COMPUTERS AND AUTOMATION

CYBERNETICS · ROBOTS · AUTOMATIC CONTROL

Vol. 4
No. 5

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Numerical Representation in Fixed-Point Computers
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The Skills of the American Labor Force
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... A. H. Raskin

The Monkey Wrench
... Gordon R. Dickson

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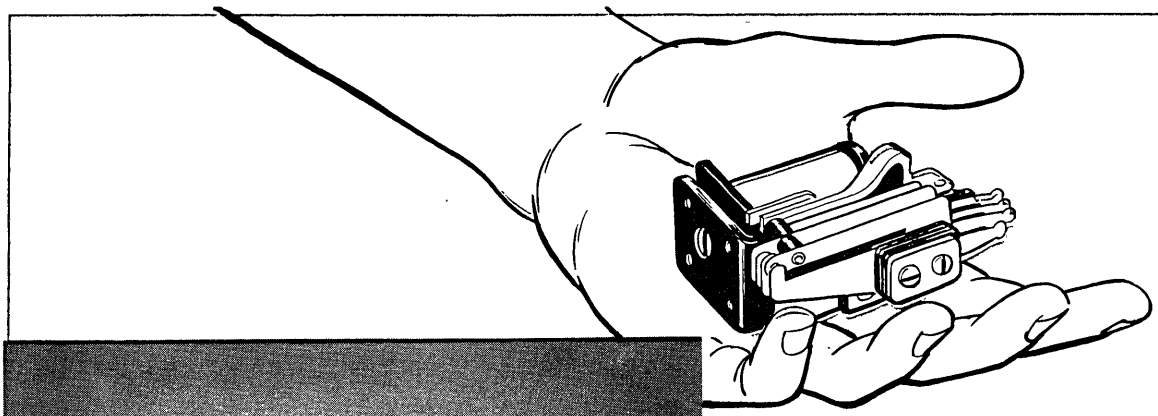

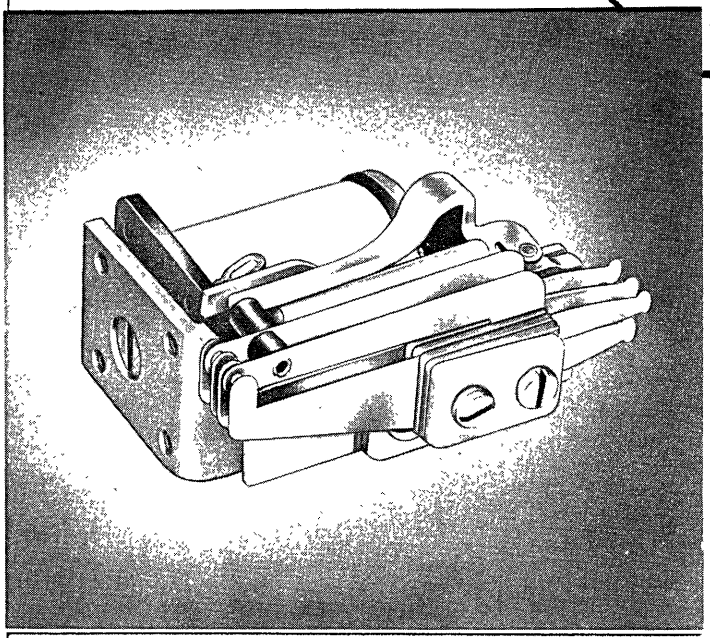

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Editor: Edmund C. Berkeley
Assistant Editors: Eva Di Stefano, Neil Macdonald, Jack Moshman, Gordon Spenser, F. L. Walker
Contributing Editors: Andrew D. Booth, John M. Breen, John W. Carr, III, Alston S. Householder, Fletcher Pratt
Advisory Committee: Samuel R. Williams, Herbert F. Mitchell, Jr., Justin Oppenheim

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THE EDITOR'S NOTES

ECONOMIC CHANGES FROM AUTOMATION

In the few days before this issue of "Computers and Automation" went to press, General Motors Corporation and the United Automobile Workers, C.I.O., began to bargain in Detroit for a new contract in regard to the company's 325,000 production workers. The New York Times said, "The union has made clear that it intends to obtain some form of a guaranteed annual wage, or it will strike....Under the union's proposal, workers would be guaranteed fifty-two weeks of pay each year; the plan would be geared into state unemployment compensation. One of the developments in the auto industry that has caused the union to emphasize the guaranteed annual wage is the spectacular advance of automation -- increased use of automatic machines in industry."

The question of how and to what relative extent stockholders, management, labor, consumers, and other sections of the people will share in the gains from computers and automation is naturally of great interest to everybody. There is at least another question raised: how should a man earn his living if a machine takes his job away? For this reason we are giving a good deal of space in this issue to three current reports: "Automation", the report of the UAW-CIO Committee on Automation; "The Skills of the American Labor Force", an address by James P. Mitchell, Secretary of the Department of Labor; and "Automation Puts Industry on Eve of Fantastic Robot Era", a report by A. H. Raskin, reprinted from "The New York Times". We hope that these three reports may stir some ideas in the thoughts of our readers, and reveal more of the applications and implications of computers and automation.

COMPUTER DIRECTORY

The next issue of "Computers and Automation", June, 1955, will be a "Computer Directory".

Part 1 of the directory is the second edition of "Who's Who in the Computer Field" which we published in 1953--54. It contains names and some information about all persons whom we know of who are really interested in computers.

Part 2 of the directory is a cumulative "Roster of Organizations in the Computer Field" based on the roster regularly published in "Computers and Automation", with entries expanded to some extent.

Part 3 of the directory is the first edition of "The Computer Field: Products and Services for Sale". It is a compendium of brief descriptions and information about machinery, systems, components, services, etc., for computing and data-handling.

We hope our readers will find the Computer Directory useful. We shall be grateful for comments, corrections, or suggestions, to be incorporated in the next edition, which will be not later than June 1956.

- END -

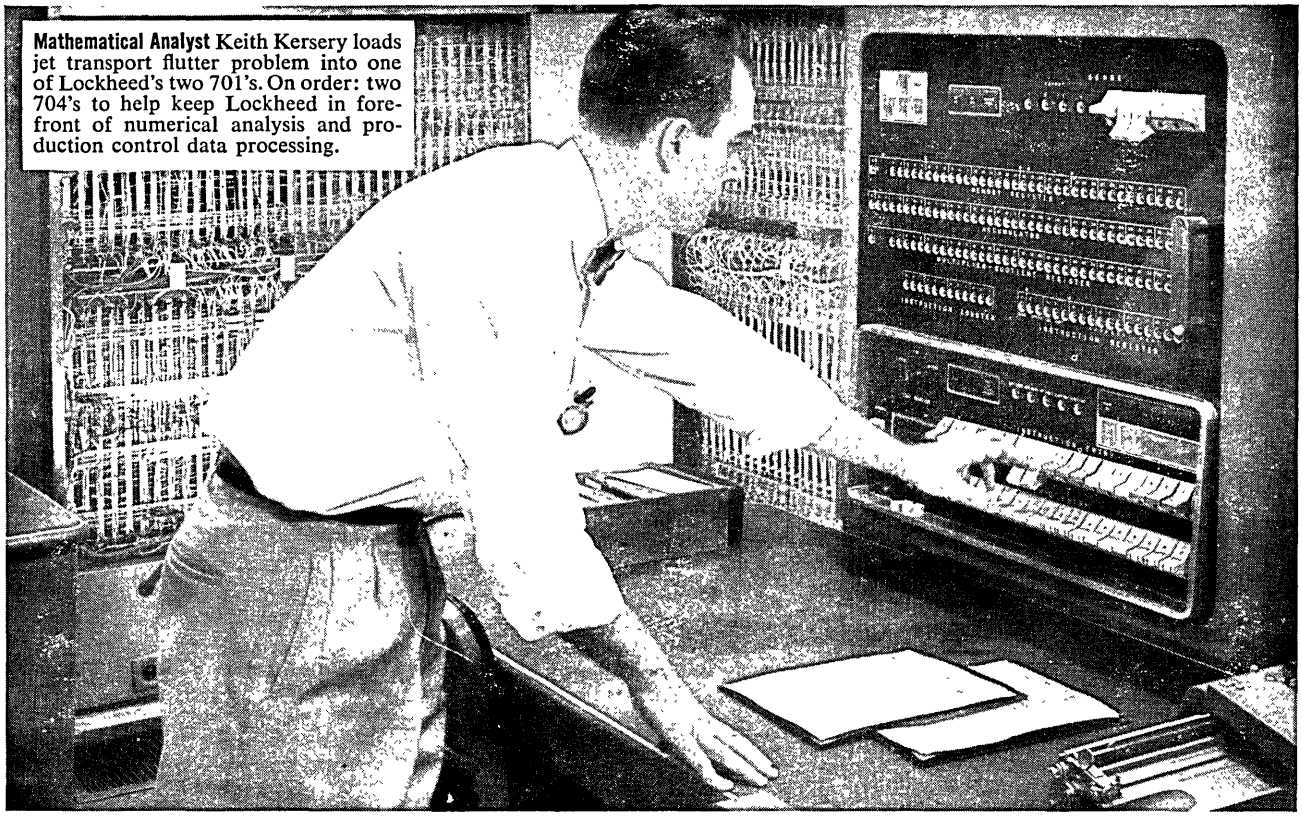
MANUSCRIPTS

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

Articles. We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it. Consequently a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions. We look particularly for articles that explore ideas in the field of computers and automation, and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 4000 words, and payment will be $10 to $40 on publication. A suggestion for an article should be submitted to us before too much work is done.

Technical Papers. Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable. No payments will be made for papers. If a manuscript is borderline, it may be returned to the author to be modified to become definitely either an article or a paper.

Fiction. We desire to print or reprint fiction which explores ideas about computing machinery, robots, cybernetics, automation, etc., and their implications, and which at the same time is a good story. Ordinarily, the length should be 1000 to 4000 words, and payment will be $10 to $40 on publication if not previously published, and half that if previously published.



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

New 701's speed Lockheed research in numerical analysis

The first airframe manufacturer to order and receive a 701 digital computer, Lockheed has now received a second 701 to handle a constantly increasing computing work load. It gives Lockheed the largest installation of digital computing machines in private industry.

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Reliability in Electronic Data Processors

William B. Elmore
Senior Systems Specialist,
Price Waterhouse & Co., New York

The question of reliability inevitably arises in any consideration of electronic data processing equipment. The fact that these processors can do so much without human intervention makes us all the more concerned that they should be deserving of our complete confidence. "Reliability," in the context of this equipment, is generally used as a rather broad term, including at least two aspects: (1) freedom of the machine from breakdown due to component failure and (2) freedom of the machine's output data from error. This paper is concerned primarily with this second aspect which will here be called accuracy.

No machine is completely infallible. In order to get some idea of just how much we can trust these machines, let us look briefly at the accuracy of electronic processors from two quite different viewpoints. First, how accurate are they from an engineering standpoint? How likely are they to make a mistake of any sort? This can, for the sake of discussion, be more or less arbitrarily called dependability. Secondly, how adequately can these machines check their own results - how likely are they to make an error undetected by their own circuits? This we may call self-checking ability. It should be emphasized that these two factors - dependability and self-checking ability - are quite distinct from each other. A desk calculator, for example, is quite dependable but it has no ability to check itself. A human with pencil and paper, on the other hand, has an ability to check himself which is limited only by his knowledge of checking methods.

Computational Dependability

In regard to both of these considerations - dependability and self-checking ability - it is important first to determine the yardstick by which these factors should be measured. They can be measured in terms of the frequency of errors in time - the number of errors per hour, per day, per week. Or they can be measured in terms of the amount of work done between errors - the number of errors per million operations, for example. It is certainly an impressive fact that some of the Bell Telephone relay computers at the Aberdeen Proving Grounds have operated for five years without any error undetected by the machines themselves. But these are slow machines by today's standards. Five year's for these computers correspond, workwise, to less than an eight-hour day for the electronic computer of the present. And this five-year period is one, not of error-free operation, but of operation free from undetected errors - errors that get through the machine's own checking circuits. These relay computers made many self-detected errors during that period. An electronic computer today can operate many hours - many days even - without any error. That corresponds to decades for the relay computers or a thousand lifetimes for a human mathematical wizard.

A user of one of the smaller-scale scientific electronic computers has also had some impressive experience. This computer was manufactured by the Underwood Corporation and is known as the Elecom 100. The uses for which it was designed did not require any checking circuits and, consquently, built-in self-checking ability is essentially nonexistent in this machine. But its dependability is quite striking. It often runs for periods up to 300 hours in solving a problem without any error. During such periods it operates on a 24-hour day, being completely unattended during 16 of those hours. Furthermore, the routine preventive maintenance is very haphazard. This particular user of the equipment employs the Elecom 100 simply to verify the computational results of an analog computer and for this reason gives it a back seat in maintenance priority. It is not unusual for anywhere from one to three months to pass without any preventive maintenance whatsoever being carried out on it.

Three hundred hours of continuous operation without error is an impressive dependability record for an electronic computer - measuring dependability in terms of time frequency of errors. And it is no reflection on the Elecom 100 to point out that the Univac, for example, in its internal operations, is about 100 times as fast. In other words, 300 hours on the Elecom 100 corresponds to about three hours on the Univac, and between eight and ten years for a desk calculator. Though three hours without error is routine for the Univac, eight to ten years without error is simply impossible for a human being operating a desk calculator. When dependability is measured in terms of work done between errors, electronic processors are more accurate by several orders of magnitude than anything before them,

human or mechanical, that we have ever had.

The performance of various physical components, such as vacuum tubes, has a fundamental effect on operating reliability and, consequently, on accuracy. Some interesting statistics have been gathered at Mass. Inst. of Technology on vacuum tube reliability. These figures were presented to an Amer. Management Assoc'n seminar on electronics in October 1954 by Dr. Jay Forrester, the Director of the Digital Computer Laboratory at M. I. T. During 10,000 hours of operation in a system employing 8,000 vacuum tubes there were 100 tube failures which necessitated stopping the machine. During this period (about five years of 40-hour weeks) preventive maintenance was carried out periodically and during this maintenance an additional 1,180 tubes were replaced. Considering only those tube failures which necessitated an unscheduled closing down of the system, we can note first that such failures occurred only about once every two-and-a-half weeks on the average. Secondly, it is interesting to compute for the system the average tube life between failures that caused these 100 instances of unscheduled closing down. Such a computation — 8,000 tubes times 10,000 hours divided by 100 unscheduled tube failures -- gives an average tube life of 800,000 hours or about 400 years of forty-hour weeks. And that 400-year figure is based on actual experience. Note that no claim is made that a vacuum tube can be made to last 400 years. But M. I. T's experience over a five-year period did indicate a rate of unscheduled failure in any one tube socket of once every four centuries. Such reliability cannot be matched by human calculators or by electromechanical devices.

On November 1, 1954 an official of International Business Machines Corp. wrote the following statement for the public record:

> "We have worked with the 702 on multiple shifts since April 1, 1954, using programs with self-contained checks and balances and have never had an error chargeable to the Arithmetic Unit or the counters."

(Reference here is to the laboratory model of the Type 702 at Poughkeepsie.) That is a period of seven months, multiple shifts. Now one 702 can keep up with about 8,500 people operating desk calculators. Can anyone imagine one person, much less 8,500 people, operating desk calculators for seven months without a single error? (Just to keep the record straight, it should be made very clear that IBM does not claim to have operated the 702 in its experimental stages for seven months without any errors at all. There have been no arithmetic errors in that time. In other words, the machine has never added, multiplied, divided, etc. and obtained an erroneous result in all that time.

Dependability of Magnetic Tape Recording

Before leaving this general subject of dependability let us look at magnetic tape in this regard. This is the medium for storage of main files when an electronic system is used and is, therefore, of considerable importance. Whether we measure reliability in terms of time or in terms of work accomplished, it seems safe to say that the most crucial link in the chain as far as electronic processors are concerned is in reading from and recording on tape.

There is a paucity of statistics in this area for the simple reason that to date there is but little experience to draw upon in jobs that involve massive records maintained on magnetic tape. Among the data that are obtainable are some results of IBM's laboratory research on their own 702 tape units. The 702 uses two so-called "parity" checks on tape -- a vertical check and a horizontal check. Of the seven bits which comprise an alphanumeric character one bit is a check bit and its value (0 or 1) is determined by the other six bits in such a way as to make the sum of all the seven bits an even number. This seventh bit check is used throughout the entire 702 system. (The Univac employs this same vertical parity check, both on tape and throughout the entire system, except that the sum of the seven bits is made an odd number in the Remington Rand system.) In recording on tape in the 702 machine, another similar parity check, not found in the rest of the system, is used. Data are recorded on the tape in seven channels across the width of the tape: characters are recorded in parallel. For this second parity check (the horizontal check) a bit is recorded in each of the seven channels at the end of a tape record and the value of this bit is determined by the other bits in the record in that same channel in such a way as to make the sum of all the bits in that channel an even number.

Using these checks for detecting errors, IBM has carried out a number of experiments with the 702 tape. Hundreds of reading and recording passes have been made with sample reels of tape selected at random from their inventory, varying record lengths being used for different passes. The results of these tests showed that the frequency of errors detected by the parity checks is about one error per 500,000,000 characters. And 500,000,000 characters is the equivalent of 6,250,000 fully punched eighty-column cards. Furthermore, 97% of the errors detected were eliminated by simply rereading the tape. If, for example, a particle of dust

is between the reading head and the tape on the first reading and an error results, a second attempt at reading the same information is generally successful. If we ignore those errors eliminated by rereading (and they do not, of course, necessitate shutting down the system) we arrive at a figure of about one error per 22 forty-hour weeks, or less than three errors per year of one-shift operation.

Such reliability in tape reading and recording is, of course, dependent upon the use of perfectly good tape with no defects in the magnetic coating. The progress in the achieving of such flawless tape is itself quite remarkable. The tape used with the 702 is manufactured for IBM by the Minnesota Mining and Manufacturing Company. Upon delivery, IBM tests the tape for defects. In April, 1952 there were, on the average, 25 defects per 2400 feet of tape as delivered by the manufacturer. In July, 1952 this figure was reduced to 11 defects per 2400 feet; in September 1952, to 1.9 defects; and in May 1954, to 0.5 defects per 2400 feet of tape. Exhaustive tests are made and corrective procedures are carried out by IBM to enable them to guarantee the tape as delivered to their customers to be completely flawless.

As for the permanency of recording, IBM tapes have been stored for three years and read back without error. From one original recording 6,000 successive readings have been made without any loss of signal strength and the test readings are still underway. Univac tape has also been subjected to severe tests in this regard. The Univac uses a metal base tape rather than the plastic base tape used by IBM. At the time the Univac was built metal tape was considered superior to plastic tape for providing a high resolving power in the magnetic coating. Since that time plastic tape has been improved tremendously and both types of tape are quite suitable at present.

Messrs. H. F. Welsh and H. Lukoff reported the results of fire tests on Univac tape at the Joint AIEE - IRE - ACM Computer Conference in December, 1952, as follows:

> "A fire test was conducted in which six reels of metal tape were placed in a safe .... The safe was placed in a furnace and the temperature inside the safe allowed to rise to 550 degrees Fahrenheit .... The six reels of metal tape were read on a Uniservo without error of any kind, although the oscilloscope revealed that the pulses had suffered a deterioration of about 10 per cent."

In regard to dependability, it might be worth pointing out that no degree of equipment dependability can correct human errors made in the transcription of raw data to punched cards, paper tape, magnetic tape or any other machine-readable medium. This, of course, is true for any machine, whether electronic or not.

Built-In Self-Checking

The second factor for consideration has to do with self-checking ability. This ability is of two sorts: the so-called built-in checks; and the programmed checks. The extent of built-in checks varies from machine to machine and is determined both by the philosophy of the designing engineers and by considerations of economics. The engineers tell us that they can give us all the built-in reliability we are willing to pay for. But they all agree that there is some point -- where that point is, is a matter of disagreement — beyond which further built-in checks are so unnecessary as to be essentially worthless.

Of the commercial machines on the market today, the Univac has probably the largest percentage of its circuits devoted exclusively to built-in checking operations. All arithmetic and logical operations are done twice in the Univac by different circuits, and the two results are automatically compared for equality. Whether duplicated circuitry is required to provide reliable self-checking ability is one of the matters of disagreement among the engineering experts. Necessary or not, it is certainly effective in insuring accuracy in the Univac. M. E. Davis, in reporting the experience of the first few months' use of the Metropolitan Life Insurance Company Univac, writes of the remarkable accuracy of the central computing unit of the system:

> "An error in results which can be attributed to faulty operation of the computer itself has not yet been found. A few instances of nonreadable recordings on answer tapes did arise... (but) if a readable answer is produced, it is correct."

And the users of the Univac at New York University report that in a year and a half of operation, there has been only one instance of undetected errors, and that arose because of a radical breakdown which could not possibly have been overlooked by the operator.

The parity check which was mentioned in a preceding paragraph is a self-checking device which is worth considering for a moment. Most machines designed to handle alphabetic as well as numeric data employ a six-bit information code. Six bits provide 64 different possible combinations of 1's and 0's and this is an ample number for representing the 26 alphabetic char-

acters, the 10 decimal digits and whatever other symbols and characters are desired. The use of a seventh bit for this parity check, or the "odd-even" check as it is sometimes called, can be had for very little additional expense of design effort or equipment. And though it is a very simple check it is also an extremely powerful one. And it furthermore is a check for just those errors which are most difficult to detect: the so-called intermittent errors which result from the operation of a marginal vacuum tube, for example. If a tube burns out completely, or works properly only a small part of the time, the errors caused by its faulty operation are so glaring that they can hardly be overlooked. The troublesome tube is the one that just misses amplifying a pulse sufficiently once an hour, say. And the parity check will catch just such an intermittent, random error every time.

A few years ago, a mathematical statistics expert determined the probability of the parity check's failing to catch a random error in an electronic computer. His work indicated that for a random error occurring once an hour, several centuries will pass before an error undetected by the parity check will occur. This (1) ignores programmed checks, (2) ignores any other built-in checks and (3) is based on a random error rate that simply does not occur with the highly developed preventive maintenance techniques of today. The frequency of of random errors is much lower than one per hour. And the parity check has proved itself a very reliable safeguard against undetected random errors.

In addition to duplicated circuitry checks and the parity check, there are several other built-in checking devices which have been incorporated in the design of electronic data processors. The recording currents in the magnetic tape heads can be tapped and sent back to the central unit for a parity check or for comparison with the data in the memory which is being recorded. The inverse of each arithmetic operation can be carried out automatically and the inverse result compared with the original factor for equality. In a machine using a fixed tape record length, a count of the number of characters read from a tape record or block can be made to insure that all characters have been read. Coded instructions can be examined for "forbidden" codes. The entire memory can be periodically parity checked. These and many other checking devices have been incorporated in one or more of the various machines which have been built. And, to repeat something that was stated before, the engineers claim that they can give us all the built-in reliability we are willing to pay for. It is simply a matter of finding a reasonable stopping point in incorporating such features.

Programmed Self-Checking

Programmed checks provide the second means for a processor's self-checking. If our earlier statement (that a human being has an ability to check himself which is limited only by his knowledge of checking methods) is accepted, then it follows that an electronic processor has an ability to check itself by programmed operation which is limited only by the programmer's skill. This is so because as far as calculation is concerned an electronic processor is as flexible as a skilled mathematician. Programmed checks can be as exhaustive as desired. Everything can be done twice by entirely different methods using entirely different parts of the memory and the results compared in two entirely different ways. For nearly all problems, however, such untrusting use of the equipment's capabilities is simply not necessary. More reasonable, realistic, and economical checks can be readily devised. Batch totals can be accumulated and checked to insure accuracy of reading input data. A count of the number of records and the totals of certain values within each record for a reel of tape can be stored on the tape and checked at each reading of that reel. And, of course, adequate accounting controls can and should be maintained.

Conclusions

On the basis of these considerations, it seems reasonable to make the unequivocal statement that the modern electronic data processor is by far and by several orders of magnitude the most reliable method of machine calculation yet devised by man. In the realm of more general data processing, the only area which seems at all questionable is the use of invisible recordings on magnetic tape as the medium for storage of vitally important records which are frequently reproduced in their entirety in the process of updating a file. And that area is questionable perhaps only for the present. If, for example, the results of IBM's laboratory testing of tape are confirmed in actual operations on extended commercial applications, any further concern in that regard should be allayed.

In the unlikely event that the parity check should prove inadequate for tape and undetected errors were thereby permitted to get through, duplicate recording on tape can be employed for checking. The National Cash Register CRC 102D already has this feature. Everything is recorded twice and read twice. And on the simultaneous readings of the duplicate recordings, comparisons are automatically carried out to insure that identical data have been read.

The manufacturers have certainly left no

(continued on page 38)

Numerical Representation in Fixed-Point Computers

Beatrice H. Worsley
Computation Centre, University of Toronto
Toronto, Canada

The majority of the universal digital calculators constructed within the past ten years normally handle numbers represented in fixed-point form. This form has been imposed largely by engineering considerations. Although it permits considerable mathematical flexibility through coding, yet it is this very flexibility which often leads to extremely tedious detailed work. Clearly defined coding techniques have been established to surmount this source of inefficiency. To understand these techniques, certain principles of numerical representation must first be considered.

Restrictions on Numerical Representation

Two restrictions apply to any number stored in a register of a digital calculator. Its magnitude is bounded above and below, and there is an upper limit to the number of its significant digits. Thus, for example, consider a Ferut register; Ferut is the Ferranti Mark I calculator installed at the Computation Centre, University of Toronto, Canada, in 1952. In the signed fractional convention, this computer stores a 40-bit word, in which one bit represents the sign, and 39 bits represent the number, and the binary point is fixed between the sign digit and the left-most numerical digit. Any number stored in this register must be between $-\frac{1}{2}$ and $+\frac{1}{2}$ and can contain at most 39 significant bits. An attempt to store any other number in the register will result either in overflow or in loss of significant digits. A number which never overflows in a register and which never contains less than a requisite number of significant digits will be said to "satisfy the requirements of the representation".

Fixed Pre-Scaling

For some problems it is possible to determine both upper and lower bounds to all parameters or functions which may be put in, or calculated as intermediate results, or put out. Let us call such a parameter or function F. It may further be possible to attach a definite scaling factor "s" to the quantity F, so that sF always satisfies the requirements of the representation. For example, suppose that F is known to lie between 200 and 0.0002 and must contain at least six significant decimal digits. If it is to be stored in a Ferut register, then "s" can be chosen as 1/1000. If all the quantities F occuring in the problem can be scaled in this manner, then it is possible to pre-scale the entire calculation.

The way in which this may be done is illustrated by the following excerpt from some calculations performed on Ferut for determining the temperature of a radioactive earth. It was required to evaluate $\frac{1}{m(\mu-m^2)}$, to five significant decimals, for m = 1, 2, ..., 100 and μ = 9.290, 28.671, 99.789, and 182.451. It was preferable that all external scale factors should be powers of 10, while powers either of 10 or 2 could conveniently be used internally. Preliminary analysis showed that $\mu/10^6$ and $m/10^3$ would be convenient forms to introduce into the calculation, whereas $\frac{1}{4}.\frac{1}{m(\mu-m^2)}$ would be the function to generate within the machine. The actual formula to be evaluated was finally written as

$$\frac{(10^{-6}/8)}{[\mu/10^6 - (m/10^3)^2] \times 10^2/2 \times m/10^3 \times 10},$$

which equals $\frac{1}{4m(\mu-m^2)}$. The initial settings to be made for each μ and a run of m from 1 to 100 then consisted of planting $m/10^3 = 0$ in one working location and $\mu/10^6$ in another. Adjusting constants, namely $1/10^3$, $10^{-6}/8$, $10^2/2$ and 10, next had to be made available to the program. The loop of the calculation contained the following sequence of operations:

1. Increase $m/10^3$ by $1/10^3$.
2. Multiply $m/10^3$ by $-m/10^3$ and add in $\mu/10^6$.
3. Multiply the result by $10^2/2$.
4. " " " " $m/10^3$.
5. " " " " 10.
6. Divide the result into $10^{-6}/8$, using a library routine which assumes that both the arguments as well as the answer can be represented in the signed fractional convention, and which retains the same accuracy as is provided in the denominator.

Careful study will show that all numbers entering into this calculation satisfy the requirements of magnitude and accuracy. In particular, for the division, the numerator is

0.000 000 125 and the denominator lies between 0.000 000 4 and 0.5. Hence the quotient always satisfies the requirements of the representation, namely it lies between $\frac{-1}{2}$ and $+\frac{1}{2}$ and retains at least five significant decimals.

Certain limitations to the fixed pre-scaling scheme are obvious. Suppose that it is desired to extend the programmed calculation to include new parametric cases. These may not fit into the scaling scheme already worked out, and so a new one, and consequently a new program, must be devised. Then again, fixed pre-scaling requires careful analysis and supplementary calculation, which can consume programmer time far in excess of that justified by the problem. Sometimes in the face of inadequate preliminary analysis, the programmer may choose to insert coded detectors for overflow or loss of significant figures. In this case, or even in the case of machines fitted with detectors for these events, alternative paths must be programmed, and these must be carefully devised to suit the calculation in hand.

Adjustable Pre-Scaling

For some problems, a set of scaling factors cannot be found to satisfy all the requirements of the representation simultaneously for all the parametric cases. It is thus often convenient to divide the parametric cases up into sections, choosing sets of scaling factors for each section. This invariably complicates the program, since the adjusting constants (e.g., $1/10^3$, $10^{-6}/8$, etc., in the radioactive earth problem) may have to be changed to remain consistent with the scaling factors, and the decimal point may have to be shifted in the printed results.

Sliding Scaling

It sometimes happens that a scaling factor "s" cannot be found for every quantity F in a problem such that sF satisfies the requirements of the representation. This is illustrated by the case of F varying between 20,000 and 0.0002 and having to retain at least six significant decimals in a Ferut register. However, it may be possible to adjust the scaling factor internally as the calculation proceeds, so that it takes on a set of values $s_1, s_2, \ldots, s_n$. Then s_n, as well as the value of s_nF, must be stored at every stage of the calculation. This technique of sliding scaling is generally intricate to apply, and only worthwhile in lengthy and strongly patterned calculations. An example is given in the section on matrix programs.

Alternative Numerical Representations

The programmer for a fixed point computer is by no means confined to working with numbers according to the representation built into the machine. Considerations such as speed and availability of storage space, as well as the requirements of the numerical representation, often arise. These suggest the use of an alternative representation, of which some examples will now be given. The term "word-length" will be used to specify the number of digits considered as an array in the arithmetical or logical functions of the computer. A storage register will normally contain one word, and, for the present discussion, it will be assumed that the word length is fixed.

Access to Half-Words

In the case of many computers (e.g., Edsac and Ferut) storage registers are subdivided into two parts, so that there is coded access to half words. Hence numbers may be stored to half-precision, only the significant halves being retained after arithmetical or logical operations. This representation is useful when scaling presents no great difficulty but when rapid-access storage registers are at a premium. For example, in some joint-life annuity calculations performed on the Ferut, it was desirable to be able to store the life tables for both male and female lives simultaneously with the instructions in the electronic store. Since the tables covered all ages from 0 to 106, they were given half-word representation.

Double-Precision

The digits stored in a pair of registers may be interpreted as representing the least and most significant parts of the same number. Thus it becomes possible to represent a number to twice the precision built into the machine. This representation is useful in working with computers which have rather short word lengths, or when performing high-precision calculations such as evaluating π to 200 decimal places. This technique can, of course, be extended to three, four or more sets or registers.

Floating-Point Form

A pair of registers may be used to represent a number in floating point form. Thus one register may be used to store the mantissa, normalized to lie, in absolute value, between say 1/4 and 1/2, and the other to store the exponent, or power to which the scale of notation must be raised so as to represent a scal-

ing factor for the mantissa. This technique really amounts to generalized sliding scaling. It permits numbers to vary over a much greater range of magnitude than that built into the computer. Programming for a floating-point representation is much simplified, since the problems of scaling are entirely eliminated and the retention of significant figures becomes a mathematical rather than a coding consideration. Only in the subtraction of nearly equal numbers can an excessive number of significant figures be lost, and this event can readily be detected by coding.

Binary-Coded Decimal Form

Another convenient form, possibly only in the case of binary computers, is to represent each number in binary-coded decimal form. Here, each set of four binary digits in a word is used to represent one decimal digit of a number. Although this does not make the most efficient use of storage space, time is saved in converting decimal numbers during input and output.

Complex Numbers

The two numbers stored in a pair of registers may be interpreted as the real and imaginary parts of a complex number.

Combinations

Numerous combinations of the above representations are possible. Thus, one could have a variety of floating-point representations by varying the relative precisions of the mantissa and exponent parts.

Coding Techniques

All such artificial representations must inevitably be supplemented by arithmetical operations coded in terms of the available machine instructions. Thus, in double-precision work, a dozen machine instructions may be needed to perform each of the operations of addition, subtraction, multiplication and so forth. For coding purposes, pseudo-instructions are usually invented to represent the equivalent of the machine instructions. In order to economize on human effort, generalized sequences of machine instructions should be programmed to handle all the usual arithmetical operations for numbers in a given representation. These sequences should be available in the high-speed store simultaneously with the master routine which is guiding the course of the calculation. Two principal techniques have been developed to cope with this situation.

Compiler Techniques

The first could be called a compiler technique. Access to the arithmetical sequences is on the multiple entry-point principle. The master program then degenerates into a set of dialling-in segments. In the case of computers with a large permanent internal store, there is no reason why these segments should not be fabricated by the computer in the course of translating pseudo-instructions into the master program.

Interpretive Techniques

The second technique is generally known as interpretive. Here the psuedo-instructions, suitably coded, are stored directly in the master program. Each time they are obeyed, they are decoded by a special routine which in turn dials in the arithmetical sequence. This second technique is not as efficient as the first, since de-coding must take place each time a pseudo-instruction is obeyed. It may lead to a more streamlined master routine, although the pseudo-code is often even more artificial and unintelligible than the machine code.

Whether the compiler or the interpretive technique is used however, a complete set of sub-routines must be written to correspond to each type of numerical representation used. Since input and output as well as functional routines must be included in each set, it is evident that the library for a fixed-point computer can become quite extensive indeed.

Types of Problems

Although all Turing machines are universal, their practical counterparts are specialized to cope with one or other of some general class of problem.

For problems which consist essentially of data-handling and involve little or no calculation, scaling usually presents few complications. Such problems can be run quite efficiently on machines with decimal or binary-coded-decimal representations, in which the decimal point is fixed but in which the word length might conveniently be varied by coding. The characteristics of the IBM 702 should be studied in this respect.

Problems of a more mathematical nature present a greater challenge to the programmer. If a large variety of these are to be prepared for solution by a fixed-point computer, the choice of floating-point representation is most attractive. However, unless the computer is sufficiently fast, and has a large storage capacity, this choice is not always justifiable.

By sufficiently fast is meant that not more than the equivalent of 1/10 of a millisecond is required to obey a single-address instruction, and by a large storage capacity is meant not less than the equivalent of 1,000 words of 40 bits each.

For slower computers with limited storage, say, single-address instruction speeds of less than 1 millisecond and storage capacity of less than 250 words of 20 or 30 bits each, floating-point representation is generally out of the question. The class of problem suitable for such a computer is seriously restricted. The programmer may have to resort to frequent output and re-input of intermediate results, with subsequent loss of efficiency.

Experience with Ferut

Ferut falls into the class of "slow high-speed" computers with large internal storage. The single-address instructions average about 1 millisecond each. The time ratio of a coded 3-address floating arithmetical instruction to the corresponding set of single-address machine instructions averages about 14 to 1.

However, organizing instructions are no slower for floating-point programs than for fixed, if the compiler techniques are used. Furthermore, input and output speeds are comparable for the two representations. Thus a ratio of 5 or 6 to 1 can be expected in the overall timing of floating-point programs to fixed. For a problem requiring one hour of production runs, this ratio is tolerable; for a fifty hour job it is out of the question.

Now that adequate floating-point routines are available, including an automatic compiling system known as Transcode, the following trend is becoming apparent. For single-shot problems of varying degrees of mathematical complexity which require only a few hours of production, Transcode is used. For simple calculations requiring many hours of machine time, fixed-point techniques are used. If there is any difficulty in scaling such problems, however, exploratory floating-point calculations are performed, to determine upper and lower bounds of relevant functions and so forth. This approach often saves the programmer many days of hand-calculation or preliminary analysis. For calculations, which are both elaborate and extensive, more individual treatment must be given. Sometimes there is no escape from a complete floating-point treatment. Sometimes it is possible to work partly in fixed-point and partly in floating, using suitable library routines to make the conversion between the two representations. This can be illustrated by programs which involve the solution of a set of linear algebraic equations as an intermediate step. Floating-point is useful for solving the equations by such methods as that of pivotal condensation, while fixed point is adequate for evaluating the coefficients for the equations, and again for carrying the solution forward into further calculation.

Routines for handling large matrices or systems of equations always require individual attention. Double-precision is adequate for solving large systems of linear equations by the iterative Gauss-Siedel process, where the kernel of the calculation simply consists of evaluating a sum of terms like $a_{ij}\ x_i / a_{ii}$. Here, the reciprocals of the diagonal coefficients, $1/a_{ii}$ should be determined and scaled in a preliminary run. To invert a large matrix by the Choleski method, one Ferut routine partitions the matrix into sub-matrices of order 4 x 4, and a power of ten is assigned in advance to each sub-matrix. This is treated as a scale-factor, which is later adjusted in a sliding manner at critical stages by the program. Each subsection of the inverse is then printed out, together with its decimal scale factor. This technique of sliding scaling is certainly more economical of machine time than a complete floating operation at every stage.

- END -

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Automation – A Report to the UAW – CIO Economic and Collective Bargaining Conference

November 12, 13, 1954

The dictionary, as yet, does not contain a definition of "automation", but already it is making striking changes in our industrial system. Some management spokesmen say automation is "the automatic handling of parts between progressive production processes"; others claim it is "a new philosophy of design, a new manufacturing method." Regardless of definition, however, technological developments involving the greater use of automatic machinery and the automatic regulation and control of this machinery are giving rise to radical changes in the factory. These changes, sporadic at the outset, are now constantly increasing in velocity and volume. The Republican tax bill changing the basis for the calculation of depreciation may tend to accelerate the scrapping of existing plant and machinery and their replacement with new and more efficient equipment and facilities. The manager of the new Ford foundry in Cleveland gave a graphic idea of the kind of changes which are taking place when he stated:

> "Ours is the only foundry in the world where the molding sand used to make castings is never touched by human hands except maybe out of curiosity."

Automation may be the forerunner of a second "industrial revolution" which will have a greater impact throughout the world than the first. Or, technological developments may come more slowly and gradually without causing major changes in economic and political institutions and relations. The experts disagree on what the future holds. One says automation is only

> "....a new chapter in the continuing story of man's organization and mechanization of the forces of nature."

Another says that automation

> "....will produce an unemployment situation, in comparison with which .... the depression of the thirties will seem a pleasant joke."

A third, who believes that the new electronic computors will be linked with automatic machinery to produce robot machines, believes that

> "....we should set up a Robot Machine with the duty of formulating social policy on the speed and circumstances of the introduction of robot machinery and with power to speed up or delay its introduction according to what the public welfare demanded."

Already there are examples where relatively few men do the work which formerly was done by many. According to Newsweek:

> "Ford's automatic engine plant turns out twice as many engines as an old-style plant, with one-tenth the manpower."

Approximately 10,000 men in the foundry and engine divisions of a major auto company now turn out the same production which formerly required more than 23,000 men. Only a large increase in total output prevented wide-scale layoffs in those divisions.

These developments are not confined to the industries with which the UAW bargains but extend throughout the economy. Newspaper articles revealed that

> "....a radio assembly line geared to produce 1,000 radios a day, with only two workers needed to run the line (is replacing) standard hand assembly (which) requires a labor force of 200."

Automatic controls have been widely introduced in the petroleum industry. One industry spokesman stated:

> "The average refinery which would employ 800 people without instrumentation would employ 12 people were instrumentation utilized to the fullest extent possible."

A prominent Harvard economist has stated that it would take approximately 600 million dollars to provide the necessary controls and instruments to automate all the plants built in 1950. During that year about one-tenth that sum was spent for that purpose. One indicator of the rate of adoption of automation is the output of the "industrial recording and controlling instruments" industry. In 1951, according to this same economist, the sales of these instruments doubled. And, if the upward trend in expenditures to automate industrial facilities continues, American industry may be fully automated within a decade. This,

according to another economist, will mean that one man will do at least the work now done by five men. These predictions, if accurate, would mean, for example, that 200,000 men could match the present output of the million UAW members in the automobile industry.

The possibility of dramatic technological advances emphasizes the need for an expanding economy built upon the broadest possible purchasing power base. Automation will increase productivity, but increased productivity without increased total production is a formula for depression. If productivity is increased within a framework of full production and full employment, the nation will prosper. If automation is irresponsibly introduced and exploited, it will bring unemployment and misery instead of security and abundance. The radical productivity increases which will accompany automation make it necessary to intensify the fight for an economy based on full production and full employment.

The key to success in this struggle is increased purchasing power in the hands of the people. We must be able to purchase the goods we produce. And, when our productive power increases, our buying power must also increase. The UAW-CIO will make its contribution toward this end by insisting at the bargaining table that purchasing power be increased sufficiently to match our productive capacity. But high hourly rates of pay for our members are not enough. Steady work is essential, week by week, month by month the year around.

Automation and the Guaranteed Annual Wage

The establishment of the guaranteed annual wage becomes imperative for workers in the face of these new and revolutionary technological changes developing in our economy. The wealth producing potential of automation is matched only by its potential for disruption and chaos unless harnessed in the interest of the nation as a whole. Workers must be provided with employment and income security so that the nation can meet these revolutionary possibilities with a minimum of disruption and hardship.

The guaranteed annual wage represents the most essential element of that needed security structure. The guaranteed annual wage will serve as a regulator of the process of technological change, tending to minimize its disruptive consequences. It will affect management decisions concerning both the timing and the placement of new automation installations so that those decisions will be tempered by a degree of social consciousness.

Under the guaranteed annual wage, management would avoid the introduction of automation in times when major layoffs would result. The introduction of new and more efficient equipment would be geared to periods of expanding markets so that other jobs would be available for the workers displaced by automation.

Similarly, the guaranteed annual wage would tend to assure that new and more efficient plants are so located as to avoid mass layoffs of workers employed in existing plants. This is particularly important in view of the fact that it is more economical in most cases to install automation in new plants than in old ones. Moreover, corporations prefer to employ on automated processes workers who have had no experience with older production methods.

In the absence of the guaranteed wage, irresponsible corporate decentralization policies, accentuated by the introduction of automation, would leave thousands of workers stranded and give rise to the widespread creation of ghost towns.

With the guaranteed annual wage, a very substantial part of the costs of corporate irresponsibility in either the timing or the geographical placement of automation would be borne by management.

Under the guaranteed annual wage, therefore, management would more likely regulate the introduction of automation with a degree of social responsibility in order to minimize its disruptive effects. Where the introduction of automation would, nevertheless, result in the displacement of some workers, the guaranteed annual wage would cushion the shock of layoffs for them, giving them a year in which to find employment commensurate with their experience and abilities, and enabling them, where desirable, to undertake retraining to fit them for better jobs. Moreover, the corporations would be impelled to provide various types of aid to such displaced workers in order to minimize their period of adjustment.

Manpower Displacement, Job Classifications, and Wage Structures

Traditional workloads and manpower requirements are being drastically changed by automation. Until recently the post war expansion of the market has concealed the fact that far fewer men are now needed to turn out the same production. Not only has there been a reduction in the number of those workers directly affected by automation, such as machine operators, foundry men, and press operators, but the indirect effects have spread throughout the plants reducing the numbers required to turn out each unit of production in such groups as sweepers, inspectors, clerks, and office workers.

Manpower displacement is not a figment of the Union's imagination. Trade journals contain statements by various management spokesmen clearly indicating the scope of the changes that automation will bring about. A Ford spokesman said:

> "Automation reduces labor tremendously. Our experience has shown that we can count on a reduction of 25 to 30 per cent in what we call 'direct' labor."

Ward's Automotive Reports states:

> "A passenger car plant, which formerly employed 36 men to feed fenders into a conveyor for spray painting, now has modernized equipment which automatically feeds six sets of fenders to a fast-moving 'merry-go-round' where varicolored finishes are applied simultaneously. One worker guides the entire operation."

Some of these new machines have dramatic effects, others cause equally large manpower displacement that is not so easily discernible. The magazine, Factory Management and Maintenance, reports on "things you won't see in the factory of the future."

> "In the factory of the future, lubrication will be a utility service just like water, steam, and electricity, rather than a manual maintenance operation. You won't see oilers running around with oil cans or pushing lubrication carts from machine to machine. Instead lubricants will be pumped through pipes to each machine from a central source. And measuring units on the machines will feed the lubricant to each bearing in the right amount and at the right time by time clock control. You won't have to stop machines to lubricate them."

> "Your factory of the future will have to have power-operated floor-cleaning equipment. One man on a power sweeper can do the work of several hand sweepers -- and do it a whole lot better."

Although the Ford Motor Company has received a good deal of publicity about its automated plants, it is not alone in its modernizing efforts. General Motors, Chrysler, and the independent producers also are installing similar machinery.

Automotive Industries reports that

> "Transfer Machine at Nash has 14 units and performs 179 operations. Man-hours for machining cylinder heads reduced more than 80 per cent."

And R. M. Critchfield, General Manager of the Pontiac Motor Division of General Motors claims that the plant in which the 1955 Pontiac engines are produced

> "....surpasses any other plant in the world for up-to-date modern automation equipment."

These examples should make it clear that industry has embarked on a full-scale program of automation. Each company is contesting with the next to see how fast it can automate its plants and thereby reduce its unit labor costs. The changes in manpower requirements, those already in effect and those yet to come, require that the Union give careful attention to manpower displacement problems.

Higher Pay For Automated Jobs

Because of the extreme changes in factory methods caused by automation, existing classifications and wage structures are becoming increasingly obsolete. In new plants the dramatic effect of automation is clearly visible. There the "new job" principle can be invoked more easily to secure new classifications and improved wage rates. In existing plants, however, where automation is installed on a piecemeal basis, it is more difficult both to pin down the degree and kind of change requiring action, and to negotiate the necessary new classifications and rates. In such situations the Union should be alert to obtain new classifications and rates even on semi-automated jobs. Our members must be prepared to continue the fight for the upward revision of rates based on new classifications for automated jobs. Management must be brought around to the acceptance of the principle that automated and semi-automated jobs require new classifications and rates whether in new plants or old.

Any efforts by management to extend existing classifications to cover these new automated and semi-automated jobs should be resisted by the Union. It is important, also, that the issue not be left to umpire or arbitration determination. Umpires and arbitrators should have no role in the determination of new classifications and wage rates because there are no objective criteria which they can apply. Since these new operations will be the basis for the wage and classification structure of the factory of the future, the Union must maintain maximum freedom to exert its full influence in the shaping of that structure.

These new classifications and rates should be established in recognition of the changed nature of jobs in which increased responsibility offsets by far any reduction in physical effort and manual dexterity accompanying automation. This increased responsibility, in most cases,

flows from the much larger investment represented by the equipment under the individual worker's control. The Chrysler Corporation, for example, stated in its monthly magazine: "In 1952, $8719.00 was employed per employee. This was a third (32.1%) more than $6600.00 employed per employee in 1951." Such large increases in investment per worker mean increased responsibility per worker. Even where there is no increase in such investment, the individual worker becomes responsible for a much larger volume of output. Automated equipment is a signpost of changed jobs in the factory requiring the negotiation of new classifications carrying higher rates reflecting the increased responsibility per worker.

Management will attempt, and in some cases has already attempted, to confuse the issue by claiming that the Annual Improvement Factor provisions of our contracts represent all the additional compensation to which workers are entitled in the shift to the new modes of production. This is a fallacious argument which the membership must be prepared to expose and to resist. The compensation for increased productivity represented by the improvement factor, payable to all workers, can in no sense be considered to be compensation to the individual worker whose specific job has been raised to higher levels of responsibility by the introduction of automation. The immense productivity gains of automation should be assessed and then shared equally by all workers in coming negotiations. The changed rates and classifications only represent recognition of the changed jobs. In cases such as the following, quoted in U. S. News and World Report, the Union obviously has not demanded that an operator receive a wage adjustment to match the productivity gain.

> "....on a rocker arm support.... the necessary drilling, reaming and cutting used to be done by five operators at two machines. They produced at the rate of 38 pieces per manhour. Now, a single operator, with only one machine, turns out more than 750 pieces in an hour. He is 20 times as productive as one was in the old setup."

The Union is not demanding that this man be paid twenty times his former rate; the Union is not demanding that individual classifications and wage rates reflect specific productivity changes. But the Union demands and expects that where different work requirements, investment, and output provide the obvious proof that a change has occurred, new classifications and rates will be negotiated. But it should be equally clear that these adjustments are separate and distinctly different from the general wage increases which are the result of the operation of the Annual Improvement Factor provision of our contracts. The improvement factor is a general device for adjusting the purchasing power of workers as a group to increased productivity, and it does not alter the fact that job classifications and wage structures, as they relate to individual jobs, cannot remain static in the face of dynamic changes in factory operations.

We expect that new machinery will reduce the physical effort requirements of jobs; this is progress. Increased responsibility and reduced physical effort, however, can only mean real progress if they are reflected in new classifications and higher wage rates for the individuals concerned as well as an equitable distribution of the productivity gains among all workers.

Changing Skills

Because automation reduces the need for manpower in particular departments and occupations by varying degrees, seniority provisions in our contracts must permit transfers for all workers directly or indirectly affected. Narrow seniority groupings are becoming increasingly obsolete and harmful to our membership. Automation, even in periods of economic expansion, introduces highly complex seniority and transfer problems. In periods of economic decline the effects of automation on employment levels and job security can produce devastating results.

In addition to reducing the number of workers required per unit of production, automation, in many cases, changes the nature of the skills and training needed on individual jobs. The single spindle drill press operator now tends an automated battery of machines which perform boring, reaming, drilling and milling operations. The sand mixer in the foundry now regulates his mixture by operating a complicated electrically controlled panel board. The chip-puller is being converted to a centrifuge operator.

A top Ford spokesman has stated that there are considerable changes in the kind of jobs that men will do in the factory of the future:

> "The hand trucker of today replaced by a conveyer belt might become tomorrow's electronics engineer....Drill press operators replaced by automatic multiple drilling machines could be trained as future tool makers."

Changes of this order pose serious transfer and retraining problems. It is apparent that without action by the Union that management may not consider it necessary to pay our members a living wage during the period of ad-

justment when they are acquiring new skills. One management official went so far as to say during a roundtable conference about automation sponsored by Fortune magazine that

> "I don't think we are consciously trying to ease the burden of our workers, nor consciously trying to improve their standard of living. These things take care of themselves."

The Union will remind the companies with which we bargain of their obligations both to their individual employees displaced by automation and to the nation as a whole. Technological change enables us to raise our standards of living. But provisions must be made so that those immediately affected do not suffer in order to provide society as a whole with long run benefits. In the course of reaching higher standards of living we will not take one step backward in order to take two steps forward.

Need For Re-Training and Broader Seniority

To meet these problems of manpower displacement within the plants, the Union must give careful attention to modernizing, strengthening, and improving those sections of our collective bargaining agreements governing layoffs, rehires, transfers, and promotions. Contract clauses should be negotiated to provide for the training and retraining at company expense of workers who now must master new skills. The broader the unit within which seniority applies, the greater is the security provided by that seniority. Local seniority agreements, therefore, should provide for the broadest possible seniority groupings to assure equitable seniority protection for the members of our Union. In addition, these local agreements should also contain simple and direct amendment procedures so that the Union can, through negotiations, meet the impact of sudden unanticipated changes.

The danger of mass displacement of workers as a result of automation emphasizes in addition the need for extending the protection afforded by seniority beyond the confines of the individual plant and company. This is particularly important for the older workers whose possibilities of finding new employment diminish with advancing years. Our agreements with multi-plant corporations must assure displaced workers of the right to inter-plant transfers based on seniority. In addition, preferential hiring clauses must be won which require all plants under UAW-CIO contract, when hiring, to give preference to laid-off workers in the same area and industry.

The Role of the Skilled Trades

Automation has also been seized upon by management, in some cases, as an excuse to attempt to break down the lines of demarcation between the skilled trades by attempting to pressure the men in one trade to do the work of those in other trades. The complexity of automation equipment, requiring as it does the services of many of the trades, is the smoke screen behind which management hides these efforts. Persistence by management in such a course of action, however, is dangerous and shortsighted both from the standpoint of the industry and of the economy as a whole. If successful, such a drive to reduce the number of journeymen employed, by overlapping in the skilled trades classifications, would inevitably undermine the basic skills so that our economy would be left only with men who are jacks-of-all-trades and masters of none. The very complexity of automation equipment and the consequent increased need for the highest possible development of journeymen skills would make the deterioration of skilled trades standards an especially serious matter. In U. S. News & World Report, a Ford spokesman acknowledges that automation

> "....greatly increases the need for electricians, mechanics, pipe fitters, toolmakers and others skilled enough to do maintenance work on the mechanical slaves."

Accordingly, the defense of the integrity of the apprenticeable trades against overlapping and dilution of jouneymen standards becomes an increasingly important Union taks in the face of automation. Success in the performance of this task will require the fullest cooperation of the skilled trades workers themselves who must vigorously resist management pressure to do work not properly a part of their respective trades.

Automation and The Duration of Contracts

The sweeping consequences of automation make it impossible to gauge either the exact nature of technological change or its social, economic, and political repercussions. But already it is clear that automation will reduce traditional manpower requirements. It will almost eliminate scrap. Under proper control, automatic equipment will continually turn out high-quality production with speeds beyond those attainable by human beings. Automation will bring about dramatic changes in the composition of our labor force. The typical auto worker of the future may be a skilled maintenance man, engineer, or analyst. Many of the

unpleasant jobs will be eliminated; the work clothes of today may be largely replaced by white shirts in the factory of tomorrow.

No one can predict now the magnitude of the increases in productive efficiency which will flow, even within a short period, from automation and other major technological advances now rapidly finding their way into our industries. It is impossible now, for example, to forecast how great an increase will be needed in the improvement factor in order to achieve a proper balance between worker buying power and the increasing supply of goods and services resulting from accelerating advances in national economic efficiency. Not only in the interest of our own membership but in the interest of the entire economy as well, our Union must maintain its full freedom to meet the problems arising out of the potentially enormous increases in the outpouring of goods and services.

One example, the electronics industry, can serve to show the kind of change that may occur shortly in our industries. According to a Department of Labor study:

> "Electronics output in 1952 was 275 per cent higher than in 1947 but was produced by only 40 per cent more workers."

This may sound spectacular but the study goes on to say:

> "Output per man may rise even faster during the next few years as a result of improvements in manufacturing techniques....These trends toward 'automation' may result in the greatest reduction in unit man-hours in the industry's history during the next few years."

In the face of potential changes of this magnitude, the UAW-CIO cannot tie itself to long term contracts. To do so would be to surrender in advance the freedom to intensify the fight for higher living standards at the very time when this fight may become more urgent than ever before. If only to maintain economic stability and full employment in the face of rapid progress in our ability to create abundance, it should be the policy of our Union to insist on short-term contracts in coming negotiations.

Under contracts of short duration, our Union will be able to keep abreast of the various developments which tend to step up the pace of advances in productivity. We will be able to evaluate the magnitude of the growth in our nation's productivity potential; and we will fight to turn this potential into higher living standards for all.

Automation and the Short Workweek

Our Union is committed to the struggle to make the fruits of technological advances available to all, and to work for abundance for people at home and abroad. From the secure platform provided by the guaranteed annual wage and with the freedom provided by short-term contracts the UAW-CIO will continue to fight for an ever-expanding national output.

The enormous potential of automation promises that within a relatively short time, it will be possible for us simultaneously to have both substantially increased living standards and greatly increased leisure in which to enjoy the abundance that we can create.

Our Union, therefore, looks forward to the day when we will take our place in the vanguard of the American trade union movement, in the next round of the historic struggle for a shorter workweek. This day we know is not distant. Barring an increase in international tensions requiring greatly increased diversion of economic resources to defense production, the timing of the fight for a shorter workweek depends basically on the rate of acceleration of productivity advances, and the degree to which our growing productivity potential is utilized.

We repudiate and will continue to resist, with all our strength, the philosophy of economic scarcity. We are aware, however, that in the world of industry and finance, growing productive power is not always seen as the tool for the creation of abundance but rather is looked upon merely as an instrument for the increase of profits. If leaders in industry and finance refuse to raise their sights and insist on an economy of low volume and high unit profits, our Union and the rest of American labor will have no alternative but to press immediately for drastic reductions in the workweek without loss of income. The UAW-CIO will not stand idly by while the era of automation produces mass unemployment instead of higher living standards and increased leisure.

After the guaranteed annual wage has been secured, therefore, the shorter workweek will take its place at the top of our collective bargaining agenda along with the continuing fight for higher living standards. The fight for the shorter workweek and for higher living standards must go hand in hand. The strategy which will determine the timing and relative emphasis of the struggle for these two objectives must of necessity remain flexible at this time.

Automation and Political Action

The magnitude of the changes which automation will bring should not be underestimated. Some problems will be solved across the collective bargaining table. Some will require that we join with other likeminded groups in the common fight on the legislative front. The Union will continue to seek the enactment of socially desirable legislation that will give positive direction to technological change. The minimum wage must be raised. National vocational training and retraining facilities must be expanded so that adult members of the labor force will find it easier to acquire the new skills demanded by the changed methods of industrial production. General educational, cultural, and recreational programs must be improved. Drastic improvements in unemployment compensation must be won to cushion the shock of technological displacement for workers not covered by the guaranteed annual wage. The Social Security Act must be amended to provide, if it proves necessary, for earlier retirement for displaced older workers who find it impossible to obtain new jobs. Relocation allowances must be provided by law to facilitate the movement to new areas of workers displaced from their home communities by new and more efficient plants located elsewhere.

Studies of Automation

The preliminary work done by the UAW-CIO clearly indicates the need for extensive studies of the problems associated with radical technological change. Studies must be made of the rate of introduction of automation and its effects in each of the industries within the jurisdiction of the UAW-CIO and throughout the economy as a whole.

These studies must include a continuing appraisal of automation's effect on the size and composition of the manpower requirements and of changes in levels of productivity in these industries. Also, it will be necessary to study questions such as the kind of changes that automation will cause in piecework and incentive pay systems.

There is a need both for detailed narrow studies on a factory by factory basis and for broad studies covering wide areas of our economy. In this connection the Union should encourage various public and private organizations to examine the potential social, economic, and political impact of automation. These studies and those of the Union will enable us to formulate comprehensive programs to ensure that technological advances are for the good of all people.

- END -

Forum

ELECTRONIC COMPUTERS AND RELATED TOPICS -- FOUR SPECIAL SUMMER COURSES

Arvid Jacobson,
Wayne University Computation
Laboratory, Detroit, Mich.

I am sending you a preliminary announcement of our summer courses. You will note that four important areas are covered: Electronic Computers, Business and Engineering Applications; Automatic Data Processing; Mathematical Programming of Management Problems; Numerical Methods and Advanced Programming Techniques. Besides our own staff, some of the foremost experts in the respective fields are going to conduct the lectures, discussions and workshops.

Representative business and engineering problems will be programmed for Wayne's UDEC as well as for several other commercially available machines. This will be done in the workshop periods each day, and the computers will be at hand to run the sample problems.

We would appreciate it greatly if you would mention these summer courses in COMPUTERS AND AUTOMATION. Our program is a cooperative effort between Wayne University and a number of business and industrial concerns. We believe that under such auspices a very realistic and strong educational activity can be developed.

ELECTRONIC COMPUTERS, BUSINESS AND ENGINEERING APPLICATIONS (First Course, June 6-11)

This first course will be devoted to a comprehensive survey of automatic computers and their applications, and to a study of the organization and components of these electronic devices. Likewise, the ideas and methods relating to programming and coding of problems for automatic computers will be considered starting from first principles. A detailed study of elementary engineering and business applications will be made in separate groups. For daily workshop periods, the students will be divided into small teams with a leader to prepare sample problems for machine solution and to run them on the Laboratory's digital computer, UDEC. In addition to these regularly scheduled lectures and work periods, there will be presentations by suppliers of computing and data processing equipment. Visits will be planned to local installations where specific applications will be described. The staff will consist of Dr. F. L. Alt, Chief, National Applied Math. Labs., NBS, and Editor,

(continued on page 38)

THE MONKEY WRENCH

Gordon R. Dickson
(Reprinted with permission from "Astounding Science Fiction" for August, 1951. Copyright by Street and Smith Publications.)

Cary Harmon was not an ungifted young man. He had the intelligence to carve himself a position as a Lowland society lawyer, which on Venus is not easy to do. And he had the discernment to consolidate that position by marrying into the family of one of the leading drug-exporters. But, nevertheless, from the scientific viewpoint, he was a layman; and laymen, in their ignorance, should never be allowed to play with delicate technical equipment; for the result will be trouble, as surely as it is the first time a baby gets its hands on a match.

His wife was a high-spirited woman; and would have been hard to handle at times if it had not been for the fact that she was foolish enough to love him. Since he did not love her at all, it was consequently both simple and practical to terminate all quarrels by dropping out of sight for several days until her obvious fear of losing him for good brought her to a proper humility. He took good care, each time he disappeared, to pick some new and secure hiding place where past experience or her several years' knowledge of his habits would be no help in locating him. Actually, he enjoyed thinking up new and undiscoverable bolt-holes, and made a hobby out of discovering them.

Consequently, he was in high spirits the gray winter afternoon he descended unannounced on the weather station of Burke McIntyre, high in the Lonesome Mountains, a jagged, kindless chain on the deserted shorelands of Venus' Northern Sea. He had beaten a blizzard to the dome with minutes to spare: and now, with his small two-place flier safely stowed away, and a meal of his host's best supplies under his belt, he sat reveling in the comfort of his position and listening to the hundred and fifty mile-per-hour, subzero winds lashing impotently at the arching roof overhead.

"Ten minutes more," he said to Burke, "and I'd have had a tough time making it."

"Tough!" snorted Burke. He was a big, heavy-featured blond man with a kindly contempt for all of humanity aside from the favored class of meteorologists. "You Lowlanders are too used to that present day Garden of Eden you have down below. Ten minutes more and you'd have been spread over one of the peaks around here to wait for the spring searching party to gather your bones."

Cary laughed in cheerful disbelief.

"Try it, if you don't believe me," said Burke. "No skin off my nose if you don't have the sense to listen to reason. Take your bug up right now if you want."

"Not me," Cary's brilliant white teeth flashed in his swarthy face. "I know when I'm comfortable. And that's no way to treat your guest, tossing him out into the storm when he's just arrived."

"Some guest," rumbled Burke. "I shake hands with you after the graduation exercises, don't hear a word from you for six years and then suddenly you're knocking at my door here in the hinterland."

"I came on impulse," said Cary. "It's the prime rule of my life. Always act on impulse, Burke. It puts the sparkle in existence."

"And leads you to an early grave," Burke supplemented.

"If you have the wrong impulses," said Cary. "But then if you get sudden urges to jump off cliffs or play Russian Roulette then you're too stupid to live, anyway."

"Cary," said Burke heavily, "you're a shallow thinker."

"And you're a stodgy one," grinned Cary. "Suppose you quit insulting me and tell me something about yourself. What's this hermit's existence of yours like? What do you do?"

"What do I do?" repeated Burke. "I work."

"But just how?" Cary said, settling himself cozily back into his chair. "Do you send up balloons? Catch snow in a pail to find how much fell? Take sights on the stars? Or what?"

Burke shook his head at him and smiled tolerantly.

"Now what do you want to know for?" he asked. "It'll just go in one ear and out the other."

"Oh, some of it might stick," said Cary. "Go ahead, anyhow."

"Well, if you insist on my talking to entertain you," he answered, "I don't do anything so picturesque. I just sit at a desk and prepare weather data for transmission to the Weather Center down at Capital City."

"Aha!" Cary said, waggling a lazy forefinger at him in reproof. "I've got you now. You've been laying down on the job. You're the only one here; so if you don't take observations, who does?"

"You idiot!" said Burke. "The machine does, of course. These stations have a Brain to do that."

"That's worse," Cary answered. "You've been sitting here warm and comfortable while some poor little Brain scurries around outside in the snow and does all your work for you."

"Oh, shut up!" Burke said. "As a matter of fact you're closer to the truth than you think; and it wouldn't do you any harm to learn a few things about the mechanical miracles that let you lead a happy ignorant life. Some wonderful things have been done lately in the way of equipping these stations."

Cary smiled mockingly.

"I mean it," Burke went on, his face lighting up. "The Brain we've got here now is the last word in that type of installation. As a matter of fact, it was just put in recently--up until a few months back we had to work with a job that was just a collector and computer. That is, it collected the weather data around this station and presented it to you. Then you had to take it and prepare it for the calculator, which would chew on it for a while and then pass you back results which you again had to prepare for transmission downstairs to the Center."

"Fatiguing, I'm sure," murmured Cary, reaching for the drink placed handily on the end table beside his chair. Burke ignored him, caught up in his own appreciation of the mechanical development about which he was talking.

"It kept you busy, for the data came in steadily; and you were always behind since a batch would be accumulating while you were working up the previous batch. A station like this is the center-point for observational mechs posted at points over more than five hundred square miles of territory; and, being human, all you had time to do was skim the cream off the reports and submit a sketchy picture to the calculator. And then there was a certain responsibility involved in taking care of the station and yourself.

"But now"--Burke leaned forward determinedly and stabbed a thick index finger at his visitor--"we've got a new installation that takes the data directly from the observational mechs--all of it--resolves it into the proper form for the calculator to handle it, and carries it right on through to the end results. All I still have to do is prepare the complete picture from the results and shoot it downstairs.

"In addition, it runs the heating and lighting plants, automatically checks on the maintenance of the station. It makes repairs and corrections on verbal command and has a whole separate section for the consideration of theoretical problems."

"Sort of a little tin god," said Cary, nastily. He was used to attention and subconsciously annoyed by the fact that Burke seemed to be waxing more rhapsodic over his machine than the brilliant and entertaining guest who, as far as the meteorologist could know, had dropped in under the kind impulse to relieve a hermit's boring existence.

Unperturbed, Burke looked at him and chuckled.

"No," he replied. "A big tin god, Cary."

The lawyer stiffened slightly in his chair. Like most people who are fond of poking malicious fun at others, he gave evidence of a very thin skin when the tables were turned.

"Sees all, knows all, tells all, I suppose," he said sarcastically. "Never makes a mistake. Infallible."

"You might say that," answered Burke, still with a grin on his face. He was enjoying the unusual pleasure of having the other on the defensive. But Cary, adept at verbal battles, twisted like an eel.

"Too bad, Burke," he said. "But those qualities alone don't quite suffice for elevating your gadget to godhood. One all-important attribute is lacking -- invulnerability. Gods never break down."

"Neither does this."

"Come now, Burke," chided Cary, you mustn't let your enthusiasm lead you into falsehood. No machine is perfect. A crossed couple of wires, a burnt out tube and where is your darling? Plunk! Out of action."

Burke shook his head.

"There aren't any wires," he said. "It uses beamed connections. And as for burnt out tubes, they don't even halt consideration of a problem. The problem is just shifted over to a bank that isn't in use at the time; and automatic repairs are made by the machine itself. You see, Cary, in this model, no bank does one specific job, alone. Any one of them--and there's twenty, half again as many as this station would ever need--can do any job from running the heating plant to operating the calculator. If something comes up that's too big for one bank to handle, it just hooks in one or more of the idle banks--and so on until it's capable of dealing with the situation."

"Ah," said Cary, "but what if something did come up that required all the banks and more too? Wouldn't it overload them and burn itself out?"

"You're determined to find fault with it, aren't you, Cary," answered Burke. "The answer is no. It wouldn't. Theoretically it's possible for the machine to bump into a problem that would require all or more than all of its banks to handle. For example, if this station suddenly popped into the air and started to fly away for no discernible reason, the bank that first felt the situation would keep reaching out for help until all the banks were engaged in considering it, until it crowded out all the other functions the machine performs. But, even then, it wouldn't overload and burn out. The banks would just go on considering the problem until they had evolved a theory that explained why we were flying through the air and what to do about returning us to our proper place and functions."

Cary straightened up and snapped his fingers.

"Then it's simple," he said. "I'll just go in and tell your machine--on the verbal hookup--that we're flying through the air."

Burke gave a sudden roar of laughter.

"Cary, you dope!" he said. "Don't you think the men who designed the machine took the possibility of verbal error into account? You say that the station is flying through the air. The machine immediately checks by making its own observations; and politely replies, 'Sorry, your statement is incorrect' and forgets the whole thing."

Cary's eyes narrowed and two spots of faint color flushed the tight skin over his cheekbones; but he held his smile.

"There's the theoretical section," he murmured.

"There is," said Burke, greatly enjoying himself, "and you could use it by going in and saying 'consider the false statement or data--this station is flying through the air' and the machine would go right to work on it."

He paused, and Cary looked at him expectantly.

"But--" continued the meteorologist, triumphantly, "it would consider the statement with only those banks not then in use; and it would give up the banks whenever a section using real data required them."

He finished, looking at Cary with quizzical good humor. But Cary said nothing; only looked back at him as a weasel might look back at a dog that has cornered it against the wall of a chicken run.

"Give up, Cary," he said at last. "It's no use. Neither God nor Man nor Cary Harmon can interrupt my Brain in the rightful performance of its duty."

And Cary's eyes glittered, dark and withdrawn beneath their narrowed lids. For a long second, he just sat and looked, and then he spoke.

"I could do it," he said, softly.

"Do what?" asked Burke.

"I could gimmick your machine," said Cary.

"Oh, forget it!" boomed Burke. "Don't take things so seriously, Cary. What if you can't think of a monkey wrench to throw into the machinery? Nobody else could, either."

"I said I could do it," repeated Cary.

"Once and for all," answered Burke, "it's impossible. Now stop trying to pick flaws in something guaranteed flawless and let's talk about something else."

"I will bet you," said Cary, speaking with a slow, steady intensity, "five thousand credits that if you will leave me alone with your machine for one minute I can put it completely out of order."

"Forget it, will you?" exploded Burke. "I don't want to take your money, even if five thousand is the equivalent of a year's salary for me. The trouble with you is, Cary, you never could stand to lose at anything. Now, forget it!"

"Put up or shut up," said Cary.

Burke took a deep breath.

"Now look," he said, the beginnings of anger rumbling in this deep voice. "Maybe I did wrong to needle you about the machine. But you've got to get over the idea that I can be bullied into admitting that you're right. You've got no conception of the technology that's behind the machine, and no idea of how certain I am that you, at least, can't do anything to interfere with its operation. You think that there's a slight element of doubt in my mind and that you can bluff me out by proposing an astronomical bet. Then, if I won't bet, you'll tell yourself you've won. Now listen, I'm not just ninety-nine point nine, nine, nine, nine, per cent sure of myself. I'm one hundred per cent sure of myself and the reason I won't bet you is because that would be robbery; and besides, once you'd lost, you'd hate me for winning the rest of your life."

"The bet still stands," said Cary.

"All right!" roared Burke, jumping to his feet. "If you want to force the issue, suit yourself. It's a bet."

Cary grinned and got up, following him out of the pleasant, spacious sitting room, where warm lamps dispelled the gray gloom of the snow-laden sky beyond the windows, and into a short, metal-walled corridor where the ceiling tubes blazed in efficient nakedness. They followed this for a short distance to a room where the wall facing the corridor and the door set in it were all of glass.

Here Burke halted.

"There's the machine," he said, pointing through the transparency of the wall and turning to Cary behind him. "If you want to communicate with it verbally, you speak into that grille there. The calculator is to your right; and that inner door leads down to the room housing the lighting and heating plants. But if you're thinking of physical sabotage, you might as well give up. The lighting and heating systems don't even have emergency manual controls. They're run by a little atomic pile that only the machine can be trusted to handle --that is, except for an automatic setup that damps the pile in case lightning strikes the machine or some such thing. And you couldn't get through the shielding in a week. As for breaking through to the machine up here, that panel in which the grille is set is made of two-inch thick steel sheets with their edges flowed together under pressure."

"I assure you," said Cary. "I don't intend to damage a thing."

Burke looked at him sharply, but there was no hint of sarcasm in the smile that twisted the other's thin lips.

"All right," he said, stepping back from the door. "Go ahead. Can I wait here, or do you have to have me out of sight?"

"Oh, by all means, watch," said Cary. "We machine-gimmickers have nothing to hide." He turned mockingly to Burke, and lifted his arms. "See? Nothing up my right sleeve. Nothing up my left."

"Go on," interrupted Burke roughly. "Get it over with. I want to get back to my drink."

"At once," said Cary, and went in through the door, closing it behind him.

Through the transparent wall, Burke watched him approach the panel in line with the speaker grille and stop some two feet in front of it. Having arrived at this spot, he became utterly motionless, his back to Burke, his shoulders hanging relaxed and his hands motionless at his side. For the good part of a minute, Burke strained his eyes to discover what action was going on under the guise of Cary's apparent immobility. Then an understanding struck him and he laughed.

"Why," he said to himself, "he's bluffing right up to the last minute, hoping I'll get worried and rush in there and stop him."

Relaxed, he lit a cigarette and looked at his watch. Some forty-five seconds to go. In less than a minute, Cary would be coming out, forced at last to admit defeat--that is, unless he had evolved some fantastic argument to prove that defeat was really victory. Burke frowned. It was almost pathological, the way Cary had always refused to admit the superiority of anyone or anything else; and unless some way was found to soothe him he would be a very unpleasant companion for the remaining days that the storm held him marooned with Burke. It would be literally murder to force him to take off in the tornado velocity winds and a temperature that must be in the minus sixties by this time. At the same time, it went against the meteorologist's grain to crawl for the sake of congeniality--

The vibration of the generator, half-felt through the floor and the soles of his shoes, and customarily familiar as the motion of his own lungs, ceased abruptly. The fluttering streamers fixed to the ventilator grille above his head ceased their colorful dance and dropped limply down as the rush of air that had carried them, ceased. The lights dimmed and went out, leaving only the gray and ghostly light from the thick windows at each end of the corridor to illuminate the passage and the room. The cigarette dropped unheeded from Burke's fingers and in two swift strides he was at the door and through it.

"What have you done?" he snapped at Cary.

The other looked mockingly at him, walked across to the nearer wall of the room and leaned his shoulder blades negligently against it.

"That's for you to find out," he said, his satisfaction clearly evident.

"Don't be insane--" began the meteorologist. Then, checking himself like a man who has no time to lose, he whirled on the panel and gave his attention to the instruments on its surface.

The pile was damped. The ventilating system was shut off and the electrical system was dead. Only the power in the storage cells of the machine itself was available for the operating light still glowed redly on the panel. The great outside doors, wide enough to permit the ingress and exit of a two-man flier, were closed, and would remain that way, for they required power to open or close them. Visio, radio, and teletype were alike, silent and lifeless through lack of power.

But the machine still operated.

Burke stepped to the grille and pressed the red alarm button below it, twice.

"Attention," he said. "The pile is damped and all fixtures besides yourself lack power. Why is this?"

There was no response, though the red light continued to glow industriously on the panel.

"Obstinate little rascal, isn't it?" said Cary from the wall.

Burke ignored him, punching the button again, sharply.

"Reply!" he ordered. "Reply at once! What is the difficulty? Why is the pile not operating?"

There was no answer.

He turned to the calculator and played his fingers expertly over the buttons. Fed from the stored power within the machine, the punched tape rose in a fragile white arc and disappeared through a slot in the panel. He finished his punching and waited.

There was no answer.

For a long moment he stood there, staring at the calculator as if unable to believe that, even in this last hope, the machine had failed him. Then he turned slowly and faced Cary.

"What have you done?" he repeated dully.

"Do you admit you were wrong?" Cary demanded.

"Yes," said Burke.

"And do I win the bet?" persisted Cary gleefully.

"Yes."

"Then I'll tell you," the lawyer said. He put a cigarette between his lips and puffed it alight; then blew out a long streamer of smoke which billowed out and hung cloudily in the still air of the room, which, lacking heat from the blowers, was cooling rapidly. "This fine little gadget of yours may be all very well at meteorology, but it's not very good at logic. Shocking situation, when you consider the close relation between mathematics and logic."

"What did you do?" reiterated Burke hoarsely.

"I'll get to it," said Cary. "As I say, it's a shocking situation. Here is this infallible machine of yours, worth, I suppose, several million credits, beating its brains out over a paradox."

"A paradox!" the words from Burke were almost a sob.

"A paradox," sang Cary, "a most ingenious paradox." He switched back to his speaking voice, "Which, in case you don't know, is from Gilbert and Sullivan's 'Pirates of Penzance.' It occurred to me while you were bragging earlier that while your little friend here couldn't be damaged, it might be immobilized by giving it a problem too big for its mechanical brain cells to handle. And I remembered a little thing from one of my pre-law logic courses--an interesting little affair called Epimenides Paradox. I don't remember just how it was originally phrased--those logic courses were dull, sleepy sort of businesses, anyway--but for example, if I say to you 'all lawyers are liars' how can you tell whether the statement is true or false, since I am a lawyer and, if it is true, must be lying when I say that all lawyers are liars? But, on the other hand, if I am lying, then all lawyers are not liars, and the statement is false, i.e., a lying statement. If the statement is false, it is true, and if true, false, and so on, so where are you?"

Cary broke off suddenly into a peal of laughter.

"You should see your own face, Burke,"

he shouted. "I never saw anything so bewildered in my life--anyway, I just changed this around and fed it to the machine. While you waited politely outside, I went up to the machine and said to it 'You must reject the statement I am now making to you, because all the statements I make are incorrect.'"

He paused and looked at the meteorologist.

"Do you see, Burke? It took that statement of mine in and considered it for rejecting. But it could not reject it without admitting that it was correct, and how could it be correct when it stated that all statements I made were incorrect. You see . . . yes, you do see, I can see it in your face. Oh, if you could only look at yourself now. The pride of the meteorology service, undone by a paradox."

And Cary went off into another fit of laughter that lasted for a long minute. Every time he would start to recover, a look at Burke's wooden face, set in lines of utter dismay, would set him off again. The meteorologist neither moved, nor spoke, but stared at his guest as if he were a ghost.

Finally, weak from merriment, Cary started to sober up. Chuckling feebly, he leaned against the wall, took a deep breath and straightened up. A shiver ran through him, and he turned up the collar of his tunic.

"Well," he said. "Now that you know what the trick was, Burke, suppose you get your pet back to its proper duties again. It's getting too cold for comfort and that daylight coming through the windows isn't the most cheerful thing in the world, either."

But Burke made no move toward the panel. His eyes were fixed and they bored into Cary as unmovingly as before. Cary snickered a little at him.

"Come on, Burke," he said. "Man the pumps. You can recover from your shock sometime afterwards. If it's the bet that bothers you, forget it. I'm too well off myself to need to snatch your pennies. And if it's the failure of Baby, here, don't feel too bad. It did better than I expected. I thought it would just blow a fuse and quit work altogether, but I see it's still busy and devoting every single bank to obtaining a solution. I should imagine"--Cary yawned--"that it's working toward evolving a theory of types. That would give it the solution. Probably could get it, too, in a year or so."

Still Burke did not move. Cary looked at him oddly.

"What's wrong?" he asked irritatedly.

Burke's mouth worked, a tiny speck of spittle flew from one corner of it.

"You--" he said. The word came tearing from his throat like the hoarse grunt of a dying man.

"What--"

"You fool!" ground out Burke, finding his voice. "You stupid idiot! You insane moron!"

"Me? Me?" cried Cary. His voice was high in protest, almost like a womanish scream. "I was right!"

"Yes, you were right," said Burke. "You were too right. How am I supposed to get the machine's mind off this problem and on to running the pile for heat and light, when all its circuits are taken up in considering your paradox? What can I do, when the Brain is deaf, and dumb, and blind?"

The two men looked at each other across the silent room. The warm breath of their exhalations made frosty plumes in the still air; and the distant howling of the storm, deadened by the thick walls of the station, seemed to grow louder in the silence, bearing a note of savage triumph.

The temperature inside the station was dropping very fast--

- END -

Automation Puts Industry on Eve of Fantastic Robot Era – Its Effect on Workers Spurs Unions' Drive for Annual Wage

A. H. Raskin
(Reprinted with permission from "The New York Times", Friday, April 8, 1955)

The electron is doing more to revolutionize American industry than atomic energy. Automation--the harnessing of electronic brains to mechanical muscles--is making normal concepts of mass production obsolete.

So fantastic are the potentialities of new control devices that it is possible to visualize acres of factory or office space in which no worker is needed. Automated equipment can process raw materials, assemble them into finished goods, package them and load them into freight cars without direct human help.

That is not all. The automated machines can adjust to variable productive conditions, correct their own mistakes, inspect the finished product, and even change their own parts when parts break or wear out. Little wonder that some engineers estimate that 70 per cent of all the machine tools now in use are outmoded.

Already automation is being used to refine oil, make artillery shells, put together television sets, bake cakes, process chemicals, generate electric power, mail out insurance bills, put through transcontinental telephone calls and build automobile engines.

In the automated operations a few engineers and a maintenance crew are all the work force required. They spend most of their time watching the flashing lights and checking the dials on the control panels; the machine does the rest, even to letting them know when it needs human attention.

Automated machines do not stop with telling other machhines what to do; they even "breed" new automated equipment. With magical new calculators, design data for huge mechanical installations can be completed in one-fortieth the time formerly required.

Vending machines are being used to sell some of the goods automation produces, but the human touch is still necessary to do most of the sales job, to say nothing of the buying. Even here automation has its foot in the door. Electronic tabulating equipment is being used to do the market research that tells a company where its customers are.

How Automation Works

The heart of automation is the feedback principle embodied in every home thermostat. When you set the thermostat for 70 degrees, you can rely on it to turn the furnace on when the temperature drops too low and to turn it off when the temperature rises too high. The same self-correcting technique is involved in automation, except that the number of variable factors controlled by the electronic brain is infinitely more complex. Once you give the brain its instructions through a punch card or a recording tape, it will carry them out with inhuman precision.

No precise boundary can be drawn between automation and mass production, and it is doubtful that one method will ever completely replace the other. What is more, the cost of automating all sections of industry and adapting all products to automation would involve so many millions of dollars that the change is bound to be gradual.

But the pace of technological progress and the pressure of business competition on large and small enterprises make it more expensive for many companies to dawdle than to accomodate themselves to the new technology. Automation is a process of today as well as tomorrow.

It opens up vistas of unparalled abundance and comfort; at the same time it stirs fears of mass unemployment and frustration. It promises a vast expansion in goods and services, sharp reductions in prices and increased opportunity for the enjoyment of leisure. It makes the three-day week-end a realizable goal; it offers emancipation from the drudgery of routine, repetitive tasks.

Retraining Plan Urged

But with these prospective blessings comes concern that liberation from drudgery also will mean liberation from any regular paycheck for large numbers of workers. Unions are demanding that the Federal Government take the lead

in working out a retraining and adjustment program to prevent widespread hardship from attending the dawn of the new industrial era.

This same concern provides a powerful spur to union campaigns for a guaranteed annual wage. By assuring a worker a full years pay after he loses his job, the wage guarantee would help a man pay his bills while he sought another job at the work he knew or trained himself for a new type of employment.

Industry is not so sure such absolute assurance of income will work out to anyone's benefit. Employers contend that pay guarantees will discourage companies from putting new workers on the payroll, impose a crushing financial obligation on industry and check the speed of technological change-over.

The basic fears aroused by automation are not new. A century and a half ago the advent of the industrial revolution stirred European workers to such excesses of anxiety that they hurled wooden shoes intoautomatic looms and smashed newly installed machinery with sledge hammers. The battle of men against machines was carried to this country. It was a major factor in the rise of American unions.

However, experience has taught labor leaders two things. One is that is is impossible to stop technological advances; the other is that it is contrary to the best interests of the workers themselves even to try. Over the long haul, labor shares with all other groups in the community the advantages of improved productive methods. This has been the root of higher wages, shorter working hours and better living standards for American workers.

More Jobs Foreseen

More to the point, the forward march of productivity has had the effect of creating more jobs than it has wiped out. New industries and new products come into being; people with more money to spend reach out for new services, attend more adequately to their medical and professional needs, provide more schooling for their children.

Union leaders do not question that this general process of long-term improvement in living standards and expansion in job opportunities will accompany automation. What worries them is what happens along the road to the new economy of abundance. They note that the steel industry is turning out a third more steel than it did a year ago with no increase in the number of workers. The automobile industry is doing much the same.

Government statistics at the end of last year indicated that all manufacturing industries were producing as much as they had a year earlier, even though the number of factory workers had dropped by nearly a million. For each man-hour of human labor the average factory turned out 7 per cent more in February of this year than in the same month of 1954. And all this with automation in its self-diapering infancy.

Population experts insist that this upsweep in productivity, going forward at double or triple the rate that has prevailed over the last half-century, comes at a happy time for the United States. Without it, they fear that the nation's problem will not be too many workers for the jobs available, but too few.

They foresee a shortage in the next ten or twenty years of qualified workers--partly because the working population will reflect the abnormally low birth rate of the depression years of the Thirties, partly because people start working later and retire earlier and partly because the work week is likely to keep getting shorter.

Skilled Workers Needed

The National Manpower Council is convinced that the next few years will see a jump in the need for technicians and highly skilled workers while unskilled workers find fewer and fewer places to work. The council warns that electricians would have to learn electronics and pipefitters hydraulics if they wanted to keep in step with science. Even a hand trucker must be able to interpret charts to discover where supplies are needed.

It is this increasing call for highly developed labor skills that has prompted Secretary of Labor James P. Mitchell to tell the country that its survival is menaced by the decline in work skills. Colleges and universities are giving increased attention to the requirements of the new industrial technology. This attention is not limited, however, to the need for more specialists in engineering and other specialized spheres.

It also extends to preparing men and women in the humanities so that they will be better equipped to guide our complex industrial society along a constructive course, to think through industrial problems and to make effective use of the leisure time that will be opened up in the next decade.

Even for technicians automation will bring some jobs. With robots giving orders to other robots and telling one another when

(continued on page 38)

The Skills of the American Work Force

James P. Mitchell
Secretary, U.S. Dept. of Labor
(Address in New York, March 7, 1955)

Our world abounds with sweeping new developments. The atom has been unleashed, causing concepts of war and peace different from any the world has ever known; and creating awesome problems which fill many with fears and doubts. Our scientists have devised new and remarkable machines for the defense of our country, and our industry is expanding constantly in new and different directions. The big and obvious problems which follow in the wake of these developments are receiving the thoughtful attention of our people.

But beneath the surface lie other fundamental problems, less dramatic perhaps, less heralded, yet serious.

It is of such a problem that I speak to you tonight--an area of national concern which challenges for solution the farthest reaches of our national imagination and intellectual resource.

What is this problem? It can be stated briefly. It is the urgent need to raise the level of the skills of the American work force.

Whether we like it or not, we are now in a race with the Communist world for technological supremacy. The products of scientific research have obviously revolutionized warfare. Compare, for example, the harbor defense guns of Fort Wadsworth, which formerly protected New York, and Nike, today's supersonic guided missile, which can seek out and destroy attacking aircraft. Where the harbor defense guns could be handled and maintained by a handful of trained men, Nike requires more than 100 highly skilled men. This new defense weapon with its complex control mechanism contains more than 1,500,000 individual parts. You can well imagine the skills and abilities required to manufacture, maintain, service and fire such a weapon.

As we in America look back in our history, we realize that we have been complacent about our natural resources -- our timber, our iron, our oil. Likewise, I think you will agree, we have been complacent about our need for scientists and technical experts.

Had it not been for Hitler's barbaric destruction of human beings, the Germans would probably have been the first nation in the world to develop the mighty power of the atom. Fortunately General Graves and America's scientists had the assistance of a handful of scientists who came to America to escape Nazi and Fascist-dominated Europe -- Einstein from Germany, Fermi from Italy, Meitner from Germany, Szilard from Hungary and Bohr from conquered Denmark.

In contrast, it is perhaps in the development of scientific and technical manpower that the Russians have shown their greatest resourcefulness. Ever since the days of Lenin the Russians have been trying to catch up with the West in the scientific fields. Today they are making a major effort to develop trained manpower.

The Russians obtain their scientific manpower by directive, but I believe the freedom and incentives of our system give us an enormous advantage in this regard. Nevertheless, the Russian efforts to increase their technical and scientific manpower should give us pause.

We have indeed been entirely too slow to realize how closely our country's economic and military strength is tied not only to the exceptional contributions of the great scientists, but also to the every-day skills and abilities of our workers. No research laboratory could operate; no pilot models could be developed; no manufacturing plant could produce without the diversity of skills represented not only by our scientists and engineers, but also by the electronics technicians, the draftsmen, the setup men, the maintenance experts, the machinists, and a host of others.

What appears to be solely a shortage of scientists is in reality a shortage of scientists and a shortage of skilled workers and technicians needed to back up the scientists. If the engineer, the physicist or the designer, is short of aides; or if the plants which make his product are short of skilled mechanics and technicians, then his skill is wasted. In short, we have to look behind the top scientist to see the full story. And that is what I would like to do with you tonight.

There are 64 million workers in America and of these about nine million are skilled. That means they have distinctive abilities and competence in work. This group cannot be in-

creased overnight. They are the product of years of experience and training.

Many semi-skilled workers eventually move up the ladder to become skilled workers, many skilled workers move into the scientific and professional group, and many scientific and professional workers move into the management area; and also, as I have mentioned, the contribution that the scientist makes is of no practical value unless what he develops can be manufactured and used. This, in turn, depends on skilled workmen and technicians.

The largest skilled group are in maintenance and repair, metal machining and the classic trades of the craftsmen in the building trades. Many skilled workers are in trades with long traditions -- the glass blower, the carpenter, the machinist, the draftsman, the millwright, the typesetter, the baker, and the barber. Others are in comparatively new fields such as the aircraft mechanic, the electronics expert, the orthopedic technician and the x-ray technician. In many jobs the old name has acquired new and different meaning. The electrician, for example, has a job wholly different from his predecessor half a century ago.

This is not a complete picture, however, for this does not indicate the segments of our work force where we are wasting workers who could be used to answer the urgent call for skills from industry and the Armed Services.

For example, women are grossly under-represented among the skilled workers except for a handful of dental and medical technicians and foremen in the garment industry. Also, there are relatively few skilled Negro workers. As I said at the outset, we just cannot afford these types of waste.

In seeking the reasons why these groups have not entered the skilled group, it is first necessary to find out exactly how workers acquire skills. We must start with the home for there is where the basic attitudes that a man or woman has toward work are formed. The skilled craftsman is no accident. He is a product of ambition, intelligence, purposeful drive, and opportunity.

He must have a firm background of basic knowledge about his trade and he must be able to develop his native talent to the utmost.

Schooling gives a worker the basic skills through which he can begin his development. Without the opportunity to acquire basic literacy, to master numbers, to be able to communicate, to learn self-discipline, he has no base on which to build the special competences needed to be a skilled worker or technician.

The Armed Forces are now an important training ground for a large number of young men. In present day America, most men spend between two and four years in the Armed Services. Maybe they do not come out as completely polished skilled workers, but, nonetheless, anyone who spends four years in the Air Force, for example, on a first enlistment, will be one or two jumps up in the acquirement of skills. As we trace back the development of the skilled worker, we find that he frequently gets his initial stimulus and some advanced training in the Armed Forces.

There are four main additional sources through which a young person now gets his skill training. First, there are formal apprenticeship training programs sponsored and promoted with industry and labor by the U. S. Department of Labor. Second, there is the relatively new development of the technical school or college. New York State has a large number of technical institutes as does California. Then, thirdly, industry has been moving toward different types of training programs which add to the skills and competence of workers and which definitely contribute to a man's being transformed from an unskilled to a semi-skilled or skilled worker.

The last source of training, which accounts for most of the skill training today outside of the Armed Forces, is perhaps the most interesting of all and is not very well understood. In this category is the man who becomes skilled simply on his own initiative through experience, by changing from one job to a slightly better one, learning as he goes along from the fellow at his elbow.

This obviously is an admirable type of man and he should never be discouraged from his efforts to pull himself up. This type of skilled worker often lacks the versatility and training depth that the more formally trained worker has. But on the other hand, some of our best skilled workers are in this group, but many of them are good only at a specific job. In terms of our national security and in terms of meeting the demands of an ever-increasing mechanization in industry, versatility and mobility are becoming a necessity for the skilled worker.

It would be reasonable to inquire now what is the exact nature of the shortages of skilled workers and technicians? The simplest way to do this is to examine the problem in terms of the military, since there we have the best facts and figures. This does not mean, however, that industry does not suffer from skill shortages in very much the same way the Armed Services do.

By the end of World War II, there were almost half a million people under the age of 30 fit for military service, but they were deferred because they had industrial skills needed to meet the procurement requirements of the Armed Services. To give you just a rough idea

of the kinds of people we are talking about, it was the aircraft mechanic, the blast-furnace blower, the cable splicer, the electrician, the lineman, the molder, the precision lens-grinder, the x-ray equipment serviceman, and the tool designer.

These shortages existed at a time when American industry was operating to maintain an armed force of over 11 million men 10 years ago. When you look at the technological changes that have taken place since World War II, can you picture the industrial skill shortages which would result from full mobilization today? Added to the list of skill shortages of 10 years ago would be atomic specialists, highly trained electronic experts who can repair such an instrument as Nike, technicians who can handle the modern radar equipment which has changed so much since World War II days and a host of others too numerous to mention.

Today, the Armed Forces, with a strength of only 3 million men, are roughly 30 percent short on fully qualified skilled personnel needed to fill many thousands of critical military jobs. For example, there is a need for some 35,000 aircraft mechanics and electronics technicians; about 25,000 electronic equipment operators; 18,000 communications equipment mechanics, and so on. These shortages reflect similar shortages in private industry. For every three skilled persons or technicians that the Armed Services require, only two are currently available, and the individuals who are in these positions in large part have been pushed in without adequate training.

Further evidence of the impingement of the shortages in this area on the efficiency of the Armed Services can be illustrated by what happens at the end of the first term of enlistment. Who re-enlists? It's the military police, food service people, to some degree the automotive maintenance men, the infantry, and supply personnel. But in the more specialized and technical areas, only 1 percent of the electronics maintenance personnel are willing to re-enlist, which simply means that industry is bidding very high because these men are scarce. Your Armed Services are in a poor position to meet this competition, although if the Congress approves the new military pay bill, the relative position of the Armed Services will be improved. More pay for the military, however, would tend to transfer military shortages to civilian industry, until a more extensive training program is undertaken.

In short, it appears that the more skill a soldier has, the less likely he is to re-enlist, which, of course, throws a very heavy weight on the Services in still another way. They have to take a large part of their budget and reinvest it in each four-year or two-year cycle to begin to train new people and as soon as they are partly trained, out they go again. This level of training in the Armed Forces undoubtedly has a direct relation to industry.

Perhaps the most important problem in connection with the expansion of skills is the relation of schooling to a man's capabilities. Schooling is the base from which workers move on to acquire special competence. To give some indication of the way in which poor schooling reduces the number of men able to take advanced training in the military or even in civilian life, here are some startling facts.

Out of the 1st Army area, the overwhelming majority of the young men who are examined have enough educational and mental equipment to be taken into the Armed Forces. Only something like 7 percent fail to pass the mental examination. And in the 5th Army area, less than 5 percent of the population, really the mentally deficient group, fail to make the grade. But in the 3rd Army area, where there were sometimes lower educational standards, as many as one out of four persons cannot pass the simple fourth grade test the Armed Forces gives as an absolute minimal requirement.

So you have a situation where the 3rd Army area has five times as many people rejected as the 5th Army area, and this is a direct consequence of the accessability of basic schooling. Fortunately, this situation is definitely better now than it was a few years ago and is improving all the time as new schools are being constructed and the general standard of living is being improved in those areas which have previously lagged behind. As they accelerate their progress, the whole nation will gain in military and industrial strength.

As you know, the Armed Services divide their personnel into five broad categories based on mental test scores. I and II are good, III is average, IV is below average, and V they do not normally take.

Now, of the people whom the Armed Services take from the different regions of the country, one out of every two from the 3rd Army area falls in group IV or below, which means that they are definitely not material for further training within the Armed Forces.

In contrast, in the 1st and 6th Army areas, only one out of four of those who are finally taken in would not be good material for further training.

There is a very strong relationship between the educational level of the population -- illustrated here by the number of high school graduates in a particular geographical

area and the number of well qualified people it can contribute to the skilled work force of the nation both in and out of the Armed Services. In the 1st Army area, more than one out of every two boys graduating from high school, and 40 percent of those who enter the Armed Forces are in the upper groups and definitely trainable. In the 3rd Army area, where only 30 percent of the young men of military age are high school graduates, only 16 percent of those entering the Armed Forces manage to qualify for the first or second group.

These proportions hold up throughout the country. Wherever you have more high school graduates, you have the highest amount of good, qualified manpower. In the Far West, for example, two out of every three are high school graduates, and about 43 percent qualify for the upper groups.

We are all interested in low taxes, but we must realize that if low taxes mean poor schools, and poor schools mean lack of adequate skills, then our economic future and our national security may be jeopardized. In addition, industry must spend more to train those who have not had the basic education necessary to perform the work modern production requires.

The factors associated with skill shortages and lack of training facilities, including what most of us would consider ordinary basic schooling, are at the very heart of one of our country's most pressing economic problems -- chronic unemployment in certain localized areas.

If you look at the areas of our country which suffer from chronic unemployment, I think you will find that many of them are areas whose skilled workers know only one skill for which employment opportunities are declining. And they are areas where, through age, lack of education or tradition there is a resistance to retraining.

There are some communities in the New England area, for example, which have for many years concentrated on one industry--textiles. To entice new industry into this area in large quantities there must be provision made for widespread retraining of the area's work force.

The most serious under-employment region in the country is probably the areas where there are marginal farming with very low skills and the coal industry. There, many workers have only one skill -- coal mining. If new industry is to be attracted into the coal areas, or into many non-industrial areas of the country, it is first necessary for the young workers there to acquire at least the basic knowledge on which new skills can be built.

Some areas of the nation have had poor roads, isolated communities, inadequate natural resources, non-productive land, and little industrial development. Such areas have lagged in providing satisfactory educational opportunities for their children. This has perpetuated the areas' disadvantage from one generation to the next.

Fortunately, in recent years some of these areas are spending a great deal of their resources to narrow this educational gap and provide better training for their children. The beneficial results of this investment have not yet been seen because there is a time lag between the training of children and the production of workers. The dividends from this expenditure will, however, start being apparent in a few years.

Just two months ago, the National Manpower Council at Columbia University released its study of "A Policy for Skilled Manpower". This report points out that the nuclear age will not eliminate the need for skilled workers. Quite to the contrary. The more highly complex and automatic the machinery of production and daily living becomes, the more skilled technicians are required to produce, operate, and service this machinery.

I think you will agree with me that the United States faces a real problem here and that it is one of critical importance. The Communist-dominated world outnumbers us in terms of population. We, therefore, must make up in skill what we lack in numbers.

There is no simple or single way in which we can raise the level of work skills in our Nation, and surely no way that the Federal Government can or should do it alone. This is a challenge to every segment of our society, particularly to industry, labor and the local community.

We cannot afford to waste our manpower as we are now doing.

We cannot afford discrimination which wastes the skills of more than six million Negroes.

We cannot afford the pitifully bad schools which plague many areas of this country.

We cannot afford the prejudice and shortsightedness which today are making it increasingly hard for workers over 45 to find a job.

We cannot afford not to make the most effective use of the 20 million women in our work force.

We cannot afford haphazard and ineffective training programs.

These are the areas where we all must strive for improvement. It is to the interest

(continued on page 38)

BOOKS AND OTHER PUBLICATIONS

Gordon Spenser, Whippany, N.J.
(List 14, COMPUTERS AND AUTOMATION, vol. 4, no. 5, May, 1955)

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

Chapin, Ned / Lecture Notes on Automatic Computers for Business Systems / Ned Chapin, 407 Gunsaulas Hall, 3140 South Michigan Avenue, Chicago 16, Illinois / 1955, multilithed, 197 pp, cost?

These extensive lecture notes formed the basis of a course given by the author in 1954 at the Illinois Institute of Technology and have been drawn from a forthcoming book by the author on the same subject. The notes are oriented toward the businessman seeking a knowledge of automatic computers which will enable him to decide the place of such machines in his business. The main section headings, adequately describe the content and are: What is an Automatic Computer, What Can an Automatic Computer Do, How Do Automatic Computers Work, Arithmetic and Logic Unit, Memory Unit, Input and Output Units, Control Unit, A Procedure for Evaluating Automatic Computer Profitability, Automatic Computers from a Business Point of View, Cost Aspects of Automatic Computers, and Systems Aspects of Automatic Computers. The text is illustrated with 57 charts, figures and tables. Three appendices are included. The first is a reference table of different number systems and their encoding. The second appendix is a glossary of computer terms that runs for six pages. The third appendix is an exhaustive survey of automatic computers that are available commercially. In this appendix of 54 pages is included a wealth of information that a potential customer will need. It provides the probable operating ratio, guarantee and delivery time, descriptions of the arithmetic, logical, memory, input-output, and control units, purchase and rental prices of the main and auxiliary equipment, air conditioning requirements, and personnel requirements.

American Management Association / "Electronics Reference Handbook" published for distribution at the AMA Conference "A Practical Approach to Electronics" / American Management Association, 330 West 42 St., New York 36, N. Y. / 1955, photo-offset and spiral-bound, 330 pp, distributed to conferees, now out of print

This ambitious publication was prepared for distribution at the AMA Conference held in New York on February 28 to March 2, 1955. The Conference program and capsule biographies of the speakers comprise the introductory material. The first section contains articles "gathered from significant company programs and statements about the commercial application of general purpose equipment". The companies represented and the titles are: Consolidated Edison Company, "Problems of Applying Electronics to General Accounting in a Public Utility"; Cresap, McCormick and Paget, "Thinking Ahead on Computers" and "The Evolution of Data Processing"; Commonwealth Edison Company, "Program for the Installation of an Electronic Computer System (Revenue Accounting)"; Lockheed Aircraft Company, "Production Scheduling and Labor Budgeting with Computers at Lockheed-Georgia"; Price, Waterhouse and Company, "Some Aspects of Reliability in Electronic Data Processing"; and Chesapeake and Ohio Railroad Company, "Making a Feasibility Study". Section II contains articles, previously published in various trade and technical journals, and "selected for their long-range value to management thought on the commercial application of general purpose equipment. The authors and titles are: Arthur A. Brown and Leslie G. Peck, "How Electronic Machines Handle Clerical Work"; Richard F. Clippinger, "Economics of the Digital Computer"; M. E. Davis, "Report of Some Early Indications of UNIVAC Operations in the Metropolitan Life Insurance Company" and "Some Current Thoughts on the Possible Use of Magnetic Tape Policy in a Life Insurance Office"; Edmund C. Dwyer, "The

Navy is Studying Electronic Computers"; William E. Eggleston, "Programming for Electronics"; Harold B. Goodwin, "Computing Material Requirements"; John A. Higgins and Joseph S. Glickauf, "Electronics Down to Earth"; Grace M. Hopper, "Compiling Routines" (reprinted from "Computers and Automation"); John Diebold, "Automation" (a condensation of selections from his book); Joseph Pelej, "Electronics - A Company Program"; P. J. Porter, Jr., "The Edison Electric Institute, Consolidated Edison, and Electronics"; and R. G. Canning, "Production Control through Electronic Data Processing". Section III is a reprint of the First Glossary of Programming Terminology prepared by the Committee on Nomenclature of the Association for Computing Machinery and previously distributed by the Association. The final section of 43 pages contains descriptions of the various company displays and exhibits that appeared at the Conference.

Tomlinson, N. P., M. Morowitz, and C. H. Reynolds / "Analog Computer Construction of Conformal Maps in Fluid Dynamics" in the "Journal of Applied Physics" / American Institute of Physics, 57 East 55 St., New York 22, N. Y. / February 1955, printed, pp. 229-232, $12 per year, $1.50 per issue

The authors' abstract follows: "A general-purpose electronic analog computer has been used extensively to construct the streamlines around two-dimensional airfoil shapes immersed in an incompressible, nonrotating, nonviscous fluid. The computer generates a circular Lissajous pattern on a plotting table, and then transforms the coordinates of the circle into airfoil shape by a conformal transformation. Two samples of the variety of airfoil shapes so constructed are shown. The accuracy of the process, which has been checked by a digital computer and a desk calculator, is quite satisfactory; the speed of the actual mapping process is highly advantageous to thorough exploration of a variety of airfoil shapes.

Miehle, William / "Numerical Solution of the Problem of Optimum Distribution of Effort" in the "Journal of the Operations Research Society of America", Vol. 2, No. 4 / Operations Research Society of America, Mount Royal and Guilford Avenues, Baltimore 2, Md. / Nov. 1954, printed, pp. 433-440, $6 annually, $1.50 per issue

This is a general procedure to obtain numerical results to a problem formulated by Koopman. Various types of effort, x_1, x_2, ..., x_n, are expended on corresponding tasks. The total effect is some general function $E(x_1, x_2, \ldots, x_n)$. The problem is to find the maximum effect if the sum of all (non-negative) efforts is some constant c and to determine the corresponding distribution of efforts. A general solution, together with a flow chart suitable for programming on an automatic digital computer, is presented. Special cases when the function E is additive or multiplicative are considered.

Emge, Benjamin F., Jr. / "Typhoon Aids Aircraft Development" in "Instrumentation", Vol. 7, No. 5 / Minneapolis-Honeywell Regulator Co., Wayne and Windrim Avenues, Philadelphia 41, Pa. / Fourth Quarter, 1954, printed, pp. 10-11, limited distribution

The Typhoon Guided Missile Simulator System, developed and built by the RCA Laboratories, is claimed to be the largest and most accurate analog computer now in use. The author describes the general type of problem for which the Typhoon is employed and discusses the problem of temperature and humidity control.

Davidson, Gareth M. / "Basic Math with AC Analogs" in "Control Engineering", Vol. 2, No. 3 / McGraw-Hill Publishing Co., 330 West 42 St., New York 36, N. Y. / March 1955, printed, pp. 57-66, $3 annually, 50¢ per single copy

Within the framework of AC electromechanical analog computers, the author described how various mathematical operations are simulated. With the description of each device and its mode of operation, the relative advantages and disadvantages as well as limitations on accuracy are discussed. Operations considered are addition, subtraction, multiplication, division, differentiation, integration and the generation of various algebraic, trigonometric and other types of functions. The text is illustrated with 18 figures.

Reddick, H. W., and F. H. Miller / Advanced Mathematics for Engineers, 3rd edit. prepared by F. H. Miller / John Wiley and Sons, Inc., 440 Fourth Ave., New York 16, N. Y./ 1955, printed, 548 pp, $6.50

This revision of a popular text and reference work differs from earlier editions by the introduction of new problems, the insertion of two articles on the numerical solution of ordinary and partial differential equations, the addition of a section on the Laplace transform, and some minor changes elsewhere. Chapter headings in the

present edition are Ordinary Differential Equations, Hyperbolic Functions, Elliptic Integrals, Infinite Series, Fourier Series, Gamma, Bessel and Legendre Functions, Partial Derivatives and Partial Differential Equations, Vector Analysis, Probability and Numerical Methods, Functions of a Complex Variable, and Operational Calculus. The typography is excellent. Problems are many and varied and answers are provided to all except those requiring a mathematical demonstration or derivation.

Baker, A. C. / "Ordinary Life Office Organization Using a Large-Scale Electronic Computer" / Submitted to the Institute of Actuaries of London, England / March 28, 1955, printed, 35 pp, $?

In order to determine the feasibility of using a modern electronic computer, the author was given access to the Ferranti Mark I Digital Computer at Manchester (England) University. The demonstration was divided into several parts. The investigation of policy records considered all problems associated with the maintenance of records on tape, suitable for computer operations. The second part concerned itself with monthly renewals, policy valuations, and record printing using a computer. The third part reviewed the specifications for a computer for an ordinary (as opposed to an industrial) life insurance company. The final part contains some general comments on financial and personnel considerations. Flow diagrams and formulas for some procedures are included in the appendix.

Stout, T. M. / "Computing Machines for Language Translation" in "Mechanical Translation", Vol. 1, No. 3 / W. N. Locke and V. H. Yngve, Room 14N-307, Mass. Inst. of Technology, Cambridge 39, Mass. / December 1954, photo-offset, pp. 41-46, $1 per year, 50¢ per issue

This article "is intended to suggest some of the linguistic problems to the engineer and to explain some of the engineering ideas for the amateur or professional linguist". The paper deals with coding problems, input-output devices, and storage. Intricacies of dictionary searching and dealing with multiple meanings are considered. Four diagrams illustrate the text.

Reynolds, A. C., Jr. / "The Conference on Mechanical Translation" in "Mechanical Translation", Vol. 1, No. 3 / W. N. Locke and V. H. Yngve, Room 14N-307, Mass. Inst. of Technology, Cambridge 39, Mass. / December 1954, photo-offset, pp. 47-55, $1 per year, 50¢ per issue

On June 17-20, 1952, the first conference on mechanical translation was held at M.I.T. The author is an IBM engineer who here reports his summary and comments upon the papers presented. The detailed summaries and the interspersed comments should prove to be of interest to engineers, linguists, and others interested in this new field.

Worley, C. W. / "Automatic Control Fundamentals" in "Automation", Vol. 7, No. 4 / Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio / April 1955, printed, pp. 37-42, $10.00 annually, $1.00 per issue

This is the first of a series of articles aimed to bridge the gap between those who make control equipment and those who use it. After a brief historical survey, the author proceeds to discuss the basic principles of control. The distinction between open and closed loops is set forth followed by a discussion of stability and accuracy problems. A final section is devoted to an exposition of criteria for applications of control systems.

Toulmin, H. A., Jr. / "Patent Problems in Automation" in "Automation", Vol. 7, No. 4 / Penton Publishing Co., Penton Bldg., Cleveland 13, Ohio / April 1955, printed, pp. 43-46, $10.00 annually, $1.00 per issue

The author discusses recent changes in the patent law of the United States and its effect on the automation industry. He concludes that the new law, in providing a wider definition of a patentable invention and in the recognition that many modern inventions are the result of team activity, will stimulate and encourage the development of the science of automation.

- END -

Forum

RECENT REMARKS

The Who's Who Entry forms that have been coming back to us currently at the rate of 50 a day provide a space for "remarks." Here are some of the recent remarks we have received. More remarks and comments are always invited, whenever any reader finds a postcard, a pencil, and has something to say.

Suggest you run summary articles on state of the art and probable future of selected subjects, i.e.: computer inputs, memory cells, output printers, etc.

George T. Brown, Jr.
Dayton, Ohio

The cartoon in the magazine each month is repellent.

Eugene E. J. McDonnell
Brooklyn, N. Y.

Why not get together with the ACM and publish one computer journal?!

Joe H. Ward, Jr.
San Antonio, Texas

The quality of the contents and general make-up has tremendously improved. Also, enjoy recent addition of Science Fiction.

P. J. Koopman
Lincoln, Nebraska

Why do you not solicit ads and deliver the magazine to subscribers free of charge as do "Electronics Design" and "Automatic Controls"?

Julian Hilman
Philadelphia, Pa.

Congratulations on the growth and continued excellence of the magazine.

Arthur Dowling
Pasadena, Calif.

I get too much mail now! Let's skip it!

William Jenney
Los Angeles, Calif.

Have recommended several persons to you for subscriptions -- every member of the ABA Committee on Electronics should have a copy.

R. E. Fendrich
Newark, N. J.

As you might guess, I feel that getting the information into a form that the computer will accept is fully as important as operating on it in the computer.

J. J. Dover
Edwards AFB, Calif.

Thank you. There is a definite need for these directories.

Jack Belzer
Columbus, Ohio

I see that your magazine is progressing magnificently. It is most interesting.

William C. Copp
New York, N.Y.

You are doing a good job in a unique way. Keep it up. I concur re Science Fiction.

John H. McLeod, Jr.
Pt. Mugu, Calif.

Informative and enjoyable reading. Would like more applications articles.

E. A. West
Shreveport, La.

An excellent publication. The very best we have seen in the field.

J. J. Feldman
Verona, N.J.

Congrats on Asimov fiction in recent issues. Might publish a bibliography of some of his works on robots during last ten years. They are very good and helped interest me in computers.

Robert E. Koning
Gainesville, Fla.

The correct word is automatization. By using only endings and ignoring the internal degrees of freedom, you decrease the linguistic capacity in ratio 10^{-M}, with $n>>1$.

W. Fuller Brown, Jr.
Philadelphia, Pa.

Excellent magazine.

I. N. Rabinowitz
Princeton, N.J.

Some of the points made above require some response from us. / We would like to run summary articles on the state of the art and the probable future of such subjects as computer input, memory cells, output printers, etc., as Mr. Brown suggests. If such articles are submitted to us, we shall eagerly print them. And we have the space. Because we produce by photo-offset, it is easy for us to vary the size of the magazine tremendously from issue to issue. We could easily go from 48 to 96 pages and back again to 48 pages in three successive issues if there were reason to do so. / We do not think cartoons are repellent. Even a cartoon, if it stimulates an idea, if it is amusing, if it relates to computers and automation, may be worth printing. We especially

continued on page 38

(continued from page 20)

Journal of the Association for Computing Machinery, Drs. E. P. Little, Saul Rosen, and H. H. Denman, and others of the Computation Laboratory.

AUTOMATIC DATA PROCESSING
(Second Course, June 13-18)

The emphases in this course will be on the survey of data processing units and systems and on suitable techniques in the programming and coding of advanced data processing problems. Also included will be a study of the common accounting areas from the point of view of mechanization with electronic devices. These would cover such activities as payroll, billing, inventories, and general and cost accounting. An additional feature will be an intensive study of the applications made in the fields of banking, insurance, utilities, merchandising, and manufacturing. Flow charting of information in data processing, actual programming of sample areas, and demonstrations on UDEC will be included in the workshop period. This course has been developed in consultation with Arthur Andersen & Co. Specialists from Arthur Andersen & Co. and from the Computation Laboratory and others who have made successful applications of electronic equipment in the field of data processing or who have performed significant research in these special areas will conduct the lectures, discussions and workshop periods.

The second week program is designed for those who have taken the first course or who have an equivalent training or experience.

MATHEMATICAL PROGRAMMING OF
MANAGEMENT PROBLEMS
(Third Course, June 20-25)

A thorough presentation will be made in this course of the basic techniques involved in linear programming. Also, game theory, dynamic programming, input-output analysis, and statistical techniques applicable to the field of management decision problems will be considered. Applications will be discussed which relate to the scheduling of distribution, production, and control of inventory; likewise, case histories and current research will be examined. The construction of various mathematical models will be considered, and the use of approximation and exact methods of solution will be studied.

Since knowledge of advanced mathematics will not be assumed, additional lectures will be provided in the basic mathematical concepts and methods involved. The solution of large scale linear programming problems using the simplex method will be demonstrated on the UDEC. Dr. George Dantzig or an associate, Rand Corp., Dr. Alex Orden, Burroughs Corp., Emil Schell, Ford Motor Co., Computation Laboratory personnel, and others will provide the instructional staff.

NUMERICAL METHODS AND ADVANCED
PROGRAMMING TECHNIQUES
(Fourth Course, June 27-July 2)

This course will consist of two related topics. A section on numerical methods will cover the solution of ordinary and partial differential equations, integral equations, algebraic systems and matrices, approximation theory, and various special mathematical topics. Special emphasis will be placed on the mathematical formulation of engineering and scientific problems, the analysis of error, and the feasibility of solutions of large systems. Prof. A. H. Taub, University of Illinois, Dr. A. S. Householder, Oak Ridge National Laboratory, Dr. David Young, University of Maryland, and others will constitute the instructional staff.

A section on advanced programming techniques will study automatic and minimum access programming, design of subroutines, floating point and multiple precision arithmetic, speed coding, and test programming for marginal performance and detection of error. Also, specific advanced programming techniques for existing installations will be presented by individuals who have had first-hand experience in their development. Drs. Grace Hopper, Remington Rand; John W. Carr, University of Michigan; H. H. Denman and other members of the Computation Laboratory staff are the instructors.

- END -

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Reliability in Electronic Data Processors
(continued from page 9)

stones unturned. They are constantly seeking new means of improving their equipment in every way, including improvements for insuring reliability. Further significant progress will perhaps have to wait for more experience in actual business use.

- END -

Automation Puts Industry on Eve of Fantastic Robot Era
(continued from page 28)

they are wrong, the most skilled workers are likely to find themselves made superflous by machines unless they have the adaptability to move to other and radically different assignments.

At the General Electric plant in Utica, for instance, automatic testing equipment was designed recently to check the reliability of military electronic devices. One girl with no technical training is able to run the new equipment. It took seven technicians with a high degree of specialization and fourteen semi-skilled workers to do the same testing job before. All were put to work on other tasks in the Utica plant.

More Work Created

But even in this instance automation proved that it could be a job-builder as well as a job-destroyer. The company is considering establishment of a new product line to turn out testing equipment that could be used by military forces in the field. Thus automation would open up a new area of employment at the same time that it provided increased security for our armed services.

President Eisenhower has made it plain that he sees nothing but good stemming from automation. He is convinced that an expanding economy will find work for those displaced by automatic machines. As the nation finds ways to do more work with fewer men, there always springs up more work to do. That is the President's view.

But he has instructed his economic advisers to keep an eye on the situation. If they decide that there are things to worry about, he has committed himself to the establishment of a Presidential commission to advise on means of smoothing out the rough spots. Everyone agrees that the future holds incalculable promise of economic betterment for all Americans. The question is: Can we get there without dislocation and suffering?

- END -

FORUM
(continued from page 36)

enjoyed the cartoon of the scientist working on the bicycle computer who had worked out π to 3000 decimals. / We are glad to have the votes in favor of science fiction. / It is against our philosophy for our magazine to be delivered free of charge, as Mr. Hilman suggests. To do so we think invites that it be thrown away. If a man pays a reasonable price for literature, he will value it and read it. And if we don't continue to do the best job we can, our subscibers will stop renewing, our subscriptions will fall off, we will quickly find out, and receive the benefits of feedback. A controlled circulation magazine does not have the benefit of this kind of feedback. / Getting the information into a form that the computer will accept is tremendously important, as Mr. Dover says. We would like to see a great deal more attention given to this subject. We shall be glad to reprint articles and papers about it. / Frankly, we don't like the word "automatization": it is a tongue-twisting word, and it is entirely clear that the people of the United States will not use it and will use instead "automation". For the same kind of reason we always say "preventive" instead of "preventative".

-- Editor

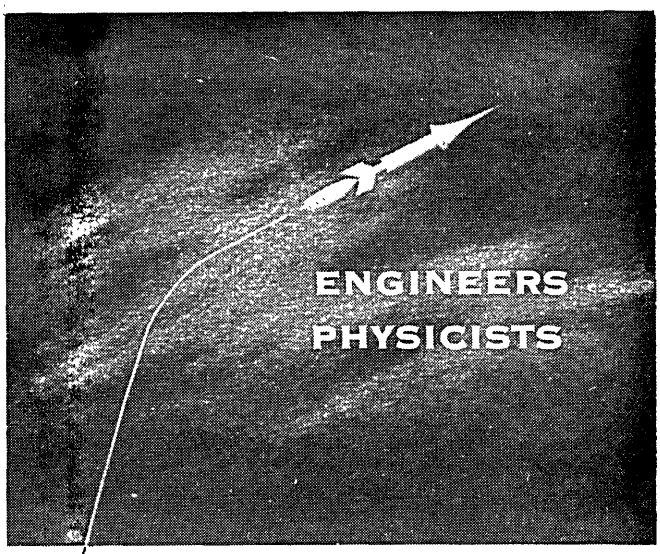
- END -

The Skills of the American Work Force
(continued from page 32)

of you, the business leaders of America, to lead the way in this effort. We in the Department of Labor and the rest of government can help. We can promote training and provide the facts and figures, but in the last analysis it is up to you to do the job.

It is the skill, ingenuity, and know-how in the brains and hands of American workmen that have built the sinews of a mighty America. This, together with our spiritual heritage, has made us a great Nation. It is my considered opinion that the level of work skills among our working people today has deteriorated dangerously and could perhaps imperil our survival as a nation. We are all greatly concerned with the preservation and development of our national resources. I suggest that the preservation and development of our human resources in terms of work skills is an even greater and more pressing concern and is worthy of the attention of every thinking person in the country. For upon the depth, breadth, and scope of the skills of American artisans may depend the hope of the free world. These critical resources must be cultivated with direction and perspective and we must begin now.

- END -



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Forum

FIRST SUPERSONIC FLIGHT SIMULATOR

Neil Macdonald

On March 14 the first supersonic flight simulator (F - 100A) was demonstrated by the U.S. Air Force at Nellis Air Force Base, Las Vegas, Nev. This simulator (see Figure 1) was made by Westinghouse Air Brake Company at Melpar, Inc., Falls Church, Virginia, a wholly - owned subsidiary of Westinghouse. The simulator includes a replica of the cockpit of the F - 100A modern supersonic aircraft with instruments electronically actuated to provide a realistic representation of flight situations characteristic of this aircraft. Through use of this device before actual flying, a pilot can be trained in both normal and emergency procedures, including flying by instruments and communicating. In the safety of a classroom, the machine provides practice particularly in situations too dangerous to allow in the air, such as a flame-out, or a failure of landing gear. Production models of the F - 100A Simulator are being made at the Union Switch & Signal Division of Westinghouse at Swissvale, Pa., where electrical and electronic devices have long been built for railroad control and signal systems. This division had previously made the F--86--D Simulator for the United States Air Force.

The F - 100A Flight Simulator occupies an area 47 feet by 18 feet. It consists of seven major assemblies and five electronic computer racks. Major assemblies include a cockpit in which controls and instruments of the actual F - 100A aircraft are duplicated; flash tubes simulate the effect of lightning; two speakers reproduce flight and engine noises for the pilot being trained. A flight instructor's console contains a duplicate of the simulator's cockpit instruments and two control panels. By means of the switches on the control panel, the instructor can set up various problems and observe the pilot's reaction to the problem. For example, a flip of the instructor's switch lets the pilot experience an engine stoppage. The simulator's analog computing system (designated MB-3) can duplicate the performance of the F - 100A aircraft, and is connected to the instruments and controls of the cockpit of the F - 100A. 60 cycle and 400 cycle voltages are used to represent mathematical quantities. Five cabinets containing 80 pull-out drawers constitute the MB-3.

- END -

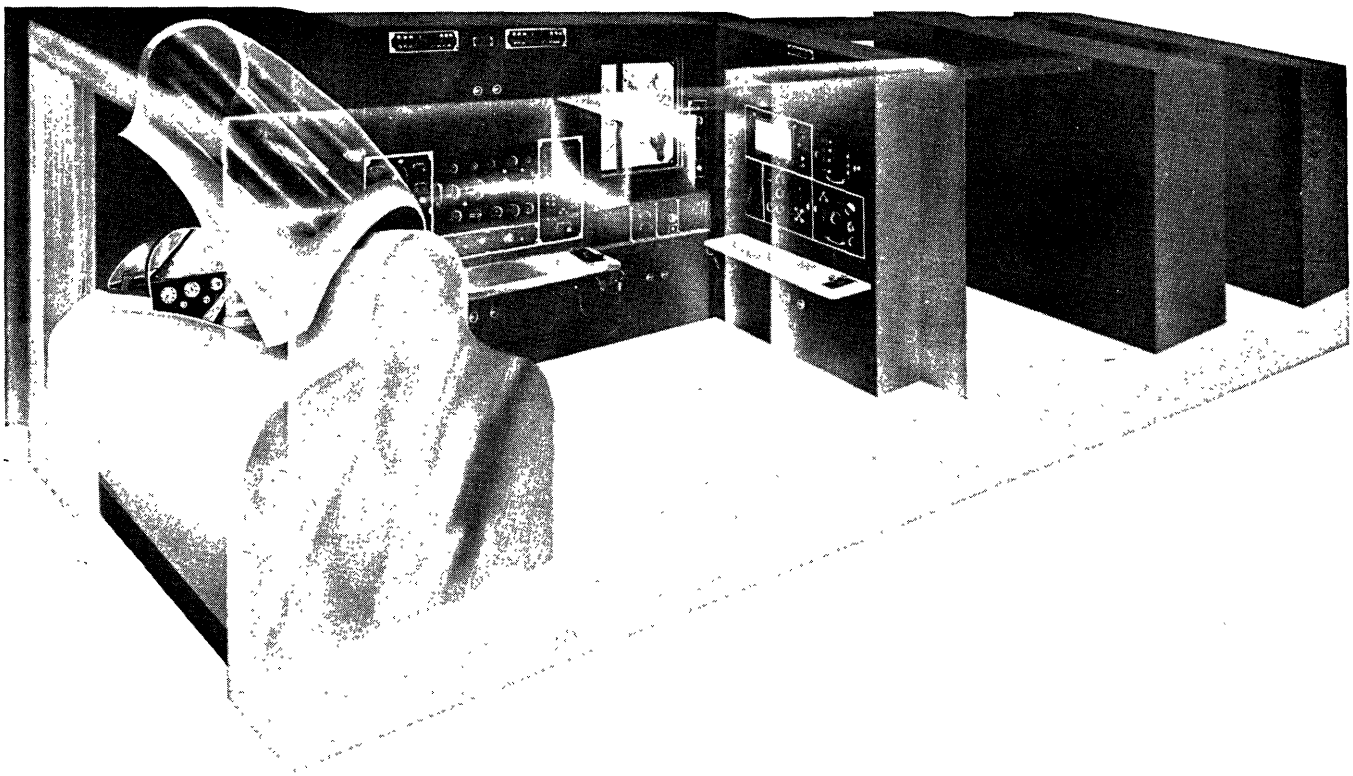

Figure 1 -- The first supersonic flight simulator, the F-100A

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"GENIACS -- Simple Electric Brain Machines and How to Make Them" by Edmund C. Berkeley, published by Berkeley Enterprises, Inc., March, 1955, 64 pp. -- Describes over 30 small electric brain machines that reason arithmetically or logically, solve puzzles, play games, etc. Each machine operates on one flashlight battery. Gives sufficient details so that each machine can be constructed with the materials in Geniac Kit No. 1, or with other materials.

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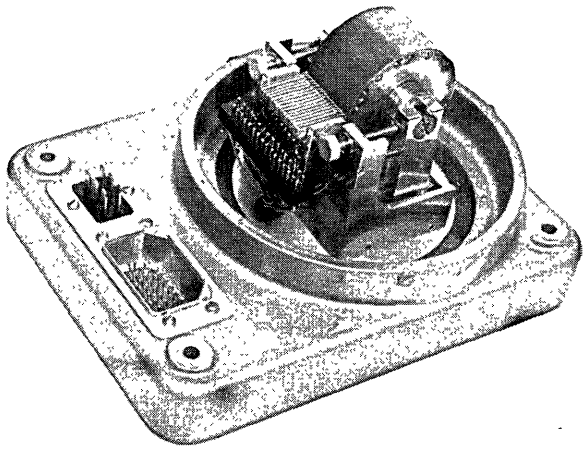

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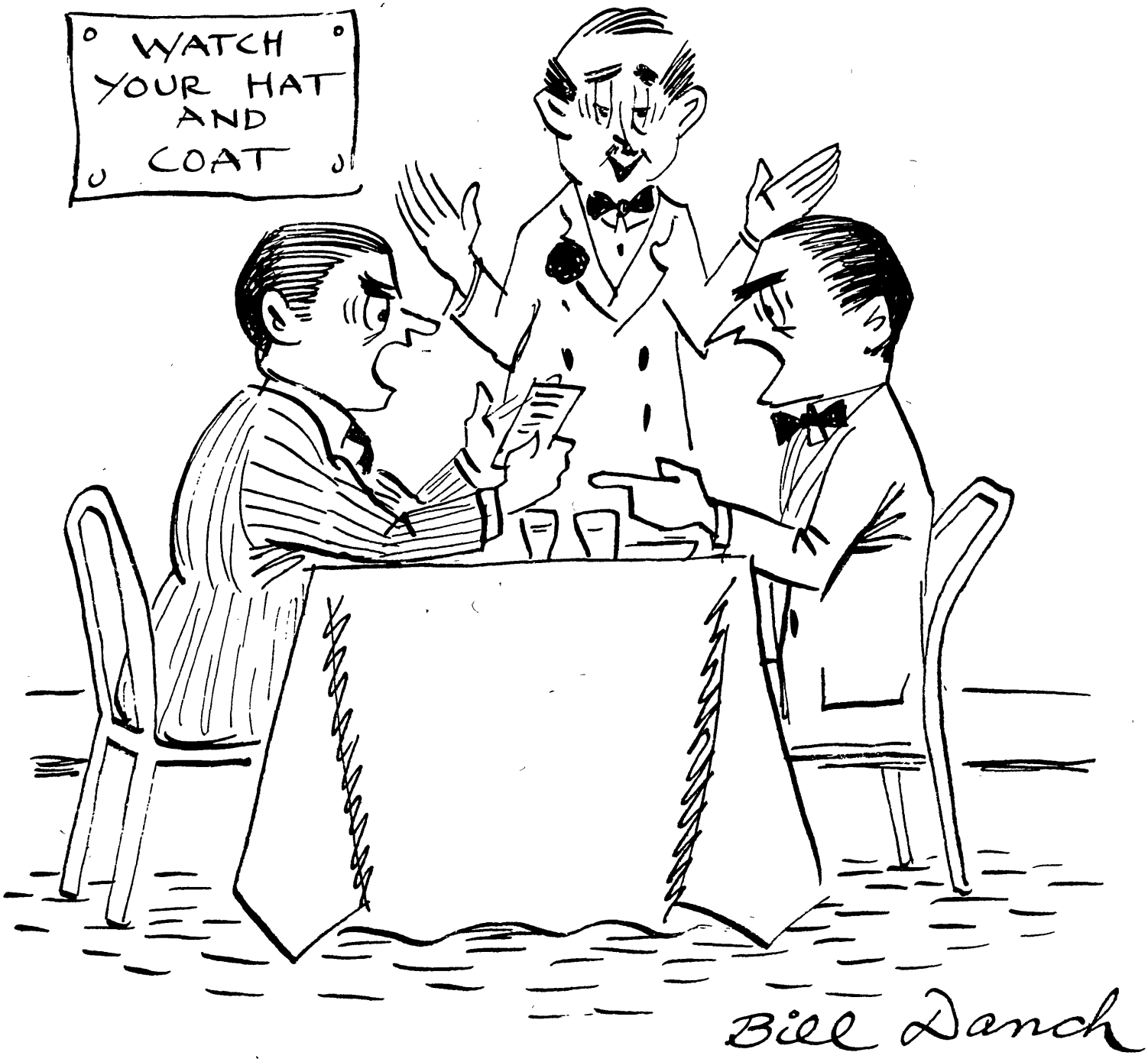

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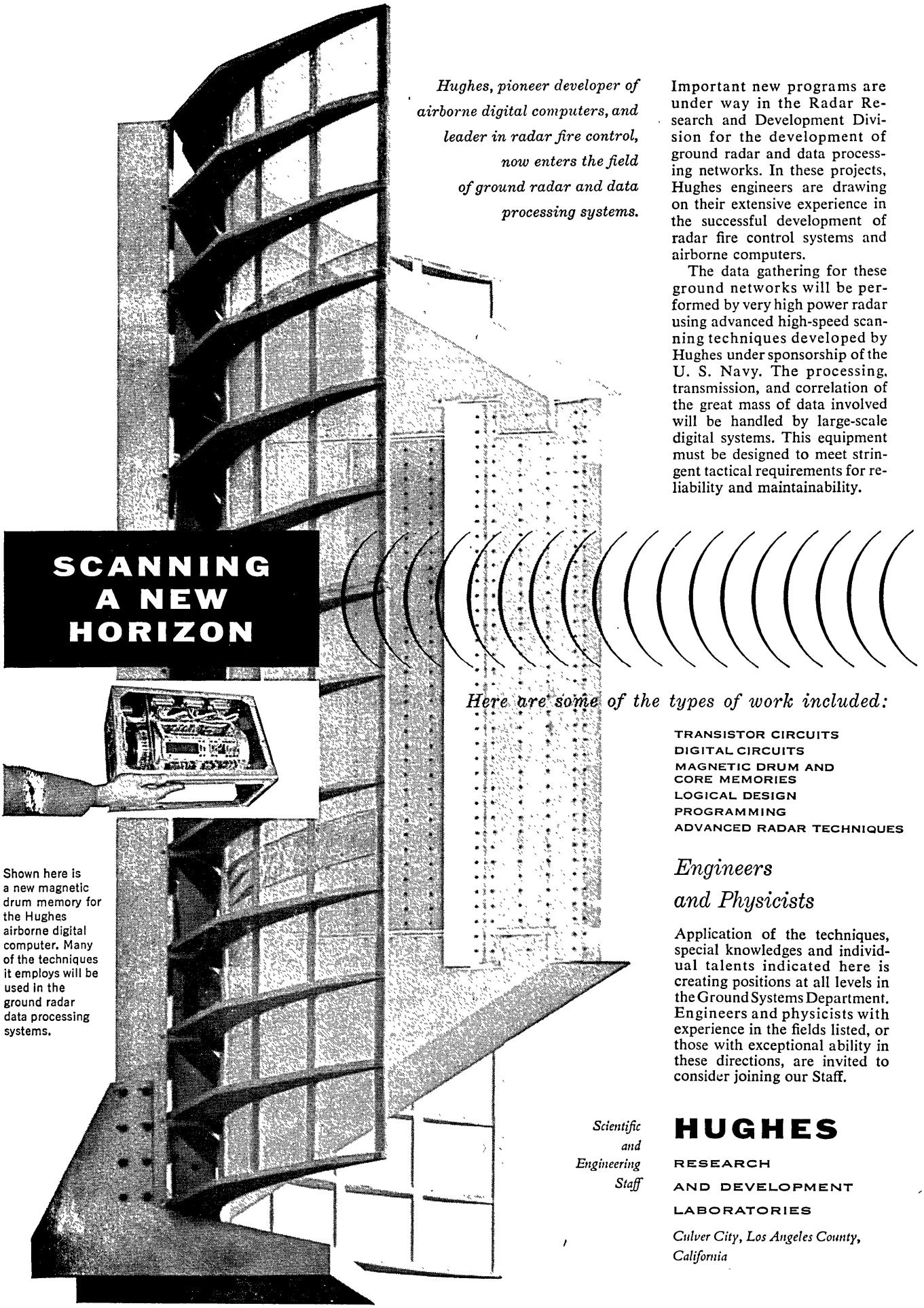

SCANNING A NEW HORIZON

Hughes, pioneer developer of airborne digital computers, and leader in radar fire control, now enters the field of ground radar and data processing systems.

Important new programs are under way in the Radar Research and Development Division for the development of ground radar and data processing networks. In these projects, Hughes engineers are drawing on their extensive experience in the successful development of radar fire control systems and airborne computers.

The data gathering for these ground networks will be performed by very high power radar using advanced high-speed scanning techniques developed by Hughes under sponsorship of the U. S. Navy. The processing, transmission, and correlation of the great mass of data involved will be handled by large-scale digital systems. This equipment must be designed to meet stringent tactical requirements for reliability and maintainability.

Shown here is a new magnetic drum memory for the Hughes airborne digital computer. Many of the techniques it employs will be used in the ground radar data processing systems.

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36 West 11 St., New York 11, N.Y.

1. What is "COMPUTERS AND AUTOMATION"? It is a monthly magazine containing articles and reference information related to computing machinery, robots, automatic controllers, 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 $4.50 a year in the United States. Single copies are $1.25. 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 1400 subscribers (as of Apr.10); over 300 purchasers of individual back copies; and an estimated 2000 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 April issue was 2200 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.

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

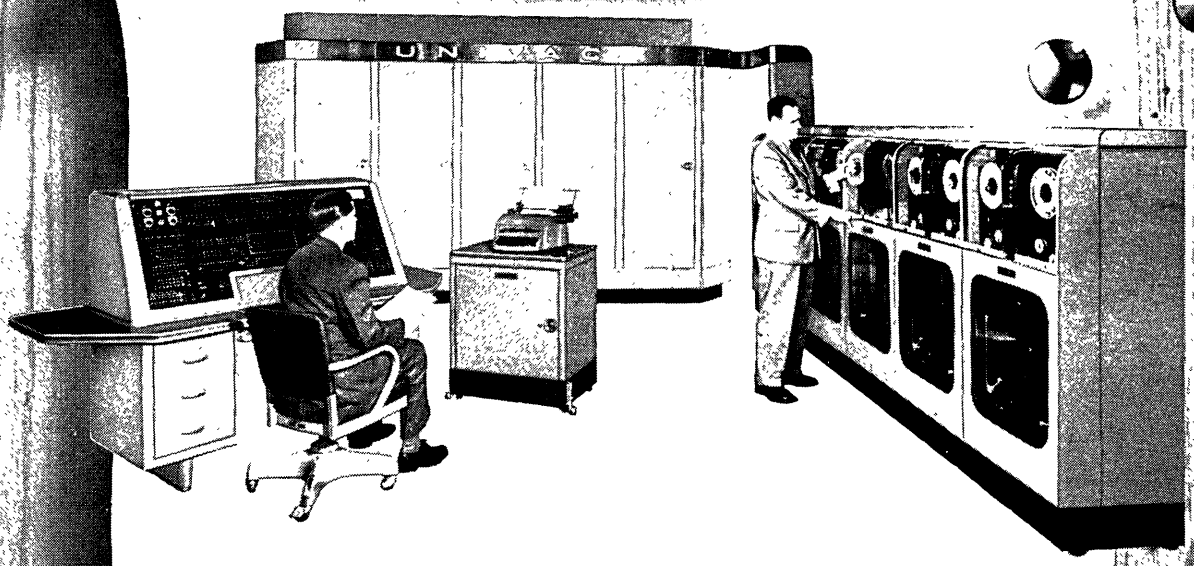
Display advertising is sold in units of full pages (ad size 7" x 10", basic rate, $170) and half pages (basic rate, $90); back cover, $330; inside front or back cover, $210. Extra for color red (full pages only and only in certain positions), 35%. Two-page printed insert (one sheet), $290; four-page printed insert (two sheets), $530. Classified advertising is sold by the word (50 cents a word) with a minimum of ten words. We reserve the right not to accept advertising that does not meet our standards.

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

The Austin Co.
Automatic Electric Co.
Burroughs Corporation
Cambridge Thermionic Corp.
Federal Telephone and Radio Co.
Ferranti Electric Co.
Ferroxcube Corp. of America
General Ceramics Corp.
General Electric Co.
Hughes Research and Development Lab.
International Business Machines Corp.
Laboratory for Electronics
Lockheed Aircraft Corp.
Logistics Research, Inc.
Machine Statistics Co.
Monrobot Corp.
Norden-Ketay Corp.
George A. Philbrick Researches, Inc.
Potter Instrument Co.
Raytheon Mfg. Co.
Reeves Instrument Co.
Remington Rand, Inc.
Sprague Electric Co.
Sylvania Electric Products, Inc.
Telecomputing Corp.

REMINGTON RAND

UNIVAC



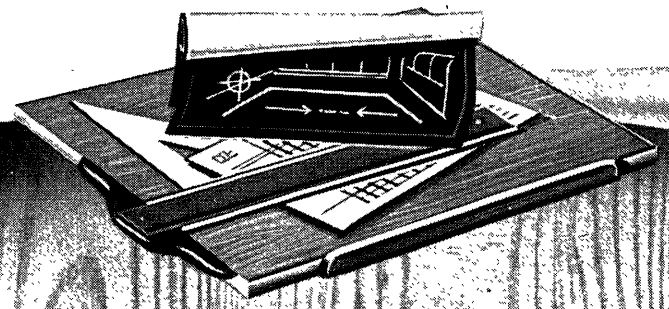
Not on the Drawing Board, Not "On Order"...

IN ACTUAL BUSINESS USE!

The Remington Rand Univac is the *only* completely self-checked electronic data-processing system now being delivered ...the only one actually proven in business use. No comparable system handles alphabetic and numeric data to turn out payrolls, control inventories, and perform the other down-to-earth routine tasks vital to American industry.

In today's competitive market, the company which cuts its overhead *first* comes out on top. Univac is already at work in many organizations, so don't wait until 1956...1957...or 1958 to cash in on the tremendous savings available with this large-scale electronic business system. The time to act is *now*, to prevent your lagging perilously behind competition in the years to come.

There's no need to wait for equipment which is "just around the corner." Read why, in an impartial article on electronic computing for business, written by management consultants of a nationally known public accounting firm. Write to Room 1562, at the address below, for your free copy of this informative survey, "Electronics Down To Earth."



Remington Rand INC

Electronic Computing Department • 315 Fourth Avenue • New York 10

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? We reserve the right not to accept advertising that does not meet our standards.

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).

Automatic Electric Co., 1033 W. Van Buren Street, Chicago, Ill. / Relays / page 2 / CA No. 33

Berkeley Division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif. / Help Wanted / page 39 / CA No. 34

Berkeley Enterprises, Inc., 36 West 11 St., New York 11, N. Y. / Geniac, Publications / pages 42, 45 / CA No. 35

Computers and Automation, 36 West 11 St., New York 11, N. Y. / Back Copies, Advertising, Reply Form / pages 46, 48, 50 / CA No. 36

Electronics Corp. of America, 77 Broadway, Cambridge 39, Mass. / Help Wanted / page 41 / CA No. 37

Ferranti Electric Inc., 30 Rockefeller Plaza, New York 20, N. Y. / Miniature Rapid Access Magnetic Drum / page 43 / CA No. 38

Hughes Research and Development Laboratories, Culver City, Calif. / Help Wanted / page 47 / CA No. 39

Lockheed Aircraft Corp., Burbank, Calif. / Career Opportunities / page 5 / CA No. 40

Monrobot Corporation, Morris Plains, N. J. / Components / page 51 / CA No. 41

Raytheon Mfg. Co., Foundry Ave., Waltham, Mass. / Binary-Octal Calculator / page 45 / CA No. 42

Remington Rand, Inc., 315 4th Ave., New York 10, N. Y. / Univac / page 49 / CA No. 43

Remington Rand, Inc., ERA Division, 1902 W. Minnehaha Ave., St. Paul, Minn. / Help Wanted / page 43 / CA No. 44

Republic Aviation Corp., Farmingdale, L.I., N.Y. / Help Wanted / page 41 / CA No. 45

Sprague Electric Co., 377 Marshall Street, North Adams, Mass. / Miniature Pulse Transformers / page 52, back cover / CA No. 46

Sylvania Electric Products, Inc., Missile Systems Laboratory, 151 Needham St., Newton, Mass. / Help Wanted / page 39 / CA No. 47

If you wish more information about any products or services mentioned in one or more of these advertisements, you may circle the appropriate CA No.'s 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.

* * *

REPLY FORMS: Who's Who Entry; Reader's Inquiry

Paste label on envelope:↓ Enclose form in evelope:↓

4¢ Postage Will Be Paid By ---

BERKELEY ENTERPRISES, INC.
36 West 11th Street
New York 11, N. Y.

BUSINESS REPLY LABEL
NO POSTAGE STAMP NECESSARY IF MAILED IN THE UNITED STATES

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

IDENTIFICATION

Name (please print) . . . . . .

Your Address? . . . . . .

Your Organization? . . . . . .

Its Address? . . . . . .

Your Title? . . . . . .

WHO'S WHO ENTRY FORM

YOUR MAIN COMPUTER INTERESTS?

( ) Applications ( ) Electronics ( ) Sales
( ) Business ( ) Logic ( ) Other (specify):
( ) Construction ( ) Mathematics
( ) Design ( ) Programming

College or last school? . . . . . .

Year entered the computer field? . . . . . Year of birth? . . . . . .

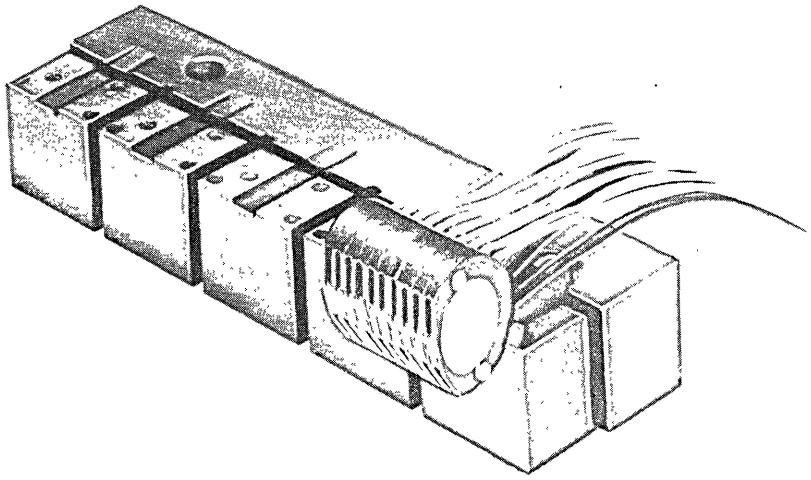
Occupation? . . . . . Anything else? (publications, distinctions, etc?)

. . . . . .

READER'S INQUIRY FORM

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

| | | |



A bank of Monrobot Ring-type Heads on adjustable mounting

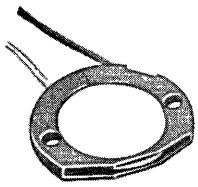
MONROBOT COMPONENTS

Researched and Developed for the Electronics Field

Monroe, for many years a leader in the design and production of desk calculators, is devoting its experience and research facilities to developing not only digital electronic computers but also component parts that are unique for their originality of design and numerous advantages.

The components, illustrated here, are Monrobot Ring-type Read/Record Heads and an adjustable fixture for magnetic drum memory systems.

Monrobot Read/Record Head assemblies have a place in any magnetic storage or arithmetic drum system. Their advantages are many. They are small and compact. Their mounting design permits accurate placement with a minimum of costly machining. When assembled and mounted they permit fine, accurate adjustments both parallel and perpendicular to the drum. They are ruggedly built to last. In their pre-engineered, precision mounting they cost less than similar unmounted head stacks; also replacement of a single head is easily made.



Monrobot Ring-type Head — small, compact

Monrobot components of this kind offer the user of electronic equipment many worthwhile benefits. There's a lot to the Monrobot component story that's worth investigating. Inquiries are invited.

MONROBOT

MONROE CALCULATING MACHINE COMPANY

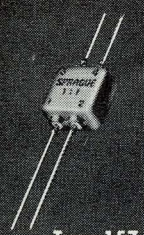
MONROBOT LABORATORY

MORRIS PLAINS NEW JERSEY

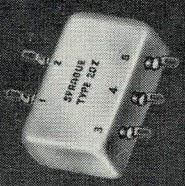
choose from this complete line of

MINIATURE PULSE TRANSFORMERS

Type 10Z
tubular pulse transformer



Type 15Z
miniature bathtub pulse transformer



Type 20Z
drawn-shell bathtub pulse transformer

Type 41Z
cylindrical pulse transformer

NOW YOU CAN CHOOSE from eighteen standard pulse transformers in four major construction styles, all in quantity production at Sprague. The standard transformers covered in the table below offer a complete range of characteristics for computer circuits, blocking oscillator circuits, memory array driving circuits, etc.

These hermetically sealed units will meet such stringent military specifications as MIL-T-27, and operate at temperatures up to 85°C. Special designs are available for high acceleration and high ambient temperature operation. In addition, the electrical counterparts of each transformer can be obtained in lower cost housings designed for typical commercial environment requirements.

Complete information on this high-reliability pulse transformer line is provided in Engineering Bulletin 502A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 377 Marshall Street, North Adams, Massachusetts.

ELECTRICAL CHARACTERISTICS OF SPRAGUE PULSE TRANSFORMERS

Type No.	Turns Ratio	Pulse Width μ seconds	Rise Time μ seconds	Primary Inductance	Leakage Inductance	Repetition Rate	Load and Output	Typical Applications
10Z1	5:1	0.1	0.04	200 μH	5 μH	1 to 2 MC	15 volts 100 ohms	Used in digital computer circuitry for impedance matching and inter-stage coupling. Pulses are of sine wave type.
10Z2	4:1	0.07	0.03	200 μH	20 μH	1 to 2 MC	20 volts 100 ohms	
10Z3	1:1	0.07	0.03	125 μH	12 μH	1 to 2 MC	20 volts 200 ohms	
10Z4	3:1	0.07	0.03	160 μH	15 μH	1 to 2 MC	20 volts 100 ohms	
10Z6	4:1	0.1	0.04	200 μH	6 μH	1 to 2 MC	17 volts 100 ohms	
10Z12	1:1	0.25	0.02	200 μH	2 μH	12KC	100 volts	Blocking Oscillator
10Z13	1:1	0.33	0.07	240 μH	2 μH	2KC	50 volts	Blocking Oscillator
10Z14	7:1:1	0.50	0.05	1.2 mH	20 μH	1MC	25 volts	Impedance Matching
15Z1	3:1	5.0	0.04	7.5 mH	22 μH	10 KC	10 volts 100 ohms	Impedance Matching and Pulse Inversion
15Z2	2:1	0.5	0.07	6 mH	15 μH		40 volts	Blocking Oscillator
15Z3	5:1	10.0	0.04	12 mH	70 μH	10 KC	10 volts	Impedance Matching
15Z4	1:1.4	6.0	0.1	16 mH	15 μH	0.4 KC	15 volts	Blocking Oscillator
20Z1	5:5:1 Push-Pull	1.5	0.25	4.0 mH	0.3 MH		5 volts 10 ohms	Memory Core Current Driver
20Z3	6:1	1 to 4	0.22	18 mH	0.8 MH	250 KC (max.)	21 volts 200 ohms	Current Driver
20Z4	6:1:1	1 to 7	0.25	55 mH	0.3 MH	50 KC (max.)	22 volts 400 ohms	Current Driver and Pulse Inversion
20Z5	3.3:3.3:1 Push-Pull	2.4	0.2	2.8 mH	0.2 MH		2.5 volts 6 ohms	Memory Core Current Driver
20Z6	11:1	6.0	0.2	90 mH	0.2 MH	50 KC (max.)	10 volts 75 ohms	Current Transformer
41Z1	7:1:1	0.50	0.05	1.2 mH	20 μH	1 MC	25 volts	Impedance Matching

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

SPRAGUE® WORLD'S LARGEST CAPACITOR MANUFACTURER

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