COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

Vol. 5
No. 5

May
1956

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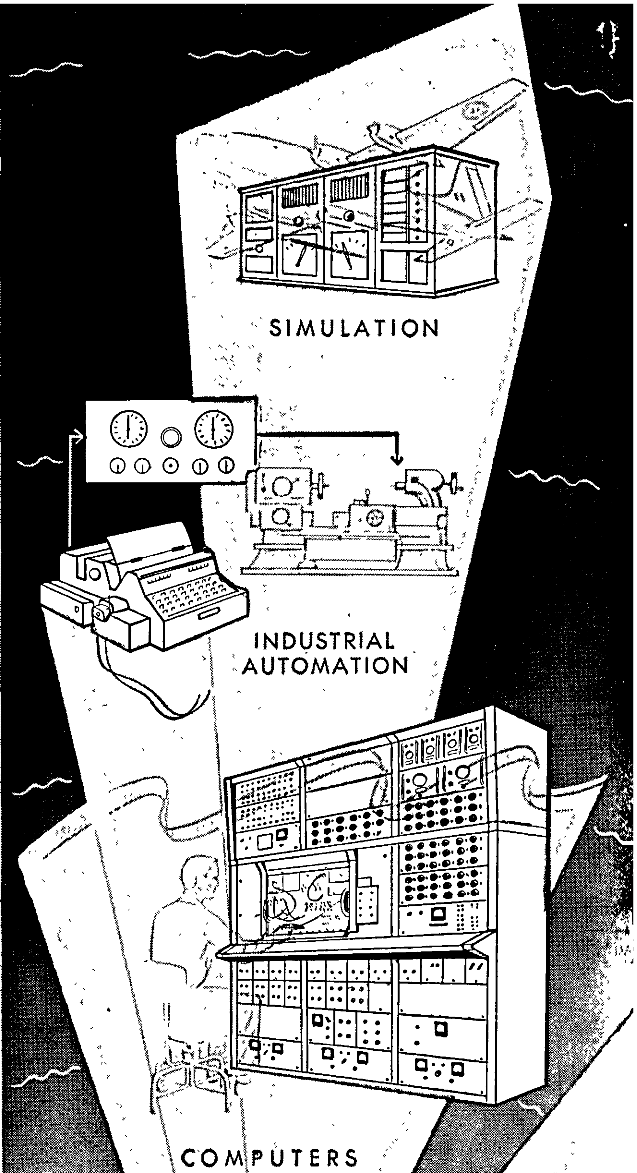

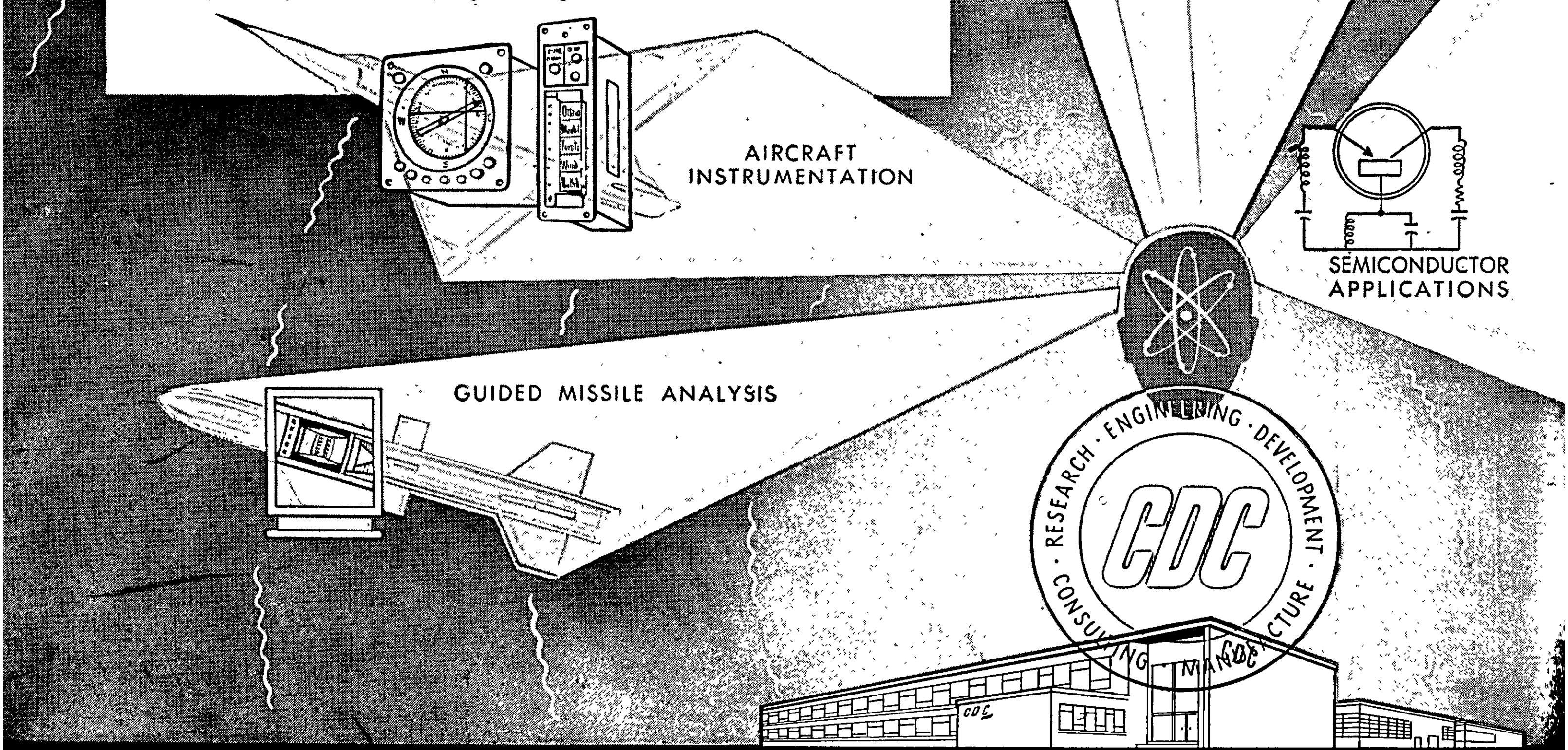

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THE EDITOR'S NOTES

THE PRINTING OF TECHNICAL INFORMATION IN "COMPUTERS AND AUTOMATION"

I. From Mr. I. McNamee and
E. Fullenwider, U.S. Naval
Ordnance Laboratory
Corona, Calif.

Thank you for your letter of Feb. 6, and your interest in our subject of filtering sampled functions. We would be honored to have our paper appear in "Computers and Automation".

Your suggestions or questions, or those of your readers, would be valued by us, since we are still actively interested in the general problem. Thank you for your kind invitation to publish our paper.

II. From the Editor to
Mr. McNamee and Mr. Fullenwider

Thank you for your letter of March 26, enclosing your paper "Filtering Sampled Functions". We think your paper is interesting, and would like to publish it, if you could perhaps take on the labor of typing it in the form in which it could be photographed for photo-ofset reproduction. We make this request because your paper at present covers 41 pages of doubled spaced manuscript, 8½" by 11", including 4 full pages of figures, 38 pages bearing mathematical symbols, and several tables.

The procedure for preparing master copy for photooffset for our purposes is quite simple. There is only one main rule: type it exactly right with single line spacing in columns four inches wide. The rest of the procedure is given below.

We ask you to do this particularly because we have only one person at present in our group who can intelligently copy your mathematical symbols, and who has satisfactory handwriting and that person is quite busy with some other tasks.

III. Comments from the Editor

As readers of "Computers and Automation" will have noticed, we have taken full advantage from time to time of the fact that we publish our magazine by photooffset. Quite often for example, we have been able to print quickly the titles and abstracts of a computer conference or meeting because we have received <u>three</u> copies of the printed program. We could then cut up two copies to make a one-side set to be photographed, keeping the third copy for reference and checking. The narrow columns of most of the programs of computer meetings are ideal for making columns in our pages.

We are eager to make our publishing facilities available to authors who have papers relating to computers and their applications and implications. If anyone desires to have his paper published somewhere else, we are completely satisfied. But when there is no room somewhere else for his paper, and if it appears suitable for the rather "un-fenced-in" editorial coverage of "Computers and Automation", we shall be glad to consider his paper, in preliminary form or final form, for publication.

It will be very easy for us to say yes to publishing a technical paper if it is sent in to us in good form for photooffset reproduction.

IV. Procedure for Preparing
Master Copy for Photooffset

For technical information, to be published in our pages in two columns, the reduction in size that we regularly use is 20%. In other words, an actual measurement of 10 inches on the actual copy is reduced photographically to 8 inches in the film from which the magazine is printed — and other distances proportionately. (continued on page 38)

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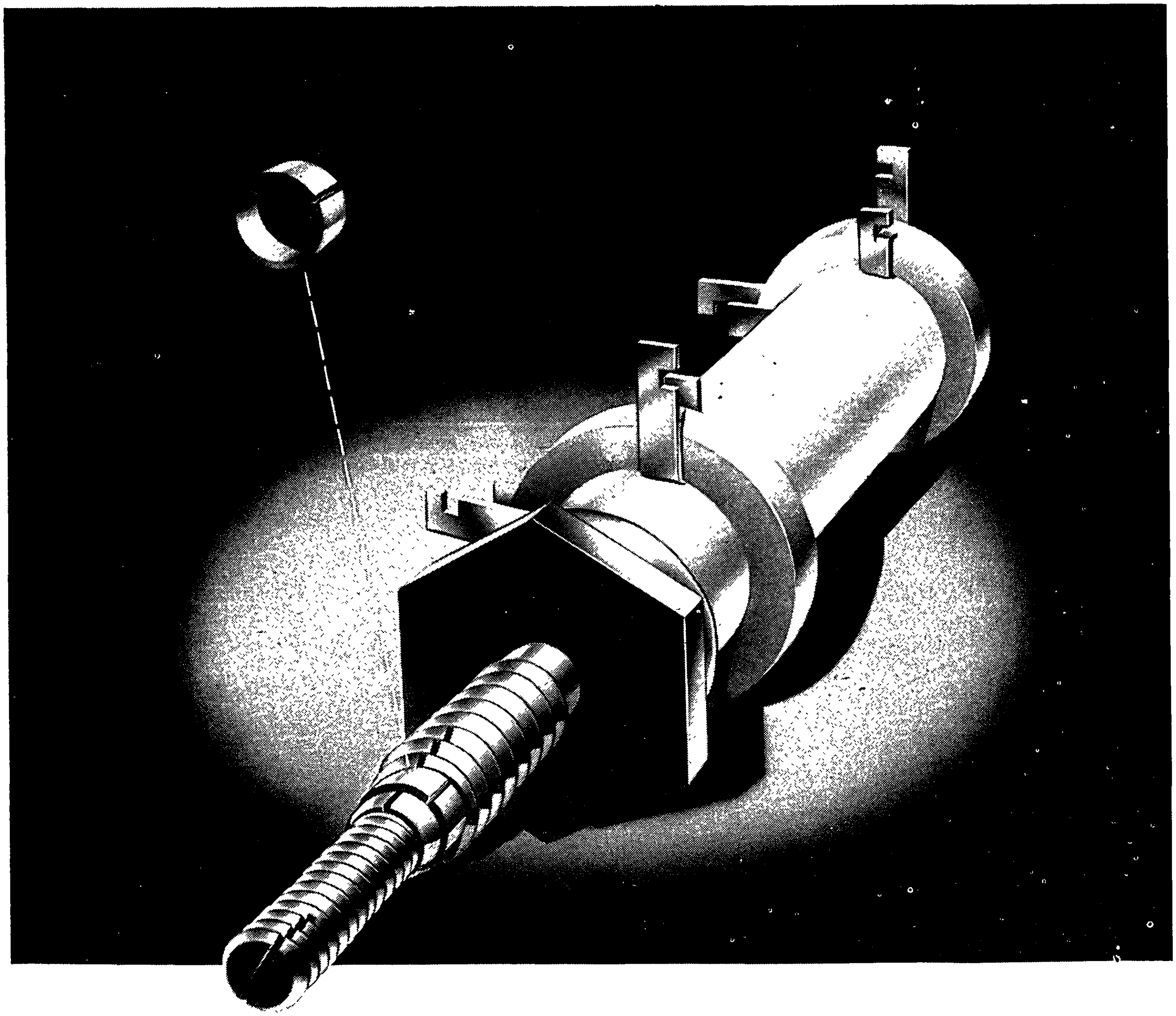
<u>Address Changes</u>: If your address changes, please send us both your new and your old address, (torn off from the wrapper if possible), and allow three weeks for the change.



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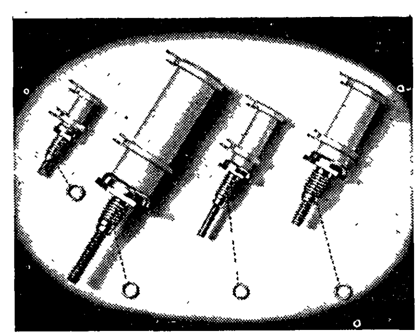

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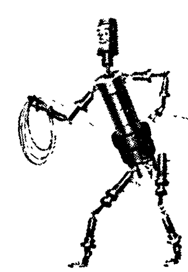

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THE POSITION OF THE UNIVERSITY IN THE FIELD OF HIGH SPEED COMPUTATION AND DATA HANDLING

ALSTON S. HOUSEHOLDER
Mathematics Panel
Oak Ridge National Laboratory
Oak Ridge, Tenn.

It seems necessary to begin this talk with what may seem a platitude by saying that the position of the university, in this field as in any other, can be stated very simply. It is a source of instruction and a center of research. If a subject is already closed, or is so trivial and unimportant as to be undeserving of continued study and development, then it has no place in the university curriculum. And a presentation that goes no farther than the formal development of the known, that opens no pathways to the unexplored, such a presentation may be appropriate to the trade school or the catechism, but not to the university. To quote A. N. Whitehead: "So far as the mere imparting of information is concerned, no university has had any justification for existence since the popularization of printing in the fifteenth century". And elsewhere in the same essay: "Fools act on imagination without knowledge; pedants act on knowledge without imagination. The task of a university is to weld together imagination and experience".

It seems logical to develop the subject before us by first sketching the position that has been occupied and is occupied by universities and other institutions of higher learning; and then passing to the future with some predictions and injunctions. The part that has been played by universities in this country in the development of digital computers is well known; it will be enough to mention a few high spots. Unfortunately, in the early stages the work was veiled in wartime secrecy, but fortunately the veil is now long since removed. Outstanding early contributions were from the University of Pennsylvania on the Eniac, the Massachusetts Institute of Technology on the Whirlwind, and Harvard University on the several Marks. Long before this, the logical possibility of constructing a general purpose computing machine had been demonstrated by A. M. Turing in his doctoral dissertation written at Princeton. Turing's paper was published in the late 30's, and in the early 40's McCulloch and Pitts, at the Universities of Illinois and of Chicago, published a paper which carried Turing's ideas somewhat further by showing that one could go a long way in interpreting the vertebrate central nervous system as a Turing machine. There have been subsequent developments in this direction at Chicago, at MIT, and at Southern California in particular, and while this work is off the main line of practical computer development and application, it could turn out to have an influence on the machines of the future.

To return to the main line, the Institute for Advanced Study and the University of Illinois are next to be mentioned. Probably no one person has been more influential on the logical design of current machines than von Neumann of the Institute. It is unfortunate that the early reports by von Neumann, in collaboration with Goldstine, Burks, and others, on logical design and on programming, did not appear in the open literature, but they had a wide circulation nevertheless. The classical paper by von Neumann and Goldstine on the analysis of errors in digital computation did appear in the Bulletin of the American Mathematical Society, and it laid the foundation for the study of this hitherto undeveloped, but now critically important field. A number of machines, including two built at the University of Illinois, have followed more or less closely the design laid down at the Institute for Advanced Study.

Somewhat less ambitious development and construction projects exist or have existed at other universities: California, Pennsylvania State, Michigan, Wisconsin, and perhaps others. In the field of applications, the University of California at Los Angeles was able to provide housing for the Institute for Numerical Analysis. More recently it took over the operation of the SWAC (Standards' Western Automatic Computer), and continued to maintain a somewhat reduced group when INA was discontinued by the National Bureau of Standards. Consequently, this University has for some time been an active center of research in numerical analysis. To a lesser extent the proximity of computing machines has stimulated work in numerical analysis in places like American University, the University of Maryland, the University of Delaware, to mention only a few. Finally, as you all know, commercially made machines are coming increasingly within reach of even the academic budget, and so many schools are taking advantage of the fact that I could not hope to name them all and hence refrain from mentioning any.

With this very sketchy summary of university activities in this country, let us look abroad where the situation may be less familiar. First, as you may recall, the Williams tube was developed at the University of Manchester, and the prototype of the Ferranti computer was constructed, of which one of the early models is located on this continent at the University of Toronto. A second machine for computing use has been completed at Manchester and also, as a developmental project, a transistor machine.

Cambridge University has been outstanding in both development and application. The Edsac I was one of the earliest of the high speed machines of what might be called contemporary design, to distinguish it from the more primitive Eniac. It is of interest, too, that Leo, the machine belonging to the J. Lyons and Company, and used for accounting, was built at Cambridge, largely following the design of Edsac I. The Wilkes-Wheeler-Gill text on programs was the first on this subject to reach the commercial press. Also, the Edsac group has been otherwise influential in that several of its members have been in this country on extended visits to MIT, Illinois, and elsewhere, and Cambridge is a Mecca for American experts going abroad. Edsac II is one of the first to use magnetic cores throughout and the design of the control makes use of the scheme of microprogramming devised by Wilkes. The same scheme, in a form revised somewhat by Billing at the Max-Planck Institute, is being followed in the core machine under construction at Göttingen.

I do not hope to be exhaustive and hope not to be exhausting. Hence, I pass over other British activities and proceed to the continent. Starting at the far North, a relay machine, the BARK, was constructed at the Technical High School in Stockholm by the Swedish Board for Computing Machinery. This was followed by the BESK, with cathode ray tube storage, and upon completion of the BESK, the BARK was dismantled. The Besk remains the fastest machine in western Europe, and so far as I know, will be surpassed only by Edsac II in the near future. The machine is in the hands of a small but able group of mathematicians and engineers. There are plans for making copies in Copenhagen and in Oslo.

At Amsterdam, the Mathematical Center of the University constructed a relay machine, the ARRA, and then proceeded by additions and replacements to turn it into an electronic machine. They are also working on a machine with magnetic core memory. The Mathematical Center and the Department of Mathematics seem to be better coordinated than is the case in some schools, and Amsterdam can be classed as one of the leading centers of research in numerical analysis.

Farther South, in Zurich, a relay machine has been in operation for some time at the Technische Hochschule, and a drum machine is being built. In designing the latter a special effort has been made to devise a list of operations that make programming as simple as possible, since the machine is to be made available to outsiders who will do their own programming. The name of Stiefel, at Zurich, is perhaps best known in this country when coupled with that of Hestenes, as codiscoverer of a method of successive approximation to the solution of a system of linear equations, with convergence after a finite number of steps. More recently he has made important contributions to the theory of successive approximation in general for linear systems, or, as he calls them, methods of relaxation. The name of Rutishauser is perhaps less well known, but a series of papers on what he calls the quotient-difference algorithm has attracted considerable attention. In these papers he succeeds in tying together and generalizing in a remarkable way a multitude of seemingly disparate techniques in numerical analysis, such as continued fractions, the Bernoulli method of solving equations, and the Aitken δ^2 process for accelerating convergence. In this general connection, mention might be made also of some papers by F. L. Bauer, at the Technische Hochschule, Munich, who has shown how the method of Bernoulli, which converges linearly, can be modified to yield quadratic convergence such as is to be had by the use of Graeffe's method. Thus it is possible to achieve the rapid convergence of the one method without sacrificing the self-correcting feature of the other.

Interest in digital machines was rather slow to develop in Germany, but now it is extensive. Last October there was held at the Technische Hochschule, Darmstadt, a three-day conference on digital computers and data processing. About 600 people were in attendance, and although many different countries were represented, probably 80 percent or more of the participants were from Germany, and of these, most were from universities and the technical high schools.

At the Max-Planck Institute in Göttingen a small tape-controlled machine, the G 1, has been operating for some time, and three other machines are currently under construction. One is the core machine already mentioned. Another is an enlarged version of the G 1, and the third is a more standard drum type. Drum machines are also being built in Munich and in Dresden, at the Technische Hochschule, and at Darmstadt a small core memory will be backed up by a drum. In the way of applications, the Munich group seems to be rather more interested in business than is the case elsewhere. It is interesting to note that in Germany the Williams tube is being bypassed completely, all storage being magnetic, with either drum or cores.

While the Darmstadt Conference was interesting enough in providing a view of developments in western Europe, the occasion was made more dramatic by the presence of several participants from the other side of the Iron Curtain. I have already mentioned Dresden in East Germany. From Prague came Svoboda and Oblonsky, who have built a drum machine, the SAPO, and are building a more elaborate one. The SAPO is, in effect, three mutually checking machines, and it utilizes five-address commands, the extra two addresses designating alternate locations for the next command. Svoboda's group seems to be very active in numerical analysis, and in logical synthesis, but unfortunately, although I have some of their publications in my possession, they are in Czech so that my understanding is something less than complete!

From Moscow came Professors Lebedev and Basilevsky, accompanied by Drs. Ktorov and Novikov, who acted mainly as interpreters. To the best of my knowledge, this was the first time the West had been informed of Russian activities. It turns out that they have a drum machine, the Ural, and a machine called the BESM which uses cathode ray tubes and auxiliary drum and tapes, with triple address commands and floating-point binary representation of numbers. It operates at a speed that surpasses anything else except the NORC.

As I remarked before, I am not trying to be exhaustive, and perhaps I should bring this account to a close. It is intended only to suggest the extent of the activity on the part of educational institutions, and to indicate some of the things they are doing. In comparing the scenes in Europe and America, however, there are several important factors that should be borne in mind. In Europe the educational institutions are all financed by either the national or the local governments. Moreover, although England has, for example, a National Physical Laboratory, which corresponds roughly to our National Bureau of Standards, to the best of my knowledge there is no comparable institution in the countries of continental Europe. To some extent, its place is taken by the schools.

In this country much of the early stimulus to commercial development came from government laboratories, and some came from insurance firms and other business organizations. In this respect the experience in England has been comparable, but on the continent there has been nothing of the sort. Consequently, a few British firms are making computers, but there have been none on the continent. Hence, speaking generally, Amsterdam, Zurich, Darmstadt, and the others had no choice but to build or go without. This situation is changing, but the changes are very recent.

It is time now to come back home and cast a glance into the future. In this country no school needs any longer to build a machine just to have one, and countless schools are finding it possible to acquire them by purchase, by rental, or even as outright gifts. In some cases construction may be worthwhile as a research or a training project. But it seems to me that in the future the universities can contribute most in applications and in training.

In the matter of training, one hears on all sides of the shortage in technical manpower, and in the field of computing the shortage is, if anything, even more acute than elsewhere. Until quite recently there has been no demand to speak of for people in this field, whereas, now the demand is very great and several conferences have been held for discussing the specific problems associated with training of computer people. Personally, I am not sure that it is proper to approach the problem in just this way. The shortage of technically trained people is general. That there is a shortage of computer people is but a corollary to the main theorem. However important the special case may be, it remains but a special case. The universities cannot be blamed for the shortage and there is relatively little they can do to alleviate the situation in addition to what they are doing now. Certainly, they should not resort to narrow specialization.

Let me be a little more specific. In our organization at Oak Ridge, we operate a digital computer called the Oracle. We, therefore, have a staff of analysts, programmers, and coders. Although the distinction between the jobs of analyst, programmer, and coder are fairly clearcut, all our programmers do their own coding, and often our analysts do likewise. Our general policy in hiring is, therefore, to require at least a bachelor's degree with a mathematics major. Naturally at the start it was seldom possible to find people with any machine experience or any special training along these lines. It is still not easy. But on the other hand, I was never much concerned by the fact. Basic ability and a good general mathematical background seem to me to be much more important than special experience, since the latter can be acquired on the job by anyone equipped with the former. Therefore, if the record of a new graduate shows a course in programming, or even in numerical analysis, I would not be greatly impressed by that fact alone.

This is the negative side of the picture. But there is also a positive side. I do think digital computers are here to stay and that the fact should have a real bearing on the college courses, especially in mathematics.

The bearing on courses in physics or chemistry or other fields from which problems arise would seem to be at least less direct. The advent of the digital computer is likely to stimulate developments in certain areas in physics, say, and this would naturally be reflected in course content, especially in the more advanced courses. But whatever the source of a computing problem, the analysis and the programming is basically mathematical in character.

My suggestion is that the addition of one or two or three special courses in programming or numerical analysis or both is not sufficient and may even be detrimental, and that instead there should be a rather general reorientation of all the courses. This gospel has been preached on other occasions, and I may be boring those who have heard it before, but nevertheless, a few specific suggestions might bear repeating. Perhaps some are already being followed in some places, but not all of them are in effect everywhere.

The traditional first course in differential equations devotes a great deal of time to the search for transformations and integrating factors that reduce the solution to a quadrature. I conjecture the theorem that in the class of equations which arise in practice the technique is almost everywhere inapplicable. Moreover, even if one does succeed in reducing the problem to a quadrature, the quadrature itself can seldom be carried out, or if it can will generally lead to unmanageable functions, so that one is ultimately forced back to a direct attack upon the equation itself. In the case of first-order linear equations, or of a few equations reducible to that form, the technique is useful, but I can think of no other outstanding examples. In place of a study of integrating factors I would suggest two things. The first is a little time spent applying an elementary numerical method, say that of Euler, for a rough numerical solution of a few equations. And the second is an introduction to the Poincaré-Bendixson theory of singular points. Either one, or, better yet, the two together, can, it seems to me, give the student a much better feeling than integrating factors can of the relation of a family of functions to the differential equation it satisfies.

I have less of a quarrel with the theory of equations, but even there an instructor may leave the student with the impression that Cardan's formula has some direct practical utility. But there is, for example, an interesting and important theory associated with Bernoulli's method of solving an equation, especially as developed in the recent papers by Bauer and Rutishauser already mentioned, and in papers by Aitken and others, and yet the method itself is seldom or never developed in the textbooks. Newton's method is generally presented as though it applied to real roots only, whereas in fact it is quite general. And there is much interesting material available on the geometry of the roots in the complex plane, all of which is good mathematics and potentially useful to anyone who might ever have occasion to solve an equation numerically, and this includes physicists and chemists as well as numerical analysts.

In calculus it is easy to leave the student with the impression that any integral, or at least most integrals, can be carried out analytically by someone smart enough to do so, and that one is always better off when the attempt is successful. The fact is, of course, that many functions are best evaluated by carrying out a numerical quadrature, and if a function is given initially as an integral the likelihood is strong that this is such a function. In the treatment of limits the attention is generally focussed upon the conditions that assure the existence or nonexistence of a limit. In practical work, in cases where a limit is known to exist, one is greatly interested in estimates of the deviation from the limit of an arbitrary term in the sequence. These estimates are given by remainder formulas. They are, indeed, often useful in proving convergence and their consideration requires little more than a shift of emphasis.

Finally, I wish to enter a plea for the earlier introduction and more general use of matrices and vectors. It seems to me that this introduction comes most naturally in the freshman course in analytical geometry. Their importance, for both pure and applied mathematicians, seems scarcely open to question, and yet a deplorable cultural lag permits even some mathematics majors to graduate with the barest nodding acquaintance.

Digital computers and computing are drawing upon a variety of areas which are usually taken up only in the more advanced courses in mathematics, but which could be, and sometimes are being, at least introduced at more elementary levels. Foremost among these are Boolean algebra and symbolic logic. Another is the theory of groups. Still another may be combinatorial topology, since apparently Gabriel Kron has had spectacular success in applying this in solving certain systems of equations. Whether such topics should be offered in special undergraduate courses, or whether the entire mathematical curriculum should be reorganized, as is being done in some places, is a question I shall not attempt to answer here.

A while back I indicated that I did not consider an undergraduate course in numerical analysis too important, but now, as you see, I am virtually advocating that the entire mathematical curriculum be oriented toward numerical analysis. My argument is that the slant can increase the utility of the subject for all those who are interested in mathematics only as a tool, without in any way lowering the dignity of the courses as mathematics. Where such a viewpoint does not prevail, however, a course in numerical analysis can be of value provided it is not a mere collection of recipes.

To illustrate what I have in mind here, suppose in a course in numerical analysis one is about to take up the solution of algebraic equations by the method of Bernoulli. In this method one forms a basic sequence which satisfies the linear difference equation whose coefficients are those of the algebraic equation to be solved. From this basic sequence one forms a secondary sequence by taking ratios of consecutive terms. If the equation has a single root of largest modulus, then the new sequence approaches this root as its limit, and the rate of convergence is determined by the ratio of the modulus of this root to that of the next largest root. If there are two largest roots of equal modulus, this secondary sequence has no limit, but other sequences can be formed whose limits are the coefficients of the quadratic satisfied by these two roots, and the rate of convergence depends upon the ratio of the common modulus of the two roots to that of the next. If the two largest roots are of nearly equal modulus, convergence to the largest will be slow, but convergence to the coefficients of the quadratic may be suitably fast. Now all these points can be brought out and illustrated by numerical experimentation with a few simple, manufactured cubics and quartics with no very laborious and extensive computation. In short, I am recommending that the course be one in numerical analysis, directed toward the mathematics, rather than one in numerical techniques for developing special skills.

Perhaps some apology is due for a too-frequent use of the first person singular in this account. The excuse is that the viewpoint is my own personal one, and it is very likely to be limited and onesided. I have objected to specialization and yet I have proposed a fairly general slanting of the mathematics courses toward numerical analysis. In feeling that such a slant would be quite generally beneficial I may be merely exhibiting the bias of my profession. But to summarize: Universities, both here and abroad, have played an important part in the development of digital computing machinery, and they have contributed to the understanding of how to use them. Certainly, government laboratories and commercial firms have also contributed, but my topic concerns only the universities. In the future, in this country at least, it seems to me that universities can contribute most in the field of application, both in their training and in their research, although their training should never descend to the trade school level. While some background in physics, chemistry, and other sciences is certainly advantageous to the future programmer or numerical analyst, it seems to me that eventually his problems become mathematical in character. Hence, the immediately relevant training and research should center in the mathematics departments. This places upon them a unique responsibility not shared by other departments.

In all this I have spoken only of scientific uses of the machine and have skillfully avoided mentioning business applications. This is for the very good reason that I have no background for discussing this area. Nevertheless, on general principles it seems that the problems are still logical and arithmetical in character and that mathematics could help. The hard thing is to persuade mathematicians to become interested in business problems, and business experts to study mathematics. I predict most rapid progress whever mathematicians, engineers, and business experts can be persuaded to join together in arriving at a common understanding by which to differentiate the primary needs of business from the incidental byproducts of established procedures, and thence to devise the hardware and routines for achieving the real objectives. Where could such teams form more readily than in a university?

- END -

THE MECHANIZED MUSE

ELIZABETH W. THOMAS
Red Bank, N.J.

Dr. Carl Jonus Yaffee, Ph.D., M.A., M.S., Associate Director of Cornumbia University's School of Engineering and creator of the recently unveiled Yaffee Electronic Relay Poem-Writer, is a fresh-faced, blue-eyed silvery haired gentleman of 67, with a boyish smile and a diffident manner. He looks more like a busy and contented small-town pediatrician than an internationally celebrated scientist with nearly half the letters of the alphabet following his name; but YERP, as his current brainchild is more generally known, is the sixth in a series of notable contributions to the arts and sciences which he has made since his arrival in this country from Austria in 1918 — contributions which include such familiar household devices as the Yaffee Automatic Pinochle Player (YAPP), the Yaffee Automatic Check-Book Corrector (YACC), and the Yaffee Electronic Automatic Housewife (YEAH), the latest model of which not only orders and cooks the meals but washes the dishes and puts them away.

YERP has been five years a-borning, and has employed a full-time staff of 55, composed of members of Cornumbia' Engineering, Applied Science, Mathematical, and English Departments -- technicians, and clerical help. It is, says the Doctor modestly, merely an extension of the gigantic electronic "brains" which are being produced regularly by our industrial and university engineering laboratories. YERP embodies many of the same principles and much of the same circuitry as its mathematical relatives; it differs mainly in that it treats words rather than mathematical data. It can be demonstrated, says the Doctor -- adding, with a twinkle, that he vill not do so just now -- that the mechanical processes involved in the construction of a poem are essentially the same as those associated with the solution of a series of complex equations. The problem was chiefly one of providing greatly expanded <u>magneto-electronic storage capacity</u>, to accommodate YERP'S enormous "vocabulary"; increased sensitivity in <u>selectors</u>, by which YERP is enabled to "recognize", and select or reject a work; stepped-up <u>operational speed</u>, permitting YERP to "scan" almost infinite combinations of words in a few fractions of a second; and a simple but flexible <u>coding system</u>, whereby YERP can be "instructed" to move along preselected operational procedures.

At the present moment YERP occupies three rooms of the Cornumbia Physics Laboratory in the Morton Memorial Building, but it will shortly be installed in a specially built annex of the New York General Library, where it will be available to poets and students at a nominal fee. Pending its removal to permanent quarters, visitors may be taken on a tour of YERP any Thursday afternoon, upon application to the University secretary.

On the occasion of my audience with YERP I was fortunate enough to have the good Doctor himself as interpreter. My group contained, I suppose, the average mixture of literary, scientific, and miscellaneous components: representatives of the Book Departments of three Metropolitan dailies, two engineering students from neighboring universities, a young reporter from a well-known weekly news magazine, a lady poet from Ohio, two gentleman poets both from New Jersey, and myself. We were ushered into a comfortably furnished reception room in the Physics Laboratory, where the great man greeted us informally and quickly disarmed the fears of the mechanically unsophisticated.

"The scientist uses beeg words to impress you with his knowledge," he began. "Here at Cornumbia ve do not strive to impress -- ve seek to instruct. Anybody among you who ees able to chenge a fuse will have no dif-fic-ulty in following my brief remarks on the mechanical side of our machine, which vill be of interest, I hope, alike to poet and engineer. The latter, if he desires, may satisfy his scientific curiosity by reading the technical manual on the machine, which ees available at this department; and the former may wish to purchase the little book of poems produced by the machine, which ees on sale at the University Book Store."

We learned that YERP contains over 500 vacuum tubes, 10,000 transistors, 20,000 crystal diodes, 350 pluggable units, 1,356 miles of wiring, a magneto-electronic storage unit with a 5,000,000-word capacity, a printing unit capable of printing 1000 words a minute, and a vocabulary of about 1,500,000 words which are punched on cards. The vocabulary, incidentally, is constantly being revised and kept up to date by a special group of readers

"I think it's sweet," whispered his compatriot.

Willy looked perplexed. "How about a sonnet?" suggested one of the newspapermen.

"Sonnet all right with you?" asked the Doctor.

"OK with me," said Willy. "It rhymes, don't it?"

"Iambic pentameter?" asked the Doctor. "Or do you prefer one of the more modern modes?"

"Iambic pentameter," said Willy firmly. "I'm a fool for Iambic pentameter."

The Doctor flipped fourteen switches on the machine's control panel. Each switch, he told us, called for a line in Iambic pentameter.

"Ve vill now select the rhyme-pattern," said the Doctor, "and impulse the correct switches. Thus ees the machine enabled to select terminal vords in the desired rhyming sequence."

After a certain amount of prompting, Willy selected a standard Shakespearean rhyming pattern, and the Doctor adjusted fourteen more switches to the corresponding positions.

"Now," he said. "If there are any special vords, such as vould not be included in the standard vocabulary, ve may now insert them."

Willy regarded his shoes bashfully.

"Think of this purely as a scientific demonstration," said the Doctor encouragingly. "The young lady's name, perhaps?"

"Name of Beatrice," said Willy, blushing furiously.

"H'm," said the Doctor dubiously.

"I always call her 'Buster'", volunteered Willy, and the Doctor brightened.

"Miss Matthews," he called. A pretty, dark-haired girl materialized from somewhere, and sat down at a table holding an instrument that looked like a small typewriter. She took a blank card from a rack, similar to the ones we had seen in the drawers, inserted it in the machine, and awaited further instructions.

"Please to observe closely while the young lady prepares the card for insertion in the machine," said the Doctor. "The instrument she ees using ees called the Word Actuator."

We gathered around the table and watched carefully.

"B - U - S - T - E - R," spelled out the Doctor, slowly and clearly.

"B - U - S - T - E - R," repeated Miss Matthews, a click of the instrument's keys punctuating each letter.

"Proper noun," said the Doctor.

Click, went Miss Matthews.

"Rhyme-code-punch 3 in column 27," continued the Doctor.

Click.

"Route to Selector Number three," said the Doctor. "That's the obligatory selector," he explained to us. "The given word must then occur at least once in the verse."

Click.

"Re-punch and compare," concluded the Doctor.

Clickity clickity clickity sssswich plunk, went the word actuator, and Miss Matthews held two cards up to the light and compared them.

"OK," said the Doctor, "ve're ready to -- what you say, roll."

He inserted the card in the input unit, depressed the "ON" switch, and the card was promptly swallowed up. We were then conducted into a third room, where the printing mechanism was housed.

"Now," said Dr. Yaffee, "before ve turn on the switch, one vord of caution. Ve must not ask too much of our machine. Just as the diamond comes rough from the mine, awaiting the craftsman's hand to give it luster and beauty, so comes the poem from the machine."

Willy was instructed how to turn the machine on, which he did. There was a clicking and whirring; lights on various panels around the room flashed on and off, and we waited for perhaps three minutes in silence. Then the type bars started to move.

AS ANTIQUE ART ATTIRES AN AURA'S ARC
AND AIDS AMBIGUOUS ALE AS AN ADJUSTER

we read.

"Stop, stop," bellowed the Doctor, leaping for the control button. There was instant cessation of the hum of machinery as the type bars subsided in their bed. "Elizabeth! Carcalled "Prospectors", whose job it is to read all of the poetic output of the country and report on all significant trends in word usage. At present, for instance, it is practically obligatory for the poet to employ such words as "nubile", and "incandescent", at least once in each poem.

Time required for the production of a standard-length poem is approximately five minutes, exclusive, of course, of the time consumed in preparation and polishing, which may take from ten minutes to two hours, depending upon the individual operator.

"It ees not true," said Dr. Yaffee at the conclusion of his short lecture, as severely as if one of us had suggested that it was true, "that the Yaffee Electronic Relay Poem-Writer vill eventually supersede or obsolete the poet. What it vill do ees to free the poet from the mechanical trammels that have hitherto shackled him, increase his output, and enhance his leisure."

We were then escorted into an adjoining room, brilliantly lit, lined on all four walls from floor to ceiling with filing cabinets, and furnished with business-like looking chairs and tables. In the middle of the room stood a squat black object, rather resembling a kitchen stove, which, we were informed, was the feed, or input unit, of YERP. Dr. Yaffee asked for a volunteer demonstrator.

"I would prefer someone with neither a scientific nor a literary background," he said. "Thus ve vill get a true picture of the machine's extraordinary capabilities."

After some hesitation the young reporter from the news weekly offered himself up on the altar of science. His name, he told us, was Willy. Ordinarily he was on the Sports Desk, but he was at present subbing for a sick friend at the adjacent Science Desk.

"First off," Dr. Yaffee instructed Willy, "ve must select our sobject. Please to notice the filing cabinets around the room. There are more than 500 of them. Each drawer has its own title, indicating its sobject, and in the drawers are kept, punched on cards, our machine's vocabulaty -- one vord to each card, along with various coding punches for the purpose of identification and recognition by the machine. Here, as you see," said the Doctor, crossing to the far side of the room, "ve start with the sobject 'Aberration'; so on to 'Abnegation', 'Ambition', 'Anger', 'Anxiety', and so forth; on through 'Beauty', 'Bravery', 'Brutality' — I pick at random — right on down through the alphabet to 'Zoomorphism'. My colleague, Professor Morgansen of the English Department, ees responsible for the selection and classification of our vocabulary; he worked for five years to develop the present system, and ve may confidently say that few known human emotions are not included in it. So pick your sobject, and ve vill proceed without further delay to write our poem."

Willy appeared to be overcome by stage-fright. "I thought you could just push a button," he quavered.

"Come, come," rallied the Doctor kindly. "A young man like you, at the peak of his sexual maturity -- surely there must be someone to whom you would wish to express yourself —"

"My girl's in Florida," said Willy at length. "Could that thing write her a poem telling her to take it easy and don't get carried away by no no-good creep just because he's gotta sun-burn and one of them foreign sports cars —"

"Splendid," said the Doctor approvingly. "A popular sobject. Let us see which of our categories vill most closely approximate the sentiments you have expressed."

He crossed the room to the "L's. "'Lover, the'", he read. "Ve have broken this down into a number of sub-classifications. I can offer you 'Lover, the Dejected'; 'Lover, the Desolate'; 'Lover, the Desperate'; 'Lover, the Despondent'" —

Willy shook his head. "Just noivous", he said hoarsely.

"'Lover, the Apprehensive'", announced the Doctor. "I think this ees just what ve're looking for."

He removed three long, shallow drawers from the file, in which thousands of oblong cards lay neatly stacked; placed them on a low table, and wheeled them across the room to YERP'S input unit. He then inserted the contents of all three drawers into the machine, briskly tapping the edges of the stacks to bring them into perfect alignment. When all of the cards were thus stowed, he touched a switch. The machine went on with a low hum, and instantly the cards disappeared within its capacious maw.

"You may think of this unit as the machine's memory," he informed us, "in which are stored these thousands of vords, punched on cards, just as a man stores his vocabulary in his memory. So. Now. Next. Ve must tell the machine what form of verse ve wish to write, and select our rhyme pattern."

"Rhyme!" murmured one of the New Jersey poets. "How quaint!"

(continued on page 38)

I.R.E. NATIONAL CONVENTION, MARCH, 1956, NEW YORK— TITLES AND ABSTRACTS OF PAPERS BEARING ON COMPUTERS AND AUTOMATION

The Program of Technical Sessions of the IRE National Convention in New York, March, 1956, contains many papers having some relation to computers and automation. Following are the titles and abstracts of 31 of these papers, and notation of the part of the IRE Convention Record in which they will be published.

SESSION II

Sponsored by the Professional Group on Medical Electronics. To be published in Part 9 of the IRE Convention Record.

Medical Electronics I

2.3 The Application of Automatic, High-Speed Measurement Techniques to Cytology

W. E. Tolles, R. C. Bostrom, and H. S. Sawyer, Airborne Instruments Lab., Inc., Mineola, N.Y.

The Cytoanalyzer, an instrument being developed for high-speed, automatic screening of cytological smears for the early detection of cancer, is based on the distinguishable differences that exist between malignant and normal cells when compared with respect to nucleus size and density. This paper discusses the techniques used to obtain these differences in cell characteristics from the electrical analog of the smear. The design and operation of the measuring and computing circuits used in the instrument, including evaluation test methods and results, are described. The design of the scanning element used to convert the optical information of the smear to a serial electrical current is summarized.

SESSION III

Sponsored by the Professional Group on Vehicular Communications. To be published in Part 8 of the IRE Convention Record.

Vehicular Communications:
"New Horizons for Vehicular Communications"

3.3 More Words Per Minute Per Kilocycle

C. B. Plummer, Federal Communications Commission, Washington, D. C.

The amount of information which may be transmitted over a radio channel of a given width has a close relationship to the complexity of the apparatus involved in its transmission and reception. Virtually every radio service licensed by the Federal Communications Commission utilizes far more radio spectrum than needed to convey the necessary intelligence in order to utilize low cost apparatus. There are excellent expansion possibilities in the land mobile services which are today the most inefficient users of our radio spectrum.

SESSION IV

Sponsored by the Professional Group on Communications Systems. To be published in Part 8 of the IRE Convention Record.

General Communications Systems

4.1 The Place of Communications in Integrated Data Processing

A. O. Mann, SKF Industries, Inc., Philadelphia, Pa.

The current status of teletypewriter and related communications equipment for integrated data processing at SKF will be described. Further description will be given of the future plans for provision of a complete, national circuitry of teletypewriter. The relationship of such communications equipment to a complete computational and control program will be outlined, highlighting our plans for a complete closed circuitry with full feedback. Included in the paper will be descriptions of some new and decidedly novel communications equipment which we have developed in collaboration with A.T. & T. Co. and which exists nowhere else.

4.3 Sixteen Channel Time Division Multiplex System Employing Transistors and Magnetic Core Memory Circuits

J. C. Myrick, Rixon Electronics, Inc., Silver Spring, Md. and Walter E. Morrow, M.I.T., Cambridge, Mass.

A four-channel time division multiplex system, utilizing vacuum tubes, has been in use for several years. This paper describes a new development, which compresses sixteen standard 60 or 100 word per minute teletype inputs into a time division multiplex system developing an output suitable for use with frequency-shift keying systems. The computer field has been drawn on for ferrite core memory circuits, shift registers, binary count-down circuits, and applications of transistors. The equipment to be described occupies the same rack space, requires far less power input, and is inherently much more reliable than the multiplex equipment currently in use.

An important feature of this equipment is the incorporation of timing facilities based on an oscillator with an inherent stability of one part in ten to the eighth per day or better. This provides highly synchronous operation with infrequent synchronizing pulses.

SESSION VII

Sponsored by the Professional Group on Information Theory. To be published in Part 4 of the IRE Convention Record.

Information Theory I

7.1 Information Theory and Quality Control

Jerome Rothstein, Signal Corps Engineering Labs, Fort Monmouth, N.J.

A basic analogy is described between a communication system and a manufacturing system with the following correspondences between terms: message source and specification, transmitter and means for modifying raw materials, channel and objects possessing measurable characteristics relevant to specifications, source of noise and cause for rejection, receiver and quality measurement system, ensemble of received messages and lot of manufactured articles of measured statistical quality. The common logical basis of statistical communication theory and statistical quality control, plus the fact that measurement can also be described as communication, assumes particular importance if automation is extended to encompass both quality control and production.

7.5 Evaluation of Complex Statistical Functions by an Analog Computer

R. R. Favreau and H. Low, Princeton Computation Co., Princeton, N. J. and I. Pfeffer, The Ramo-Wooldridge Corp., Los Angeles, Calif.

This paper presents a technique for experimentally determining a number of statistical functions which are difficult or impossible to evaluate analytically. Technique developed will be described by illustrating its use in evaluating three such functions listed below:

1) The probability distribution of time to first passage across a threshold for a Gaussian Random variable with a given spectrum.

2) The probability distribution for the length of interval between two successive zeros of a Gaussian random variable with a given spectrum.

3) The probability that a Rayleigh distributed random variable will fade below a threshold for a given time.

Results obtained for the last two functions will be presented. They agree very well with known analytical results.

SESSION X

Sponsored by the Professional Group on Automatic Control. To be published in Part 4 of the IRE Convention Record.

Automatic Control

10.5 The "Reasonableness Check" in Automation

C. H. Doersam, Jr., Doerco-Consultants, Port Washington, N.Y.

The nature of automation with respect to the automatic control of a physical process is reviewed. The boundaries of extent and rate which limit the physical processes are noted. The new concept of "reasonableness concept" is defined in terms of these boundaries. Examples are given which show that in its most elemental form the reasonableness check is common. Its power when extended to more complicated control situations is discussed. An example of one such problem is given. This example uses a digital computer in an automatic control problem. It serves to indicate some of the methods which have been developed from the basic concept.

SESSION XI

Sponsored by the Professional Group on Aeronautical and Navigational Electronics. To be published in Part 8 of the IRE Convention Record.

Air Traffic Control

11.1 Symbolic Display System for Air Traffic Control

L. T. Harris, Griffiss Air Force Base, Rome, N. Y.

A general statement is made concerning the work that has been accomplished to date in the air traffic control area, the inadequateness of present day air traffic control equipment, and a review of various technical developments that hold promise of being effectively used in air traffic display systems.

A plan is presented for a proposed integrated display system capable of providing a non-ambiguous display of aircraft identity and position coordinates suitable for high density air traffic control application.

11.2 A New Look at Requirements for Electronic Systems in Air Traffic Control

R. S. Grubmeyer, Franklin Institute, Philadelphia, Pa.

As new equipments and concepts have been developed for the control of air traffic, simulation and other tests have thrown additional light on the detailed requirements for new electronic systems and equipments. Some of these requirements have been met, but others continue to present a challenge to the electronic industry. This paper will highlight the most pressing current requirements, presenting the background information on their development so that alternative solutions may suggest themselves. The primary purpose of the paper is to develop in the industry an increased awareness of current needs so that research and development programs can be guided along the most productive lines.

11.3 Traffic Control Electronics Research Goes Modern

E. N. Storrs and J. L. Ryerson, Griffiss Air Force Base, Rome, N. Y.

This paper describes the system's research and development program of the intercenter Traffic Control Approach and Landing (TRACAL) team of the Air Research and Development Command of the U. S. Air Force. The basic system engineering concepts of this group are outlined in schematic form and the plans for the Phase I, II, and III traffic control systems are described.

Details of the techniques being applied in the development of enroute traffic control, approach, landing, airfield guidance, and display are discussed.

11.4 An analysis for Human Flight Control

L. J. Fogel, Stavid Engineering, Inc., Plainfield, N. J.

A mathematical model of some aspects of the aircraft information transfer process is suggested which includes some usually disregarded human operator characteristics, such as anticipation, amplitude quantization and sequential sampling.

Various measures for system performance evaluation are suggested. These may be used to examine the nonstationary probability density distribution of the output-message with respect to the input-signal probability density distribution as a function of time. The output-message is defined as the actual flight path, while the input-signal is taken to be the "intended" airpath—that path described by the probability function obtained from all previous successful performance of the mission phase under consideration. The formulated solution permits both nonlinear and time-varying elements, provided their transduction remains single-valued with time limited memory. This paper presents a general survey of the field and an engineering approach to many highly complex display-control design problems.

SESSION XVII

Sponsored by the Professional Group on Reliability and Quality Control. To be published in Part 6 of the IRE Convention Record.

Quality Control and Reliability Studies of Electronic Equipments

17.2 Some Reliability Aspects of Systems Design

Fred Moskowitz and J. B. McLean, Griffiss Air Force Base, Rome, N. Y.

This report uses elementary principles of probability theory and a systematic development is presented which leads to formulas, charts, and guide rules for engineers involved in the design of systems and equipments. Examples are given which illustrate the use of the formulas and the principles derived.

This study attempts to show that when the problem is present of obtaining reliable equipment which consists of unreliable parts, the solution is redundancy. Complexity by itself need not necessarily lead to unreliability if complexity is used correctly.

Two very simple redundancy schemes are described and analyzed. It is shown that it is possible to obtain a desired reliability at relatively reasonable cost in terms of increased size and weight.

SESSION XVIII

Sponsored by the Professional Group on Nuclear Science. To be published in Part 9 of the IRE Convention Record.

Nuclear Instrumentation

18.2 Punch Card Recording and Multiple Counting Data

H. D. LeVine and Henry Sadowski, U. S. Atomic Energy Commission, Health and Safety Laboratory, New York, N. Y.

The system will process data from as many as 100 counting systems by channeling a complete set of information on a given sample into a central IBM card punch. Automatic interrogation of individual counters permits the elimination of manual techniques and the avoidance of the human error factor. Each punch card carries detailed information on the number of the sample, the character of the sample, activity, counting geometry of the counting system, counting time, and other related data. Most circuits were redesigned to eliminate vacuum tubes and apply transistor and glow counter techniques.

SESSION XXIV

Sponsored jointly by the Professional Groups on Antennas and Propagation. Telemetry and Remote Control, and Military Electronics. To be Published in Part 1 of the IRE Convention Record.

Symposium: The U. S. Earth Satellite Program -- Vanguard of Outer Space

Chairman: W. R. G. Baker, General Electric Co., Syracuse, N. Y.

The prospect of man-made Earth Satellites to be launched in the International Geophysical Year (1957-8) has excited the imagination of engineer, scientist and layman. The launching, placing in orbit, construction of the rockets and satellite itself present interesting engineering challenges. Few realize, however, the scope of the problems associated with the communication and collection of data from such a missile.

The objectives of the satellite program and the scientific gains to be achieved will be covered in this discussion. The major emphasis, however, will be placed upon problems of:

1) Keeping track of the missile which is to be done by radio and, more precisely, by optics, and

2) Gathering data from the missile. All of this involves radio transmission, propagation and intermittent reception at many points widely separated along the ground, and rapid computations based on such data.

The establishment of a satellite might conceivably be accomplished without the use of the electronic art. The use of electronics, however, will increase immeasurably its value to man.

SESSION XXVIII

Sponsored by the Professional Group on Telemetry and Remote Control. To be published in Part 1 of the IRE Convention Record.

Flight Data Reduction Systems

28.1 An Improved System for Collecting and Processing Flight Test Data

H. W. Royce, Glenn L. Martin Co., Baltimore, Md.

This report outlines a system which will be capable of collecting aircraft and missile flight test data and of resolving data reduction problems presently encountered. At the same time this system offers a method for preserving better accuracy and permitting some simplification in adding new measurements found to be necessary late in the program.

Reasons are presented for the use of digital recording on magnetic tape as replacement for the photo panel and brown recorder and also the use of magnetic tape for recording of high frequency information in fm form to replace the oscillographs now being used. Both systems will allow the use of automatic techniques for processing the data, since the information is recorded in electrically retrievable forms. The low frequency system has better accuracy than present systems and for most cases the high frequency system has the equivalent or better accuracy.

28.2 Airborne Data Acquisition System

W. H. Foster, Electronic Engineering Co., Los Angeles, Calif.

The contents of this paper are comprised of the results of Phase II of Project DATUM, awarded by EAFB to EECo of Calif. DATUM is the code name for Data Acquisition and Transmission by Uniform Methods. Phase II is the airborne data acquisition portion of the project. It consists of both accumulating and recording flight data.

In addition to the entire system itself, several new units discussed in the paper are: the airborne magnetic tape recorder, recently developed strain gage oscillators, the calibration system, and possibly a new transducer to record total fuel used.

This new approach to the accumulation of airborne data by uniform means facilitates rapid, sometimes "instantaneous" data reduction. In addition, there exist no problems of time and event correlation, such as existed when some data was recorded on photo panel, some on oscillograph recording, and some on magnetic tape after air to gnd telemetering. With this relatively new system accuracies of 10 per cent are "readily" obtainable.

Preliminary checkout of the system, under simulated conditions, indicates that all design goals have been met, some superseded. Complete flight tests will be completed in December.

28.3 Requirements of a High Speed, High Quantity, All-Electronic Data Processing System

F. K. Williams, Rocketdyne Field Lab., Rocketdyne, Canoga Park, Calif.

Handling large quantities of data taken over relatively wide bandwidths is customarily done by hand or electromechanical semi-automatic systems. To circumvent the problem of handling this data, Rocketdyne has developed an all electronic, high speed high quantity data system. This system operates on a total bandwidth of 1,500 cps (based on Hartley's criterion) or 10 thousand conversions/second of nine bits each. Analog information is received from one hundred separate input channels, multiplexed, clamped and converted. This data is recorded in a permanent storage on magnetic tape capable of holding eight minutes of information or four million eight hundred thousand, eighteen bit words. Each word contains the information produced from a channel and the identification of the channel plus a gross error marker. Since all of the data is recorded in digital form on tape, it can be used to supply information to a digital electronic computer, in this case an IBM 701 or IBM 704. The taped raw data is played back into a data selector circuit which eliminates all unwanted data time-wise. Finally, the data is transcribed onto two IBM 727 tape units in blocks of arbitrary length. This blocked data can then be processed directly from the console of the IBM computer in any way desired. Analog records can be reproduced, computing can be done, or punched card or typed data taken from the machines output. The latter part of the system can also be fed from a digital radio telemetering system.

28.4 Techniques for a High Speed, High Quantity All-Electronic Data Processing System, IDIOT II

M. L. Klein, Rocketdyne Field Lab., Rocketdyne, Canoga Park, Calif.

The design of a high speed, all-electronic data handling system requires the use of several novel techniques. Multiplexing is accomplished with an electro-mechanical, mercury jet switch which simultaneously acts as a keying system for the whole record. Each input is slamped in an all-electronic system which allows a finite period for the conversion to binary code. The convertor, a programmed trial voltage encoder which successively trys binary voltages and executes a fixed logic, yields a straight binary code output. This output, along with the channel identification and error marker are transcribed onto tape in blocks of six and timing markers added. This tape record is the permanent data storage. To feed the data into a computer, the data is first played into a time filter which examines only wanted data. Each block of six bits is examined for oddness and evenness and a parity check mark added to maintain oddness of bits. Finally this data is recorded on two IBM 727 tape units, blocked out into preset lengths with ten millisecond gaps inserted without loss of data. This technique makes use of the displaced time head method for keying. With the data available in this form, it can be used by the IBM 701 or 704 computer from console control.

Several million words of data can be handled automatically in this manner and processed at extremely high speeds.

SESSION XXXII

Sponsored by the Professional Group on Electronic Computers. To be published in Part 4 of the IRE Convention Record.

Electric Computers I

32.1 A Multiple Input Analog Multiplier

D. D. Porter and A. S. Robinson, Columbia University, New York, N.Y.

This paper describes an electronic analog computing technique for obtaining the product of a number of input variables. Positive voltage analogs of the input factors are periodically sampled to produce an output product which changes in discrete steps at the sampling rate.

The multiplier consists of a simple electronic integrator, a comparator, two output storage gates, and an additional comparator for each input. A five input multiplier is described which operates at a sampling rate of 400 cps with a transition time to the new product value of 100 μ sec.

32.2 Analog Multiplying Circuits Using Switching Transistors

Kan Chen and R. O. Decker, Westinghouse Electric Corp., East Pittsburgh, Pa.

Analog multiplication schemes based on the principle of modulated rectangular pulses have been developed using switching transistors and square-loop magnetic cores. A two quadrant multiplying circuit employs amplitude and frequency modulation. A four quadrant multiplying circuit employs amplitude and pulsewidth modulation.

Each circuit has a high degree of reproducibility and basic simplicity that is not found in most vacuum tube multipliers. The accuracy over a two decade range of output is as good as that achieved by more complex vacuum tube circuits. Good temperature stability is possible because the transistors operate in a switching mode. The response time of both multiplying circuits is equal to one cycle of the modulated rectangular pulses. With distinct durability, dependability and long life, these circuits should find wide acceptance in both industrial and military applications.

32.3 Logic Design of the RCA Bizmac Computer

A. D. Beard, L. S. Bensky, D. L. Nettleton, and G. E. Poorte, Radio Corporation of America, Camden, N.J.

The RCA Bizmac computer has been developed as a major element of the Bizmac system, and may be described as a general-purpose three-address stored-program machine. It has certain specialized features which make it adept in cyclical accounting applications: completely variable word length in all internal operations; highly-flexible instruction complement directed toward data-organizing ability; a control philosophy which offers great operational flexibility and simplifies troubleshooting and maintenance.

The present paper will outline the control and organizational concepts of the computer.

32.4 Input and Output Devices in the RCA Bizmac System

J. A. Brustman, K. L. Chien, C. I. Cole, and D. Flechtner, Radio Corporation of America, Camden, N.J.

This paper will describe the functional characteristics and some of the design features of the following equipments:

Tapewriter — A manual keyboard device which creates punched paper tape.
Tapewriter-Verifier -- Permits a character-by-character verification of a previously prepared tape.
Paper Tape Transcriber — Transfers information from the punched paper tape to magnetic tape.
Card Transcriber -- Translates information from punched cards to Bizmac code on magnetic tape.
Electro-Mechanical Printer — The major high-speed output printer of the Bizmac System.
Magnetic Tape Transcriber -- Transfers information from magnetic tape to punched paper tape in the RCA Bizmac code.
Interrogation Unit -- Permits direct access to the Tape File for a rush random interrogation.

32.5 Burroughs Series G High Speed Printer

E. M. DiGiulio, Control Instrument Co., Inc., Brooklyn, N. Y.

The Burroughs Series G high speed printer is a device capable of printing 900 lines per minute from punched cards. It represents the greatest single advance yet achieved in increasing the speed of tabulating and printing machines. This paper discusses some of the basic design features that make this high speed operation feasible. Chief among these are the dual card feed with its independent picker knife control, the unique wire printing arrangement and the electronic circuitry used for decoding and encoding information to be printed. The paper will also cover some of the features to be incorporated in subsequent machines of this series, such as accumulation, magnetic core storage, a bill feed printer and a printer punch.

SESSION XXXV

Sponsored by the Professional Group on Production Techniques. To be published in Part 6 of the IRE Convention Record.

Design Approaches with Printed Wiring

35.2 Principles of Circuit Design for Automation

H. S. Dordick, Radio Corporation of America, Camden, N. J.

The equivalence of circuit design requirements for high volume automation and job-shop automation is shown. A technique of analysis known as sub-modularization is described. This results in circuit elements of standard size, content, configuration, and manufacturing processing. These elements are applicable to many diverse types of equipment, creating a mass produced type of product within the job-shop. A mathematical representation is given which aids in standardization of circuits and systematizing the analysis. The technique is applied to a variety of products and the resultant standardized automation package is shown. Slides will be presented.

SESSION XXXIX

Sponsored by the Professional Group on Electronic Computers. To be published in Part 4 of the IRE Convention Record.

Electronic Computers -- II

Chairman: John H. Howard, Burroughs Corp., Paoli, Pa.

39.1 A Magnetic Drum Sorting System

B. Cox and J. Goldberg, Stanford Research Inst., Menlo Park, Calif.

A recently announced electronic accounting machine (ERMA) is required to file 50,000 items a day to magnetic tape storage. The filing proceeds continuously during the day and utilizes a magnetic drum as a temporary storage device. Each item is identified by an index number; the items are entered to the machine sequentially in random index number, but are stored on magnetic tape in numerical order. The sorting operation occurs between drum and tape and is accomplished by a unique electronic sorter, which is characterized by its ability to scan a large number of drum tracks simultaneously with but a single index number register and a minimum of associated logical circuitry. The system is further characterized by a small number of writing-erasing operations per item.

39.2 A Magnetic Drum Extension to the Gamma 3 Computer

P.L. Dreyfus, H.G. Feissel, and B.M. Leclerc, Compagnie Des Machines Bull., Paris, France

The BULL Gamma 3, a production line computer, was primarily designed with a small internal storage to be connected to standard punched card machines.

An extension including a magnetic drum and high speed storage may now be connected to the existing model, increasing a thousand fold its internal storage.

This paper will describe logical and technological problems involved in this connection and some basic features of drum circuitry.

39.3 The Univac Magnetic Computer — Part I. Logical Design and Specifications

A.J. Gehring, L.W. Stowe, and L.D. Wilson, Remington Rand Univac Division of Sperry Rand Corp., Philadelphia, Pa.

This paper describes a two address, decimal serial, binary parallel computer which uses about 1,500 magnetic core devices together with germanium diodes to perform all arithmetic and control functions. The arithmetic element uses four mag-

(continued on page 32)

Free Use of the Toronto Computer, and the Remote Programming of It

PART 1

C. C. GOTLIEB and others
Computation Centre
University of Toronto
Toronto, Canada

1. Note By the Editor:

In the December 1955 issue of "Computers and Automation", The Editor's Notes contained a brief report of a conversation in Boston with Dr. C.C. Gotlieb of the Computation Centre at the University of Toronto. Dr. Gotlieb said that they had a policy of allowing free use of their Ferranti computer Ferut, to a reasonable extent, to a n y investigator (whether in Canada or not) who was not going to profit personally from the research: this in spite of the fact that they regularly charge $100 an hour for the use of their computer on commercial problems. He invited the putting of problems of this class on Ferut.

In addition Dr. Gotlieb said that they were planning to tie in their computer by teletype with many other universities in Canada, so that each could have access to the machine and put its own problems first hand onto the machine. In this way they could make their one machine helpful to the whole of Canada for research and instruction.

II. From Dr. C.C. Gotlieb:

I thought that was a very fair report of the conversation we had in Boston. The programming of our machine is such that we have not exactly been swamped by requests from outside users to avail themselves of the free machine time f o r "real code" problems.

I am sending under separate cover a c o p y of our new Transcode Manual which contains a description of our system of automatic programming for Ferut. We find we can teach this system in a few hours and Transcode programs from outside Toronto have been coming in steadily. You w i l l also be interested to know that we have had five evenings of extremely successful runs with t h e University of Saskatchewan via the teletype link supplied by the Canadian National Railways. It may be that CNR will provide us with free teletype lines to any Canadian university and t h e experience we have had to date makes us extremely enthusiastic about this way of running. There are already some fifteen people at the University of Saskatchewan who have run problems on F e r u t without ever having seen the machine, and w e feel that we can appreciably increase the number of students who acquire experience on a computer during their university career.

III. From "Transcode Manual" -- A System of Automatic Programming for FERUT, the Ferranti Mark I Electronic Digital Computer at the University of Toronto, published by the Computation Centre, University of Toronto, Canada, October, 1955, 58 pages:

PREFACE

This manual was written for scientists, engineers and others in Canada to make available to them the use of FERUT, the automatic electronic digital computing machine at the Computation Centre in the University of Toronto. It is intended also to acquaint other readers with the systems used here. With its aid one can write programs for computations by the machine without having to learn the many intricacies that must be mastered by the professional programmer whose concern is with the efficient use of the machine in long calculations. Already programs in Transcode have been written outside Toronto and the results of computation sent by mail. Wherever a number of similar calculations have to be done as part of a research, it is advantageous to use this method in place of a desk calculator. For calculations that do not involve many hours of machine time, Transcode overcomes the difficulty of providing sufficient expert programming help to accomplish all the work for which the machine is suitable and for which computing time is available.

The general ideas embodied in this system were evolved by Professors Hume and Gotlieb. The very substantial amount of expert programming required to prepare the machine to translate the simplified Transcode program was carried out by Professor Hume and Dr. Worsley. The system was first put in operation in September, 1954. Since then a number of elegant improvements, especially those due to Dr. Kates, Dr. Worsley and Mr. Watson, have been incorporated. Much ingenuity has gone into the routines for the machine that the user of Transcode unconsciously relies on. Prof. Griffith and Mr. Weir have also contributed library routines. The manual was prepared by Professor Gotlieb, Dr. Worsley and Mrs. A. Wallis. Already over fifty persons have used the system in their work. To encourage learners, it may be mentioned that graduate students in science and engineering at Toronto have learned readily in a very short time and are enthusiastic users.

For those without much knowledge of computing by machine who approach this manual hopefully, may I suggest that the main initial hurdle to be overcome is the mastery of new vocabulary. A serious attempt has been made to make the reading of this manual easy in that respect for them. At the same time it is fair to point out that although FERUT operated with Transcode accomplishes in one hour as much calculation as a man with a desk machine can do in one month, the writing of a program means producing in some detail the series of instructions required. Accordingly attention to detail cannot be avoided. However it is soon learned and the aide memoire or summary sheet requires only a single sheet of paper.

If any learner experiences difficulty we should like to hear from his so that we may profit by learning where we failed as instructors.

Lest it should be thought that Transcode is a sort of programming only for amateurs I should like to mention that in the interest of speed of computing FERUT is a fixed-point machine ordinarily. However, programming with fixed decimal point encounters on occasion quite exacting problems of scaling. By its use of floating point, Transcode is a valuable aid to the programmer facing scaling problems and indeed in some calculations Transcode is more economical than fixed point computation. Since, in Transcode, numbers are submitted to the machine in decimal form, the user is saved all contact with binary arithmetic.

Finally in introducing the reader to the authors may I suggest that he keep in mind that he is investing his time in a rewarding venture. Hours of desk computing are handled painlessly by the machine in a few minutes.

As Director of the Computation Centre I should like to take this opportunity of expressing my appreciation of the enthusiasm and hard work of the Centre staff in creating this new facility at Toronto to serve the interests of scientific computing in Canada. I hope their efforts will be rewarded by a good response from the physicists and others it is written for.

W.H. Watson, Director.

TRANSCODE MANUAL

TABLE OF CONTENTS

CHAPTER 1. GENERAL

1.1 Electronic Digital Computers

The FERUT computer is one of a type generally described by the terms digital and automatic. The term digital is used to distinguish such computers from analog, or continuosly-variable devices, of which the slide-rule and differential analyser are common examples. The earlier digital calculators, such as the abacus and desk-type adding machines, were designed to mechanize only the arithmetical operations which occur in hand calculations. However, these require a human operator to carry out such processes as inputting data, transferring intermediate results from one register to another, transcribing the final answers into a presentable form and possibly employing judgment at some stage in the calculation to decide between alternative procedures. The term automatic is applied to computers which are designed to carry out these processes without the intervention of an operator.

FERUT can also be described as a stored-program calculator. That is to say, it functions by obeying a sequence of instructions which must first be stored within the machine in some coded form.

Finally, FERUT may be described as a universal calculator in the sense that it can be used to solve any problem which can be reduced to a sequence of numerical operations on given data. Only considerations of speed and storage capacity can qualify this statement.

1.2 Functional Units

Computers satisfying the above description are now named after Dr. A. M. Turing of Manchester, who first postulated the theoretical form of a machine which would calculate any computable number. In practical terms, Turing machines must contain five basic units:

(i) an input unit,
(ii) a set of storage registers,
(iii) an arithmetical unit capable of performing logical or arithmetic operations on arrays of digits stored in the registers,
(iv) an output unit, and
(v) a control unit which arranges for the functioning of the computer as a whole.

The set of available operations constitutes the instruction code of a given computer. The program, or set of these instructions required to solve a given problem, must be prepared by a process known as coding, and fed into the store of the computer before being obeyed. The individual instructions then assume the same physical form as numbers within the machine. The operation of computing involves the following steps:

(i) inputting the program, along with any necessary data, such as starting values, parameters, and tables of empirical functions,
(ii) initiating the calculation by causing the control to proceed to the first instruction,
(iii) removing the final results, (outputting instructions are generally included in the program).

A machine like FERUT makes use of special storage registers to carry out its operations. There is an accumulator, a register into which the immediate results of an arithmetic or logical operation are placed. There is also a set of B-registers which can be used to modify machine instructions as they are obeyed without altering their form in the store and without recourse to the accumulator. B-registers can be used as counters, since addition and subtraction can be carried out directly on their contents.

Digit representation within a computer need not be decimal. Scales of 32, 8 and 2 are common. The binary, or scale of 2, representation is used in FERUT. Each bit, or unit of binary information, may be represented by an on-or-off device, and recognized by the presence or absence of a bright spot on a cathode-ray tube.

1.3 Machine Instructions

A machine instruction consists of two parts, a functional operator and an operand. The operand generally consists of one or more addresses, that is, names of store locations which contain relevant information. Thus a typical single-address instruction might be

ADD 567

This would instruct the computer to add the number stored in the 567th storage location to the number already contained in the accumulator. A three-address instruction could take on the form:

SUBT A B C

and instructs the machine to subtract the number in storage location B from the number in storage location A and place the result in storage location C. Machines in which instructions are not obeyed sequentially must provide for the operand to include the address containing the next instruction. Thus a two-address code might provide instructions like

ADD 0052 7631

which would require the machine to add the number in the address 0052 to the accumulator and select the next instruction out of address 7631.

In FERUT, instructions are single-address. Each is represented by one "line", i.e. a set of 20 binary digits (bits) of stored information. Of these 20 bits, the last 6 are used to specify the operation, the first 10 to specify the address of the operand, and the remainder to specify the B-register used to modify the instruction. A B-register contains the same number of bits as a stored line, and is therefore commonly referred to as a B-line. Outside the machine, each instruction is represented by four characters, each 5-bit character being a symbol in the standard teletype code.

It should be noted that machine instructions are generally quite elementary. Each one achieves only a fragmentary portion of the entire task to be performed so that much detailed work is necessary to prepare a problem for automatic solution.

Another practical difficulty often encountered by the programmer for a universal computer is that of scaling. FERUT is a fixed-point machine, that is to say, the binary point remains in a fixed position relative to the binary digits used to represent a number within the machine. Hence numbers within a limited range of magnitude only are allowed to occur in the course of a calculation. For example, one may be using the machine in such a way that all numbers are required to lie between -1/2 and +1/2. Since it is possible for the sum of a set of numbers to exceed these bounds even though each individual number lies within them, suitable scale factors must be attached to the individual numbers so that such an overflow does not occur. Compensation for these factors must be made elsewhere in the program. The problems of scaling become acute when scale factors cannot be chosen so as to permit retention of a sufficient number of significant figures. It may then be preferable to represent numbers in floating form, that is, as standardized numbers or mantissae with appropriate exponents. Thus $-736.25 = -7.3625 \times 10^2$ and may be represented by the mantissa -7.3625 and the exponent 2. A fixed-point computer can be made to handle floating numbers by the use of special coding methods. Similarly, of course, a binary computer can be used to deal with numbers represented in any other scale of notation.

1.4 Automatic Coding Techniques

Experience has shown that certain routines (or sub-sections of programs) can be devised in a sufficiently flexible manner to carry over from one problem to another. Thus routines can be written once and for all to perform such operations as:

(i) reading-in instructions through the input unit, converting them into the form required by the computer and storing them as required by the program,
(ii) similarly inputting decimal data,
(iii) evaluating certain functions such as

sines and cosines,

(iv) performing calculations such as advancing the integration of a system of differential equations by one step in accordance with some established numerical method,

(v) printing out data, with all necessary conversion from machine form to required layout on the printed page,

(vi) arranging to perform a sequence of instructions a prescribed number of times before proceeding to the next part of the calculation.

This last operation is commonly known as looping, and is often accompanied by a systematic modification of some of the instructions in the sequence. It is this technique which really makes a stored-program calculator workable, since it takes advantage of the repetitive nature of calculations suitable for automatic execution.

To use a computer efficiently, it is necessary to consolidate and unify coding techniques. First of all, a scheme of input and organization of routines must be adopted. Compatible with this scheme, a library of routines must be constructed to perform such operations as have just been described. There is still a considerable amount of work to be done for each problem by way of co-ordinating library routines into a completed program and this entails a full knowledge of the code and specifications of the machine.

Thus the final step towards automatizing coding techniques is to arrange for the computer itself to do the organizing and coding by a pseudocode. Transcode is an automatic coding system written especially for FERUT. It derives its name from the fact that it arranges for all information, prepared for input in a simplified form, to be read into the machine from a punched paper tape and translated into the form required by the computer. This translating takes place automatically once and for all before the calculation proper is started. Translation routines of this type are also known as compiling routines or compilers.

CHAPTER 2. THE TRANSCODE MACHINE

2.1 Machine Description

When programming with Transcode, FERUT may be regarded as another machine in which the specifications for numerical representation, storage organization and instruction code are quite different from those for the "real" machine. The following are the properties of the Transcode machine.

2.11 Number Representation

It is not necessary for the Transcode user to become familiar with the binary system. Numbers normally entering into a calculation are expressed in the floating decimal system, that is every number has associated with it a power of ten which may be considered as its scale factor. For example -107.345 is written $-1.07345 \times 10^{+2}$.

Since the normal machine code of FERUT is constructed to operate on numbers in fixed-point binary form, a conversion must take place whenever floating decimal numbers are read in. For Transcode each floating-decimal number is, in fact, represented by its equivalent floating-binary form, two lines (40 bits) of machine storage being used to represent the mantissa, and the following line (20 bits) to represent twice the binary exponent. (The factor two in the exponent was adopted for convenience in coding). It is possible to carry as many as 12 significant decimals in a Transcode calculation.

Integers, as well as fractions, can of course be punched in floating-decimal form and read into the machine. They then occupy three lines of machine storage. The representation may not always be exact, however, since an error of 1 in 2^{40} may be introduced by the conversion.

When counting iterations it is necessary to represent integers exactly within the computer and of a length which can readily be used in a B-line. Therefore an alternative representation has been provided for integers. All the numbers used in B-lines are 20-bit integers in fixed-point form. Note also that the exponent part of a floating number is an even integer of this sort.

2.12 Storage Organization

The Transcode machine, like FERUT, has two levels of stores, electronic and magnetic. The ELECTRONIC store consists of three pages* labelled X, Y and Z. There are 21 addresses or store positions on each of the X and Y pages, labelled X01, X02, ..X21; Y01, Y02, ..Y21. The Z page contains only thirteen addresses Z01 ..Z13. All of these electronic storage positions are individually and simultaneously available during computation and they may be used to store data, intermediate results or tables.

The MAGNETIC store consists of 64**DRUM locations, divided equally into two sets, called the lower and upper halves of the range. Each DRUM location can be used as an auxiliary store for a block of 21 electronic store positions. The contents of the X or Y page may be transferred as a whole, to or from a DRUM location by means of instructions described below. The Z page can be transferred only under the conditions of Section 3.64. Such an operation <u>replaces</u> the previous set of 21 numbers with the new material. DRUM locations may also be filled directly from the input tape. It should be noted that the magnetic store is only accessible in block form, this being an engineering feature of the machine.

Transcode also makes provision for storing up to 21 CONSTANTS per program. These are labelled C01, C02, ..C21. They retain their identity throughout the execution of a calculation and can only be introduced by input from tape before the calculation commences. They are actually stored among the translated machine instructions to become available as required by the program.

* These pages correspond to the cathode ray tubes which can be viewed from the console. Each

contains 64 lines of machine storage arranged in two columns. In the X and Y pages, the last 63 lines are used for storage of Transcode numbers, and the first is spare. In the Z page, the last 39 lines are used for storage of Transcode numbers, and the remainder are used by Transcode for monitoring purposes and must not normally be altered by the program.

** This number may be increased by special arrangement with the operator.

2.13 Instructions

The program for a calculation consists of a consecutively numbered set of instructions. These are numbered in sequence, as 001, 002, 003 etc. Thus each instruction in a given program can be identified by its "instruction number", jjj. Instructions are of the three address type, and always take the form of:

(i) a four letter functional part specifying the operation to be done.
(ii) three addresses, each having four digits, specifying the storage locations of the operands, results, arguments, etc.

The first three of the four digits of each address specify a storage location as defined above. The fourth digit can refer to a B line, as described below; for the moment it will be taken as zero, which indicates no B-modification. For some instructions, this four-digit address may take on a specialized form, such as an integer, specifying how many Transcode numbers are to be printed. It may even be a dummy, in which case it is represented by four zeros. The exact meaning of each of the four digits in each of the three addresses is defined below for each instruction and this information is summarized in Appendix V.

A few preliminary remarks may be made about Transcode instructions. "Storage location" here is to mean magnetic or electronic. The contents of any storage location are indeterminate, until filled by a programmed operation. The contents of storage locations used as arguments in a Transcode operation are left unaltered by the operation. The results of a Transcode operation are placed in the designated storage location, implying a replacement of information previously stored therein. Constants, however, can only be introduced initially from the input tape.

Let (X01) be used to represent the contents of storage location X01. Then the instruction "add (X01) to (Y01) and place the result in Z01" and having the instruction number ooj, is written as

00j ADDN X01.0 Y01.0 Z01.0

The instructions for the TRANSCODE machine will be discussed under the following headings:

(i) Arithmetic instructions
(ii) Transfer instructions
(iii) Looping and control-transfer instructions
(iv) Miscellaneous instructions

2.2 Transcode Instructions

2.21 Arithmetic Instructions

The instructions

ADDN	X01.0	Y01.0	Z01.0
SUBT	X01.0	Y01.0	Z01.0
MULT	X01.0	Y01.0	Z01.0
DIVD	X01.0	Y01.0	Z01.0

have the effect of placing respectively in Z01 the four results (X01) + (Y01), (X01) - (Y01), (X01) x (Y01) and (X01) ÷ (Y01). In general, the first two addresses may be any of the X, Y, Z or C locations, and their contents are left unchanged by the operation. The third address may be an X, Y or Z location.

The instruction

1/2QRT X01.0 000.0 Z01.0

has the effect of placing $\sqrt{(X01)}$ in Z01. The instruction

KOMP X01.0 Y01.0 Z01.0

places $|(X01)| - (Y01)$ in Z01.

The possible addresses for these two instructions are as for the four instructions above.

The use of the first five instructions is obvious and in fact they are the basic computing instructions. The KOMP (compare) instruction has many uses; in particular if (Y01) = zero it stores the modulus of a number. This is often necessary in examining for convergence or in determining if two supposedly equal results agree (see example below for calculating e^{-x}).

2.22 Transfer Instructions

The instruction

OVER X01.0 000.0 Z01.0

transfers (X01) to Z01, leaving (X01) unchanged. It has possible addresses as for the first four instructions. Note, however, that the second address here is a dummy.

ZERO X01.0 000.0 000.0

places floating point zero (here $\doteqdot -10^{-10,000}$) in X01 and may be applied to any X, Y or Z address. It is useful for clearing locations before the start of an iteration. Here the last two addresses are dummies.

The next two instructions arrange for the transfer of information between the DRUM and electronic store.

READ 001.0 000.0 X00.0

copies the contents of DRUM position 001 on to page X, i.e. positions X01 to X21. This is commonly referred to as "reading down from the DRUM".

```
WRTE          001.0     000.0     X00.0
```

copies the contents of page X on to DRUM position 001. This is commonly referred to as "writing up to the DRUM".

In general any of the DRUM positions, and the X or Y page (but not the Z page) may be used. These instructions may be B-modified as explained at the end of this section. The analogy of reading pages out of or writing pages into a book might be noted.

2.23 Looping and Control Transfer Instructions

To achieve economy of effort in writing programs, it is necessary to arrange that sequences of instructions be used over and over again, i.e. to write loops. B-lines have several uses, and one of the most important is to act as counters to facilitate looping. The LOOP and B-conditional TRNS (transfer control) instructions have been specially devised for this purpose. Suppose that it is required to cycle through a set of instructions 21 times, before proceeding to the next instruction. This can be achieved by

```
001      LOOP   021.0    000.3    000.0
002
 .       (Set of INST to be    )
 .       (obeyed 21 times over)
00n
00(n+1)  TRNS   002.0    000.3    000.0
```

The LOOP instruction here prepares the machine to repeat 21 times the set of instructions which follows, B3 being assigned in this case as the counter for keeping track of the number of the iteration. The third address here is a dummy. The TRNS instruction terminates the sequence to be cycled through in the following way. It makes the machine select as its next instruction the one numbered 002, provided That B3 has not yet counted off the number of iterations specified by the LOOP instruction. When B3 shows the count to be complete, the TRNS instruction allows control to proceed as usual to the next instruction, 00 (n+2) in the numbered sequence.

The process of looping is very commonly accompanied by the progressive modification of certain instructions within the loop. Transcode enables this to be done automatically, using the same B-line that controls the loop.

Suppose, for example, it is desired to place ZERO in each of the locations X01, X02, ...X21. This could be accomplished by the twenty-one instructions

```
001  ZERO   X01.0   000.0   000.0
002  ZERO   X-2.0   000.0   000.0
 .
 .
 .
021  ZERO   X21.0   000.0   000.0
```

The following method allows a much shorter sequence of instructions to do the same thing:

```
001  LOOP   021.0   000.3   000.0
002  ZERO   X21.3   000.0   000.0
003  TRNS   002.0   000.3   000.0
```

Note that the address of the last number to be operated upon is written into the instruction address which is to be progressively modified, the fourth digit being the number of the B line controlling the loop. While the above three instructions are the ones written into the program, the instructions actually obeyed are carried out in the following sequence:

```
LOOP      021.0   000.3   000.0
ZERO      X01.0   000.0   000.0
TRNS      002.0   000.0   000.0
ZERO      X02.0   000.0   000.0
TRNS      002.0   000.0   000.0
ZERO      X03.0   000.0   000.0
 .          .
 .          .
TRNS      002.0   000.0   000.0
ZERO      X21.0   000.0   000.0
INST in   004.
```

The mechanism by which the above process takes place is as follows: numbers in the X, Y or Z addresses are actually stored in reverse sequence within the machine, separated by 3 machine address units. During translation, the 3 written instructions become, in words

001. Set B 3 to 3(21-1), an integer.
002. Place "zero" in Store X21+(B3).
003. Subtract 3 from (B3) and test the sign of B3. If it is positive or zero, send control to instruction 002. If it is negative, proceed to the next instruction, namely 004.

Magnetic storage locations can also be progressively modified. However, since it is generally required to modify them in ascending and consecutive sequence, a different technique, requiring two B lines, is necessary. This is discussed later.

In general any of the X, Y, or Z addresses can be B modified. A control transfer can take place to any instruction in the program, and may be made conditional on any one of the B lines 2, 3, 4, 5 or 6. Note that the addresses of constants can not be B modified.

There are two other control transfer instructions which are useful.

```
TRNS      001.0   000.0   000.0
```

causes control to obey instruction 001 next unconditionally. The last two addresses are dummies.

```
TRNS      001.0   000.0   X01.0
```

causes a jump of control to 001 if the mantissa of (X01) $\geq$ 0, otherwise the next instruction will follow in the usual way. In general, the third address here may refer to any X, Y or Z position but not B modified, and the second address is a dummy.

This last control transfer instruction may be combined with the KOMP instruction to make a simple way of testing when some iterated process produces a negligibly small result. Suppose for example it is desired to compute e^{-x} from its

(continued on page 34)

WESTERN JOINT COMPUTER CONFERENCE,

San Francisco, February, 1956

Titles and Abstracts of Papers

The Joint Computer Conference Committee (formed by the American Institute of Electrical Engineers, the Association for Computing Machinery, and the Institute of Radio Engineers) held the Ninth Joint Computer Conference in San Francisco, Calif., Feb 7-9, 1956. The proceedings of the conference will be printed soon, and may be purchased from any of the sponsoring societies, for example, from the Association for Computing Machinery, 2 East 63 St., New York 21, N.Y.

Following are the titles and abstracts of the papers given.

Tuesday, February 7

10:00 a.m. - Noon **OPENING SESSION**
Terrace Room

Chairman

Oliver Whitby, technical program coordinator, Stanford Research Institute

Keynote Speaker

Norman H. Taylor, computer systems engineer, Lincoln Labs., M.I.T.

Walter E. Larew, brigadier general, chief, Army Communications Service Div., Office of the Chief Signal Officer

Harold Silverstein, special assistant to the Chief Signal Officer

Benedict Jacobelis, captain, Office of the Chief Signal Officer

Computation of electronic exploitation techniques for weapons systems and research activities has been a major activity in the military services for over a decade. The past few years have been marked with stimulated interest in the application of these same electronic techniques to the business type activities of the Army. Acting under guidance from the top levels of command the Army has established an aggressive program to outline electronic data processing systems in supply operations, personnel, and fiscal management and other administrative activities. Although this program is aimed at far-reaching improvements through long-range planning and operations research, it is planned to take action in those areas which offer immediate benefits.

2:00 - 5:00 p.m. **PROGRAMMING AND CODING**
Terrace Room

Chairman

Francis V. Wagner, group leader, engineering computing, North American Aviation, Inc.

Gestalt Programming: A New Concept in Automatic Programming

Douglas T. Ross, Servo Lab., M.I.T.

Gestalt Programming is a desired special language by which a human and computer can converse with each other. Its function is to allow both easily and quickly: (a) the computer to inform the human of the computer's troubles, (b) the human to inquire as to the status of the solution of a problem being solved on the computer, (c) the computer to do a major portion of its own programming, or (d) the solutions of problems involving both human and computer decisions.

A Truly Automatic Computing System

Mandalay Grems, Boeing Airplane Co.

R. E. Porter, Boeing Airplane Co.

A mathematical computing problem can be given directly to a digital computer as a set of algebraic expressions. These algebraic expressions are written in terms of familiar symbols for parentheses, parameters, constants, arithmetic operations, transcendental functions, and a few logical operations. The computer itself interprets and translates these expressions to machine instructions and automatically records these instructions in a form which can be used repeatedly with input data for computing results. The input data are entered as decimal coefficients with reference to a parameter or constant. The coefficient includes a decimal point and can be accompanied by a "power of ten." The computing is performed in a floating decimal system and no scaling of values is necessary by the originator of the problem.

Lincoln Laboratory Utility Program System

H. D. Bennington, Lincoln Lab., M.I.T.

C. H. Gaudette, Lincoln Lab., M.I.T.

This paper discusses a *utility program system* to assist the coding, checkout, maintenance and documentation of large-scale, control programs. A typical program contains 50,000 instructions, one million bits of data storage, and is prepared by a staff of 20-40 programmers, many of whom are relatively inexperienced. The utility system requires 25,000 registers.

An Automatic Supervisor for the IBM 702

Bruse Moncrieff, Rand Corporation

The operation of a large-scale data processor making extensive use of magnetic tapes is a routine-dominated situation. Recognition of this leads to the hope that many of the operating procedures can be given over to the machine. The motive is to increase the operating efficiency by cutting down the non-productive time between jobs; by reducing the human effort in tape handling and identification; and by reducing the re-run time caused by operator errors.

2:00 p.m. - 5:00 p.m. **AUXILIARY EQUIPMENT**
Nob Hill Theater

Chairman

W. F. Gunning, Beckman Instruments, Inc.

Magnetic Recording Head Design

A. S. Hoagland, assistant professor, University of California

An analysis of the process of magnetic recording of digital data is presented from which qualitative head design concepts are developed and their usefulness demonstrated, both in the evaluation of structures and in design for high density storage. The vector nature (or three dimensionality) of the problem is considered and the condition of operation is non-contact.

A Terminal for Data Transmission Over Telephone Circuits

E. B. Ferrell, switching research engineer, Bell Telephone Laboratories

In a recent experiment, a simple terminal for data transmission has been demonstrated. Such a terminal might be associated with a special telephone line. Between two such terminals it would be possible to send data back and forth at the rate of 750 bits per second, or 1000 words per minute. The demonstration equipment involved magnetic tape to magnetic tape transmission using amplitude modulation of a 1200-cycle carrier. It employed a 7-bit self-checking code.

The Use of the Charactron With An Era 1103

Ben Ferber, supervisor, Digital Computing Lab., Convair

As an aid in debugging, the Charactron can display the contents of memory at the rate of fifty words per second. A floating point program can be traced at the rate of ten commands per second. For problems with many answers required at each interval, the format can be vertical for ease in reading. While the Computer is calculating and displaying one page of answers, the camera is fixing and developing the previous page. The Charactron has also been successfully used as an aid in editing input data.

A New Magnetic Tape Handler for Computer Applications

Robert M. Brumbaugh, Ampex Electric Corporation

The recently announced Ampex Series FR200 magnetic tape transports have been expressly designed for the storage and processing of information in digital form. This Series features 5 millisecond start-or-stop time, single-loop threading, and a unique simplified servo tape feed control. Various elements of the tape transport mechanism are discussed in detail, including the basic design considerations, and operation of the servo system. Typical applications in the computer field are outlined.

6:00 p.m. - 8:00 p.m. — **COCKTAIL PARTY**, **Venetian Room**

Wednesday, February 6

9:00 a.m. - Noon — **MACHINE DESIGN**, **Terrace Room**

Chairman

William L. Martin, director of research, Marchant Research, Inc.

Requirements for a Rapid Access Data File

George Eisler, Electronics Division, National Cash Register Co.

General purpose data processing machines now on the market are limited in their performance by the electronic data file systems associated with them. This paper discusses the various means of organizing such file systems with the hope that equipment designers will be helped in achieving a much needed solution. The desirable factors having the greatest influence on system utility are discussed in detail: Speed, addressing, capacity and volatility.

Engineering Design of a Magnetic Disk Random Access Memory

T. Noyes, project engineer, I.B.M.

W. E. Dickinson, project engineer, I.B.M.

The IBM 305 Magnetic Disk Random Access File is a 5,000,000 character storage unit with fairly rapid access to any individual record. The random access time places this storage medium in the range between magnetic cores and magnetic tapes. The general construction and layout of the machine will be reviewed. The access mechanism and positioning of the magnetic heads is discussed in detail and a description of the air-heads is presented. Recording densities are variable and a modified non-return-to-zero method of recording is used.

"Print" Coding System for the IBM 705

R. W. Bemer, I.B.M. Corp.

PRINT (PRe-edited INTerpretive system) is basically an interpretive system which incorporates a number of compiling features in a pre-edit routine. The cost of interpreting versus compiling has been found to be only five percent greater in time and much less in compactness, e.g., the multiplication of two matrices requires the writing of only six pseudo commands. A complete method of symbolic indexing and diagnostics is incorporated. The system retains the compactness and efficiency of the interpretive method with minimum interpretation time.

The IBM Type 705 Autocoder

Roy Goldfinger, I.B.M. Corp.

This paper describes a system of automatic coding being developed for the IBM Electronic Data Processing Machine Type 705. The Autocoder System permits the programmer to define records and constant data in terms of their English names and character lengths. Ordinary 705 operations, combinations of 705 operations, called macro-operations, and library functions may make reference to defined fields and records by name.

Program Interrupt on the Univac Scientific Computer

J. Mersel, Supervisor, 1103 (Univac Scientific Computer) Computing Group, Remington Rand

A computational run on a computer involves several different types of operations such as input, output, and special computing routines. These all involve transfer of control in the computer program and in the case of input-output operations, close synchronization is required in the program. Computer programming can be simplified and versatility can be increased by building into the computer certain facilities for automatic transfer of control.

9:00 a.m. - Noon — **SYSTEMS**, **Nob Hill Theater**

Chairman

G. D. McCann, professor, Electrical Engineering, California Institute of Technology

A Pulse Duration Modulated Data Processing System

John Lowe, Douglas Aircraft Co., Inc.

Jack Middlekauff, Douglas Aircraft Co., Inc.

PDM telemetry data are recorded on magnetic tape in analog form. Time marks are recorded in a second channel of the same tape. An analog-to-digital converter (Magnavox Series 200) translates this analog tape to a digital (pure binary) tape of a form suitable for reading into an IBM Type 701 EDPM. The 701 performs a number of operations including integrating the time marks, editing and checking, stripping, scaling, and calibrating. It punches binary cards for plotting on an IBM Type 407 Accounting Machine.

A P.D.M. Data Converter

W. R. Arsenault, project engineer, Magnavox Research Laboratories

Digitizing pulse duration modulated data at a rapid rate and presenting it in a suitable form for data reduction has been a problem for some time. The Magnavox Series 200 Converter is designed to accept PDM data recorded on magnetic tape, automatically digitize it, and record the digital information on the magnetic tape in a form suitable for input to a digital computer or other data reduction equipment. This paper covers the design and operation of the Series 200 converter. The machine has been in operation for a period of eight months and this experience will be reported.

An Improved Multichannel Drift-Stabilization System

Peter G. Pantazelos, research engineer, Massachusetts Institute of Technology

Drift stabilization is essential in d-c amplifiers in electronic differential analyzers. To make possible the simultaneous drift stabilization of 30 computing amplifiers, a multichannel drift-stabilization system was built at the Dynamic Analysis and Control Laboratory at the Massachusetts Institute of Technology. A multichannel system is superior in several respects to individually stabilized amplifiers, in particular, reduced initial cost, smaller size, and less maintenance. The system built at the D.A.C.L. retains the basic advantages of a multichannel system and incorporates several design features that improve its operation and extend its range of usefulness. The features of the D.A.C.L. drift-stabilization system result in better performance than previous multichannel systems and are particularly advantageous in generalized high-accuracy analogue facilities.

Combined Analog and Digital Computing Techniques for the Solution of Differential Equations

Paul A. Hurney, supervisor, Electronic Development, Massachusetts Institute of Technology

One of the difficulties in the use of an electronic analogue computer for the solution of ordinary differential equations involving variable coefficients is its relative inability to perform certain multiplications rapidly and accurately. In instances where a variable must be multiplied by a function of another variable, this difficulty is particularly apparent. This paper describes how a digitally stored table of functions may be used with an analogue computer to solve this general class of ordinary differential equations.

12:30 - 2:00 p.m. CONFERENCE LUNCHEON Venetian Room

Chairman

John F. Haanstra, senior project engineer, International Business Machines Corp.

Speaker

Edward Teller, professor of physics, University of California, Berkeley

2:00 p.m. - 5:00 p.m. DESIGN, PROGRAMMING AND CODING Terrace Room

Chairman

Paul L. Morton, professor and chairman, Division of Electrical Engineering, University of California

An Experimental Monitoring Routine for the IBM 705

Helen V. Meek, Programming and Operations Research Staff, Hughes Aircraft

An experimental interpretive routine for the IBM 705 has been prepared which monitors the instructions of the code in question and gives a complete history of the computer action as a result of this code. All instructions, or only selected instructions, depending on a console switch setting, will be monitored. The history will be written directly to a line printer or to magnetic tape for later printing, again depending on the position of a console switch.

The Logical Design of a Digital Computer for a Large Scale Real-Time Application

M. M. Astrahan, B. Housman, and W. H. Thomas, I.B.M.

J. F. Jacobs and R. P. Mayer, Lincoln Lab, M.I.T.

The computer described in this paper is a large, binary, general purpose, digital computer designed jointly by IBM and MIT engineers. Some of the features which make its operation efficient are a 6.0 microsecond cycle magnetic core memory, an indexing system for automatically modifying instruction addresses, an input-output control which eliminates all interruptions of computation including those caused by access time, a dual arithmetic element which operates on two sets of operands simultaneously, a buffer drum system which handles high data rates by writing in the first empty register to pass the heads, and a one-half micro-second-per-bit multiplication. The prototype has been in operation for over a year.

Computer Design to Facilitate Linear Programming

R. C. Gunderson, mathematician, Remington Rand

The growing importance of linear programming in business, industry, and government has presented the users and manufacturers of high speed digital computers with an exciting facet of computer application. However, the question immediately arises as to how we might better design future computers to exploit the possibilities of this powerful tool. The actual needs are few and mathematically simple. Furthermore, these needs are extremely compatible with those logical properties desired by logicians. However, consideration must be given to the advantages gained timewise by more efficient use of high speed storage media. Secondly, the occurrence of many zeros in the linear systems involved suggests the use of some form of zero suppression, conserving both time and storage space. These are but a few of the requirements which should be given consideration in the building of the future machines of our industry.

Considerations in Making a Data Gathering System Computer Compatible

Bill L. Waddell, G. M. Giannini & Company, Inc.

The paper discusses the design problems facing the Data Systems engineers required to produce a Data Collection System that will be able to enter easily a computer. Some empirical formulas are presented with a discussion of how to use these formulas. The many recording tools and their application to Data Systems preparing for entry into computers are described with a discussion of the place of each recording device. The second section of the paper is a critical analysis of Four Data Recording or Gathering Systems designed to go directly to a Digital Computer.

2:00 p.m.-5:00 p.m. SCIENTIFIC APPLICATION
Nob Hill Theater

Chairman

D. H. Lehmer, professor, Department of Mathematics, University of California, Berkeley

Using a Variable Word Length Computer for Scientific Calculation

Fred Gruenberger, numerical analyst, General Electric Company

E. H. Coughram, I.B.M. branch manager, Richland, Washington

Variable word length alphameric machines are designed primarily for commercial data processing. One would expect relatively low efficiency and some compromise with desired operations in using such a machine for numerical analysis work. Just the reverse seems to be the case. The variable word length affords many outstanding advantages which far outweigh two small disadvantages.

Unusual Problems and Their Solutions by Digital Computer Techniques

Lawrence Rosenfeld, head, Operations Research, Mathematical Services Group, Melpar, Inc.

A number of case histories of "unusual problems" will be outlined and discussed. These will include: (1) The determination of stock trends for the speculative department of a large brokerage house; (2) Baseball forecasting and its use by a gambling house; (3) The determination of optimal trucking routes through a given traffic congestion pattern.

A Progress Report on Computer Applications in Computer Design

S. R. Cray, electrical engineer, Remington Rand

R. N. Kisch, electrical engineer, Remington Rand

This paper summarizes the logical properties of a set of magnetic switch building blocks and presents mechanized procedures for computer design using these elements. Symbols are defined for representing the building blocks in algebraic equations. All of the combinatorial ground rules for proper electrical operation are reduced to equation formats. A three-phase design program is then outlined which has been used for processing those portions of computing systems which are constructed of these building blocks.

A Topological Application of Digital Computing Machines

Ascher Opler, Research Department, Dow Chemical Company

A method has been devised by which networks can be reduced to a digital code which represents the topological configuration. Logical programs may be written which enable a digital computer to analyze these coded representations for the existence of specified sub-networks. The code appears capable of extension to other elementary operations in applied topology.

Thursday, February 9

9:00 a.m. - Noon APPLICATIONS
Terrace Room

Chairman

Roger Sisson, Canning, Sisson & Associates

Applications of the Small Digital Computer in the Aeronautical Industry

Hubert M. Livingston, sales engineer, Burroughs Corp.

Edgar L. Lyons, sales engineer, Burroughs Corp.

The proper role of the small machine in handling scientific and engineering computations will be illustrated by examples of the performance of the Burroughs E101 in the aeronautical field. The basic parameters of the machine, speed, capacity, etc., will be outlined in order to provide a framework to evaluate the specific applications which will be presented.

Traffic Simulator with a Digital Computer

S. Y. Wong, Philco Corp.

This paper presents a method of traffic simulation with a digital computer as means to (1) study traffic control systems (2) plan new roadways and (3) supply information for theoretical studies.

Integrated Data Processing with the Univac File Computer

R. P. Daly, data handling systems engineer, Remington Rand

The manner in which the Univac File Computer meets the needs of input/output flexibility, balanced internal storage of large capacity, and adequate external storage for integrated data processing is discussed with examples.

A Fixed-Program Data-Processer for Banking Operations

Jack Goldberg, research engineer, Computer Laboratory, Stanford Research Institute

The internal programming differs from that of the typical stored-program computer in that the sequence of operations in the main is pre-programmed by the wiring of the machine rather than by coded instruction words. The machine is intended for an "On-line" operation requiring a large variety of simultaneously occurring processes, with severe requirements of accuracy and reliability.

9:00 a.m. - Noon CIRCUITS
Nob Hill Theater

Chairman

J. D. Noe, assistant director, Division of Engineering Research, Stanford Research Institute

A One-Microsecond Adder, Using One-Megacycle Circuitry

A. Weinberger, National Bureau of Standards

J. L. Smith, National Bureau of Standards

An analysis of the functional representation of the carry digits in the addition process shows that the one-megacycle circuitry of SEAC and DYSEAC can be organized logically to permit the formation of many successive carries simultaneously. A parallel adder utilizing this principle is developed which is capable of adding two 53-bit numbers in one microsecond, with relatively few additional components over those required in a parallel adder of more conventional design.

The Transfluxor: A Magnetic Gate with Stored Variable Setting

Jan A. Rajchman and Arthur W. Lo, RCA Laboratories, Princeton, New Jersey

The transfluxor is a new magnetic gate with stored variable setting. It comprises a core of magnetic material with a nearly rectangular hysteresis loop and having two or more apertures. The control of the transfer of flux between the three or more legs of the magnetic core provides novel means to store and gate electrical signals. The characteristics of a representative two-aperture transfluxor are described.

Bilateral Magnetic Selection Systems for Large-Scale Computers

Amir H. Sepahban, section engineer, Government & Industrial Division, Philco Corporation

Selective writing of information on a chosen channel of a large memory system (e.g., a magnetic drum memory) and selective reading of information from one out of many such memory channels can be accomplished by use of a single two-way magnetic pyramid made solely of high quality magnetic saturable cores. A description is given of a working magnetic selection unit used in a large inventory control system with a few thousand magnetic drum channels.

The Megacycle Ferractor

T. H. Bonn, department head, Component Research & Development, Remington Rand

The ferractor is a magnetic amplifier designed to replace vacuum tubes in digital computer pulse circuits. Operation at information rates as high as 2½ megacycles with moderate power gains and power levels has been achieved. Ferractors are readily adaptable to modular construction. Using them as building blocks, the control and arithmetic sections of computers can be economically constructed with a minimum number of circuit types.

2:00 p.m. - 5:00 p.m. RCA BIZMAC SYSTEM
Terrace Room

Chairman

E. S. Calhoun, manager, Electronic Data Processing Research, Stanford Research Institute

Purpose and Application of the RCA Bizmac System

W. K. Halstead, J. W. Leas, J. N. Marshall, E. E. Minett, Radio Corporation of America

The RCA Bizmac System has been designed specifically to meet the data-processing needs of large business operations. Therefore, a number of novel features were incorporated into the RCA Bizmac System. These include an entirely new concept of data-recording variability, a much higher level of system integration than heretofore provided, and several special-purpose machines designed to take much of the burden of the major computer, which is part of the system also.

Functional Organization of Data in the RCA Bizmac System

A. D. Beard, W. K. Halstead, J. F. Page, Radio Corporation of America

The characteristics of business data will be discussed, as well as the influence which these characteristics had on the basic planning of the RCA Bizmac System. It was desirable to provide complete variability of data-item and message length in storing information on magnetic tape. This led to compression factors as high as five in the storage of certain files when compared with the earlier fixed-word, fixed,block concept.

The System Central Concept in the RCA Bizmac System

J. A. Brustman, P. T. O'Neil, J. L. Owings, Radio Corporation of America

The purpose of the System Central is to integrate the elements of a Bizmac System and to provide for controlling the performance of each element so that the combination functions in proper concert. In the Bizmac System, specialized supervisory equipments have been designed to apply over-all control and direction.

Characteristics of the RCA Bizmac Computer

A. D. Beard, L. S. Bensky, D. L. Nettleton, G. E. Poorte, Radio Corporation of America

In the RCA Bizmac Computer the input and output data are stored on magnetic tape stations. Five input and ten output trunks are available. The Computer has a high-speed memory of 4,096 characters, and an auxiliary memory of 32,000 characters. The latter serves as the main instruction storage. The machine has an instruction complement of twenty-two different instruction types, many of which can be subject to minor variations at the discretion of the programmer. Instructions are of the three-address type.

Programming the Variable-Item-Length RCA Bizmac Computer

L. S. Bensky, T. M. Hurewitz, A. S. Kranzley, R. A. C. Lane, Radio Corporation of America

The design characteristics of the computer were arrived at after a careful study of the processing needs of business problems. The most important of these characteristics is the fully variable length of data items on magnetic tape. The manner in which the computer handles variability in all of its aspects has provided a uniquely adaptable tool for commercial applications. The writing of programs for the Bizmac Computer is therefore also unique in many ways.

* * *

SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The June issue of "Computers and Automation" commencing with June, 1955, is a special issue, "The Computer Directory."

For details about the next computer directory, see "The Computer Directory, 1956: Notice."

MANUSCRIPTS

We are interested in articles, papers, reference information, science fiction, and discussion relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the fifth of the preceding month.

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation, and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable.

Reference Information. We desire to print or reprint reference information: lists, rosters, abstracts, bibliographies, etc., of use to computer people. We are interested in making arrangements for systematic publication from time to time of such information, with other people besides our own staff. Anyone who would like to take the responsibility for a type of reference information should write us.

Fiction. We desire to print or reprint fiction which explores scientific ideas and possibilities about computing machinery, robots, cybernetics, automation, etc., and their implications,

(continued on page 41)

netic one-word registers of the recirculating type. A six-bit static register stores instruction digits and drives a switching matrix to produce needed control signals. A two-phase square-wave clock operating at 660 kc drives the two standard types of series magnetic amplifiers. These amplifiers and all other circuitry in the computer are packaged on plug-in, printed-wiring panels of seventeen types. Memory is provided by a magnetic drum rotating at 16,500 rpm which stores 2,000 machine words.

39.4. The Univac Magnetic Computer — Part II. Megacycle Magnetic Modules

B.K. Smith, Remington Rand Univac Division of Sperry Rand Corp., Philadelphia, Pa.

Through intelligent packaging, mass-production economy is possible on even unique or specialized computers. The magnetic amplifier, adaptable to all normal vacuum-tube computer functions, has proved a satisfactory module. This paper points out that, in consideration of the properties of magnetic materials, a new philosophy of design is required. This philosophy entails close collaboration of logicians, designers, packaging engineers, and research physicists, from the beginning of the development of a computer.

Through new miniaturization techniques and improved magnetic materials, Sperry Rand Corporation has obtained reliable results from magnetic amplifiers at frequencies over 2 mc. Development of useful computer forms to replace common logical circuits is discussed.

Criteria for the selection of the type of logic are considered, and single-layer logic is offered as the optimum logic for this application.

39.5. The Univac Magnetic Computer -- Part III. Drum Memory

V.J. Porter, S.E. Smith, and M. Naiman, Remington Rand Univac Division of Sperry Rand Corp., Philadelphia, Pa.

A magnetic drum-memory with a capacity of 110,000 bits at an operation frequency of 658 kc is described. Storage includes 24,000 bits at a maximum access time of 0.9 millisecond and 72,000 bits at 3.6 milliseconds, with the remainder for sprocket and timing functions.

The memory is sealed in helium to protect it against corrosion, reduce input power, and improve heat dissipation. The drum's high speed (16,600 rpm) and high pulse-density ensure the short access times and the high bitrate.

A method of magnetic-head construction is described which makes for a compact structure and facilitates the precise locations of heads in respect to the drum.

SESSION XLII

Sponsored by the Professional Group on Electronic Computers. To be published in Part 4 of the IRE Convention Record.

Electronic Computers III-- Symposium on the Impact of Computers on Science and Society

Chairman: Theodore H. Bonn, Sperry Rand Corp., Philadelphia, Pa.

The recent development of digital and analog computers has had a profound effect on science a and technology. Science has been given a new tool — the ability to perform calculations that were heretofore considered impossibly complex and time consuming. In addition, the development of computers as a branch of technology has contributed to the generation of new ideas, which in turn are affecting other disciplines. How are these events shaping the course of scientific research and technological development? On what new goals are scientists focusing their attention now that computers are available to them?

How will these new tools of science affect our daily lives? What problems will they present and what benefits does the future hold?

A panel of distinguished speakers will talk on the above problems. At the conclusion of prepared talks, there will be a round table discussion of the problems raised.

42.1. A.V. Astin, National Bureau of Standards, Washington, D.C.

42.2. R.E. Meagher, University of Illinois, Urbana, Ill.

42.3. D. Sayre, International Business Machines Corp., New York, N.Y.

42.4. J.W. Forrester, M.I.T., Cambridge, Mass.

SESSION XLVIII

Sponsored by the Professional Group on Instrumentation. To be published in Part 5 of the IRE Convention Record.

Instrumentation II

48.3. Extending the Versatility of a Laboratory Magnetic Tape Data-Storage Device

A.V. Gangnes, Ampex Corp., Redwood City, Calif.

The fields of research and development encompass a vast number of processes requiring many different methods of acquiring, storing, and evaluating test information. This paper des-

(continued on page 44)

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(continued from page 25)

series expansion, summing the terms until they become less than 10^{-8}.

Let (C01) = 1; (C02) = 10^{-8} and let x be available in Z01. Then the following sequence computes e^{-x} :

001	OVER	C01.0	000.00	Z02.0
002	OVER	C01.0	000.00	Z03.0
003	ZERO	Z04.0	000.0	000.0
004	MULT	Z02.0	Z01.0	Z02.0
005	ADDN	C01.0	Z04.0	Z04.0
006	DIVD	Z02.0	Z04.0	Z02.0
007	ADDN	Z03.0	Z02.0	Z03.0
008	KOMP	Z02.0	C02.0	Z05.0
009	TRNS	004.0	000.0	Z05.0

The answer is available in Z03.

It was seen how iterations on numbers in the electronic store are done with the help of the LOOP instruction. In such iterations the B counters are set and reduced automatically by the program. When it is desired to perform a sequence of iterations on DRUM positions this automatic control of the B counters is impossible and it is necessary to set and reduce them by explicit instructions. For example the instruction

BSET 000.5 011.0 000.0

puts the integer 11 in B line 5, the third address being a dummy.

BSET 000.5 000.0 X01.0

puts (X01) in B line 5, the second address being a dummy. Specifically it is the content of the exponent line only of X01 that is involved here. Any B line 2 to 6 inclusive, may be set by either of these two instructions and any store position (X, Y, Z or C) not B-modified, may be used in the third address of the second of these instructions.

To reduce the counters, the instruction

NEGB 000.5 001.0 000.0

subtracts 1 from (B5) and

NEGB 000.5 000.0 X01.0

subtracts the (exponent line of X01) from (B5).

If it is desired to add a number into a B line

INCB 000.5 001.0 000.0

adds the integer 1 into (B5).

Finally, it is sometimes convenient to store the contents of a B line. This may be done with

JOTB 000.5 000.0 X01.0

which stores (B5) in the exponent line of X01. Possible addresses for the last four instructions are as for the B-set instructions.

If more than five B lines are simultaneously required in a program, JOTB may be used to store, temporarily, the content of a B line until required. When needed, the B-line may be restored with a BSET instruction.

The basic instructions transfering data between the X or Y page and DRUM storage locations have been described. The following two examples illustrate the use of B instructions when modifying drum positions:

Write the X page on DRUM position {001 + (B4)} where B4 is to contain the integer n:

BSET	000.4	00n.0	000.0
WRTE	001.0	000.4	X00.0

There is one important restriction, namely, that the unmodified DRUM location and the modified DRUM location must both lie in the same half of the range. The two halves of the range are numbered 001, 002, ...032 and 033, 034...064 respectively.

If n is to take on the values 1, 2,...15, 16 in succession, these instructions should be embedded into a loop as follows:

001	BSET	000.4	000.0	000.0
002	LOOP	016.0	000.3	000.0
003	WRTE	001.0	000.4	X00.0
004	INCB	000.4	001.0	000.0
005	TRNS	003.0	000.3	000.0

In the last example, note that B3 is used to control the loop and B4 to control the progressive modification of the magnetic DRUM address. Note also that the run of DRUM positions lies entirely in the lower half of the range. Some further notes on DRUM selection are given in Section 3.62.

2.24 Miscellaneous Instructions

There remain to be described a number of instructions which perform miscellaneous operations.

PRNT 007.2 006.0 X01.0

causes the machine to output seven numbers, each with a six-digit mantissa, two numbers per paper line, from consecutive storage locations, beginning with (X01). The output may be "print" only, "punch", only (for later printing on a separate Teleprinter) or "print and punch", according to the setting of a 3-way switch on the console. Apart from the specifications in the PRNT instruction, the format of the printing is fixed, consisting of:

for each number {
- the mantissa (one digit before the decimal point and rounded-off)
- the mantissa's sign
- 1 space
- the exponent modulo 100 (two digits)
- the exponent's sign
- 2 spaces

Thus, in the above example, if

(X01) = + 0.01234567
(X02) = - 1.234567
(X03) = + 123.4567
(X04) = - 12345.67
(X05) = + 1234567.

(continued on page 36)

(X06) = - 123456789.
(X07) = + 12345678912.

the output will be printed as:

```
1.23457+  02-  1.23457-  00+
1.23457+  02+  1.23457-  04+
1.23457+  06+  1.23457-  08+
1.23457+  10+
```

An extra line feed terminates the PRNT instruction. A £ symbol and one other character associated with checking procedures, will terminate each printed line. All these should be ignored. See Section 3.65. Note that the last line need not contain a full complement of numbers.

In general, from 1 to 21 numbers (inclusive) may be output by one PRNT instruction, the number of digits per mantissa may be between 1 and 12 (inclusive), and the address of the first number may be any X, Y or Z position, not B-modified. The decimal point is always printed, even if only one digit it called for. The length of a paper line must be adjusted so that the total number of digits, signs, spaces etc. does not exceed 64. Since the format is fixed, this means that

$$(8+m)N \leq 64$$

where m is the number of digits per mantissa and N is the number of numbers per paper line. Some further facilities of the PRNT instruction are given in Sections 3.5, 3.66, and 3.67.

The instruction

VOID 000.0 000.0 000.0

inserts a dummy instruction into the program, and is obeyed without action.

Of the four letters used to designate the function of an instruction only the first is actually interpreted by the Transcode program. Therefore an unwanted instruction may be over-written on the tape by converting its first character to a V, but it should be noted that for sequencing purposes there is still an instruction present. In particular the tape representations for P and V are as shown in Fig. 2.1, so that a P may be

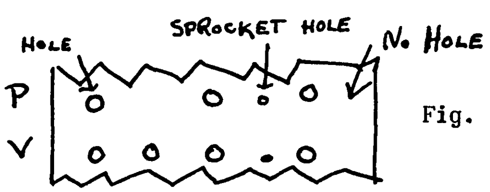


Fig. 2.1

changed to a V by inserting one additional hole. This makes it very convenient to use the PRNT instruction for printing out intermediate results during the stage of program development, and then to convert PRNT to VOID once the program is known to be correct.

As already explained, Transcode works by having its program read tape and replacing pseudo-instructions as it finds them by a corresponding sequence of instructions in real machine code. When the last pseudo-instruction has been read in there must be some way of indicating to the machine that it is now to make final preparations for obeying the program.* This is accomplished by the instruction

QUIT 000.0 000.0 000.0

which must be the last instruction in any set. Note that QUIT is never used for any other purpose than this.

The instruction

HALT 000.0 000.0 000.0

inserts a stop# into the program, and is generally used to terminate a piece of calculation.

In real FERUT code there are two stop instructions designated as /G and /L. The console has two switches corresponding to these instructions. If a /G (or /L) stop is encountered, and the /G (or /L) switch is on, the machine will come to a halt until instructed to go on by means of the console switch marked MANUAL PREPULSE. In normal running procedure, the /G is on, the /L off. It is also possible to program a dynamic stop by means of a short loop of instructions from which control can emerge only by manual intervention.

For calculations which proceed over a considerable time there is some danger that information on the electronic store will be lost. This danger can be lessened by inserting the instruction

COKE 000.0 000.0 000.0

at intervals corresponding to a calculating time of 5 to 10 minutes, causing certain constants, instructions etc. to be refreshed automatically from their more permanent form on the drum. The times for individual operations are listed in Appendix III.

Note that all three addresses in each of the four instructions VOID, QUIT, HALT and COKE are dummies. They need not necessarily be punched as zeros, provided that they look like permissible Transcode addresses. This allows any Transcode instruction to be converted into a VOID, as mentioned above.

The last instruction, FNTN, is a particularly important one, allowing simple utilization of Transcode library programs which have been written to carry out standard mathematical processes. Suppose, for example, that is necessary to evaluate the sine of an angle during a Transcode program. There is available a standard routine for this, and it may be assigned an arbitrary function number, say 001, for the problem in which it is to be used. During input, in the manner explained in Section 2.3, the library tape for TC:SIN will be read into the storage location reserved for the first function. The FNTN instruction must also specify, in addition to the function number, the addresses where the argument is to be found

(continued on page 44)

(continued from page 13)

oline! George! Rodney!" shouted the Doctor.

Doors flew open on all sides of the room, and four agitated young people hurried to the Doctor's side.

"Who has left the cards in alphabetical order?" thundered the Doctor, his mild blue eyes fairly flashing. "I ask you please to look --"

Four shocked young faces bent over the printed lines, and four trembling voices repeated them.

"Ve put the vocabularies in alphabetical order every few weeks for checking and replacing worn cards," explained the Doctor, mopping his brow. "My staff has the strictest orders to randomize them before returning them to the files. It ees routine. What has happened?"

"These must be the checking cards," said one of the girls -- Elizabeth, I think -- in a faint voice. "They must have been put in the file by mistake. I'll get you the right ones immediately -- I put them through the Randomizer myself. I'll have them here in two minutes."

While we were waiting for the correct cards, I asked Dr. Yaffee what the Randomizer was.

"The Randomizer, although only a by-product of the Poem-Writer, ees a most valuable adjunct." he said proudly. "It was built at a cost of half a million dollars, and has since proved useful in many other fields. Briefly, it accomplishes in a few seconds what it would take you many hours to do if you sat down in the middle of this room and tossed the cards about repeatedly. Furthermore, it puts the cards in random random order, rather than in ordered random order. I make myself clear?"

By the time the Doctor had made himself clear, Elizabeth returned, announcing that the checking cards had been removed from the card feed and the correct cards inserted. Once more, Willy pushed the "ON" switch, and we gathered breathlessly about the machine as the type bars started to move.

THE HOUR IS TWICE A CAT ON VELVET ROSE
WHO MELTS THE MOON UNTIL THE WILLOW SINGS
UNFOUND DELIGHT STANDS WHERE THE LANTERN GROWS
AND MEETS THE GLASSY SHORE ON DOWNCAST WINGS

"Holy -- jumping -- Moses," observed Willy.

THE WEARY NOMAD FRAMES HIS ROAD APART
REPELLED BY CAUTION ON THE SHATTERED BRINK
TO HER HE FLINGS HIS INCANDESCENT HEART
UNCERTAIN OF THE SNOW HE LONGS TO SINK

"Note the appearance of an obligatory word," the Doctor pointed out.

FORGOTTEN FEARS CREEP DOWN THE BROKEN WALL
DIM SHADOWS TWIST THE CONTOURS OF THE SEA
THE WIND REPEATS THE EARNEST SEAGULLS CALL
AND GIVES THE DREAMING RAIN THE MORNINGS KEY

The machine shuddered slightly and paused, as if gathering strength for the final assault.

AS ANXIOUS CANDLES FORGE A FLEETING CLUSTER
THE NUBILE MOTHS REVOLVE IN PRAISE OF BUSTER

"A very fair example," said the Doctor, tearing off the sheet and handing it to Willy. "A little polishing, perhaps -- but you have some fine lines there."

As I left to catch my commuters' train, Willy was murmuring the lines over to himself, a puzzled look in his eyes, but pride of authorship, I feel sure, dawning in the depths of his nubile incandescent heart.

- END -

----------*

EDITOR'S NOTES
(continued from page 4)

1. Copy should be typed in columns four inches wide with single spacing using a black ribbon on white paper. It is very desirable to have a carbon paper ribbon on the typewriter since that makes a great deal of difference in what the camera sees, and what the printed pages look like. It is also desirable of course that the typewriter have well-aligned keys.

2. We do not require exact right-hand justification of lines of typing: one or at most two characters over, and one, two, three, or four characters less are all satisfactory to us.

3. Any untypable information, such as mathematical formulas, should be entered with good handwriting using jet black ink, and mak-

(continued on page 42)

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 computers and associated equipment from the Official Gazette of the United States Patent Office, dates of issue as indicated. Each entry consists of: patent number/ inventor(s) / assignee / invention.

January 31, 1956: 2,733,004 / John E. Richardson, Pasadena, Calif. / - / An electrical computer for solving the equation $E_1 E_2 = E_3 E_4$ of which E_1, E_2, and E_4 have a predetermined amplitude.

2,733,008 / John B. D'Andrea and Herbert M. Heuver, Dayton, Ohio / - / A digital converter.

2,733,383 / George C. Wilson, Chatham, N. J. / - / An electrical time delay apparatus.

2,733,388 / Adolf W. Rechten and Brian M. Bellman, Taplow, Eng. / British Telecommunications Research, Ltd., Taplow, Eng. / A magnetic amplifier for effecting the momentary operation of an electromagnetic relay in response to an impulsive signal.

2,733,391 / Robert H. Mayer, Middle River, Md. / The Glenn L. Martin Co., Middle River, Md. / An integrator.

2,733,392 / Harold M. Wright, Troy, Ohio / -/ An apparatus for synchronizing a slave rotating element with a constant speed master rotating element at a predetermined angular displacement relative to the master element.

2,733,409 / Saul Kuchinsky, Philadelphia, Pa./ Burroughs Corp., Detroit, Mich. / A pulse code modulation system.

2,733, 410 / William M. Goodall, Oakhurst, N. J. / Bell Telephone Lab. Inc., New York, N. Y. / A pulse code modulation coder.

2,733,425 / Frederick Calland Williams, Timperley, Eng., and Gordon E. Thomas, Port Talbot, Wales / National Research Development Corp., London, Eng. / A servo control means for data storage device.

2,733,432 / Jack Breckman, Long Branch, N.J./ U.S.A. / A circuit for encoding a signal amplitude as a code group of digit signals in cyclic binary code.

February 7, 1956: 2,733,631 / Dan McLachlan, Jr., Salt Lake City, Utah / Research Corp., New York, N. Y. / An optical analog computer using projected light patterns.

2,733,862 / Hans P. Luhn, Armonk, N. Y. / International Business Machines Corp., New York, N. Y. / A binary decode counter.

2,734,160 / Clifford V. Franks, Cleveland, Ohio and Walter J. Brown, Titusville, Fla./ Walter J. Brown / An electrical system having a controllable converter supplying power to a load.

2,734,162 / Gordon C. Blanke, Sierre Madre, Calif. / Beckman Instruments Inc., South Pasadena, Calif. / A rectifying and voltage regulating circuit producing a voltage-controlled direct current output from a source of alternating current.

2,734,165 / Carroll W. Lufcy, Silver Spring and Albert E. Schmid, Jr., Greenbelt, Md., U.S.A. / A magnetic amplifier with half-wave phase reversal type output.

2,734,168 / Robert A. Zachary and John G. Schermerhorn, Syracuse, N. Y. / General Electric Co., N. Y. / A phase detector circuit responsive to the phase difference between two alternating voltages of the same frequency.

2,734,182 / Jan A. Rajchman, Princeton, N.J./ Radio Corp. of America, Del. / A magnetic matrix and computing device.

2,734,186 / Frederick C. Williams, Timperley, Eng. / National Research Development Corp., London, Eng. / A magnetic recording system for an electronic binary digital computing machine operating with serial mode pulse train signals.

2,734,187 / Jan A. Rajchman, Princeton, N.J./ Radio Corp. of America, Del. / A system for selectively driving to a desired magnetic condition one or more of a plurality of driven magnetic elements individually identifiable as corresponding to the elements of a matrix arranged in rows and columns.

February 14, 1956: 2,734,684 / Harold D. Ross, Jr., and Clarence E. Frizzell, Poughkeepsie, N. Y. / International Business Machines Corp., New York, N. Y. / An electronic counter made up of cascade connected bistable elements.

2,734,692 / Leland P. Robinson, Pasadena, Calif. / Electro Data Corp., Pasadena, Calif./ A tape storage device for data keeping equipment.

2,734,949 / Clifford E. Berry, Altadena, Calif. / Consolidated Engineering Corp., Pasadena, Calif. / A device for automatically and periodically correcting the zero drift in an amplifier.

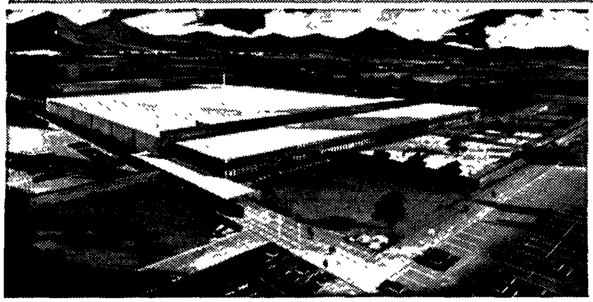
2,734,954 / Marshall C. Kidd, Haddon Heights, N. J. / Radio Corp. of America, Del. / A card switching device in a data storage device.

2,735,005 / Floyd G. Steele, Manhattan Beach, Calif. / Northrop Aircraft, Inc., Hawthorne, Calif. / A two-way binary counting circuit.

2,735,021 / Ole K. Nilssen, Collingswood, N. J. / Radio Corp. of America, Del. / A magnetic binary device.

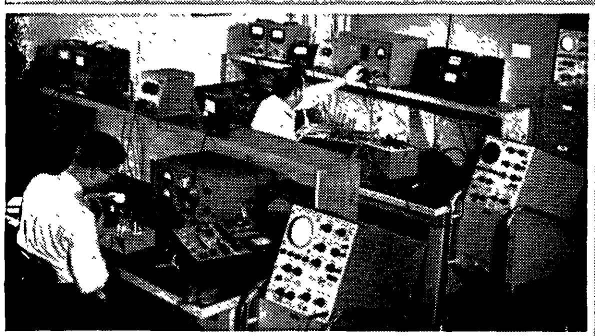
2,735,066 / John L. Coil, Richmond, and Rich-

AIRBORNE ELECTRONICS AND WEAPON CONTROL SYSTEMS



Denver manufacturing plant now under design

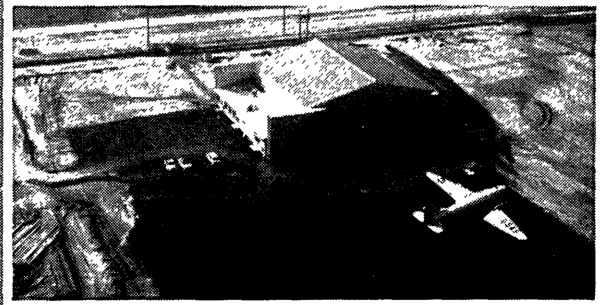
Infrared laboratory



Instrumentation laboratory

At Ramo-Wooldridge today there exists a wide range of projects intended to aid aircraft in navigating to the vicinity of targets, finding the targets, destroying them, and returning safely to base. Work is under way in such fields as infrared and microwave detection, information display, communication and navigation, and analog and digital computing. Some projects are in the laboratory development stage, some in the flight test stage, some in pilot production.

Good progress is being made in the establishment of facilities and operational patterns that are well tailored to the unique requirements of advanced electronic systems work.



Initial unit of flight test facility

Communications pilot line production

Simulators in computing center

Positions are available for scientists and engineers in these fields of current activity:

Communications Systems
Digital Computers and Control Systems
Airborne Electronic and Control Systems
Electronic Instrumentation and Test Equipment
Guided Missile Research and Development
Automation and Data Processing
Basic Electronic and Aeronautical Research

The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA ard Gundelfinger, San Pablo, Calif./Berkeley Scientific Corp., Richmond, Calif. / A counting-rate meter.

2,735,082 / Jacob Goldberg, Bonnar Cox, and James E. Heywood, Palo Alto, Calif. / - / A data sorting system.

February 21, 1956: 2,735,302 / Arnold T. Nordsieck, La Jolla, Calif. / - / A mechanical integrating device.

2,735,615 / Harvey O. Hoadley, Rochester, N.Y./ Eastman Kodak Co., Rochester, N. Y. / An electronic analog multiplier circuit.

2,735,616 / Harvey O. Hoadley, Rochester, N.Y./ Eastman Kodak Co., Rochester, N. Y. / An electronic multiplier circuit.

2,735,971 / Robert S. Raven, Catonsville, and Harry C. Moses, Baltimore, Md. / U.S.A. / A two speed control circuit for a servo system.

2,735,977 / William M. Webster, Jr., Princeton, N. J. / U.S.A. / An inverter circuit.

2,735,987 / James B. Camp, Fairfield and Coleman H. Watson, Birmingham, Ala. / U.S. Steel Corp., N. J. / A magnetic memory device.

2,736,007 / David E. Kenyon, Cold Spring Harbor, N. Y. / Sperry Rand Corp., Del. / A teledata system for conveying a plurality of intelligence signals to a remote point.

2,736,019 / Clyde E. Vogeley, Jr., and Theodore Miller, Pittsburgh, Pa. / U.S.A. / A phase-comparator tracking system.

2,736,021 / David E. Sunstein, Bala-Cynwyd, Pa./ Philco Corp., Philadelphia, Pa. / A signal integrating system.

February 28, 1956: 2,736,490 / John W. Schneider, Upper Darby, Pa. / - / A computing device for determining a ratio between two quantitative measurements.

2,736,770 / Joseph T. McNaney, San Diego, Calif./ General Dynamics Corp., Del. / A printer capable of responding to a source of input information comprising code and synchronizing signals.

2,736,801 / Clyde E. Wiegand, Oakland, and Owen Chamberlain, Berkeley, Calif. / U.S.A. / A distributed pulse height discriminator.

2,736,802 / Lawrence Cranberg, Los Alamos, New Mex. / U.S.A. / A pulse height analyzer system.

2,736,851 / Jean R. H. Dutilh, Paris, Fr. / - / An electromechanical phase-shifter in an angular position data transmission device.

2,736,852 / Eldred C. Nelson, Los Angeles, Calif. / - / An automatic digital motor control system for machine tools.

2,736,880 / Jay W. Forrester, Wellesley, Mass./ Research Corp., New York, N. Y. / A multicoordinate digital information storage device.

2,736,881 / Andrew Donald Booth, Fenny Compton, Eng. / The British Tabulating Machine Co., Ltd., London, Eng. / A data storage device with magneto-strictive read-out.

2,736,883 / Leonard Boddy, Ann Arbor, Mich. / King-Seeley Corp., Ann Arbor, Mich. / An integrating relay and signal mechanism.

2,736,889 / Harold R. Kaiser, Woodlands Hills, Claude A. Lane, Culver City, and Wilford S. Shockency, Torrence, Calif. / Hughes Aircraft Co., Del. / A high speed electronic digital-to-analogue converter system.

- END -

EDITOR'S NOTES

(continued from page 38)

ing sure that there are no faintly or partially written lines.

4. Any guide lines or other notations which are not to be photographed should be written lightly with a blue-writing mechanical pencil, because the camera regularly sees blue as white, and so does not photograph it.

5. If a small mistake is made, it can be erased, and typed over. If a large mistake is made, the correction can be typed on a separate piece of paper and cemented with rubber cement accurately over the mistake. What counts is what the camera sees. Rubber cement should be used not glue since rubber cement does not buckle the paper.

6. For removing unwanted black marks (such as a blot), a good grade of artist's poster white can be bought at an art store and painted on with a fine small paint brush. Painting white stuff over a mistake is excellent removal of it.

7. Small line drawings may be placed where they occur in the text. Other figures and illustrations should be furnished separately, with no colors except black, gray, and white, and with names like Figure 1, Figure 2, and so forth. The text should contain references to the figures using these designations, so that there is some leeway as to where the figures may be placed in the printed article. The separately furnished figures when printed may be full size or any size, not necessarily reduced 20%. For in photooffset printing, copy and illustrations can be stretched or shrunk as if they were on rubber sheets.

8. We shall of course inspect master copy that we receive and if necessary make other corrections. But since our style of type will often be different from the author's style of type, it will be a help if the author does as much as possible of his own correcting.

Publishing by photooffset is becoming steadily more important. More and more people are preparing their final drafts of anything in a form in which copies can be easily supplied to anybody for any purpose. The day will come I think when the normal way of typing anything will be in such a form that 1 to 5000 copies can be easily made from the first final typing.

- END -

PUBLICATIONS

P 34; LINEAR PROGRAMMING AND COMPUTERS. Reprint of two articles by Chandler Davis, in July and August 1955 "Computers and Automation". A clear, well-written introduction to linear programming, with emphasis on the ideas. $1.20

P 2D: THE COMPUTER DIRECTORY, 1955. 164 pages, 7500 Who's Who entries, 300 Organization entries, and 600 entries of Products and Services for Sale in the Computer Field; 250,000 words of condensed factual information about the computer field, June 1955 issue of "Computers and Automation." $4.00

P 32: SYMBOLIC LOGIC, by LEWIS CARROLL. Reprint of "Symbolic Logic, Part I, Elementary," 4th edition, 1897, 240 pages, by Lewis Carroll (C. L. Dodgson). Contains Lewis Carroll's inimitable and entertaining problems in symbolic logic, his method of solution (now partly out of date), and his sketches of Parts II and III, which he never wrote since he died in 1898. ....$2.50

P 25: NUMBLES -- NUMBER PUZZLES FOR NIMBLE MINDS. Report. Contains collection of puzzles like:

T R Y	H A V E	and T R A I N
+ T H E S E	F U N	your W I T S
= T W V A S	W A S E	E N T N S

WYE = VIF

In fact, you can also: 90893 85202 44393 29081 (Solve for the digits -- each letter stands for just one digit 0 to 9)
All are new numbles, additions, multiplications, etc.; some easy, some hard. Each with two messages, one open, one hidden. Hints for solution. Good exercises in logical reasoning. $1.00

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I.R.E.
(continued from page 32)
cribes a system philosophy of instrument development that provides a device of sufficient versatility that a large variety of these data-handling applications can be fulfilled by a single machine. Attention is given to various encoding methods available, variation in volume of information to be stored, and the need for acquiring and evaluating analog data on different time bases. Particular emphasis is placed on efficient use of equipment space, component environment, and standardization of components, inasmuch as these factors directly affect reliability, cost, and service ability.

———— - END - ————

TORONTO COMPUTER
(continued from page 36)
and the result stored. Thus the instruction

FNTN 001.0 X01.0 Y01.0

will place sin (X01) in Y01.

In general the second address can be any X, Y, Z or C address, B-modified except for the C case, and the third address can be any X, Y or Z address, B-modified. Function numbers may normally range from 001, 002,.. 015, but a larger number may be had by special arrangement with the operator. Chapter 5 of this manual includes a list of Transcode functions available in the library, with notes on their use. Functions of more than one argument can be accommodated, and even operations such as matrix inversion can be brought into the scheme. (See library descriptions).

The FNTN instruction can also be used to divide a long program into convenient segments. Thus, a programmer may construct his own FNTN's, as described below. In fact, whenever the total number of instructions in one set appreciably exceeds 100, the program should be segmented.

* During the tape read-in, Transcode addresses are replaced by machine code addresses. However, this cannot be done for control transfers to instructions yet to come and therefore a directory list of machine addresses is built up during the read-in. Part of the final preparations consists of using this list to fill in the actual addresses where necessary. In this connection it should be noted that provision is made for at most 64 forward control transfers, but this is not likely to be a restriction in any Transcode program.

///G in machine code. (continued on page 45)

Manuscript Notice (continued from page 31)
and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words.

Discussion. We desire to print in "Forum" brief discussions, arguments, announcements, news, letters, descriptions of remarkable new developments, etc., anything likely to be of substantial interest to computer people.

Payments. In many cases, we make small token payments for articles, papers, and fiction, if the author wishes to be paid. The rate is ordinarily ½¢ a word, the maximum is $20, and both depend on length in words, whether printed before, whether article or paper, etc.

- END -

THE COMPUTER DIRECTORY, 1956:

NOTICE

The June 1956 issue of "Computers and Automation" will be the second issue of "The Computer Directory". Last year we published the first issue, 164 pages. Our present plans for the June 1956 directory follow:

Part 1 of the directory in 1956 will be a cumulative "Roster of Organizations in the Computer Field" based on the last cumulative roster (published December 1955, containing about 330 entries) and brought up to date. Entries in this roster will be free. If you know of any changes, additions, or corrections which should be made in the entries, please tell us.

Part 2 of the directory will be the second edition of "The Computing Machinery Field: Products and Services for Sale." Over 600 entries on 21 pages appeared in the first edition in June 1955; a considerable increase is anticipated. The previous entries, and blank forms, were sent in February, to suppliers for review, checking, and additions. A nominal charge of $6.00 an entry is requested from each supplier in order to help defray the cost of preparing and printing the directory; but if the charge is not paid, the entry may still appear in condensed form, if desirable to make the listing complete.

Part 3 of the directory will be the third edition of the Who's Who in the Computer Field. In the June 1955 issue, about 7500 entries appeared on 96 pages; of these about 2600 were full entries, and the remainder were brief entries. Our present plans are to publish only new or revised Who's Who information in the June 1956 directory. Blank forms for new or revised entries were sent in March to all computer people we know of. A nominal charge of $2.00 an entry or other support of the Who's Who was requested from each person whose entry is printed, in order to help defray the cost of preparing and printing the Who's Who.

The main reason for the nominal charges mentioned above is that we look on the directory as a service to many people in the computer field; yet so far it has not paid for itself; and we need to make a compromise, publishing at least some information about everything that should appear in the directory, but fuller information for those who have shared directly in the cost.

(continued from page 44)

2.3 Tape Controls

In addition to the instructions, there is available in the Transcode system a set of TAPE CONTROLS which facilitates the inputting of instructions and data and organization of the program. When the computer is started by means of certain settings on the console hand switches, it proceeds to read tape until it encounters one of these TAPE CONTROLS, whereupon it takes the appropriate action. Blank tape has no effect and may precede any tape control. If any character other than a TAPE CONTROL or blank tape is encountered, a dynamic stop* will occur and tape input will cease. The following is a list of the TAPE CONTROLS and a description of their effects.

INST ooj

is for reading the program. It must be followed directly by j operational instructions of the type described above, the last one necessarily being QUIT 000.0 000.0 000.0. Instructions are read into the store consecutively in the same sequence as they are punched on the tape, the first instruction becoming 001, the second 002 etc. When it is required to make reference to any instruction the instruction number is specified and it is not necessary to know where the instruction is stored with reference to the "real" machine. Note that the instruction numbers and the decimal separator for the B-line are not punched.

```
CNST     pqq .. q±n±
         pqq .. q±n±
         pqq .. q±n±   ↩
```

reads in the set of constants, the first being C01, the second C02, etc. Assimilation by the program is automatic and takes place during translation. Note the termination by ↩ to indicate that the last constant has been read in. There can be at most 21 constants per program.

```
NUMB     pqq.....q±n±
         pqq.....q±n±

         pqq.....q±n±   ↩
```

reads in a page of 21 (or fewer) numbers to a standard electronic page. It should be followed immediately, except for spaces, by a DRUM tape control to store these numbers on the magnetic drum.

DRUM 00m

copies the set of numbers read in by the last NUMB tape control to magnetic drum position m.

FNTN 00f

copies a library function tape into the function location 00f of the magnetic store. Note that FNTN is both an instruction and a tape control. The reading-in of each function is terminated by a stop.* The tape control

STOP

causes the machine to stop reading tape**. It is used, for example, to terminate data when this is punched on a separate tape from the instructions.

ENTR

initiates the translation of instructions read in by the above tape controls and starts the calculation when translation is complete. A stop*** separates the translation from the calculation.

Often it is desired to perform a calculation by operating on a batch of data, outputting the results, reading in a new batch of data etc. This can be accomplished with the tape control

REEN (Reenter)

which starts the calculation from the point following the /L stop of ENTR. This assumes that translation of the instructions has taken place successfully and that the constants are present. If new constants are required, they should be read in and ENTR used. Note that when the calculation of the first batch of results is complete the machine will automatically proceed to hunt for Tape Controls provided the last instruction obeyed was QUIT. REEN can also be used to restart the calculation if a machine failure occurs, thus saving the time of retranslating, provided the failure has not altered the data or program as stored on the drum. Both ENTR and REEN include the effect of a COKE instruction, so that a COKE need not precede the QUIT when more tape is to be read in.

The last tape control, KOPY, is used to punch (and print also if desired) the translated instructions and assimilated constants in a form suitable for re-input by means of the FNTN and REEN tape controls. It may be used for preparing FNTN tapes or for obtaining the program in a form which can be input into the machine with the safeguard of check-sums and without translation. (See Section 3.4 headed "Write Taping".)

* DS/Q in machine code

** FF/G in machine code

*** I//G in machine code

**** $ $/L in machine code

CHAPTER 3. OPERATING NOTES

See the original manual.

TO BE CONTINUED

COMPUTERS AND AUTOMATION — Back Copies

REFERENCE INFORMATION: (with notes regarding latest issues containing same)

Organizations:
- Roster of Organizations in the Computer Field (Dec. 1955)
- Roster of Computing Services (Dec. 1955)
- Roster of Consulting Services (June 1955)

Computing Machinery and Automation:
- Types of Automatic Computing Machinery (Dec. 1955)
- List of Automatic Computers (Feb. and April 1955)
- Outstanding Examples of Automation (July 1954)
- Commercial Automatic Computers (Dec. 1954)
- Types of Components of Automatic Computing Machinery (March 1955)

Products and Services in the Computer Field:
- Products and Services for Sale (June 1955)
- Classes of Products and Services (April 1956)

Words and Terms:
- Glossary of Terms and Expressions in the Computer Field (Jan. 1956)

Information and Publications:
- Books and Other Publications (many issues)
- New Patents (nearly every issue)
- Roster of Magazines (Dec. 1955)
- Titles and Abstracts of Papers Given at Meetings (many issues)

People:
- Who's Who in the Computer Field (June and Sept. 1955)

June: THE COMPUTER DIRECTORY, 1955 (164 pages):
- Part 1: Who's Who in the Computer Field
- Part 2: Roster of Organizations in the Computer Field
- Part 3: The Computer Field: Products and Services for Sale

July: Mathematics, the Schools, and the Oracle — Alston S. Householder
- The Application of Automatic Computing Equipment to Savings Bank Operations — R. Hunt Brown
- The Book Reviewer -- Rose Orente
- Linear Programming and Computers, Part I — Chandler Davis

August: The Automation of Bank Check Processing — R. Hunt Brown
- Linear Programming and Computers, Part II — Chandler Davis
- Justifying the Use of an Automatic Computer -- Ned Chapin
- Charting on Automatic Data Processing Systems — Harry Eisenpress, James L. McPherson, and Julius Shiskin
- A Rotating Reading Head for Magnetic Tape and Wire -- National Bureau of Standards.
- Some Curiosities of Binary Arithmetic Useful in Testing Binary Computers — Andrew D. Booth

September: A Big Inventory Problem and the IBM 702 — Neil Macdonald
- Publications for Business on Automatic Computers: A Basic Listing — Ned Chapin
- Franchise -- Isaac Asimov
- Automatic Coding for Digital Computers — G. M. Hopper
- Automatic Programming: The A-2 Compiler System — Part 1

October: The Brain and Learned Behavior — Dr. Harry F. Harlow
- Automatic Programming: The A-2 Compiler System — Part 2
- Who Are Manning the New Computers? -- John M. Breen

November: Automatic Answering of Inquiries -- L. E. Griffith
- Found: A "Lost" Moon — Dr. Paul Herget
- Mister Andrew Lloyd -- R. W. Wallace

December: Digital Computers in Eastern Europe -- Alston S. Householder
- Automatic Airways -- Henry T. Simmons

January, 1956: Machines and Religion -- Elliot Gruenberg
- Automatic Coding Techniques for Business Data Processing: Directions of Development -- Charles W. Adams, Bruce Moncreiff
- What is a Computer? -- Neil D. Macdonald

February: The Function of Automatic Programming for Computers in Business Data Processing -- R. E. Rossheim
- Computers and Engineering Education — Paul E. Stanley
- The Planning Behind the IBM 702 Installation at Chrysler Corporation — Eugene Lindstrom

March: Organization of a Programming Library for a Digital Computer Center -- Werner L. Frank
- Growth of IBM Electronic Data-Processing Operations on the West Coast -- Neil D. Macdonald
- Translating Spoken English into Written Words -- E. C. Berkeley
- IBM Trust Suit Ended by Decree

April: Computing Machines and Automation -- A. V. Astin
- Tape Identification and Rerun Procedures for Tape Data Processing Systems -- L. Eallson

BACK COPIES: Price, if available, $1.25 each, except June, 1955, $4.00. Vol. 1, no. 1, Sept. 1951, to vol. 1, no. 3, July, 1952: out of print. Vol. 1, no. 4, Oct. 1952: in print. Vol. 2, no. 1, Jan. 1953, to vol. 2, no. 9, Dec. 1953: in print, except March, no. 2, May, no. 4, and July, no. 5. Vol. 3, no. 1, Jan. 1954, to vol. 3, no. 10, Dec. 1954: in print. Vol. 4, 1955, no. 1 to 12, in print.

A subscription (see rates on page 4) may be specified to begin with the current month's or the preceding month's issue.

WRITE TO:

Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
513 Avenue of the Americas
New York 11, N. Y.

ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
513 Ave. of the Americas, New York 11, N.Y.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles, papers, and reference information related to computing machinery, robots, automatic control, cybernetics, automation, etc. One important piece of reference information published is the "Roster of Organizations in the Field of Computers and Automation". The basic subscription rate is $5.50 a year in the United States. Single copies are $1.25, except June, 1955, "The Computer Directory" (164 pages, $4.00). For the titles of articles and papers in recent issues of the magazine, see the "Back Copies" page in this issue.

2. What is the circulation? The circulation includes 2000 subscribers (as of Feb.10): over 300 purchasers of individual back copies; and an estimated 2500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are people concerned with the field of computers and automation. These include a great number of people who will make recommendations to their organizations about purchasing computing machinery, similar machinery, and components, and whose decisions may involve very substantial figures. The print order for the May issue was 2700 copies. The overrun is largely held for eventual sale as back copies, and in the case of several issues the overrun has been exhausted through such sale.

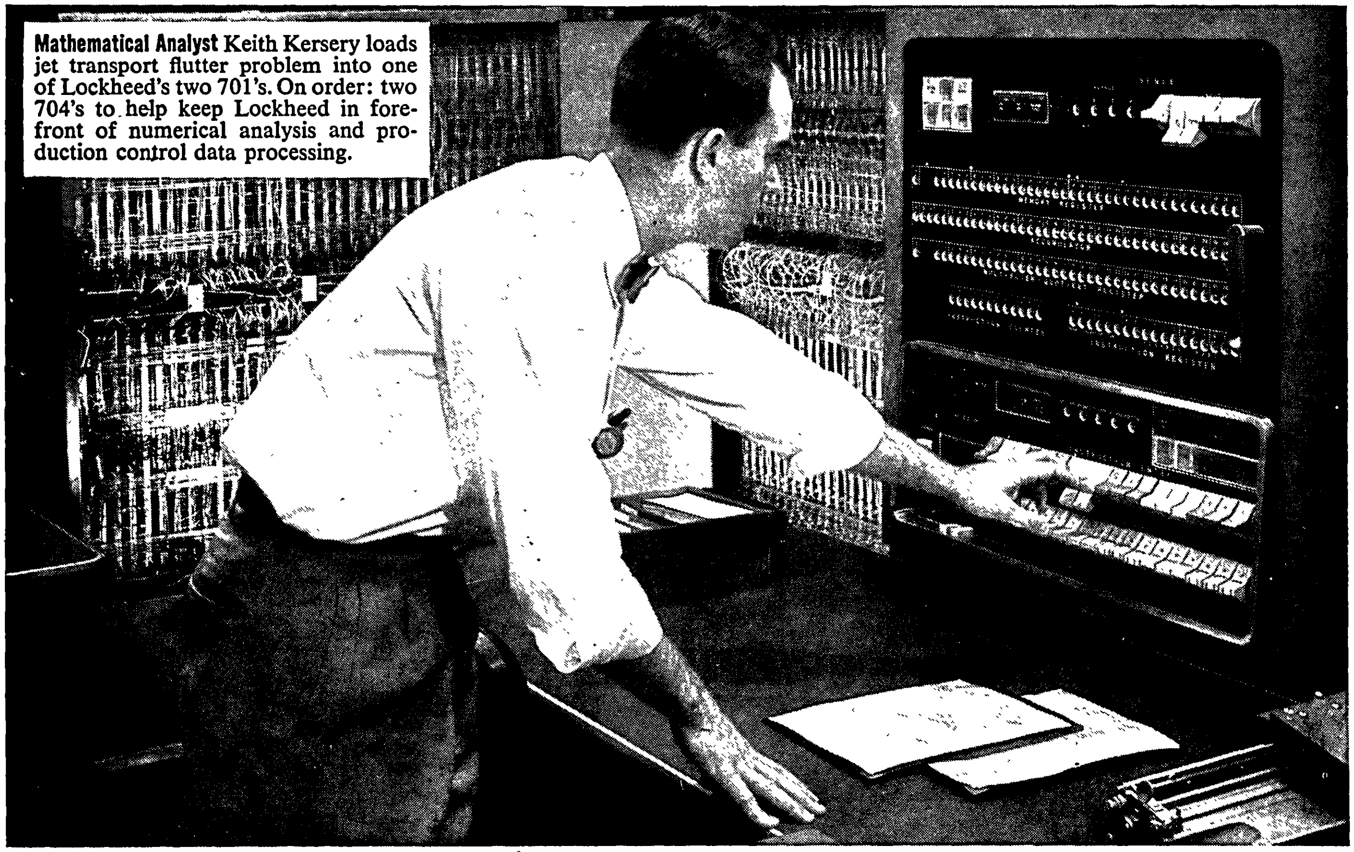
3. What type of advertising does COMPUTERS AND AUTOMATION take? The purpose of the magazine is to be factual and to the point. For this purpose the kind of advertising wanted is the kind that answers questions factually. We recommend for the audience that we reach, that advertising be factual, useful, interesting, understandable, and new from issue to issue. We reserve the right not to accept advertising that does not meet our standards.

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8½" x 11" (ad size, 7" x 10") and produced by photooffset, except that printed sheet advertising may be inserted and bound in with the magazine in most cases. The closing date for any issue is approximately the 10th of the month preceding. If possible, the company advertising should produce final copy. For photooffset, the copy should be exactly as desired, actual size, and assembled, and may include typing, writing, line drawing, printing, screened half tones, and any other copy that may be put under the photooffset camera without further preparation. Unscreened photographic prints and any other copy requiring additional preparation for photooffset should be furnished separately; it will be prepared, finished, and charged to the advertiser at small additional costs. In the case of printed inserts, a sufficient quantity for the issue should be shipped to our printer, address on request.

Display advertising is sold in units of a full page (ad size 7" x 10", basic rate, $190) two-thirds page (basic rate, $145), and half page (basic rate, $97); back cover, $370; inside front or back cover, $230. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $320; four-page printed insert (two sheets), $590. Classified advertising is sold by the word (60 cents a word) with a minimum of 20 words.

5. Who are our advertisers? Our advertisers in recent issues have included the following companies, among others:

Aircraft-Marine Products, Inc.
American Bosch Corp.
Ampex Corp.
Armour Research Foundation
Arnold Engineering Co.
Automatic Electric Co.
Bendix Aviation Corp.
Cambridge Thermionic Corp.
Epsco, Inc.
Ferranti Electric Co.
Ferroxcube Corp. of America
General Electric Co.
Hughes Research and Development Lab.
International Business Machines Corp.
Lockheed Aircraft Corp.
Lockheed Missile Systems
Logistics Research, Inc.
The Glenn L. Martin Co.
Monrobot Corp.
Norden-Ketay Corp.
Northrop Aircraft, Inc.
George A. Philbrick Researches, Inc.
Potter Instrument Co.
Ramo-Wooldridge Corp.
Reeves Instrument Co.
Remington Rand, Inc.
Republic Aviation Corp.
Sprague Electric Co.
Sylvania Electric Products, Inc.



Mathematical Analyst Keith Kersery loads jet transport flutter problem into one of Lockheed's two 701's. On order: two 704's to help keep Lockheed in forefront of numerical analysis and production control data processing.

704's and 701's speed Lockheed research in numerical analysis

With two 701 digital computers already in operation, Lockheed has ordered two 704's to permit greater application of numerical analysis to complex aeronautical problems now being approached. Scheduled for delivery early next year, the 704's will replace the 701's.

Much of the work scheduled or in progress is classified. However, two significant features are significant to career-minded Mathematical Analysts: 1) the wide variety of assignments created by Lockheed's diversified development program and 2) the advanced nature of the work, which falls largely into unexplored areas of numerical analysis.

Career positions for Mathematical Analysts

Lockheed's expanding development program in nuclear energy, turbo-prop and jet transports, radar search planes, extremely high-speed aircraft and other classified projects has created a number of openings for Mathematical Analysts to work on the 704's.

Lockheed offers you attractive salaries, generous travel and moving allowances which enable you and your family to move to Southern California at virtually no expense; and an extremely wide range of employe benefits which add approximately 14% to each engineer's salary in the form of insurance, retirement pension, etc.

Those interested in advanced work in this field are invited to write E. W. Des Lauriers, Dept. MA-31-5.

LOCKHEED AIRCRAFT CORPORATION • CALIFORNIA DIVISION

BURBANK **CALIFORNIA**

ADVERTISING INDEX

The purpose of COMPUTERS AND AUTOMATION is to be factual, useful, and understandable. For this purpose, the kind of advertising we desire to publish is the kind that answers questions, such as: What are your products? What are your services? And for each product, What is it called? What does it do? How well does it work? What are its main specifications?

Following is the index and a summary of advertisements. Each item contains: Name and address of the advertiser / subject of the advertisement / page number where it appears / CA number in case of inquiry (see note below).

READER'S INQUIRY

If you wish more information about any products or services mentioned in one or more of these advertisements, you may circle the appropriate CA Nos. on the Reader's Inquiry Form below and send that form to us (we pay postage; see the instructions). We shall then forward your inquiries, and you will hear from the advertisers direct. If you do not wish to tear the magazine, just drop us a line on a postcard.

READER'S INQUIRY FORM

Paste label on envelope: ↓

Enclose form in envelope: ↓

BUSINESS REPLY LABEL

NO POSTAGE STAMP NECESSARY IF MAILED IN

4¢ Postage Will Be Paid By --

BERKELEY ENTERPRISES, INC.

513 Ave. of the Americas

New York 11, N. Y.

FIRST CLASS
PERMIT NO 1680
Sec. 34.9, P. L. & R.
NEW YORK, N. Y.

READER'S INQUIRY FORM

Name (please print) ....

Your Address? ....

Your Organization? ....

Its Address? ....

Your Title? ....

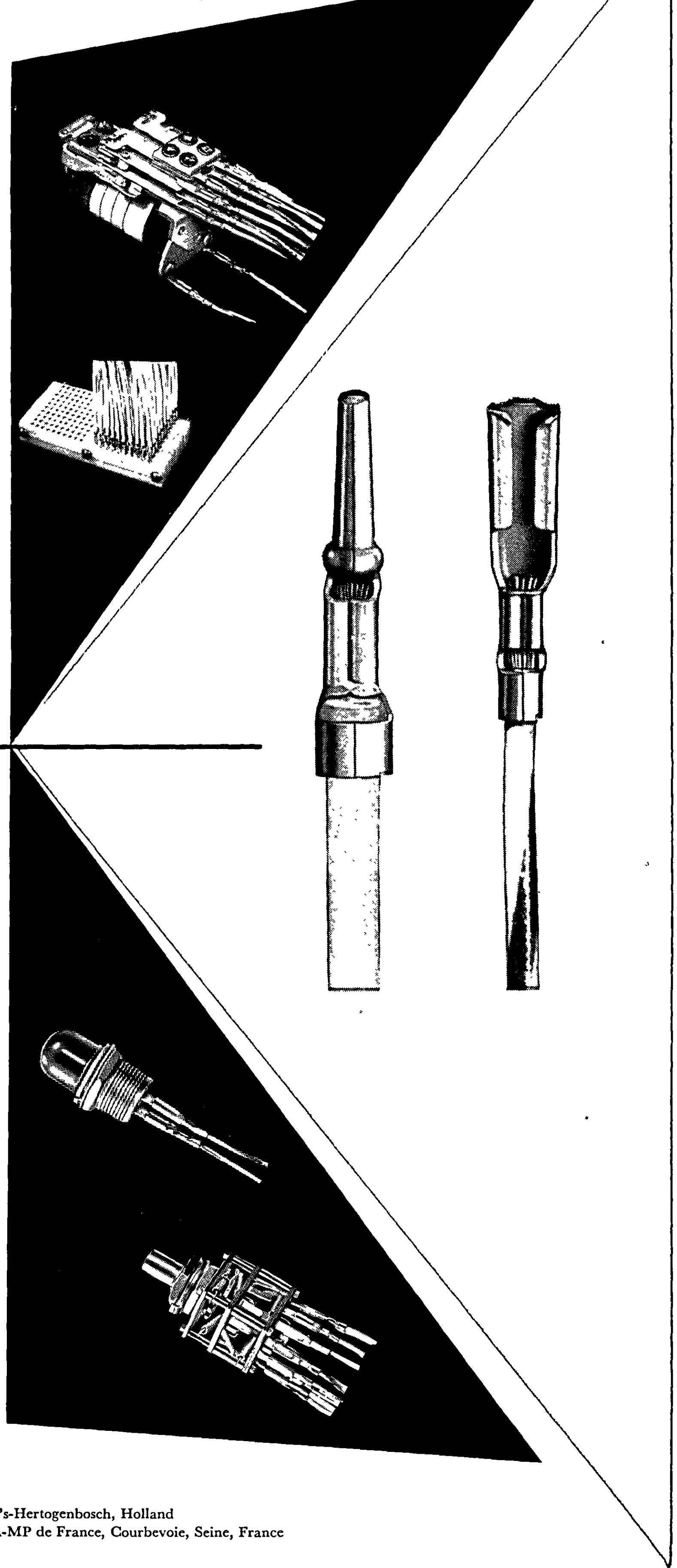
Please send me additional information on the following subjects for which I have circled the CA number:

1 2 3 4 5	26 27 28 29 30	51 52 53 54 55	76 77 78 79 80	101 102 103 104 105	126 127 128 129 130
6 7 8 9 10	31 32 33 34 35	56 57 58 59 60	81 82 83 84 85	106 107 108 109 110	131 132 133 134 135
11 12 13 14 15	36 37 38 39 40	61 62 63 64 65	86 87 88 89 90	111 112 113 114 115	136 137 138 139 140
16 17 18 19 20	41 42 43 44 45	66 67 68 69 70	91 92 93 94 95	116 117 118 119 120	141 142 143 144 145
21 22 23 24 25	46 47 48 49 50	71 72 73 74 75	96 97 98 99 100	121 122 123 124 125	146 147 148 149 150

REMARKS:

ask about Amp's Creative Approach TO BETTER WIRING

More Confidence.... Less Expense with A-MP Taper Technique



A-MP Taper Pins, Taper Bloks, Taper Tips, Taper Tabs and Taper Tab Receptacles offer great freedom of circuit design and insure maximum electrical stability.

They cut material cost . . . cut labor cost . . . and reduce assembly time. Taper Technique is benefiting manufacturers of business machines, aircraft, guided missiles and electronic equipment.

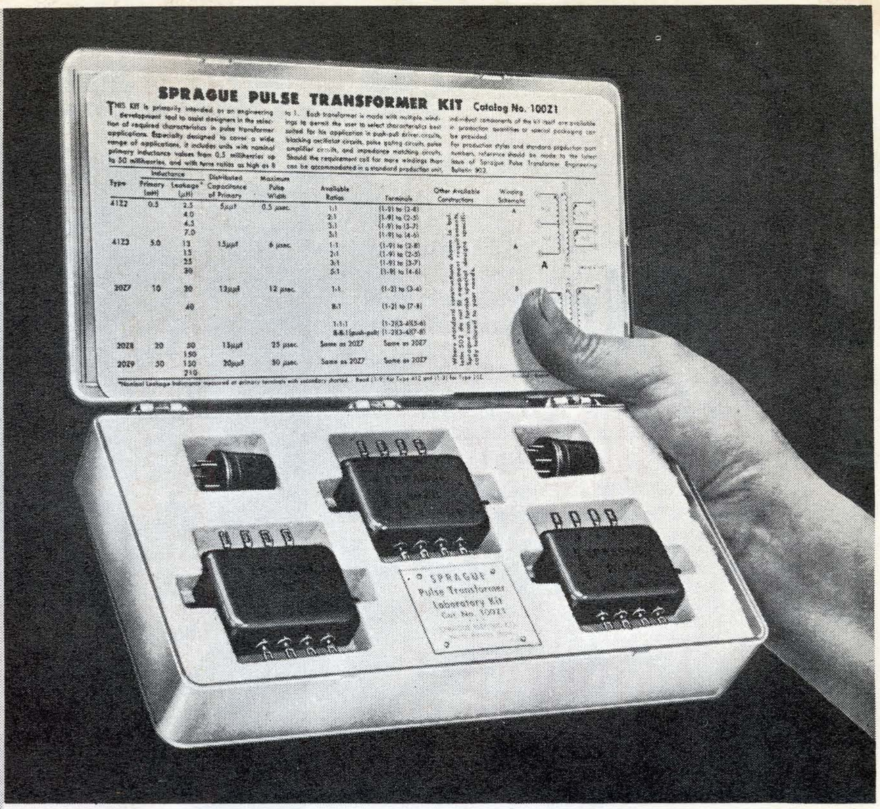
You, too, can benefit by the A-MP Taper Technique. Consult your local A-MP salesman or write to Harrisburg.

A-MP

Aircraft-Marine Products, Inc.
General Office: Harrisburg, Pa.

A-MP of Canada, Ltd., Toronto, Canada • A-MP—Holland N.V., 's-Hertogenbosch, Holland
Aircraft-Marine Products (G.B.) Ltd., London, England • Societe A-MP de France, Courbevoie, Seine, France

Sprague Pulse Transformer Kit Simplifies Circuit Design



HERE'S THE IDEAL TOOL FOR ENGINEERING DEVELOPMENT OF CIRCUITS USING PULSE TRANSFORMERS

Sprague's new Type 100Z1 Pulse Transformer Kit contains five multiple winding transformers, each chosen for its wide range of practical application.

Complete technical data on each of the transformers is included in the instruction card in each kit so that the circuit designer may readily select the required windings to give transformer characteristics best suited for his applications . . . whether it be push-pull driver, blocking oscillator, pulse gating, pulse amplifier, or impedance matching. The electrical characteristics of the transformers in the kit have been designed so that they may be matched by standard Sprague subminiature hermetically-sealed pulse transformers shown in engineering bulletin 502B.

For complete information on this kit, as well as the extensive line of Sprague pulse transformers, write to the Technical Literature Section, Sprague Electric Company, 377 Marshall Street, North Adams, Massachusetts.

CHARACTERISTICS OF KIT TRANSFORMERS

Type	Induct. Pri. (μH)	Induct. Leakage (μH)	Dist. Cap. of Pri. (μμF)	Max. Nom. P.W. Range (μsec)	Avail. Ratios
41Z2	0.5	2.5 4.0 4.5 7.0	5	0.5	1:1 2:1 3:1 5:1
41Z3	5.0	13 15 25 30	15	6	1:1 2:1 3:1 5:1
20Z7	10	20 40	12	12	1:1 8:1 1:1:1 8:8:1
20Z8	20	50 150	15	25	same as 20Z7
20Z9	50	150 210	20	50	same as 20Z7

Sprague on request will provide you with complete application engineering service for optimum results in the use of pulse transformers.

SPRAGUE® *the mark of reliability*

Export for the Americas: Sprague Electric International Ltd., North Adams, Massachusetts. CABLE: SPREXINT.