Fabri-Tek Inc., announced sales of $6,272,256 for the six-month period ending September 30, 1964. This compares with $3,445,057 sales reported for the same period in 1963. Sales for the first half of the current fiscal year represent an 82 percent increase over sales for the same period in 1963.

As a pioneer in the manufacture of vacuum-deposited magnetic memories, Fabri-Tek introduced the first production thin-film memory system on the market last year. They recently shipped a high-speed, thin-film system to the Imperial College of Science and Technology of the University of London, England.

PLANNING RESEARCH DOUBLES PROFITS

Planning Research Corporation reports first quarter earnings of $99,000 — up 100% from the $49,500 in the same quarter last year.

Dr. Robert W. Krueger, PRC president, announced that gross revenues for the quarter ending Sept. 30 reached $2,034,000, up 51 percent from the $1,347,000 in the same quarter last year.

He noted that the company's revenues from the Department of Defense are expected to continue to increase in coming years. "Of the $15 to $20 billion in the research and development budget, about 10 percent — or $2 billion — will be spent on the kind of work we can do for government. And this percentage is growing," the PRC executive said.

At the same time Dr. Krueger emphasized that Planning Research is actively pursuing a non-government market of $5 billion a year — money being spent for highly complex management research.

POTTER INSTRUMENT HAS RECORD ORDER LEVEL

Potter Instrument Co. reports receipt of over $5 million in new orders during the first 12 weeks of the fiscal year ended Sept. 19, 1964, compared to $1.88 million in new orders during the same period a year ago. Total order backlog rose to $8,327,400 compared to $3,990,100 at the same point last year.

Sales for the 12 week period were reported at $2,285,000 with a net income after taxes of $82,100. For the same period in 1963, sales were $2,332,900 with net income of $78,700.

Potter reports that its new products introduced during the past year, including a line of IBM-compatible vacuum column tape transports, an incremental tape drive, a digital printer/plotter, and the RAM cartridge loading mass memory system, contributed substantially to achieving the record backlog.

ITEK REPORTS RECORD EARNINGS

Itek Corp. reports record income for the year ended September 30, 1964 totalling $1,236,000, representing an increase of 37 percent over 1963 earnings of $904,000.

Sales reached $43 million, an increase of 14 percent over fiscal 1963 and 7 percent above the previous high of 1962.

Commercial sales increased from 35 percent to 44 percent of total company sales during the year.

At the close of the fiscal year, Itek's backlog of government contracts stood at a record high of $38 million, compared to $20 million last year.

MONTHLY COMPUTER CENSUS

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

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

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

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

AS OF DECEMBER 10, 1964

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS**
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	11	1
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	21	1
	ASI 2100	Y	$3000	12/63	6	1
	ASI 6020	Y	$2200	4/65	0	3
	ASI 6040	Y	$2800	7/65	0	2
Autonetics	RECOMP II	Y	$2495	11/58	64	X
	RECOMP III	Y	$1495	6/61	20	X
Bunker-Ramo Corp.	TRW-230	Y	$2680	8/63	11	3
	RW-300	Y	$5000	3/59	40	X
	TRW-330	Y	$5000	12/60	30	X
	TRW-340	Y	$7000	12/63	12	16
	TRW-530	Y	$6000	8/61	24	3
Burroughs	205	N	$4600	1/54	61	X
	220	N	$14,000	10/58	41	X
	E101-103	N	$875	1/56	120	X
	E2100	Y	$535	8/64	100	1200
	B100	Y	$2800	8/64	14	25
	B250	Y	$4200	11/61	95	12
	B260	Y	$3750	11/62	90	150
	B270	Y	$7000	7/62	90	25
	B280	Y	$6500	7/62	99	40
	B370	Y	$8400	7/65	0	20
	B5000	Y	$16,200	3/63	24	14
	B5500	Y	$35,000	10/64	13	6
Clary	DE-60/DE-60M	Y	$525	2/60	255	0
Computer Control Co.	DDP-19	Y	$2800	6/61	3	X
	DDP-24	Y	$2500	5/63	48	61
	DDP-116	Y	$900	2/65	0	22
	DDP-224	Y	$3300	12/64	0	12
Control Data Corporation	G-15	N	$1000	7/55	320	X
	G-20	Y	$15,500	4/61	26	X
	160*/160A/160G	Y	$1750/$3500/$12,000	5/60;7/61;3/64	385	19
	924/924A	Y	$11,000	8/61	28	3
	1604/1604A	Y	$38,000	1/60	60	X
	3100	Y	$7350	12/64	0	12
	3200	Y	$12,000	5/64	15	52
	3300	Y	$15,000	7/65	0	15
	3400	Y	$25,000	11/64	2	15
	3600	Y	$58,000	6/63	27	18
	3800	Y	$60,000	5/65	0	14
	6600	Y	$110,000	8/64	1	6
Digital Equipment Corp.	PDP-1	Y	$3400	11/60	55	2
	PDP-4	Y	$1700	8/62	50	6
	PDP-5	Y	$900	9/63	80	5
	PDP-6	Y	$10,000	10/64	1	8
	PDP-7	Y	$1300	11/64	2	12
	PDP-8	Y	$525	4/65	0	16
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	24	X
Friden	6010	Y	$600	6/63	190	105
General Electric	205	Y	$2900	10/64	5	18
	210	Y	$16,000	7/59	58	X
	215	Y	$5500	11/63	32	12
	225	Y	$7000	1/61	120	2
	235	Y	$10,900	12/63	28	16
	415	Y	$5500	5/64	22	102
	425	Y	$7500	7/64	10	45
	435	Y	$12,000	10/64	2	22
	455	Y	$18,000	6/65	0	6
	465	Y	$24,000	6/65	0	3
	625	Y	$50,000	2/65	0	10
	635	Y	$65,000	12/64	0	14
General Precision	LGP-21	Y	$725	12/62	140	45
	LGP-30	semi	$1300	9/56	430	3
	RPC-4000	Y	$1875	1/61	98	1
Honeywell Electronic Data Processing	H-200	Y	$4200	3/64	190	570
	H-300	Y	$3900	7/65	0	9
	H-400	Y	$5000	12/61	105	5
	H-800	Y	$22,000	12/60	63	17
	H-1400	Y	$14,000	1/64	8	5
	H-1800	Y	$30,000	1/64	5	8

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-2200	Y	$11,000	10/65	0	25
	DATAmatic 1000	N	$40,000	12/57	4	X
H-W Electronics, Inc.	HW-15K	Y	$490	6/63	3	4
IBM	305	N	$3600	12/57	420	X
	360/20	Y	$1800	12/65	0	600
	360/30	Y	$4800	5/65	0	2100
	360/40	Y	$9600	5/65	0	700
	360/50	Y	$18,000	7/65	0	380
	360/60	Y	$35,000	10/65	0	110
	360/62	Y	$50,000	11/65	0	42
	360/70	Y	$80,000	10/65	0	150
	650-card	N	$4000	11/54	300	X
	650-RAMAC	N	$9000	11/54	60	X
	1401	Y	$4500	9/60	7575	725
	1401-G	Y	$1900	5/64	400	550
	1410	Y	$12,000	11/61	470	140
	1440	Y	$3500	4/63	1250	320
	1460	Y	$9800	10/63	850	680
	1620 I, II	Y	$2500	9/60	1520	20
	701	N	$5000	4/53	1	X
	7010	Y	$19,175	10/63	55	38
	702	N	$6900	2/55	3	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	40	X
	7040	Y	$14,000	6/63	62	25
	7044	Y	$26,000	6/63	45	12
	705	N	$30,000	11/55	78	X
	7070, 2, 4	Y	$24,000	3/60	515	10
	7080	Y	$55,000	8/61	71	2
	709	N	$40,000	8/58	11	X
	7090	Y	$64,000	11/59	46	2
	7094	Y	$70,000	9/62	240	15
	7094 II	Y	$76,000	4/64	58	45
ITT	7300 ADX	Y	$18,000	7/62	9	6
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	155	X
	Monrobot XI	Y	$700	12/60	440	160
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	250	115
	NCR - 390	Y	$1850	5/61	735	160
Philco	1000	Y	$7010	6/63	15	0
	2000-210, 211	Y	$40,000	10/58	19	2
	2000-212	Y	$52,000	1/63	5	2
	2000-213	Y	$68,000	6/65	0	0
Radio Corp. of America	Bizmac	N	$100,000	-/56	3	X
	RCA 301	Y	$6000	2/61	530	90
	RCA 3301	Y	$11,500	7/64	10	22
	RCA 501	Y	$14,000	6/59	98	3
	RCA 601	Y	$35,000	11/62	4	1
	Spectra 70/15	Y	$2300	11/65	0	8
	Spectra 70/25	Y	$5000	11/65	0	5
	Spectra 70/45	Y	$9000	3/66	0	10
	Spectra 70/55	Y	$15,000	5/66	0	4
Raytheon	250	Y	$1200	12/60	160	15
	440	Y	$3500	3/64	7	7
Scientific Data Systems Inc.	SDS-92	Y	$900	2/65	0	20
	SDS-910	Y	$2000	8/62	103	34
	SDS-920	Y	$2700	9/62	69	6
	SDS-925	Y	$2500	12/64	0	4
	SDS-930	Y	$4000	6/64	10	21
	SDS-9300	Y	$7000	11/64	1	7
UNIVAC	I & II	N	$25,000	3/51 & 11/57	30	X
	III	Y	$20,000	8/62	78	20
	File Computers	N	$15,000	8/56	23	X
	Solid-State 80, 90, & Step	Y	$8000	8/58	325	X
	Solid-State II	Y	$8500	9/62	42	2
	418	Y	$11,000	6/63	8	7
	490	Y	$26,000	12/61	37	18
	1004	Y	$1900	2/63	2150	500
	1050	Y	$8000	9/63	115	225
	1100 Series (except 1107)	N	$35,000	12/50	14	X
	1107	Y	$45,000	10/62	21	5
	1108	Y	$50,000	7/65	0	12
	LARC	Y	$135,000	5/60	2	X
				TOTALS	23,497	20,020

X = no longer in production.

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

** Some of the unfilled order figures are verified by the respective manufacturers; others are estimated and then reviewed by a group of computer industry authorities.

(Continued from page 12)

lectual revolution than has atomic energy. And he will tell anyone who cares to listen about the second industrial revolution which is freeing men's brains as the first one freed their bodies. But not many will go from there to explain clearly and convincingly how the benefits of this freedom are to be distributed equitably among all. V. M. Gloushkov writing recently in the Sunday supplement "Nedelja" on the subject of cybernetics, concludes his article as follows: "With capitalism, the installation of cybernetic machines results automatically in greater exploitation of the workers. In a communist society the cybernetic machine —this amazing achievement of human genius—give mankind unlimited control over nature."

Certainly we are not willing to accept this description of capitalism, but it will not be proved false unless some of the ingenuity hitherto absorbed in the development of computers is soon directed to consideration of the social utilization of computers. Since unemployment tends to concentrate at the lower end of the intellectual and educational spectrum, one obvious answer is education, optimally started with one's grandparents. One reads in a recent issue of *"Computers and Automation"* about Project PREPARE which is currently training "35 unemployed or partially employed workers of limited educational background and skills," these 35 having been selected from "hundreds of applicants." Little enough and late enough! For the remaining hundreds it is certainly too little.

The problem is serious and pressing. Probably nothing else ever presented us with so great a challenge. Will computers and automation prove to be a boon or a bane to a capitalistic society?

(Continued from page 17)

cation of physiological structures and psychological behaviours of animals and human beings.

We can hazard a conjecture, based on analogy with other growing organisms, that there will be no "artificial intelligence" in machines until they are actually growing devices, in which equipment and program are interchangeable, and in which efficient equipment "grows" or "is grown" to replace those portions of the stored information or algorithms which have been proved successful or optimised in some sense. Since most computer programmers, the end users, are not interested in, willing to, or capable of crossing the gaps to the biological and social scientists, they will be left even further behind when this sort of "growth" begins.

There now exist computer programs combined with process control systems that can re-tool an existing computer design, stored inside a computer, and produce an algorithm for controlling a wiring machine to change wiring interconnections on a panel. There exist routines to make machines grow, some beginning to be more effective than any routines that we can see to make human programmers grow. Is this too violent a criticism to make in a situation as dynamic as the present man-machine interface?

No computer programmer can truly assess the situation until he begins to take part in this growth process himself. The children of the revolution must grow with it or pass out of its sweep.

References

1. Gorn, S. "Specification Languages for Mechanical Languages and Their Processors—a Baker's Dozen." *Communications of the ACM,* Vol. 12, December 1961, pp. 532-542.
2. Iverson, K. *A Programming Language,* John Wiley, New York, 1962.

(Continued from page 22)

produce a tape or card deck which becomes the input to the network generating device.

An extremely useful feature of the computer programs which pre-process the networks for visual presentation is the ability to "band" groups of activities vertically, while at the same time, time-phasing them horizontally. For example, the ADMA system will permit 21 vertical bands which means 21 different significant groupings of activities can be identified in each vertical column or time segment. The bands might correspond to performing organizations, or functional areas.

Concluding Comments

Network techniques for planning and control are gaining wide acceptance in both commercial and government projects. A recent survey showed that, at the end of 1963, 50% of PERT use was devoted to non-government projects as compared to 19% in 1959. Furthermore, the PERT/COST extension sponsored by DOD and NASA is receiving much attention throughout industry and government.

Computers can be used to increase greatly the effectiveness of this new technique.

APPENDIX I

SURVEYS OF PERT AND MANAGEMENT SYSTEMS IN GOVERNMENT AND INDUSTRY

1. "Computer Programs for PERT and CPM." Technical Paper No. 13, February 28, 1963, published by Operations Research, Inc., Silver Springs, Md. This survey lists about 52 PERT and CPM computer programs together with brief program descriptions and the person to contact if more information is required; it also lists 14 "check points" which are important in comparing programs, such as error checking, file maintenance, and other desirable program features. A brief tabular comparison of CPM and PERT program characteristics is also presented. Cost, $1.00.
2. "1963 Capabilities Handbook," in *Management Systems,* pages 49-62, March, 1964, published by Aerospace Management, 56th and Chestnut Sts., Philadelphia 39, Pa. Survey of 93 Aerospace companies at 133 locations. Lists all management systems, specific applications, effort applied, and company contacts. A tabulation is presented of the current proliferation of PERT and PERT-like systems within industry. Among the facilities surveyed, a large number of references are made to the current or planned use of PERT or PERT-COST. Other management tools are also listed and an indication of the implementation effort is given.
3. "Glossary of Management System Terminology," June, 1963, published by PERT Orientation and Training Center (POTC), Bolling Air Force Base, Washington 25, D. C. This document identifies and describes 120 management systems and techniques. Explanatory charts and system flow diagrams are included in some cases; and in all cases, a reference source is given. POTC is an excellent source of general information on PERT and PERT/COST.
4. "Network Type Management Control Systems Bibliography"' Rand Memo, RM 3074-PR, February, 1963 (B. L. Fry), published by Rand Corporation, 1700 Main St., Santa Monica, Calif. Refers to 260 documents; indexed by author and title. Available through Defense Documentation Center, AD 298075.
5. "SHARE Survey of PERT Programs," published by SPERT Committee of SHARE, c/o Dr. Arthur B. Kahn, Westinghouse (A A Division), Baltimore, Md. This survey is hardware-oriented, identifying about 12 major computing systems and some 40 to 50 programs for use on these computers. Not restricted to IBM equipment.

Presented as part of the IEEE Winter Lecture Series on PERT and PERT/COST, January 9, 1964, Babson Institute, Wellesley, Mass.
All information shown in manufacturer's data charts was derived from commercially available brochures and periodicals and from discussions with manufacturer's representatives or persons actually using the systems presented.

CLASSIFIED

OFFERED FIRST TIME TO DISTRIBUTOR OR MANUFACTURER: Patented input equipment punches digital time on IBM cards for data processing cost accounting, wage, attendance. Eliminates both time clerks keypunching. Kawachi, P.O.B. 20, Grand Central, New York, N.Y. 10017

WANTED: Key Punches #024, 026. Verifiers #056. Sorters 083, 084, 085, 088, 403, 407, 602A, 407, 1401. FOR SALE: 858 Cardatype. 031, 063, 080, 402, 523, 552. 805 Test Scorer. 824 Tape Card Punch. 031, 055. L.A. Pearl Co., 801 Second Ave., New York, N.Y. 10017

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.

NEW PATENTS

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

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

September 1, 1964

3,147,461 / Morton Mondschein, 120 Christabel St., Lynbrook, LI / 20% to Camil P. Spiecens, New York, New York / Information Storage Apparatus.

3,147,462 / Donald B. Levinson, Beverly Hills and Edward Lindell, Los Angeles, Calif. / General Precision, Inc., a corp. of Delaware / Control System for Magnetic Memory Drum.

3,147,471 / George J. Giel, Los Angeles and Ray K. Livengood, Torrence, Calif. / Electro-Logic Corp., Venice, Calif., a corp. of Calif. / Digitizing Electrical System.

3,147,474 / Ivan Mervin Kliman, Glen Head, N. Y. / Sperry Rand Corp., Great Neck, N. Y., a corp. of Delaware / Information Transformation System.

September 8, 1964

3,148,358 / Richard L. Snyder, Malibu, Calif., Hughes Aircraft Co., Culver City, Calif., a corp. of Delaware / High Speed Memory Elements.

3,148,359 / Robert A. Leightner, Tioga Center, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Shift Register.

September 15, 1964

3,149,312 / Munro K. Haymes, Poughkeepsie, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Cryogenic Memory Device With Shifting Word Registers.

3,149,313 / Gerhard Merz, Rommelshausen, Wurttenberg and Hans Reiner, Stuttgart, Germany, / International Standard Electric Corp., N. Y., a corp. of Delaware / Ferrite Matrex Storage Device.

3,149,314 / John J. King, Great Neck, N. Y. / Sperry Rand Corp., Great Neck, N. Y., a corp. of Delaware / Core Memory Addressing.

3,149,315 / Frank Pravda, Stillwater, N. Y. / The National Cash Register Company, Dayton, Ohio / a corp. of Maryland. / Automatic Sensing System.

3,149,316 / Edward A. Quade, San Jose, Calif. / International Business Machines Corp., N. Y., a corp. of N. Y. / Inductive Matrix Arrangement For Sensing Magnetic Configurations.

September 22, 1964

3,150,269 / Norbert G. Vogl, Jr., Wappingers Falls, N. Y. / IBM Corp., N. Y., a corp. of N. Y. / Magnetic Switching Device.

3,150,353 / Chris A. Lay, Jr., Wayne, N. J. and Alfred K. Susskind, Concord, Mass. / by Mesme assignments to Giddings & Lewis Machine Tool Company, Fond du Lac, Wisconsin, a corp. of Wisconsin / Digital Information Handling Apparatus.

BOOKS AND OTHER PUBLICATIONS

Moses M. Berlin
Allston, Mass.

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

Braffort, P., and D. Hirschberg / Computer Programming and Formal Systems / North-Holland Publishing Co., P. O. Box 103, Amsterdam, Holland / 1963, printed, 161 pp, $5.60

This book presents eight papers dealing with various aspects of the relationship between computer programming and formal logical system theory. The papers were originally presented in somewhat different form at two seminars held in the IBM World Trade European Education Center of Blaricum, Holland, in 1961. Among the titles: "Mechanical Mathematics and Inferential Analysis," Hao Wang; "A Basis for a Mathematical Theory of Computation," John McCarthy; "Programming and the Theory of Automata," Arthur W. Burks; and "The Algebraic Theory of Context-Free Languages," N. Chomsky and M. P. Schutzenberger. The papers describe applications of computers to "non-numerical" projects, including language translation, pattern recognition and information retrieval.

Balakrishnan, A. V., and Lucien W. Neustadt, editors, and 25 authors / Computing Methods in Optimization Problems / Academic Press, Inc., 111 Fifth Ave., New York, N. Y., 10003 / 1964, offset, 327 pp, $7.50

The proceedings of a conference held at the University of California, Los Angeles, January 30-31, 1964, are here presented, except the discussions. The fourteen papers discuss various aspects of computer application to optimization problems, emphasizing recent research progress and computing experience in specific large-scale problems. Among the titles: "Several Trajectory Optimization Techniques," "A Comparison Between Some Methods for Computing Optimum Paths in the Problem of Bolza," "An On-Line Identification Scheme for Multivariable Nonlinear Systems," "Study of an Algorithm for Dynamic Optimization," and "Synthesis of Optimal Controllers Using Hybrid Analog-Digital Computers." No index.

Gutenmakher, L. I. / Electronic Information-Logic Machines / Interscience Publishers, 605 Third Ave., New York 16, N. Y. / 1963, printed, 170 pp, $8.00

This translation from the Russian provides a detailed description of the special-purpose information-retrieval computer developed at the Laboratory for Electromodelling of the Academy of Science, U.S.S.R. The design criteria for the computer are based upon the Soviet Union's policy of centralized information filing. The book is edited by Allen Kent, who spent five weeks during 1958-9 in Moscow, discussing the subject matter. The six chapters include: "Fundamental Concepts," "The Machine Memory," "The Transfer of Information in the Memory," and "Problems of Machine Processing of Information." Bibliography, author and subject indexes.

Hoernes, Gerhard E., and Melvin F. Heilweil / Introduction to Boolean Algebra and Logic Design / A Program for Self-Instruction / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1964, printed, 306 pp, $5.95

This programmed-learning text separates Boolean algebra from those techniques used only by logic designers and presents an independent treatment of each subject. The authors maintain that upon completion of the program's 500 frames, the reader will understand Boolean algebra postulates and theorems, and be able to utilize Karnaugh maps and the Quine-McCluskey method. IBM and some high schools and colleges have used the program to train field personnel and logic designers. Following the book's two parts, four appendices include: "Symbols," "The Binary Number System," "Diode Circuits," and "Relay Logic." Answers to problems, a summary of Boolean algebra theorems, references, and an index are given.

Tocher, K. D. / The Art of Simulation / D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. / 1964, printed, 184 pp, $5.95

This book (printed in Great Britain) brings together information from the theory of mathematical statistics, the use of partial differential equations for problem solving, and the field of Operational Research. Its aim is to unify the theory of sampling and Monte Carlo techniques. An elementary knowledge of statistics and probability theory is required. Thirteen chapters include: "Sampling from a Distribution," "Random Number Tables," "Random Number Generators," "Estimation," "General Simulation Problems," and "Design of Simulation Experiments." References and index.

Maley, Gerald A., and Edward J. Skiko / Modern Digital Computers / Prentice-Hall, Inc., Englewood Cliffs, N. J. 07632 / 1964, printed, 216 pp, $10.00

This is an introductory text to the design and programming of large scale digital computers, with particular information about the IBM 7090-4 and 7080 systems. A prefatory assertion is that, "a complete comprehension of computers cannot be obtained without a basic understanding of programming . . . the competent programmer knows how his computer system operates." Toward this dual enlightenment, the authors present ten chapters including: "Introduction to Computer Terminology," "Floating-Point Arithmetic Operations," "FORTRAN Automatic Coding System," "Core Storage," "The Business Computer," and "Modern Computer Concepts." Index.

Gallager, Robert G. / Low-Density Parity-Check Codes / M. I. T. Press, Cambridge 42, Mass. / 1963, printed, 102 pp, $4.00

This book discusses theoretical and experimental work in low-density coding, which is one of three techniques for efficient communication over noisy channels. The author analyzes a class of coding schemes, and cites profitable applicability for some of the schemes. Six chapters include: "Distance Functions," "Probability of Decoding Error," "Decoding," and "Experimental Results." Three appendices include mathematical relevances. References and an index are included.

Singer, James / Elements of Numerical Analysis / Academic Press Inc., 111 Fifth Ave., New York 3, N. Y. / 1964, printed, 395 pp, $8.75

This text for junior undergraduates and first year graduate students in natural and social sciences offers a comprehensive introduction to methods for obtaining and verifying numerical results. In addition to descriptions and applications of algorithms and tables, the author includes discussions of underlying concepts which help the reader "strike out on his own." Among the nine chapters are: "Numbers and Errors," "The Numerical Solution of Algebraic and Transendental Equations in One Unknown; Geometric Methods," "Numerical Differentiation and Integration," and "Curve Fitting." Each section includes problems; answers, a bibliography, and an index are given.

Yes, a Farrington Series 1P Optical Reader "reads" ordinary typewritten text and transfers it directly onto punched cards, paper tape, or magnetic tape at the rate of 225 characters per second.

Why?

To help you break the computer input bottleneck . . . eliminate costly keypunching and verification . . . increase accuracy and operating efficiency . . . ease your job training requirements and reduce personnel turnover by using typewriters instead of keypunches.

In short, to give you more computer input for less money . . . as much as 44 per cent less! Farrington Series 1P is designed for the profit conscious businessman.

Just two more points. Farrington readers process documents at a lower cost than any other optical reading equipment. And the Farrington system permits the preparation of input documents on typewriters at the source!

Let us tell you more about Farrington's line of Page Readers and Document Readers. Write, wire, or call: Farrington Manufacturing Company, Shirley Industrial Area, Springfield, Virginia. Telephone: Area code 703 • Fleetwood 4-5000.

FARRINGTON

"HOW DO YOU READ ME?"

"QUICKLY, ACCURATELY, AND ECONOMICALLY."

Circle No. 15 on Readers Service Card