COMPUTERS
AND
AUTOMATION

CYBERNETICS · ROBOTS · AUTOMATIC CONTROL

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1956

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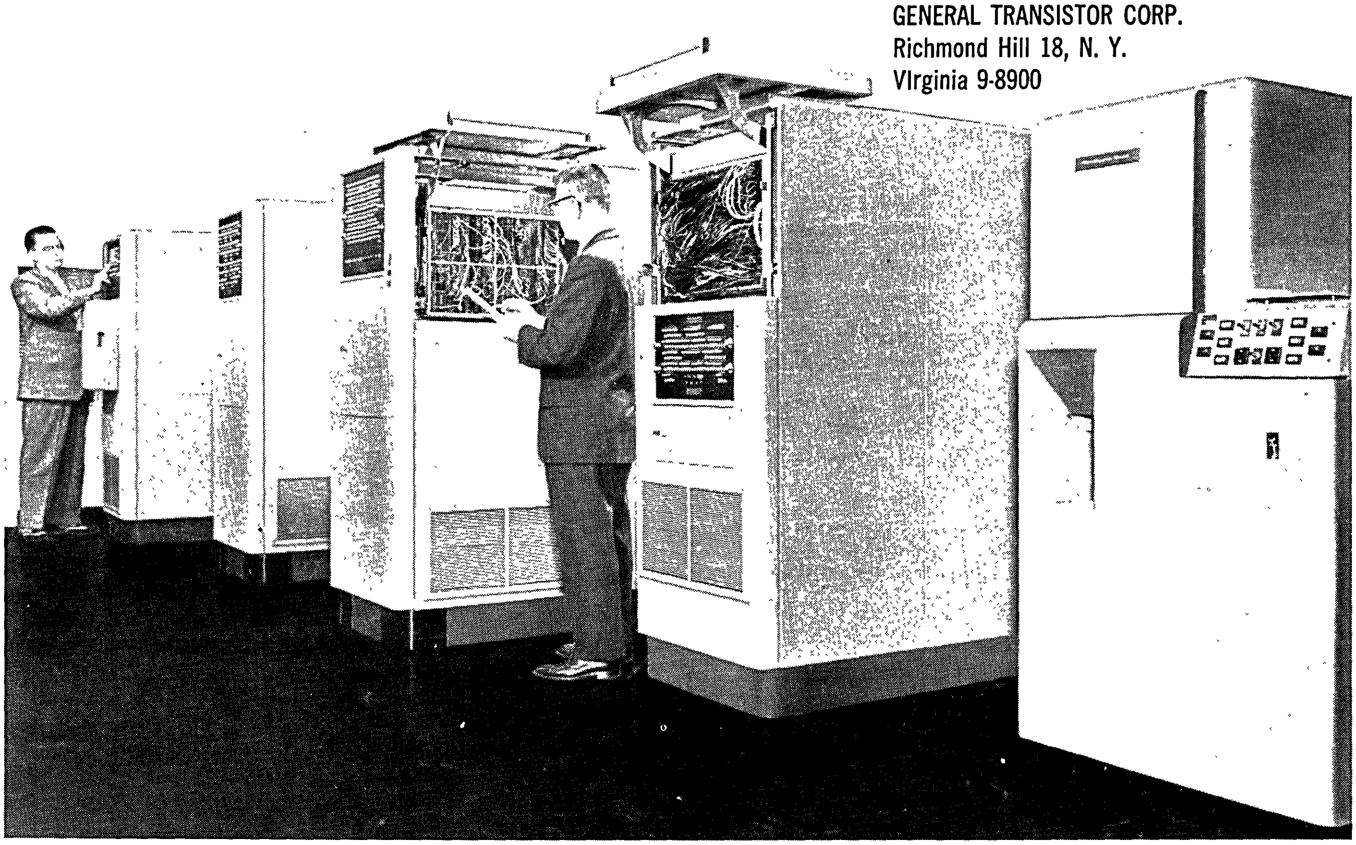

COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

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THE EDITOR'S NOTES

THE GLOSSARY REPRINTED

To our surprise, the October 1956 issue of "Computers and Automation" containing the 4th edition (cumulative) "Glossary of Terms in the Field of Computers and Automation" is almost exhausted. 3000 copies of the issue were printed; somewhat over 2450 were sent to subscribers; over 400 single copies have been sold; only about 125 are left.

Accordingly, we have reprinted the glossary. It is available at $1 a copy with discounts for quantity orders.

We have received a number of requests for permission to reprint the glossary free. We are reluctant to grant such permission, since the glossary represents a great deal of work done by members of the staff of "Computers and Automation", except in special and unusual cases, as for example translation into a foreign language. But we shall be glad to fill orders for copies of the glossary in quantity at a discount.

WHO'S WHO IN THE COMPUTER FIELD, 1956-57

This extra number of "Computers and Automation" will according to present plans contain the names and addresses of all computer people we know of, and the estimate is still over 10,000. The last permission to publish addresses from one of the contributors of names has been unofficially given.

We expect to close the main part of the Whp's Who listings on November 30. Supplements, corrections, and changes will as usual be published from time to time in current issues of "Computers and Automation".

NEWS RELEASES

We have long resisted the flood tide of information from advertising agencies and publicity bureaus in which literature advertising products puts on the mask of news. But some kinds of releases of information in this general class actually contain news which we believe is of some interest to computer people. In this issue accordingly, we begin publication of selected "News Releases".

GREETINGS TO COMPUTERS

Christmas is coming — and we wish our subscribers, our readers, and all computer people:

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                        O O L
HOLIDAY ) G R E E T I N G S
          H O L I D A Y
            E I L D L E G
            H O L I D A Y
            O N R N L S O S
            O N L S L T G L
                I R T N N A

                    G I T = H Y D
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and 37983 06839 37830 01611

(Solve for the digits; each letter stands for just one digit 0 to 9, although one digit may be represented by more than one letter.)

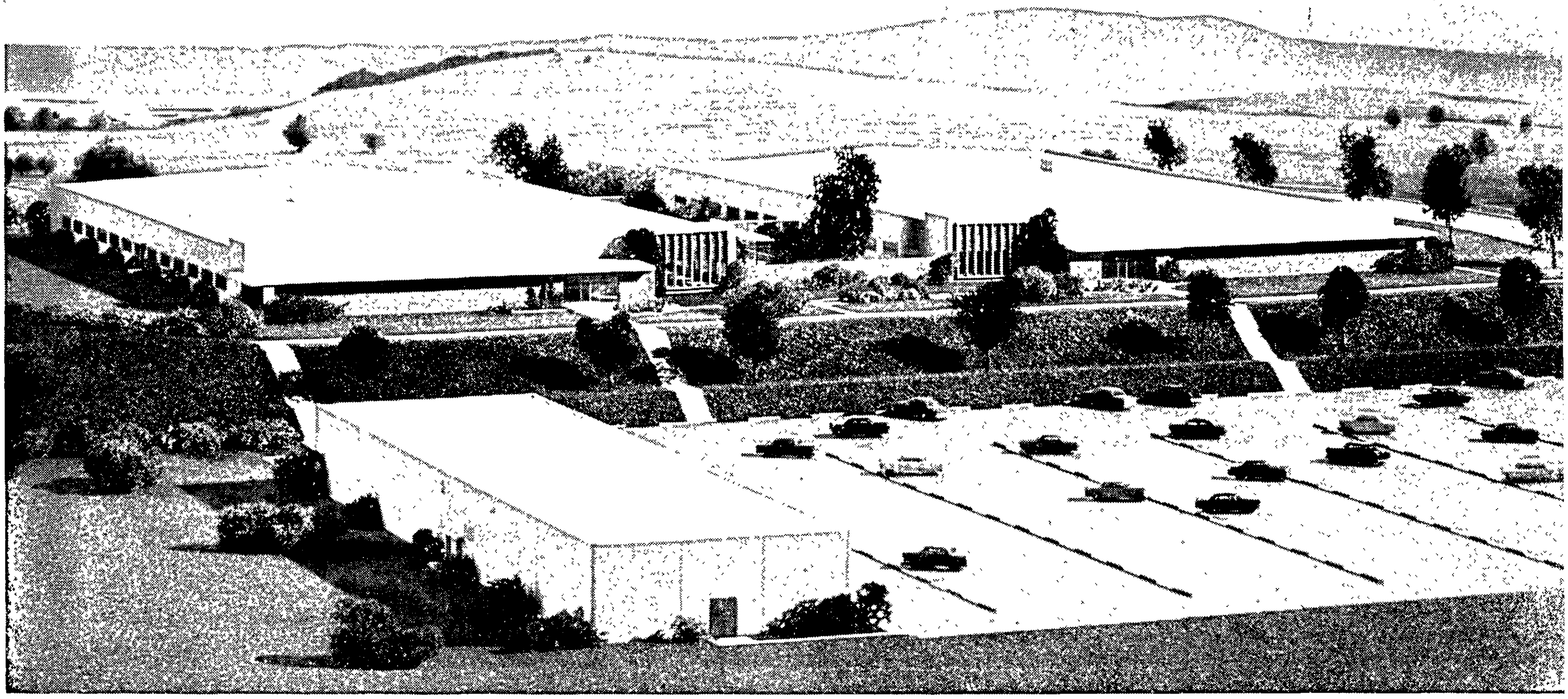
This is a Numble, a number puzzle for a nimble mind; for hints for solution, write us. The solution will appear in January.

We shall be most interested to learn of the programming of any automatic computer to solve this kind of problem. The challenge, offered now for the third December, remains unanswered, so far as we know.

——————————*

INDEX OF NOTICES

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



INDEXING FOR RAPID RANDOM ACCESS MEMORY SYSTEMS

ARNOLD I. DUMEY
Roslyn Heights, N.Y.

A number of memory devices are on the market, or under development, which have the following characteristics:

1. A storage unit contains a large number of addressable locations, say between 50,000 and a million.

2. Each location stores from 50 to 200 characters.

3. Access to a location takes a small time, from a few hundred milliseconds to several seconds.

4. Access time varies within small limits, i.e., the present situation of the read-out device does not influence the time required to get it to its next position.

5. Read-out time is relatively fast.

6. Calls to the memory do not have to be preordered, i.e., they arrive in random order. It is the randomness of the calls which suggested the terminology "random access memory".

Some of the publicized mechanisms of this type are, Mass (Multiple Access Storage System) of Telecomputing Corporation, Ram of Potter Instrument Company, the Ramac 650 and 305 "jukebox" of IBM, and the high density magnetic drum of LFE.

In many situations such devices are useful just as they stand. For example, items in an inventory may be numbered from 00001 to 50,000. In the addressable location corresponding to 37415 we may store the useful information on the item having that number. Such information may be its cost, quantity on hand, reorder point, warehouse location, etc. Let us call the item number, which is the name of the thing we want to find information on, the item description. The information which is in the file, and which we want to see, we will call the stored information, or simply, information.

Item descriptions of the type last described are controlled, which means they have been assigned by the organization which runs the filing system. By means of this control, the user of the memory is able to save himself the trouble of finding out where information about an item is stored in the memory. Thus, an employer of several thousand people can control "time clock numbers" so that they fall in the range 1 to 10,000. A telephone company can control its telephone books by maintaining "reverse telephone books" which are used to find the subscriber's name and address, when his phone number is given.

Cases of the controlled type are tailor-made for random access memories. However, they represent a minority of those which occur in practice.

More usually, a part number or catalog number is a long string of digits and letters, sometimes implying a description and in other cases resulting from a long, outmoded, historical process. For example, there exists an inventory of parts, some 60,000 line items in all, in which the part numbers consist of up to 15 digits and letters. In other words only 60,000 item descriptions are used out of a possible set of over 10^{15}. The name and address part of a telephone book entry runs to about 30 characters. If we consider all the possible sequences 30 characters long (where a character can be letter, digit, or space) there are 37^{30} such sequences. A memory which would operate like the controlled item description memory would have to have 37^{30} addressable locations in it. This is inflationary. We want to be able to work uncontrolled item descriptions in a random access memory, and do it economically.

The practical bounds on what we can or must do are:

1. The number of locations in the memory.
2. The capacity of each in characters or bits.
3. The geometry of the memory, i.e., is an address a binary number, a decimal one, or whatever?
4. The number of items we expect to store.
5. The size of each item in characters or bits.
6. Sometimes, the work load per day and the time required to process an item are important; but this point will not be considered here.
7. Whether we must store everything on every item, or whether we can leave some items out, or store only part of the information on items, or both.
8. "Mortality" of items: is the list one which changes not at all, in small degree, or are items continually being added or dropped?
9. Whether we can go to more than one location to find an item.
10. The nature of the item description, i.e., size distribution, etc.

Although there is no simple rule which covers all combinations of the foregoing, a workable solution is almost always possible.

Take the game of Twenty Questions, for example. A large storage drum can be used effectively, where there is no list mortality, in the following manner. The stored items are first placed in order. If there are N drum tracks each of which will hold M items, the first M items are loaded on track 1, the second M items on track 2, etc. In look-up, one examines the center track. If the items thereon are "higher", according to the ordering relation, than the item desired, go to the track halfway between the center track and track 1. If the items on the center track are "lower", go to the track halfway between the center track and track N. On the second round the process is repeated within that half of the drum in which the second track to be examined lies. On the third round the search is narrowed to a quarter of the drum and so on. At the worst, only $\log_2 N$, rounded off to the higher integer, tracks need be examined. The expectation of the number of tracks to be searched is $(\log_2 N) - 1$.

There is a variant of this method, under which it is sufficient that every item on a track n be an upper bound (under the ordering relation) to every item on track $(n-1)$. Within a track the items need not be ordered. Under this method $[(\log_2 N) - 2]$ single items, each on a different track, must be examined, plus two whole tracks. With fast head switching, and large M, this method offers a significant time saving. Furthermore, the relaxation of order within a track permits leaving part of each empty, so that some deletions and additions (mortality) are permissible.

The method is to look at the center track first, as in Twenty Questions above. However, only one item description on the track is compared with the item description being looked up. If the stored item description is higher, we switch to the lower center track of the lower half. Again we examine one item description. There are two possibilities.

1. Both stored item descriptions are higher. Then certainly the center track can be eliminated from consideration, as we have found a new upper bound.
2. The new item description is lower. If we then switch to the track halfway between the center track and the second track, we will eliminate one of the two under the same sort of reasoning set forth in the preceding paragraph.

Continuing this process eventually narrows us down to two contiguous tracks. These two must be examined completely as the item is on one of them. With fast switching the elapsed time for finding the item is substantially less than in Twenty Questions. The chance that the item description would be found on one of the intermediate comparisons has been ignored, as it is a second order probability.

In both these cases we have found the item without previously finding its address.

Still postulating the large drum, here are two address-finding schemes for drums.

In the first, each storage track is assigned an upper bound in the ordering scheme. That bound for any track is lower than any item in the next track. It is not necessary that these bounds be evenly spaced, if the distribution of items along the ordering scale is known to be uneven. On a set of "address tracks" each such upper bound is recorded, in order and perhaps with the number of the associated track also recorded. On look-up, the address tracks are searched first. According to the method of indicating track location, the track address is found, either by counting up or straight read-out, as soon as an upper bound number is read out which either equals or exceeds the item number.

In the second method, as each item is recorded in storage, its exact location is stored on the address tracks. The address tracks are first searched for the location. This method would be useful where distribution along the ordering scale is extremely variable, mortality is high, and the number of characters in the item is large relative to the number of characters in its item description.

All of the above methods require us to do a great deal of work, in switching, comparison, or computation, after we have tied up the memory device. We might be better off if there is something we can do to the item description before we go to the memory.

For convenience, let us assume that the number of addressable memory locations is 100,000, that we have 50,000 item descriptions (names and addresses, parts numbers, or the like), and that the item description is very long, as much as 30 alphanumeric characters (37 possible including blank or spare). Let us also assume item mortality.

There are 37^{30} possible item descriptions. Certainly there is no one-to-one mapping of that set of 37^{30} into another set of 100,000. But we are only using 50,000 descriptions out of our set of possible descriptions. Can this help us?

Sometimes the answer is yes, as an example from the author's experience will show. A certain manufacturing company had a parts and assemblies list of many thousands of items. A mixed digital and alphabetic system of numbering items was used, of six positions in all. Eight complex machines or assemblies were sold to the public. These had item numbers taken from the general system. In setting up a punch card control system on these eight items it was first proposed to record the entire six digit number for each item. However, examination of the eight assembly numbers disclosed that no two were alike on the fourth digit. It was therefore sufficient, for sorting purposes, merely to record the fourth digit, thereby releasing five badly needed information spaces for other purposes.

This rather extreme case indicates that an examination of the item description may disclose a built-in redunancy which can be used to cut the field down to practical size.

Usually we are not this fortunate. However, we can abandon the hope of uniqueness of assignment of memory location in favor of practical, or statistical, acceptability. For example, study of the item descriptions may reveal that a subset of the character positions distributes randomly. Suppose it were found that the middle five digits of a part number of 15 digits were distributed randomly. Incidentally, it is quite easy to make investigations of this sort by ordinary data handling techniques. Let us decide to use these five digits as the item description for our memory of 100,000 locations. Since we have 50,000 items, we are faced with the following:

1. The probability of filling any particular location is 1/2.
2. The expectation for any location is .5 items.
3. The items generally will distribute according to the Poisson distribution.
4. If each location holds only one item there will not be room for duplicates under the addressing scheme.

We must deal with item 4 somehow. There are several methods:

1. By exception. Store only the most popular item (inventories usually classify parts as "fast" or "slow") in cases where there are duplicates. Look up the overflow items by some other means, or manually. It is surprising how often this method pays off.
2. Rearrange the memory. For example, if
   a. Only odd numbered addresses are used,
   b. An addressed location and the one next to it, e.g., 01921 and 01922 are always examined,
   c. We treat our five digit derived part numbers as though they were odd. Thus part number 17424 becomes 17423,

   then we have 50,000 items going to 50,000 addresses. However, now each address has a capacity of two items, with an expectation of one. The number of overflow will markedly drop.

3. Adjust the addressing scheme, according to a method which will be described later, to reduce the number of direct addresses, and use the excess locations to store overflows. Put the overflow address at the tail end of stored item information. What the best reduction is varies from case to case. Note that the expectation of the number of accesses to be made goes up when these methods are used. At each access we check by using the complete item description, usually.

4. Some combinations of the foregoing are possible, and sometimes even indicated, depending on the equipment and the problem. Remember that the addressing scheme merely gets us to a memory location. Normally the entire item description is needed to make sure we are working with the correct item in memory.

Worst in the scale of difficulty is the case where the description employs many character positions, mortality is high, and we can find no good subset of positions to work with as in our part number example. Here are two ways of dealing with the problem.

1. It may turn out that the set of character positions vary independently, but each position does not distribute uniformly. Say there are K possible different characters in a column, the most frequent of which occurs 25% of the time. If it is possible to collect subsets of characters whose combined frequency equals 25%, we have four instead of K categories, and for that column at least have reduced our radix from K to 4. A combination of this technique with those of selection and others above described can reduce our descriptive population to the point where it fits the memory. It is clear that this is a randomizing technique under the restriction of character independence. It is also clear that the method applies to uniform distributions where the number of characters is not a prime. It must be emphasized that all we have done is decrease the number of possible item descriptions to fit the number of memory storage locations which are addressable. The cost of doing this is that we do not have unique assignment of storage locations, such as we have in a controlled situation. But, if we have ended up with a random distribution of the item descriptions we have reduced the problem to one of taking care of overflow, and we have described ways of solving that problem satisfactorily.

2. Consider the item description as though it were a number in the scale of 37 or whatever. Or write it as a binary number by using the appropriate punched tape coding. Divide this number by a number slightly less than the number of addressable locations (the writer prefers the nearest prime). Throw away the quotient. Use the remainder as the address, adjusting to base 10, as the case may be.

3. There are several other transformations which are quite good enough. Which one to use depends upon the nature of the associated computing equipment and other characteristics of the particular problem at hand.

Like many other data handling problems, the problem of transformations cannot be disposed of by a brief sketch of salient points. In considering the practicability of a solution, many related problems must be weighed, even including input preperation, distribution of information among different files, and sometimes procedural reforms or changes. But at least we are not wholly without techniques to use.

-END-

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CORRECTIONS

In the October issue, on the front cover at the left, replace "Vol. 5, No. 9" by "Vol. 5, No. 10".

In the June issue, "The Computer Directory, 1956", page 19, last line, in the "Roster of Organizations" under "Philco Corporation", replace "Transac match control" by "Transac math control".

In the same issue, on page 59, in the "Roster of Products and Services", under the heading "50. Pulse Transformers", the following should be inserted as the first entry:

ALADDIN RADIO INDUSTRIES, INC., 703-705 Murfreesboro Road, Nashville, Tenn. / DESCR: more than 50 types of standard pulse transformers built to either military or commercial specifications; complete engineering bulletins including applications data available / USE: blocking oscillators, impedance matching, pulse inversion circuits, etc. / \$1.53 to \$12.00

SELF-REPAIRING AND REPRODUCING AUTOMATA

Richard L. Meier
Program of Education and Research
in Planning
University of Chicago
Chicago, Ill.

Memorandum

To: All persons associated with projects for constructing self-repairing and reproducing automata

From: Your agent in Mikrobiologia (who attended the DNA Symposium at Ann Arbor, Michigan, June, 1956)

This trip was undertaken because it has been reported that self-repairing and reproducing automata already existed in this territory. First let me say that the reports were an understatement of the true situation. Actually there appear to be 10^8 to 10^9 different models of such automata in existence, a large share of them with populations exceeding 10^{10}! Each model has been assigned a name derived from an archaic language.[1]

The models are often not easily differentiated from each other. Therefore my task is quite a bit more difficult than was supposed at the time of your initial assignment to me.

One remarkable point is that the solution to the design and construction problems seems to have been arrived at by brute force techniques — a monstrous sequence of trial and error which culminated in a successful system! However, as often happens when this procedure is resorted to, the operations by which this success was achieved were not satisfactorily recorded. No one in the history of this territory has assembled a self-repairing and reproducing automaton.[2] Obviously, vigorous efforts have been underway to unravel the mystery of their mode of functioning ever since the existence of these automata was discovered by a lens-grinder named Leeuwenhoek. Although thus far some interesting progress seems to have been made, yet the total picture is still rather confused.

I know you are mainly interested in the mechanics of the reproduction system, but before I can do that justice some things must be explained about the language, the materials of construction, and the techniques employed in Mikrobiologia.

Language and Documentation

The language of Mikrobiologia is not pure, but is strongly infused, if not dominated, by the terminology originating in Biochymia, a rapidly advancing branch of the Chymia family of cultures. There appear to be two, three, or sometimes a half-dozen names for the same material or the same process.

The reports of current studies are voluminous, running perhaps 2 to 3 x 10^4 pages per year, and, for reasons to be given later, most of them are careful to review experimental operations in considerable detail. At the experimental stage another language begins to emerge which seems to be based largely upon the instrumentation of the laboratories. Altogether about 200,000 persons, including beginners, use the major dialects of Mikrobiologia in their day-to-day activities.

I mention these features of language primarily to excuse my troubles in translation. Where analogs do not exist, I will try to use the most modern terminology in Mikrobiologia, but otherwise I shall attempt to translate into our own language. Their systems theory is sufficiently similar to our own to make this worthwhile.[3]

The indexing and classification of the reports are strongly addicted to alphabetization and require considerable amounts of cross-indexing. The documentation service is spotty, but reasonably good. They use annual or periodic reviews, usually of a critical nature, much more than we. Such reviews are extremely handy in in providing persepective for the visitors who, like myself, are willing to learn the language.

Materials of Construction

A key feature of these automata is that they are incredibly small — almost all fall within the range of 10^{-3} to 10^{-4} cm. in diameter! Their mass ranges from 10^{-10} to 10^{-7} g. Compare this with our own proposed micro-micro assemblies!

Equally important is the instability of the components and the sub-assemblies which are employed. The normal temperature range of operation is 5^{o}—50^{o} C, while a few models are able to tolerate greater extremes. Optimum functioning, based upon maximum growth or replication rates, seems to be in the range of 25^{o}—40^{o} C for most models. Under these circumstances the respective sub-assemblies have a mean useful life of 10^{-1} to 10^{4} seconds. As might be expected, the principal memory storage units are generally the most stable elements.

The most common non-aqueous material is a class of substances called proteins. They are built up of ordered chains of smaller units called amino acids, of which there are more than a score varieties. The latter are left-handed structures where such distinctions are at all possible. There are 10^{2} to 10^{5} amino acids per protein unit, and the information residing in a given unit appears to depend upon both their ordering in the chain as well as its coiling and folding properties. The proteins are used for carrying and assisting the effectors which assemble and take apart the structures within the automaton (enzymes). They may be used also for building internal frameworks of various kinds.

A large proportion, if not all, of the proteins are specific for the model in which they were built up. This occurs even though 99% of the internal tasks in any model of automaton are shared with a good many other models. In other words, across-the-board standardization of sub-assemblies has not occurred. A simple stochastic process cannot be used in assembling amino acids into proteins, because the latter show no signs of randomisation. These automata are sometimes curiously uneconomical from a contemporary point of view.

There are other components also. There is a class called carbohydrates; of these starch is used primarily for energy storage, and cellulose serves as a sack or cage enabling many automata to keep the components from being dropped along the wayside. The rarer forms of carbohydrate are used in either of these two ways.

Another class of components are the fats, used for hoarding energy as a rule, but in small quantities they are combined with proteins in order to achieve special tasks, one of them being the creation of small non-aqueous zones which may provide quick storage for useful intermediates not readily soluble in water.

Perhaps 5% of the non-aqueous mass of a smoothly functioning automaton in Mikrobiologia is made up of a tremendous aggregation of smaller components almost randomly mixed.[4] The scrap and the waste finds its way into this pool and so do the newly acquired components which the automaton picks up from the environment.

I have left the most interesting material to the last. This is the substance that preserves the bulk of the information. If the automaton is to create another in its own image, then this substance must be recreated in every essential detail. It is their version of a universal Turing machine reduced to finite dimensions. The material is called nucleic acid, which comes in a stiff,coiled, rod-shaped form, DNA, and a somewhat thicker, less homogeneous form, RNA. The latter operates something like a branch office which may contain only a portion of the master files, and then, very likely in a subordinate form, but is given responsibility for certain specialized operations.

The Energy System

The power supply for these automata is terribly complicated because it must operate in an aqueous medium. Nothing as simple as a connection to the power line exists here. Chemical energy must be husbanded; it is transferred from sub-assembly to sub-assembly aided mainly by the random kicks obtained from kT, by a hand-in-glove type fitting of one sub-assembly with another, and by some strategic positioning of sub-assemblies so that they form what is in effect an assembly line for manufacturing components.

Components involved in the energy-transfer chain are so numerous they must, almost of necessity, become accessories to other functions as well. Some of the most prevalent components are used as raw materials for certain amino acids, some may be employed for constructing signal-detecting equipment, for expediting movement, and for other independent substructures. A typical energy transfer cycle, put into block diagram form, would appear as shown in Figure 1:

It might be noted in passing glucose also functions as the base component of starch, pyruvate is used in synthesizing several amino acids, and acetate is the basic raw material for fats.

Most automata conduct several such energy transfer cycles so that if, for one reason or another, one of them fails, the others enable the equipment to perform indefinitely at satisfactory (but not peak) levels. One major class traps photons from the solar spectrum in the 4000-6000A^{o} range and uses the energy, combining it with waste products that are normally dumped into the environment, to generate a supply of metabolic intermediates. (Photosynthesis).

Under optimum conditions for reproduction the automata in Mikrobiologia are capable of retaining within their external membranes 10-20% of the energy extracted from the environment, although in rare instances figures in the 30-40% range have been reported. This is a most remarkable thermal efficiency in view of the clumsy system for internal energy transfer which must be used in an aqueous milieu.

The Miscrostructure of Reproduction

The standard history for a reproducing automaton is that it continues to grow until it reaches roughly twice its original mass, whereupon it undertakes a rather involved program for splitting into two more or less equal automata. The latter are ordinarily referred to as daughters. Thus, when everything is working smoothly, the population will be distributed between a maximum and minimum size only a factor of two or so apart. Once in a while, by relatively gentle modifications of environment, it is possible to get long chains of automata (when daughters adhere to each other). In the presence of some chemicals introduced through the environment, it is possible to obtain replication of only certain sub-assemblies. Similarly it is possible to amputate an automaton and force it to resynthesize the normal stock of enzymes, thus delaying the reproduction program indefinitely. However at a certain stage of growth there appears to be a clear-cut irreversible decision that the fission process should be set into motion. After this decision, amputation no longer serves to prevent reproduction. Thus, the reproduction process itself seems to operate with some kind of trigger system.

The master-records of the automata are kept in protected nuclei. Upwards of 90% of all the information transferrable to the daughters is found within these nuclei. But how are the master-records to be replicated so that a new copy can come into existence? Some new and very ingenious ideas have been unveiled recently which fit the current stock of observations.

The DNA, it now seems quite sure, is a rigid helix made up of two side-by-side strands. The helix has a length almost as great as the diameter of some of the smaller automata. It is believed that these strands uncoil to replicate, but more will be said of this process later. The strand is made up of repeating units, each composed of a base, deoxyribose, and triphosphate. There are only four types of base emplyed, and they are paired off in a complementary fashion. There is only one kind of deoxyribose involved, and also only one structure of triphosphate that is permitted. The transferable information, therefore, can only reside in the pairing of the bases. Since there are only two choices in base pairs, each of them taken either of two ways (ab or ba), only two bits of information can be stored in the sub-system which was illustrated. The volume required is $1x10^{-21}$cc. per binary digit stored. A complete helical element can store 4000 to 12, 000 bits. Self-sustaining automata appear to carry around about twenty such elements at a minimum, while a hundred is a more common figure.

The means by which the information is "read off" of the DNA is still quite obscure. One view is that this is done by means of forming a similar material on the surface of the DNA, thereby, receiving its imprint, then twisting the new chains off and dispatching them to other areas in the automaton. This material is called RNA. Like DNA it combines bases, sugars, and triphosphates into a chain. It seems quite possible that this chain also forms a double-stranded, or even triple-stranded, helix, although somewhat fatter in the circumference. The bases, in three instances out of four, are the same as DNA, the sugar portion must be similar in all but a few respects, and the triphosphate appears to be identical. This means that the RNA must have a somewhat different code from the original record. There is extra redundancy built into it. But, once the information has been scanned, what is done with it?

The evidence is pretty strong that RNA is responsible for the manufacture of the protein of the enzymes. The information in the RNA may be imparted through a "template." The most ingenious descriptions of what a template might be like have started with the assumption that RNA could absorb to its surfaces certain free-floating components, many of them with a base-sugar-phosphate combination not greatly dissimilar from its own structure. However it is not able to duplicate itself like DNA (because of the redundancy?). Therefore free-floating amino acids fitted into this knobby superstructure, exactly, according to contours that were specified. A string of 150 to 500 amino acids is normally absorbed (requiring 4-5 bits apiece to be uniquely specified). Then an enzyme comes along zipping up the main adhesion points of the amino acids. When it is finished, the protein (correct in every detail, otherwise the "zipping" would not have been finished and the fragment would have been locked to the template, so that the automaton is forced to cannibalize the whole set-up and build a new one from the components) is carefully folded in a predetermined fashion and floated off. Thus it makes room for new amino acids to drift in to adhere to the appropriate spots on the template. The process of protein formation under conditions favorable to growth has been measured and is known to take 1-10 seconds, which suggests that individual decisions to "zip" or "not to zip," if indeed they are made, require time on the order of one millisecond apiece.

Amplifiers and Multipliers

Now that I have described the energy release system, and the information transfer system, it becomes obvious that some relatively unique amplifiers and multipliers must be involved.

Perhaps the diagram in Figure 2 will be helpful for visualizing the overall system as it operates for one generation. The signals stored in a single DNA element must be transferred about 1-100 times in a single generation in the RNA code, and each of the latter translates this code into the protein chain version at the rate of 5-50 times a minute. Each enzyme is capable of absorbing components, accomplishing its set task, and desorbing the product at rates as high as 10^5 per second, although it would be more normal for this figure to represent the integral number of cycles carried out per generation (say a duration of 10^3-10^4 sec) for the average enzyme.

In this procedure the "noise" introduced by amplification is trivial. Their automata have ultra high fidelity by our standards. At the moment it seems likely that only a small fraction of the information residing in the protein is fed back to guide the synthesis of new DNA. This might be just enough to prevent "drift" due to temperature and other environmental changes.

As with most "multipliers", the space constants in these systems are more critical than the time constants. The geometric configurations that have been built in are exceedingly rigorous. The transitions from one state to another however are often organized into micro "trigger-systems" whose threshold may be raised or lowered by a factor of three or more.

Mapping the DNA

What kinds of information are stored where? In order to answer this question some rather elaborate statistical techniques have been worked out for analyzing the flaws in automata. They are particularly useful for discovering the flaws which arise spontaneously and carry over from generation to generation (mutations). The frequency of single identifiable flaws is almost always less than 10^{-4} per generation. Many of the automata with such flaws are capable of changing back to the normal state with frequency greater or less than the frequency of appearance. It has been clearly established that virtually all of the specifiable characteristics can be traced to information resident on the DNA. Through the mutations it is possible to map the points on some undesignated strand of DNA which correspond to a series of structural characteristics. Very soon the natives of Mikrobiologia hope to establish which strands control which properties and which base-pairs determine the structure of certain specific enzymes.

It is possible to compare the DNA with an error-free magnetic tape capable of storing 4000-12,000 bits with perhaps 1000-2000 more in the structure in the vicinity which may be affected by a much larger amount of background noise. It has been shown that a "word", or single instruction, can be stored in a region equivalent to three base-pairs, and that other equally definite instructions may be found to be residing on the "tape" within eight base-pairs distance. However some other instructions have been shown to be spatially diffuse and cannot be resolved so finely. They may require spans of 150 base pairs or more. In addition, they are known to "overprint" many other more specific instructions. Perhaps the diagram in Figure 3 of DNA would help describe the situation. Perhaps the spacing necessary for separating the short "words" from each other is scanned at a lower "frequency" with a broader "band width". This would appear to be the economic thing to do but no one understands yet how this property is reflected in the amplifier system.

The rate of scanning by RNA must be carried out at something like 10^3-10^4 bits per second under

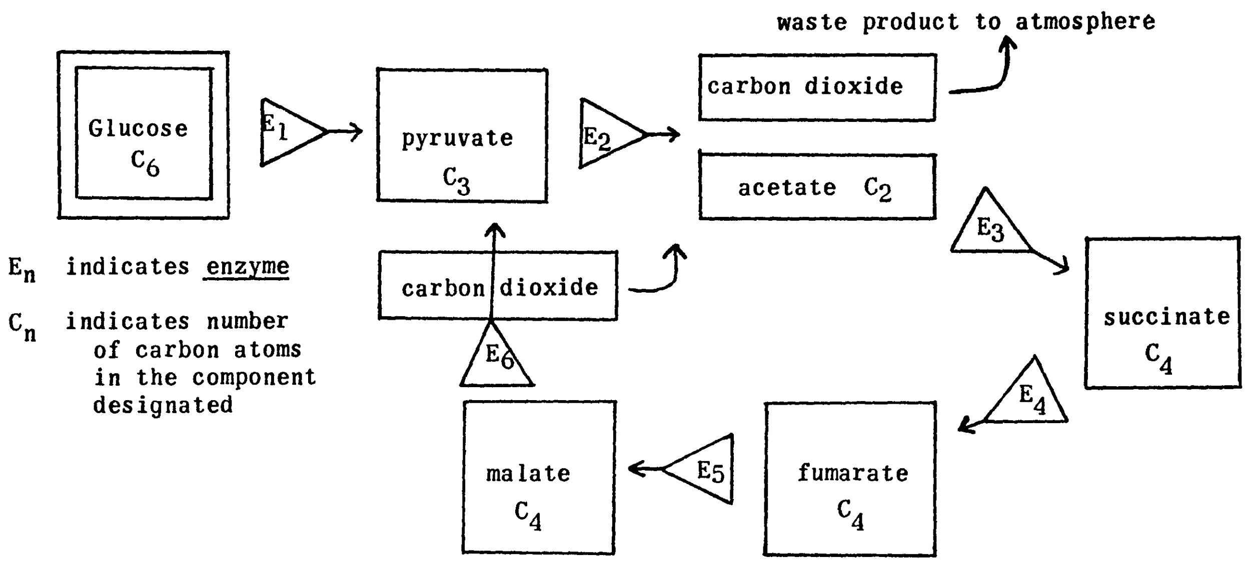

Figure 1.

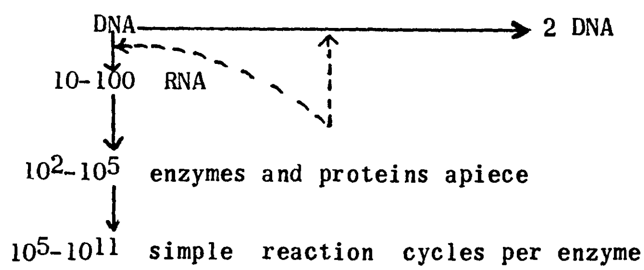

Figure 2.

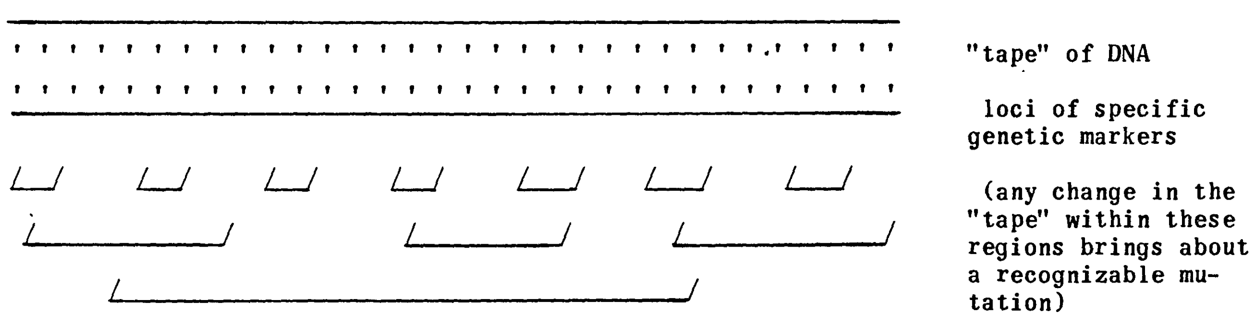

Figure 3.

optimum conditions. It seems likely that the process is diffusion-controlled since this rate would require that several yes-no decisions concerning quite large components would be made each millisecond.

There is another interesting observation that has been made in this work. If a series of markers, A, B, C, D..... are required in sequence for the fabrication of a given enzyme, then the instructions, as recorded on the DNA, are given in the same sequence. At the moment there appears to be no good reason why this should necessarily hold, but if it continued to turn up in subsequent studies it may be key to deciphering the codes of the DNA and the RNA. It may be suggestive also of some important economy to be gained in the scanning process.

Fundamental Decision Rules

I have said nothing as yet about cooperation and competition between the respective models of automata, and the kinds of phenomena that arise in the course of these interactions. The models have more plasticity in their adaptation to changed circumstances than I have implied thus far. When one considers the population size and the frequency of mutations, it is easy to see that a few units might survive a given shock by happening to develop the best combination of mutations, and that these combinations can be passed on almost indefinitely to the progeny.

Nor have I mentioned the real villians for many of the models in Mikrobiologia. There exist assemblies called viruses, shaped like tiny hollow machine screws and bolts, which are able to gain admittance to automata of the variety to which they are adapted. Once inside, the virus induces the automaton to allocate a large part of its production system to the manufacture of protein and RNA for new virus. Often the virus is so greedy the host automaton is rendered inoperable. As parasites they can be exceedingly effective, sweeping through a pure population within a generation or two, causing better than 99.9% destruction. The viruses range in size from 10^{2} to 10^{5} of the size of an automaton. Most of them contain some DNA, but very few, if any, enzymes. Troublesome though they may be for the automata, the viruses offer unique opportunities for gaining an understanding of the higher levels of organization.

When an automaton is hard-pressed for energy or raw material, its volume shrinks. The most expendable material, after fat and carbohydrate appears to be protein. The RNA content also gradually declines, but it provides very little in the way of substance that can be transformed into metabolic intermediates. Sometimes the whole mechanism shrinks to a kernel which has an extremely low metabolic rate (called a spore) but one which can quickly come back into full activity as soon as the environment becomes more normal. As a spore it is as impervious to shock as extra-cellular viruses and not too different in composition.

An alternative defense method employed when faced with predators, including some viruses, involves distributing fake components or poisons in the vicinity. These are called anti-biotics.

Still another strategy is to keep certain capacities on a reserve basis which can be triggered off on a moment's notice so that an important share of the enzyme-manufacturing capacity is devoted to the new activity. The inducible enzymes possibly use the same amino-acid chain as some other enzyme but the folding of the chain is modified, and perhaps a new effector employed, so that it can carry out a different task.

There seem to be a series of primitive "values" which have been built into these automata over the 10^{12}-10^{13} generations they appear to have existed. For example, each is responsible for its own survival (a later report upon complex societies of differentiated automata would show that this is not as obvious as it seems because the group may find some individuals, or certain types of them, expendable). Yet the mortality of each unit is recognized, because the greatest possible emphasis is put upon high fidelity replication. (The line survives intact over many generations because of the emphasis upon precision in reproduction).

The compromise between adaptability and precision has also been settled by the history of the line. In most models it is now strongly suspected that there are provisions for combining the experiences of independent lines. This prevents the loss of the rarest capacities to adapt (when isolated geographically, a hereditary line will usually not be pushed to exhibit all of its adaptive capacities in order to survive and may lose some of the unused ones through mutation), and it may, very infrequently, add a new capacity developed in the course of surviving some novel exigency. The methods by which they may be done depend upon the direct transfer of DNA from an automaton of one hereditary line to another belonging to a related line.

(cont'd on page 32)

THE COMPUTER'S CHALLENGE TO EDUCATION

Clarence B. Hilberry
Wayne State University
Detroit, Mich

(Presented July, 1956, at the Wayne State University Computation Laboratory summer course; slightly condensed)

Although I am a complete layman in this new field of yours, I would like to talk tonight about some of the educational implications of the computer as I see them. I fear that much of what I shall say will seem trite to you, but this is a danger I must accept if I am to talk at all!

Computer Represents a New Phase of the Industrial Revolution

When a hundred years from now, someone sits down to write the history of man's technological development, the automatic computer may not rate as the most important of our achievements. I would guess that the discovery of the wheel, for example, is likely to hold its position of intrinsic importance for some time to come. But I think our historian is likely to trace to the computer a new industrial revolution as of great scope as the first Industrial Revolution and coming with vastly increased suddenness. Only 26 years ago, Dr. Vannevar Bush built the first operating automatic analog computer; the first automatic digital computer was put into operation only some twelve years ago. The adaptation of the computer to carry out the information-processing functions of business concerns has come only in the last two or three years. Who is to predict what the computer, acting as a giant lever, will do to transform business and industrial processes?

In addition, the computer differs from earlier technological advances in important ways. Earlier tools mechanized a manual process, replacing human fingers and human energy in routine manual tasks. The computer rises to a new level, to mechanize routine mental processes. And in addition, it permits us to study the behavior of entire complex systems. And since the information is presented to us with fantastic speed, our actual knowledge of complex systems has greatly increased. Equally important, our capacity for control and prediction and our capacity for insight into these complex systems has also been greatly extended.

Contributions of the Computer

The powerful influence of the computer on our common life, therefore, lies in its contribution, in the broadest sense, to science and technology.

Quantitative and logical investigations in science can be carried out on a scale undreamed of only two or three decades ago. Scientific principles and models can be verified against experimental facts with small cost and hazard. Thus, new bodies of scientific knowledge have been established and new bodies of knowledge will be added as a result of research performed on computers.

The amount of engineering research that has been done on analog and digital computers is generally well known. These include development of atomic energy, new power plants for aircraft and automobiles, improved aircraft design, new materials and improvement of other materials to perform under extreme conditions of heat, stress and vibration.

Again in the field of automatic control, the computer has extended our knowledge of self-regulating mechanisms by enabling us to experiment with the principles of feedback in great generality. As a consequence, we have today such fabulous results as the guided missile, the pilotless aircraft, the automatic control devices which run large segments of continuous process industries and intricate manufacturing operations. These studies have also shed new light on the behavior of living organisms, and on information and how it is communicated.

During the past year or two, the computer has come into its own as a record keeper, a data processor and an analyzer of business conditions and trends. Here its potential is vast and its implications far-reaching. Thus, when up-to-the minute information of a complex operation is fed into a mathematical model by a computer and analyzed there, reliable facts emerge which assist management in making timely and wise decisions. In many cases, these aids in management decision-making are new tools never before available to the manager.

For example, computers have potential contributions in research in the social sciences, such as efforts to understand our economy and to find means to prevent ruinous fluctuations in it. Needless to say, great areas of social science research have not to date been explored because, like the physical sciences and technology, they involve problems of extreme complexity far beyond the unaided capacity of any individual or research team to resolve. We may look forward to achievements in the social sciences, as a result of the use of the computer, no less dramatic than those in other fields.

Computers and Higher Education

I now wish to consider how these automatic computing and data processing machines affect education.

Inherent in the Wayne State University Computation Laboratory, and the programs of instruction and research which spring from it, are not only some of the greatest opportunities which lie before us, but also a quantity of the most difficult problems which will face higher education in America in the next generation.

Beginning with the Computation Laboratory, then, let me mention some of these most pressing problems and perhaps suggest directions in which we might seek the answers to some of them. I hope in the near future that I shall be able to explore some of these ideas in much greater detail with representatives of the business and industrial community. But tonight, I can only open up some of these subjects, and hope that some of you will be willing to give me the benefit of your reactions to them.

All the problems are closely interrelated. I mention them here in an order which I hope will have a logical sequence:

1. Totality of Knowledge. The first problem then, is that the totality of knowledge increases these days with enormous rapidity. We have already seen that the computer itself has contributed in no small way to this end. The University faculties find themselves constantly with the necessity of including, by some process, these masses of new information within the educational structure.

The temptation is enormous simply to require that more courses be taken and more time be spent in preparing for any of the college degrees. For practical purposes, the Bachelor's Degree in Engineering now requires four and a half years, and the Colleges of Pharmacy are seriously proposing five years for a Bachelor's Degree in Pharmacy. The extension of the number of months of study is obviously, however, no general answer to this rapid accumulation of new knowledge.

One of the answers lies in the creation of new kinds of high specialization such as the programs springing out of the Computation Laboratory. After a strong undergraduate program, combining general education with a major in mathematics or mathematics and physics, a student can prepare himself, through a Master's Degree, for initial quite heavy responsibilities as a specialist in one aspect or another of this broad field of electronic computation.

2. Number of New Fields Requiring High Specialization. In this very fact, however, lies the second of the problems which I'd like to mention to you, for the number of new fields requiring such high specialization is increasing rapidly, and I see no reason to think that the process may not accelerate still further. Only a handful of years ago, no university in the country had a Computation Laboratory, to say nothing of the sequence of educational programs which are now organized around such laboratories.

In each of these new fields of high specialization, demand almost inevitably develops both for work leading to degrees and for a wide variety of in-service education aimed at upgrading present employees in related fields in business and industry. During the years of the life of our Computation Laboratory, for example, 750 students have enrolled for credit courses, and twice that many have studied without credit, including those who have taken such workshops as the one you are engaged in this summer.

And in addition to the classroom theoretical education, a large number of men and women have acquired mastery of such practical phases of computers as design of components, operation, maintenance, trouble-shooting, mathematical and numerical analysis of a great variety of problems, the development of programming techniques, the analysis of real accounting system, and numerous other actual, technical and business experiences.

3. Costly Programs. Third, it is hardly necessary for me to remark that these programs of high specialization tend to be the most costly of all our educational programs. In the field in which we are most interested, it is obvious that no educational program is possible at all unless we provide and maintain a computer or computers and related equipment. — And I must pause here to say what I shall develop in just a moment — that this Computation Laboratory would have been entirely impossible had not the greater Detroit community worked with us and provided the money necessary to launch the whole program. The whole program is a completely cooperative program between Wayne and Detroit business and industry.

It is true in this particular case that the Computation Laboratory is able to provide direct services to Detroit business and industry, and that ultimately the Laboratory proper may conceivably be self-supporting. But many other programs have no such income producing potential, and I would remind you that even here the Computer which happens to be housed in a University laboratory becomes obsolete just as rapidly as the one set up in an industrial research center. I am afraid there is no escaping the fact that higher education will become increasingly more expensive if universities attempt to meet these needs of our growingly complex society.

4. Basic Research. The fourth problem, like the third, is closely related to the problem of costs. Organic to any university program must be a coordinated program of basic research, for research is fundamental to sound instruction, as well as to the outward thrusts which we must always make into the unknown and the unexplored. In the Computation Laboratory, we are proud of the research which has been carried forward in component design, numerical and programming analysis, in mathematical and data processing methods in business. We must find ways to increase the amount of fundamental research which is done across the University fields.

5. Increased Quantity of Graduates. The fifth problem is of a quite different sort. I can think of no program anywhere in our higher institutions out of which we are turning enough graduates to meet our immediate needs. In many of the fields, such as education and engineering, we are falling very far behind indeed. Since this lag becomes greater as the momentum of our population increase in this country accelerates, is it not clear that the one problem we don't need to worry about, even though there is a good deal of worry here and there about it, is the problem of our having too many students being educated in our colleges and universities? As far as I can look into the future, I see no reasonable hope of American universities providing adequate numbers of graduates to meet pressing social needs.

I think I need not even comment on the lack of men and women with adequate preparation in the field of our special interest here tonight.

Our basic task in this field is to find ways to attract that large percentage of the very ablest high school graduates who now do not attend College, to do so.

As a result of this failure of ours to produce enough graduates, all universities are in competition with business and industry and the professions for the men and women of genuinely creative minds, which every university must have on its faculties if it is to produce creative minds in its graduates. This is a problem which concerns business and industry and the professions as much as it concerns the universities. I believe it is true that a genuinely creative intelligence in a university classroom tends to attract and to stimulate creative minds. On the other hand, I believe it is equally true that a mediocre mind tends to produce mediocrity even in minds of higher potential because it places no demands upon them. If a situation develops in which universities cannot retain their full share of the really fine creative minds of every college generation, the effects will, I believe, be all too quickly felt in business and industry itself.

6. Use of Human Resources. Since it seems to me axiomatic that you in business and industry and we in education are annually going to be less well staffed to do the job which is required of us, how can we find new ways of utilizing the human resources of our organizations with far greater efficiency and effectiveness? I am inclined to think that we can learn in this regard a good deal from the medical profession. The medical profession has pioneered in the creation of a whole series of medical aides and medical technicians. These aides and technicians, adequately trained to carry their responsibilities, relieve the physician of an

enormous amount of fairly routine work at the same time that they provide satisfying and rewarding jobs for men and women who might otherwise be doing manual labor.

In visiting one of the computer installations in Detroit recently, I was conducted through the installation and given a running commentary on the operation of the computer by a young man who, it later turned out, had never finished high school. It was clear that he had very important responsibilities indeed in relation to the operation of the computer, but they were obviously responsibilities which did not require the kind of specialized training which a university program provides. Is this not exactly what should happen? Is it not possible that you in business and industry have physicists, chemists, and engineers carrying responsibilities far below those which they should be prepared to carry if university education in these fields is adequate? Do we not perhaps need to sit down together with officers of high schools, and representatives of labor as well, to review our needs, to determine the responsibilities of each agency concerned? For a part of this enormous job of technical training will obviously continue to be done by business and industry itself.

It is clear that the simple competition among us for people is not going to increase the number of people available to us. Is it not possible that out of a new kind of job analysis in which we assume a core of new technical aides carrying most of the routine work and releasing the college educated specialists for creative activities including management responsibilities, — is it not possible that we might hope to find one positive answer to the man power problem which faces us all?

I am by no means sure this would begin to be enough and we need to discuss the whole problem together for it is one problem, I believe, not two problems, one of industry and one of education.

7. Mingling of Problems of Business and Problems of University. Finally, since it is increasingly difficult, as I view the problem at least, to separate the problems of business and industry from those of education, I am moved to ask how can we best promote the sustained cooperative consideration of these mutual problems without which I fear they will not be resolved.

I said earlier that this Laboratory and all it represents would have been quite impossible without the active cooperation of Detroit business and industry. That cooperation is represented by the men who have served on the two advisory committees to the Laboratory, the Policy Advisory Committee and the Technical Advisory Committee. It seems to me that here again the Laboratory is a kind of symbol of the kind of fruitful interrelationships which surely lie ahead. To each of the advisory committee members here tonight, I would like to express the deep gratitude of this University for your interest, for the hours of effort that you have put into the consideration of the problems of the Laboratory.

Out of our experience in such cooperative enterprises as this Laboratory, I hope we may find the ways by which we may sit down to talk about problems which are larger than any one industry, far larger than this Laboratory or this University. They are the problems of American business and industry and of American higher education. They will be resolved only as, with what I hope is typical American foresight and inventiveness, we find ways to work together toward their resolution. Out of our experience in the cooperative undertaking which is this Computation Laboratory, I for one look forward with great confidence to the future.

- END -

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EASTERN JOINT COMPUTER CONFERENCE

NEW YORK, DEC. 10-12, 1956 "NEW DEVELOPMENTS IN COMPUTERS"

—PROGRAM, TITLES, AND ABSTRACTS

The 1956 Eastern Joint Computer Conference is taking place Dec. 10-12, 1956, at the Hotel New Yorker and Manhattan Centre, New York. Following is the program sponsored jointly by the Institute of Radio Engineers, the American Institute of Electrical Engineers and the Association for Computing Machinery. All registrants receive a free copy of the proceedings. Others may order a copy of the proceedings from any one of the three sponsoring societies, such as the Association for Computing Machinery, 2 East 63 St., New York 21, N. Y.

Monday, Dec. 10, Morning:

J. Wesley Leas, Radio Corporation of America
Session Chairman

1. Welcome, J.R. Weiner, Remington Rand, Conference Chairman

2. Introduction and Keynote, Howard T. Engstrom, National Security Agency, Washington, D. C.

3. "New Computer Developments Around the World", by Everett S. Calhoun, Stanford Research Institute, Stanford, Calif.

4. "Evaluation of New Computer Components, Equipments, and Systems for Naval Use", L. D. Whitelock, Bureau of Ships, Washington, D. C.

Monday, Dec. 10, Afternoon: NEW SYSTEMS

Professor Norman Scott, University of Michigan
Session Chairman

5. "The Transac S-1000 Computer", J. L. Maddox, J. B. O'Toole and S. Y. Wong, G and I Division, Philco Corp., Philadelphia, Pa.

6. "A Transistor Computer with a 256 x 256 Memory", J. L. Mitchell and K. H. Olsen, Lincoln Laboratory, MIT

7. "Design Objectives for the IBM Stretch Computer", S. W. Dunwell, IBM Research Laboratory, Poughkeepsie, N. Y.

8. "A New Large-Scale Data-Handling System — Datamatic 1000", J. E. Smith, DATAmatic Corporation, Newton Highlands 61, Mass.

9. "The Tradic Leprechaun Computer", J. A. Githens, Bell Telephone Laboratories, Whippany, N. J.

10. "Functional Description of the NCR 304 Data-Processing System for Business Applications", M. S. Shiowitz, A. A. Cherin, National Cash Register Co., and M. J. Mendelson, formerly with National Cash Register Co., now with Norden-Ketay Co.

Tuesday, Dec. 11, Morning: CIRCUITS AND COMPONENTS
Chairman: Theodore A. Kalin, Air Force Cambridge Research Center

11. "Ambient Approach to Solid-State Computer Components", J. K. Hawkins, Logistics Research, Redondo, Beach, Calif.

12. "A Magnetically Controlled Gating Element", D. A. Buck, Lincoln Laboratory, MIT

13. "A 2.5-Megacycle Ferractor Accumulator", by T. H. Bonn and R. D. Torrey, Remington Rand Univac, Div. Sperry Rand Corp., Philadelphia, Pa.

14. "High-Temperature Silicon-Transistor Computer Circuits", by J. B. Angell, Research Division Philco Corp.

15. "A Saturable-Transformer Digital Amplifier with Diode Switching", E. W. Hogue, National Bureau of Standards, Washington, D. C.

16. "High-Speed Transistor Computer Circuit Design", R. A. Henle, IBM Research Laboratories, Poughkeepsie, N. Y.

17. LUNCHEON: Speaker to be announced.

Tuesday, Dec. 11, Afternoon: INPUT-OUTPUT DEVICES
Chairman: William K. Burkhart, Monroe Calculating Machine Co.

18. "An Automatic Input for Business Data-Processing Systems", K. R. Eldredge, F. J. Kamphoefner and P. H. Wendt, Stanford Research Institute, Stanford, California

19. "The Burroughs Electrographic Printer-Plotter for Ordnance Computing", Dr. Herman Epstein, Burrough Corp., and Paul Kintner, Aberdeen Proving Grounds, Aberdeen, Md.

20. "A Transistorized Transcribing Card Punch", C. T. Cole, L. I. Chien and C. H. Propster, Commercial Electronic Products, RCA, Camden, N. J.

21. "Apparatus for Magnetic Storage on Three-Inch-Wide Tape", R. B. Lawrence, R. E. Wilkins and R. A. Pendleton, Datamatic Corp., Newton Highlands 61, Mass.

22. "Synchronization of a Magnetic Computer", J. Keilsohn and G. Smoliar, Remington Rand Univac, Div. Sperry Rand Corp., Philadelphia, Pa.

Wednesday, Dec. 12, Morning: HIGH-SPEED MEMORIES

Chairman: Professor Morris Rubinoff, University of Pennsylvania

23. "A Technique for Using Memory Cores as Logical Elements", L. Andrews, National Cash Register Co.

24. "Recent Developments in Very High-Speed Magnetic-Storage Techniques", W. W. Lawrence, IBM Research Center.

25. "A Low-Cost Megabit Memory", R. A. Tracy, Burroughs Corp., Research Center

26. "A Compact Coincident-Current Memory", A. V. Pohn and S. Rubens, Remington Rand Univac.

27. "A Cryotron Catalog Memory System", A. E. Slade, Arthur D. Little, Inc.

Wednesday, Dec. 12, Afternoon: RANDOM ACCESS MEMORY FILES

John Howard, Underwood Corporation
Session Chairman

28. "The Datafile — A New Tool for Extensive File Storage, D. N. MacDonald and C. L. Ricker, ElectroData Corporation, Pasadena, Calif.

29. "Engineering Design of a Multiple Access Storage System (Mass)", M. L. Greenfield, Telecomputing Corporation.

30. "A Large-Capacity Drum File", V. J. Porter and H. F. Welsh, Remington Rand Univac, Div. Sperry Rand Corp., Philadelphia, Pa.

31. "System Organization of the IBM 305", M. L. Lesser and J. W. Haanstra, IBM Laboratory

32. CONFERENCE SUMMARY: John W. Carr, III, University of Michigan, President of the Association for Computing Machinery

ABSTRACTS

3. New Computer Developments Around the World, by Everett S. Calhoun, Stanford Research Institute, Stanford, California: Mr. Calhoun spent three and a half months visiting more than 50 computer installations or developments in over 15 countries. His trip that ended the first of November took him to Japan, the Philippines, India, the Middle East, Greece, Italy, Switzerland, Germany, France, Holland, Belgium, Denmark, Sweden, Norway, Scotland, and England. He will report on new developments in the computer field around the world, and on the significance of these developments in the United States.

4. Evaluation of New Computer Components, Equipments and Systems for Naval Use, by L. D. Whitelock, Bureau of Ships, Washington, D. C.: The purpose of this paper will be to outline in considerable detail the various criteria used by the Bureau of Ships in evaluating new computer components, equipments and systems. These criteria are also generally applicable to the planning of the Research and Development Program. Some of the criteria to be considered are: environment, function, performance, technical feasibility, logistic support, maintenance, design philosophy, and comparative costs. Examples will be given. Some goals for future development (Where do you go from here — philosophically?) will be presented with particular respect to prospective Bureau of Ships' requirements.

5. The Transac S-1000 Computer, by J. L. Maddox, J. B. O'Toole, and S. Y. Wong, Government and Industry Division, Philco Corp., Phila., Pa.: This is a description of the circuits, logical design, and organization of an all-transistor computer. It is a high-speed computer designed mainly for scientific calculations and data processing.

6. A Transistor Computer with a 256 x 256 Memory, by Jack L. Mitchell and Kenneth H. Olsen, Lincoln Laboratory, Massachusetts Insistitute of Technology: TX-O is a high-speed digital computer which was built to demonstrate and operationally test 5-megapulse transistor circuitry and a 65,536-word magnetic-core memory. The word length is 19 bits; 1 is a parity check bit for memory, 16 bits are assigned to memory addressing and the 2 remaining bits are used to select among three memory-reference instructions and one micro-programming instruction. The logic is performed by standardized packages using surface barrier transistors. The memory is a 7 microsecond, random access, coincident-current magnetic-core unit. Two 256-position magnetic-core switches are used to drive the X and Y coordinate lines. Both vacuum tubes and transistors are used in the circuitry.

7. Design Objectives for the IBM Stretch Computer, by S. W. Dunwell, IBM Research Laboratory, Poughkeepsie, N. Y.: A high-performance, solid-state computer is under development. The computer will

employ 10 megapulse transistors and two classes of rapid-access magnetic core memory. The high performance is a result of using higher-speed components than any now available and a new concept of computer organization in which several parts of the machine operate concurrently and asynchronously.

8. A New Large Scale Data Handling System — Datamatic 1000, by R.M. Bloch, Dr. W.C. Carter, Dr. E.J. Dieterich, J. Ernest Smith, Datamatic Corporation, 151 Needham Street, Newton Highlands 61, Mass.: The D-1000 embodies many innovations both in its systems and equipment design which are believed to constitute significant advances over conventional techniques for high-speed data processing. The system provides on-line data storage in excess of 10^{10} bits and permits a sustained processing rate of 250,000 bits per second. The machine design makes extensive use of magnetic core and crystal diode circuitry. Physically, the D-1000 consumes 180 KVA, occupies 5000 sq. ft. of floor space and provides its own air-conditioning.

9. The Tradic Leprechaun Computer, by J.A. Githens, Bell Telephone Laboratories, Inc., Whippany, N.J.: LEPRECHAUN is a general-purpose stored program, digital computer using more than 5000 transistors. Storage for 1024 18-digit binary words is provided by a coincident-current magnetic core memory requiring only 160 transistors. The logic of the computer is mechanized using direct coupled transistor logic (DCTL) circuitry. Designed for use in programming and logical design research on digital computers for military real-time control applications, LEPRECHAUN features extreme flexibility in the logical interconnections. The computer also serves as a research vehicle for the study of the operating characteristics and reliability of transistors in DCTL circuitry and in driving a magnetic core memory. This paper describes the design, construction, and operating experience with the computer.

10. The Functional Description of the NCR 304 Data Processing System for Business Applications, by M.S. Shiowitz, A.A. Cherin and M.J. Mendelson (Mr. Mendelson was formerly with National Cash Register Co., and is now with Norden-Ketay Co.): This paper will describe the characteristics of the new National Cash Register, Electronic Data Processor 304. This processor, although a general purpose machine has been designed specifically to handle business problems. The paper will include the overall system philosophy, the functional elements of the system and their capabilities. A detailed presentation will be made of the word structure, command structure, order code and the various special features which the system possesses. In addition, the paper will present in detail the capabilities of the Tape File scheme which is an integral part of the system.

11. Ambient Approach to Solid-States Computer Components, by Joseph K. Hawkins, Logistics Research, Redondo Beach, California: The present trend away from vacuum tubes in digital computers and other electronic equipment is discussed with advantages and disadvantages described. The present state of semiconductor devices and magnetic circuits, together with future possibilities and requirements, are briefly outlined. Development of a successful set of computing circuits is also traced. Operation of the three basic logical elements is explained and reliability and limitations discussed. Memory, layout, timing, and special magnetic drive circuits are described. Some of the salient features of the high-speed computer in which these magnetic components are currently utilized are listed.

12. A Magnetically Controlled Gating Element, by Dudley A. Buck, Lincoln Laboratory: Advances in understanding of the solid state of matter have made possible at least one successful electronic component involving the control of electrons in a solid — the transistor. Other new solid-state components are possible wherein the flow of electrons is controlled by an electric or a magnetic field. A study of the non-linearities of nature suitable for such use has led to an amplifier based in the destruction of superconductivity by a magnetic field. In its simplest form, the device consists of a straight piece of wire about one-half inch in length over which is wound a single-layer control winding. Current in the control winding produces a magnetic field which causes the central wire to change from its superconducting state to its normal state. The device has current gain, that is, a small current in the central wire, and it has power gain. The requirement that it operate in liquid helium would have precluded serious thought of its application ten years ago. A large number of these small components can be interconnected as a digital computer of small size, light weight, low power dissipation, and the promise of high reliability.

13. A 2.5 Megacycle Ferractor Accumulator, by R.D. Torrey and T.H. Bonn, Remington Rand Univac, Div. Sperry Rand Corp., Phila., Pa.: Experience with pulse magnetic amplifiers has shown that appreciable power gain is realized at information rates of several megacycles. An experimental accumulator using only magnetic cores, resistors and diodes has been constructed and operates at a frequency of 2.5 megacycles. The device serves to demonstrate the feasibility of high-frequency Ferractor Circuitry at that frequency. The circuits represent a substantial improvement over those used in the 660 kc Univac Magnetic Computer. The power source for the accumulator is a 2.5 megacycle sine wave. Thirty-seven cores are used and all circuits for cycling, synchronizing input signals and output display are included. Input is by means of a push button that adds unity each time it is depressed, and the total count is shown by means of incandescent lamps that are powered directly by the magnetic cores. Three basic package types are used, a magnetic amplifier, magnetic inverting amplifier and diode cluster package, and all logical functions are achieved by proper interconnection of these packages.

14. High-Temperature Silicon-Transistor Computer Circuits, by James B. Angell, Research Division

Philco Corp.: The recent advent of high-speed silicon alloy transistors has made possible the design of logic circuits for digital computers having the capability of reliable operation up to temperatures well above 125°C. The characteristics of these transistors are such that even direct-coupled circuits, which are among the most sensitive to temperature, can provide such operation. Switching times on the order of 0.2 microseconds are common, so that operating rates above 500 kc are feasible. This presentation will describe the temperature dependence of the characteristics of these transistors, emphasizing those properties which are most important for circuits. Circuit techniques for optimizing performance, in view of the device characteristics, will be described. The particular advantages and limitations of various circuits using these transistors will be discussed.

15. A Saturable-Transformer Digital Amplifier with Diode Switching, by E.W. Hogue, National Bureau of Standards, Washington, D.C.: A digital amplifier of simple, non-critical design incorporating a saturable voltage transformer is described. The clock is a two-phase, sine-wave voltage source in the hundred-kilocycle range. In structure and mode of operation the amplifier stage is particularly suited for use with two-level diode gating to provide the <u>and</u> and <u>or</u> logical functions. A <u>complementer</u> employing two saturable transformers provides the <u>not</u> functions. The volt-second transfer characteristic of the stage critically determines the stability of transmission of binary signals in a long register, or in any closed loop. Factors governing the shape of this characteristic are discussed. The overall characteristic for n stages is then derived and used to predict binary transmission stability.

16. High Speed Transistor Computer Circuit Design, by R.A. Henle, IBM Research Laboratory: Transistor circuits using the IBM diffused base transistor are being developed for use in a new high performance computer. These circuits make use of certain characteristics of the IBM diffused base transistors which enable them to amplify efficiently, pulses in the millimicrosecond region. Some of these circuits and their design problems will be discussed.

18. An Automatic Input for Business Data Processing Systems, by K.R. Eldredge, F.J. Kamphoefner and P.H. Wendt, Stanford Research Institute, Stanford, California: Computers for business applications are generally input limited and require excessive manpower for data preparation. This can be reduced and gains can be made in speed and reliability if the data forms for the computer and human are compatible. Documents must be prepared for manual use in conjunction with many phases of automatic business or technical data handling, and such documents with suitable format arrangements can be fed directly to the computer input with the techniques described. The numbers and symbols on the document are printed in magnetic ink in conventional form and size, and machine reading can be accomplished at rates exceeding 5000 characters per second. The documents themselves have been handled at rates up to 50 per second.

19. The Burroughs Electrographic Printer-Plotter for Ordnance Computing, by Dr. Herman Epstein, Burroughs Corp., and Dr. Paul Kintner, Aberdeen Proving Grounds: This paper will be divided into three parts. The first part will cover a system concept involving an automatic digital data handling system feeding a high-speed output directly rather than through a buffer such as a tape storage system. This system concept is discussed in some detail with respect to its applicability in certain areas. Some representative programming details are indicated for this type of system involving the ORDVAC Computer. Part 2 covers the design approach, and details of the particular mechanization which was chosen to satisfy requirement based upon Electrographic Recording. The Electrographic Recording Technique is reviewed and the various relevant parts of the plotter and its capability are discussed. Part 3 covers some of the results obtained on the feasibility model of the plotter in actual use.

20. Transistorized Transcribing Card Punch, by K.L. Chien, C.T. Cole, and C.H. Propster, Commercial Electronic Products, RCA, Camden, New Jersey: A Transistorized Card Punch will be described which provides a means for punching electronic accounting machine cards with data from magnetic tape at the rate of up to 150 cards per minute. The design features will be shown and the functional requirement of the device reviewed. Interesting facets of the design will be described in detail, including the mechanical design of the punch mechanisms and the accuracy control features. This paper will also describe the transistorizing approach to simplifying circuits used in the unit.

21. Apparatus for Magnetic Storage on Three-Inch Wide Tape, by R.B. Lawrence, R.E. Wilkins, and R.A. Pendleton, DATAmatic Corporation, Newton Highlands 61, Mass.: This paper deals primarily with the mechanical portion of the DATAmatic 1000 Magnetic File Unit. A reel of tape weighs about 21 pounds and contains 50,000 pre-established and pre-inspected block locations. Each block contains 62 words of 52 bits recorded in 31 information channels. Tape speed is 100 inches per second, in either direction as required; starting and stopping times are about six milliseconds. Tape motion is controlled by fast-acting pneumatic valves which communicate vacuum to either of two continuously counter-rotating capstans or to a stationary brake surface. The surfaces not in engagement with the tape are provided with low-pressure air lubrication.

22. Synchronization of a Magnetic Computer, by G. Smoliar and J. Keilsohn, Remington Rand Univac, Div. Sperry Rand Corp., Phila., Pa.: The problems of transferring data into and out of a magnetic computer are easily solved by the use of shift registers employing Ferractors. These Ferractors and the circuits in which they are used are quite similar to those in the amplifiers and complementers of the arithmetic and control sections of the computer. This paper will describe the logic of the synchronizing circuits, the special modules used in their shift registers and the problems encountered in the design, construction and test of this part of the

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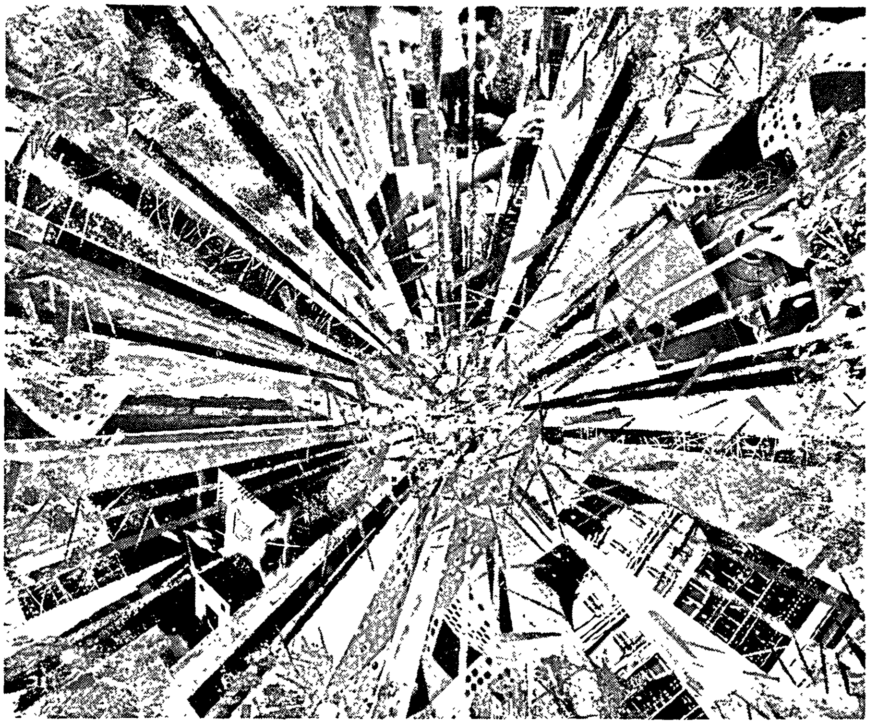

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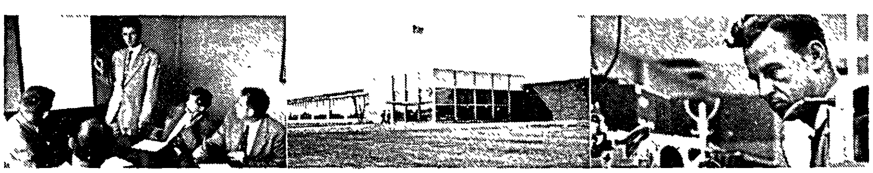

Senior Electronic Engineer With experience in drum memories for digital computer systems. Excellent opportunity to form and head project in this work.	**Senior Computer Circuitry Engineer** With transistor experience in digital computer applications. Core circuitry experience desirable.
Senior Systems Logician Must be a strongly creative man with demonstrated ability in digital computer logical design.	**Senior Mechanical Engineer** Advanced degree, broad experience in digital computer design, drum design, tape-handling systems, input-output equipment.

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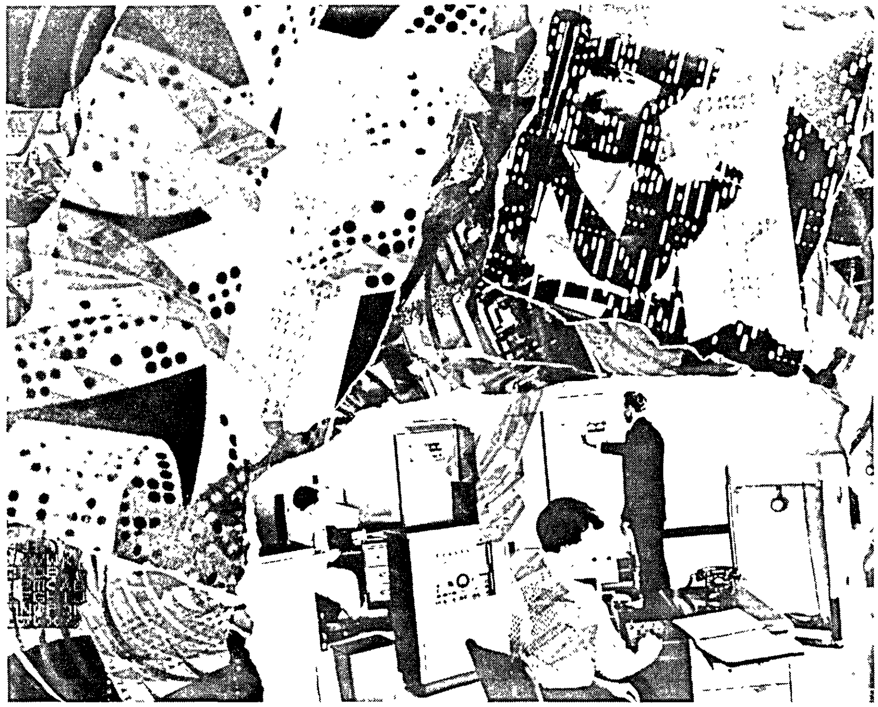

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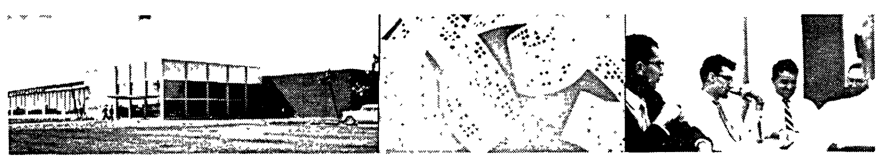

Operations research specialist With advanced degree in mathematics. Experienced in mathematical formulation of business and management problems, and familiar with the functions of electronic equipment in operations research techniques.	**Senior computer systems engineer** Advanced degree preferred, although not required, either in engineering or mathematics. Broad background in logical and systems design and ability to do independent research in computer structures and computer logic.
Senior data-processing systems designer With technical degree and extensive background in formulating computer systems for business data-processing. Should have experience in application of equipment as well as in design.	**Computer applications specialist** With technical degree. Should have solid experience in programming, systems analysis and applications studies. Work is adaptation of computer characteristics to business data-processing requirements.

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THE NATIONAL CASH REGISTER COMPANY
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computer.

23. A Technique for Using Memory Cores as Logical Elements, by Ladimer Andrews, National Cash Register Co., Hawthorne, California: A method of using small ferrite memory cores as logical elements in a control or computing system is discussed. The "inhibit-wound core" is presented as a design concept. A scheme for using inhibit-wound cores in the basic "and" and "or" gates is expanded to the general binary switching function. These cores are then considered to be the register of a computing system. The technique of this paper provides a straightforward method for accomplishing the gating, transferring, counting, and arithmetic operations to be performed on the information in the register. "Flip-flops" used for one bit storage and decision are shown to be a special case of this same concept. An example of the application of these techniques to a positioning device is made and operating experience with a small fixed program digital-computer is given.

24. Recent Developments in Very-High-Speed Magnetic Storage Techniques, by W. W. Lawrence, Jr., IBM Research Center, Poughkeepsie, N. Y.: Developments of new magnetic elements have shown that rapid access memory systems with complete operating cycles of a fraction of a microsecond are feasible. This paper describes the theory of operation of some of these elements and presents experimental data on the performance of samples.

25. A Low-Cost Megabit Memory, by Robert A. Tracy, Burroughs Corp. Research Center, Paoli, Pennsylvania: Present matrix memories are almost exclusively made using ferrite cores as the basic element. Numerous problems are encountered with these elements including such varied items as uniformity, testing, strain sensitivity, fabrication, cost and temperature sensitivity. A new magnetic memory element has been discovered which solves many of these problems. Its operation in a matrix memory can be made practically identical to the ferrite cores, thus offering a direct replacement. The cost of a complete matrix promises to be less by a factor of ten. Fabrication is easily adapted to production techniques. The element is not strain sensitive and the temperature sensitivity is quite low.

26. A Compact Coincident Current Memory, by S. Rubens and A. V. Pohn, Remington Rand Univac Division, Sperry Rand Corp., St. Paul, Minn.: This paper will discuss a novel magnetic memory array assembled entirely from etched circuits. A new magnetic structure is used which permits high-speed operation with access in one microsecond. Circuitry is designed to minimize eddy current losses. The techniques by which the component parts of the array are fabricated will be discussed, particular emphasis being given to the process for making the magnetic elements. Hysteresis loops of the material will be shown, together with read-in and read-out wave forms.

27. A Cryotron Catalog Memory System, by Albert E. Slade, Arthur D. Little, Inc.: An entirely new method of obtaining a catalog memory has been devised, based on use of the Cryotron as a passive device. It now appears possible to construct a catalog of predetermined and fixed content containing a half a million words or a smaller catalog whose content may be changed. The system is interrogated by comparing a new word with the entire catalog simultaneously. If the new word exactly matches a word in the catalog, a weighted output is obtained. With present techniques, it may be possible to make a comparison every ten microseconds. It will take ten to one hundred times that long to write a new word.

28. The Datafile—A New Tool for Extensive File Storage, by Duncan N. MacDonald and Charles L. Ricker, ElectroData Corporation, Pasadena, California: This paper will discuss the design and application of an advanced magnetic tape storage system with facilities for automatic access to files as large as 200,000,000 characters with average access times in the five to twenty second range. The Datafile System, which employs standard magnetic tape and recording techniques, also provides an economical solution to many medium speed random access problems and avoids awkward and time consuming tape handling processes.

29. Engineering Design of a Multiple Access Storage System (MASS), by Morris L. Greenfield, Telecomputing Corporation, North Hollywood, California: The Telecomputing MASS has a storage capacity of 120 million bits or 15 million 8-bit characters in non-volatile magnetic form, disposed over 10,000 metallic tapes. Character address on each tape is established by a clock-pulse channel. Information contained in a group of characters on any tape is available for reading or altering within two seconds. Among the unique features of the MASS are the methods of transporting and positioning a carriage which contains the tape handling and reading-writing equipment, selecting a particular tape, and sequential control of mechanical operations.

30. A Large Capacity Drum File, by H. F. Welsh and V. J. Porter, Remington Rand Univac Division, Sperry Rand Corp., Phila., Pa.: A drum file will be described which provides rapid access to a large store of information. The design details will be shown and the logical requirements of the system discussed. In particular, the method by which the recording heads are floated above the drum surface will be shown, together with selector mechanisms for positioning the head for cooperation with a desired band of information. The drum file design provides for storage of 18 megabits. There are 100 bands of information and the selector can step from band to band, to sequentially read in or out, once each drum revolution. The entire file can be scanned in a fraction of a minute.

31. System Organization of the IBM 305, by M. L. Lesser and J. W. Haanstra, IBM Laboratory, San Jose,

(cont'd on page 31)

COMPUTER MODELS DELIVERED AND ON ORDER

The following table indicates the numbers of automatic digital computing machines and systems that had been delivered or were on order as of approximately September, 1956. This table was prepared by John Diebold and Associates, management and automatic data processing consultants, 40 Wall St., New York 5, N.Y., from data supplied by the manufacturers except in the case of Remington Rand Univac. It is reproduced in "Computers and Automation" by permission.

Computer Model	Company	Delivered	On Order
Bendix G-15	Bendix Aviation Corp., Computer Div.	20	10
Bizmac (RCA)	Radio Corp. of America	2	1
Burroughs E-101	Burroughs Corp.	54	37
Datamatic 1000	Datamatic Corp.	0	2
Datatron	Electrodata Corp., Div. of Burroughs	40	40
Elecom 50	Underwood Corp.	0	40
" 100	"	3	0
" 120	"	5	0
" 125	"	1	3
" 200	"	1	0
IBM 604	Intern. Bus. Mach. Corp.	2,820	80
" 607	"	249	124
" 608	"	0	35
" CPC	"	128	7
" 650	"	403	930
" 701	"	19	0
" 702	"	14	0
" 704	"	22	58
" 705	"	24	133
Monrobot III	Monroe Calculating Machine Co.	1	0
" V	"	1	0
" VI	"	5	4
National Cash Register 102	National Cash Register Co.	25	5
Readix	J.B. Rea Co.	3	0
Royal Precision (& Librascope) LGP-30	Royal Precision Corp. (& Librascope)	0	9
Teleregister:	Teleregister Corp.		
Reservation System	"	2	6
Inventory System	"	1	0
Bank System	"	0	3
Univac I	Remington Rand Univac Div., Sperry Rand Corp.	31	14
" II	"	0	35
" 66/120	"	266	48
" 1103, 1103A	"	17	16
" File Computer	"	4	over 100

News Release
Stromberg-Carlson

SWIFT OUTPUT: 10,000 CHARACTERS PER SECOND

San Diego, Calif., October, 1956 — Development of a device which can record data from modern electronic computers many times faster than any previously used method has been announced by Stromberg-Carlson, a Division of General Dynamics Corporation.

Harold P. Field, general manager of Stromberg-Carlson - San Diego, where the instrument has been designed and manufactured, said it is capable of recording data equal in amount to that in a 300-page book in just 30 seconds. The first complete Model 100 has just been shipped from Stromberg-Carlson's San Diego plant to the Operations Research Office of Johns Hopkins University, Baltimore, Maryland.

The Model 100 can record in permanent, readable form the output from an electronic computer at speeds more than 10 times those attained by any computer readout system previously used, Field said. The device utilizes a CHARACTRON Shaped Beam Tube of a seven-inch diameter, a sort of "electronic typewriter," newly developed by Stromberg-Carlson engineers in San Diego.

Large computing laboratories have for some time faced the problem of recording the information from electronic computers as fast as the computers could turn it out. As a result data has had to be stored in computer readout registers until it could be recorded by electric typewriters, card punch machines or other systems. Because such devices could not keep up, computers at times have been kept idle. Computer laboratory technicians explain that a new problem cannot be put into a computer until the answer to the last one has been cleared out.

"Time on a $1,500,000 computer is valued at something like $300 an hour; so it can be seen that a speedier output system is not only vastly more convenient, but saves thousands of dollars in large computing laboratories," Field said.

The heart of the CHARACTRON Computer Readout, Model 100, is a seven-inch shaped beam tube, recently developed by Stromberg-Carlson - San Diego. This tube, designated the Type C7C11, reproduces letters and numbers each of which is just thirty-thousandths of an inch in height. By utilizing this tube the Model 100 can reproduce and photograph these tiny characters at the rate of 10,000 per second. The screen or face of the tube can accommodate a maximum of 6,500 letters and numbers at any one time. Thus the screen can be filled three times in two seconds and at that rate a 300-page book of 50,000 words (300,000 characters at an average of six characters per word) could be reproduced in just 30 seconds.

The CHARACTRON Shaped Beam Tube has been called an "electronic typewriter" because it utilizes a stream of electrons, extruded through tiny metal stencils to create numbers and letters at split-second speed on a phosphor-coated screen, similar to the screen of a television set. The vastly increased speed of the Model 100 computer readout is possible because the seven-inch shaped beam tube is smaller and reproduces smaller characters than earlier models. Thus more data can be displayed and recorded in a given space.

The Model 100 assembly includes: the tube itself; electronic circuitry which operates the tube, interprets and synchronizes instructions from the computer; a high-voltage supply; digital-to-analog converters and a power supply for operating the electronic circuits and a camera recorder. The face of the tube is positioned in the assembly so that the letters and numbers reproduced can be recorded by a specially designed camera on 35 millimeter film. Although it requires two-thirds of a second to fill the screen to its capacity of 6500 characters (65 lines, 100 letters and/or numbers to the line) most applications require less than the full capacity for one frame. Thus the photographic recording equipment is designed to take a picture of the screen 10 times a second. When this full photographic recording speed is used the film must be taken from the camera and developed in a conventional photographic dark room. However, if a speed of one frame every two seconds is sufficient, as it is in many applications, the photographic equipment can be used as a self-sufficient unit, automatically exposing, developing and fixing the film. The unit thus arranged also projects the developed film on a monitor screen, for two seconds — sufficient time to allow a visual check on each frame. To use these 35-mm film recordings of data from an electronic computer, a scientist may either project the negative on a screen, or if a record is desired for a written report, positive photo prints can be made by conventional photographic methods.

News Release

Underwood Corporation

ELECTION PREDICTIONS BY ELECTRONIC COMPUTER

An estimated twenty million Americans watched a new electronic computer make its debut on Election Day, November 6, when Elecom 125, Underwood's new medium-scale computer, successfully predicted the outcome of the U. S. presidential race over the combined TV and radio network of the American Broadcasting Company.

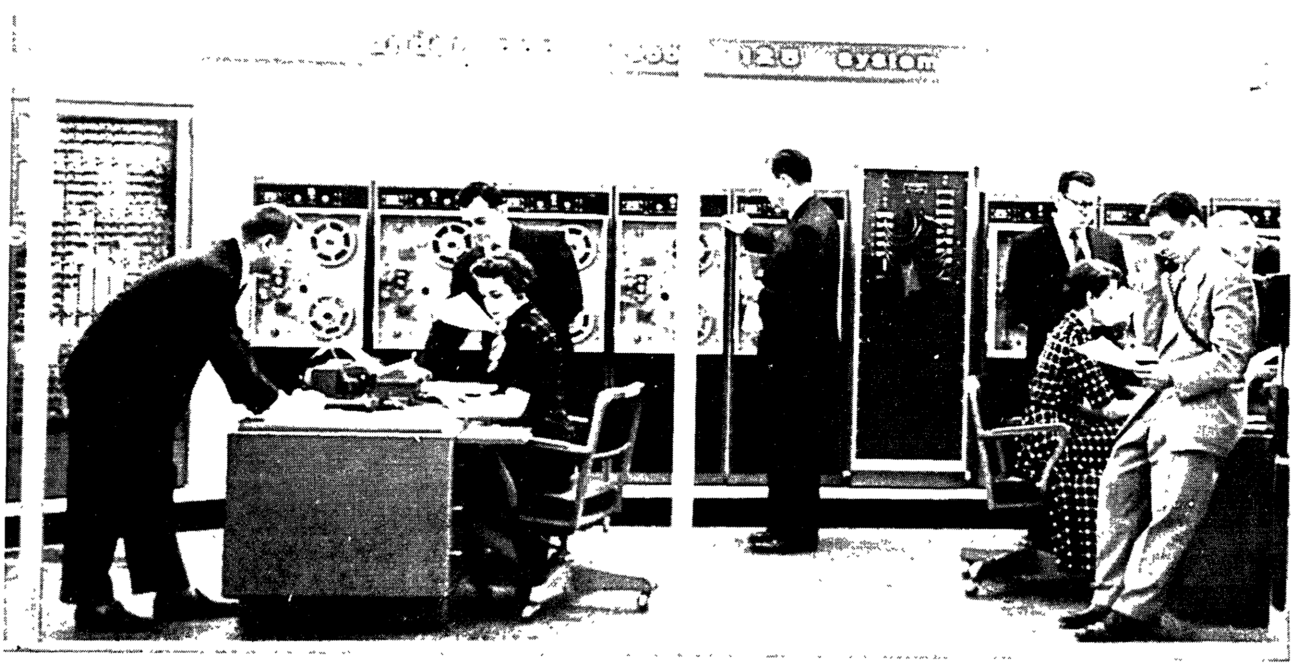
Elecom 125 made its first prediction at 8:05 p. m., forecasting a landslide for President Eisenhower and "less than 100 electoral votes for Stevenson". Its second prediction at 9:05 p. m. was 71 electoral votes for Stevenson as compared with the 74 which Mr. Stevenson actually received.

An ABC remote crew was stationed at Underwood's Business Machine Demonstration Center at One Park Avenue, New York. From that point, throughout the evening, Elecom appeared on television with its predictions. The new computer, installed a month previously, operated without an error. The final remark made by the computer at 2:35 a. m. was "I've racked by electronic brain and I still say 71 electoral votes for Stevenson." The comment was typed out automatically before the cameras on a special Underwood electric typewriter with large size type.

To prepare Elecom for its election predictions, Mr. Louis Bean, political analyst, and Dr. Leon Nemerever, a mathematician of Underwood's programming staff, analyzed quantities of information on past presidential elections back to 1916 and fed these figures into the computer. 1956 returns, received by teletype, were digested on the spot by Underwood programmers and fed directly into the computer. Elecom made its predictions on the basis of a comparison of early 1956 election returns with data on previous elections.

The Elecom 125 is designed expressly for general business applications, and sells for approximately $350,000; it has a useful work output that compares with computers in the million dollar range. The Elecom 125 system consists of the Elecom File Processor and the Elecom Electronic Computer. The File Processor sorts, collates, separates, and categorizes data, relieving the Computer of these routine operations. Arithmetic calculations, updating, and summary compilations are performed by the Computer. The two units can operate together or independently, either simultaneously or one at the time.

The Elecom 125 System which appeared on TV is a permanent part of Underwood's Business Machine Demonstration Center, and will be used to process Underwood company records, to provide computing service for other companies, and for demonstrations.



ELECOM 125, Underwood Corporation's new medium-scale electronic computer system, as it looked Election Night, November 6, when it made its first public appearance predicting the outcome of the presidential election over ABC television and radio network.

GLOSSARY OF COMPUTER TERMS: COMMENTS

I. From Teruhiko Bessho
Electrical Communication Laboratory
Musashino-shi, Tokyo, Japan

I just got a "Computers and Automation" of January 1956 today. The matter was informed by your previous letter of air mail, and I have been waiting for it. Thank you very much for your kindness. As mentioned in your previous letter, I write down below "words which are not collected in the glossary". Of course, in these words, there may be many which are not suitable for the object, or worse, which are incorrect.

(1) Digital Computer
Algebraic Adder, Cascaded Carry, Check Problem, Complete Carry, Delay-line Memory, Delay-line Register, Destructive Reading, Dispatcher, Dynamic Sequential Control, End Around Carry, Flow Diagram, Function Unit, Least Significant Digit, Most Significant Digit, Non-Destructive Reading, Partial Carry, Self-instructed Carry, Separately instructed Carry, Static Register

(2) Analog Computer
Automatic Balancing Circuit, Boost Resister, Circle Test, Coefficient Multiplier, Coefficient Potentiometer, Helical Potentiometer, Integrating Capacitor, Integrating Resister, Linear Computing Element, Machine Equation, Machine Block Diagram, Network Calculater, Nonlinear Computing Element, Operational Amplifier, Patch Board, Photoelectric Function Generator, Photoformer, Problem Board, Quarter Square Multiplier, Servo Computing Element, Sign Changer, Summing Amplifier, Summing Integrater, Time Division Multiplier, Time Scale Factor

(These words are obtained chiefly by comparison between the glossary and the Collection of Terms of Electronic Computer (The Journal of the Institute of Electric Communication Engineers of Japan, vol. 39, no. 8 (1956.08) 743/745))

As to terms of memory device, I noticed the following words which are favourable to be collected in the glossary.

Auxiliary memory, Blemish (in charge-storage tubes), Decay, Decay time, Echo, Lattice Memory cores, Memory operation time (= access time), pigeonhole memory system, Prime (in charge-storage tubes), Resolution (= the number of storage sites per unit area), Read out pulse (= sensing pulse), redistribution, Retention time, Switching Coeff. ($S_w = (H-H_o)T$, T: switching time, H: external magnetic field, Ho: an intercept value usually related to the knee of the loop), Spurious output, Staticizor (This is a flip-flop which is normally reset into one of its stable states and is triggered into its opposite state if a pulse is applied to its input terminal), Spill, Shading, Shift-register, Two-state device (=binary cell), "Warp and weft" memory, Zero-to-one ratio (a kind of S/N ratio when we read magnetic cores).

II. From the Editor:

We are grateful for Mr. Bessho's comments. Since they were received too late for taking into account in the 4th edition of the "Glossary of Terms in the Computer Field" published in the October issue, they will be considered in the 5th edition.

We should be glad to receive comments, additions, revisions, and corrections of the cumulative glossary published in the October issue. A glossary, in order to stay up to date, does need help from many volunteers.

On formal request to us, by appropriate persons, we expect to authorize the translation of the glossary into French, Russian, Japanese, German, or other languages, just as translation into Italian has been authorized.

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SPECIAL ISSUES OF "COMPUTERS AND AUTOMATION"

The June issue of "Computers and Automation" in each year commencing with 1955 is a special issue of "The Computer Directory" containing a cumulative "Roster of Organizations", and a cumulative "Roster of Products and Services in the Computer Field", and other reference information.

In late 1956 or early 1957, we shall publish Edition No. 2 of a cumulative "Who's Who in the Computer Field", as an extra number of "Computers and Automation".

NEW PATENTS

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

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

August 28, 1956: 2,761,063 / Julian H. Bigelow, Princeton, N.J. / U.S.A. / An electrostatic memory system having a binary voltage generating circuit.

2,761,100 / Lawrence E. Alberts, Minneapolis, Minn. / Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. / Automatic Control system for aircraft.

2,761,102 / Lester L. Brown, Los Angeles, Calif. / - / An electrical program controller.

Sept. 4, 1956: 2,761,315 / Niels Y. Anderson, Jr., Buffalo, William M. Kaushagen, Kenmore, and Karl D. Swartzel, Snyder, N.Y. / U.S.A. / A flight line computer system.

2,761,620 / John L. Lindesmith, Sierra Madre, and Edward P. Drake, Glendale, Calif. / Clary Corp., Calif. / A computing system.

2,761,621 / Esmond P.P. Wright and Alexander D. Odell, London, Eng. / International Standard Electric Corp., New York, N.Y. / An electric calculating circuit.

2,761,968 / Milton L. Kuder, Washington, D.C. / U.S.A. / An electronic analog-to-digital converter.

Sept. 11, 1956: 2,762,563 / Edward W. Samson, Watertown, and Edmund B. Staples, Westwood, Mass. / - / A binary number system converter.

2,762,564 / Edward W. Samson, Watertown, and Edmund B. Staples, Westwood, Mass. / - / A binary number system converter.

2,762,565 / Earl E. Libman, Brooklyn, Aaron D. Fialkow, New York, John W. Bozeman, Baldwin, and Irving Gerst, Brooklyn, N.Y. / Control Instrument Co., Inc., Brooklyn, N.Y. / An anti-aircraft gun computer.

2,762,566 / Joshua Stern, Silver Spring, Md. / - / A code matching system.

2,762,915 / Alan S. Bagley, Los Altos, Calif. / Hewlett-Packard Co., Palo Alto, Calif. / An electronic decade scaler.

2,762,921 / Robert A. Henle, Hyde Park, N.Y. / International Business Machine Corp., New York, N.Y. / A binary trigger circuit.

2,762,936 / Richard D. Forrest, Los Angeles, Calif. / Hughes Aircraft Co., Del. / A diode, pulse-gating circuit.

2,762,959 / Jack D. Welch, Cedar Rapids, Iowa / Collins Radio Co., Cedar Rapids, Iowa / An automatic gain control for electric servo systems.

2,762,961 / Robert A. Colby, Marion, Iowa / Collins Radio Co., Cedar Rapids, Iowa / A shaft positioning mechanism.

Sept. 18, 1956: 2,763,432 / Raymond A. York, Syracuse, N.Y. / General Electric Co., N.Y. / An electronic counter

2,763,780 / Charles W. Delton, Irving and Jack Scott Mason, Dallas, Tex. / Texas Instruments, Inc., Dallas, Tex. / A binary frequency divider.

Sept. 25, 1956: 2,764,343 / Bernard Diener, Culver City, Calif. / Hughes Aircraft Co., Culver City, Calif. / An electronic switching and counting circuit.

2,764,344 / Coe E. Westcott, Seattle, Wash. / Boeing Airplane Co., Seattle, Wash. / A mechanical binary digital to analog converter.

-END-

COMPUTER CONFERENCE
(cont'd from page 26)

California: The advent of the magnetic disk random access file enables processing of business transactions as they occur. The IBM 305 is designed specifically for such applications. This permits data processing to be on a current basis at all times. The new system employs stored program control for information transfer (including arithmetic) only. Each instruction is self-contained and transfers a field of information from any place in the system to any other on a fully-variable-length basis. All logical decision is based on control-panel logic. The actual logical organization of the machine will be discussed, including the data transfer paths, the decimal arithmetic system, and the input-output links. The control system is discussed with emphasis on the ability of the machine to "overlap" operations.

-END-

AUTOMATA
(cont'd from page 15)

Such a transfer is quite a remarkable operation because these automata are organized so that, if the DNA ahould get away from its protective coating of protein, it is quickly chopped to pieces by one of the enzymes. Thus they are protected against foreign DNA from some other model. If they were not armed with such an enzyme, foreign DNA might have been able to generate the same activity as the viruses, and it might have been a devastating weapon in the competition between the various classes of models.

Nevertheless, despite the hazards of the membranes and the enzyme, some DNA does get through occasionally. It may substitute for parts of strands or whole strands of DNA already functioning in the automaton. How much of this occurs among the smallest automata is still a puzzle. Yet the occasional donation of DNA elements from one unit to another appears to have a sufficient value to justify a few facilitating modifications in the membrane that enable a ready transfer from a donor to an acceptor (sexual union). In general, the larger and more complex the model, the more elaborate the provision for the transfer of DNA. In this elaborate form the mechanism is called sex.

This transfer of DNA appears to be the most fundamental method of communication between automata in Mikrobiologia. Sexual union provides a means for combining experience at the highest level of abstraction achieved by the automata. Unless the initial population grew to an exceedingly high figure at the time of the evolution of the automata (10^{12} individuals), the chances are strong that all strains would have died out in 10^{13} or so generations. It does not seem surprising now to speculate that the "brute force" solution for self-sufficiency was not complete until sex was invented. The universal Turing machine in mathematics does not have to deal with noise, but these automata operate in the real world with finite tapes and the Second Law of Thermodynamics. They have postponed the death of the line almost indefinitely by finding a method of capitalizing on the experience of predecessor models of related lines.

---

1. I have as yet found no one who can decode the language, which is called Latin, but it appears that most of the workers here know some of the grammar and etymology.

2. In the language of Mikrobiologia this is called a cell, but since this term has a meaning quite different from that which is used by the physical chemistry groups specializing in mobile power sources, I must stick to the term "automaton."

3. Whenever using a word from their language, it will be underlined, according to the standard usages for dealing with foreign languages.

4. There are a) salts, used often for tying subassemblies together or providing them with a protective coating, b) metabolic intermediates, which are semifabricated components, and c) metabolic wastes, the unusable scrap which must be discarded. About 10^3 items have been identified, with numbers of each ranging from 10^2 to 10^{10}.

-END-

————————————————————*

Forum

FOURTH CONFERENCE ON HIGH SPEED COMPUTERS, BATON ROUGE, MARCH 1957

Charles W. Barnett
Research Programmer
Office of the Comptroller
Louisiana State Univ.
Baton Rouge 3, La.

The 1957 Conference on High Speed Computers will be held at Louisiana State University, Baton Rouge, Louisiana, from March 5 through March 8, 1957. This conference is open to businessmen, office managers, accountants, engineers, chemists, physicists, economists, statisticians and other potential users from all sections of the country. Topics scheduled for discussion by nationally recognized speakers include office procedures, statistical operations and numerical methods designed for the adaptation of problems to machine solution. Several manufacturers of computing equipment will be represented through exhibits or demonstrations of computers in operation.

Inquiries concerning the conference may be directed to:

Dr. J. W. Brouillette
Director, General Extension Div.
Louisiana State University
Baton Rouge 3, Louisiana

Forum

IBM ELECTRONIC DATA PROCESSING OPERATIONS IN THE MIDWEST

To Neil D. Macdonald, Assistant Editor, from
Robert L. Fara, Head
Numerical Analysis Branch
U.S. Naval Avionics Facility
Indianapolis 18, Ind.

I have just read your article, "IBM Electronic Data Processing Operations in the Midwest", in the August 1956 issue of "Computers and Automation". I realize that writing such an article is a large undertaking, and you only intended to give some examples; nevertheless, we are disappointed at not being included, especially since we have one of the first, if not <u>the</u> first, 650 delivered in the Midwest. Perhaps the oversight is due to the fact that we have never listed our organization on your roster, although individuals in your organization have been listed in "Who's Who in the Computer Field".

The following is our organization entry form as outlined in "Computers and Automation".

1. Numerical Analysis Branch
   Mathematics Division
   Research and Test Department
   U.S. Naval Avionics Facility (formerly U.S. Naval Ordnance Plant)

2. Indianapolis 18, Ind.

3. Fleetwood 7-8311

4. I.B.M. Card Programmed Calculator, 650 Magnetic drum calculator and associated auxiliary machines.

5. Research (primarily airborne fire control)

6. Nine employees in the Numerical Analysis Branch exclusively, although other mathematicians, physicists and engineers also use the equipment.

7. Although there have been desk calculating facilities here since this plant was built in 1942, no automatic calculators were used until the CPC was installed in May 1952. The 650 was added in May 1955.

Other 650 installations not included in your paper are:

Allison Division of General Motors
Indianapolis, Indiana
Two 650's and a 700 series machine on order

Cummins Engine
Columbus, Indiana
One 650

Indiana University
Bloomington, Indiana
One 650

Wright-Patterson Air Force Base
Dayton, Ohio
Several machines, the number and types unknown to me.

----------*

News Release
Beckman Instruments, Inc.

BECKMAN DATA PROCESSING SYSTEM

FULLERTON, CALIF., OCTOBER 30, 1956 — Beckman Instruments, Inc., announced that its Scientific Instruments Division has begun development of a high-speed electronic data processing system, capable of recording up to 5,000 pieces of test information in a single second, for the Westinghouse Electric Corp.'s Aviation Gas Turbine Division at Kansas City, Missouri.

The system will be used in jet engine development programs now underway at the Westinghouse facility. It will cost approximately $223,000.

Designed to record split-second changes in temperature, pressure and other physical variables, the Beckman system will enable Westinghouse engineers to chart engine performance with extreme precision. Use of the system will yield performance data virtually impossible to obtain through other recording methods, according to Beckman spokesmen.

The 200-channel data processing system will measure and record both frequency analog and voltage analog signals. Data will be coded on magnetic tape and fed to an IBM 704 Computer for study.

The system is scheduled for delivery in August, 1957.

BOOKS AND OTHER PUBLICATIONS

(List 22, "Computers and Automation", Vol. 5, No. 12, December 1956)

This is a list of books, articles, papers, and other publications which have a significant relation to computers, automation, and related subjects, and which have come to our attention. We shall be glad to report other information in future lists, if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / a few comments. If you write to a publisher or issuer, we would appreciate your mentioning the listing in "Computers and Automation".

Institute of Radio Engineers, Professional Group on Information Theory /1956 Symposium on Information Theory IRE Transactions on Information Theory, Vol. IT-2, no. 3, Sept. 1956 / IRE One East 79 St., New York 21, N. Y./ 1956, photooffset, 221 pp., $9.00.

Contains 19 technical papers written and preprinted for the 1956 Symposium on Information Theory held at MIT, Cambridge, Mass., September 10 to 12, 1956. Included are papers on coding, automata, information sources, information users, applications of information theory, etc.

Hall, C. L., and R. E. Klautsch / On-Line Automatic Data Reduction, Tunnel E-1, Gas Dynamics Facility / Arnold Engineering Development Center, USAF, available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C./ April, 1956, photooffset, 34 pp., cost?

(Review by Edith Taunton)

A brief and interesting description of the means whereby test data from an intermittent supersonic wind tunnel (Tunnel E-1) are fed directly from test measurements into an electronic computer for recording and analysis. Includes a number of systems diagrams and photographs of equipment.

Forbes, George F. / Digital Differential Analyzers, An Applications Manual for Digital and Bush Type Differential Analyzers / G. E. Forbes, 10117 Bartee Ave., Pacoima, Calif./ 1956, photooffset, 190 pp., $7.50.

(Review by Edith Taunton)

A full explanation of digital differential analyzers, their nature and applications, brought up to date. This third edition contains the author's earlier monographs and later information. A thorough summary of digital differential analyzer methods and equipment. The book is well-written, and is a sincere attempt to make the mathematical approach to this application field as elementary as possible.

Woodward, P. M./ Probability and Information Theory, with Applications to Radar/ McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. and Pergamon Press, Ltd., London/ 1955, printed, 128 pp. $4.50.

A monograph in the Pergamon Science Series reporting on the applications of probability and information theory to radar. The author devotes his first three chapters to introduction of mathematical techniques used in probability theory, the analysis of waveforms and noise, and information theory. He also discusses some of the problems encountered in detecting signals among noise and shows how the mathematical techniques described may be applied to radar. This work is a clear-cut presentation of the code in which much of "the mathematical theory of electronics and radar is nowadays expressed," and an exposition of information theory techniques.

Canning, Richard G./ Electronic Data Processing for Business and Industry / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y./ 1956, printed, 332 pp., $7.00

A discussion of the application of automatic digital data-processing machines to clerical functions in business and industry. The book defines electronic data processing, illustrates programming of typical clerical operations, etc., and attempts to help management determine what electronic data processing might do for its problems, and to show management how to go about investigating its possibilities. The author follows systems engineering approach, regarding a company as an integrated operation, and then suggests a data processing system to meet the overall requirements of such an operation.

Levin, Howard S./ Office Work and Automation/ John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y./ 1956, printed, 203 pp., $4.50

(Review by Edith Taunton)

A discussion of the new tools -- computers, operations research methods, etc. -- of our era of automation which are designed to help executive management. The author is an authority on office management and statistics, and he presents his materials clearly, with adequate illustration.

Eckert, W. J., and Rebecca Jones / Faster, Faster / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1956, printed, 160 pp., $3.75
(Review by Edith Taunton)

A brief, simple, well-expressed text describing a typical giant electronic calculator — the IBM NORC (Naval Ordnance Research Computer) — its operation and applications. The book proper is written for the layman, to help him understand giant electronic calculators, but five useful appendices give the characteristics of the NORC, a summary of operations, an example of programming, etc., for specialized computer people.

Lo, Arthur W., R. O. Endres, J. Zawels, F. D. Waldhauer, and C. Cheng / Transistor Electronics / Prentice-Hall, Inc., Englewood Cliffs, N. J. / second printing Jan. 1956, 521 pp., $12.00

The combined work of five engineers in the RCA Laboratories. A presentation of transistor electronics, proceeding from a discussion of the fundamental concepts of transistor physics through analyses of transistor circuits and practical techniques of circuit design. There are ample illustrations of circuit design. The last chapter, over 60 pages long, deals with pulse circuits.

Alsop, Joyce, Anne T. Flanagan, and Eric V. Hankam / Bibliography on the Use of IBM Machines in Science, Statistics and Education; 5th edition with index / International Business Machines Corp., Watson Scientific Computing Lab., 612 West 116th St., New York 27, N. Y. / Jan. 1956, printed, 81 pp., free

A listing of 907 technical articles which have appeared describing IBM machine methods useful for research in the fields of science, statistics and education. This publication brings up to date the earlier bibliographies published in 1947, 1950, 1952 and 1954.

Seely, Samuel / Electronic Engineering / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N. Y. / 1956, printed, 525 pp., $8.00

This book, a companion volume to the author's "Radio Electronics", is largely devoted to analyses of electronic circuits. The physical operations of the circuits are explained, and a mathematical explanation of circuit operation is given wherever feasible. The book begins with a general introduction to tubes and tube circuit principles, discussing electron tube characteristics, vacuum triodes as circuit elements, etc.; it then considers in detail the more important electronic circuits. It includes a sound discussion of solid-state theory and a brief treatment of transistors as circuit elements. It is intended ti equip the reader who has a basic electrical engineering background with a practical working understanding of analytical techniques in electronics engineering and with means for combining various types of electronic circuits to achieve operational results desired. Chapter 6 is devoted to electronic computing circuits with particular reference to analog computers.

National Electronics Conference / Proceedings of the National Electronics Conference, Vol. XI / National Electronics Conference, Inc., 84 East Randolph St., Chicago, Ill. / 1955, printed, 1040 pp., $5.00

This volume contains 102 technical papers and three addresses presented during the Eleventh Annual National Electronics Conference, October, 1955; it includes four papers on computers and computer elements.

- END -

INDEX

This index covers information published in the twelve issues of COMPUTERS AND AUTOMATION, vol. 4, no. 12, Dec. 1955, to vol. 5, no. 11, Nov. 1956. In order not to delay the current issue, Dec. 1956, it has not been included in this index. The last part of each entry gives: volume / number (month of issue), page number.

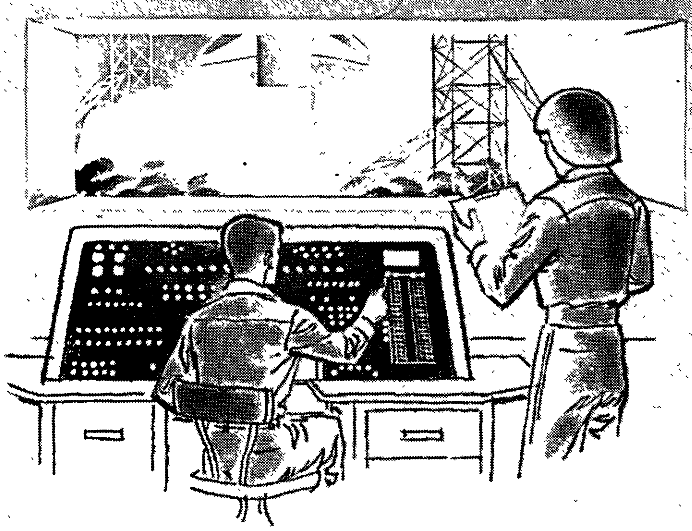
(cont'd on page 38)

ICBM

to be guided by UNIVAC

New applications are continually being found for Remington Rand Univac electronic computing systems. They are playing a vital and versatile role in scientific research, business, industry, communications and transportation. Now Univac is engaged in the design and development of a guidance system for the Air Force's Intercontinental Ballistics Missile—a system which will guide such missiles as the "Atlas" and the "Titan."

Univac offers engineers and technicians opportunities in virtually every field of professional interest. The diversity of its operations means stability and continued growth for Univac—and for members of the Univac team. Univac offers you interesting assignments, excellent opportunities and starting salaries that are among the highest in the field. Say: "I'm with Univac." Investigate the following permanent positions.



IMMEDIATE OPENINGS FOR:

ELECTRONIC DESIGN ENGINEERS

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ELECTRO-MECHANICAL DESIGN ENGINEERS

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FIELD LOCATION TECHNICIANS

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MATHEMATICIANS

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Send complete resumé to

Remington Rand Univac

DIVISION OF SPERRY RAND CORPORATION
J. N. WOODBURY
Dept. SD-15
1902 W. MINNEHAHA AVE., ST. PAUL W4, MINNESOTA

(cont'd on page 40)

(cont'd on page 42)

WHO'S WHO in the COMPUTER FIELD, 1956-7

- Second cumulative edition
- Extra number of "Computers and Automation"
- Coming out beginning of 1957
- Containing **NAMES, ADDRESSES AND OTHER INFORMATION** for about 10,000 COMPUTER PEOPLE
- probably over 150 pages long
- every entry is free (see entry form in November issue

Print Quantity. We plan to print about 800 copies to sell prepaid before publication at $15 each, estimating that one third of our 2400 subscribers to "Computers and Automation" will buy a copy; but the print quantity will be increased if necessary to cover all prepaid orders received before December 13, 1956. The Who's Who extra issue of "Computers and Automation" will not be included in the subscription.

- - - - MAIL THIS ORDER FORM - - - - -
(or a copy of it)

Order now — the print quantity will cover only prepaid orders received prior to December 13, 1956.

Date________________

To: Computers and Automation
Berkeley Enterprises, Inc.
815 Washington St., R185
Newtonville 60, Mass.

Please send us __________copy(ies) of WHO'S WHO IN THE COMPUTER FIELD, 1956 (extra number of "Computers and Automation"), at $15 a copy.

We enclose $____________. Please mail copy, when published to:

Name:

____

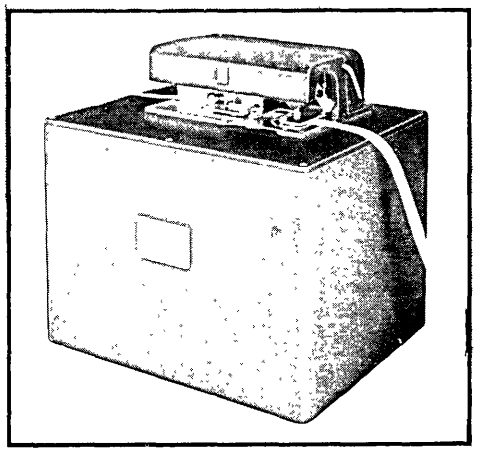
Address:

____

FERRANTI

HIGH SPEED TAPE READER

...handles punched tape data at electronic speeds



The Ferranti High Speed Tape Reader accelerates to full speed within 5 milliseconds and stops within 3 milliseconds. It has been in use at leading computer installations for over two years and has achieved a sound reputation for simplicity and reliability in regular operation.

FAST (1) Mark II model reads at speeds up to 200 characters per second, and stops the tape from full speed within a character position—within .03 inch. The tape is accelerated to full speed again in 5 milliseconds and the following character is ready for reading within 6 milliseconds of rest position.

(2) Mark IIA model reads at speeds up to 400 characters per second, and stops within .1 inch.

VERSATILE Both models read either 5 level, 6 level or 7 level tape by simple adjustment of an external lever.

SIMPLE The tape is easily inserted without complicated threading. Lap or butt splices are taken without any difficulty. The same tape may be passed thousands of times without appreciable tape wear. The optical system has no lenses or mirrors to get out of alignment. Friction drive is independent of sprocket hole spacing.

LARGE OUTPUT Amplifiers are included for each channel, including a special squaring circuit for the sprocket hole signal. Output swing between hole and blank is greater than 20 volts.

FERRANTI

Dimensions: 9" x 11½" x 11¼" **Weight: 37 lbs.**
For use with long lengths of tape up to 1000 feet, spooling equipment operating up to 40 inches per second for take-up or supply is available separately.

FERRANTI ELECTRIC, INC.

30 Rockefeller Plaza New York 20, N. Y.

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Forum

WESTERN JOINT COMPUTER CONFERENCE, LOS ANGELES, FEBRUARY 26, 27, 28, 1957

The 1957 Western Joint Computer Conference, sponsored by the Institute of Radio Engineers, the Association for Computing Machinery, and the American Institute of Electrical Engineers will be held in Los Angeles, Calif., on Feb. 26, 27, and 28, 1957, Tuesday, Wednesday and Thursday at the Hotel Statler, Los Angeles, Calif. The conference theme is "Techniques for Reliability".

The secretary of the conference is William S. Speer, Norden-Ketay Corporation, 13210 Crenshaw Boulevard, Gardena, Calif., from whom more information may be obtained.

* ——— * ——— *

ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
815 Washington St., Newtonville 60, Mass.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles, papers, and reference information related to computing machinery, robots, automatic control, cybernetics, automation, etc. One important piece of reference information published is the "Roster of Organizations in the Field of Computers and Automation". The basic subscription rate is $5.50 a year in the United States. Single copies are $1.25, except the June issue, "The Computer Directory", (1956, $6.00; 1955, $4.00). For the titles of articles and papers in recent issues of the magazine, see the "Back Copies" page in this issue.

2. What is the circulation? The circulation includes 2500 subscribers (as of Nov. 10); over 300 purchasers of individual back copies, and an estimated 3000 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are people concerned with the field of computers and automation. These include a great number of people who will make recommendations to their organizations about purchasing computing machinery, similar machinery, and components, and whose decisions may involve very substantial figures. The print order for the October issue was 3000 copies. The overrun is largely held for eventual sale as back copies, and in the case of several issues the overrun has been exhausted through such sale.

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

4. What are the specifications and cost of advertising? COMPUTERS AND AUTOMATION is published on pages 8 1/2" x 11" (ad size, 7" x 10") and produced by photooffset, except that printed sheet advertising may be inserted and bound in with the magazine in most cases. The closing date for any issue is approximately the 10th of the month preceding. If possible, the company advertising should produce final copy. For photooffset, the copy should be exactly as desired, actual size, and assembled, and may include typing, writing, line drawing, printing, screened half tones, and any other copy that may be put under the photooffset camera without further preparation. Unscreened photographic prints and any other copy requiring additional preparation for photooffset should be furnished separately; it will be prepared, finished, and charged to the advertiser at small additional costs. PLEASE DO NOT SEND US METAL PLATES OR ELECTROS; please send reproduction proofs instead. In the case of printed inserts, a sufficient quantity for the issue should be shipped to our printer, address on request.

Display advertising is sold in units of a full page (ad size 7" x 10", basic rate, $190) two-thirds page (basic rate, $145), half page (basic rate, $97), and quarter page (basic rate, $55); back cover, $370; inside front or back cover, $230. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $320; four-page printed insert (two sheets), $590. Classified advertising is sold by the word (60 cents a word) with a minimum of 20 words.

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

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

ENGINEERS-SCIENTISTS: ANNOUNCING A VAST PROGRAM IN MISSILES RESEARCH AND DEVELOPMENT IN PHILADELPHIA WITH MANY ATTRACTIVE PROFESSIONAL OPPORTUNITIES

The Missile & Ordnance Systems Department of General Electric

Where We Are...

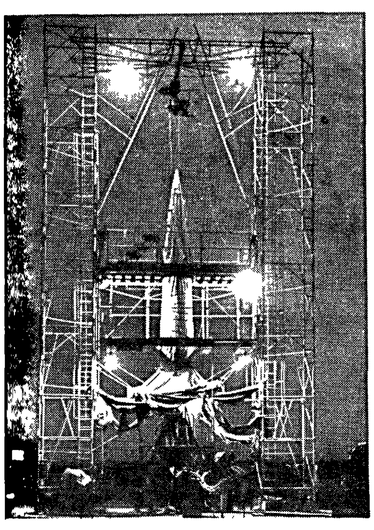
In PHILADELPHIA near 30th St. PRR Station...until our new 110 acre facilities are ready in Valley Forge —17 miles by Schuylkill Expressway from Downtown Philadelphia.

What We're Doing...

A PRIME CONTRACTOR—developing the ICBM and IRBM Nose Cones complete with nuclear arming and fuzing devices, gyros, accelerometers, resolvers, induction generators, amplifiers, servos. This G-E Department is the center of company-wide studies in viscosity, diffusion, thermal conductivity, radiation, laminar and turbulent shock layers, etc., for a vast missile system program.

How We're Doing It...

The Department's primary objective is to create the country's TOP TEAM on Guided Missile Research and Development and with this team assume FULL MISSILE SYSTEM RESPONSIBILITY for the entire General Electric Company. This will involve making use of the tremendous potential in the company's more than 100 operating departments and its many research laboratories.



ZERO minus 4 hours! A G-E test missile, still shrouded in the early morning dampness before launching, represents more than a decade of research and development.

Where We're Headed...

INTO EVERY PHASE OF MISSILE RESEARCH & DEVELOPMENT including:

..MISSILE WEAPONS SYSTEMS—target and missile tracking—radars—computers—handling equipment—launching equipment—logistics equipment—and others, all designed FROM THE GROUND UP as one system!

...SPECIFIC MISSILES—also Satellites including propulsion, guidance, airframes, and warhead arming and fuzing devices.

...SPECIAL COMPONENTS OF MISSILES —such as inertial guidance systems.

What We're Using...

HYPERSONIC WIND, SHOCK, HELIUM TUNNELS—mass accelerators—linear accelerators—electric arc mass accelerators—hyper-velocity shock tunnels. UNDER DEVELOPMENT: the LARGEST GAS SHOCK TUNNEL in the country...PLUS laboratories and equipment second to none. AND WHEN NEEDED—the resources of over 100 other G-E departments!

What All This Means to You...

Stable career growth, full use of your abilities, creative experience and rapid advancement either into management or further specialization, with a profesional staff that is expanding rapidly.

Scientists with advanced degrees will have a particularly attractive opportunity to engage in high levels of basic and applied research in such advanced fields as Astrophysics, High Temperature Phenomena, Advanced Mathematical Concepts, Aerodynamics, Classical Physics, Materials Development, and Communications Theory.

..Engineers and Scientists with education and experience in any of the fields listed below are invited to correspond with us...

DEGREE: *Electrical Engineer, Aeronautical Engineer, Aerodynamics, Mechanical Engineer, Physics, Mathematics.*

EXPERIENCE: SYSTEMS—*Development, Synthesis, Operations Analysis* • AEROPHYSICS • COMPUTER DESIGN—*Analogue, Digital* • MATERIALS & PROCESSES • INSTRUMENTATION —*Telemetry, Transducers, Recording, Recovery* • DATA PROCESSING—*Systems Design, Analysis, Programming* • GUIDANCE—*Intertial Guidance, Component Development* • TECHNICAL WRITING • FIRE CONTROL • STRUCTURES — *Thermodynamics, Electrical Design, Stress Analysis, Structure Design, Vibration, Aerodynamics* • ARMING AND FUZING—*Component Development, Test Equipment* • FIELD TEST • SYSTEMS TEST • GROUND SUPPORT EQUIPMENT DESIGN—*Controls, Handling Equipment, Launching Equipment.*

> Missile & Ordnance Systems Department would be pleased to receive a resume of your education and experience.
>
> All resumes will be carefully reviewed by the MANAGERS of our various technical components. You will be invited to visit our offices and discuss the work we are doing directly with the manager with whom you would be working. All communications will be entirely confidential. (You need not reveal the name of your present employer.)

Please send resume to Mr. John Watt, Room 510-11

MISSILE & ORDNANCE SYSTEMS DEPARTMENT

GENERAL ELECTRIC

3198 Chestnut Street • Philadelphia, Pennsylvania

ADVERTISING INDEX

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

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

READER'S INQUIRY

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

READER'S INQUIRY FORM

Paste label on envelope: ↓

Enclose form in envelope: ↓

BUSINESS REPLY LABEL

NO POSTAGE STAMP NECESSARY IF MAILED IN U.S.A.

4¢ Postage Will Be Paid By —

BERKELEY ENTERPRISES, INC.

38 East 1st Street
New York 3, N. Y.

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

READER'S INQUIRY FORM

Name (please print)..

Your Address?..

Your Organization?..

Its Address?..

Your Title?..

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

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

REMARKS:

Electronic Computers on your staff

Now, any business, large or small, can put electronic computers to work to cut costs and increase efficiency.

C.D.C. is proud to announce Canada's first Data Processing Centre established by private enterprise. Located at the Company's Head Office in Ottawa, this centre is available to serve government and industry in any part of Canada.

USE OUR SERVICE . . .

. . . If you are planning to obtain your own computing facilities, you can have C.D.C. test your procedures and solve specimen problems using this centre.

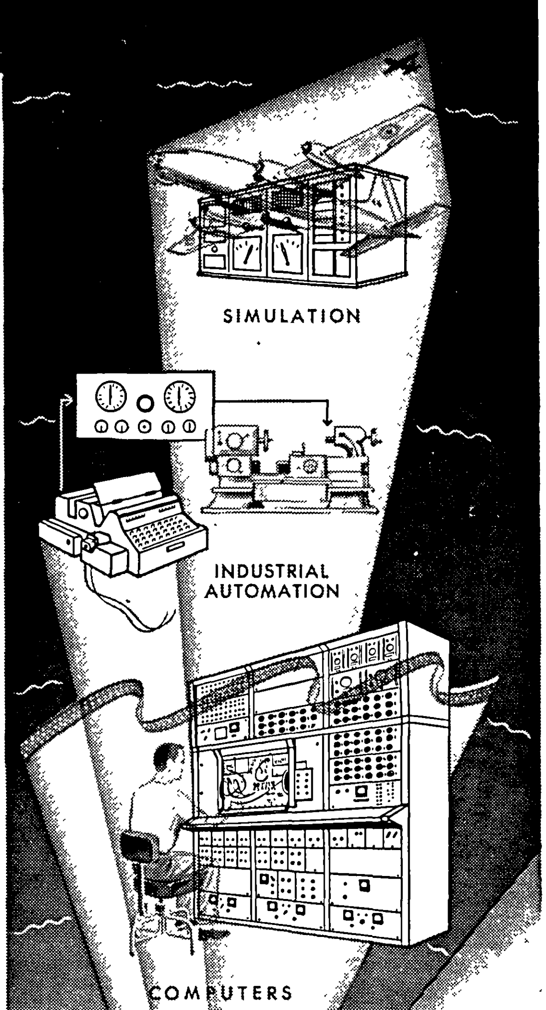
. . . If you have your own computing facilities, you can transfer your peak loads or overloads to C.D.C.

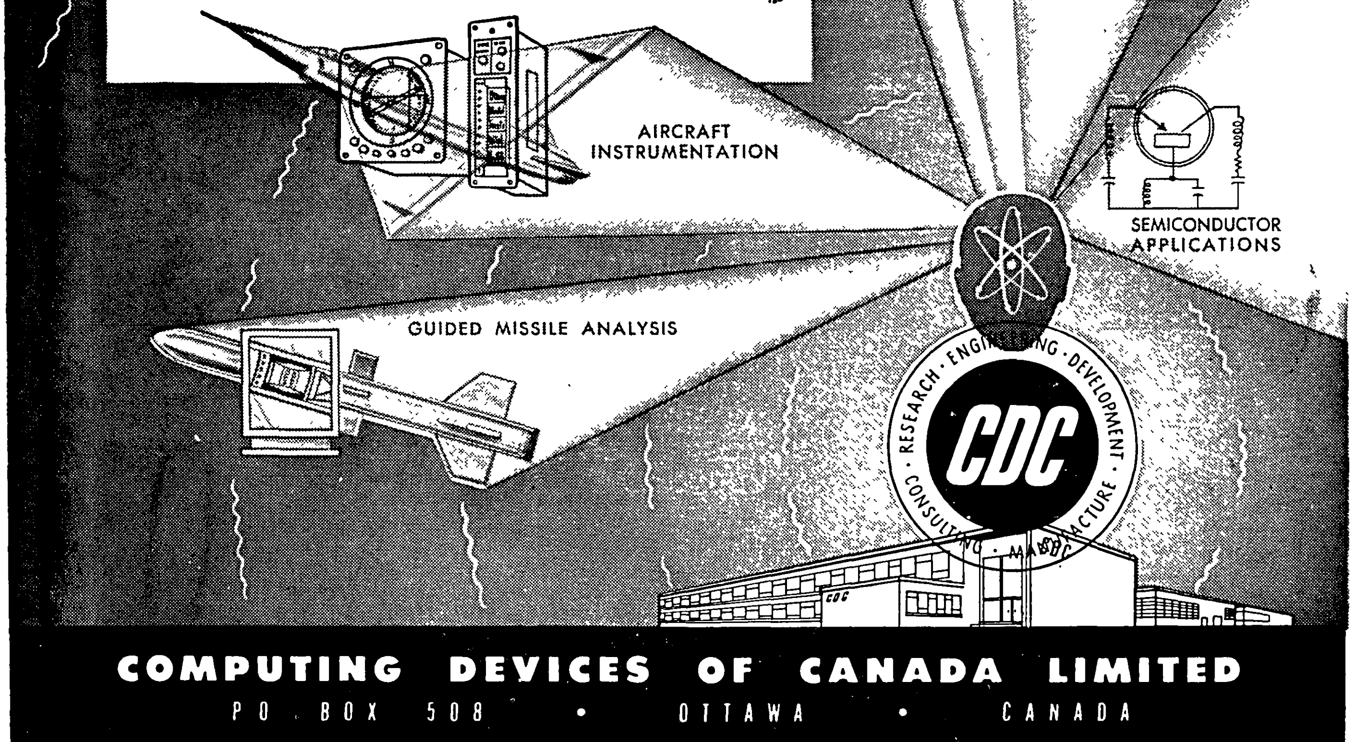
. . . If you cannot justify having your own computing facilities, you can make use of those at this centre.

. . . If you are confronted with an unusually difficult research problem, you may find you have neither the necessary staff nor sufficient facilities — in such a situation, the C.D.C. Computing Centre will be found invaluable.

. . . If you have continually recurring computing or data processing problems, you can arrange to lease communication facilities linking your office directly with the C.D.C Centre.

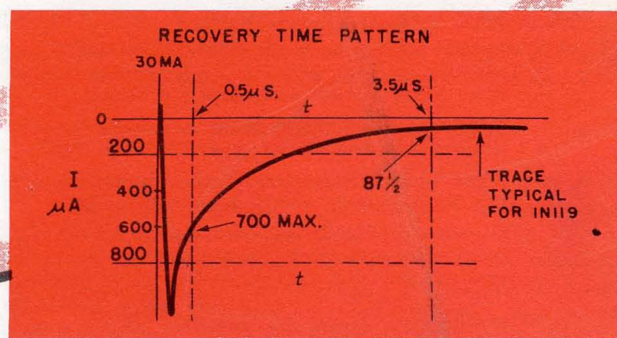
Highly qualified and experienced applied mathematicians and engineers, backed by the latest computer facilities, both digital and analog, are at your service for problem formulation and analysis, programming, computation, data reduction, application of data processing equipment to business procedures, practical instruction in computer operation and programming. 5604R3





COMPUTING DEVICES OF CANADA LIMITED

P.O. BOX 508 • OTTAWA • CANADA



TYPICAL RECOVERY TIME TRACE FOR THE TYPE IN119

IBM "giant brain" with microsecond memory

...incorporates Sylvania diodes with fast recovery time

The IBM 705 is a "giant brain" general purpose data processing system which incorporates unique flexibility of input-output devices. Its Magnetic Core Memory can recall data at the rate of 9 millionths of a second per character.

To meet the 705's requirements for speed, Sylvania Crystal diodes are designed and measured for fast recovery time. Recovery time tests, conducted on a 100% basis, are measured for maximum reverse current at 0.5 microseconds and 3.5 microseconds. Back resistance is swept dynamically between zero and -70 volts at 60 cycles and 55°C. Tests are also conducted on the types IN119 and IN120 for minimum drift, flutter, and hysteresis.

Sylvania produces a complete line of computer diodes, produced and tested under the same standards as the IN119 and IN120. For applications requiring high forward conductance with excellent recovery time, Sylvania offers a complete line of V.L.I. (*very low impedance*) diodes.

Write for complete details on these as well as general purpose Sylvania diodes. Address Dept. M15R.

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., Montreal

LIGHTING · RADIO · TELEVISION · ELECTRONICS · ATOMIC ENERGY