COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

Question
... Isaac Asimov

Computers and Weather Prediction
... Bruce Gilchrist

Random Numbers and Their Generation
... Gordon Spenser

Problems Involved in the Application of Electronic Digital Computers to Business Operations
... John M. Breen

Computers to Make Administrative Decisions?
... Hans Schroeder

Components of Automatic Computing Machinery — List of Types (cumulative)

Automatic Computers — Estimated Commercial Population (cumulative)

Vol. 4
No. 3

MARCH
1955

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"Simple Electric Brain Machines and How to Make Them" by Edmund C. Berkeley, to be published by Berkeley Enterprises, Inc. in March, 1955, 64 pp. -- Describes over 25 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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COMPUTERS AND AUTOMATION

CYBERNETICS • ROBOTS • AUTOMATIC CONTROL

Vol. 4, No. 3 March, 1955

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THE EDITOR'S NOTES

REFERENCE INFORMATION

Two more kinds of reference information appear for the first time in this issue of COMPUTERS AND AUTOMATION: "Components of Automatic Computing Machinery -- List of Types" and "Automatic Computers -- Estimated Commercial Population". We hope these pieces of reference information will be useful to our readers. As always, we shall much appreciate comments, additions, and corrections; in any compilation there is no way of being completely right the first time, and every compilation requires negative feedback, adjustment to error.

WHO'S WHO IN THE COMPUTER FIELD

Considerable progress is being made in the organization of the "Who's Who in the Computer Field" scheduled to be published in "The Computer Directory, 1955", which is the June issue of COMPUTERS AND AUTOMATION. We have had punch cards made showing the name, company, street address, city, and state for some 6000 names on various lists of computer people. There are duplicates between these lists; the proportion of duplicates seems to be about one quarter. About March 1 we shall send out a mailing with reply cards to all these names in order to obtain Who's Who information for the directory.

Another use for this punch card file will be that it will be possible for us to furnish the Joint Computer Conference Committee of the Association for Computing Machinery, the Institute of Radio Engineers, and the American Institute of Electrical Engineers, with mailing labels produced by punch card machines for mailing meeting announcements to every person who has attended a recent computer meeting or who has otherwise demonstrated his real interest in automatic computers.

There will be other ways besides whereby this punch card file of computer people's names and addresses can be made available on a proper basis to the general advantage of computer people.

COMPUTER DIRECTORY -- SECOND NOTICE

The June, 1955, issue of "Computers and Automation" will be a "Computer Directory". The present plans in regard to this directory issue are as follows.

Part 1 of the directory will be the second edition of "Who's Who in the Computing Machinery Field" which we published in 1953-54. It will contain names and some information about all persons whom we know of or can find who are really interested in computers. Entries will be free. If there are 4000 such persons and 80 entries to a page, this part of the directory will be 50 pages long.

If you are "really interested in computers" and desire to have an up-to-date entry for you in this directory, please send us your name and address and ask for a who's who entry form, or else complete the "Identification" and "Who's Who Entry Form" in the style that is published in the magazine (see page 42, and send the entry form to us.

Part 2 of the directory will be a cumulative "Roster of Organizations in the Computing Machinery Field" based on the roster regularly published in "Computers and Automation", with entries expanded to some extent. Entries in this roster will also be free, in order that it may be as complete as possible. This part of the directory may be 20 pages long. If you know of any changes, additions, or corrections, which should appear in the Roster of Organizations which we publish, we would be grateful to you for sending them to us.

Part 3 of the directory will be the first edition of "The Computing Machinery Field: Products and Services For Sale". It will be a compendium of descriptions, pictures, etc., of machinery, systems, components, services, etc., for computing and data-handling. Organizations are invited to submit descriptions of their products and services for inclusion in this part, at an advertising cost substantially less than our regular advertising rates; if the description fits exactly with editorial requirements, and can be photo-offset as it stands, the cost is still less. Details are available on request. It is anticipated that 50 to 150 pages of information, descriptions, and advertising may make up this part.

If you are the sales director or advertising director of an organization having any such products, please send us (1) your name, title, organization, and address, (2) total number of different products and services that you would like to have mentioned or described in this compendium, and (3) a list of the names or identification of such products and services. We will then send you entry forms for reporting their particulars. At least some of the

(continued on page 30)

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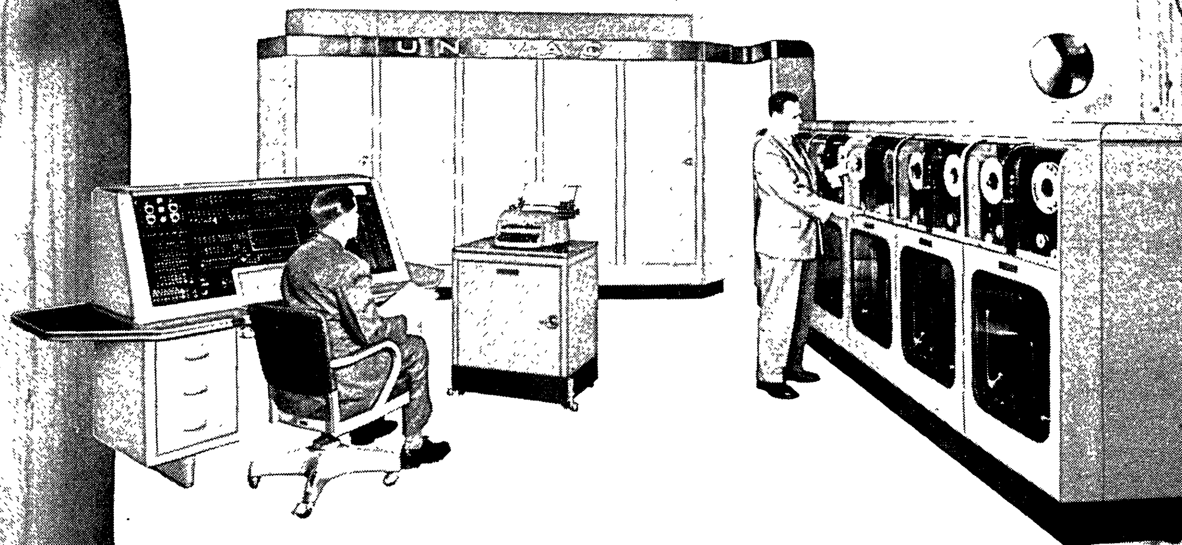

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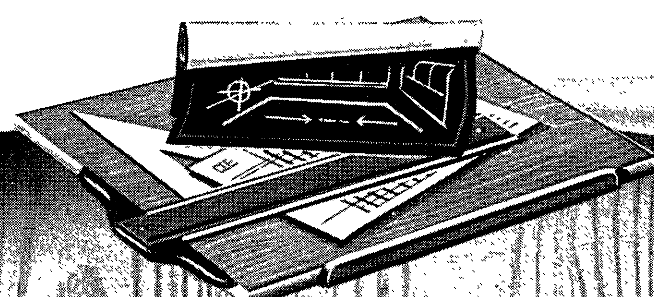

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QUESTION

Isaac Asimov
Waltham, Mass.

The corridors within Multivac were commodious and well-ventilated. There were even nooks where a technician could pause to eat his sandwich and pour a hot cup of coffee for himself out of his thermos bottle.

But Ben LeLancey was always a bit uneasy when he interrupted a hard day in that manner.

"It doesn't seem right," he muttered. "I get the feeling Multivac is staring down at me and doesn't like it."

Joe Cialli, who was an old hand as computer technician and who could actually remember the days before Multivac could talk, found statements like that revolting.

He said, "The trouble with you, Ben, is that you let size impress you." He moved his hand in an upward, crossward arc. "Nothing. Just size. Just a billion tubes, two billion relays, four billion circuit-complexes, and--nothing. In here," and he tapped his forehead gently, "everything."

"I know that," said Ben, troubled. He looked about him. He didn't see the end of Multivac in either direction. It was half a mile long, a quarter of a mile thick, five stories high. It was the world repository of all knowledge. The Library of Congress was all but obsolete. The smallest junior college, any village factory for buttonhooks, could plug into it and learn whatever could be learned. Problems in economics and sociology that were too complicated for a generation of scientists even to approximate were solved by Multivac in a matter of minutes.

Joe watched Ben's eyes and seemed to read his mind without trouble. "Sure," he said, "it solves problems. But only when we set up the proper relationships, feed in the pertinent data, adjust the circuits for necessary correlations. After that, it's just electrons following lines of least resistance."

"What more is the human brain?" demanded Ben, challengingly.

"Ah, but the brain isn't half a mile long. It fits in one skull. And the human brain can create. A human brain wrote "Hamlet" and human brains built Multivac. There's no comparison. A machine is no more than a machine, whether it's a lever or Multivac."

They sat on little stools, their backs against the smooth wall of the resting recess. All about them were the glowing indicators, whose ever-changing pattern of light acted as guide-spots to the immensely complex electron-flow that twisted and writhed within Multivac's vast interior.

Multivac was "on its own" now; that is, no question was being put to it, or would be put to it for some time. It was making correlations at random.

Ben stared at the steam curling up lightly from his coffee and thought of that. He said, "It's awfully quiet, today."

"No correlations, I suppose," said Joe, indifferently.

"I don't like it when it's on its own. I keep wondering: What's it doing? What's it thinking about?"

"This is your problem, not Multivac's. Random correlations. What's mysterious about it? It's like giving a person so many hours a day off his job in order that he might spend his time thinking quietly."

"All right. You admit Multivac can think."

Joe Cialli snorted. "Just a metaphor, Ben. It happens not to be thought in any literal sense. When you throw in the random correlation circuit, all you're doing is letting the electron flow be determined by the chance effects of thermal noise. Throw the dice and see what turns up; turn the kaleidoscope and watch the design; set twenty million billion monkeys to work on twenty million billion typewriters---"

And as though on cue, Multivac's quiet, resonant voice filled the corridor. It said: "GEORGE...WASHINGTON...WAS...FATHER...OF... HIS...COUNTRY...BUT...HAD...NO...CHILDREN."

Joe laughed and the echoes of his mirth rasped sacrilegiously against Ben's ear.

Ben said, "Stop that, Joe."

Joe subsided to a grin. "It's funny, isn't it? Why not laugh? There's your example of random correlation for you. Multivac had the datum that George Washington is called

'Father of his Country'. He also had the datum that Father George had no children. He put the two together."

"And sounded surprised," said Ben. "It seemed an incongruity to him. He's been thinking about it."

"You're hopeless," said Joe. "Multivac can't sound surprised. His voice isn't fitted for inflection. And he can't think. He just correlated two statements containing an element of contradiction and therefore connected them with the conjunction 'but.' He just made a special case of the statement: "a but not a." He looked at his watch. "Well, fifteen minutes more and he's off his own. Back on informational utility and then you can stop worrying." He yawned.

But Ben put his elbows on his knees and buried his chin in the palm of one hand. "He's too quiet. That's the only thing he's said. After all, he's getting bigger all the time. More circuits. More data. More refinements. When he started, he could accept data only when it was reduced to a binary puncture pattern. He could only give out answers in the same way. Then it could print words instead of having to make patterns. Then it could throw words on a screen. Now it can speak words in any of ten languages, and it can accept spoken data."

"What of it?"

"How much bigger, how much more complex, before it becomes alive. At what moment will it stop being a machine and become a person? There must be some boundary line."

"You're being metaphysical. You might as well ask when can a piano compose its own symphony, just because it is being tuned to greater and greater perfection."

Ben stared again at all that magnificance of complexity about him, of which he could see only an inner skin. All those millions of tons of matter, so carefully designed--- Surely, there could come a point when machine was too feeble a word.

Multivac remained quiet. Usually, its time "on its own" was a medley of odd scraps of information, off-hand correlations, occasionally a startling conjoining of isolated facts that set human scientists busily and excitedly to work.

But now, only that casual remark about George Washington. Nothing more.

Ben thought uneasily: It's meditating. It's deep in thought about something.

He shook himself to break the mood.

Joe Cialli got heavily to his feet. He said, "How could you ever tell it was alive, anyway? What would be the magic giveaway?"

Ben said, "Well, let's throw Multivac off its own and into informational." (He would be relieved to do this, and even more relieved when his week's session of interior duty would come to an end and he could take his place outside the mach----the thing, whatever it was.)

They walked to one of the main section levers and made certain it was in series-lock so that its shift from one main circuit to another would simultaneously shift circuits in every one of the hundred other main sections.

Ben lifted his hand, and midway in the gesture, froze.

Multivac spoke again!

The words tumbled grandly down the corridor, echoed back, and sounded again, while Ben and Joe stared white-faced at one another. And then Joe reached for the lever, managed to hook his fingers about it and ram it home.

The voice of Multivac cut off.

But Ben could still hear it.

He could hear Multivac saying, over and over, till cut off:

WHO...AM...I.........WHO...AM...I....... WHO...AM...I.........WHO...AM...I.........WHO ....

- END -

Computers and Weather Prediction

Bruce Gilchrist
Institute for Advanced Study
Princeton, N. J.

During the past few years there has been considerable and growing interest in the application of high speed computing machines to the problem of weather prediction. Numerical weather prediction has in fact become now an important part of meteorology besides providing an important group of users of electronic computing machines.

The pioneer in numerical weather prediction was a British physicist, Lewis Richardson, who, around 1920, suggested a comprehensive method of preparing weather forecasts by numerical means. Despite the failure of the examples given, his book describing the system went a long way toward laying the foundations of modern numerical forecasting. Richardson's failure was probably due to his being too ambitious and being too far ahead of other branches of meteorology. Having no conception of an electronic computing machine Richardson envisaged a myriad of hand computers in order to man his dream of a numerical forecasting center. A quarter of a century had to pass before a serious attempt was made to convert this dream into reality.

This second birth of numerical weather prediction owes much to John von Neumann, whose interest in computing machines as well as numerical weather prediction led to the formation of a meteorology group as part of the Electronic Computer Project at the Institute for Advanced Study (IAS). This group, led by Jule Charney, produced in 1950 the first reasonably successful numerical forecasts. These forecasts were made using the ENIAC. It was not until the spring of 1952 that the IAS machine was first used. Since then, however, the meteorology group has been a major user of the IAS machine and has played a major rôle in developing new and improved forecasting methods. In addition to using its own machine the IAS has also made some forecasts using an International Business Machines Type 701 computer.

Following the success of the early Princeton forecasts several other groups of researchers became interested in the problem. While up to the present none of these groups has had such easy access to a computing machine as the IAS group has had, several have been able to use electronic computers. In this country a group at the Air Force Geophysics Research Directorate's Cambridge Research Center has made a fairly long series of forecasts using an IBM 701 computer. The U. S. Weather Bureau has also made some experimental forecasts using a Remington Rand 1103 (Univac Scientific) computer. In Europe a group at the University of Stockholm has made forecasts using the BESK, and in England the Meterological Office has made forecasts using LEO.

These experimental forecasts made during the past four years have so encouraged the U. S. Government that a joint Air Force and Navy, Weather Bureau unit has been set up in Washington to test numerical weather prediction on a routine basis. This unit is expected to start producing daily predictions in the spring of 1955 using an IBM 701 computer. This will be the first computer devoted full-time to meteorological problems. The establishment of this unit should not be regarded as indicating that all or indeed most of the problems of numerical forecasting have been solved. Rather it marks the acceptance of the numerical method as a valid forecasting tool and a decision to judge its worth by extensive use, in the course of which many refinements and, we hope, major improvements will be made.

While it is a comparatively easy task to write down in general terms the mathematical equations governing the motions of the earth's atmosphere, it is an entirely different problem to solve them. Not only are the differential equations highly non-linear, the boundaries of the atmosphere highly irregular and the relative importance of many atmospheric processes not known, but there is also the difficulty that we can never observe exactly what the atmosphere is doing at a particular moment in time. It is furthermore sometimes suggested that since the motion of the atmosphere is generally in an unstable state, it is fundamentally impossible to predict its motions. While this may be true in particular cases, the results to date would seem to disprove the generality of this suggestion.

The first task of the numerical forecaster is therefore to reduce the problem itself to a more tractable form. This involves making many simplifying assumptions which in comparison with some other physical sciences may appear very great and perhaps even arbitrary. For instance, the earth is assumed to be flat, though still rotating, all motions are assumed adiabatic, and small scale phenomena such as wind gustiness are neglected. It almost goes without saying that the differential equations are linearized. These assumptions can only be justified by the results which to date have fortunately been most encouraging for forecast periods up to twenty-four hours.

All numerical forecasts made up to the present time have been for comparatively small areas of the earth's surface and with only very limited definition in the vertical. Using the results of these experiments it is of interest to estimate the characteristics of a computing machine of sufficient size to produce routine weather predictions over the whole Northern Hemisphere. Let us assume that we require a definition of approximately 200 kilometers in the horizontal and 200 millibars in the vertical. To cover the whole Northern Hemisphere with such a grid would require approximately 28,000 grid points. We further assume that the method to be used will be sufficiently similar to the present ones to allow certain time comparisons to be made and that a period of 1/2 hour will be allowed for the preparation of a 24-hour forecast.

On the basis of experience we must allow for the storage of at least four quantities per grid point, each quantity to a significance of at least 12 binary digits. Our machine will thus require a storage medium for approximately 112,000 words of at least 12 binary digits each. If suitably arranged, this storage could be made partly of high speed storage as provided by an electro-static or magnetic core memory, and partly of auxiliary storage such as magnetic drums and tapes. Although some present machines have this capacity, their rates of access to this data are not fast enough. The storage problem is then not one of capacity, but rather one of finding a storage medium with a sufficiently fast access time.

Again relying on our past experience we must allow the time equivalent of at least 50 multiplications per grid point per time step. This time covers the logical operations, additions, and such like as well as the actual multiplications involved in the computations. Thus if we require 48 half-hour time steps for a 24-hour forecast, we will have to take the time equivalent of 67×10^6 multiplications. Thus if the total time allowed is a half hour, the machine must have a multiplication time of approximately 30 microseconds. This is approximately ten times faster than that obtainable with nearly all present machines. This also implies a corresponding improvement in all other operations of the machine including the access time to the memory. Such an increase of speed will require considerable further research and development before it is widely attainable.

These rough calculations do not take into account any meteorological refinements which we will undoubtedly want to add to the present forecasting models in order to increase their accuracy. They also do not take into account the time which may be required to process the input data, that is, the time required for applying some objective method of analyzing the initial data, which comes from a widely distributed set of observing stations, in order to produce data suitable for the forecasting system. The estimates may, however, indicate that the computing problem met with in the forecasting problem is a great one, and we have not, as yet, computers available to tackle it in its entirety. This is not to say, of course, that our present computers cannot be of very great use. They are, in fact, probably still ahead of our meteorological knowledge.

Note: After the foregoing was written, announcement of the Naval Ordnance Research Computer (NORC) shows that it has characteristics which approach the requirements of meteorological forecasting. While its arithmetical speeds are very good, actual coding experience will determine whether or not the limited electrostatic storage plus the high speed tapes can supply sufficient rapid access memory.

- END -

————————————*

Forum

COMPUTER "THINKING"

Francis T. Chambers,
Applied Science Corporation of Princeton,
Princeton, N. J.

A charter but non-vocal subscriber to "Computers and Automation", I am finally compelled to express myself, first in relief on reading Mr. Chauvenet's rebuttal to Mr. Rosenthal's "The Capacity of Computers Not to Think" which, with its a priori definition of thinking as a human process, its anthropomorphically weighted vocabulary ("flash of intuition", "passion", "... heart desires", etc.!) and its illogical arguments, was the worst example of its kind that I have come across in print in a long time. I was surprised that he omitted to state that if the creator had wanted us to have thinking machines, they would have been mentioned in the Bible.

I would suggest, though, that a kernel of thought exists in Rosenthal's article, which is that an "uncomfortable" or unbalanced situation, combined with a built-in urge toward balance is the gestalt required as a basis for thinking as he would like to have it defined: viz, servomechanisms, the homeostat, etc.

- END -

Random Numbers and Their Generation

Gordon Spenser
Whippany, New Jersey

Many people have an intuitive concept of a set of random digits, a random selection of the digits 0, 1, 2, 3, up to 9, repetitions allowed. The term "random" implies that, if one has a sequence of digits which are allegedly random, the next digit cannot be predicted. Some further reflection would indicate the additional requirement that, in fact, any one of the ten possible digits should have an equal chance of occurring. Granting this, it follows that all numbers, 00, 01, ..., 98, 99, are equally likely when a sequence of random digits are considered pairwise. If someone, whom we might call John Jones, were asked to write down 200 random digits, he would probably try to make the ordering of the individual digits "random" to the point of excluding successive repetitions like 00, 11, 22, ..., 99. But even if Jones did not do this, it is likely that the sequence he wrote down would be unsatisfactory because it would be "too random".

What can be too random in a sequence of random numbers? It is not unreasonable to assume that Jones would pay careful attention to the fact that one would expect and desire approximately equal frequencies of each digit. In fact, he would likely write down 200 digits, examine them, and then change some digits in order to achieve 10 per cent 0's, 10 per cent 1's, etc. Now it may be shown mathematically that the chance that 200 digits, selected at random, should result in precisely 10 per cent of each of the ten possible values is about 1 in 1,000,000,000. Approximately equal frequency is expected; but absolutely equal frequency is a very rare event, and would be "too random".

Tests of Randomness

Various tests have been proposed for testing the randomness of a sequence of digits. The five most common types of tests are the frequency, serial, run, gap, and poker tests.

The frequency test is the simplest; it is almost self-explanatory. It consists simply of examining the discrepancy between the observed frequency of each of the ten digits and the theoretical frequency equal to 10 per cent of the total number of digits. The frequency test, as well as the other tests described below, is failed if the discrepancies are too large, or too small.

Serial tests examine the digits for any selective tendency for one digit to follow another.

The run test looks for significant departures from the theoretical in the frequency with which one digit is repeated 1, 2, 3, ... times in succession.

In the gap test the digits are scrutinized for the agreement of the length of the gaps between repetitions of the same digit. Thus the sequence 5 2 8 3 5 5 6 2 has a gap of three between the first and second 5's, a gap of six between the 2's and a gap of zero between the second and third 5's.

Finally, the poker test groups the digits into subsets of five and then compares the resulting distribution of poker hands with the theoretical. Possible poker hands, with illustrative sets of digits, are:

1. All different - 8 9 2 5 1
2. One pair - 3 6 3 1 2
3. Two pairs - 7 7 9 3 9
4. Three of a kind - 0 4 9 0 0
5. Straight - 6 4 7 5 8
6. Full house - 1 3 1 1 3
7. Four of a kind - 5 2 5 5 5
8. Five of a kind - 6 6 6 6 6

A flush is not possible.

Exactly how these tests decide whether a sequence of digits is random or not random is technical and outside of the scope of this discussion.

The Need for Random Digits

An example of the use of random digits appears in recent work to create a mathematical theory which would describe the spread and propagation of rumors within a closed, isolated community. One of the assumptions made is that each individual to whom the rumor has been imparted has a circle of acquaintances to some of whom he will, in turn, repeat the rumor. If one of these acquaintances hears a rumor for the second time, according to the theory he spreads it no further (although, in fact, he may consider this independent verification and spread the rumor with added vigor); but if the acquaintance hears the rumor for the first time, he now becomes the center of another group to which he may transmit the rumor. In this elementary framework, the number of acquaintances to whom the rumor is repeated, as well as the specific individuals involved, are random quantities.

One way of testing the mathematical theory in the laboratory is to simulate the total population of the community by using the memory cells of a computer, and to program the computer to transmit the information from one simulated individual to another. Specifically, several adjacent cells in the storage may refer to a given individual. Contained in the cells are the cell numbers of acquaintances and a "yes" or "no" indication as to whether or not the rumor has reached this point. For simplicity, we will assume each individual to have nine acquaintances.

At some intermediate stage in the program the rumor reaches individual X, say. The indicator is examined first. If it is at the "yes" version, nothing further is done with X. If not, it is changed to "yes" and a random digit is called for. This will indicate the number of acquaintances to whom the rumor is passed. If this digit is p, then p additional digits are obtained to indicate the specific individuals involved, say R, S, U and V.

The program would then store the addresses of R, S, U and V and proceed on to R, where the pattern is repeated. If now Y and Z are produced in this manner at R, they are added to the list behind R, S, U and V, and R is dropped, each other address moving up one place. S is next investigated, and the procedure repeated.

With a finite population, the rate of propagation of the rumor will eventually decrease and die out as more and more people are already cognizant of the information. Upon completion of the simulated problem, one can see how many persons did, or did not, receive the rumor and how long, in some suitable units, it took to spread.

This is but one example of the use of random digits in computation. One may easily conceive of the spread of a neutron chain reaction in an essentially similar manner. Another example may deal with circuits in a transcontinental telephone switching system. Many other possibilities present themselves.

Some problems require relatively few random digits, but others demand many millions. How can they be obtained?

Existing Tables

The first attempts to obtain random digits resulted in producing tables of such digits. The first table of random digits was that published in 1927 by Tippett; it contained 41,600 digits derived from census reports. In 1938, M. V. Kendall and Babington Smith brought forth a table of 100,000 random digits obtained by observing numbers on a spun disk. Other collections followed, the largest being the table produced by the Rand Corp., published last year, having 1,000,000 digits. The Rand table, generated by a physical device, is available on punched cards.

Other sources of random digits have been tried; some have been notably inadequate. Numbers drawn from the London telephone directory showed a deficiency in 5's and 9's. Numbers culled from the latitude and longitude of geographical locations in an atlas were also bad; the distribution of listed locations is not uniform over the globe, but is affected, of course, by oceans, deserts, polar regions, etc.

For modern high-speed computing, where many random digits are needed, it is often uneconomical to reproduce an existing table onto the machine's external, or slow, storage to be used as necessary. The fast, internal storage will rarely be sufficiently large to store all the digits required, along with storing the program and other problem parameters. If, then, needed random digits are not to be quantities generated outside the machine, they must somehow be generated within, and by, the computer.

High-Speed Generation

Random digits may be generated at high speed in a computer in two ways, physically or arithmetically. A physical procedure utilizes some physical device which is made an integral part of the computer. Its output may, for example, be related to the number of cosmic rays detected by a scintillation counter. Practical difficulties are threefold:

1. If the computation is to be checked by repetition, it is necessary to store all the random digits used. Not only would a possibly prohibitively large storage therefore be required, but the original program must then be altered to obtain the random digits from the storage unit instead of from the physical generating device.

2. Even if only a few random digits are required, more would have to be checked in order to insure randomness.

3. The added piece of physical equipment represents additional cost.

Arithmetical generation of random digits, being deterministic, is not in the true sense random. Numbers so generated are usually termed "pseudo-random". It is required that such numbers satisfy certain prescribed tests for randomness, even though one could, given the computing algorithm and the original conditions,

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A Mechanical Analog Computer for Solving Linear Simultaneous Algebraic Equations

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The importance of a machine for solving quickly linear simultaneous algebraic equations in engineering practice may be indicated by pointing out the extent of the problems in which such equations occur. Problems in free vibration, steady forced vibration, and impact may be set up for the complex linear systems as sets of simultaneous linear algebraic equations. Problems in elastic stability may be similarly treated. Statistically indeterminate structures are analyzed in terms of simultaneous algebraic equations. Additional applications in the fields of aircraft wing load distribution, control surface effectiveness, divergence, flutter, and static and dynamic airplane stability have been discussed (1). An electrical machine for solving the simultaneous equations resulting from spectrographic analysis of hydrocarbons has also been discussed (2). Thus, it can be seen that the field of application of linear simultaneous algebraic equations is broad indeed, and knowledge of various rapid methods of solution of such problems may well be of considerable value to a practicing engineer.

This paper describes a mechanical analog computer capable of solving a set of simultaneous linear algebraic equations. A model has been actually constructed; its schematic diagram is shown in Fig. 1, and its picture in Fig. 2.

Consider the set of three simultaneous linear algebraic equations

$$\begin{aligned} A_{11}X_1 + A_{12}X_2 + A_{13}X_3 &= C_1 \\ A_{21}X_1 + A_{22}X_2 + A_{23}X_3 &= C_2 \qquad (1) \\ A_{31}X_1 + A_{32}X_2 + A_{33}X_3 &= C_3 \end{aligned}$$

Although the discussion will be limited to this set of three equations for demonstration purposes, it is equally applicable to systems involving many more equations. It is for systems of ten, twenty, or more equations in fact that computing machines are actually desirable or necessary.

To solve these equations, the computer must perform the following operations: (a) the multiplication of a constant into a variable for each term on the left hand side of Eqs. (1); (b) summing the sets of products for each of Eqs. (1); and (c) equating the sum to the constant terms C_1, C_2, C_3. These arithmetical procedures may be done by mechanical, electromechanical or electronic methods. In the present model, only mechanical equipment is used.

All variable quantities are represented by shaft rotations. Multiplication of a variable by a constant is accomplished by the insertion of an appropriately ratioed gear between the shaft whose turns represent the value of the variable and the shaft whose turns represent the value of the product. The addition of two variable quantities is accomplished by means of a differential gear assembly. In such a unit, the number of turns of the output shaft is the average of the number of turns of the two input shafts. In other words, the number of output turns is one-half the sum of the input turns. This produces in addition a scale change which must be compensated by setting up necessary gear ratios or by interpreting the results obtained from the machine.

The shafts, gears and differentials thus constitute the main elements of the machine. Revolution counters are used on the shafts representing the unknowns and also on the constant term shafts (C_1, C_2, C_3) in order to provide numerical answers and to indicate when the solution has been accomplished.

The schematic diagram of the apparatus necessary for solving Eqs. (1) is shown in Fig. 1. Shafts are indicated by lines; gear ratios, adders and counters are indicated by rectangular blocks. Handcranks for operating the machine are shown with the three constant term counters. In this diagram it will be noted that the X_1 shaft is geared up by means of the ratios A_{11}, A_{21} and A_{31} to provide the three equations of Eqs. (1). The X_2 shaft is similarly geared up to provide the second term products and the X_3 shaft to provide the third term products. In adder (1) one-half the sum of $A_{11}X_2$ and $A_{12}X_2$ occurs. This is converted to the true sum by means of a geared step-up of 2. In adder (2) one half of the sum $A_{11}X_1 + A_{12}X_2 + A_{13}X_3$ occurs. This is also converted to the true sum by a geared step-up of 2. (Actually, the insertion of the geared step-ups at these points is unnecessary and would not ordinarily be done. Instead, an equivalent procedure would be to use $4A_{11}$ as the gear ratio in the X_1 multiplier, $4A_{12}$ in the X_2 multiplier and $2A_{13}$ in the X_3 multiplier. Then, the sum appearing on the summation side of adder (2) will be exactly $A_{11}X_1 + A_{12}X_2 + A_{13}X_3$.) This sum must equal C_1 in accordance with Eqs. (1). Adders (3) and (4) produce $A_{21}X_1 + A_{22}X_2 + A_{32}X_2$ and equate the sum of C_2. Adders (5) and (6) perform a similar operation for the third of Eqs. (1).

In the operating procedure adopted for the model, the machine was driven by cranks on the constant term shafts. The crank on C_1 was operated until its counter registered the value of C_1. The shaft was then locked against turning and the crank on C_2 operated until the value of C_2 appeared in its counter. This shaft was also locked against turning at this time, and the crank on C_3 operated to obtain the value of C_3 in the final counter. The correct values of the unknowns were then read from the X-counters.

The demonstration model is shown in Fig. 2. It is constructed of gears and differentials obtained from war surplus outlets at a small fraction of original cost. Most of the coefficients are built into the unit so that they are not subject to variation. However, two of the coefficients (A_{11} and A_{12}) may be set in gear boxes (shown in back left corner of unit) having four different settings, so that some variation is permitted in the equations, other than that obtained by the unlimited variation possible in the constant term values. Spur-type differentials are used for adding. Hand cranks are shown next to the constant term counters at the front of the unit. The unknowns are registered in the counters on the right.

The values of the coefficients are:

$A_{11} = K, 3K, 4K, 6K$ (adjustable)

$A_{12} = K, 3K, 4K, 6K$ (adjustable)

$A_{13} = -A_{23} = 1A_{33} = 1/(8K)$

$-A_{21} = A_{22} = A_{31} = A_{32} = K$

where $K = 54/110$ (due to odd gear ratios available in surplus property apparatus.)

For purposes of comparing analytical solutions with analog machine solutions, the following set of equations has been solved by both methods:

$$KX_1 + 6KX_2 - \frac{1}{8K} X_3 = 12$$

$$KX_1 + KX_2 - \frac{1}{8K} X_3 = -24$$

$$-KX_1 + KX_2 - \frac{1}{8K} X_3 = -48$$

After setting all counters to zero, the constant term cranks were operated in turn to attain in their respective counters the values of 12, -24 and -48. The readings of the X-counters were then $X_1 = -24.44$, $X_2 = -3.49$, $X_3 = 134.65$. The analytical solution gave the values $X_1 = -24.444$, $X_2 = 134.649$, indicating an accuracy of 2 parts in 3500 for the worst root.

To determine how well zero roots are shown by the machine, the constant terms on the right of Eqs. (2) were changed, respectively, to 100, -100, -100, and solutions obtained both analytically and by means of the analog computer. After turning the input cranks to the above settings, the X-counters were found to read $X_1 = 00000$, $X_2 = 00000$, $X_3 = 392.6$. The analytical solution gives the results $X_1 = 0$, $X_2 = 0$, $X_3 = 392.7$. The accuracy of the machine in this case is 1 part in 4000.

When an attempt is made to solve an incompatible set of equations, the machine locks up and cannot be operated. A simple example of a two-equation system which binds the machine is

$$X_1 + X_2 = 1$$

$$X_1 + X_2 = 2$$

Obviously, these two equations are not compatable.

Comparisons may be made between this machine and some of the other linear algebraic equation solvers. Potentiometric equation solvers are widely used for solving linear algebraic equations because of their simplicity and the low cost of their component parts (2). The iterative method used for solving the equations in this type of computer is a mechanical equivalent of the Gauss-Seidel numerical process. The method requires that the equations be "well-conditioned" to insure the convergence towards a solution.

Electronic simultaneous equation solvers (4) avoid iterative methods but introduce the all too frequent possibility of positive feedback which often limits their usefulness. A digital computer has been designed for the special purpose of solving linear algebraic equations (5). This high-speed machine can handle 300 variables (emphasizing the fact that any good digital computer is better than the best of the analog computers,) and solve problems involving matrix products, Fourier analysis, etc.

For the analog computer discussed in this paper, it can be said that the machine has an advantage over potentiometric types in avoiding the iterative process by solving the algebraic equations directly, simply by turning the constant term cranks to the required values. Positive feedback, the drawback of the electronic simultaneous equation solver, is also avoided, as is the need that the diagonal of the determinant of coefficients must contain the largest coefficients of the rows. The cost of a mechanical computer of the type outlined in this paper, but designed for 10 to 12 variables, would run considerably higher than the potentiometric equation solvers. With n^2 decimal gear boxes (at

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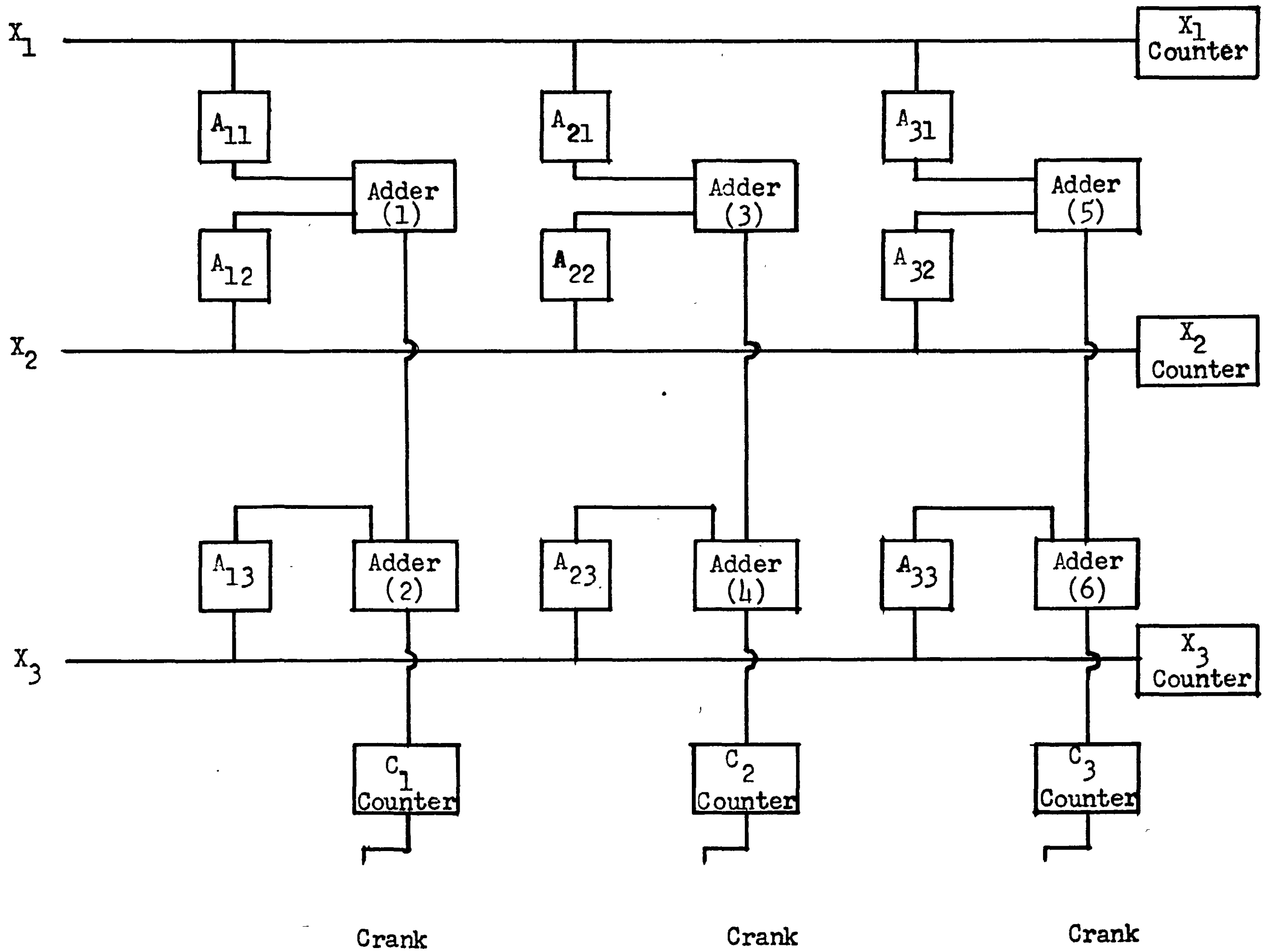

Fig. 1. SCHEMATIC DIAGRAM OF MODEL ANALOG COMPUTER

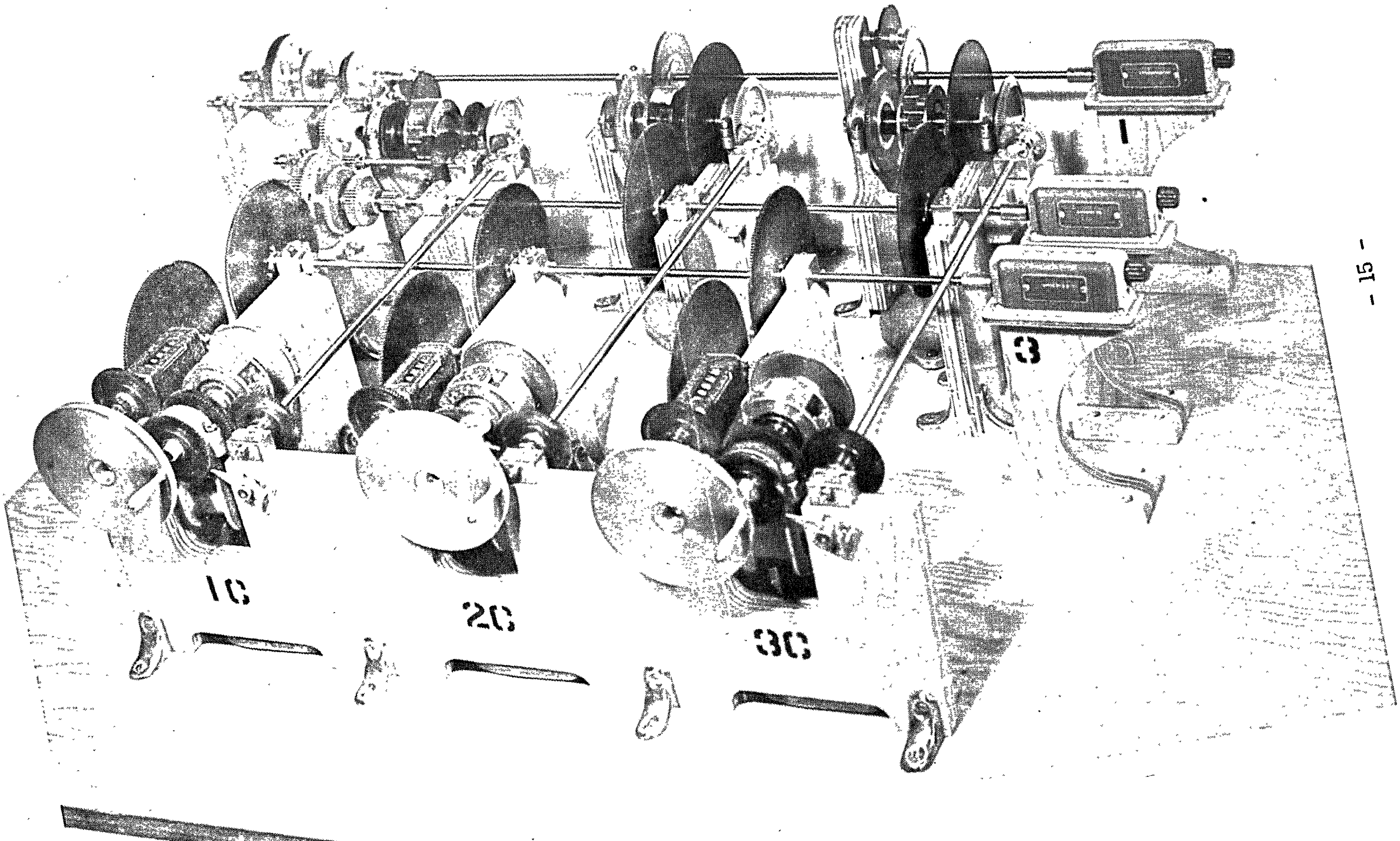

Fig. 2. MODEL MECHANICAL ANALOG COMPUTER

Problems Involved in the Application of Electronic Digital Computers to Business Operations

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(Note: The following consists of three excerpts from an unpublished thesis completed June, 1954 for the degree of master of business administration at the American University, Washington, D. C.)

THE NEED FOR A NEW APPROACH

The possible applications of computers to business can be found to range across a wide spectrum of suitability for computer processing. Because of this, the tasks handled within a firm may involve several levels of difficulty. The applications must be studied individually and in combination to evaluate their suitability for computer processing. Because investment in a computer is large, its efficient use is of prime importance when a choice may be made among several applications.

Such revelations often come as a shock to the businessman who has been led to expect a change in the office through electronics without effort on his part. The severity, duration and effect of the shock will depend on the individual and the thoroughness with which he has investigated the use of computers in business applications. For his own protection he must realize that the computer, as it is today, appears to be the product of the last phase in the development of a "great idea." It seems probable that future developments will tend to be improvements on what is known rather than radical basic discoveries. It has been suggested that the next "great idea" to be explored will be the use of computers in either automation or business data processing.[10] If this is so, the businessman must be ready to play his part by familiarizing himself with computers and reviewing the way data is processed in his office to prepare the way for electronic equipment.

The systematic analysis of business data processing has received the attention of several professional groups and large companies, who have suggested procedures suitable for conducting such an inquiry.[11] Insurance companies have been particularly active in investigating and experimenting with computers, and have published comprehensive reports of their findings. The consensus of their reports is uniformly emphatic in calling for individual re-thinking of applications and careful evaluation of computers before investment.[12] Several approaches to the problem are open to both businessmen and manufacturers interested in business data processing.

<u>Functional analysis of applications.</u> The first and most obvious of these is the review of present business procedures to assure that they perform an efficient function. Many of the apparent difficulties in the applications of computers may well be due to inefficient methods. The mere transfer of present manual or machine procedures to computer processing without change may not be the best means of accomplishing the desired result. The need for review of procedures is constantly stressed in publications dealing with business applications.[13] In particular, the need for functional thinking in terms of an entire process seems overdue. The businessman has become accustomed to equating long, detailed reports with efficient control. Too often, procedures are superimposed and reports pyramided in the hope that quantity will accomplish what might have been brought about with less waste by functional thinking. This concept has recently been challenged by an article suggesting the benefits to business of familiarity with communication or information theory. In this theory, information is equated with news, and efficiency becomes a function of news transmitted and no-news suppressed.[14] Its practical application in business would be one way to reduce or eliminate the overload on computer output devices.

<u>Operations research.</u> The recently developed techniques of operations research may also aid business in adapting its procedures to computer processing. Applied to military situations during the war, operations research provided the solution to many complex problems by developing mathematical models of logistic and tactical operations. In recent years industrial problems have been receiving the attention of experts in this field.[15] Since their solution will result from the development of mathematical models, these problems will become more amenable to processing by computers.[16]

<u>Improved communication.</u> Still another possible approach is open to both manufacturers and potential users. Research and development intended to close the gap between present computers and future machines more suitable to business has already been undertaken by manufacturers. They have designed and built special purpose machines to perform specific operations in business. They are developing input, output and memory devices specifically for business data processing. Too frequently, however, the manufacturer works without an adequate idea of his customer's desires and expectations because the designer and businessman lack a common bond of understanding.

In this area it has become clear that businessmen and designers must communicate with each other. Such interchange of information will serve to clarify what is expected by the one, and what existing techniques enable the other to provide.

The opportunity which this last approach offers is coupled with the responsibility which the businessman will have of extending his knowledge. This is not to say that he must become an electronic engineer or applied mathematician, but he must have a clear concept of how computers operate, what computer equipment is available, and how the equipment can be applied to the various phases of business data processing.

COSTS OF COMPUTER OWNERSHIP

Businessmen have been made painfully aware in recent years that business data processing can become a costly necessity to a firm. The rise in clerical salaries and the growth in volume of paperwork have caused overhead expenses to rise spectacularly. It is hardly surprising, therefore, that businessmen reacted quickly to any suggestion of a practical method to reduce costs. Many such suggestions were made concerning computers, but few of them were specific in saying how these savings would be achieved. A greater service to businessmen and computer manufacturers would have been done by reducing generalities to definite statements about the costs of equipment, installation and operation for complete data processing systems.

Equipment costs. In many published articles dealing with computers, the authors have mentioned equipment costs which are often misleading. This may be attributed to lack of experience in the field or to too ready acceptance of manufacturer's claims. While it is true that many small computers are priced by their manufacturers in the range of from $50,000 to $100,000, it is found that they are usually scientific machines. That is to say, they are stripped-down computers with minimum input and output equipment, limited external memory facilities, and technical characteristics which in some cases reduce their utility in business applications. The businessman who investigates these small computers finds in most cases that they will be useless to him unless he adds magnetic tape drive units, punched card input-output facilities, printer units or other equipment to the basic unit. If this is done the price rises rapidly and, in most cases, approaches $200,000 for the combination of units of equipment needed for an integrated system.

This situation does not seem to prevail in the case of the large computers. This may be due in part to the need to sell them by emphasizing savings rather than price, and in part to the fact that a number of the large machines have been in use for a number of years and their prices have become relatively well known.

The firm which considers the use of computers must deal with specifics. It must determine whether the computer being investigated can be used as-is or, if it cannot, how much the extra equipment needed will cost.

Costs of Installation. In addition to the cost of equipment, the initial expense of acquiring a computer will be increased by freight and insurance charges incurred in moving the machine and the costs of preparing the site for its installation.

It is not unusual for prices of computers to be quoted f.o.b. at the manufacturer's plant. The buyer may have to pay freight and insurance charges. Since computers are delicate machines, the costs of transcontinental haul may in some cases be a deciding factor in choosing between two machines of approximately the same price.

The site at which the computer is to be installed must also be selected and prepared by the buyer. If a site above ground level is to be used, means must be provided to raise the computer as well as to move it horizontally to its final location. Obviously, sufficient space must be provided for its installation. Attention must be given not only to square-footage, but to the third dimension as well if false flooring or special interconnecting ducts are needed. Electrical wiring of adequate capacity must be provided, and should be terminated in the type of electrical fittings required by the computer's power cables. Temperature and humidity control may also be necessary to assure that proper operating conditions are maintained.

Costs of operation. The operating costs of computers are similar to those of other data processing installations. They include operators' salaries, cost of supplies of punched cards, magnetic tape, paper tape, continuout forms, etc., and the cost of maintenance parts. Since the cost of all but the last will depend on the application, their magnitude will vary and can be determined with reasonable accuracy when the factors of each case are known. The cost of maintenance parts is discussed separately in a following paragraph.

Personnel requirements and training problems. Operating personnel for an electronic data processing system fall into several categories, the number in each depending on the nature of the application.[31] The largest group of these is made up of the operators of input and output devices. One operator per machine is normal for input equipment, while one operator may be able to handle several output devices. The level of skill and type of training needed to prepare these operators is similar to that necessary for comparable punched card equipment. Arrangements can usually be made with the manufacturer for any special training needed to operate input and output devices.

The operation of arithmetic-logic and control units is a specialized task and should be the responsibility of a trained person on each operating shift worked. The qualifications of the computer operator are still a matter of debate, but a common area of agreement exists as to the need for a person possessing a high degree of native intelligence. The experience of a government agency operating a large computer installation shows that over a period of months, an intelligent clerk can become as skilled in handling controls as a much more highly trained programmer.[32] Several of the smaller computers on the market are advertised as requiring only the services of an intelligent clerk for satisfactory operation.

Training programs for computer operators are usually conducted by manufacturers prior to the installation of equipment. This training is usually included in the cost of the computer for a designated number of persons. Additional trainees are accepted on a contract basis at extra cost. The housing and subsistence of trainees during the training period are the responsibility of the buyer. A typical training course for computer operators offered by a leading manufacturer lasts for ten weeks.[33]

The need for a trained programmer will depend on the expected amount of change in operating procedures of the business which will affect prepared programs. In some cases when assistance can be obtained from service bureaus on a contract basis, it may prove advantageous to use these facilities. When changes may be frequent and cause constant re-programming the company will undoubtedly benefit from the permanent services of a programmer.

The programmer should ordinarily possess sufficient mathematical training to enable him to prepare programs for statistical and other mathematical problems which may arise in processing the firm's data. Training of a programmer is usually included in the cost of the computer, with additional trainees accepted at extra cost. For most firms, the logical choice for such training is a member of the management engineering or office procedures staff who possesses the requisite mathematical background. A training course for programmers offered by a leading manufacturer requires 14 weeks to complete.[34]

The outright purchase of a computer places the problem of maintenance at the door of the buyer. The high reliability in operation required of computers in business applications makes this function extremely important. One or more maintenance men will be required to make pre-operational checks, carry out preventive routines and repair the equipment when it fails. The minimum training to qualify a man for this work on a small computer should include the theoretical and practical aspects of television or radar maintenance supplemented by training in computers themselves. On larger computers, one or more engineers and several technicians may be required. In locations remote from manufacturer's service bureaus, a full time maintenance staff will undoubtedly be required for a computer installation. Training courses for maintenance men, available under the same conditions as those for operators and programmers, last 26 weeks.[35]

Potential users of computers should be aware that the supply of personnel skilled in the operation, maintenance and programming of computers is short. Until this situation changes, trained personnel will be in demand and vulnerability to labor piracy will frequently be the lot of the user who has invested in their training.

Cost of maintenance parts. The cost of spare parts for maintenance falls into two classes. The relatively predictable or constant costs will usually be confined to the replacement of parts such as vacuum tubes and crystal diodes. Complete data on replacement costs of these parts are not available, but engineering estimates of a replacement rate of 25% annually for vacuum tubes and 10% for crystal diodes are considered reasonably accurate.[36] Since only a few different types of vacuum tubes and crystal diodes are used in most computers, a small inventory of these parts will provide for all but the most unusual emergencies.

Less predictable parts failures present a different problem. Although these are infrequent, the possibility of failure and its consequences makes the ready availability of an adequate inventory of parts essential. The user who is near enough to the factory or to a service bureau may only require a small inventory of parts. The remote user, however, must prepare for all eventualities by maintaining a large inventory. The preparation of a recommended list of spares by the manufacturer can aid the user substantially to protect himself at minimum cost. The need to hold this cost down can be seen from an estimated value of $30,000 assigned to an inventory of spares for a large computer maintained by a government agency. The same agency suggested that the pooling of parts by users of the same type of computer where possible would be both practical and economical.[37] An inventory of $5,000 is not considered excessive for small computers.

APPLICATIONS ANALYSIS

Definition of term. Applications analysis may be defined as a detailed statement of the personnel, equipment and procedures required for business data processing. As applied to computers, it may be a relatively simple presentation showing, for example, how a single function such as inventory control may be performed with a special purpose computer. Again, it may be a far more complex analysis required to determine which combination of a number of functions is best suited for efficient processing with a general purpose machine.

Applications analysis employs methods which are similar to those used in the study of office procedures and systems, but its aim may be quite different. An analysis of a business procedure by accepted methods may only deal with the improved performance of a specific function by itself, without reference to other procedures. The analysis of general purpose computer applications ordinarily involves the integration of several functions for efficient processing as a system. This is so because the capacity of the computer and the large investment in a data processing system make a high utilization factor imperative. Achievement of this goal will usually require the processing of data from a number of departments or sections of a firm which may be operating independently, and often will necessitate judgments regarding the relative priority assigned the work of each of these. This requires a high degree of cooperation, study and understanding on the parts of an organization affected by the analysis if the conclusions reached are to receive willing acceptance.

Time required. In most instances, the analysis is a complex undertaking which will require months to complete. The familiarization of personnel with computers in general and their application to the particular operations of the firm will not be accomplished overnight. The collection and analysis of data also requires time. Ordinarily the firm which seriously considers the use of a computer must plan the investigation long before a contract is signed for its rental or purchase.

Personnel required. The question of who will make the applications analysis is not easily solved at present because of the lack of experienced personnel. Within the firm, systems and procedures analysts appear to be the most promising investigators since they are already familiar with the firm's internal operations. Their efforts may be supplemented by the formation of a committee of department representatives who can both offer direction and familiarize themselves with the possible effects of computer data processing on their departments. The work of these groups should become less difficult as more non-technical literature is published and a body of principles is formed.

As an alternative, the firm may select a management consultant to study its operations and recommend a computer for its use. This is not always easy or possible at present because few consultants seem to have built up their staffs in this specialty and many are unwilling to recommend equipment at a time of rapid technological advance. It is to be expected, however, that this situation will change within a few years.

Preliminary selection. The primary purpose of an applications analysis is to select the combination of functions which will allow most efficient use of a computer. To avoid waste of time and effort, the study of the firm's operations should be restricted to standardized procedures which are carried out repetitively and frequently. Functions which are highly dependent on human judgment are difficult -- in some cases impossible -- to adapt to computer processing. Those which are performed infrequently and which are subject to change are likely to become more expensive if they are selected for computer processing.

Assembly of data. Following the selection of suitable functions, all possible data concerning them should be collected. The qualitative aspect of this task should present no particular difficulty since flow charts and procedure manuals are normally available to provide the necessary information. Needless to say, these sources should be verified by an on-the-spot check to assure that workers are doing what the book specifies. The human tendency to interpret and improvise is always present and may result in material departures from prescribed procedures.

Quantitative information on the data processed must be gathered at the same time. The actual volumes of work must be determined, since average volumes may conceal a range of activity which could swamp computer facilities during peak loads. In addition, it is necessary to obtain accurate counts of the alphabetic and numeric characters found in each type of unit data processed. This information will be used later to estimate requirements for input-output equipment and information storage devices, as well as computing times. It must not be gathered carelessly. The experience of applications engineers indicates that few firms have current records of this information available for planning purposes.

It is also advantageous to assemble cost data on present methods while this investigation is being completed. While it is not always possible to allocate costs exactly, a reasonably good estimate should be made in doubtful cases. A comparison of the costs of present and proposed methods will aid in computer evaluation, and may serve to illustrate the waste caused by inefficient procedures which are often found when present methods are examined functionally.

Functional analysis. A functional examination of collected data follows logically as the next phase of the study. Its aim is to decide whether each procedure serves a purpose which justifies its retention, and its result should be a set of procedures from which inefficiency and duplication of effort have been eliminated. Procedures too frequently seem to become ends rather than means and are cherished like tribal customs long after they have ceased to be useful. With the completion of the examination, the procedures which are to be retained should be clearly expressed and their value to management verified.

Determination of equipment requirements. The data collected in the course of the applications analysis must next be translated into approximate quantities of equipment needed for data processing. If function has been clearly defined, the type of output data, the method of processing, and the quantity and type of input data required should be easily determined. These elements are considered in the order given, and the equipment requirements determined from the volume of data handled.

Output data may either be printed out as a visual record or stored on magnetic tape, punched cards, or on similar storage media. The number of characters per unit record multiplied by the number of records will give the total number of characters which are to be printed out if an electric typewriter is used or stored if magnetic tape or punched tape are employed as storage media. Most electric typewriters and paper tape punches operate at speeds of ten characters per second, and the time required can be found by simple arithmetic. Output speeds and storage densities on magnetic tape vary with computers, and must be calculated for each case.

High speed line printers and card punches usually handle data by printing or punching a record at a time. The total number of records divided by the number of records printed or punched per unit of time will give the machine hours needed to produce output data on these machines.

When these units are operated independently of the computer with suitable conversion equipment, many output units can be used to reduce the time required for the task. Scheduling requirements and total cost will be greatly affected if a poorly chosen combination of functions is processed. Examples will be given in the following section of this chapter to show how the requirements for each of several functions can be compared to determine the load which will be placed on the various units of the computer. Too great a load placed on output units may result in appreciable idle time at other points in the system and should be avoided.

The form of the output data will indicate the processing necessary to produce it, as well as the input and file data needed. With some practice, the operations necessary to carry out a process can be determined by a person who has a grasp of programming techniques. Several elementary articles are available on this subject which will at least provide an introduction to the art.[53] Processing times determined in this manner will enable some idea of the capabilities of the computer to be formed. They should, whenever possible, be rechecked by experienced programmers until the amateur programmer gains sufficient experience to work with assurance.

Requirements for input and filed data should be well defined at this stage of the investigation. Manual speeds of three characters per second can be divided into the total number of input characters required to determine the machine-hours needed for its preparation. Data filed on magnetic tape will require different quantities of tape and tape handling units with various computer units, but the equipment needs can be calculated from manufacturer's specifications. The need for periodic processing of changes in filed data should be taken into consideration in applications where changes may be frequent.

Changing to computer processing. The need for selection of several functions for computer processing should not be taken to imply a need to begin the processing of all simultaneously. In most cases this is not possible; a prudent phasing-out of changes from manual or machine processing to computer use is necessary in most cases.

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33) Remington Rand, Inc., Catalog of Courses in Electronic Computers (New York: Remington Rand, Inc., Electronic Computer Department, 1953), p 9 et passim.

34) Same as reference 33.

35) Same as reference 33, pp 15-18.

36) Ralph A. Niemann, "Operation of the Naval Proving Ground Computer Installation", Symposium on Managerial Aspects of Digital Computer Installations, Department of the Navy, Office of Naval Research (Washington, 30 March, 1953) p 28.

37) See reference 32, p 35.

(continued on page 34)

Components of Automatic Computing Machinery—List of Types

(Edition 1, cumulative, information as of Feb. 3, 1955)

The purpose of this list is to report types of components of automatic machinery for computing or data processing. We shall be grateful for any comments, corrections, and proposed additions or deletions, which any reader may send us.

LIST

1. Storage mediums, for both internal and external storage:
   - Punch cards
   - Punched paper tape
   - Magnetic tape
   - Magnetic wire
   - Metal plates
   - Plugboards, i.e., panels of patch cords
     -- All these physical forms express machine language; when inserted into a machine, they give the machine information and instruction; when left in a filing cabinet, they hold information and instructions in reserve for later use. Sometimes it is the whole area or volume of the storage medium which is used, as in the ordinary punched card. Sometimes it is only the edge which is used, as in edge-punched cards or edge-slotted metal plates.

2. Storage mediums, internal only:
   - Magnetic drums
   - Magnetic tape units
   - Magnetic cores, arranged either one-dimensionally as in a magnetic shift register or in two or three dimensions as a magnetic core matrix memory; they may be made of special iron alloys, iron oxide ceramics called ferrites, etc.
   - Electrostatic storage tubes, in particular cathode ray storage tubes
   - Delay lines, of mercury, quartz, nickel, etc.
   - Relays, in relay registers, and stepping switches
   - Electronic tubes, in registers of flip-flops, counting rings, etc.
   - Switches: toggle switches and dial switches
   - Buttons and keyboards
   - Rotating shafts
   - Voltages

3. Calculating and controlling devices:
   - Relay and stepping switch circuits
   - Electronic tube circuits
   - Rectifier circuits, using diodes: electronic tube, germanium, selenium, silicon
   - Transistor circuits
   - Auxiliary circuit elements: amplifiers, pulse transformers, voltage regulators, etc.
   - Analog computing elements: resolvers, synchros, integrators, adders, etc.
   - Automatic process controllers as such, pneumatic, electronic, hydraulic, etc.

4. Input devices:
   - Buttons
   - Switches
   - Paper tape readers: mechanical, electrical, photoelectric
   - Punch card readers: mechanical, electrical, photoelectric
   - Magnetic tape readers
   - Automatic curve followers: photoelectric
   - Scanners: electric, photoelectric
   - Sensing instruments of all kinds
     -- The category "sensing instruments" verges into the science of instrumentation, where humidity, temperature, pressure, volume, flow, liquid level, etc., and many other physical variables can be measured and reported to a machine in machine language.

5. Output devices:
   - Visual displays, such as oscilloscope screen, lights, etc.
   - Electric typewriter, or other electrically operated office machine
   - Line-at-a-time printer
   - Matrix printer, that forms each character by a pattern of dots
   - Automatic plotter, which will trace or plot a curve according to information delivered by the machine
   - Facsimile printer
   - Photographic recording
   - Positioning devices, that may operate a valve, roller, tension arm, etc., resulting in control of a manufacturing operation or process

- END -

* * *

BULK SUBSCRIPTION RATES

These rates apply to subscriptions coming in together direct to the publisher. For example, if 5 subscriptions come in together, the saving on each one-year subscription will be 25 percent, and on each two-year subscription will be 33 percent. The bulk subscription rates, depending on the number of simultaneous subscriptions received, are shown below:

Table 1 -- Bulk Subscription Rates (United States)

Number of Simultaneous Subscriptions	Rate for Each Subscription, and Resulting Saving to Subscriber: One Year	Two Year
10 or more	$3.00, 33%	$5.40, 40%
5 to 9	3.33, 25	6.00, 33
4	3.75, 17	7.00, 22
3	4.00, 11	7.50, 17
2	4.25, 5	8.00, 11

For Canada, add 50 cents for each year; outside of the United States and Canada, add $1.00 for each year.

(continued from page 11)

write down any digit in the sequence.

One arithmetic procedure that appears plausible and has been investigated is the use of individual digits of irrational numbers, that is, numbers whose decimal parts contain an infinite number of digits and which do not form a repeating pattern. The numbers considered have included $1/\sqrt{2}$, π, e, and certain logarithms. The frequency test was failed by the digits of $1/\sqrt{2}$. Both π and e were subjected to exhaustive tests with e failing many; π, on the whole, stood up well. A most interesting, and curious, theorem due to Franel states that if one considers the sequence of digits in the k-th decimal position of the sequence of common logarithms of the integers in their natural order, then the proportional frequency of any digit in this derived sequence does not tend to <u>any</u> limit. In any event, the computation time necessary to produce random digits using any of these irrational numbers is too large, compared with more economical procedures described below.

Another arithmetical procedure proposed for obtaining random digits makes use of numbers and is called the "mid-square" procedure. Starting with a k-digit number, the method calls for successive squaring and extracting of the middle k digits of the resulting 2k-digit square. Some tested numbers have given satisfactory results, but serious drawbacks attend this method. A theoretical study of the sequence of digits resulting from starting the sequence with an arbitrary number has, so far, not been possible. In some cases, the sequence degenerates into all zeros. Furthermore, no prediction can apparently be made regarding the length of the sequence before it repeats itself. As a consequence of these disadvantages, the mid-square method has largely been superseded by what is called the "residue-class" method, which we shall now explain.

The residue-class procedure was developed originally for use on a binary computer, but has been extended to decimal machines and can, in principle, be applied to computers using any number base. Specifically, in a binary machine, with p binary digits per machine word, one could proceed in the following manner: Select an odd power of 5 that is within the capacity of the computer and designate this to be a constant multiplier. Square this multiplier and keep only the last p digits. This is the residue. Form the product of the residue and the constant multiplier, again keeping only the last p digits as the new residue, etc. If the two least signigicant bits are eliminated from consideration, the digits of the residues have been found to satisfy the usual tests for randomness. Moreover, it can be proved that one obtains a sequence of 2^{p-2} such residues before the cycle of numbers repeats itself. The two least significant digits are dropped because they are invariably 01. Some modifications in the multiplier and the number of digits dropped are necessary in a decimal computer, and these naturally affect the length of the basic cycle.

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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.

<u>Articles.</u> 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.

<u>Technical Papers.</u> 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.

<u>Fiction.</u> 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.

Roster of Organizations in the Field of Computers and Automation

(Supplement, information as of February 10, 1955)

The purpose of this Roster is to report organizations (all that are known to us) making or developing computing machinery, or systems, or data-handling equipment, or equipment for automatic control and materials handling. In addition, some organizations making components may be included in some issues of the Roster. Each Roster entry when it becomes complete contains: name of the organization, its address and telephone number, nature of its interest in the field, kinds of activity it engages in, main products in the field, approximate number of employees, year established, and a few comments and current news items. When we do not have complete information, we put down what we have.

We seek to make this Roster as useful and informative as possible, and plan to keep it up to date in each issue. We shall be grateful for any more information, or additions or corrections that any reader is able to send us.

Although we have tried to make the Roster complete and accurate, we assume no liability for any statements expressed or implied.

This listing is a supplement to: the cumulative listing containing over 230 organizations published in the November issue of "Computers and Automation", vol. 3, no. 9, pp. 9 to 19 and 30; the supplements in the December issue, vol. 3, no. 10, p. 23, the January issue, vol. 4, no. 1, p. 36, and the February issue, vol. 4, no. 2, p. 30. This listing contains only additions or corrections as compared with previous listings.

Abbreviations

The key to the abbreviations follows:

Size
- Ls Large size, over 500 employees
- Ms Medium size, 50 to 500 employees
- Ss Small size, under to employees (no. in parentheses is approx. no. of employees)

When Established
- Le Long established organization (1922 or earlier)
- Me Organization established a "medium" time ago (1923 to 1941)
- Se Organization established a short time ago (1942 or later) (no. in parentheses is year of establishment)

Interest in Computers and Automation
- Dc Digital computing machinery
- Ac Analog computing machinery
- Ic Incidental interests in computing machinery
- Sc Servomechanisms
- Cc Automatic control machinery
- Mc Automatic materials handling machinery

Activities
- Ma Manufacturing activity
- Sa Selling activity
- Ra Research and development
- Ca Consulting
- Ga Government activity
- Pa Problem-solving
- Ba Buying activity
  (Used also in combinations, as in RMSa "research, manufacturing and selling activity")

*C This organization has kindly furnished us with information expressly for the purposes of the Roster and therefore our report is likely to be more complete and accurate than otherwise might be the case. (C for Checking)

ROSTER

Bill Jack Scientific Instrument Co., 143 Cedros Ave., Solana Beach, Calif. / Skyline 5-1551/ *C
Airborne analog computers for "Recon" systems, aerial cameras; recording cameras; etc. Ms (450) Se(1949) DIc RMSa

Donner Scientific Corp., 2829 7th St., Berkeley 10, Calif. / Berkeley 7-3150 / *C
Analog computers. Ss (40) Se(1953) Ac RMSa

General Cybernetics Corp., affiliate of The Angle Computer Co., Inc., 1751 No. Coronado St., Los Angeles 26, Calif. / Normandy 3-1300 / *C
Linear motion transducer reporting 1/10,000 of an inch position change; high-speed converter of punched cards to tape; industrial automation, electronic gages for automation processes, etc. Successor of General Cybernetics Associates. Ss(18) Se(1953) DAICc RCMSa

General Precision Laboratory, 63 Bedford Road, Pleasantville, N. Y. / Pleasantville 2-2000/ *C
Rapid electronic analysis of punchcard data, etc. Ls(1200) Se(1945) DIc RMSa

Genisco, Inc., 2233 Federal Ave., West Los Angeles, Calif. / Arizona 8-1276, Bradshaw 2-9749 / *C
Computer components of electro-mechanical type, transducers, analog-to-digital converters, accelerometers, pressure transducers, components for automation and automatic control; etc. Ms(85) Se(1947) ICc RMSa

G. M. Giannini & Co., Inc., Laboratory Apparatus Div., 918 East Green St., Pasadena 1, Calif. / SYcamore 3-2101 or RYan 1-7152 / *C
Digital data recording systems; analog to digital converters, etc. Ms(100) Se(1944) Dc RMSa

Hathaway Instrument Co., 1315 So. Clarkson St., Denver 10, Colo. / Spruce 7-2696 / *C
Transducers, analog and digital recorders, relays, etc. Ms(100) Me(1939) Ic RCMSa

Kaiser Metal Products, Inc., Fleetwings Division, Bristol, Pa.

(continued on page 32)

BOOKS AND OTHER PUBLICATIONS

Gordon Spenser, Whippany, N. J.
(List 12, COMPUTERS AND AUTOMATION, vol. 4, no. 3, March, 1955)

This is a list of books, articles, periodicals, 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.

Leiner, A. L., and others / National Bureau of Standards Report 3459, "Summary Technical Report on the Logical System Design of the DYSEAC", 4 volumes / National Bureau of Standards, Washington 25, D. C. / 1954, photooffset, 397+264+59+?pp, cost?

This report, issued in four volumes, describes the logical design features of the DYSEAC. Volume I describes the system specifications and organization and contains detailed chapters on each of the major units. Volume II contains indices of tube stages, manual switch leads, and external selector leads. Collected into Volume III are the various block diagrams, chassis charts, and other package and functional diagrams. Volume IV contains wiring tables.

De Turk, J. E., and others / Basic Circuitry of the MIDAC and MIDSAC / Willow Run Research Center, Engineering Research Institute, University of Michigan, Ypsilanti, Mich. / 1954, photooffset, 113 pp, (numbered in sections), $2.00

This report, in four parts, describes the final packaged circuitry of the MIDAC and MIDSAC. Part I describes the basic package, plug-in circuits; Part II discusses their assembly to obtain functional units; Part III presents an example of a simplified serial-binary arithmetic unit built up of the functional building blocks; and Part IV considers some basic mechanical constructional features. Two appendices present further details on design factors and the use of the package units. The text is illustrated by many schematic diagrams and photographs of actual elements.

Shea, Richard F., editor / Principles of Transistor Circuits / John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y. /1953, printed, 535 pp, $11.00

An introduction to this important field of electronics written for both the graduate student and the practising engineer. To achieve generality, the treatment is built about generalized equivalent circuits to represent, in a convenient manner, the majority of transistors now in use. One chapter deals with applications to computer circuits, both analog and digital.

Snyder, John I., Jr. / "The American Factory and Automation" in "The Saturday Review"/ Saturday Review Associates, Inc., 25 West 45 St., New York 36, N.Y. / January 22, 1955, printed, pp. 16-17..., 20¢ per copy, $7.00 annually

Automation in some form is shown to have existed for centuries, but has grown in importance with the degree of industrialization. The author takes the position that the immediate limiting factor in the growth of the automatic factory is the design of proper control equipment. Other problems include plant layout, plant and product design, and the cooperation of labor. He looks forward to an acceleration in the trend towards automation within the next twenty years.

Lear, John / "Mechanical Mice -- With and Without Men" in "The Saturday Review" / Saturday Review Associates, Inc., 25 West 45 Street, New York 36, N.Y. / January 22, 1955, printed, pp. 17..., 20¢ per copy, $7.00 annually

Starting with a description of Theseus, the mechanical mouse introduced by C. E. Shannon, which was able to "remember" the correct path through a maze once it was established, the author describes some of the varied tasks now being done routinely by robot equipment. Included in this term is modern electronic computing equipment ranging from some new IBM models to Fosdic, one of the Census Bureau's newest machines, which can read census forms, extract and file information. A final section discusses the problems of technological unemployment and expresses an optimistic conclusion.

"Mathematical Tables and other Aids to Computation," issue, October, 1954 / National Research Council, 2101 Constitution Ave., Washington, D. C. / 1954, printed, 68 pp, $1.50 per issue, $5 annually

Contains bibliographical reviews, notes, discussions of mathematical tables, and the following papers: "A Generalization of the Method of Conjugate Gradients for Solving Systems of Linear Algebraic Equations" by J. H. Curtiss; "On the Estimation of Quadrature Errors for Analytic Functions" by P. Davis and P. Rabinowitz; "Integrals Occurring in Problems of Molecular Structure" by A. Dalgarno; "Characters of Symmetric Groups of Degree 15 and 16" by R. L. Bivins and others; and "A Useful Technique in Programming for Analog Computers" by J. E. Maxfield.

Control Engineering / "Automatic Freightyard Shuffles Cars Quickly Yet Gently", January, 1955, McGraw-Hill Publishing Co., Inc. 330 West 42 St., New York 36, N. Y. / printed, pp 28-37, 50¢ per copy, $3.00 annually

A general description of the automatic equipment installed in the Union Pacific freightyard in North Platte, Nebraska and of the prior conditions it was designed to correct. The general discussion is followed by two specific parallel explanations of speed and switching control systems.

Higgins, Thomas J. / "Basic Books for Your Control Engineering Library: -- Computers and Numerical Analysis" in "Control Engineering", January, 1955 / McGraw-Hill Publishing Co., Inc., 330 West 42 St., New York 36, N.Y. / 1955, printed, pp. 57-62, 50¢ per copy, $3.00 annually

A comprehensive, annotated bibliography of books, journals and reports dealing with computers and computing techniques. The discussion is divided into five sections: computers, analog machines, digital computers, general content, and numerical analysis. A general description of the particular work is woven into the running text; there follows a list of 72 complete references, which may be of value to those interested in the field and art of computation.

Allison, William / "A Broad Look at Analog Computers" in "Control Engineering," February, 1955 / McGraw-Hill Publishing Co., Inc., 330 West 42 St., New York 36, N.Y. / 1955, printed, pp. 53-57, 50¢ per copy, $3.00 annually

This article examines the basic philosophy of analog computers and seeks to class digital machines as a special case of the analog. Superiority of performance is claimed for an A.C. electromechanical approach to analog computers for control systems.

Ridenour, Louis N., editor / Modern Physics for the Engineer / McGraw-Hill Book Co., Inc., 330 West 42 St., New York 36, N.Y. / 1954, printed, 499 pp / $7.50

This is a collection of lectures delivered at U.C.L.A. by authorities in their respective fields for an extension course bearing the title of the book. The lectures are grouped into three parts: In Part 1 are chapters on "Relativity", "Atomic Structure", "Physics of the Solid State", "Magnetism", "Microwave Spectroscopy", "Nuclear Structure", "Electronuclear Machines", "Actinide Elements and Nuclear Power" and "Elementary Particles". Part 2, called "Man's Physical Environment", has 5 chapters dealing with astrophysics geophysics and meteorology. Part 3, entitled "Information and its Communication", has 4 chapters on "Electrons and Waves", "Semiconductor Electronics", "Communication Theory" and "Computing Machinery". The last chapter, 46 pages long, written by the editor, examines historical background, organic parts and design in general, and the ORDVAC in particular. A discussion of programming and coding (5 pages) is followed by speculations on future prospects and social implications of computers.

Klein, Martin L. / "Digital Techniques and Binary Numbers" in "Instruments and Automation", December, 1954 / The Instruments Publishing Co., Inc., 845 Ridge Avenue, Pittsburgh 12, Pa. / 1954, printed, pp 1944-1947, $4.00 annually

An unusually simple, straightforward and lucid account of number systems with particular stress placed upon the binary system. The reader is led in detail through the procedures for adding and multiplying binary numbers. The arithmetic is followed by a discussion of "binary electronics" and the basic flip-flop circuit. Applications to computing machines are discussed. Possibilities of the use of diode matrices in process control circuits are examined.

June, Stephen A., and six others / "The Automatic Factory — A Critical Examination" in "Instruments and Automation", December, 1954 / The Instruments Publishing Co., Inc., 845 Ridge Avenue, Pittsburgh 12, Pa./ 1954, printed, pp 1952-1957, $4.00 annually

The fifth of a series, this article is called "Contemporary Automaticity". Observations are made on current situation and trends in the automobile and vacuum cleaner industries by using case studies. Attention is drawn to Project "Tinkertoy", a joint project of the

Navy and the National Bureau of Standards involving the mechanized production of electronic sub-assemblies. The following conclusions are advanced: (1) The greater the financial resources of a company, the better it is able to overcome obstacles in the way of automation. (2) One of the chief difficulties in automation is the ability to measure and understand the complexities of the production process, and this is coupled with the shortage of qualified engineers. (3) Financial return is the key factor in changing the production process, and this will frequently have the effect of limiting automation at some point short of the complete automatic factory. (4) Automation in an industry depends upon the market for its product. Greater demand justifies changes in the way of greater mechanization as is the case when the market is least concerned with style. The less style is a factor, the greater the freedom of a firm to redesign products to conform to the needs of automatic processes. (5) Automation must operate and be justifiable within the framework of an individual company.

Leaver, E. W. and J. J. Brown / "Mining Low Grade Ores is Economical with Automatic Control" in "Automatic Control", January, 1955 / Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. / 1955, printed, pp 4-9, distributed free to qualified personnel, $10.00 annually to others

The authors present an optimistic view of the magnitude of economical sources of many raw materials that are commonly thought to be in short supply, based on conventional refining methods. No longer will only the rich and large concentrations be exploited. Automatic control has paved the way to mine marginal, widely dispersed sources. In particular it will be possible to mine the air, sea, and topsoil for minerals that exist in abundance, but in minute concentrations. One such example, now in operation, is the extraction of magnesium from the sea.

Rosen, H. A., and M. W. Fossier / "A Desk-Model Electronic Analog Computer" in "Transactions of the IRE Professional Group on Electronic Computers", December, 1954 / Institute of Radio Engineers, 1 East 79 St., New York 21, N. Y. / 1954, printed, pp 20-24, $13.00 annually

Describes the Deac'n, an inexpensive, desk-model analog computer. The basic design includes nine stable high-gain D.C. amplifiers, each of which can be made to produce a variety of functional responses. The authors envision its use in many situations not otherwise conducive to an analog computer. They suggest it be used as the tool of an individual engineer in a manner similar to the arithmetic desk calculator.

International Business Corp. / Applied Science Division Technical Newsletter, No. 9, January, 1955 / International Business Machines Corp., 590 Madison Ave., New York 22, N.Y. / 1955, printed, 69 pp, free

A collection of four papers, dealing with applications or aids in using different major IBM machines. The first paper, "Research in Language Translation on the IBM Type 701" by Peter Sheridan, provides a full description of the widely publicized Russian-English translations accomplished under the direction of the Georgetown University Institute of Language and Linguistics. Flow charts of the program, operational syntax subprogram, and lexical syntax subprogram are included. The second paper, by G. R. Trimble, Jr., "Subroutines for the IBM Type 650", provides full programs for various matrix, trigonometric, exponential and square root subroutines. The third paper is "A 101 Control Panel for Testing General Purpose CPC Cards", by R. W. Hamming. The final paper, written by W. R. Harvey, is entitled "The Analysis of Non-Orthogonal Data with IBM Equipment", and describes computational procedures, using the IBM Type 602-A multiplying punch, in the statistical analysis of non-orthogonal data.

Smith, W. W., and others / The Impact of Computers on Office Management: Experience in Computer Application / American Management Association, Office Management Series No. 136, 330 West 42nd St., New York 36, N.Y. / 60 pp, illus., paper, $1.75

A summary of the experience of companies investigating the use of large scale computers in business applications. Observations on the possible sociological effects of automatic data processing.

- END -

Computers to Make Adminstrative Decisions?

Hans Schroeder
Milwaukee, Wisconsin

Within the past few years computing equipment has appeared in many places which seem to have little connection with "computing" as such. The versatility of the machines has been demonstrated by applications ranging from the solution of syllogisms and the checking of insurance contracts to the control of intricate production machinery.

An area of potential application of computing equipment which has as yet received rather too little attention is the use of computers to take over some of the functions of government. A law-making body such as a Congress or Parliament concerns itself primarily with two kinds of questions: (1) questions of emotion and opinion, and (2) questions of fact and reason. The first kind of question ranges from confirming the appointment of an official to making declarations of war. (This is not to belittle declarations of war, for there are few acts equally effective in making rulers remembered by posterity). With these questions a computer probably could do little.

The second kind of question, however, is now to a large extent ready for the application of computers, and will be still more ready as more extensive and detailed studies of economics are made (again with the help of "giant brains"). Issues such as choosing sales tax versus income tax, setting up of tax rate schedules, determining the necessity and the amount of tariffs, become a subject for the machine. Without having a machine digest and interpret the formidable amount of data, an economist can only make an educated guess at the actual optimum conditions.

Price supports on agricultural products, the mode of supporting prices, acreage limitations, credit restrictions, and many more questions should be, but are not always, decided on the basis of an analysis of the facts, or are decided when an undesirable trend has already become evident. As computers have begun to be used to pre-calculate the weather, so may they be used to foresee other trends by detailed analysis of large quantities of input data.

As economics and sociology lose some of their empirical character and become a science in which more reliable predictions can be made <u>and</u> the results verified, more and more of the questions of the first kind will become questions of the second kind.

The prospect of deciding issues "by machine" rather than by conventional discussion and vote may seem somewhat frightening at first glance, and may even produce visions of a state such as is described in Orwell's book, "1984". One should realize, however, that there is nothing intrinsically inimical about machines; he who considers machines per se as personal enemies commits the same error as one who feels that rules of traffic deprive him of his freedom of movement. Machines have already demonstrated that they can find sounder solutions to problems than human beings can and are quicker besides. To enable a government body to render better solutions does not mean abandonment of democratic government. In fact, the help of machines may make democratic government a more attractive system than it is now, by enabling it to be more efficient; this would eliminate the major disadvantage of that form of government. Dictatorial governments are known for their speed but not always their wisdom. As far as systems of government are concerned, it seems that "you can't have your cake and eat it, too"; however, computers may eventually help us do just that.

The problem to be overcome is twofold. The first major area of difficulty is the matter of making the man in the street accept a piece of electronic apparatus as an accredited member of government. This problem is by no means a small one. Some people seem to be developing a "machinophobia", which may have had its beginning in the start of the industrial revolution: wherever machines appeared in quantity, unemployment and misery followed (temporarily).

Then there are the remains of the medieval school of thought which considered man in all respects to be the center of the universe. The dethronement of the "perfect" human being has been pretty much accepted; the sun and stars do not revolve about the earth any more and man can be surpassed in quality and quantity of work by a machine. But that there should be machines which apparently out-think a human being is still a bitter pill.

In addition there is the science-fiction theme of machines coming to life, and rendering their creators slaves. Until there are machines that can reproduce their own kind, and are conscious of their own existence, there is no such danger; and such machines seem unlikely to be ever produced. In convincing a person of the desirability of using machines in government, the stress should therefore be put on the "benevolent" machine, and the fact that men will always be necessary to build, instruct, "feed", and maintain the machine.

(continued on page 29)

PATENTS

Hans Schroeder
Milwaukee, Wisconsin

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

December 21, 1954: 2,697,549 / G W Hobbs, Scotia, N Y / Gen Elec Co / Counter which may count in any one of several radices
2,697,649 / R I Roth, Mount Pleasant, N Y / Int'l Business Machines Corp, New York, N Y / Machine for transferring data from perforated record cards to film
2,697,808 / E F MacNichol, Jr, Hamilton, Mass, and H S Sack and R N Work, Ithaca, N Y / Servo system employing direct current resolvers

December 28, 1954: 2,698,134 / G Agins, Brooklyn, N Y / American Bosch Arma Corp / Electric computer using potentiometers
2,698,135 / A P Davis, Stamford, Conn, and J V Macomber, Rockville Centre, N Y / American Bosch Arma Corp / Calculating device for vector addition
2,698,382 / K M Uglow, Jr, and J T Mengel, Silver Spring, Md / - / Electronic switching method using triodes
2,698,383 / N F Moody, Ottawa, Ont, Canada / Nat'l Research Council, Ottawa, Ont, Can / Binary switching and counting circuit
2,698,399 / L W Orr, Springfield, and E A Sands, Phila, Pa / Burroughs Corp / Magnetic deflection means for electrostatic storage tube
2,698,427 / F G Steele, La Jolla, Calif / Digital Control Systems, Inc, La Jolla, Calif / Magnetic memory channel recirculating system

January 4, 1955: 2,698,932 / R L Wathen, Hempstead, N Y / Sperry Corp / Servo stabilizing system for automatically tracking radar

January 11, 1955: (no applicable patents)

January 18, 1955: 2,699,895 / R C Knowles, New York, N Y / Sperry Corp / Angular rate measuring system for predicting type gun control system
2,700,067 / W Lockemann, Haar, and C Bodenstein, Munich, Germany / Siemens & Halske A G, Munich, Germany / Apparatus for magnetically storing teleprinter signals
2,700,135 / W E Tolles, Mineola, N Y / U S A, Sec'y of the Navy / Multiplying circuit
2,700,146 / A E Bachelet, New York, N Y / Bell Tel Labs, Inc, New York, N Y / Pulse counting and registering system
2,700,147 / G.L Tucker, New York, N Y / Int'l Business Machines Corp / Information storage by using free nuclear induction

- END -

*——————— * ———————*

COMPUTERS TO MAKE ADMINISTRATIVE DECISIONS?
(continued from page 28)

The second major area of difficulty is in governments themselves. Governments have always been known to grow and increase their scope of influence and control; they seldom impose limitations on themselves, let alone voluntarily diminish in size. A government is very much like a privately owned corporation with one difference: it always exists, no matter what its financial condition. Executives in a government, faced with the fact that machines might replace them or even improve on their ability to make decisions, are in the same spot as a worker who is about to be replaced by a machine but is able to prevent its introduction. Few such workers would permit the introduction of such a machine. But as computers acquire stature and maturity, they will undoubtedly penetrate governments more and more. The rate at which computers will take over government functions is likely to be so slow as not to require any noticeable decrease in the government's size; their effect may be simply to reduce the rate of increase of government during the period of changeover. The taxpayer would still benefit because after the change the government will be smaller than it would have otherwise been, had it kept on increasing at its natural rate.

The use of machines as an active part of a government may appear somewhat fantastic now, but it is likely that it will seem much less so a decade or two hence. Within the present century alone the attitude of individuals, especially in the technically advanced nations, has become one of objective realism. The development will probably continue. Possibly in 2000 A. D. people will say: "Debate a national budget and vote on it? How peculiar! Why, then, don't they vote on the date of the next full moon?"

- END -

A MECHANICAL ANALOG COMPUTER
(continued from page 13)

$100 ea.) (where n is the number of variables) and n(n-1) differential adders (at $50 ea.), a ten-equation solver might cost upwards of $20,000.00.

References

1. Dennis, P.A., and Dill, D.G., "Application of Simultaneous Equation Machines to Aircraft Structure and Flutter Problems", Journal of the Aeronautical Sciences, Vol. 17, February 1950, p. 107.
2. Berry, C. E., Wilcox, D.E., Rock, S.M., and Washburn, H.W., "A Computer for Solving Linear Simultaneous Equations", Journal of Applied Physics, Vol. 17, April 1946, p. 262.
3. Soroka, Walter, "Analog Methods in Computation and Simulation", McGraw-Hill Book Co., New York.
4. Goldberg, E. A., and Brown, G.W., "An Electronic Simultaneous Equation Solver", Journal of Applied Physics, Vol. 19: 339-345 (1948).
5. Stone, J.J., "The USAF - Fairchild Specialized Digital Computer", Mathematical Tables and Other Aids to Computation, Vol. VII, pp. 35-38, (1953).

- END -

* ——— * ——— *

Forum

ASSOCIATION FOR COMPUTING MACHINERY MEETING

Sidney Kaplan,
Camden, N. J.

The 1955 annual meeting of the Association for Computing Machinery — the only one to be held solely by the Association during the year -- will take place in Philadelphia, September 14-16, 1955. Sessions will be at the Moore School of Electrical Engineering at the University of Pennsylvania. As in the past, this meeting is intended to serve both as a place for the reporting of new ideas and developments in the applications of computing machinery and as a place for renewing old friendships and making new ones.

More information will be announced when available. The address of the Association is 2 East 63 St., New York 21, N. Y.

- END -

AUTOMATIC COMPUTERS -- ESTIMATED COMMERCIAL POPULATION

(Cumulative, information as of December, 1954)

The purpose of this list is to consolidate announcements made in recent months by automatic computer manufacturers about their production of general purpose computers. The count is limited to equipment installed and in use; machines under construction are excluded. We shall be grateful for any additions or corrections that any reader is able to send us.

Burroughs Corp. (UDEC)	2
ElectroData Corp. (CEC 36-101, etc.)	8
Hogan Laboratories, Inc. and Nuclear Development Associates (Circle Computer)	4
International Business Machines Corp. (including Type 604, 607, and 700 series computers)	2,500
Logistics Research, Inc. (ALWAC)	3
Marchant Calculators, Inc. (MINIAC)	1
Monrobot Corp. (Monrobot series)	3
National Cash Register Co. (CRC-102A, 107)	18
Remington Rand, Inc. (including UNIVAC, ERA 1101, 1102, 1103 and 409-2 computers)	129
Underwood Corp. (ELECOM 100, 120, 200)	7

- END -

* ——— * ——— *

THE EDITOR'S NOTES
(continued from page 4)

information can probably be reported free in the directory issue.

The closing date for most parts of the directory issue will be about April 20.

- END -

Forum

COOPERATIVE GRADUATE SUMMER SESSION IN STATISTICS

Herbert A. Meyer, Director,
Univ. of Florida, Statistical Laboratory,
Gainesville, Fla.

A summer session in statistics will be held at the University of Florida from June 20, 1955, to July 29. This summer session is jointly sponsored by the University of Florida, North Carolina State College, Virginia Polytechnic Institute, and the Southern Regional Education Board. The courses to be offered include two in statistical methods, two in statistical theory, advanced analysis, theory of sampling, theory of statistical inference, mathematics for statistics, statistical research in education and psychology, and a seminar in recent advances in statistics. The total tuition fee will be $35 for the six weeks term, with some exemptions. Each course will carry approximately three semester hours of graduate credit. This is the second of a series of annual cooperative graduate summer sessions in statistics.

For more information, please inquire of the writer.

- END -

* ——— * ——— *

Forum

BINARY ADDITION TABLE -- CORRECTION

Dr. Vergil N. Slee, Professional Activity
Study, Barry County Health Council
Center, Hastings, Mich.

Am I correct in my deduction that the addition table on page 11 of Volume 4, No. 1, January 1955 of Computers and Automation, in the article by J. B. McCall is incorrect? And, that it should read as follows:

+	0	1
0	0	1
1	1	10

Reply by the Editor:

Thank you for calling our attention to the error in the article in January issue by J. B. McCall. The addition table is as you state it to be.

- END -

ROSTER OF ORGANIZATIONS

(continued from page 24)

Digital delay generators for accurate measurement and generation of time intervals, etc. Ic RMSa

Magnetics, Inc., Box 230, Butler, Pa. / Butler 71-745 / *C
  Metallic cores of high permeability material for computers and magnetic amplifiers. Ms (250) Se(1949) Ic RMSa

Magnetics Research, Inc., 142 King St., Chappaqua, N. Y. / Chappaqua 1-0052 / *C
  Magnetic components for analog and digital systems and computers; miniature magnetic shift registers; etc. Ss(10 to 20) Se(1952) DAIC RCMSa

The Newton Co., 55 Elm St., Manchester, Conn./ Mitchell 3-5104 / *C
  Shaft-to-digital converters; digital computers, digital control systems, etc. Ms (130) Se(1947) DIc RMSa

Phebco, Inc., 3640 Woodland Ave., Baltimore 15, Md. / Mohawk 4-2350 / *C
  Analog-to-digital converter; digital computers. Ms(55) Se(1952) Dc RMSa

Specialties, Inc., Syosset, N.Y., and Charlottesville, Va. / Syosset 6-2790 / *C
  Precision potentiometers, servos, magnetic amplifiers, transformers, etc. Ms (400) Se(1942 Ic RMSa

The Walkirt Co., 145 West Hazel St., Inglewood, Calif. / OR 8-2873, OR 1-0212 / *C
  Unitized circuit packages, plug-in units, other digital computing activities. Ss (20) Se(1948) Dc RMSa

- END -

* ——— * ——— *

NOTICES

For information on:	See Page:
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Bulk Subscription Rates	22
Manuscripts	23
Who's Who Reply Form	42

Address Changes: If your address changes, please notify us giving both old and new address, and allow three weeks for the change.

Forum:

ELECTRONIC SCANNING AND DETECTION OF POSSIBLE CANCER CELLS

Neil Macdonald, New York

On January 30, a program of development of an automatic visual analyzer of possible cancer cells received grants of $50,000 each, one from the American Cancer Society and one from the National Cancer Institute of the United States Public Health Service. These grants were made to the Airborne Instruments Laboratory, Mineola, L.I., to support the continued development of the analyzer. The program is under the direction of Walter E. Tolles, physicist, of the company staff, and Dr. George N. Papanicolaou, professor emeritus of Cornell University Medical College, who is a consultant.

The experimental form of the machine uses television techniques to scan electronically microscope slides made from smears of portions of body tissues and body liquids. The scanning technique changes the television picture into electronic signals, and a computer then will distinguish between normal and cancer cells. This distinction is accomplished by measuring four features of cells: the size, the color, the diameter of the nucleus, and the optical density of the nucleus.

In the reports of the analyzer so far, there is no statement that it has actually been fully successful in distinguishing cancer cells from normal cells. But even if the analyzer could select only 5% of the slides as representing possibly abnormal cells, the machine would in effect multiply by 20 the number of human beings trained to examine and distinguish cancer slides.

- END- -

APPLICATION OF COMPUTERS TO BUSINESS OPERATIONS
(continued from page 21)

53) Walker H. Thomas, "Fundamentals of Digital Computer Programming", Proceedings of the Institute of Radio Engineers, 41:1245-49, October, 1953.

- END -

Forum:

He Made His Mark

Bill Danch
Woodstock, N. Y.

" -- Big chief in data processing!"

PUBLICATIONS: Symbolic Logic, Computers, Robots, etc.

BRIEF — FILLED WITH INFORMATION — CLEAR — SCIENTIFIC —
RETURNABLE WITHIN WEEK FOR FULL REFUND

You can see them for the asking — Why not take a look at them?

P 5: BOOLEAN ALGEBRA (THE TECHNIQUE FOR MANIPULATING 'AND', 'OR', 'NOT', AND CONDITIONS) AND APPLICATIONS TO INSURANCE: also DISCUSSION. Reprint. Explains in simple language: what Boolean algebra is; how to recognize the relations of Boolean algebra when expressed in ordinary words; and how to calculate with it. Contains problems, solutions, comments, discussion. $1.50

P 4: A SUMMARY OF SYMBOLIC LOGIC AND ITS PRACTICAL APPLICATIONS. Report. Rules for calculating with Boolean algebra. Other parts of symbolic logic. Applications of Boolean algebra to computing machinery, circuits, and contracts. Many complete problems and solutions. $2.00

P 14: CIRCUIT ALGEBRA -- INTRODUCTION. Report. Explains simply a new algebra (Boolean algebra modified to include time) that applies to on-off circuits, using relays, electronic tubes, rectifiers, gates, flip-flops, delay lines, etc. Covers both static and sequential circuits. Applications to control, programming, and computing. Problems and solutions involving circuits. $1.90

Berkeley Enterprises, Inc.
815 Washington St., R112, Newtonville 60, Mass.

Please send me your publications circled
P4 P5 P14 and
( ) your announcement of publications.

Returnable in seven days for full refund if not satisfactory. I enclose $______ in full payment. (Add 10¢ per item to cover cost of handling and mailing.)

My name and address are attached.

COMPUTERS AND AUTOMATION - Back Copies

ARTICLES AND PAPERS: October, 1953: Computers in the Factory -- David W. Brown
The Flood of Automatic Computers — Neil Macdonald
The Meeting of the Association for Computing Machinery in Cambridge, Mass., September, 1953 -- E. C. Berkeley
November: Who Will Man the New Digital Computers? -- John W. Carr III
Electronic Equipment Applied to Periodic Billing — E. F. Cooley
Air-Floating: A New Principle in Magnetic Recording of Information -- Glenn E. Hagen
December: How a Central Computing Laborarory Can Help Industry -- Richard F. Clippinger
"Combined" Operations in a Life Insurance Company Instead of "Fractured" Operations — R. T. Wiseman
"Can Machines Think?": Discussion — J.L.Rogers and A. S. Householder
January, 1954: The End of an Epoch: The Joint Computer Conference, Washington, D. C., December, 1953 -- Alston S. Householder
Savings and Mortgage Division, American Bankers Association: Report of the Committee on Electronics, September, 1953 -- Joseph E. Perry and Others
Automation in the Kitchen -- Fletcher Pratt
February: Language Translation by Machine: A Report of the First Successful Trial -- Neil Macdonald
Reflective Thinking in Machines — Elliot L. Gruenberg
Glossary of Terms in Computers and Automation: Discussion -- Alston S. Householder and E. C. Berkeley
March: Towards More Automation in Petroleum Industries -- Sybil M. Rock
Introducing Computers to Beginners -- Geoffrey Ashe
Subroutines: Prefabricated Blocks for Building — Margaret H. Harper
Glossaries of Terms: More Discussion — Nathaniel Rochester, Willis H. Ware, Grace M. Hopper and Others
April: Processing Information Using a Common Machine Language: The American Management Association Conference, February, 1954 — Neil Macdonald
The Concept of Thinking -- Elliot L. Gruenberg
General Purpose Robots -- Lawrence M. Clark
May: Ferrite Memory Devices -- Ephraim Gelbard and William Olander
Flight Simulators -- Alfred Pfanstiehl
Autonomy and Self Repair for Computers -- Elliot L. Gruenberg
A Glossary of Computer Terminology -- Grace M. Hopper
July: Human Factors in the Design of Electronic Computers — John Bridgewater
What is a Computer? -- Neil Macdonald
September: Computer Failures -- Automatic Internal Diagnosis (AID) -- Neil Macdonald
The Cost of Programming and Coding -- C.C.Gotlieb
The Development and Use of Automation by Ford Motor Co. -- News Dept., Ford Motor Co.
Reciprocals -- A. D. Booth
October: Flight Simulators: A New Field -- Alfred Pfanstiehl
Robots I Have Known — Isaac Asimov
The Capacity of Computers Not to Think — Irving Rosenthal, John H. Troll
November: Computers in Great Britain — Stanley Gill
Analog Computers and Their Application to Heat Transfer and Fluid Flow -- Part 1 -- John E. Nolan
All-Transistor Computer -- Neil Macdonald
December: The Human Relations of Computers and Automation -- Fletcher Pratt
Analog Computers and Their Application to Heat Transfer and Fluid Flow — Part 2 -- John E. Nolan
Economies in Design of Incomplete Selection Circuits with Diode Elements -- Arnold I. Dumey
January, 1955: Statistics and Automatic Computers -- Gordon Spenser
Eastern Joint Computer Conference, Philadelphia, Dec. 8-10, 1954 -- Milton Stoller
The Digital Differential Analyzer -- George F. Forbes
A Small High-Speed Magnetic Drum -- M. K. Taylor
An Inside-Out Magnetic Drum -- Neil Macdonald
February: Problems for Students of Computers -- John W. Carr, III
Recognizing Spoken Sounds by Means of a Computer -- Andrew D. Booth
The Significance of the New Computer NORC -- W. J. Eckert
The Finan-Seer -- E. L. Locke
Approaching Automation in a Casualty Insurance Company -- Carl O. Orkild

REFERENCE INFORMATION (in various issues):

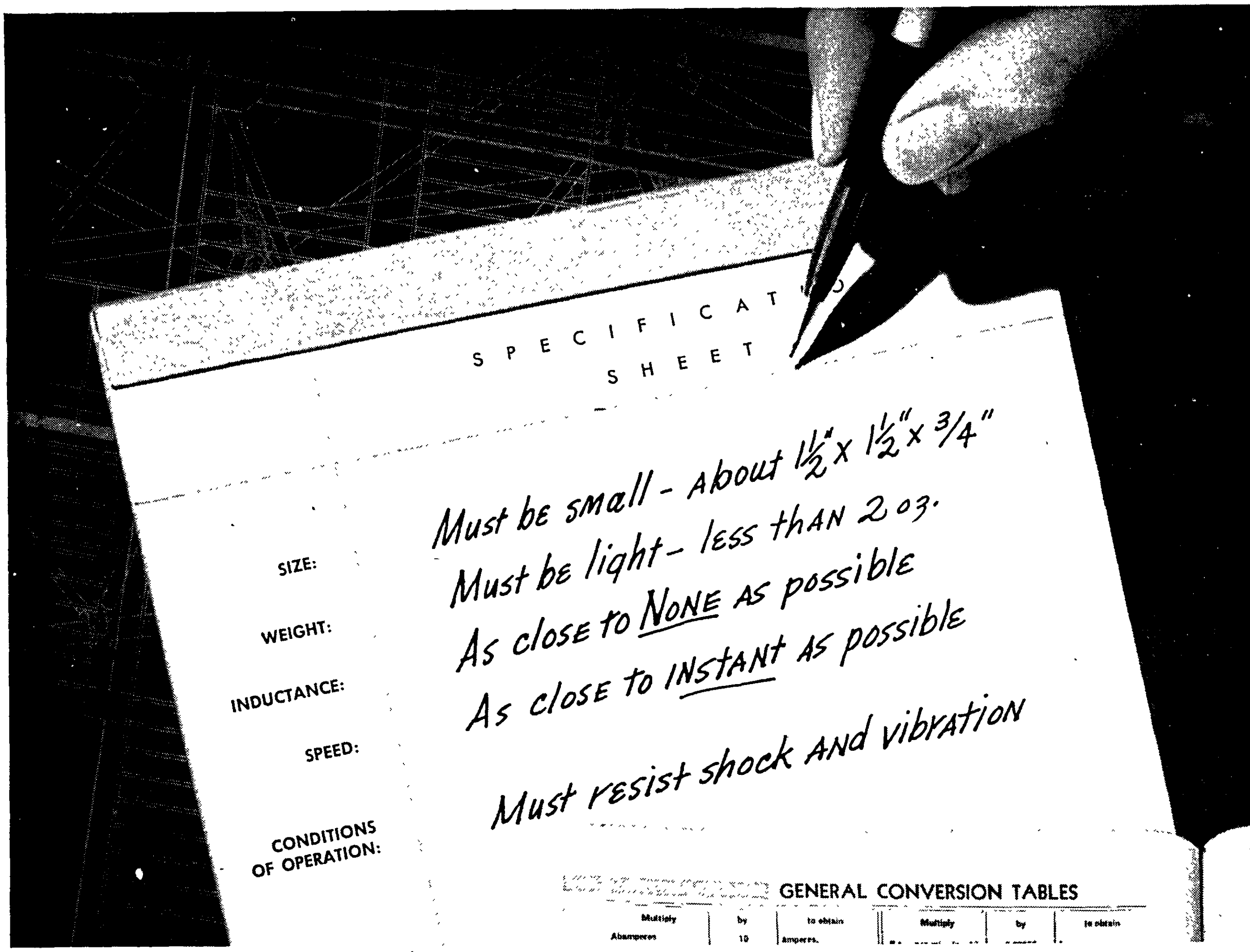
Roster of Organizations in the Field of Computers and Automation / Roster of Automatic Computing Services / Roster of Magazines Related to Computers and Automation / List of Automatic Computers / Automatic Computing Machinery -- List of Types / Who's Who in the Field of Computers and Automation / Automation -- List of Outstanding Examples / Books and Other Publications / Glossary / Patents

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

A subscription (see rates on page 4) may be specified to begin with any issue from Feb. 1955 to date.

WRITE TO:

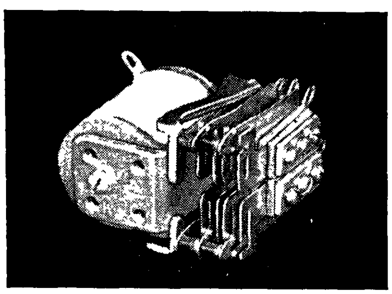
Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
36 West 11 St., New York 11, N. Y.



When you list these requirements for a relay:

you've specified

the Automatic Electric Class S Relay!



Class S Relays are also available PLUG MOUNTED... to give these additional advantages:

minimized inventory

Manufacturers of process control equipment have standardized on plug-in relays. In that way a manufacturer can interchange the same basic relay in many of its models.

fast, simplified inspection and maintenance

Manufacturers of remote control assemblies specify "plug-in" relays; whole banks of relays can be removed in seconds.

adaptability to hard-to-get-at locations

Manufacturers of machine tools with space problems use "plug-in" relays. Less clearance space is required for installation or removal of relay.

For years the Class S Relay has been meeting conditions like these, and others just as exacting . . . distinguishing itself for dependability . . . amazing users again and again with its stamina.

It's used in aircraft to adjust propeller pitch and synchronize engines, to operate landing flaps and landing gear, to provide automatic pilot equipment with snap and accuracy. It's used in guided missiles. In radio and TV, it is employed to select channels, to repeat pulses. It has hundreds of applications in manufacturing process control, computers, telemetering, automation.

The Class S Relay *probably* has a space-saving, weight-saving, money-saving application somewhere in your products. We'll be glad to send you complete facts and figures on this and the many other Automatic Electric relays. Ask for Circulars 1702 and 1803.

Write: Automatic Electric Sales Corporation, 1033 West Van Buren Street, Chicago 7, Illinois. In Canada: Automatic Electric Sales (Canada) Ltd., Toronto. *Offices in principal cities.*

RELAYS **SWITCHES**

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

ADVERTISING IN "COMPUTERS AND AUTOMATION"

Memorandum from Berkeley Enterprises, Inc.
Publisher of COMPUTERS AND AUTOMATION
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. The magazine was published monthly except June and August between March, 1953, and September, 1954; prior to March 1953 it was called "The Computing Machinery Field" and published less often than ten times a year.

2. What is the circulation? The circulation includes 1300 subscribers (as of Dec. 15); over 300 purchasers of individual back copies; and an estimated 1500 nonsubscribing readers. The logical readers of COMPUTERS AND AUTOMATION are some 3500 or 4000 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 Feb. issue was 2100 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. A mailing to some 2000 nonsubscribers in December, 1953 (with 173 responses up to March, 1954) indicated that two-thirds of them saw the magazine (library, circulation, or friend's copy) and of these two-thirds over 93% "liked it".

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"x10") 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" by 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
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.
Ketay Manufacturing Co.
Laboratory for Electronics
Lockheed Aircraft Corp.
Logistics Research, Inc.
Machine Statistics Co.
Monrobot Corp.
Potter Instrument Co.
Raytheon Mfg. Co.
Reeves Instrument Co.
Remington Rand, Inc.
Sprague Electric Co.
Sylvania Electric Products, Inc.
Telecomputing Corp.

ADVERTISING INDEX — MARCH, 1955

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).

Aircraft-Marine Products, Inc., 2100 Paxton St., Harrisburg, Pa. / AMP Wire Terminators / page 43 / CA No. 1

Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill. / Plug Mounted Class "S" / page 39 / CA No. 2

Berkeley Enterprises, Inc., 36 West 11 St., New York 11, N.Y. / Geniac, Publications / pages 2, 37 / CA No. 3

Computers and Automation, 36 West 11 St., New York 11, N.Y. / Back Copies, Advertising, Reply Form / pages 38, 40, 42 / CA No. 4

Electronics Corp. of America, 77 Broadway, Cambridge 39, Mass. / Help Wanted / page 31 / CA No. 5

Ferranti Electric, Inc., 30 Rockefeller Plaza, New York 20, N.Y. / Miniature Rapid Access Magnetic Drum / page 34 / CA No. 6

Ferroxcube Corp. of America, East Bridge St., Saugerties, N.Y. / Magnetic Core Materials / page 41 / CA No. 7

Hughes Research and Development Laboratories, Culver City, Calif. / Help Wanted / page 21/ CA No. 8

Lockheed Aircraft Corp., Burbank, Calif. / Career Opportunities / page 35 / CA No. 9

Machine Statistics Co., 27 Thames St., New York 6, N.Y. / Punch Card Tabulating Services / page 33 / CA No. 10

The Rand Corp., 1700 Main St., Santa Monica, Calif. / Help Wanted / page 41 / CA No. 11

Raytheon Mfg. Co., Foundry Ave., Waltham, Mass. / Magnetic Shift Register / page 37 / CA No. 12

Remington Rand, Inc., 315 Fourth Ave., New York 10, N.Y. / Univac / page 5 / CA No. 3

Republic Aviation Corp., Farmingdale, L.I., N.Y. / Help Wanted / page 31 / CA No. 14

Sprague Electric Co., 377 Marshall St., North Adams, Mass. / Noise Filters, Capacitors / page 44 /back cover / CA No. 15

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:↓

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

4¢ Postage Will Be Paid By --

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

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

IDENTIFICATION

Name (please print)...
Address ...
Organization (& address)?...
Title? ...

} Please fill in completely

WHO'S WHO ENTRY FORM

Year of Birth? ...

MAIN INTERESTS:
( ) Design
( ) Construction
( ) Applications
( ) Sales
( ) Electronics
( ) Mathematics
( ) Business
( ) Programming
( ) Other (specify): ...

College or last school? ...

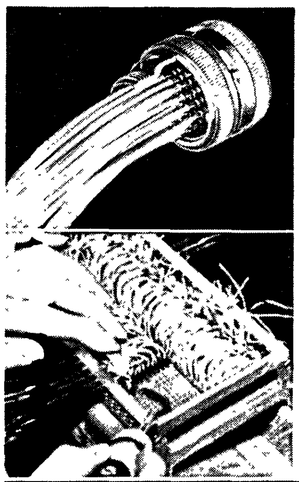
Year of entering the computing machinery field?

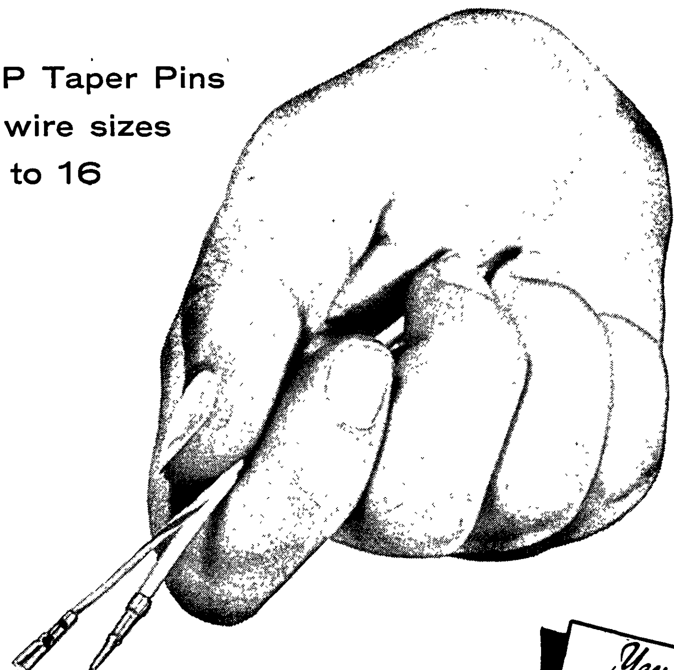
Occupation? ... (Enclose more information about yourself if you wish — it will help in your listing.)

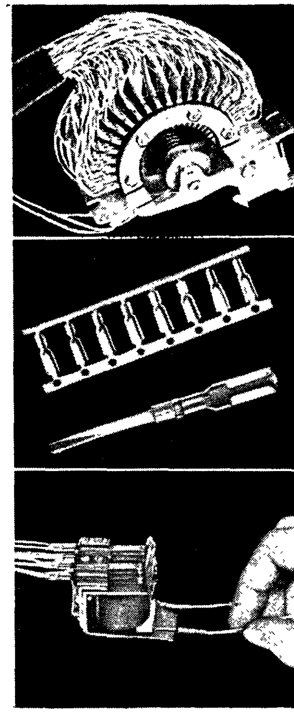
READER'S INQUIRY FORM

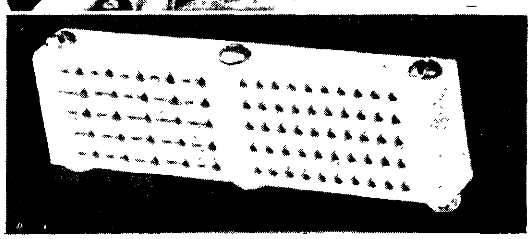
Please send me additional information on the following subjects for which I have circled the CA number:

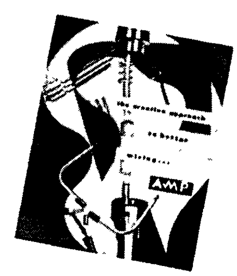
1	2	3	4	5	26	27	28	29	30	51	52	53	54	55	76	77	78	79	80	101	102	103	104	105	126	127	128	129	130
6	7	8	9	10	31	32	33	34	35	56	57	58	59	60	81	82	83	84	85	106	107	108	109	110	131	132	133	134	135
11	12	13	14	15	36	37	38	39	40	61	62	63	64	65	86	87	88	89	90	111	112	113	114	115	136	137	138	139	140
16	17	18	19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



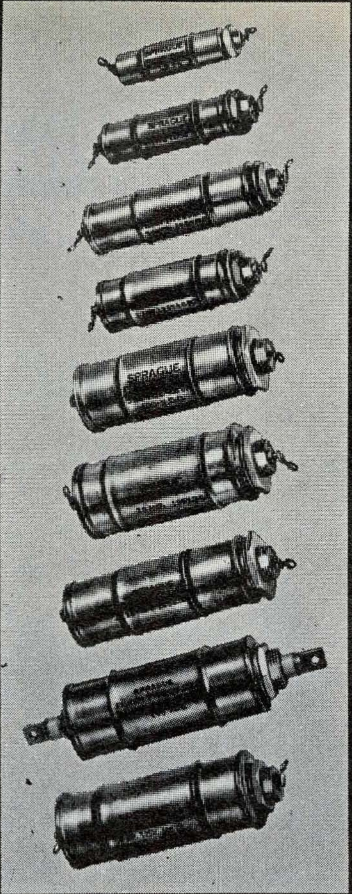







AMP

New
HIGH INSERTION LOSS NOISE FILTERS



Now Sprague brings you a complete series of miniaturized, bulkhead-mounting interference filters for aircraft and mobile electrical and electronic equipment in ratings from 0.1 ampere to 20 amperes for both 125 volt dc and 125 volt ac, 400-cycle service. These filters meet all pertinent MIL and AN requirements for operation at temperatures from —55°C to +85°C. All designs are hermetically sealed with glass- or ceramic-to-metal solder seal terminals.

These filters are available to meet *your* production schedules from the West and East coast plants of a reliable, old-line manufacturer. For Engineering Data Sheets on the units in which you are interested, write today to the Technical Literature Section, Sprague Electric Company, 11325 West Washington Blvd., Los Angeles 66, California, or 377 Marshall St., North Adams, Massachusetts.

SPECIFICATIONS

RATING		CATALOG NUMBER	CHARACTERISTICS							
CURRENT (AMPS)	VOLTAGE FREQUENCY		WEIGHT (OZS.)	SIZE (DIA." X LENGTH")	INSERTION LOSS (DB) AT GIVEN FREQUENCIES (MC) (50 OHM SYSTEM)					
					.15	.5	1	10	100	400*
0.1	125VDC	1JX54	1.5	⅝ x 1⅞	63	100	100	112	>84	>80
1	125VDC	1JX36	2	25/32 x 2¼	56	81	>100	86	>90	>73
1	125V/400CY 400VDC	1JX42	5	31/32 x 2 15/32	50	79	96	97	80	>56
5	125V/400CY 400VDC	5JX15	6.5	1 7/32 x 3	60	90	>112	100	>70	>70
5	125VDC	5JX18	3.7	31/32 x 3 1/16	59	89	> 95	>105	>90	>73
10	125V/400CY 400VDC	10JX15	8.5	1 11/32 x 3 13/32	59	88	>100	87	>80	>79
10	125VDC	10JX16	7.5	1 7/32 x 3¼	74	106	>109	>113	>93	>81
20	125VDC	20JX14	9	1 11/32 x 2 15/16	57	88	>103	> 99	>90	>83
20	125V/400CY 400VDC	20JX15	10	1½ x 3 19/32	56	88	>100	>114	>83	>60

*Beyond the range of measurement

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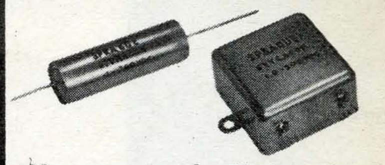
Now
STYRACON "B" CAPACITORS

In Wide Range Of Needed Values For Critical Applications



Now you can select Sprague Styracon "B" capacitors in the most needed voltage, capacitance, and tolerance values for those critical applications in analog and digital computers, precision timing circuits, etc.

Employing a specially processed polystyrene plastic film as the dielectric, these capacitors have extremely high insulation resistance, freedom from dielectric absorption, extremely low power factor (or high Q), close capacitance tolerance, and unusually excellent capacitance stability. Temperature coefficient of capacitance over the rated operating temperature range of —55°C to +85°C is—100 ppm/°C and practically linear, and is independent of frequency.

Sprague Styracon "B" capacitors are also available in various mechanical configurations to meet application needs. All are hermetically sealed in metal cases.

Write for Engineering Bulletin 250A, available on letterhead request to the Technical Literature Section, Sprague Electric Company, 377 Marshall Street, North Adams, Mass.

uF	VDC	CATALOG NO.		CASE STYLE
		± 5% TOL.	± 2% TOL.	
.01	200	114P10352S2	—	TUBULAR
.01	600	114P10356S2	—	
0.1	200	114P10452S2	114P10422S2	
0.1	600	114P10456S2	114P10326S2	
0.5	200	111P1J	111P1G	BATHTUB
0.5	600	111P3J	111P3G	
1.0	200	111P2J	111P2G	
1.0	600	111P4J	111P4G	

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