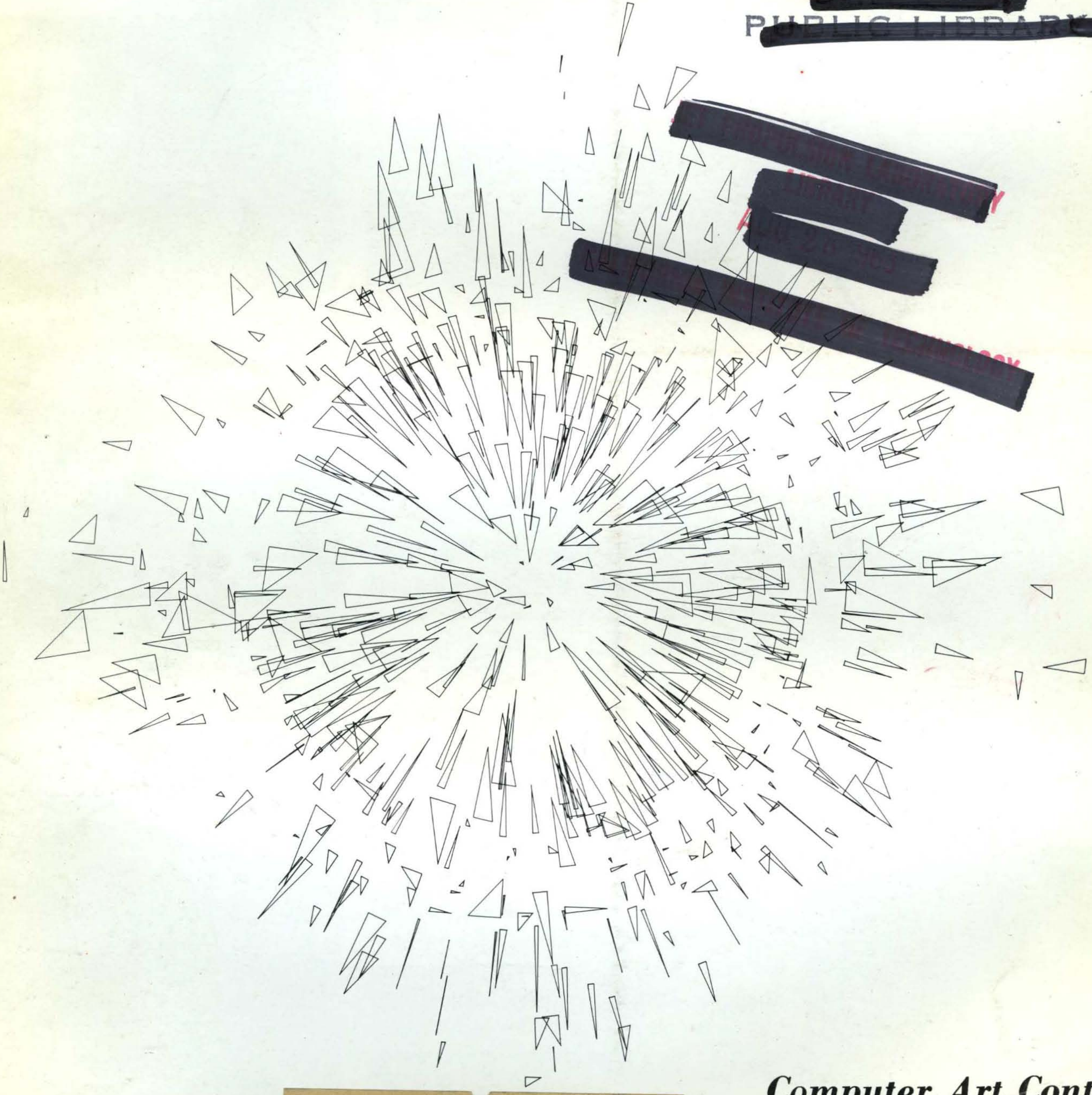
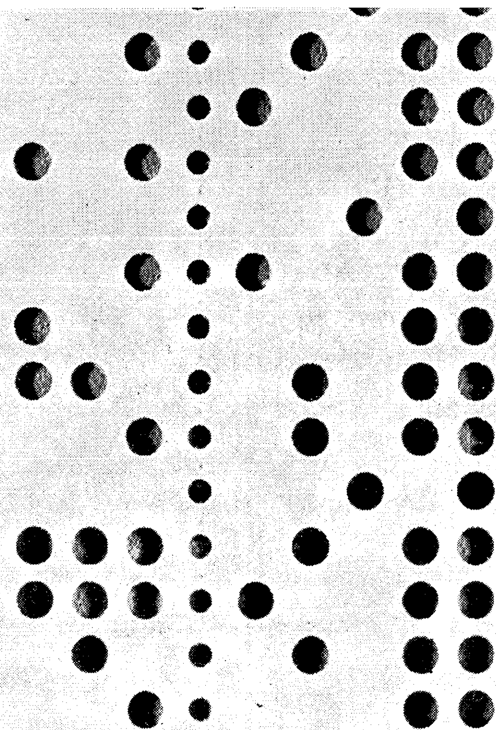
August, 1963

computers and automation



Computer Art Contest First Prize



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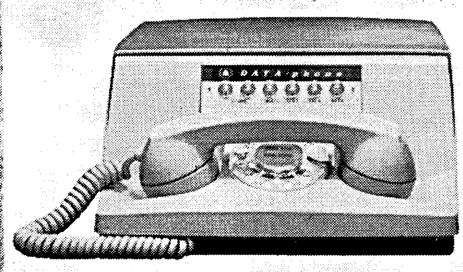

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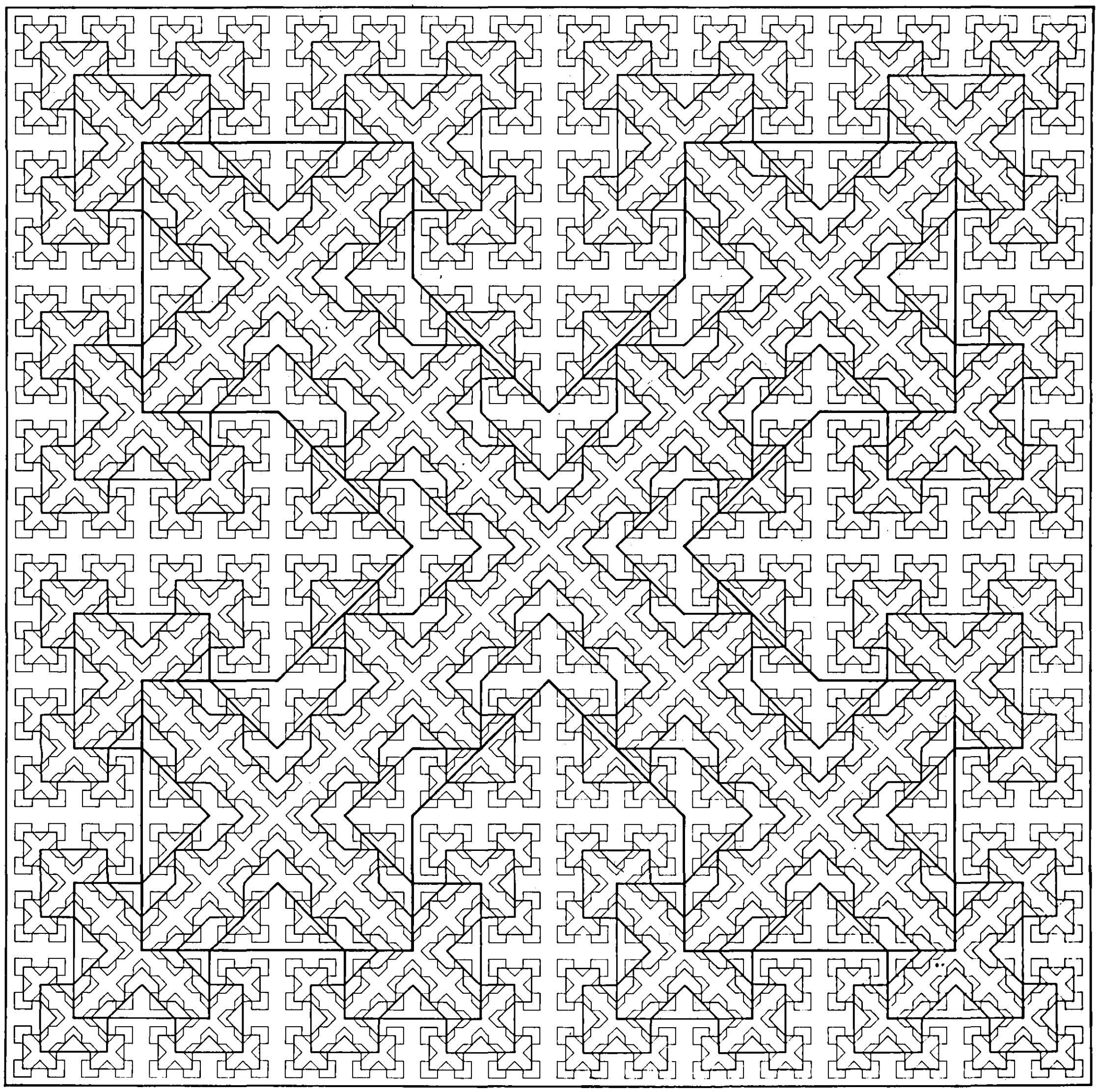


c & a EDITORIAL

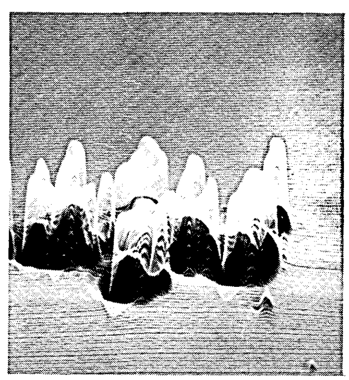
The Computer and Art

The cover photograph on our January 1963 issue (see the small inset picture) was an example of an artistic design produced by an automatic computer. This set us thinking. So in February we announced a "Computer Art Contest," an informal contest for examples of visual creativity in which a computer plays a dominant role; our August issue was to announce the results.

The first prize goes to the art on our front cover for this issue: a "Splatter Pattern" produced as a plot of the radial and tangential distortion of a camera lens. It is a valid plot of an actual computer-found solution, graphed automatically by a DATAPLOTTER made by Electronic Associates, Inc., Long Branch, N. J.

The second prize, "Stained Glass Window," shown above, was produced on the same plotter by programming a digital computer to solve an area-filling equation; the line widths in the plot were varied by using different ruling pens.

The editors of **Computers and Automation**, though without professional qualifications in the field of art, have agreed that these two designs are beautiful, and should be published. And we hope that the next Computer Art Contest which we shall run will call forth more such computer



art, unusual, creative, beautiful. We invite our readers to submit work or ideas which they or their associates have produced in this area of computer art.

Edmund C. Berkeley

EDITOR

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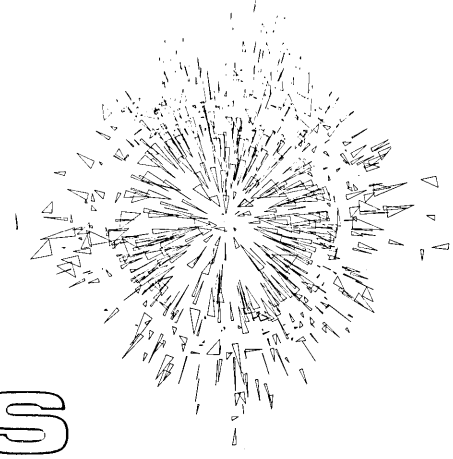
First prize in our Computer Art Contest for the front cover of the August issue goes to the "Splatter Diagram" produced by a computer-directed plotter. More on this subject is on page 3.



computers and automation

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In This Issue

In Every Issue

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c & a
READERS' & EDITOR'S FORUM

INTERNAL REVENUE SERVICE APPROVES TAX DEDUCTION FOR EDUCATION EXPENSE IN STRIVING TO KEEP UP WITH TECHNOLOGICAL CHANGE

Mrs. Helen Solem
Hillsboro, Oregon

From the District Director of Internal Revenue came this unpretentious but momentous notice recently:

> Our recent examination of your tax liability for the year indicated discloses that no change is necessary to the tax reported. Accordingly, the return will be accepted as filed.

Thus culminated seven long months of argument.

The question was:

> When Is Education Expense a Legitimate Tax Deduction?

I felt certain that education expense incurred in striving to keep pace with technological changes in data processing would qualify for tax exemption under Internal Revenue Code 11,501, Regulation 1.162.5 (a):

> An individual's expenses for education are deductible if primarily undertaken for maintaining or improving skills required in his trade or business or employment, or to meet the express requirements of his employer or the requirements of applicable law or regulations imposed as a condition for his retention of his salary, status or employment.

And I accordingly regarded my education expense as a legitimate tax deduction.

The IRS auditor examining my return denied the deduction and billed me for an additional $86 under IRS regulations:

> 27—The cost of education required of a taxpayer in order to meet minimum requirements for qualification or establishment in his intended trade, business, or specialty is not deductible because it is personal in nature; and
>
> 28—The cost of education undertaken primarily for personal purposes or for fulfilling general education aspirations is not deductible expense.

To me it was plain the Internal Revenue people in the Northwest, perhaps even across the nation, did not fully comprehend the impact of computers on data processing methods today. It seemed to me a very important task to explain this clearly and point out some of the significant implications for society.

When a RAMAC 305 and an IBM 1401 computer system are ordered and then installed so as to turn out payrolls, update inventory records, do forecasting, prepare sales analyses and other such reports—more efficiently and more economically than are being turned out using standard punch card machine methods, more education is often required in order for the people involved to stay employed on that work.

This fact took a long time sinking in for many tabulating machine operators. Some of them resisted the changes with all their strength. In the beginning of using computers there were many examples of human error and the resulting machine "garbage" that they pointed to in ridicule. More than one large firm in the Northwest gave up their computer investment and simply wrote it off as a very costly mistake.[1] However, more and more frequently the word spread around at management conferences and in journals of the singular, spectacular cost-cutting possible as the enlightened, pioneering managers persisted and sought diligently for better trained people.

Though all of this seemed obvious, it was not obvious to a good many people who should have been more knowledgeable on the subject. When my tax deduction was first disallowed, I consulted some friends in the tax counselling world. They sincerely advised me to accept the auditor's findings. I became more convinced than ever that the very people who should be guiding the thinking and the economic progress of the Northwest were unaware of some of the fundamental changes occurring in society.[2]

Continual education is one of the most desperate needs in the whole field of technology today. Automation is already a tremendously big field and is ever changing, advancing. For most of us formal education in subjects such as mathematics, economics, statistics, English composition is necessary in order to keep in step.

There are relatively few organized training centers. For the majority of us further education will depend on individual initiative. Moreover, technical training is only a part of becoming fully competent. In order to turn out professional work professional training is required. Such attributes as learning to critically evaluate the problem at hand, or to put in writing ideas and instructions in order to communicate, must be acquired. Even the gradual developing of the person by the discipline higher education generates must be acquired. These are all necessary in order to solve the technical problems of today—in order to put the machines to work and to upgrade people.

It is good to have concrete recognition of this fact at last from the Internal Revenue Service.

1. See **Computers and Automation**, May, 1961, "Bugs in Automation."
2. I am indebted to the accountants of Pattullo & Gleason, Tax Counsellors, for the reference material they provided and the use of their fine library.

c & a

EDITOR'S SCRATCHPAD

The next time you meet an old acquaintance who greets you with a "So what's doing in your field?", be prepared. There is no need for a desperate random search of memory in the hope of retrieving something impressive. Listed below are a string of current facts about the computer field designed to raise the eyebrows of even as skeptical a person as your Aunt Tilly (who always said you and your computers would never amount to anything). These bit-size nuggets of computerology were compiled by the Public Information Office of the American Federation of Information Processing Societies, and include:

There are 12,000 machines of all sizes in the United States, and installations are increasing by approximately 500 per month.

90% of all the computers in the world are in the United States.

95% of all the computing power in the world is in the United States.

The total power in the United States is equal to the ability to perform 110,000,000 additions every second.

Today's price for execution of a computer operation is roughly 1,000,000 additions per dollar.

By 1967 the price for computer operations should be reduced to 10,000,000 additions per dollar.

Computers range in price from $18,000 to more than $2,000,000.

They can be rented for from $600 per month to $60,000 per month.

Current large machines cost about 10¢ per second.

The industry employs more than 1,000,000 people. It has created wholly new skills, professions, and technologies.

The computer industry is making equipment deliveries of approximately $1.5 billion a year.

Equipment deliveries are expected to reach $5.5 billion in 1970.

The computer industry is growing twice as fast as the electronic industry as a whole.

Third-generation computers will cost 2.5 times more than current equipment but will operate 10 times faster.

There are more than 20 companies manufacturing electronic computers; more than 200 companies are making peripheral and accessory equipment.

The total rental of current machine installations is in the area of $75 million per month.

* * * * *

We are wondering where UOALPASKB (the Use of Outlandish Acronyms to Label Projects and Activities by those who Should Know Better) will end. In fact, a computer engineer friend of ours told us recently that at his company one of the time factors governing the development of new R&D proposals for the government was HFSCDUIAP (How Fast Someone Could Dream Up an Interesting Acronym for the Project).

Some of the jaw-breaking examples of UOALPASKB we have noted recently are SICODCPT (Special Interest Committee on Digital Computer Programmer Training), and ICIREPAT International Committee on Information Retrieval for Experts in Patent Office Techniques).

Really, isn't the computer field beset with enough language problems without artifically creating more? By the time the meanings of ordinary English words in the computer field are stabilized and standardized, we shall find that there are hundreds of weird and unpronounceable acronyms to deal with.

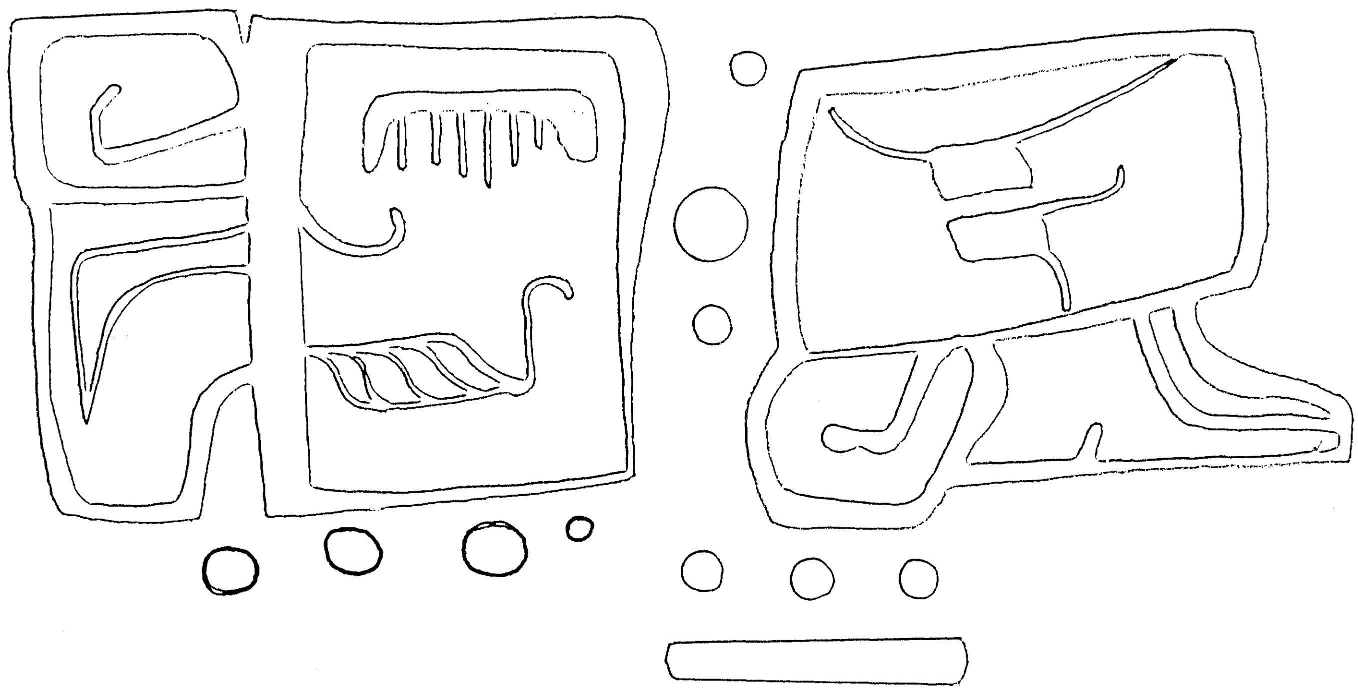
We think it is time for a counter-attack. We are hoping to form a LSOAOFL (Let's Stamp Out Acronyms Over Five Letters) Club. Readers sympathetic with this endeavor should submit their names (no initials!, please) to LSOAOFL Club, c/o Computers and Automation, 815 Washington Street, Newtonville 60, Mass.

* * * * *

MARKET TIP: LOOK FOR a large increase in the number of computers in the defense installations. Estimates recently have been revised upward to approximately 1075 computers in defense installations by the middle of 1964. Previous estimates for 1963 indicated 775 computers in use in such applications by mid-July. Currently there are over 825.

Over-all defense expenditures for computers and punched card installations, including supporting personnel and contractual services is expected to exceed $515 million in fiscal year 1964.

Conducted by Leichtlicht Schreibfeder



Three Siberian computer scientists—Edward Evreinov, Yuri Kosarev, and Valentin Ustinov—have largely deciphered hitherto unread manuscripts of ancient Maya. They achieved this using 100 hours on an electronic computer.

The Data

In the jungle of Yucatan are ruined cities, towers, temples, palaces, ancient pyramids and steles, covered with sculptured images and written characters; they were discovered in the 19th century. Somewhat later there was found the "Relacion de las Cosas de Yucatan" ("Report on the Affairs in the Yucatan") by Diego de Landa, a Spanish missionary, which had lain for 300 years on the shelves of the Royal Library in Madrid. The manuscript spoke about the Maya people who had built cities in the Yucatan, and reproduced similar strange written characters. Manuscripts with writings and characters that strikingly resembled these were also found in the museums of Dresden, Madrid, and Paris.

For unlocking the riddle of the Maya writing, there were in addition the "Chilam-Balam" volumes of historico-mythological, calendar and astrological content, written during the period of colonialism in the language of Maya, but in the Spanish alphabet. Also, there was the Coronel grammar of 1620, one of the earliest Maya grammars; and several lexicons compiled by Spanish missionary-monks, including the most authentic of these, the so-called "Motul Lexicon."

The first researchers among the mysterious Maya manuscripts—Brasseur de Bourbourg, Cyrus Thomas, B. L. Whorf, and others—sought to read the manuscripts using the "Landa Alphabet." Landa's "Relacion de las Cosas de Yucatan" gave much information about the Maya culture, and the alphabet he suggested contained 27 hieroglyphs. Moreover, he gave the hieroglyphs denoting the names of the 20 days of the month and of the 18 months of the Maya calendar.

Using Landa's information, researchers after many years came to understand the Maya calendar and their astronomical tables. Cyrus Thomas succeeded in deciphering three words. But when these researchers tackled the task of deciphering the manuscripts, they found 300-odd hieroglyphs. In addition to the hieroglyphs of the "Landa Alphabet," some hieroglyphs of the manuscripts were definitely ideographic, that is, they conveyed whole ideas, in the same way as "÷" meaning "divided by" is an ideogram.

These researchers pored over the available information about the Maya language, but attempts to decipher a more or less coherent portion of the manuscripts remained unsuccessful. In 1945, in fact, one investigator, Paul Schellhas, who had devoted nearly all his life to the decipherment of the Maya writing, declared: "The manuscripts do not make sense. They will never be deciphered. Never. . . ."

Another Attempt

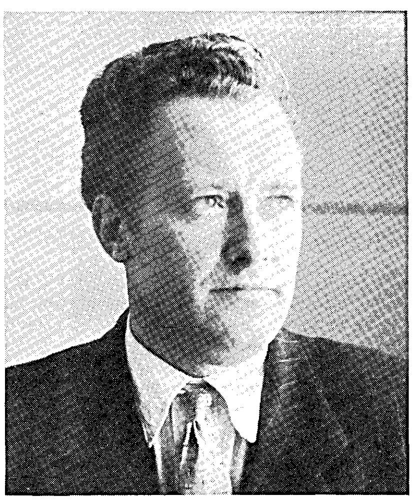
Before graduating from Moscow University, Valentin Ustinov had specialized in the history of Ancient Greece. A specialist in computing technique, Yuri Kosarev is an alumnus of the Kiev University. Edward Evreinov graduated from the Department of Automation and Remote Control of the Institute of Railway Engineers. When certain leading Soviet scientists moved to Siberia, these young men went with them, and the three found themselves at the Institute of Mathematics of the Siberian Branch of the USSR Academy of Sciences in Novosibirsk.

In April 1960 in Moscow, a group of people gathered in the study of

DECIPHERING ANCIENT MAYA WRITING
With Aid from a Computer

Nicolai Meisak
Novosty Press Agency
Moscow, U.S.S.R.

A report on the multiple-pronged, computer-based effort to determine the meaning of ancient Maya writing, carried out by three Soviet scientists in Novosibirsk.



Valentin Ustinov

Academician Sobolev, who at that time still headed the Chair of Computational Mathematics of the Moscow University; there the idea was ardently advocated that it was high time to make the electronic computer the tool of the historian and the linguist. Evreinov suggested that an attempt be made to decipher the Maya manuscripts by means of the electronic computer. Sobolev agreed.

Puzzle

Even the most complicated crossword puzzle is child's play compared with the job that confronted the three new researchers on the Maya writings.

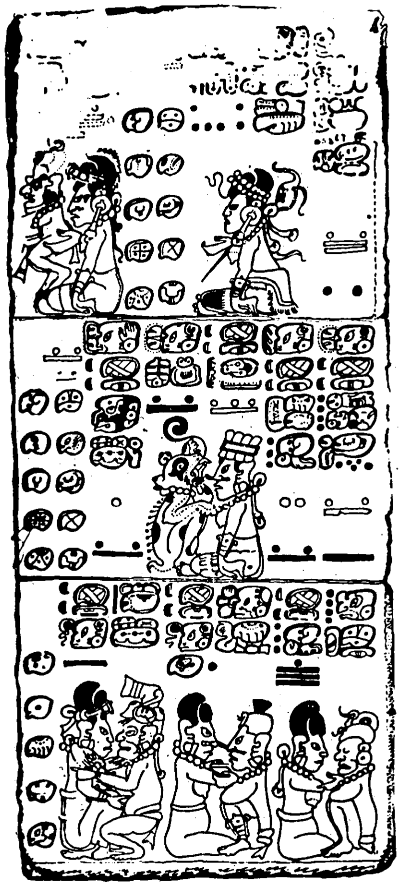
Evreinov, Kosarev and Ustinov began to prepare the "machine stage." They went carefully through the material left by their predecessors—a veritable mountain of volumes: The catalogues of Maya characters compiled by Heitz and Zimmermann, the information on Maya deities, the important work by Eric Thompson, the work of A. Tozzer and Allen, who studied the Maya language and explained the drawings of plants and animals found in the manuscripts,

Edward Evreinov

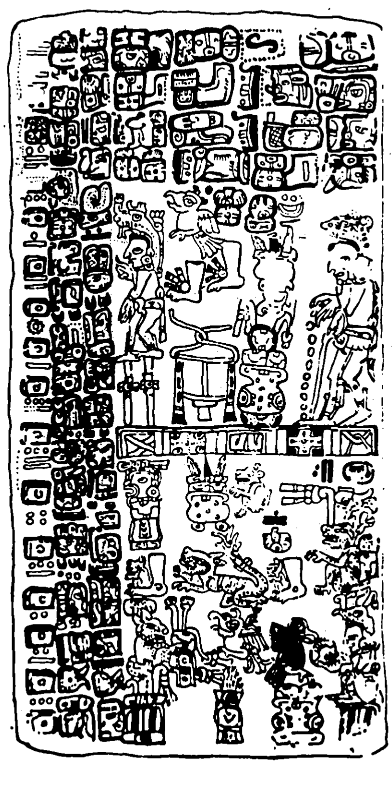
Yuri Kosarev

treatises on the Maya calendar, astronomy and mathematics, the "Grammar of the Maya Language," various lexicons. And, finally, the works of a Soviet researcher, Yuri Knorozov, who gave assistance to the Siberian scientists in the early stage of their studies.

Proceeding through the work of their precursors, the Siberians developed their own method of search. It seemed that those who preceded them had attacked the problem from some particular side, but from *one* side only. Evreinov, Kosarev and Ustinov decided to attack it from all sides at



A page from the Dresden manuscript



A page from the Madrid manuscript

once, using the computer. They studied the drawings, the elements thereof, calendar dates, the hieroglyphic characters, their combinations; they compiled many auxiliary lexicons, indices, manuals. They systematized the gigantic mound of information, and repeatedly checked and re-checked.

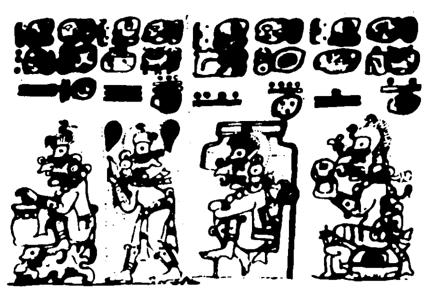
Three Stages

They divided the work into the following three stages:

1. *Manuscript analysis.* They sought to establish as fully as possible the relationships existing in the manuscripts, the statistical characteristics of individual elements of the manuscripts, how the characters, drawings and dates combined with each other, the logical connections between the elements of the manuscripts. Finally, on this basis, they assigned a formal (i.e., not involving semantics) characteristic for each hieroglyph.

2. *Analysis of the Maya language.* They analyzed the Maya language on the basis of the sources of the period of the Spanish conquest. They sought to determine its basic statistical relationships, to establish how often this or that particular letter, word, syllable, or other element occurred, how separate elements of the language combined with each other, the character of the sentence structure, the word order, etc. In this way they obtained formal characteristics for each element of the Maya language from the sources of the period of the Spanish conquest.

D 34 c - 35 c



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4) +10 XI - 10		5) +15 XIII - 5		6) +9 IX - 14		7) +11 VII - 5	

4) u mach Chac ox Can ti mac

5) u mach Chac baac zijl ti

6) u mach Chac ku otoch ti caan

7) u mach Chac caan nak zij/l/

The upper part of this figure shows in four columns samples of Maya signs. The middle part of the figure shows each of these signs converted into computer coding expressing the Maya signs. The four rows at the bottom of the figure show the computer decodings, in a phonetic representation of Maya.—The passage is in the nature of a "priestly synopsis," containing predictions and rites such as: "God Chak rules this day," or "Days of God Chak's reign," "Rainy day," "Day of sacrifices," "Day of bloody offering," "Cloudy days." The Soviet scientists insist that this is only a rough outline of the translation and that historians and philologists still need to work on the phrases.

3. *Identification of the hieroglyphs.* They sought to identify the hieroglyphic characters of the manuscripts, with the Maya language. They found satisfactory proof that in its stylistic features, the language of the manuscripts did not differ significantly from the language of other sources of the period of the Spanish conquest. This fact offered a direct opportunity to identify the hieroglyphic characters of the manuscripts with elements of the Maya language, as given by the sources of the period of the conquest. The scientists narrowed down the number of identifications—they compared those elements of the manuscripts and the sources which bore resemblance to each other. The task facing them was still immensely complex, considering that the "Motul Lexicon" contained 35 thousand words, whereas the "Chilam-Balam" contained 64 thousand. To identify a word by the letters composing it one might have to scan more than 900 pages of the lexicon.

Computer Assistance

All that had to be processed—hieroglyphs; calendar symbols; the drawings of the manuscripts; the "Motul Lexicon"; the "Chilam-Balam" books (written in the Latin alphabet, and containing many words of the ancient language); other materials—were all translated into a language understandable to the computer.

A second page from the Madrid manuscript

Each hieroglyph was assigned a three-digit number. Each letter of the Maya language in the sources was represented by a two-digit number, corresponding to its ordinal place in the alphabet. For instance, the Maya word "sasa" ("cocoa") when translated into machine language looked like this: "03 01 03 01 21."

Each drawing and each element of a drawing received a code. The head, the arm, the foot, even the position of the foot, arm, head, finger, and eyes in a hieroglyph were each assigned a definite number. The entire vast amount of material became a sequence of numbers. Drawings and characters encoded in numbers now could be easily compared and identified; their elements could be easily found in the encoded texts and compared with other parts of the manuscripts. This form of encoding made it possible to process Maya texts on an automatic computer.

Algorithms and Programs

The algorithms and programs used belonged to the class of logical operations on information. The most frequent operation was systematizing great files of information, considerably exceeding the capacity of the finite memory of the computer.

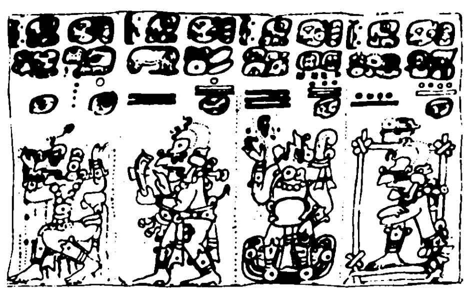
The next task was the scanning of the dictionary for words that had definite letters in definite positions. A simple algorithm was adopted for the solution of the problem. Divided into equal portions, the lexicon was fed into the finite memory of the computer from punch cards or magnetic tapes; 10 words at a time were checked for the presence of definite letters in definite positions. The specific input time (per one word) then amounted approximately to half a minute.

These programs typically have high input and output time, and use of many logical commands. The problem is therefore close to the problems of machine translation, statistical processing of economic data, and mechanized accounting.

The computer processed huge files of information. Then, before the watching scientists, there began to emerge the main formal relationships of the Maya language, the formal features of the hieroglyphic characters. The statistical features of the Maya language were determined; a logical picture of the analysis of the drawings and characters was given. The computer in its 100 hours did a job that it would have taken a man centuries to perform.

(Please turn to Page 44)

D 35 c - 36 c



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(3) 054-314-024	(4) 471	(3) 463	(4) 505-452	(3) 145-135-312-...	(4) 204-174-013	(3) 056-060-063	(4) 143-414-155-533
8) +20 I - 5		9) +10 XI - 15		10) +15 XIII-10		11) +9 IX - 19	

8) u mach Chac hech haa muan

9) u mach Chac zuy zac kup

10) u mach Chac hom xoc-... kin akab

11) u mach Chac ti ot olom otoch

A second sample.

THE COMPUTER IN THE BATHTUB
or
Programming Techniques for Processing Clues and Hints

Peter Kugel
Technical Operations
Burlington, Mass.

How to proceed in the direction of having a computer make associations and discoveries, even some unexpected ones.

Archimedes: "Eureka!"

Archimedes is reported to have discovered a basic principle of physics while taking a bath in a tub. This paper deals with one element in the problem of programming a computer to do the same kind of thing. I am, of course, not interested in the physical problem of squeezing a computer into a bathtub. What is striking about the story of Archimedes is not the physical "where" of the discovery, but rather, the intellectual "where."

One would expect Archimedes to discover a principle of physics while puttering around a laboratory or while scribbling on a blackboard—but not while washing himself. Yet one suspects that there is something essential about Archimedes being in the bathtub to the making of his discovery. He did not make his discovery in a laboratory or on a blackboard not only because laboratories and blackboards as such had not yet been invented, but also because it was rather essential that he be doing something that was, by the standards of his time, not germane to the problem at hand, so that he might gain an essentially new insight into his problem. In other words, there was something about his being engaged in something seemingly utterly irrelevant that was important for solving his problem in a creative and novel way.

What was essential was probably not merely that his mind needed a rest. Rather it needed some new (and at the time, a seemingly irrelevant) input. His creative act consisted in seeing the relevance of this input (Archimedes floating in the bathtub) to his problem (the metallic makeup of a golden crown he had been asked to assay), a relevance which no one had ever seen before and which nobody had ever taught him (or programmed him) to recognize.

The problem of getting the computer (figuratively) into the bathtub, therefore, is not one of freeing it from drudgery and allowing it a little bit of leisure time to rest its transistors. Rather it seems to be the problem of getting the computer to "rub" ideas together in novel ways; of figuring out ways to get the computer to "see" the relevance of apparently irrelevant information. This is really the problem of programming the general notion of relevance, on the one hand, and of programming the way of finding pieces of information according to this criterion, on the other hand; it is with this problem that I want to deal.

Creativity

Much of what we call creativity seems merely to be the ability to see new kinds of relevance in this Archimedean kind of way, and the anecdotal history of science is studded with examples of this. One thinks of Newton sitting under the apple tree and seeing the relevance of a falling apple to the orbit of Saturn; of James Watt in the kitchen seeing the relevance of the behavior of a pot lid to the problem of producing artificial horses;[2] of Glaser seeing the relevance of bubbles in a glass of beer to the problem of detecting the paths of sub-atomic particles; and of others. True, these stories may be apocryphal and thus only serve to show what liars historians of science can be. But they are reminiscent of an experience familiar to most of us, though perhaps on a somewhat less grandiose scale, namely, that some apparently irrelevant fact has led us to the solution of a problem that had been bothering us.

How do we put the pieces together? Or, since that seems to be a question which we shall not be able to answer before we know a lot more about the brain than we can

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[1] This paper is an expurgated and annotated version of three of my others: "Contemplative Computers," read at the IEEE Winter General Meeting in New York, N. Y., in January, 1963; "Data Retrieval for Command and Control," read at the MORS in Santa Monica, Calif., in November, 1962; and "A Data Structure for Data Retrieval," read at the Association for Computing Machinery Meeting in Syracuse, N. Y., in October, 1962. What has been expurgated has been some of the details and as much of the jargon and mathematical symbolism as seemed feasible. The annotations consist largely of the addition of further examples and illustrative material.

[2] One suspects that Watt did not see his problem in terms of the notion of "artificial horses," but the term is no sillier than the term "artificial intelligence."

hope to know in the near future, how can a computer be made to put pieces together in a similar way?

Using Memories

Computers do not seem to be able to use their memories in the way that Archimedes and Newton are reputed to have used theirs at these moments of creative insight. This is not to assert a statement about sizes and speeds. Rather it is to assert that the organization of the memories of computers appears to differ from the organization of human memory.

Suppose that we ask a computer or a human being if it or he has ever heard of Joe Smith. To ask a computer, we ask it to look through the contents of its memory and see whether it can match the string of letters (and a blank) J, O, E, , S, M, I, T, H. Unless we have prepared for this by (say) putting all strings of letters in alphabetical order we will have to make our computer look through all of its "memory traces" for a match. But people don't seem to have to do this. Somehow a person seems to just reach into his mind and find the right memory trace so that he can say that "Yes, that trace was there" (or, more likely, "Sure, I know him"). Furthermore, the human being can say much more about the person to whom this trace refers.

A person is not as literal and plodding in looking for that trace as the computer. It appears that the person does not need to match the trace character by character. As a matter of fact, the human being person is likely to answer, "Yes, I know him," if the person has heard of Joe Smythe or if he has merely heard Sam Smith introduce his son as Joe (or even as Joseph, so that the trace doesn't match the one demanded by the question anywhere). Human beings seem to be able to find facts, or even logical consequence of facts, in their memory according to relevance, and not as computers seem to require, in terms of the specified location of the memory trace in the head, or in terms of the precise form of the memory trace.

But perhaps the most striking performance is that indicated in an exchange like:

"Do you know Joe Smith?"
"No."

for here the laconic respondent seems to be saying that something is not in his memory, apparently without even searching it exhaustively (and he is almost always right).

Factors in Discovery

These far more mundane instances of human information processing illustrate the two factors we have pointed to in Archimedes' discovering. One thing that was required was to see the relevance of such memory traces as that representing Sam Smith saying, "This is my son, Joseph," to a question that doesn't match that utterance anywhere, and the other was the ability to reach into the brain and find the relevant thing in such a way that when nothing relevant to a question is found one can say there is nothing relevant to be found.

In the case of Archimedes, these questions boil down to the question of how the fact (of Archimedes in the bathtub) and his problem (of the makeup of the crown) got together in the consciousness of Archimedes. Why did they pop up at the same time, and how did the mind connect them together when they did?

How can the computer be made to handle information in the way that the human memory does? The differences between the way the two handle information are striking. Consider just a few.

Differences Between Human Memory and Computer Memory

The human mind does not seem to be able to add or multiply without the use of auxiliary devices (such as pencil and paper); people who can multiply with facility, multiply "in their heads," are frequently also of very limited ability otherwise, sometimes feebleminded (*idiots savants*). But the computer can add and multiply with an ease and speed which gladdens the hearts of advertising copy-writers.

People make mistakes. One can put things into a human memory which insist on coming out wrong. (Try to get a young child to pronounce "spaghetti.") Computers, unless one damages the memory trace, can parrot anything.

However, conputers can be easily thrown by a typographical error which does not seem to bother a human being at all. (The typographical error in the preceding sentence did not prevent the reader from understanding it.)

One can store things in a person's mind which he cannot get at; and yet, under hypnosis we appear to find out that it was there all the time. But with a computer one can get it to dump core memory and list all its tapes.

Human beings can remember things when they become relevant. (We remember that we have to buy toothpaste when we pass a drugstore.) With a computer we can interrupt its thoughts occasionally to check whether a certain request has become relevant, but such a process is not like the one which appears to be involved in our remembering toothpaste while passing a drugstore. It is not just that the thought is continually being popped up to check whether it has become relevant. If this were the case, how would one explain that women seem to remember that they have left the oven on at home only when they see someone burning leaves fifty miles away?

And finally, the human memory is often illogical. Consider a conversation like:

"Do you remember the name of that tall guy at the party last night?"
"No, but I think it begins with X."
"That's right, it was Felix."

Overcoming the Differences

But the purpose of this article is not merely to illustrate the differences between the way people process information and the way computers do it. Its main purpose is to show one way that this difference might, in very small part, be overcome.

Today we feel pretty sure, for reasons which I shall not recount here, that anything whatever that can be done in the way of information processing can be done on a computer. And I feel pretty sure that there is nothing to human thinking that is not information processing. (I am as aware as the reader that human beings also have emotions, but let us, for the moment, assume either that emotions can be treated as a kind of information, or that we shall call "thinking" only those mental processes that can be done without those parts of the emotions that cannot be represented as information. These processes may not include creative thought, but even if they do not, it seems to me that the only way to prove this is by assuming they do and going as far as one can go.)

The problem, then, is that of modeling, inside a computer, or in terms of the processes of a computer, basic building blocks in terms of which the kinds of human mental processes in which we are interested can be constructed.

Let us look at the whole job somewhat more prosaically. What I am concerned with doing is designing a filing system for storing, mixing, and retrieving data in certain ways; ways which both the grandiose and ordinary examples listed above have suggested.

Data as Strings of Characters

To simplify the problem, let us consider only a very limited kind of data. We shall assume that our data consists (as does this article) of strings of typographical characters. Further, we assume that the computer does not know what the strings "mean" and that it has no way of representing meanings in terms of visual images, sounds, or any of those sensations in terms of which people think (probably incorrectly) that they store meanings.

The computer resembles a rather literal-minded file clerk who must be told precisely what to do in terms of the rather simple operations with which he is familiar. Our problem is similar to that of the neurologist attempting to explain how the human memory does its work in terms of extremely elementary electrochemical reactions, but our problem is simpler because our operations are more similar to what the mind seems to do and because we are not concerned with verisimilitude.

Filing Operations

The kind of filing system I shall describe in this paper is perhaps best explained by means of an example. Suppose that all we want to do is to keep track of the locations of people, and suppose further that some person (say, our friend Felix whom we met at the party last night) is now living in San Francisco. In our file this fact might be represented by the string of characters: FELIX IS LOCATED IN SAN FRANCISCO. Let us call such a string a "datum." It gives us "information" about the string FELIX and about the string SAN FRANCISCO. Since San Francisco is in California, we would like the filing system to give us some information about the string CALIFORNIA, and since Felix is our friend we would like it to give us some information about OUR FRIENDS. Human beings, we feel, could use the string of characters in our file (together with an unspecified something which we pass off as "common sense") to answer questions like, "Do you have any friends in California?" and our problem is to develop some sort of system whereby our stupid, but diligent and fast, computer/file clerk could do the same thing: that is, come out with the string of characters FELIX IS LOCATED IN SAN FRANCISCO in response to the string DO YOU HAVE ANY FRIENDS IN CALIFORNIA?

Although the example may seem frivolous, the problem is not trivial.

List Structures

The structure I want to consider is an extension of the notion of a "list structure" which is often used in handling information processing problems on computers.[3]

List structures were developed to overcome the limitations of the usual information-storage techniques. For example, the usual way of storing information is as follows:

Computer Address	*Item*
K + 1	First Item
K + 2	Second Item
.	.
.	.
.	.
K + N	N'th Item

Such structures have at least two disadvantages which list structures are intended to eliminate. First, to add an item in the middle of a list, all the items below it on that list must be moved. Second, as data are added, lists will overflow the space assigned to them, and other lists will have to be moved to provide the space required. List structures avoid these difficulties by not storing items in sequential locations. Instead items are stored in any available location, along with the address of the next item on the list.

List structures look like this:

Computer Address	*Item*	*Address of Next Item (Link)*
W	Second Item	Z
.		.
.		.
.		.
X	First Item	W
.		.
.		.
.		.
Y	Last Item	0 (zero)
.		.
.		.
.		.
Z	Third Item	Q

To add an item to the middle of a list, it is now merely necessary to change the appropriate chaining entry, which we shall call a "link," and add the new item in any free location with the appropriate link. The removing of items is also simplified.

Extension of a List Structure

The structure we are going to discuss is an extension of the notion of a list structure. It differs from a list structure in that the computer can not only tell what is next after an item on a list by examining the item, but also what is prior to it. It thus allows the computer to determine the list to which any item belongs, given only the location of the item. We do this by having links go in both directions.[4]

We will also insist that elements which appear in several lists appear only once in the internal representation of the computer, and this is perhaps the basic characteristic of our file structure. It makes it possible to determine all the uses made of a given meaningful unit in a datum, and all information that the system has about this unit (such as its synonyms).

Colored Threads

To illustrate this notion, suppose a writer is trying to produce sentences with only a dictionary and colored thread. To express a given sentence, say THIS IS TUESDAY, he can run a thread through the words THIS, IS, and TUESDAY, in that order. If he runs a second thread through a given word, say TUESDAY, he may choose a thread of a different color to avoid the possibility that his "reader" may get confused at the word TUESDAY and end up in a different sentence from that in which he began.

Such a situation simplifies certain kinds of searches through these sentences. Thus, for example, it is now possible to find everything said about Tuesday except where our writer referred to this day by means of synonyms. Such cases can also be handled if the system contains data about meaningful units, since the statement that "TUESDAY and THE DAY AFTER MONDAY are synonyms" uses the word TUESDAY and therefore requires a thread through that word. The synonymity can thus be discovered by an examination of the threads through TUESDAY.

From/To List

In a computer, the equivalent of such threading is accomplished by means of a device called a "from/to list," which is a list of pairs of addresses associated with every meaningful unit in the data base. As its name indicates, this pair of addresses consists of the address of the unit which precedes the given unit in a datum, and the address of the unit which succeeds it.

For example, suppose that our given piece of information, our datum (we'll call it Datum 1), is the following:

AIRCRAFT 99/LOCATED AT/EDWARDS AFB

Let the phrases separated by slashes be the "meaningful units." To represent this datum, we put the address of LOCATED AT next to the phrase AIRCRAFT 99, the

[3] The best discussion of list structures and their uses in probably Alan Newell's (Ed.) "Information Processing Language—V Manual," Prentice-Hall, Inc., 1961.

[4] To the best of my knowledge, this type of two-directional list was first used by Aiko Hormann in SDC's ROVER programming system.

addresses of AIRCRAFT 99 and EDWARDS AFB next to LOCATED AT, and so forth. Thus, if we denote the address of a phrase . . . by A(. . .), our structure representing this datum is as follows:

Address	*Phrase*	*From*	*To*
A(Aircraft 99)	Aircraft 99	0	A(Located At)
A(Located At)	Located At	A(Aircraft 99)	A(Edwards AFB)
A(Edwards AFB)	Edwards AFB	A(Located At)	0

This is how the threading of the datum is represented on a computer. However, we still have the problem of representing individual words. Unlike the words in a dictionary which can accommodate many threads, the words in a computer cannot accommodate more than one from/to pair. Therefore, to represent meaningful units (the equivalent of the words in the dictionary), we introduce a list of the from/to pairs, which we call a *from/to list.* We now have two kinds of associative list structures, one that goes in two directions and denotes the data, and one that goes in one direction and denotes words. The chaining entries in the former kind of list are the from/to pairs, and the chaining entries in the second kind of list we call the *links.* Thus, if we had an additional datum (Datum 2), that:

AIRCRAFT 99/ASSIGNED TO/SQUADRON X

we would have the following situation at the location of AIRCRAFT 99:

Address	*Phrase*	*From*	*To*	*Link*
A(Aircraft 99)	Aircraft 99	0	A(Located At)	Y
Y		0	A(Assigned To)	0

Threading

Let us switch back briefly to our threading. One thing that we have left out of our considerations is the coloring of the threads. Using just the machinery we have described so far the hypothetical author of these data (Datum 1 and Datum 2) will have no difficulty when he uses single words more than once, since he will not get lost when threading down a list. If, however, he uses a sequence of words twice, he will run into trouble when he tries to read what he has written. Suppose he wants to write both THIS IS TUESDAY and WEDNESDAY THIS IS NOT. As long as he was using colored threads he could simply use a different color for each sentence and not run into trouble. Using our from/to lists, however, he runs into difficulty when he is chaining down the first sentence and gets to the word IS. At this point all that he knows is that he is in a sentence which comes from the word THIS, but there are two such sentences. He might equally well finish up on either one so that he could come up with the sentence THIS IS NOT, which he never intended to write in the first place.

Local Identifiers

In order to avoid this one can do the computer equivalent of putting in local colors. What one does is to allow local tags, called "identifiers," which are numbers intended to keep one from getting lost in such situations. Suppose that we have already stored the sentence THIS IS TUESDAY and now want to store WEDNESDAY THIS IS NOT. When we are storing the word IS in this second sentence we observe that he have another sentence which comes from THIS so we tag the from/to pairs representing these uses of THIS with numbers (say 0 and 1) and tag each representation of IS with the same number as this appropriate THIS. Now, when we are chaining down a sentence and come to its THIS, we pick up the appropriate identifier which allows us to pick up the correct pair representing IS. We can thus avoid possible confusion.

One of the more interesting characteristics of such structures comes from the fact that one needs identifiers and that the space in a computer is limited. These two facts force one to permit no more than a certain maximum number of identifiers at any juncture. When these are used up, one is forced to put one's "words" together. Thus, if one uses the pair THIS IS too often, one has to make a new "word" out of them together. In this way such memory structures are forced to form units in terms of which their memories are stored and their world is "conceptualized." These units are a product of their experience. Give two such structures different experiences and the ways they chunk their memories (and store new facts) will differ.

Returning now to the aircraft example, note that the phrase AIRCRAFT 99 is not repeated in the second from/to pair. Each item in the data structure now has four parts: an address, the phrase itself, a from/to. pair, and a link, and space must be saved for each. Often these spaces will not be used, and thus ways have been considered to eliminate them for practical applications. The largest amount of space must be saved for the data parts, and where this space is not used (as at address Y above) there is great waste. For this reason, as well as to simplify data storage, one can use a dictionary, ordered alphabetically, to translate from a phrase to a computer address. Now it is not necessary to store the phrase at the address which represents it in the computer, since the "meaning" of the address is uniquely represented by the dictionary. In addition, a dictionary simplifies the job of finding data parts (since the dictionary is ordered alphabetically) and it allows one to handle certain synonyms automatically (one uses the same address as the dictionary "definition" of the equivalent phrases). Our data structure now has two parts and it looks as follows:

1. Input Dictionary

Phrase	*Address*
Aircraft 99	A(Aircraft 99)
Assigned To	A(Assigned To)
Edwards AFB	A(Edwards AFB)
Located At	A(Located At)

2. Memory Structure

Address	*From*	*To*	*Link*
A(Aircraft 99)	0	A(Located At)	Y
Y	0	A(Assigned To)	0
A(Located At)	A(Aircraft 99)	A(Edwards AFB)	0
	etc.		

Retranslation

To retranslate data into the phrases they represent, we need another dictionary for outputting purposes. Such an output dictionary will contain the same entries as the input dictionary, but they will be sequenced by increasing address numbers to simplify the job of finding a phrase in terms of the addresses that represent it.

One characteristic of such a structure that might be remarked on at this point is that if we only allow a program to be "conscious" of things which it can express, then it cannot be "conscious" of how it is thinking once it has gone beyond the input dictionary and until it gets back to the output dictionary. Human beings seem to be subject to some such limitation.

Another thing about these dictionaries is that they make it possible to store a lot more memories than a straightforward list of facts, provided only that our list of facts contains lots of similar parts.

Question Answering

Our total structures can be used in computer programs which can answer certain types of questions. In order to simplify our considerations, let us assume that questions and data have the same syntax and that questions are distinguished from data by the presence of some sign, say ? . Letting our system speak pidgin English (or an equivalent), the problem of a routine which can answer a question like PARIS IN FRANCE? assuming that the datum PARIS IN FRANCE exists in the memory and independently of the particular words in the position of PARIS, IN, and FRANCE is now simple to produce. It goes from the node IN and looks for the from/to pair whose entries are the addresses of PARIS and FRANCE. This is a quite general but also quite elementary routine.

It is also relatively simple to devise routines which will answer questions such as PARIS IN . . . ? (an equivalent of "Where is Paris"), given a datum of the form PARIS IN FRANCE in the memory. However, more powerful machinery is required to answer questions of the form NEW YORK CITY IN U.S.A.? given only the data NEW YORK CITY IN NEW YORK STATE and NEW YORK STATE IN U.S.A. (This is a simple inference for human beings to make, but that is not the point. Human beings have available to them (implicitly) other information and machinery which make the implication appear obvious.) More powerful machinery is also required for such inferences as that required to take data containing NEW YORK CITY IS NEAR NEWARK, NEWARK IS IN NEW JERSEY, and respond to a question with NEW YORK CITY IS PROBABLY IN NEW JERSEY.

Incorrect Guesses

Such an inference, however wrong in its conclusion, is justified on the basis of the limited given information. Indeed, we shall want systems which make incorrect "guesses" so that, for a given application, we shall be able to "teach" our system by giving it information, testing it, giving it more information, and so forth. I see no reason why we should expect our artificial intelligence not to require "teaching." Indeed, it seems to me that a good "learning machine" should be teachable from a good "teaching machine." One way of looking at the structure and algorithms discussed in this paper is as a way of extending existing computers so that they can be programmed by the same kind of programmed teaching as people can be taught.

Meta-Data

For the purposes of making such types of inferences we add to our structure a different kind of element much like the elements that represent data parts but which need not be linked to address in the input dictionary. We call such elements "meta-data."

Meta-data represent facts about parts of other data. Consider, for example, a fact about the relation expressed by the string of letters IS LOCATED IN. We know that if A is located in B and B is located in C, then A is located in C, no matter what we have in the place of A, B, and C. Mathematicians express this fact by calling the relation expressed by IS LOCATED IN "transitive." In general, knowing such facts about parts of data allows us to make more complex inferences of the types suggested above.

Our structures provide a good vehicle for writing routines that utilize such meta-data. For one thing, they make it possible to discover whether or not there are any relevant meta-data that can be used to find an appropriate answer when no answer can be found by direct search. (They simplify the job of finding premises from which a desired conclusion can be deduced.) Since a meta-datum about a datum of the form L(x) uses the string L; it is linked to this string by the from/to list associated with the element representing L. It can thus be found directly from the address of that element. For another thing, it is quite easy to write routines which search for data usable with meta-data. Thus, for example, much of the reasoning one would expect in fact-retrieval is that which can be expressed in the logic of relations. If one is looking for an answer to a question of the form R(x,y)?, and one knows that R is transitive, a simple algorithm consists of trying to match the "to" entries of the element representing x with the "from" entries of the element representing y.

If the data represent classes and their members, and one obtains a question of the form C(x)?, one may, upon failure by simpler searches, consider classifying x to see if it is linked, via the element representing class membership, to any other element, and then investigate the "C-ishness" of the members of those classes (all of which can be found by tracing back down from the class name). The kinds of exhaustive search required for some kinds of inferences are thus simplified.

Principles and Relative Success

A system given the kind of rule of procedure described in the previous paragraph might keep track of particular principles used and their subsequent success or failure. (This is one reason for allowing the system to make "mistakes.") If a principle appeared to be of considerable value in a given kind of case, it might be put at the head of some sort of queue and by using principles from the heads of queues, the system might adapt to the questions of its particular environment. For example, going to instances of the class "man" might be useful if a system knew a lot of individual men, but not useful for the class "goldfinch" (unless the system represented a goldfinch or an ornithologist who knew a lot of individual goldfinches). Thus, a given system might develop quite different principles in one environment than it would in another, and thus develop something akin to a "personality."

Discovery of Principles

We can carry the notion of meta-data to higher levels. Thus, we might consider meta-data which are themselves about meta-data (rather than about data). Such meta-data might explain how human beings learn such facts as that "is located in" is transitive (which most human beings seem to use without knowing that they know it). For example, suppose that we have a higher level datum which tells us to assume transitivity (or any other characteristic of relations) whenever it seems to hold in lots of instances. For example, the relation IS LOCATED IN would be assumed transitive if we had lots of data pairs of the form: A IS LOCATED IN B_1 and B_2 IS LOCATED IN C such that B_1 and B_2 were the same string. By the use of such a process a computer program might learn to discover principles which it could later use for making inferences.

"Introspection"

We might christen such a process of looking for higher level meta-data "introspection." It consists of trying to generalize from facts we already know. The results of such introspection need not (and probably should not) be given the status of permanence immediately. One might have the computer hold them as temporary hypotheses. Hypotheses can then be checked by making the "guesses" that they imply, or, in other words, asserting the data which follow from them.

The process of "inventing" hypotheses in this manner can be time-consuming. This suggests that it might be conducted during a computer's "spare time." One might construct a list of problems for which solutions were sought and allow incoming data to provide "hints" for solution. A systematic technique for doing this could consist of placing data which represented problems to the heads of lists so that when new data was stored in these lists, it would be compared to the "nagging" problems at their heads. The discovery of a solution to such nagging problems, at some time when we did not appear to be "thinking" about them (i.e., when they were not in the "control" register), has some of the characteristics of "sudden insights," or the phenomenon of thinking up (too late) clever things one "might have said" in a situation now past.

Remembering When Appropriate

Such a mechanism might account for such human capabilities as the ability to remember things when they are appropriate. For example, we remember that we need razor blades when we pass the drugstore, because when we store the fact that we are passing a drugstore, we may have an automatic routine to scan the heads of nodes in close structural proximity to the node being stored. If we had noted the lack of razor blades recently, this fact would be chained to the head of the node "razor blade" and thus be "recalled" during the storage process. On the other hand such memories need not always occur precisely when they are appropriate, as is indicated by the fact that we do not remember to turn off the light when we leave the house, but rather when we see a light on in a house some ten miles away.

"Contemplation"

The problem of getting appropriate insights by introspection during "spare time" quite naturally suggests the problem of control: how should systems of the "contemplative" sort required for obtaining insights be controlled, or in more anthropomorphic terms: how can such systems decide what to "think" of next? Here there are really two types of questions. One is what sorts of goals (if any) should such a system set for itself, and the second is how is it to sequence through its data in the pursuit of these goals. Let us examine the second question. Let us assume that for some reason we wish to give such a system "free will"; that is, we would like it to be able to "contemplate" independently. What sort of a request is this?

We appear to have at least four alternatives as to how control might be determined. The first is to permit a random element, either by use of random numbers for switching, or by choosing unreliable components. In such a manner the behavior of the system might be made unpredictable, but one feels that such unpredictability should not be called "free will." It seems no more like free will than a twitch.

Three other sources of control are available, and they have quite obvious human analogues. We can allow the system to be controlled by its immediate experiences, we can allow it to adapt as a function of its total experience (perhaps allowing the importance of the previous experience in this role to be a function of its age, or of some utility measure) or we can specifically determine the modes of choosing that it is to subscribe to by programming fixed orders.

The first two of these modes are similar to the notion of a human being being controlled by his environment, while the third is similar to the human being being controlled by his heredity. (This latter human situation may not be completely described by considering control only since one way that heredity may influence the behavior of the organism might also be comparable to having an initial set of data at birth.)

Behavior

One can imagine a structure constructed so that its control was determined by some mixture of these. If one places an appropriate emphasis on the second type of control, one can permit such a structure to develop a "personality" over time. The importance of early experience in the development of such a structure is that these experiences, using perhaps the kinds of mechanisms described in the next section, determine the units in terms of which subsequent experience is coded, and there is a sense in which these units may later become inaccessible to the structure and therefore beyond its ability to change. If we add to such a structure: a utility-ordering on elements with negative utilities; permitting of items to get pushed down the list if their values are negative; the utility of nodes to be associative under amalgamation into new elements—then we seem to get a limited model of something that might be called a "neurosis." Certain parts of the memory with no outwardly "apparent" negative utility, which have inherited it from some "hypothesis" confirmed in the early experience of the structure, may tend to get avoided, and this will not be accessible to the program's conscious control.

If the behavior of a particular structure (built up by "experience" or data over time) is hampered by such situations, we may simply erase its tapes and clear core memory. Alternatively, we may examine its structure and attempt to debug its "misconceptions." However, if the structure contains much that is valuable and was difficult to produce, and if its structures are too complex for us to interpret, we may seek to chain back by means of its own associative links and "suggest" revisions. In other words, we may "talk" to it in terms of its own input dictionary. However, it will avoid, for the reasons suggested above, precisely those areas which caused the trouble in the first place. We may therefore "suggest" some sort of "free association" without utilities. I am not suggesting that we put an IBM 7090 on some sort of "psychoanalytic couch." What I am suggesting is that, much as we imitated human learning in programming such structures for an application by giving them data, so the debugging of such structures may require a partial imitation of our procedures for doing this with humans.

The "personality" of such a structure is determined by its program and its experience. If these are mixed appropriately, it might be said to be "free" in that these combinations of heredity and environment determine its "personality" and its control is determined by this "personality." It is not clear that such "freedom" is desirable, but it is one way of allowing these machines to "transcend" their creators. If these creators find that this leads to unhappy results, they can, as has been observed, always pull out the plug.

Goals

Let us now briefly consider the main problem of "freeing" introspection, namely, how such systems might determine their goals. Surely, if their goals are completely determined by their programmers, they cannot be said to have "free will" except perhaps in the sense that they can choose the way toward these goals. Is there any reason, aside from curiosity on our part, why one should allow a system to select its own goals? I think there is. Much of what goes under the name of "intelligence" appears to be largely a matter of setting appropriate goals. This is suggested by the case of many problem-solving programs (to take just one example) where much of the "intelligence" consists of setting appropriate subgoals.

One requires only some ultimate goal (which may be quite abstract indeed, perhaps merely that of maximizing some sum of utilities) seems to need to be unchangeable in the absence of some sort of outside intervention. Such a goal might be the equivalent of "curiosity" (which is not necessarily ultimate in a human being but might be useful for a program intended to solve problems). The question of what the problems such a "curious system" considered might then be determined by "it." Certainly the problem of what problems to consider is one that, in human beings, is credited with requiring considerable intelligence.

It might even be argued that problem raising is a more fundamental skill than problem solving. Problem solving (of the kind that appears to be of interest in artificial intelligence) requires problem raising abilities to set subgoals which, unlike the solution desired, are attainable by means known to the system.

Immediate, Given Goals

We seem to be inordinately concerned with computer programs which accomplish some immediate, given goal. Even in the field of "artificial intelligence," where some of these immediate goals seem impractical (one proves theorems, plays games, and so forth), we still seem to have our eyes set on some tangible result. It seems that we might study things that computers might do which do not seem to yield immediate results, or at least which do not imply that the computer is doing anything in particular to attain such results. In short, we might consider things that computers might do in their "spare time" when they were not reaching for goals we had specifically set for them.

When one considers that many of the most interesting human creations are the result of spare time (and this gets us back to Archimedes), this concern may not strike one as completely frivolous.

Critical Size

In this article I have suggested a way of structuring the memory of a computer which might allow it to perform in some ways like the human memory. I have also considered some of the problems that might be associated with such structuring. I have not said that this is the way that the human memory is structured, although I have described some of the behavior of the human memory that strikes me as puzzling. Nor have I said that this kind of structuring is likely to produce creative thoughts in computers of the size we have today. In the kinds of structures I have discussed, size is probably very important if one may expect to get much in the way of really creative thought. If anything is to come of this kind of structuring, it will perhaps come only when the computer's memory reaches some "critical size" so that a chain reaction can set in.

Idle Curiosity

I have also tried to suggest that it might be of interest to write programs which would be allowed to develop more or less by themselves, or which would at least be allowed a bit of time in which to "goof off." True, we might well end up having computers give us outputs in which we were not interested or which somehow seemed useless to us. But perhaps allowing idle curiosity is a prerequisite for useful creative work. Galvani's curiosity over the twitching of frog's legs might have been looked at as idle, as might Fleming's curiosity over the sterile spot on his mold-infected culture which led to the discovery of penicillin, or Roentgen's curiosity over his spoiled film which led to his discovery of X-rays.

One can insist that computers stick to the work that we have set out for them, but there may be a penalty to be paid here. I am reminded[5] of the story of Sir William Crookes who invented the tube that fogged Roentgen's film. Sir William had the same stroke of luck as Roentgen did, for his experiments with Crookes' tubes also resulted in the fogging of his film. However, Crookes was more practical and serious-minded than was Roentgen: this fogging interfered with his work and his reaction was to fire off a letter to his supplier complaining about the fogged film that was interfering with the progress of physics! If Roentgen had been programmed like Crookes, perhaps X-rays (and nuclear physics) might never have been discovered.

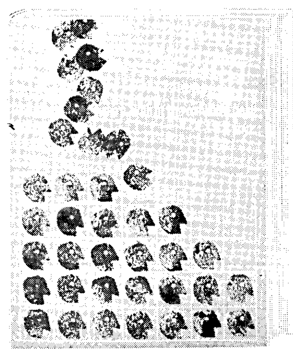
I would be less than honest if I did not confess that I am not always sure that this would have been such a bad thing.

[5] An incident brought to my attention by Price's "Science Since Babylon," Yale University Press, 1960.

here it is!

who's who in the computer field -'63/'64

A new comprehensive edition of the **WHO'S WHO IN THE COMPUTER FIELD** is available. This is the first edition in over five years. All entries are complete and accurate as of January, 1963. This handsome, clothbound book is the standard biographical reference on over 5000 leaders in **computer applications/ design/ education/ logic/ mathematics/ marketing/ programming/ systems analysis**



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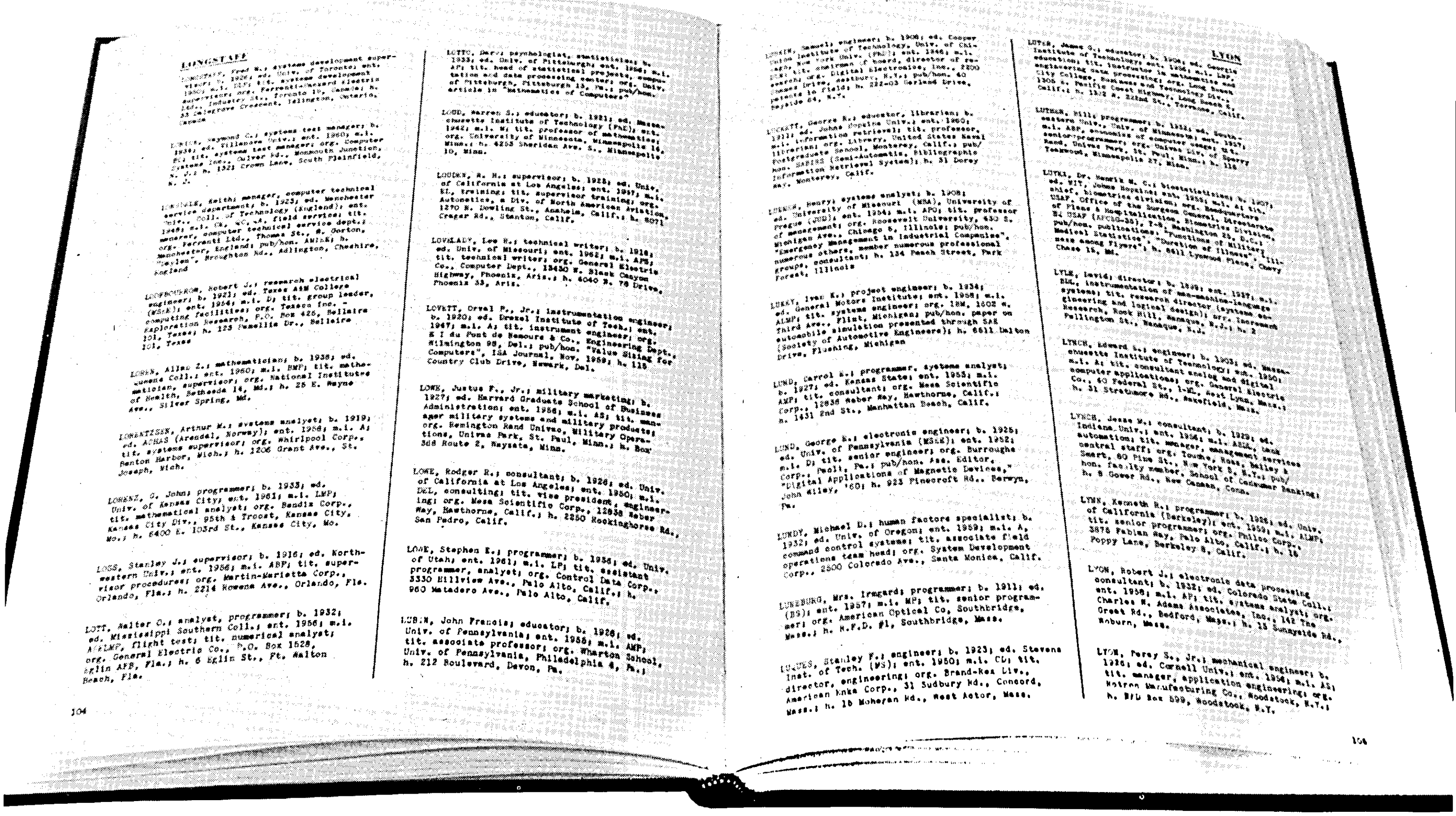


ELECTRONIC COMPUTERS AND SCIENTIFIC RESEARCH

(Part 1)

Stanislaw M. Ulam
Los Alamos Scientific Laboratory
Los Alamos, New Mexico

A mathematician who is noted for starting an experimental method (the Monte Carlo method) for statistically examining complex mathematical situations, reports on further steps in using an electronic computer for finding out and collecting remarkable situations, and checking conjectures about them.

a marvelous extension of the use of symbols

The advent of large computers has created apprehension among some mathematicians and scientists. It is feared that individual scientific efforts will be pushed into the background or replaced by less imaginative, purely mechanical habits of research. Such fears seem to me quite groundless. The computer can be looked upon as an extension of a very old and simple invention—a stylus or a pencil. Even the most abstract thinkers agree that the simple act of writing down a few symbols on a piece of paper helps enormously in the thinking process. Concentrating on what is visually in front of one, rather than relying exclusively on the patterns in the memory, seems to be very useful. In this respect alone, and it is not a trivial one, the new electronic machines provide a marvelous extension of the use of symbols in science, increasing our effective memory. Furthermore, computer display devices enable one to visualize patterns, be they ever so abstract, in a way which extends the range of the *Gedanken Experimente* that have given rise to so many new ideas in mathematics and pure physics. In presenting some aspects of the new art and outlining the possibilities of novel experiments, my point of view is that of a customer, a user of this new research tool, the electronic computer.

It is significant that some of the earliest ideas and inventions in the field of automatic calculation were due to people with an extremely abstract turn of mind. Pascal produced a calculator. Continuing through Babbage in the nineteenth century and ending with the mechanical relay devices of Vannevar Bush at M.I.T., one sees enormous progress in the techniques attempting to realize a program of Leibnitz. But it is essentially at the end of the Second World War, when new developments in electronics made possible much faster and more compact machines, that the new era may be said to have started. Relatively large memories and the use of a general code increased greatly the variety of problems which could be handled by the machine. Von Neumann's contributions were especially important in this respect. While the systems of wired connections remained fixed, a diversity of codes for different problems on the same physical background enabled one to treat a wide range of mathematical schemas.

The technology of the machines themselves is still in rapid development. During the last decade, the speed of the elementary operations that the machine performs (simple logical orders, additions and multiplications of real numbers) has increased by a factor of about 100. Modern computers can multiply two numbers, each of 40 binary digits or so, in 1 microsecond or less. The size of fast-access memories has also increased by a very large factor. The readily accessible memory is of the order of 100,000 words; there is no essential limit to the size of a memory with slow access.

Some of these characteristics will no doubt be further improved during the next few years. Rapid progress in miniaturization techniques hastens the trend toward smaller, more compact machines. Parallel to this development is an improvement in the variety of new logical and mathematical orders concerning Boolean and other operations. More recently, auxiliary and ancillary equipment is becoming available which permits a visible display of the results obtained by the computers. At the same time, work is proceeding on easier methods of insertions or changing the data going into the calculation or, indeed, changing the course of the calculation itself, on the basis of the results produced and displayed by the machine. This will bring about a more intimate cooperation (if one may properly use the expression) between scientists and programmers, on the one hand, and the machine, on the other.

intimate cooperation between machine and human being

It is known that Gauss greatly favored experimentation. When he was asked how he managed to divine some of the remarkable regularities of numbers, he answered, "*Durch planmässiges tattonieren,*" through systematic trying. This may well be considered a definition of the pragmatic method in mathematical research. Its modern application, using electronic computers, has already produced a vast body of literature, from which one chooses for purposes of illustration not necessarily the most important examples, but those which are familiar and, perhaps, more personal.

As all mathematicians know, great mysteries remain in number theory, despite the logical simplicity of the subject; there are very simple questions, explainable to a ten-year-old, which are still unanswered. Many of these concern properties of primes. It has proved fruitful to examine the *appearance* of primes as written in the binary system; this is a quick and simple process, using computers. One tries to obtain by inspection some general rule regarding the distribution of 0's and 1's in the binary expression of a prime integer. The so-called Fermat primes are of the form $2^{2^n}+1$ (Figure 1). By means of a computer, one easily develops a long list of such integers. It is seen that Fermat primes can be described as prime integers whose expression in binary notation contains two 1's, the rest of the digits being 0's. It is conjectured that there are infinitely many Fermat primes.

n	Decimal Notation	Binary Notation
0	3	11
1	5	101
2	17	10001
3	257	100000001

Figure 1. Fermat primes.

One could ask a seemingly simpler question: Are there infinitely many primes in whose binary expression there is any fixed number, k, of 1's? Even this weaker conjecture seems very hard to prove. At Los Alamos, we have used a computer in statistical studies of the combinatorial properties of the distributions of the 0's and 1's in primes. One day, Dr. Mark Wells, who was working with me, said, "Of course, one cannot expect the primes to have asymptotically the same number of 1's and 0's in their development, since the numbers divisible by 3 have an even number of 1's." Taking this remark as representing some very easily provable elementary fact, I returned to my office. But then I found, after considerable effort, that I could not establish it. In fact, the statement is not even true (Figure 2). The first integer

Decimal Notation	Binary Notation
3	11
6	110
9	1001
12	1100
15	1111
18	10010
21	10101

Figure 2. Integers divisible by 3.

divisible by 3 which has an odd number of 1's in its binary expression is 21.

Nevertheless, a great majority of the integers divisible by 3 seem to have an even number of 1's. Beginning with this observation, Wells managed to prove a general theorem: among all the integers divisible by 3, from 1 to 2^n, those which have an even number of 1's always predominate, and the difference between their number and the number of those with an odd number of 1's can be computed exactly and is of the order of $3^{(n-1)/2}$. It is even more interesting that he developed corresponding proofs for integers divisible by 5, 7, and some other numbers, although these theorems become harder and harder to prove. A paper describing this work will appear in a mathematical journal. This provides a very nice, if modest, illustration of the claim that an examination of special cases, yielded quickly and in abundance by a computing machine, may stimulate a mathematician to conjecture, and then perhaps to prove a general truth.

quick examination of abundant special cases

Professor S. Chowla, a famous number theorist now at the University of Colorado, mentioned to me recently his interest in the equation

$$\binom{l}{3} + \binom{m}{3} = \binom{n}{3}$$

where l, m, and n are integers. For example,

$$\binom{5}{3} + \binom{5}{3} = \binom{6}{3}$$

That was the only case of a solution in integers which he knew, and he thought that this was the only one possible. As a result of the brief discussion between us and a young student at the university, we decided to investigate the problem on a computing machine. It turned out that, even for moderate values of n ($n < 100$), there were many other solutions. Inspection of the special nature of these gave Chowla an approach to the proof that there are infinitely many such triplets. He also proved there is only one solution, the one stated above, when l and m are equal.

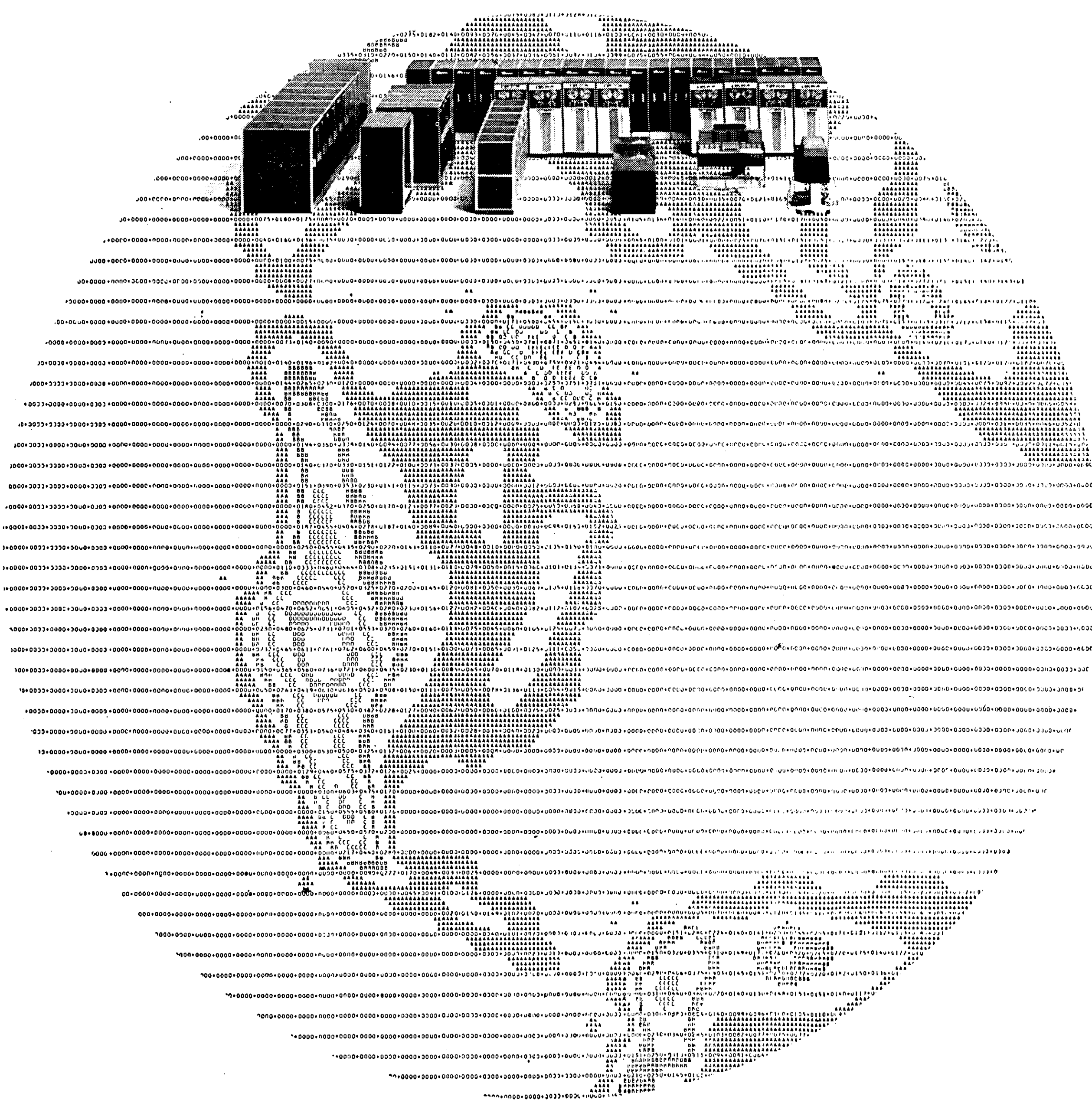
It seems to be true that mathematicians are not happy unless they can prove that something exists but is hard to find, or else that there are infinitely many members in a given set. But it is significant, as in this case, that the infinity of solutions was suggested by the finite process carried out on the machine. One may hope that not only isolated curiosities, but hints about general facts, will be obtained through empirical work followed by thought. D. H. Lehmer in California has shown the great value of computing machines in number theory research.

empirical work followed by thought

Other illustrations of the pragmatic method can be found in certain topics of what can be called elementary algebra. It is perhaps not generally realized how little is known to mathematicians about transformations which are not linear. In a space of, say, three real variables, x, y, and z, one can consider a transformation

$$x' = f_1(x, y, z)$$
$$y' = f_2(x, y, z)$$
$$z' = f_3(x, y, z)$$

where f_1, f_2, and f_3 are not linear functions, but quadratic functions, of these variables. Almost everything is known about the linear case, but if quadratic or higher-order transformations are involved, some of the simplest questions concerning the properties of such transformations and the behavior of their iterations remain unanswered.



It is more than mere curiosity to inquire about these; there are indeed practical reasons for studying nonlinear transformations and equations. The laws of nature do not require that fundamental relationships involve only linear operators. Despite the success of the well-established (linear) quantum theory, there are now indications that in certain basic aspects it is essentially nonlinear. Of course, in classical theories, such as hydrodynamics, the equations are nonlinear from the beginning. Hence it is useful to give a brief account of a systematic investigation, performed with the aid of computers, of some elementary mathematical problems concerning quadratic transformations in the space of two, three, and four dimensions.[1]

population of
n particles
of different "colors"

Let us imagine a population of n particles of, say, three different types, which may be thought of as different colors. The number n is very large. We assume that these objects collide or mate in pairs, at random, and that each pair will produce a pair of offspring for the next generation, the color of the offspring being uniquely determined by the colors of the two parents, according to a fixed rule; i.e., the characteristics of the offspring are a function of the characteristics of the two parents. Many such rules are mathematically possible. We shall not restrict ourselves to those that might make biological sense, but consider the problem in its full generality. Suppose x, y, and z denote the proportions of the particles of each type in the original population. Then $x + y + z = 1$. Given a rule of inheritance of the colors for the next generation, the question is: How will the fractions change in the course of time, that is to say, with the passage of generations?

The new compositions of the population could be, for example,

$$x' = y^2 + z^2$$
$$y' = 2xy + 2xz$$
$$z' = x^2 + 2yz$$

This corresponds to the following scheme: Two y particles produce a particle of the x type. So do two z particles. The collision of an x particle and a y particle, or an x particle and a z particle, produces a y particle. The mating of two x particles, or a y particle and a z particle, yields a z particle. This is, of course, an arbitrary prescription. It turns out that there are about 100 different such prescriptions, even considering as different only such which cannot be made to coincide by permutations of the letters. One will assume that a rule, once chosen, remains valid for subsequent generations and that fixing the rule, one obtains the proportions of each color in the course of time by iterating the initial transformation (that is to say, composing it with itself). Mathematically the problem is in two variables only, since if $x + y + z = 1$, it is also true that $x' + y' + z' = 1$, and so on. One can therefore consider the iterates of the transformation in two variables only.

It turns out that, depending on the initial rule, a great variety of cases arises. In some, starting with any initial distribution, i.e., with any point in the plane, the iterates converge to a fixed point, which indicates convergence of the population to a stationary distribution. For other rules, however, one observes convergence, not to an interior point, but to an oscillating system. Paul Stein and the writer have examined a case in four variables and have obtained a periodic limiting cycle of the order of 12. In some other cases, there is a convergence to strange limiting curves.

(To be continued in the September issue)

(Reprinted with permission from "The Age of Electronics" edited by Carl J. Overhage, published by McGraw Hill Book Co., New York, N. Y., 1962)

"ACROSS THE EDITOR'S DESK"

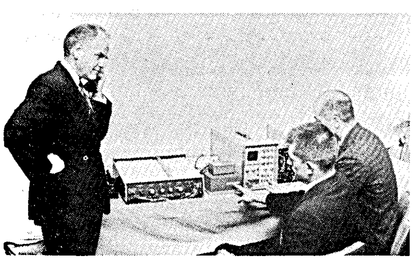
Computing and Data Processing Newsletter

TABLE OF CONTENTS

NEW APPLICATIONS

DOCTORS — CONTINENTS APART — CONSULT VIA COMPUTER

In a recent experiment, RELAY, the National Aeronautics and Space Administration's communications satellite, was used to transmit encephalograms, 'brain waves', from Bristol, England, to Minneapolis, Minnesota. Diagnosis in Minneapolis was performed on-line with the aid of a Computer of Average Transients (CAT) -- and results were interpreted and sent back to England via NASA'S RELAY satellite, within one minute.



-- The National Aeronautics and Space Administration's communications satellite, was used to transmit electroencephalograms, 'brain waves', from Bristol, England, to Minneapolis, Minnesota.
The demonstration was carried out under the supervision of Dr. Reginald G. Bickford of the Mayo Clinic, Rochester, Minnesota. On the telephone is Dr. Bickford; center is Mr. Wayne Russert, Electronic Technician, Mayo, and Mr. Don Carroll, Electronics Supervisor Electroencephalograohy Department, also of Mayo.

For the purposes of the experiment, Mrs. Charles Ray, the wife of a doctor on the research team, served as the "patient". At the Burden Neurological Institute, Bristol, England, scalp electrodes were affixed and evoked responses to stimuli were obtained. The electroencephalograms were transmitted from the Institute in England via land line to the British transmission station at Goonhilly to RELAY and back down to the receiving station at Nutley, N.J., and by land line to Minneapolis. There the signal was fed into the computer. The actual evoked responses received by the CAT were masked in a background of dense noise. The computer isolated the encephalographic patterns, through an averaging process, and within seconds presented very accurate data that made immediate "diagnosis" possible. The "diagnosis" was relayed back to England, again via the RELAY satellite.

Dr. Reginald Bickford, Director of the Encephalography Laboratory of Mayo Clinic, who supervised the research team, said that the experiment opens up vast possibilities in the field of medical consultations heretofore completely impossible. The test was conducted in cooperation with NASA'S Communications Systems, Office of Applications.
(For more information, circle 20 on the Readers Service Card.)

HOSPITAL INFORMATION SYSTEM

Several departments at The Childrens Hospital, Akron, Ohio, will be linked to a central computer next spring, in an extensive hospital information system. The system will speed the flow of patient information to and from key locations and relieve nurses of many of their clerical duties.

Children's Hospital, in a joint effort with IBM Corp., has been studying the information traffic at the hospital for more than a year. One of the results of the study was the validation of earlier estimates that nurses are spending about 40% of their time on such clerical duties as the handling of doctors' orders for patients and keeping notes on the condition of patients. With the IBM 1710 control system nurses will be able to spend more time on direct patient care.

The system will be used initially to process doctors' orders -- written instructions concerning medication, diets, laboratory tests and x-ray examinations -- the four categories into which most doctor's orders fell according to the hospital information analysis. The system also will be able (as a by-product of direct patient care activities) to take essential information for streamlining accounting, budgeting and hospital management techniques.

-- A computer console will be the central point of a hospital information system at The Children's Hospital of Akron. Shown at the console are Nursing Service Supervisor Janet M. Holloway and Hospital Administrator Roger Sherman.

Up to five forms that nurses originate now for each doctor's order, will be eliminated by the new system. For example: if an order is to administer medication, an automatic entry will be made in the patient's record which is stored in the computer. This identifies the patient, tells what the doctor has ordered and indicates the dosage and frequency of administration. From this single order, the pharmacists will fill the order and return the medication to the nursing station. Charges for the medication will be sent to the computer automatically and billed to the patient's account. A schedule will also be produced automatically so that at predetermined intervals the nursing station will be advised of the medication to be given at a certain time. After administration of the drug, the nurse will confirm the action through the terminal. If no confirmation is received, another notice will be sent out reminding the nurse that the medication has not been administered.

Communication devices, called terminals, will be used to get information to and from the central computer. Seven of these units will be located at nursing stations where patient records are maintained and where doctors' orders originate. Additional units will be installed in some service departments such as the laboratory, pharmacy and x-ray department and in the business and accounting offices.
(For more information, circle 21 on the Readers Service Card.)

READING FILM WITH A COMPUTER

A computer system has been developed by Information International, Inc., Maynard, Mass., which can read data from 16 or 35 mm. film automatically and print out the data on paper or record it on magnetic tape for further computer processing and analysis. The film reading system is based on three major elements: a PDP-1 digital computer, together with a visual display scope; a film reading device; and computer programs for using the computer and film reader.

The process involves the scanning of film by a rapidly moving light point on the visual display scope. The output of this scanning operation is detected by a photosensitive device in the film reader and relayed to the digital computer for further processing and analysis.

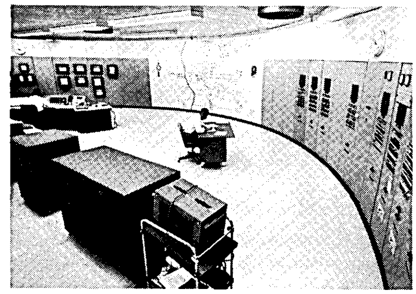
The system can read almost any format of data on film, with appropriate modifications to the basic computer program. This includes data represented in the form of lines, graphs, points, and other similar forms of data. Once the basic data is obtained from the film, almost any type of desired output may be obtained.

The film reading system is suitable for such applications as analysis of data produced by oscillographs or other types of graphic recorders; tracking and analysis of objects for which motion pictures are available (e.g., missile tracking studies); reading of astronomical or astrophysical data recorded on film; reading photographs of cloud chambers, bubble chambers, and spark chambers; and counting of particles (such as blood cells or bacteria) in photographs.
(For more information, circle 22 on the Readers Service Card.)

FLUCTUATING ELECTRICAL DEMANDS CONTROLLED BY DIGITAL COMPUTER

The Public Service Company of New Mexico, whose power generators meet the daily needs of some 109,000 electrical users from Las Vegas, N.M., in the north, to Deming some 300 miles to the south, has adopted an all-digital dispatch system. Power flowing from two Albuquerque steam generation plants is being controlled precisely by a digital computer.

An IBM 1710 control system is installed at Person Station on the outskirts of Albuquerque where it is a part of the system dispatch center. The large semi-circular room with a wide illuminated power system map and a compact console



is the operations hub for the Public Service Company. Components of the control system include: an IBM 1712 terminal unit, which brings electrical load and frequency data into the dispatch center; an IBM 1711 data converter, which translates this information into computer language; and a transistorized IBM 1620 computer, which takes these messages, processes them, and prepares instructions for the turbines governing the systems.

The computer also displays information on a system dispatcher's console in lighted numbers that can be read from a distance. From this console, the dispatcher observes and oversees the automatic regulation of two turbine generators nearby as well as three other units located 18 miles away at Reeves Station. A microwave link makes instantaneous control possible.

The primary job of the 1710 digital dispatch system is to insure that enough electricity flows at a constant frequency of 60 cycles per second to meet the demands of homes and businesses as well as the demands of neighboring utilities who buy and sell energy to one another.

Every ten seconds the computer takes the information relayed from various measuring points on the transmission system and performs a new load-frequency calculation. Within a split second, after each calculation is made, the proper response is relayed to the turbine. The adjustment of electrical generation follows two seconds later.

Once a minute the computer turns its attention to the economic dispatch problem and decides how the generation should be allocated among the five generators to produce the required power at the lowest cost. The load is allocated to the various generators by taking into account such essentials as fuel costs, turbine efficiencies and transmission line losses, all of which are stored in its memory.

Once each hour an electric typewriter, controlled by the computer, automatically produces a complete log showing such things as system load, generation, transmission line losses, and other important information. Formerly, the dispatcher had to calculate this information by hand -- this took 10 or 15 minutes per hour; the computer does it in 20 seconds or less while still performing all of its other jobs.
(For more information, circle 23 on the Readers Service Card.)

NEW CONTRACTS

NCR TO LEASE NEARLY 200 MODEL 390's TO AIR FORCE

National Cash Register Co., Dayton, Ohio, has been awarded a contract for the lease and maintenance of up to 175 of its Model 390 data processing computer systems at Air Force bases. The equipment will be used to process payrolls (see story in 'Automation') for more than 800,000 military personnel, and will be installed in about 105 Air Force bases in the U.S. and about 25 overseas. Some bases will have more than one system. It was not possible to set a figure on the amount of the contract immediately; estimates are that an annual expenditure of about $4½ million will be involved.
(For more information, circle 30 on the Readers Service Card.)

SDS TO STUDY MEDICAL AND BUSINESS INFORMATION NEEDS FOR PUERTO RICAN MEDICAL CENTER

An $83,000 contract has been awarded to the System Development Corp., Santa Monica, Calif., to study the total medical and business information needs of a new $63-million medical center in Puerto Rico. Under terms of the six-month study contract, SDS will perform a study of system operational requirements at the large centralized medical facility of the Corporacion de Servicio del Centro Medico de Puerto Rico. The results of the study will provide the center with the necessary requirements for the design and installation of an appropriate information-handling system.

The medical center, located in San Juan, is scheduled to go into full-scale operation in January 1965. It will be an integrated complex of hospitals and medical services, under a single managership and board of directors.
(For more information, circle 31 on the Readers Service Card.)

MESSAGE PROCESSING SYSTEM TO BE BUILT BY BURROUGHS

A new Automatic Message Processing System (called AMPS) will be built by Burroughs Corporation, Detroit, Mich., and installed at Fort Ritchie, Md., under a $2½ million Army contract. AMPS will provide classified and reliable communications and will handle integrated electronic administration for the Joint Communications Agency at Fort Ritchie. The system has been designated AN/FYC-1 by the Army. It will use a newly-developed Burroughs D825 modular computer and auxiliary units.
(For more information, circle 32 on the Readers Service Card.)

TRW COMPUTER DIVISION AWARDED $23.5 MILLION CONTRACT FOR ARMY COMMAND & CONTROL PROGRAM

A $23.5 million contract for research and development of tactical automatic data processing systems for use in the Field Army has been awarded to the Computer Division of Thompson Ramo Wooldridge Inc., Los Angeles, Calif. The work will be performed at Fort Huachuca, Ariz. over a five-year period. This is part of the Army Materiel Command's project, Command Control Information Systems for the 1970 Field Army (CCIS-70). CCIS-70 is designed to provide Field Army of the future with greater flexibility, accuracy and decision-making speed. TRW will serve as technical assistant to the Army in the development of five subsystems: fire support; intelligence; operations; logistics;and personnel and administration.
(For more information, circle 33 on the Readers Service Card.)

BRIGHAM YOUNG UNIVERSITY CONTRACTS FOR ANALOG COMPUTER

Comcor, Inc., a subsidiary of Astrodata, Inc., Denver, Colo., has announced a $51,100 contract with Brigham Young University, Provo, Utah, for a CI-170SS analog computer system and the new CI-308 ±100 volt DC operational amplifiers. Delivery for the system is scheduled for September.
(For more information, circle 34 on the Readers Service Card.)

SPACE MEMORY SYSTEM CONTRACT AWARDED TO ELECTRONIC MEMORIES, INC.

A contract, in excess of $100,000, has been awarded to Electronic Memories, Inc., Los Angeles, Calif., for the development and delivery of an airborne severe-environment memory system. The random access memory is being built to MIL-E-5400 specifications and will deliver 1024 26-bit words, with a 4 microsecond read/write cycle. The contract was awarded by Sperry Utah Division, Sperry Rand Corporation, Salt Lake City, Utah.
(For more information, circle 35 on the Readers Service Card.)

DEPARTMENT OF DEFENSE TO USE AUERBACH PROGRAMMED-INSTRUCTION COURSE ON REQUIRED COBOL-1961

The Department of Defense has purchased the rights to reproduce and distribute, for use throughout the government, the programmed-teaching course developed by the Auerbach Corporation, Philadelphia, Pa., on Required COBOL-1961, the Common Business Oriented Language used for computer programming. Under the terms of the agreement, the government will receive the complete four-volume, 3900-frame instructional text plus a student manual, which contains course illustrations, a comprehensive glossary of COBOL and data-processing terms, and a complete handbook of Required COBOL-1961 specifications.
(For more information, circle 36 on the Readers Service Card.)

CONTRACT FOR DISCFILE SYSTEM

Data Products Corp., Culver City, Calif., has received a contract from System Development Corp., Santa Monica, Calif., for a DISCfILE system. The system consists of a high density DISCfILE

with associated logic and a controller that will interface directly to the IBM Q-32 computer. System Development Corporation will use the system in the development of special programming techniques.
(For more information, circle 37 on the Readers Service Card.)

HRA AWARDED CONTRACT FOR SELF-INSTRUCTIONAL SYSTEM

Hamilton Research Associates, Inc., New Hartford, N.Y., has been awarded a contract to develop a self-instructional system in PERT/Cost for Air Force managers. The contract was let by the Air Force Systems Command, Electronics Div., Laurence G. Hanscom Field, Bedford, Mass. HRA will supply copies of the program to the Air Force but will retain civilian publication rights.
(For more information, circle 38 on the Readers Service Card.)

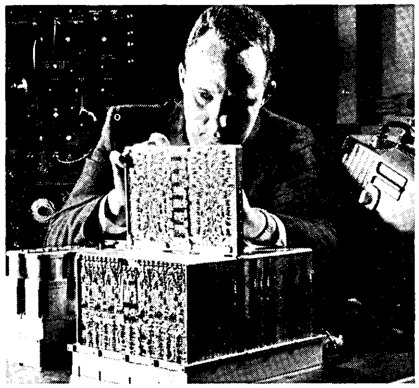
SEA/AIR NAVIGATION STUDY CONTRACT AWARDED

The Univac Division of the Sperry Rand Corp. has begun a world-wide sea/air navigation study sponsored by the National Aeronautics and Space Administration. The initial objective of the study is to determine computer requirements for a system that will automatically provide navigation information to merchant shipping, aircraft, and central monitoring sites. Ultimately the system could include most types of surface ships and aircraft.

Plans for the total system involve the use of large-scale, shore-based computers for collecting and processing navigation information, and earth satellites for ship-computer communication. The six-month program will be conducted at the UNIVAC Engineering Center, Blue Bell, Pa.
(For more information, circle 39 on the Readers Service Card.)

$1.5 MILLION FOLLOW-ON CONTRACT FROM HONEYWELL

General Precision, Inc., Glendale, Calif., has been awarded a $1.5 million supplementing contract from Honeywell to produce additional guidance computers for NASA's Centaur spacecraft. The contract calls for production of six flight computers, a "test-bed" computer for use in manufacturing checkout, and spare-parts.



-- Centaur computer checkout. A technician checks circuit card of computer for NASA's Centaur spacecraft. The computer is designed to aid in the guidance of the Centaur spacecraft on a series of planned orbital, lunar, and interplanetary flights.

Work will be performed by the Librascope Division of General Precision's Information Systems Group. Librascope's digital computer is designed as a part of the Centaur inertial guidance system, developed and manufactured by Honeywell's Aeronautical Division at St. Petersburg, Fla.
(For more information, circle 40 on the Readers Service Card.)

COMPANY RECEIVES THREE CONTRACTS

Data Display, Inc., St. Paul, Minn., recently has been awarded three contracts.

NASA Langley Research Center, Hampton, Va., has awarded a contract for $229,897 to the company for equipment to be supplied consisting of a high-speed-computer microfilm plotter and printer to be used to record the output data from a variety of digital computers and data sources.

NASA Manned Spacecraft Center, Houston, Texas, has awarded a $596,183 contract for the delivery of two digital display systems, the dd51/m2 and the dd74G. Both units will be used for dynamic on-line display of pre-launch data on manned spacecraft at Cape Canaveral, Fla.

The third contract was awarded the company by the U.S. Air Force Missile Test Center, Patrick Air Force Base, Fla., for the development of a system to display dynamic trajectory and impact prediction information to the Range Safety Officer at Cape Canaveral. The contract was in the amount of $196,700.
(For more information, circle 41 on the Readers Service Card.)

NEW INSTALLATIONS

MICROFILM RECORDER & DISPLAY SYSTEM FOR UNIV. OF CALIF.

Data Display, Inc., St. Paul, Minn., has delivered its first model dd80 high speed microfilm recorder and display system to the University of California, Lawrence Radiation Laboratory. (Two additional dd80 systems are under construction.) The dd80 records computer derived data at 110,000 characters per second onto 35 mm film. The system presently operates on-line to an IBM 7090 computer.
(For more information, circle 42 on the Readers Service Card.)

IBM 7094 INSTALLED AT AVCO

An IBM 7094 electronic data processing system has been installed at Avco Research and Advanced Development Division headquarters in Wilmington, Mass. The computer will be used for much of the research and mathematical calculations involved in advanced atmospheric re-entry studies and re-entry vehicle development for the Apollo spacecraft project. More than 100 programs already have been written for the computer dealing chiefly with these problems. The heat shield is regarded as the most critical component on the Apollo vehicle, which will re-enter the earth's atmosphere at a speed of approximately 25,000 miles per hour.

Other tasks the computer will be used for are: design of advanced re-entry vehicles for the Minute Man ICBM; design of engines for propelling space vehicles; development of rocket nozzles for very large space boosters; and studies of entry into both planetary and earth atmospheres in conjunction with the Mars and Venus missions.
(For more information, circle 43 on the Readers Service Card.)

DEFENSE MEDICAL SUPPLY CENTER INSTALLS $1 MILLION COMPUTER SYSTEM

A million dollar computer system to centralize military medical supply requisitions has been installed at the Brooklyn headquarters of the Defense Medical Supply Center. The new system, an IBM 1410/1301 random access data processing system, is part of a nationwide centralized stock system, which began operations in July, at all nine commodity supply centers of the Defense Supply Agency (DSA). All DSA supply centers now will have a single set of stock records and will direct shipments from storage depots to various Service installations. Medical supply requisitions now will be processed by the Brooklyn headquarters computer.

The single system will replace nine different procedures used formerly by the DSA centers. Six former methods for reporting errors in shipments will be reduced to one. The system uses the Military Standard Requisition and Issue Procedure instituted July 1, 1962 throughout the Department of Defense.
(For more information, circle 44 on the Readers Service Card.)

GENERAL DYNAMICS/ELECTRONICS EQUIPMENT TO WORK WITH "STRETCH"

General Dynamics/Electronics, San Diego, Calif., has announced the sale of a high speed electronic printer subsystem for use with the IBM 7030 "STRETCH". The equipment was sold to the MITRE Corp., Bedford, Mass., to be used in its work in support of the Air Force Electronics Systems Division (EDS).

Inititally seven S-C High-Speed Electronic Printers will be supplied. In addition, General Dynamics is providing the control group electronics, which functions as a complex switching network between the printers and the computer.
(For more information, circle 45 on the Readers Service Card.)

UNIVERSITY INSTALLS IBM 7074

The University of Rochester, Rochester, N.Y., has installed a new IBM 7074 computer system to replace the IBM 7070 computer installed less than two years ago. The new system has computing speeds two to ten times greater than those of the older model. It will be used in conjunction with IBM 1401 and 1620 computers for scientific calculations.
(For more information, circle 46 on the Readers Service Card.)

TRW CONTROL COMPUTER SYSTEM FOR KAWASAKI ETHYLENE PLANT

Nippon Petrochemicals Company, Ltd., will install a Thompson Ramo Wooldridge TRW-330 control computer system at its ethylene plant in Kawasaki, Japan. The fundamental objective of the system is to operate the entire plant for maximum profit. Among the more important operations to be controlled and the areas in which primary benefits are expected to result, are: individual furnace operation, parallel furnace operation, decoking operation, recovery section, compressor section, and fuel and utilities section.
(For more information, circle 47 on the Readers Service Card.)

APPLIANCE PLANT TO INSTALL BURROUGHS B260 COMPUTER SYSTEM

American Motors' Kelvinator plant, Grand Rapids, Mich., will install a Burroughs B260 Computer System later this year. The B260 will replace a complex of existing tabulating equipment now in use. The electronic computer will provide the plant's management with more complete and timely reports on parts requirements, quantities and deadlines to meet production forecasts. The Kelvinator plant produces all of the company's major home appliances.
(For more information, circle 48 on the Readers Service Card.)

NCAR TO INSTALL CONTROL DATA 3600

The National Center for Atmospheric Research (NCAR), Boulder, Colo., will install a CONTROL DATA 3600 digital computer in November of this year. The computer will be used to solve urgent problems, central to NCAR's goal of understanding basic processes of weather and other atmospheric phenomena. The NCAR was established three years ago to carry out basic research in atmospheric sciences and to stimulate a more vigorous national effort in the field. It is managed by a non-profit corporation of U.S. universities, and sponsored by the National Science Foundation.
(For more information, circle 49 on the Readers Service Card.

ANALOG SYSTEM INSTALLED AT TENNESSEE EASTMAN PLANT

A 5800 DYSTAC computer has been installed by Computer Systems, Inc., Fort Washington, Pa., at the Tennessee Eastman Company plant, Kingsport, Tennessee. Its prime application will be for solutions to problems in chemical kinetics.
(For more information, circle 50 on the Readers Service Card.)

UNIVAC 1107 TO BE USED FOR TRAFFIC CONTROL IN TORONTO

A Univac Thin-Film Memory Computing System has been delivered to the Metropolitan Toronto City Hall, Toronto, Ontario, Canada. It is the heart of an advanced system of traffic control which is expected to reduce congestion and speed up the flow of vehicles by more than 20 per cent.

Two thousand automatic detectors, measuring density and direction of traffic flow along major arteries, simultaneously feed fast-changing information into the central computer. The 1107 evaluates the interrelationship of the data and the effects of corrective signal control, and, within fractions of a second, gives directions to a thousand traffic lights throughout the city. A smaller specially built real-time Univac 418 computer controls the input from and the output to the traffic signals.

In addition to providing for all normal demands of traffic control, the new computing system will instantaneously provide for emergency conditions (fire, collision, etc.), rerouting traffic around the troubled area, until the cause of the trouble is eliminated.
(For more information, circle 51 on the Readers Service Card.

COMPUTING CENTER ORDERS ASI-210 COMPUTER

Electronic Calculating Service, Inc. (ECS), Los Angeles, Calif., has ordered an ASI-210 high-speed general-purpose digital computer from Advanced Scientific In-

struments Division of Electro-Mechanical Research, Inc., Sarasota, Fla. The computer system, valued at $135,000, marks the first installation of an ASI-210 computer on the West Coast and also is the first ASI-210 to be used wholly for a computer service center operation. It will be used primarily by ECS in handling special purpose civil engineering programs.
(For more information, circle 52 on the Readers Service Card.)

CDC SUPPLIES COMPUTERS FOR MULTI-SATELLITE TRACKING NETWORK

A total of nineteen Control Data 160-A computers, along with associated auxiliary equipment, have been delivered by Control Data Corporation, Minneapolis, Minn., for the U.S. Air Force Satellite Control Facility. The systems have been placed in the USAF's Space Systems's Division Satellite Control Center, Sunnyvale, Calif., as well as at remote tracking sites around the globe. The Control Data 160-A digital computers will replace present control systems now in use for positioning and pointing radar and telemetry antennas. The yearly lease cost of the computer systems involved in the project is in excess of $5.3 million.
(For more information, circle 53 on the Readers Service Card.)

WASHINGTON POST TO INSTALL RCA 301

The Washington Post will install an RCA 301 computer system for the automatic justification and hyphenation of newspaper copy and classified advertising. The system will include tape punch devices and five high-speed line-casting machines operated by printers. It is expected to be in operation by early Fall.
(For more information, circle 54 on the Readers Service Card.)

ASI COMPUTER FOR ARMY RESEARCH

The Advanced Scientific Instruments Division of Electro-Mechanical Research, Inc., Sarasota, Fla., has delivered an ASI 210 general-purpose digital computer system to Adaptronics, Inc., Minneapolis, Minn. The system will be used primarily in connection with a research and development project being conducted at Adaptronics for the U.S. Army using digital computer simulation of advanced systems. Other uses will include computer studies of learning machines and analyses of the foundations of machine intelligence. The digital computer system was ordered under a special government priority and was delivered within 30 days after receipt of order.
(For more information, circle 55 on the Readers Service Card.)

SBC CONVERTS TO IBM 7094

The Service Bureau Corporation has converted the IBM 7090 at its New York Data Processing Center to an IBM 7094. The conversion speeds up processing time by 20 to 30 per cent and increases the computer's overall capacity. It is available on a 24-hour basis.
(For more information, circle 56 on the Readers Service Card.)

ORGANIZATION NEWS

BURROUGHS OPENS TWO NEW COMPUTER CENTERS

Burroughs Corporation has opened two new electronic computer centers, one at its ElectroData Division plant in Pasadena, Calif., and a second at its marketing headquarters, Los Angeles, Calif.

The center at Pasadena includes $3 million worth of data processing equipment. Computers include the B5000, two B200 series systems and a 220. The Los Angeles marketing facility houses two computer systems, a B200 and 205.
(For more information, circle 60 on the Readers Service Card.)

GKI HAS NEW DIVISION

General Kinetics Inc., Arlington, Va., has created a "Magnetic Tape Services Division" to make available, to industry and Government, complete commercial services for evaluation and rehabilitation of magnetic tape. GKI's first rehabilitation center for instrumentation magnetic tape is now operating at a Government installation in Florida. Production is at a rate over a million feet of magnetic tape per week.
(For more information, circle 61 on the Readers Service Card.)

DIGITAL FORMS SUBSIDIARY IN OTTAWA, CANADA

Digital Equipment Corp., Maynard, Mass., has established a Canadian subsidiary in Ottawa, Ontario, Digital Equipment of Canada, Ltd. The new subsidiary will handle sales and service of Digital's line of computers, circuit modules, and memory test systems in the Canadian provinces.
(For more information, circle 62 on the Readers Service Card.)

CONTROL DATA ESTABLISHES AUSTRALIAN COMPANY

Control Data Corporation, Minneapolis, Minn., has announced the formation of a new company, to be called CONDATA Australia Pty. Limited, as a result of the recent acquisition by Control Data of the Computer Division of E. L. Heymanson & Co., Pty. Ltd., of Melbourne, Australia. E. L. Heymanson & Co. is a manufacturer's representative operating in Australia and New Zealand, the Computer Division of which has been representing Control Data Corporation there for approximately one year.

Control Data has assumed complete responsibility for orders accepted by E. L. Heymanson on their behalf, as well as training support requirements and maintenance commitments. It has also assumed responsibility for current proposals submitted to prospective purchasers by E. L. Heymanson for Control Data services and equipment. The nucleus of this operation is the former staff of the Computer Division of E. L. Heymanson & Co.
(For more information, circle 63 on the Readers Service Card.)

CONTROL DATA ACQUIRES RIGHTS TO ITEK DIGIGRAPHIC SYSTEM

Control Data Corp., Minneapolis, Minn., has acquired rights to Itek's Digigraphic System and certain of the assets relating to development and manufacture of these systems, for an undisclosed amount of cash and other considerations. Control Data has assumed responsibility for completing existing orders for Digigraphic components.

The Digigraphic System, developed over the past 2½ years by Itek Corporation, Lexington, Mass., is a method for direct "real-time" communication between man and computer. Further development and production of the principal digital electronics elements of the system will now be carried on by Control Data. Itek will retain responsibility for development and production of key non-digital components, including precision cathode-ray tubes. The complete system will be marketed by Control Data.

As a part of the basic agreement, Control Data has agreed to supply Itek with Digital Display equipment for use in Itek's Graphic Data Handling Systems.

The Digigraphic operation will continue at the Itek location pending the acquisition of Control Data facilities near Boston's Route 128.
(For more information, circle 64 on the Readers Service Card.)

FORD TRANSFERRING AERONUTRONIC DIVISION TO PHILCO CORP.

Aeronutronic Division of Ford Motor Company is being transferred to Philco Corporation, a wholly owned subsidiary of Ford. The transfer will strengthen both Aeronutronic and Philco, permitting better coordination of Ford's space and defense activity. Aeronutronic, Ford's space research unit, (which is located at Newport Beach, Calif.) has built some small military rockets and been involved in moon research projects. Philco makes communication equipment, missile guidance and control gear and other military-electronics items.
(For more information, circle 65 on the Readers Service Card.)

CLARY CORP. EXPANDS OVERSEAS

The Clary Corporation is expanding sales and service of its Computer Division into European markets. The English firm of Digital Measurements Ltd. will represent the Clary DE-60 "Little Giant" electronic computer and arithmetic center, in the United Kingdom and Sweden. Digital Measurements Ltd. of Mytchett, Hampshire, will not only represent the Clary DE-60 but will also incorporate the computer into the design of new systems.
(For more information, circle 66 on the Readers Service Card.)

NEW COMPUTER PROGRAMMING AND CONSULTING FIRM

Programmatics, Inc., Los Angeles, Calif. has been formed. The corporation, with David E. Ferguson (President), David A. Nelson (Vice-President), and Hayden T. Richards, provides services in computer programming and consulting.
(For more information, circle 67 on the Readers Service Card.)

COMPUTING CENTERS

GE OPENS SIXTH & SEVENTH IPCs

General Electric Company has opened its sixth Information Processing Center in New York City and the seventh in Cleveland, Ohio. The new centers are part of General Electric's planned nation-wide network. The previously established centers are located in Phoenix, Ariz.; Dallas, Texas; Washington D.C.; Schenectady, N.Y.; and Chicago, Ill.

The New York Information Processing Center has a GE-225 computer system. The system will be used to aid customers in such projects as scheduling construction jobs, school classroom scheduling, traffic flow studies, inventory and production control in retailing and manufacturing, and for scientific and technical investigations.
(For more information, circle 68 on the Readers Service Card.)

BOEING ANALOG COMPUTER FACILITY

A $3 million analog computer facility is now in operation at The Boeing Company in Seattle, Wash. It will be used for engineering design and development studies in areas such as guidance and flight control, structural dynamics, and other physical systems.

The installation contains four EASE (Electronic Analog Simulation Equipment) computers (manufactured by the Berkeley Division of Beckman Instrument Co.), two 1100 Series computers and two 2100 Series. The facility includes about 1200 operational amplifiers, 600 multipliers, 300 function generators and 74 resolvers. It is equipped with the latest auto-

-- Boeing personnel operate a section of the company's new analog computer facility. The computers can be used separately or be interconnected to form a large computing complex.

matic digital input-output systems, allowing complete tape-controlled setup and check-out. Large oscilloscope displays, in addition to the latest in conventional recorders and plotters, are provided for use during repetitive computer operation. Appropriate digital sub-systems are planned for use in "hybrid" (combined analog-digital) computation in addition to certain units already in use.
(For more information, circle 69 on the Readers Service Card.)

RCA CONSTRUCTING NEW SCIENTIFIC DATA PROCESSING CENTER

The Radio Corporation of America is building a new scientific data processing center at the company's David Sarnoff Research Center, Princeton, N.J. The center will include the RCA 601 computer, the largest and fastest computer built by the company. Support for the 601 system will be provided by the smaller RCA 301, together with associated punched card equipment, magnetic tape stations, and an on-line printer for use in translating and recording research data passing in and out of the 601. The complex also will include a FORTRAN processor (FORmula TRANslator) which will automatically convert normal mathematical language used by scientists into machine language.

The center will be used for research in lasers, plasma physics, solid-state theory, character recognition devices, advanced computer memories and computer programming.

It will also be a supplement for two other RCA 601 customers -- the New Jersey Bell Telephone Company and the New Jersey Public

Service Gas and Electric Company. (For more information, circle 70 on the Readers Service Card.)

CONSUMER/AUDIENCE PROFILE SERVICE

SDRS-Data Inc., of New York recently demonstrated a new computerized service called Consumer/Audience Profile Service (C/AP). The service combines research data on the buying habits of media audiences with published media rates to provide advertising agencies with analyses of consumer audiences, rather than total audiences. It describes the audience characteristics of some 200 different media vehicles in terms of the actual users and purchasers of any of 50 different product categories.

The firm also unveiled the advertising industry's first data communications system, which links a computer to a nation-wide teletype network. This permits agencies anywhere in the U.S. to obtain immediate media, market research and other information from Data, Inc. The heart of the system is a Honeywell 400 computer and a specially-designed communications unit developed by Honeywell Electronic Data Processing, Wellesley Hills, Mass.

One demonstration showed C/AP data from the New York market area in six product categories, combined in a four-step process with rate data from four local media (New York Times, New York News, NBC-TV, and CBS-TV). Within five minutes, the Honeywell 400 analyzed the data and produced a two-media combination representing the best "media mix" for each of six products. This was based on the lowest cost to reach the largest unduplicated audience of prospective buyers of each product. (Product categories shown were dog food, cigarettes, cleansers, facial tissues, wines and automatic washers.)

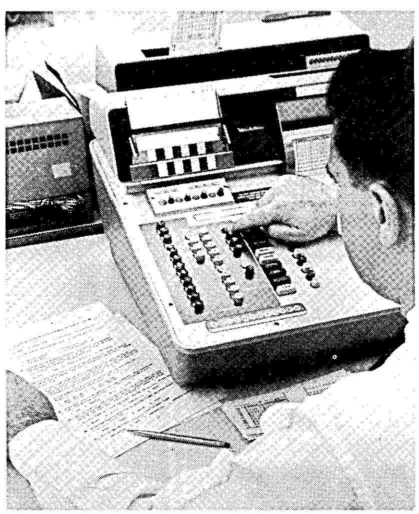
In another demonstration, a New York ad agency, Lennen and Newell, transmitted a request for data over the teletype network, directly to the computer. The entire exchange, from call-up to completion of transmission took less than two minutes. The teletype system used was Western Union's Telex network.

Data, Inc. has already begun to transfer the 15 Standard Rate and Data media and market directories to magnetic tape for computer processing. Eventually every major market area in the nation, as well as the entire U.S. market, will be included in the C/AP surveys. (For more information, circle 71 on the Readers Service Card.)

EDUCATION NEWS

COAST-TO-COAST NETWORK OF TEACHING MACHINES

Nine hundred desk-top size teaching machines are located in 89 cities throughout the U.S.A., and all are connected to a central electronic computer in Denver, Colo., by high speed telephone lines. This coast to coast network, called the Instamatic System, was built by The Teleregister Corp., Stamford, Conn., for the United Air Lines, to give its agents all over the country accurate control of passenger space. It easily handled the reservations function and had capacity left over. This is being devoted to teaching United's agents how to use the system to better advantage.



-- Push-button lessons: United Air Lines passenger agent selects button on the Teleregister Instamatic agent set, which has been set up as an instructive unit. Answers are recorded on cards as agent operates machine and refers to programmed lesson (at left). Complete program is stored in Instamatic "memory drum" at United's Reservations Center in Denver.

United Air Lines currently has three training programs operating on Instamatic machines. Its agents learn how to use the system to give customers quicker service on flight information, fare computation, and air travel card use. Each training program involves three prerequisites: a printed text; the Instamatic agent set; and a written program of multiple-choice questions, which have been coded and introduced to the computer's memory. A small cardboard mask placed over the keyboard of the agent set, automatically keys it for the learning and/or testing operation. A special code plate, instead of the reservation flight plate, is inserted into the agent set. Otherwise, the teaching function uses Instamatic's regular communications network and its Telefile computers in Denver. The system permits each agent to "study" during slack periods, without loss of time on the job. (For more information, circle 72 on the Readers Service Card.)

NEW PRODUCTS

Digital

FRIDEN 6010 ELECTRONIC COMPUTER

The Friden 6010 Electronic Computer System is the first contribution of Friden, Inc., San Leandro, Calif., to the electronic computing field. The new computer is a solid-state, desk-sized unit, weighing less than 400 pounds. The 6010 provides for 240 decimal digits of storage capacity organized into 15 registers or words of 16 digits each. Programming is accomplished by wiring of program panels. Each panel can be wired for one or more programs.

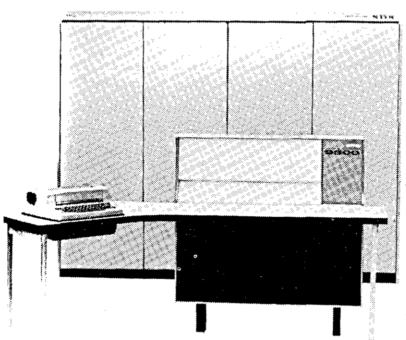
Five main components make up the Friden 6010 digital computer: input-output unit, control unit, arithmetic unit, storage and logic units. With the exception of the input-output unit, all sections are contained in the central processor which performs all computing and logical operations. Addition and subtraction are accomplished in 1.3 milliseconds and multiplication in 50 milliseconds. Input-output speeds are 10 characters per second. The machine can be programmed for square root and division.

The 6010 can be plugged into any standard wall outlet and requires no air conditioning.
(For more information, circle 77 on the Readers Service Card.)

SDS 9300 — DIGITAL COMPUTER

Scientific Data Systems, Santa Monica, Calif., have introduced a high speed, general purpose digital computer, designated Model SDS 9300. It is intended for general purpose scientific computation and special purpose systems integration.

The SDS 9300 can execute typical floating point programs, using a 48-bit word, at rates in excess of 100,000 instructions per second. It adds in 1.75 microseconds and multiplies in 7 microseconds, including indexing.



-- Console and cabinet for the new SDS 9300. The device is relatively small and is transportable. It requires no air-conditioning.

The SDS 9300 may have up to 8 automatic data channels, each operating in excess of 2 million 24-bit words per second. Eight magnetic tape units can operate concurrently, all at 96 kc, without disturbing the arithmetic computations, which can take place simultaneously. The basic core memory is expandable to 32,768 words, all addressable. Each word contains 24 binary bits, plus one parity bit. In addition to 8 automatic data channels, three other types of I/O are available, one of which permits up to 1024 channels of priority interrupt; another allows data transfer of up to 2,285,000 characters per second.

All SDS 920 peripheral equipment will operate with the 9300. A complete software package is supplied for each level of communication between user and computer, including Fortran II, and Symbolic Assembler.
(For more information, circle 73 on the Readers Service Card.)

DSI 1000 COMPUTER

Data Systems, Inc., Grosse Pointe Woods, Mich., has developed a real-time, general-purpose digital computer, called DSI 1000. It is priced to sell starting at less than $10,000. The DSI 1000 is a binary, single address, stored program computer. The memory cycle time is 1.6 microseconds. There are 2048 12-bit words with an average random access time of 100 microseconds.

The DSI 1000 may serve as a separate unit or as an integral part of a computer system. The unit is adaptable to other data processing equipment, communications equipment, and standard input-output devices; it accepts 1, 3, 6, 8 or 12-bit bytes, serial or parallel input or output.
(For more information, circle 74 on the Readers Service Card.)

PROGRAMMED DATA PROCESSOR-5

Digital Equipment Corp., Maynard, Mass., has developed a new PDP-5 computer. It can be used as an independent information-handling system or as the control element in larger systems. It is a single-address, fixed-word, stored-program computer operating on 12-bit, 2's complement binary numbers. Memory cycle time is 6 microseconds. Fully parallel processing provides a computation rate of 55,555 additions per second. The PDP-5 is available with 1024 or 4096 words of random access, magnetic core memory.

The standard PDP-5 is contained in a single bay. It consists of an internal processor, operator console, and memory. Additional bays may be added to accommodate future expansion. A Teletype (Model 33ASR) combination reader-punch and typewriter is supplied as standard equipment. It allows paper tape to be read or punched, or information to be typed in or out, at a rate of 10 characters per second.
(For more information, circle 75 on the Readers Service Card.)

GE PROCESS AUTOMATION COMPUTER

A small, highly flexible process computer has been developed by General Electric Co., Phoenix, Ariz. The new computer, designated GEPAC 4000, has been designed to meet industry needs in those areas where process computers have so far not been applied by management because of their size, inflexibility, or expense. (GEPAC stands for General Electric Process Automation Computer.)

The computer is small and compact. All the hardware for a typical system -- except printers and similar peripherals -- is housed in one cabinet. This includes the central processor with 8000-word memory, scanner, and related input/output equipment for 100 points. The GEPAC 4000 uses binary, fixed-point arithmetic, with 24-bit word size. Core storage is directly addressable; access time is 1.5 microseconds, with a memory read-write cycle of 5 microseconds.

The computer was designed primarily for on-line process functions in chemical, petroleum, steel, paper, cement and electric utilities. Yet the computer is also capable of off-line, fundamental data processing. Modular design gives a variety of options in the central processor and in input/output equipment to meet specific applications. Silicon semiconductors give it an environmental temperature range, without air conditioning, from 32 to 131 degrees Fahrenheit. The computer operates on 110 volts AC.

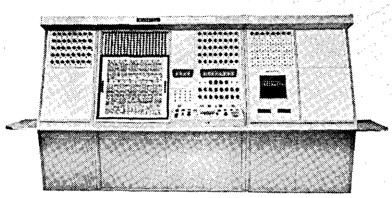
The GEPAC 4000 computer is completely compatible with General Electric's GEMAC sensors and instruments and new Directo-Matic® II control. This permits inclusion of the computer in a process system, without the expense of "interface" or "matchup" equipment. A full library of software is also available.
(For more information, circle 76 on the Readers Service Card.)

Newsletter

Analog

MARK III ANALOG COMPUTER

Computer Products Inc., Belmar, N.J., has introduced an all new "Mark III" analog computer. The Mark III has all necessary computing elements for a full computer system within a single console. This includes 200 operational amplifiers, 180 pots and 60 multiplier products. Printed



circuits are used for all plug-in components; digital packaging techniques are used. The patchboard layout allows maximum use of bottle plugs to minimize patchboard clutter.

The Mark III has real time, iterative, and hybrid applications. It includes three-mode all-solid-state amplifier switching and solid-state serial-entry-address system.
(For more information, circle 78 on the Readers Service Card.)

Digital-Analog

CO-OPERATIVE EFFORT DEVELOPS COMPLETE SCIENTIFIC COMPUTER

Electronic Associates, Inc. and Computer Control Company, Inc., have cooperated on the development of a new computer, known as the HYDAC 2400.

The HYDAC 2400 is a complete scientific computer that combines a general-purpose analog and general-purpose digital computer into a single integrated system. The HYDAC 2400 system includes, as components, a general-purpose analog computer, a general-purpose digital computer, and a Digital Operation System for interface and control. The analog and digital computers can be used separately from the combination called HYDAC 2400.

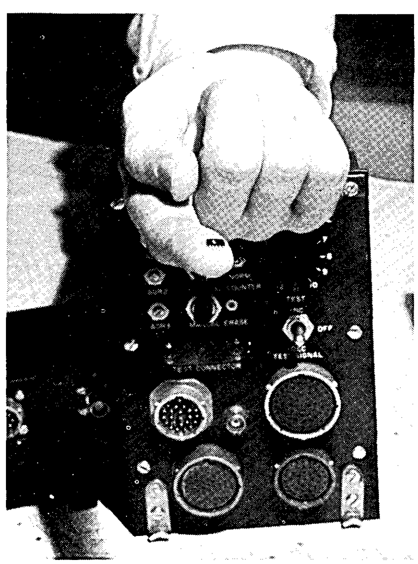
Under the agreement between the two companies, EAI will market the new computer.
(For more information, circle 79 on the Readers Service Card.)

Data Transmitters and A/C Converters

AIRBORNE LORAN-C RECEIVER

Engineers at Sperry Gyroscope Company, Great Neck, N.Y., are developing a half-cubic-foot airborne Loran-C radio navigation receiver that contains more than 25,000 components invisible to the eye. The 19-pound receiver -- called AN/ARN-76 -- is expected to provide position fixes accurate to within a few hundred feet almost anywhere over the Northern Hemisphere. The development is supported by the U.S. Navy Bureau of Weapons.

The receiver is said to be the first application of microcircuitry to the original design of a complete electronic sub-system. Ninety-five per cent of its circuits are being made of tiny silicon semiconductor wafers. The wafers will be mounted in banks of 100 or more on post-card-size, plug-in units; each will contain up to 40 "invisible components" created within the wafer itself by varying the purity and molecular structure of the silicon.



-- Match-head-size silicon semiconductor wafer is one of more than 800 microcircuits in Loran-C radio navigation receiver.

Operation of the ARN-76 has been so simplified that operator training will take only 15 minutes. The number of controls has been reduced from 29 to 5. The receiver will be the cockpit link between a pilot and ground-based Loran-C transmitters.

Existing Loran-C receivers can spot their position to within approximately 1000 feet at a range of some 1000 nautical miles from the nearest transmitters -- they have an extreme range of only 1500 miles. The ARN-76 is expected to plot position within 600 feet at a range of 1000 miles from the nearest transmitters and have an extreme range of 2500 miles.
(For more information, circle 80 on the Readers Service Card.)

DATANET-30 & DATANET-600

Two new products, combining high-speed communications with electronic data processing, have been announced by General Electric Company, Computer Department, Phoenix, Ariz. The Datanet-30 is a solid-state binary digital processor that handles both messages and data. Information is transmitted over two or four-wire voice or Teletype-quality lines at selected speeds, ranging from 60 to 3000 words per minute. The Datanet-600 automatically sends, receives and monitors binary digital data through five, six, seven, or eight-level perforated tape code over two-wire, voice quality phone circuits at 500 words per minute. It has an automatic error-checking and correcting device to insure accurate transmission. Both of the new products are compatible with General Electric's computers and with each other.
(For more information, circle 81 on the Readers Service Card.)

AUDIO COMPUTER INQUIRY SYSTEM

Honeywell EDP, Wellesley Hills, Mass., has demonstrated a low-cost data communications system which uses a small, manually-operated keyboard to send information over commercial telephone lines to a "talking" computer. The computer is designed to handle a variety of inquiry information from remote locations, and processes the information, transmitting the answer through a telephone receiver in an audible, voice form.

The major components of the system include a 16-key, 5-inch by 5-inch keyboard and a Honeywell computer. The computer is modified to include a multi-channel audio tape on which is recorded the digits from 0 to 9 and a number of control statements. By depressing a series of three control and numerical digit keys, an operator can call any of 28 different inquiry routines programmed for the computer. After calling a specific routine, the operator then keys the inquiry information directly into the computer. At the end of the transmission, an "end" key is depressed which activates the computer's audio generation mechanism, causing the correct answer to be "spoken" into the remote handset. A typical inventory inquiry takes less than 40 seconds from call-up to completion.

The audio system in the computer consists of a multi-track magnetic tape loop which is scanned by a "reading head". Each track on the tape loop contains an audio reproduction of a single digit or control word.

Among the potential uses of the system are credit checking services, banking inquiry systems, automatic telephone number updating, and inventory control functions.
(For more information, circle 82 on the Readers Service Card.)

BUSINESS COMMUNICATION NETWORK CONTROL SYSTEM

The new IBM 7740 communication control system, operating alone or linked to a computer, can automatically control the flow of message traffic through a network of sending and receiving units scattered across a city or around the globe. Operating as an independent system, the 7740 can control data transmission and the routing of messages. When linked to a data processing system, it permits instantaneous computer processing of information received from remote points.

The 7740's operation is completely automatic. Control is maintained by a program stored in its magnetic core storage. Manual handling of messages or tapes at a communications center is eliminated. As many as 1000 or more average-length messages a minute can be edited, logged and transmitted to their destination.
(For more information, circle 83 on the Readers Service Card.)

Software

TAB CONVERSION SPEEDED BY TABSIM

A simulation program to speed the conversion of tabulating equipment tasks to computer processing has been developed for the Honeywell 400 and 1400 computers by Honeywell Electronic Data Processing of Wellesley Hills, Mass.

The program, called TABSIM, simulates the functions of conventional tabulating equipment. It is now available to H-400 users. TABSIM accepts parameters which specify the format of the data cards received as input and the structure of the report to be produced as output. TABSIM is a "load-and-go" type package, which permits automatic program assembly and data processing by the computer without manual intervention. The program accepts FARGO language.
(For more information, circle 84 on the Readers Service Card.)

IBM DESIGNS PROGRAM TO HELP DEFENSE INDUSTRY CUT COSTS

IBM Corp. has announced a PERT COST computer program to help control complex defense industry projects. It is designed to control cost, time, and manpower factors, in projects ranging from construction of a nuclear submarine to production of a new jet airplane or space system.

PERT COST is an advanced critical path technique and an outgrowth of the PERT (Program Evaluation and Review Technique) system developed by the Navy's Special Projects Office in 1958. While PERT is based primarily on time factors, the PERT COST technique also considers the effects of cost and manpower.

The new program may be used by management on an IBM 7090, 7094 or 7094 II computer. There are 67,000 specific instructions to the computer. The IBM PERT COST program can be used effectively for almost any project where successful completion depends on numerous interrelated activities in the areas of research, engineering supply, manufacturing and distribution. It is available to users without charge from IBM branch offices. The PERT COST program incorporates the design characteristics specified by the Department of Defense and the National Aeronautics and Space Administration in establishing a guide to a uniform PERT COST program.
(For more information, circle 85 on the Readers Service Card.)

Input-Output

GE-200 BANK TRANSIT SYSTEM

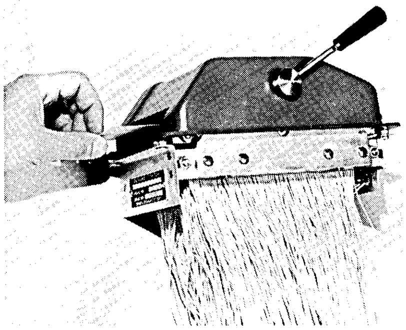
A new bank transit computer system, known as the GE-200 Bank Transit System, has been developed by General Electric Company, Computer Department, Phoenix, Ariz. It can automatically read, sort and list more than 140,000 checks per hour, some 100 times faster than manually-operated proof machines. The system has been designed to handle the mounting volume of MICR-encoded checks clearing through commercial and Federal Reserve banks.

A basic GE-200 bank transit system consists of a central processor with 4096-word memory, including a console typewriter; a 2000-line-per-minute multiple-tape lister made up of six lists of 24 printing positions each; a G-E 1200 per minute document handler; and 400-per-minute punched card reader. All of the devices can operate concurrently.

The system is able to handle data simultaneously from two 1200-per-minute document handlers, thus doubling the speed of data-processing to 2400 checks per minute. Up to four 6-tape listers may be connected to the central processor to prepare 24 lists. The modular concept of the system permits assembly of various equipment configurations to meet individual requirements.
(For more information, circle 86 on the Readers Service Card.)

DREXAMATIC CARD READER

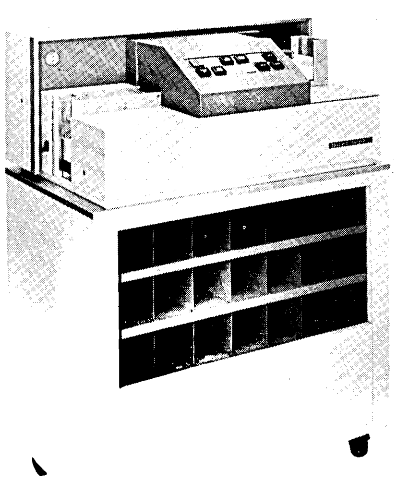
A new device which accepts programming from a punched IBM card, completely wired with integral leads to each of its 960 switches, has been developed by Drexel Dynamics Corp., Horsham, Pa. Each of the 960 switches contains two potted leads for a total of 1920 wire leads eminating from the instrument. The wire leads can be terminated either in individual pin connectors or in various types of potted connectors, dependent upon the card reader's function. Identification or keying of leads is accomplished both by color coding and by providing different combinations of lengths.



This static memory device, the Drexamatic Model 2224 Card Reader, uses standard IBM cards to program any static memory in automated process batching operations, and in the automated production testing of electrical components and systems. The program can be varied by inserting different IBM cards in the reader unit. The memory status is independent of power failure or of severe environmental conditions.
(For more information, circle 88 on the Readers Service Card.)

LOW-COST CARD READER

A new, low-cost card reader, which provides punched card compatibility for less expensive computer systems, has been developed by Burroughs Corp., Detroit, Mich. The new solid-state reader, Burroughs BC122, has serial (column by column) reading. It is capable of transmitting either binary or alphanumeric information to any computer system.



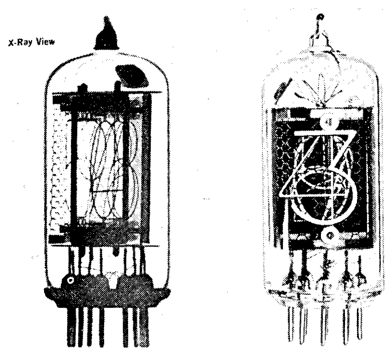
An internally generated strobe pulse samples each column, maintaining precision read timing and accuracy. Photoelectric sensing provides improved reliability and ease of maintenance. Demand or free flow rate of 200 cards per minute is maintained by an immediate access clutch. The first column is read within 85 milliseconds of initial demand. Hopper capacity is 500 cards each.
(For more information, circle 90 on the Readers Service Card.)

Components

BIQUINARY NUMERICAL INDICATOR TUBE

A biquinary numerical indicator tube, designated the type ZM1032, has been developed by Amperex Electronic Corp., Hicksville, L.I., N.Y. It is designed for readout applications in digital voltmeters, cash registers, calculating machines, counters, and computers. With this biquinary tube, only 7 transistors are needed in the driver circuitry instead of the usual 10.

The construction of this biquinary tube differs from ordinary decade indicator tubes. It has two separate anodes and is divided internally into two vertical compartments by a shield electrode. The rear compartment contains one anode and the figures 0-2-4-6-8. The front compartment contains the other anode and the figures 1-3-5-7-9. The figures are connected electrically in pairs: 0 to 1, 2 to 3, 4 to 5, 6 to 7 and 8 to 9. Externally the tube is a standard 9-pin miniature glass type requiring a standard low-cost socket.

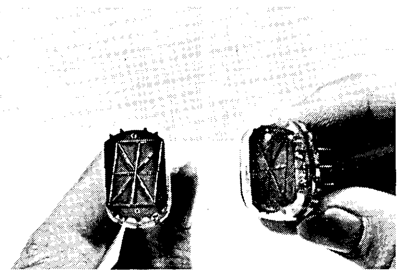


Amperex "Bi-Qui" type ZM1032 biquinary numerical indicator tube

The figures (bright neon red) are 6/10 inch high and are placed one behind the other, becoming visible at the same spot for "in-line" readout.
(For more information, circle 91 on the Readers Service Card.)

ALPHA-NUMERIC NIXIE ® TUBE

A cathode tube, which can display all the letters of the alphabet and the numerals 0-9 as well as special symbols in a single tube, has been developed by Burroughs Corporation, Electronic Components Div., Plainfield, N.J. The new Alpha-Numeric NIXIE® Tube, Type B-5971, has 13 cathode segments and a common anode, mounted within a rectangular shaped glass envelope.



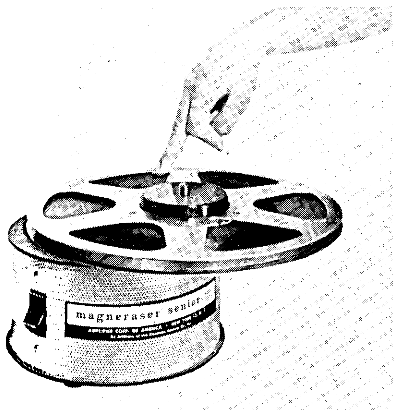
-- The Alpha-Numeric NIXIE® Tube, left, has its glass envelope removed to show the 13 cathode segments that form either letters, numerals or special symbols when illuminated.

Characters are formed by grounding the appropriate cathode segments with respect to the anode. They appear as a bright, "continuous line" red neon glow. A brightness of 200 foot lamberts allows the 7/10 inch high characters to be read under high ambient light conditions at a distance of 25 feet. The new NIXIE Tube can be operated from low cost germanium or silicon transistors in circuits which can provide electrical memory for the readout.

A wide range of applications for the new NIXIE Tube includes military tactical situation displays, stock quotation displays, and airline arrival and departure boards.
(For more information, circle 92 on the Readers Service Card.)

BULK TAPE ERASER

A heavy-duty professional bulk tape eraser, offered by Amplifier Corp. of America, New York, N.Y., erases tapes on the reel with a once-around revolution of the reel. The Magneraser Senior is designed for use with audio, computer, telemeter, and machine-control tapes; and with 8, 16, and 35 mm sound stripes. It erases the most severely overloaded tapes, lowering background noise levels 3 to 6 dB less than some new (unused) tapes. The single spindle



position accommodates 3, 5, 7, and 10½ inch reels without spindle shifting. It erases ¼ and ½ inch wide tapes as well as 16 and 35 mm magnetic sound film tracks. The Magneraser Senior has an automatic On-Off Rocker Switch which cannot be left on accidentally.
(For more information, circle 93 on the Readers Service Card.)

AUTOMATION

DIGITAL COMPUTER CONTROL SYSTEM FOR A FOOD PROCESSING FIRM

A computer control system that has been more than two years in planning, will be installed in the new $22 million bakery being built by the Kitchens of Sara Lee, Deerfield, Ill. The organization freezes its baked goods fresh from ovens. The computer control system will simultaneously direct the production processes and the complex multiple operations of an automated warehouse.

The heart of the control system, designed and developed by the Honeywell Special Systems division, will be the solid-state Honeywell 610 digital computer. In this installation, the computer will execute approximately 180,000 warehouse instructions every three seconds, monitor some 300 process variables and scan inputs from process sensors at a rate of 200 per second to an accuracy of one-tenth of one per cent. Every 15 seconds the computer will calculate and update its memory as to the exact position of every conveyor and pallet in transit. At the same time, it will issue system control commands that are to be executed in the next 15-second interval.

The computer system will be under control of a master program that will permit concurrent operation of more than 100 individual programs. In effect, the master control program will act as a "traffic cop" by making extensive use of priority interrupts. The Honeywell 610 has up to 896 interrupts, in multiples of 16, making it unnecessary for the computer to search programs or scan external events in order to determine what it should do.

From a central control room in the huge plant the computer system will provide strict control of product quality and uniformity by:
1) monitoring the bulk storage status and use of liquid and dry ingredients;
2) monitoring and controlling batch blending and mixing operations using formulations stored in the computer's memory;
3) computing and continuously monitoring the set points of time cycles, oven zone temperatures, speeds of oven conveyors, and other process equipment to insure uniform baking;
4) monitoring product change-overs;
5) directing the random storage of palleted products in a holding freezer;
6) directing their retrieval for shipment on a first-in-first-out basis;
7) directing the assembly in an auxiliary freezer of mixed product pallets.

In addition, the computer system will serve as a data collection center for management by providing, on magnetic and perforated tapes and on log sheets, up-to-the-minute engineering and accounting information.
(For more information, circle 94 on the Readers Service Card.)

WORLD-WIDE AUTOMATION OF AIR FORCE MILITARY PAYROLL

The U.S. Air Force has disclosed plans to process electronically the payroll for over 800,000 military personnel by installing computers at every major Air Force Base throughout the world. The huge computer network will use from 160 to 174 NCR 390 data processing systems, manufactured by the National Cash Register Company, Dayton, Ohio. The computers will be installed at approximately 105 bases in the United States and 25 bases overseas. The new program appears to be the first time that any branch of the armed services has automated the handling of individual pay records on a global, service-wide basis.

The new system is based on the NCR 390's ability to process data electronically and still retain individual "hard-copy" military pay reccrds. Each pay record lists name, service number, pay rate, deductions, and all other pertinent information on the face of the form. The back of the same pay record has magnetic "memory" strips which electronically store the data shown on the face of the form and also provide instructions to the computer. When the airman's pay record is placed in the computer, the stored information is automatically read and the computer calculates the net pay from over 50 possible entitlements and deductions and prints out a pay list. At the same time it punches all data needed for writing the paycheck, into a strip of paper tape which subsequently directs the computer to print all paychecks in one continuous operation. When an airman is transferred to another base his pay record will be forwarded for automatic processing by the computer at his new base.

The increased speed and improved control provided by the new payroll system are expected to save the Air Force hundreds of thousands of dollars.
(For more information, circle 95 on the Readers Service Card.)

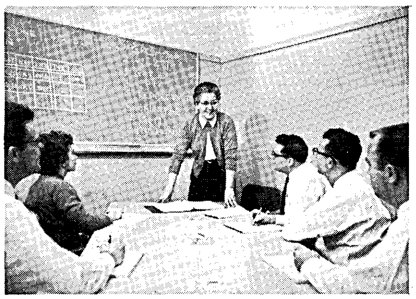
PEOPLE OF NOTE

COMPUTER "WOMAN OF DISTINCTION"

Nancy Lee Tafel is one of a handful of women managers in what up to now has been a man's world -- the computer industry. She heads a team of eight specialists determining new uses for computers at General Electric's Computer Department, Phoenix, Ariz. She is the only woman manager among 150 executives.

Nancy Tafel joined the General Electric Company in its Major Applicance Division, Louisville, in 1951 initially as a secretary; then as specialist in file analysis; and soon thereafter as computer programmer. In 1957 she moved to Phoenix as business-applications specialist for the Company's Computer Department.

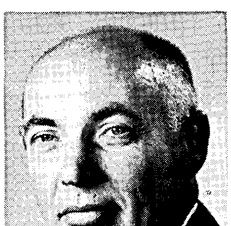
When she was appointed manager, she had already played a major role in developing programming packages for the first all-transistorized electronic data-processing system in banking -- Bank of America's Electronic Recording Method of Accounting -- better known in banking circles as ERMA.



-- Nancy Tafel discusses current developments in General Electric Computer Department "software" programs with some members of her group.

JOHN D. MADDEN JOINS IBM DATA SYSTEMS DIVISION

John D. Madden has joined IBM's Data Systems Division in the capacity of Manager, Programming Technology. Mr. Madden was formerly director of information processing and associate director of research for System Development Corp. In his new post, Mr. Madden will play a major role in the planning and development of programming systems incorporated in IBM's large data processing systems.



Mr. Madden is chairman-elect of the American Federation of Information Processing Societies (AFIPS) and a member of the National Council of the Association for Computing Machinery (ACM). He was chairman of the Los Angeles chapter of ACM from 1958 to 1960.

HONEYWELL EDP NAMES BLOCH A VICE PRESIDENT

Richard M. Bloch has been named a vice president of Honeywell Data Processing. He will continue to specialize in marketing development activities in his new position for the division. Mr. Bloch is the originator of Honeywell EDP's Orthoscanning optical scanning system; Orthotronic Control, an error detection-correction system; and other special data processing systems. He holds several key patents in the data processing industry. Mr. Bloch is a member of numerous professional societies and has authored many technical papers on the data processing industry.

STANDARDS NEWS

ISO RECOMMENDS CONTINUED WORK BY PROGRAMMING LANGUAGE GROUPS

The International Standards Organization Committee on Programming Languages for Computers and Information Processing (ISO/TC 97/SC5) reviewed the work of the American Standards Association working groups on FORTRAN (X3.4.3) and COBOL (X3.4.4) at their recent meeting in Berlin, and recommended that the American groups continue their work and present proposals on FORTRAN, COBOL and COBOL test programs at the next ISO meeting in May 1964 in New York City.

The Subcommittee decided to continue their survey of current programming languages so that information on the extent to which they are actually in use and their fields of application will always be readily available to committee members. Information more than two years old will normally be deleted.

The group also decided to establish a procedure that can be used to evaluate a new language candidate for standardization.

ALGOL 60, which was previously presented to the Subcommittee by the International Federation for Information Processing was considered as the first candidate language, and the Committee asked IFIP to make proposals by January, 1963 relating to an ALGOL subset, Input-Ouput facilities to the full ALGOL, and media code representations of ALGOL symbols for punched cards and 5 to 8 channel punched tape.

Delegations to the conference came from France, Germany, Italy, the Netherlands, Sweden, United Kingdom, and the U.S.A. Denmark sent an observer, and representatives of the European Computer Manufacturers Association and IFIP were also participants.

MEETING NEWS

IDP CONFERENCE REVIEW

The 1963 International Data Processing Conference drew more than 8000 people to Detroit's Cobo Hall, June 25-28, to see a business exposition, featuring equipment and services of nearly 100 firms. It was the largest exposition in the 12-year history of the conference, sponsored by the Data Processing Management Association (DPMA).

Some 2100 data processing executives attended seminar discussions conducted by computer experts from major equipment manufacturers, educational institutions and government agencies. The seminars covered three subject areas: data processing management, computer management, and punched card management.

Foreign delegates included a ten-man party sent to the U.S. by the Nippon Office Management Association, Tokyo, to study newest management procedures and equipment developed in this country. Data processing techniques used by Japan's larger corporations are comparable to those used in this country, according to Yoshino Mayuke, leader of the study team and manager of the EDP department, Nomura Securities Co., Ltd., but smaller companies in Japan lag far behind in EDP techniques, he added. Mayuke and his companions are members of the Tokyo chapter of the DPMA.

Another foreign visitor to the convention was Wilhelm E. Ludwig of Stuttgart, West Germany, president of Unimatronic, Kg. Ludwig, who represents American electronic manufacturers in West

Germany, said data processing management, equipment and techniques in Germany, and in Western Europe generally, are comparable to those used in this country. "There is a difference in the way we hold conventions, however," he said. "We have broad industrial shows such as the Hanover Fair where several thousand companies from all sectors of industry may display their goods. Conventions such as DPMA, which confine themselves to a particular field, allow for greater depth of investigation and are more fruitful for their specialized audience."

The similarity among the advanced industrial countries in their use of data processing management techniques was noted by Ray R. Eppert, president of the Burroughs Corp., in his keynote speech. "Cultural differences become blended... In an individual corporation, this means that traditional lines between domestic and international operations must be blurred. All company executives -- not just those in an international division -- must become world market oriented."

At the DPMA convention, Robert S. Gilmore of Information, Inc., Torrance, Calif., was elected international president of the association for 1963-64, succeeding Elmer F. Judge of Cessna Aircraft Co., Wichita, Kansas. The new executive vice president is John K. Swearingen of General Electric Co., Louisville, Ky., and the secretary-treasurer is Dell L. Haggard of Peoria, Ill.

Several million dollars worth of electronic equipment from virtually every major computer firm was demonstrated during the four-day show.

Highlights included:

- The Burroughs Corporation medium-scale B280 computer system equipped with two high-speed printers processing four jobs at once.
- A new desk-size computer, the 6010, shown for the first time in the United States by Friden, Inc.
- International Business Machines' 1440 system with disc storage and the company's 6400 ledger processing equipment.
- The 1004 punched card processing machine shown by the Univac division of Sperry Rand Corporation.
- NCR's Card Random Access Memory (CRAM) which features replaceable packets for use with the firm's 315 data processing system.
- The General Electric 225 computer featuring interrogation of the computer by teletype on an inventory control application.
- A "voice answering" device with Honeywell 400 computer, a new development from this company.
- And an RCA general purpose 301 computer on production scheduling, inventory control, and subscription fulfillment.

ACM-NCA BANKING SYMPOSIUM

National Computer Analysts, Inc., of Princeton, N.J. was host to a recent Banking Automation Symposium in Princeton, N.J. Over 175 people representing banks and savings institutions, manufacturers and service organizations, and the federal government attended the meeting. The theme of the sessions was set by Mr. John J. Sheehan, Vice President of NCA, who said in his keynote address, "the computer in banking is evolving to a role as an income producer as well as an expense reducer."

"Creative new services such as, checkless cashless payrolls, budget financing, and mass payment collections are currently under development." He went on to say that such services "enable the bank to develop markets heretofore inaccessible because of the lack of adequate technology."

Mr. William R. Cosby, President, Princeton Bank and Trust Company, remarked that the "banking industry must be aware of new markets and new services" and emphasized the necessity of "team work in approaching management problems." He further stated that Comptroller of the Currency, James J. Saxon, was performing a distinct service to banking by his critical appraisals of current bank regulations.

In a following paper, Mr. Roy M. Freed, Esq., of the Philadelphia law firm of Blank, Rudenko, Klaus, and Rome, highlighted neglected areas in the legal implications of banks acquiring, using, and selling data processing services. Mr. Freed said, "that authorized outside processors are subject to the same examination and regulation by the government, as the bank is for which it does processing." This alleviates the fears of some banks to have their work performed by outside service bureaus.

In other papers presented at the Symposium, Dr. James B. Eckert, Chief, Banking Section, Division of Research and Statistics, Federal Reserve Board, Washington, D.C., emphasized the importance of proper account classification in the designing of automated systems for banks; Mr. George J. Leibowitz, Director, Systems Development Division, Internal Refenue Service, Washington, D.C., outlined the impact of new IRS reporting requirements as concerns interest paid on deposits; and Mr. Jack P. Besse, Assistant Cashier, Data Processing and Planning, Federal Reserve Bank of Philadelphia, Pennsylvania, highlighted the various aspects of off-site processing as seen from a bank examiner's viewpoint.

BUSINESS NEWS

ELECTRICAL MACHINERY MAKERS EXPECT GAINS IN 3RD QUARTER

A study just completed by the Industry Studies Department of Dun & Bradstreet reports the 1963 third quarter outlook, as seen by electrical machinery manufacturers, is optimistic as compared with the third quarter of 1962. Of executives interviewed in the survey, 64% expect a sales gain. This is 1% above the expectations for all manufacturers. Only 36% feel sales will continue at present levels.

To handle this upswing in business, 23% of the electrical manufacturers expect to add employees. This contrasts markedly with all manufacturers of whom only 15% expect an increase in the number of employees and 4% expect a decline.

Of 1538 manufacturers, wholesalers and retailers questioned, manufacturers were the most optimistic. But, surprisingly, the optimism expressed is below the level for the same period in 1962. Businessmen apparently are not impressed with the present growth rate and are doubtful whether it will continue at the level recorded so far in 1963.

The ability of the electrical machinery manufacturers to translate sales increases into increased profits appears in doubt. Only 43% expressed expectations of gains in net profits for the third quarter while 54% felt there would be no change. This is substantially below the expectations of all manufacturers.

Contributing to this uncertain profit situation is the indication that only 9% of electrical machinery executives expect an increase in selling prices. This contrasts sharply with the hopes of 14% of all manufacturers for price increases. Of the electrical machinery manufacturers 29% expect a gain in inventory levels while only 4% foresee a decline. Manufacturers collectively expect a much lower rate of inventory accumulation.

Businessmen generally indicate that new orders may dip slightly in the third quarter of 1963 as compared to the same period in 1962. But electrical machinery manufacturers appear more confident about new orders than do all manufacturers.

Electrical machinery manufacturers expect profit increases in the third quarter and have stressed new product development and improvement to obtain sales gains, says Dun & Bradstreet's Industry Studies Department. Improved advertising techniques and expansion of sales plans are to be used to accelerate sales efforts.

DIGITRONICS REVENUES INCREASE 130%

An increase of 130% in gross revenues is reported by Digitronics Corporation, manufacturer of electronic data processing and transmission equipment for the fiscal year ended March 31. Sales of equipment doubled, while rentals of its Dial-o-verter high-speed transmission systems quadrupled to bring total revenues to $4,187,000, as compared with $1,818,000 in the previous year.

Earnings before taxes equalled $451,000, showing an increase of nearly 85% over the $244,000 reported a year earlier.

Deliveries in the last quarter of the fiscal year were several times larger than in any quarter in the company's history. The total backlog at May 31st was $3,126,000, compared to $2,900,000 reported a year earlier.

The Dial-o-verter System, created by Digitronics, transmits data at high speeds over regular telephone lines. Dial-o-verter terminals currently are operating in 175 installations in 60 cities throughout the country. Trans-Atlantic service, inaugurated last September between New York and London for Socony Mobil Oil Co. is being extended to France and the Common Market with transmission for The New York Times and Time, Inc., over the cables of the French Cable Co.

	Year Ended 3/31/63	Year Ended 3/31/62
Gross Revenues	$4,187,075	$1,818,428
Gross Profit	1,609,924	800,924
Earnings Before Taxes	451,285	244,839
Net Earnings	222,285	141,839
Per Share	43.7¢	31.2¢

LFE RECORDS LOSS

A net loss of $340,000 after a federal income tax credit of $329,000 for the fiscal year ended April 26, 1963, is reported by Laboratory For Electronics, Inc. Consolidated gross income amounted to $60,901,000. These figures compare with a net income of $102,000, after federal income taxes, on gross income of $61,483,000 for the previous year.

According to Henry W. Harding, LFE president, "The loss was caused principally by the operations of the Tracerlab and Keleket Divisions. Reorganization of management and facilities, improvement of existing products, and development of new products resulted in heavy costs and operating losses, especially during the last half of the year."

Commenting on the operating results of other LFE divisions, Mr. Harding said, "Sales of Eastern Industries and Automatic Signal Divisions were more than 20 per cent over the preceding year and were accompanied by a substantial improvement in earnings.

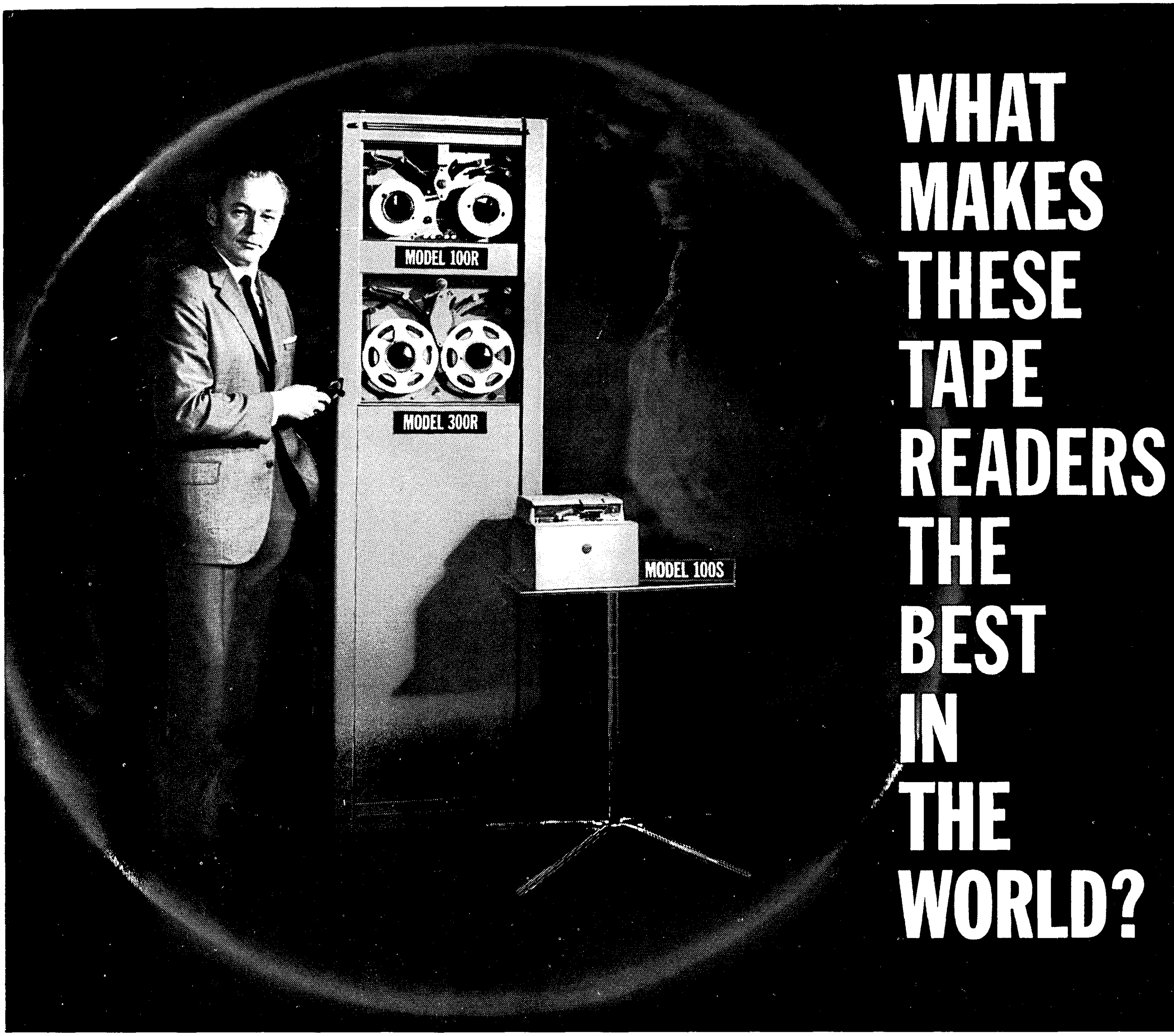
"Gross income of the Electronics Division declined somewhat during the year, reflecting the phasing out of the F-105 Doppler navigation program. However, profit margins improved as a result of substantial reductions in overhead expenses, so that the effect of the reduced volume was minimized."

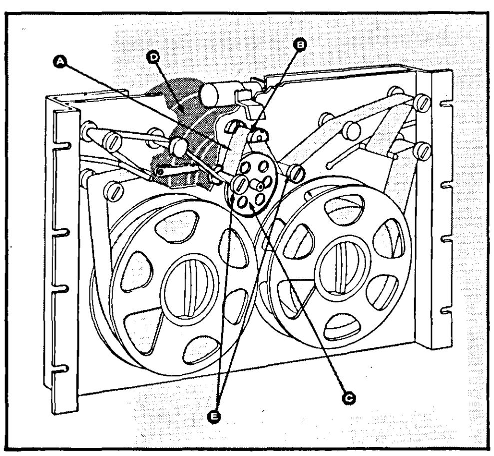
USEFUL PUBLICATIONS

NEW PERT CHART AVAILABLE

A new aid to PERT network construction is available. It is the PERT TIMER, a newly designed alignment chart which shows the probabilistic times required for PERT networks, including the variability of time estimates and the probabilities for completing on schedule. The one page chart is available without charge.
(For more information, circle 96 on the Readers Service Card.)

Circle No. 8 on Readers Service Card →





Mechanical simplicity . . . which yields a degree of reliability unattainable by any other paper tape reader! Simplicity made possible through the utilization of the revolutionary PMI printed motor direct drive servo. Movement of the tape through the read head is achieved by merely starting and stopping a printed motor. The brakes, clutches and pinch rollers that cause big trouble and down time in conventional tape transports are completely eliminated.

Line by line cycle: movement of tape (A) over read head (B) is controlled by drive capstan (C)—attached directly to shaft of PMI printed motor* (D); spring-loaded rollers (E) hold tape gently against capstan, keeping tape movement in exact accord with capstan rotation; advance command pulse accelerates motor, capstan, and tape; as read head detects next sprocket hole, a reverse pulse to motor halts capstan and tape with next character perfectly aligned in read head. **U.S. Patents of Printed Motors, Inc. Pending.*

PHONE, WIRE OR WRITE FOR COMPLETE INFORMATION

Photocircuits
CORPORATION
TAPE READER DIVISION
Glen Cove, N. Y.

MONTHLY COMPUTER CENSUS

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

To aid our readers in keeping up with this mushrooming activity, the editors of COMPUTERS AND AUTOMATION present this monthly report on the number of American-made general purpose computers installed or on order as of the preceding month. We update this computer census monthly, so that it will serve as a "box-score" of progress for readers interested in following the growth of the American computer industry.

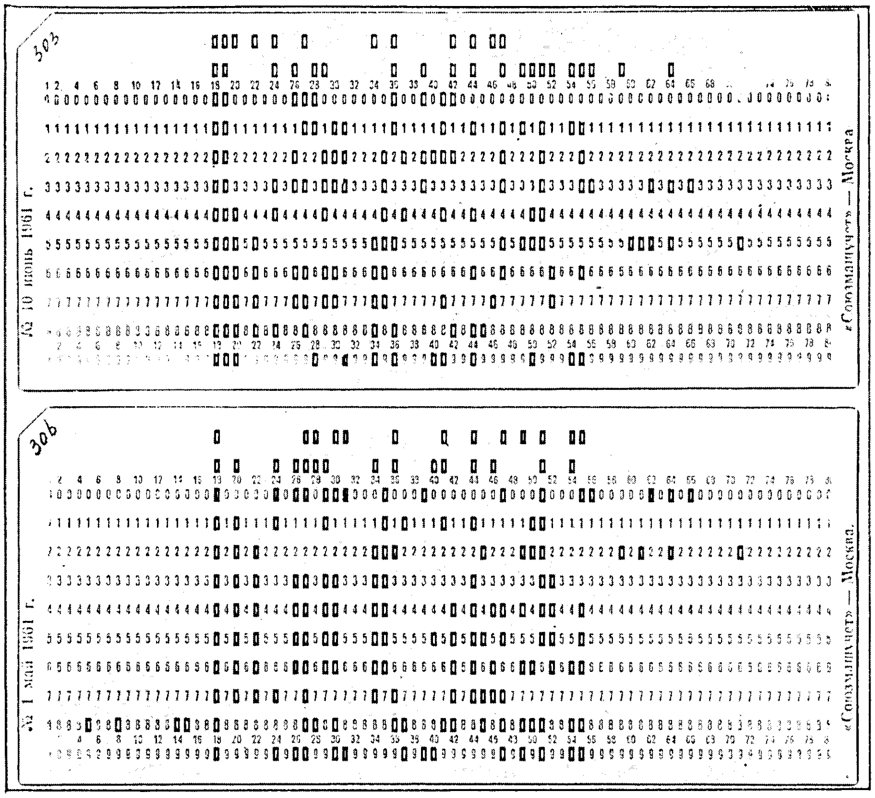
Most of the figures are verified by the respective manufacturers. In cases where this is not so, estimates are made based upon information in the reference files of COMPUTERS AND AUTOMATION. The figures are then reviewed by a group of computer industry cognoscenti.

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

AS OF JULY 20, 1963

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	12	10
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	9	3
	ASI 420	Y	$12,500	2/63	1	X
Autonetics	RECOMP II	Y	$2495	11/58	125	X
	RECOMP III	Y	$1495	6/61	32	X
Burroughs	205	N	$4600	1/54	70	X
	220	N	$14,000	10/58	48	X
	E101-103	N	$875	1/56	154	X
	B250	Y	$4200	11/61	60	35
	B260	Y	$3750	11/62	40	44
	B270	Y	$7000	7/62	24	26
	B280	Y	$6500	7/62	25	22
	B5000	Y	$16,200	3/63	8	20
Clary	DE-60/DE-60M	Y	$525	2/60	131	4
Computer Control Co.	DDP-19	Y	$2800	6/61	3	X
	DDP-24	Y	$2750	5/63	1	10
	SPEC	Y	$800	5/60	10	0
Control Data Corporation	G-15	N	$1000	7/55	300	1
	G-20	Y	$15,500	4/61	22	2
	160/160A	Y	$1750/$3000	5/60 & 7/61	310	25
	924/924A	Y	$11,000	8/61	10	14
	1604/1604A	Y	$35,000	1/60	52	8
	3600	Y	$52,000	6/63	2	5
	6600	Y	$120,000	2/64	0	1
Digital Equipment Corp.	PDP-1	Y	Sold only about $120,000	11/60	42	9
	PDP-4	Y	Sold only about $60,000	8/62	16	10
	PDP-5	Y	Sold only about $25,000	11/63	0	2
El-tronics, Inc.	ALWAC IIIE	N	$1820	2/54	32	X
General Electric	210	Y	$16,000	7/59	75	5
	215	Y	$5500	-/63	0	22
	225	Y	$7000	1/61	125	73
	235	Y	$10,900	-/64	0	5
General Precision	LGP-21	Y	$725	12/62	20	41
	LGP-30	semi	$1300	9/56	395	5
	L-3000	Y	$45,000	1/60	1	0
	RPC-4000	Y	$1875	1/61	90	18
Honeywell Electronic Data Processing	H-290	Y	$3000	6/60	10	1
	H-400	Y	$5000	12/61	56	76
	H-800	Y	$22,000	12/60	50	11
	H-1400	Y	$14,000	5/64	0	4
	H-1800	Y	$30,000 up	11/63	0	2
	DATAmatic 1000	N	-	12/57	5	X
H-W Electronics, Inc.	HW-15K	Y	$490	6/63	1	2

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
IBM	305	N	$3600	12/57	790	X
	650-card	N	$4000	11/54	670	X
	650-RAMAC	N	$9000	11/54	190	X
	1401	Y	$3500	9/60	6100	2700
	1410	Y	$12,000	11/61	210	365
	1440	Y	$1800	9/63	0	1050
	1460	Y	$9800	10/63	0	56
	1620	Y	$2000	9/60	1390	250
	701	N	$5000	4/53	4	X
	7010	Y	$19,175	2/64	0	32
	702	N	$6900	2/55	4	X
	7030	Y	$160,000	5/61	6	X
	704	N	$32,000	12/55	71	X
	7040	Y	$14,000	6/63	10	42
	7044	Y	$26,000	6/63	3	14
	705	N	$30,000	11/55	140	X
	7070, 2, 4	Y	$24,000	3/60	430	215
	7080	Y	$55,000	8/61	50	24
	709	N	$40,000	8/58	33	X
	7090	Y	$64,000	11/59	270	87
	7094	Y	$70,000	9/62	12	16
	7094 II	Y	$76,000	4/64	0	2
Information Systems, Inc.	ISI-609	Y	$4000	2/58	19	1
ITT	7300 ADX	Y	$35,000	7/62	6	2
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only - $5800	3/58	175	2
	Monrobot XI	Y	$700	12/60	265	207
National Cash Register Co.	NCR - 102	N	. -	-	28	X
	- 304	Y	$14,000	1/60	29	0
	- 310	Y	$2000	5/61	41	42
	- 315	Y	$8500	5/62	82	130
	- 390	Y	$1850	5/61	389	320
Packard Bell	PB 250	Y	$1200	12/60	150	15
	PB 440	Y	$3500	9/63	0	10
Philco	1000	Y	$7010	6/63	1	23
	2000-212	Y	$52,000	1/63	2	7
	-210, 211	Y	$40,000	10/58	21	8
Radio Corp. of America	Bizmac	N	-	-/56	4	X
	RCA 301	Y	$6000	2/61	256	245
	RCA 501	Y	$15,000	6/59	81	14
	RCA 601	Y	$35,000	11/62	2	6
Scientific Data Systems Inc.	SDS-910	Y	$1700	8/62	17	41
	SDS-920	Y	$2690	9/62	13	15
Thompson Ramo Wooldridge, Inc.	TRW-230	Y	$2680	7/63	0	8
	RW-300	Y	$6000	3/59	37	2
	TRW-330	Y	$5000	12/60	11	18
	TRW-340	Y	$6000	12/63	0	4
	TRW-530	Y	$6000	8/61	18	6
UNIVAC	I & II	N	$25,000	3/51 & 11/57	52	X
	Solid-State II	Y	$8500	9/62	14	23
	III	Y	$20,000	8/62	6	59
	File Computers	N	$15,000	8/56	65	0
	60 & 120	N	$1200	-/53	860	8
	Solid-state 80, 90, & Step	Y	$8000	8/58	538	120
	490	Y	$26,000	12/61	7	9
	1004	Y	$1500	2/63	100	1475
	1050	Y	$7200	9/63	0	2
	1100 Series (except 1107)	N	$35,000	12/50	25	X
	1107	Y	$45,000	10/62	4	12
	LARC	Y	$135,000	5/60	2	X
X -- no longer in production				TOTALS	16,070	8,203



Two of the punch cards coded.

MAYA WRITING

(Continued from Page 11)

The First Results

Before long, the scientists read the first sentences: "Kavil, the God of Maize, fires vessels of white clay . . . ," "The God of Death fires vessels of white clay . . . ," "Jaguar [the name of a deity] fires vessels of white clay . . . ," "The land of the God of Death . . . ," "The land of the God of Maize . . . ," "The food of the God of Death . . . ," "There is a holiday in the land of Itsamn [the name of a deity] . . . ," "The God of War—the women's burden." The mysterious manuscripts received a voice.

No Guarantee of Final Accuracy

"Of course, in the solution of such problems," said the scientists, "there is no guarantee of absolute truth. We give only the most probable solution with the given amount of information. If the initial amount of information were greater, the solution naturally would have been more exact.

"We confined ourselves only to two manuscripts; the Paris manuscript was not used, in view of its physical deterioration. Moreover, the manuscripts contain many errors introduced by the ancient scribes, and many half-obliterated characters. The names of the gods, for instance, are represented by drawings or portraits and not by phonograms. They were identified tentatively. We have accomplished only a part of the work; researchers in the future will have more to do.

"The system of programs we have worked out for the Maya manuscripts can be applied to many other linguistic tasks. Also the Madrid and Dresden manuscripts still require careful study and additional work. There is much that the philologists could ponder over, considering particularly that the manuscripts represent a kind of syllabus for priests in performing various rites. They are not always coherent. The sentences are often short and fragmentary."

The Siberian scientists took 10 months (from April 1960 to January 1961) to carry out the investigation.

They proved the expediency of applying electronic computers in certain problems of historical science and its auxiliary divisions—archeology, numismatics, paleography, as well as decipherment of unknown writing.

Reference

The work done is being reported in a four-volume work (over 1,000 pages long), "The Application of Electronic Computers to the Study of the Written Language of Ancient Maya," issued by the Siberian Branch of the USSR Academy of Science, published at Novosibirsk, 1961-1963.

CALENDAR OF COMING EVENTS

Aug. 4-9, 1963: International Conference and Exhibit on Aerospace Support, Sheraton-Park Hotel, Washington, D. C.; contact F. K. Nichols, Air Defense Div. Directorate of Operations, DSC/O Hdqs., USAF, Washington 25, D. C.

Aug. 8-9, 1963: 6th Annual Summer Conference, Pacific Science Center, Seattle, Wash.; contact Harold Ostling, Secy., Northwest Computing Association, P. O. Box 836, Seahurst, Wash.

Aug. 20-23, 1963: Western Elec. Show and Conference (WESCON), Cow Palace, San Francisco, Calif.; contact WESCON, 1435 La Cienega Blvd., Los Angeles, Calif.

Aug. 27-Sept. 4, 1963: 2nd International Congress on Automatic Control Swiss Industries Fair, Basle, Switzerland; contact R. M. Emberson, Professional Groups Secretary, IEEE, Box A, Lenox Hill Station, New York 21, N. Y.

Aug. 28-30, 1963: Association for Computing Machinery, Annual Meeting, Denver, Colo.

Sept. 9-11, 1963: 7th National Convention on Military Electronics (MIL-E-CON 7), Shoreham Hotel, Washington, D. C.; contact L. D. Whitelock, Exhibits Chairman, 5614 Greentree Road, Bethesda 14, Md.

Sept. 9-12, 1963: 18th Annual ISA Instrument-Automation Conference & Exhibit, McCormick Place, Chicago, Ill.

Sept. 9-12, 1963: International Symposium on Analog and Digital Techniques Applied to Aeronautics, Liege, Belgium; contact M. Jean Florine, 50, Avenue F. D. Roosevelt, Brussels 5, Belgium.

Sept. 16-20, 1963: 2nd Institute on Electronic Information Display Systems, The American University, SGPA, The Center for Technology and Administration, 1901 F St., N.W., Washington 6, D. C.; contact Dr. Lowell H. Hattery, The American University, Washington 6, D. C.

Sept. 23-27, 1963: International Telemetering Conference, London Hilton Hotel, London, England; contact F. G. McGavock Associates, 3820 E. Colorado Blvd., Pasadena, Calif.

Oct., 1963: 10th Annual Meeting, PGNS 2nd International Symposium on Aerospace Nuclear Prop. and Power

Oct. 1-3, 1963: 8th Annual National Space Electronics Symposium, Hotel Fontainebleau, Miami Beach, Fla.; contact Hugh E. Webber, Martin Co., Orlando, Fla.

Oct. 7-9, 1963: 9th National Communications Symposium, Hotel Utica, Utica, N. Y.

Oct. 8-11, 1963: Int'l on Electromagnetic Relays, Tohoku University, Sendai, Japan; contact C. F. Cameron, School of Eng., Oklahoma State University, Stillwater, Okla.

Oct. 14-15, 1963: Materials Handling Conference, Chamberlain Hotel, Newport News, Va.; contact R. C. Tench, C & O Rlwy Co., Rm. 803, C & O Bldg., Huntington 1, W. Va.

Oct. 14-16, 1963: Systems and Procedures Association, 16th International Systems Meeting, Hotel Schroeder, Milwaukee, Wis.; contact Systems & Procedures Association, 7890 Brookside Dr., Cleveland 38, Ohio

Oct. 17, 1963: 4th Annual Technical Symposium, University of Maryland, Baltimore, Md.; contact Hugh Nichols, Dunlap and Associates, Inc., 7220 Wisconsin Ave., Bethesda, Md.

Oct. 21-23, 1963: East Coast Conference on Aerospace & Navigational Electronics (ECCANE), Baltimore, Md.

Oct. 24-25, 1963: Symposium on Automatic Production in Electrical and Electronic Engineering, The Institution of Electrical Engineers, Savoy Place, London W. C. 2, England

Oct. 28-30, 1963: 19th Annual National Electronics Conference and Exhibition, McCormick Place, Chicago, Ill.; contact Prof. Hansford W. Farris, Electrical Engineering Dept., Univ. of Mich., Ann Arbor, Mich.

Oct. 28-Nov. 1, 1963: Business Equipment Manufacturers Assn. Exposition and Conference, New York Coliseum, New York, N. Y.; contact Richard L. Waddell, BEMA, 235 E. 42nd St., New York 17, N. Y.

Oct. 29-31, 1963: 10th Annual Mtg. PGNS 2nd Intn'l Symposium on Plasma Phenomena & Meas., El Cortez Hotel, San Diego, Calif.; contact H. A. Thomas, Gen. Atomics Div., Genl. Dynamics, San Diego, Calif.

Nov. 4-6, 1963: NEREM (Northeast Research and Eng. Meeting), Boston, Mass.; contact NEREM-IRE Boston Office, 313 Washington St., Newton, Mass.

Nov. 4-8, 1963: 10th Institute on Electronics in Management, The American University, 1901 F St., N.W., Washington 6, D. C.; contact Marvin M. Wofsey, Asst. Director, Center for Technology and Administration, The American University, Washington 6, D. C.

Nov. 10-15, 1963: 9th Annual Conference on Magnetism and Magnetic Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.; contact Mr. C. J. Kriessman, Physics, Materials and Processes Sec., Box 500, Blue Bell, Pa.

Nov. 12-14, 1963: Fall Joint Computer Conference, Las Vegas Convention Center, Las Vegas, Nev.; contact Mr. J. D. Madden, System Development Corp., Santa Monica, Calif.

Nov. 18-20, 1963: 1963 Radio Fall Meeting, Manger Hotel, Rochester, N. Y.; contact EIA Engineering Dept., Room 2260, 11 W. 42 St., New York 36, N. Y.

Nov. 18-20, 1963: 16th Annual Conference on Engineering in Medicine and Biology, Lord Baltimore Hotel, Baltimore, Md.; contact Richard Rimbach Associates, 933 Ridge Ave., Pittsburgh 12, Pa.

Nov. 19-21, 1963: Fifth International Automation Congress and Exposition, Sheraton Hotel, Philadelphia, Pa.; contact International Automation Congress & Exposition, Richard Rimbach Associates, Management, 933 Ridge Ave., Pittsburgh 12, Pa.

Dec. 5-6, 1963: 14th Nat'l Conference on Vehicular Communications, Dallas, Tex.; contact A. C. Simmons, Comm. Industries, Inc., 511 N. Akard, Dallas, Tex.

Feb. 3-7, 1964: ASTM International Conference on Materials, Sheraton Hotel, Philadelphia, Pa.; contact H. H. Hamilton, American Society for Testing and Materials, 1916 Race St., Philadelphia 3, Pa.

Feb. 5-7, 1964: 5th Winter Conv. on Military Electronics (MILECON), Ambassador Hotel, Los Angeles, Calif.; contact IEEE L. A. Office, 3600 Wilshire Blvd., Los Angeles, Calif.

Feb. 12-14, 1964: International Solid-States Circuits, Sheraton Hotel & Univ. of Pa.

Feb. 26-28, 1964: Scintillation and Semiconductor Counter Symposium, Washington, D. C.

Mar. 23-26, 1964: IRE International Convention, Coliseum and New York Hilton Hotel, New York, N. Y.; contact E. K. Gannett, IRE Hdqs., 1 E. 79 St., New York 21, N. Y.

Apr. 21-23, 1964: 1964 Spring Joint Computer Conference, Sheraton-Park Hotel, Washington, D. C.; contact Zeke Seligsohn, Pub. Rel. Chairman, 1964 SJCC, 326 E. Montgomery Ave., Rockville, Md.

Apr. 22-24, 1964: SWIRECO (SW IRE Conf. and Elec. Show), Dallas Memorial Auditorium, Dallas, Tex.

ADVERTISING INDEX

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

NEW PATENTS

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

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

May 14, 1963

3,089,961 / William M. Overn, Richfield, and Arthur V. Pohm, White Bear Lake, Minn. / Sperry Rand Corp., New York, N. Y., a corp. of Delaware / Binary Logic Circuits Employing Transformer and Enhancement Diode Combination.

3,090,034 / George W. Fredericks, Woodhaven, and William J. Lamneck, Jamaica, N. Y. / Bell Telephone Laboratories, Inc., New York, N. Y., a corp. of New York / Parallel-to-Serial Converter Apparatus.

3,090,035 / Smil Ruhman, Waltham and Elmer T. Johnson, Watertown, Mass. / Raytheon Company, Lexington, Mass., a corp. of Delaware / Digital Computing Systems.

3,090,037 / Victor T. Shahan, Wappingers Falls, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Magnetic Memory.

May 21, 1963

3,090,828 / George W. Bain, Fort Wayne, Ind. / International Telephone and Telegraph Corp. / System for Large-Area Display of Information.

3,090,836 / Wincenty Bezdel, London, England / International Standard Electric Corp., New York, N. Y., a corp. of Delaware / Data-Storage and Data-Processing Devices.

3,090,923 / Hermann P. Wolff, Millbrook, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Logic System, Using Waves Distinguishable as to Frequency.

3,090,943 / Willard D. Lewis, Mendham, N. J. / Bell Telephone Laboratories, Inc., New York, N. Y., a corp. of N. Y. / Serial Digital Data Processing Circuit.

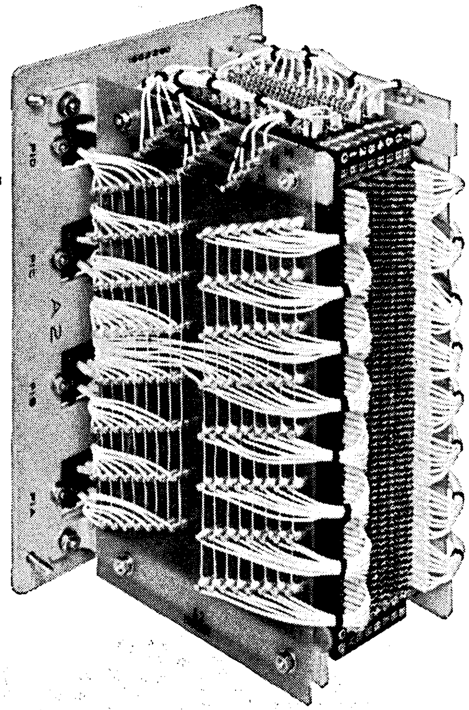
3,090,946 / Andrew H. Bobeck, Chatham, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of New York / Electric Information Handling Circuits.

3,090,947 / George G. Hoberg, Berwyn, Pa., and Otto Hohnecker, Midland Park, N. J. / Burroughs Corp., Detroit, Mich., a corp. of Michigan / Magnetic Storage System.

May 28, 1963

3,091,700 / Samuel D. Harper, Auburndale, Mass. / Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a corp. of Delaware / Electrical Digital Coding Apparatus.

every bit assured...



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