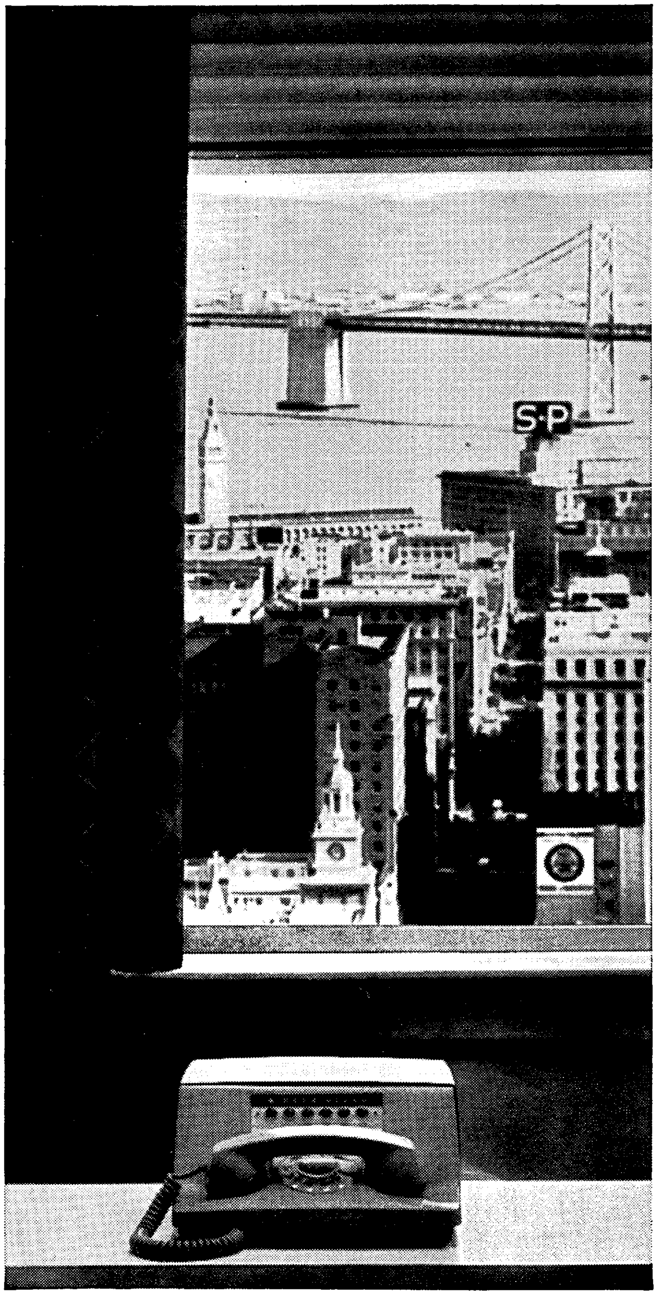
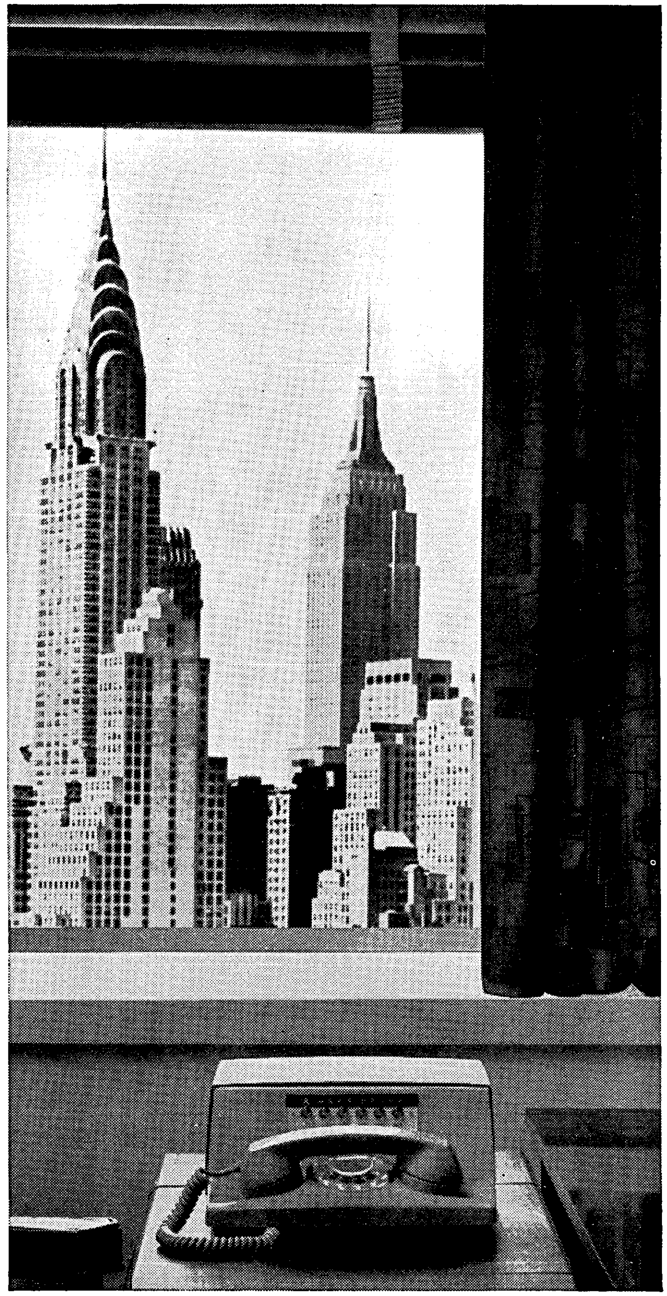
Teaching Machine Issue / March, 1963

computers and automation

In the Classroom of Tomorrow . . . *"A Transistor for the Teacher?"*





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"A Transistor for the Teacher" may well be the rhyme of tomorrow's school children if experiments in automated education such as those being conducted with computer-controlled tutoring machines at the System Development Corp. are successful. Don Bushnell (seen guiding class in photo) provides on page 8 an up-to-date review of progress in this area.

computers and automation

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computers and data processors: construction, applications, and implications, including automation

In This Issue

In Every Issue

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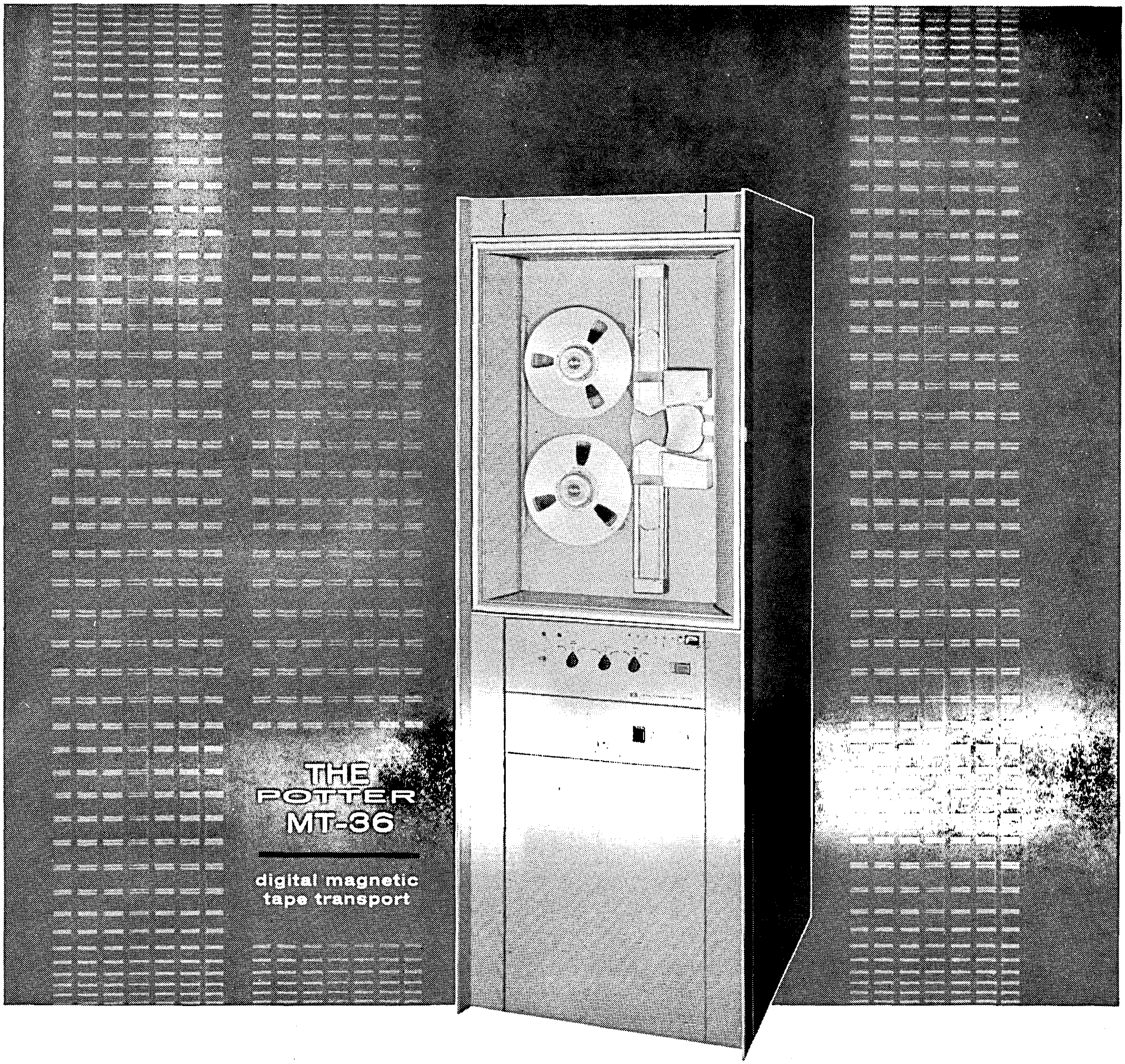

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Readers' and Editor's Forum

CENSUS PRAISED

To the Editor:

I am a member of a committee of the National Academy of Sciences looking into the amount of Federal Support which should be given to computer centers in the U. S. I want to tell you that we find your Monthly Computer Census very useful. I hope you will continue it.

A. H. ROSENFELD
Lawrence Radiation Laboratory
University of California
Berkeley 4, Calif.

MORE NOTES ON USED COMPUTERS

To the Editor:

The **Computers and Automation** articles, "The Case for Buying a Used Computer" and "The Used Computer Market" in your November 1962 issue are very timely for people in data processing and computer work who are facing the question of either selling or buying a used computer. These articles are the only well informed source data which I have seen that have been published on the subject of the still infant used data processing equipment market. Hearty congratulations to you for this good work. I hope it will become a regular feature.

You might be interested in some information that came to me indirectly recently about trade-in practices in one area of this market. An IBM 1401 about two years old is soon to be replaced with advanced equipment. It is my understanding that the trade-in offer from the manufacturer was a figure of about 35% of the original purchase price. This is of interest, I believe, since for all practical purposes the trade-in allowance offered by a manufacturer at any given time puts a price floor under such late model used data processing equipment.

It is my understanding that up to last August the IBM branch offices were supplied with lists of machine trade-in prices which the branch managers and salesmen could use as a basis for immediate trade-in deals with any customer. This arrangement was cancelled sometime last Fall, and now all proposed trade-in's must be written up and sent to IBM headquarters for individual quotations. It is also my understanding that there is a list of somewhat older card operated equipment for which no trade-in is offered. Probably a similar arrangement is used by all of the major manufacturers.

A practical working level of used computer market values depends in part on an analysis such as was presented in "The Case for Buying a Used Computer" and a discussion between buyer and seller on such practical questions as programming for a different computer, an additional computer or a first computer. Also there is the very basic question of repairs and maintenance, together with the future utility value of the used computer to a user for an estimated span of years.

Until recently the end product of an ADP system with qualified supervision was accounting or other data processing results that came wrapped up in a tidy package for a monthly rental which included systems service and machine maintenance. Now with the advent of a used computer market a computer can be purchased for a fraction of its original price, but systems service and maintenance must often be provided from somewhere else in order to insure satisfactory results for the buyer.

To the large firm with a well developed systems, methods, or data processing department, this is not especially a problem. For the medium sized and smaller firm, these services are available from the manufacturers, and from many well qualified CPA's and management consulting firms.

Important factors to consider in any used computer transaction are the questions: Who takes it down and packs it in its present location? Who unpacks, assembles it, and tests it out at a new location? How much will these essential services cost? It is my understanding that some large computer users are adding full-time Customer Engineer technical people to their staffs. For the medium and smaller firms whose volume will not justify a full-time man, there are several Technical Engineer service firms in the larger metropolitan areas to supplement the machine repair services from the manufacturers.

If the prediction in the closing paragraph of "The Used Computer Market" story comes true, then there will be a sharply increased demand for the services of qualified technical maintenance engineers, either from the manufacturers, private service groups, or the user's own staff. Notably, there are now several dealer firms who are willing to work with those faced with computer equipment obsolescence in making the prediction in that article come true.

NICHOLAS H. DOSKER, JR.
Louisville 2, Kentucky

PLAUDITS FROM A POETIC READER

To the Editor:

Reading your December and January numbers was rather like awakening one morning to find one's faithful old motorcar transmogrified into a splendid new machine. It was comforting to find the same dependable engine, but with more horses; the still firm suspension, with an even smoother ride; intriguing to note the elegant refinements of an interior already tastefully functional—and all this enclosed by a dashing new exterior. Allow me, Sir, to congratulate you.

While engaged in all this automotive imagery, let me rehearse for you a mercifully brief tale of a man called Auto, in a form neither poetry nor even prose run mad:

Auto had some sums to do,
The computer printed one;
But since he put in two plus two,
Computers Auto may shun.

JAMES X. SHORT
Cambridge, Mass.

COMPUTERS

At the recent Workshop on Educational Data Processing held at the System Development Corporation in Santa Monica, California,[1] it was reported that increasing numbers of school districts and higher learning institutions are installing electronic data processing systems (EDP systems) for the management of educational data. This development of course is associated with the already extensive use of electronic accounting machines in the offices of pupil-personnel, registrar, and business; and it seems to forecast even further automation in our schools and universities.

There is good evidence, too, that such automation will gradually extend into the classroom itself. Automatic translating machines, computer-based teaching-devices, rapid document-retrieval systems, computerized models of school-system operations, and other similar applications of computer technology are coming to fruition. And the digital computer and its peripheral equipment will support most of the subsystems in the total school-system. These applications, of course, will have an impact on education provided the research is taken out of the laboratory and introduced into real school situations.

Developments

The research and technological developments discussed at the Workshop can be summarized as follows:

1. *The Computer-Based Teaching Machine.* By branching students laterally, backward, and forward through subject material, the machine develops a course of study individually suited to each individual student's educational background, level of motivation, and aptitude.
2. *Information Retrieval Systems.* Up-to-date information in any area of the arts and sciences can be provided by information centers using: abstracting and translating machines; techniques of rapid retrieval and dissemination of data; and data-link transmission lines that link the school computer with information centers.
3. *Simulation Programs.* Computer-based programs of simulation will aid management and teaching by:
   a. supplying periodic economic or population forecasts;
   b. helping to balance budgets;
   c. giving guidance in the planning of new educational facilities;

The instructor (at the right) shows the subject his decisions on a machine developed for "Project Decision," a psychological research program conducted cooperatively by The Catholic University of America and ACF Electronics, a division of ACF Industries. The instructor checks the actions taken by the subject on his console (not in this picture). The subject decides how much to risk, at what odds, to achieve a "payoff" in a series of numerical problems. The answers appear on the large matrix facing the instructor.

IN EDUCATION

DON D. BUSHNELL
Automated Education Project
System Development Corporation
Santa Monica, California

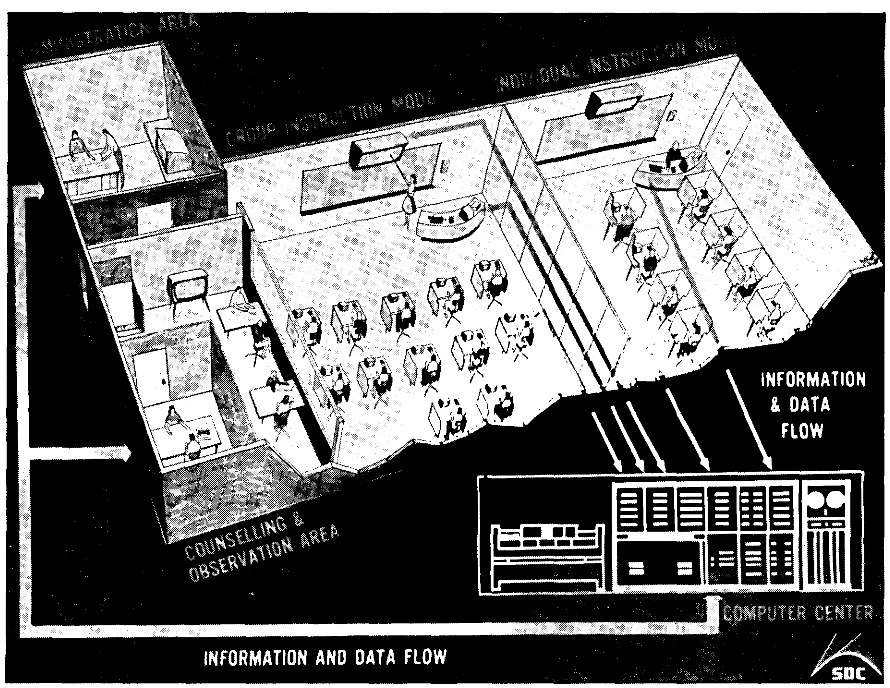
d. expediting the training and selection of educators;
e. making classroom and vocational instruction easier.

4. *The Automated Classroom.* New technical developments have occurred for processing educational data and for organizing instructional material in the classroom. Counselor and teacher data displays, automated diagnostic routines, and programs permitting student-directed exploration of subject matter will result from such techniques.

An Integrated Educational Data Center

In an educational system, a single integrated center for data processing may serve the needs of the administrator, teacher, counselor, curriculum developer, and student. For example, students might carry on independent study with programmed materials, and the machine would make detailed records of their responses, recording the answers chosen by the student to the questions presented by the teaching machines. These records would be stored on magnetic tape in a central computer. The information thus stored would be summarized for the counselor, for it would reveal much about each

Artist's sketch of a laboratory simulating an experimental school, and using the concept of a central data store.



student's individual learning problems. The curriculum developer would have summary reports telling many students' learning experiences; he would use these for evaluating curriculums and proposing modifications. Teachers would have an up-to-date account of each student's extent of understanding of the subject matter. The school librarian could update the record of the student's information-needs, and could guide the teacher in selecting particular materials that would be helpful. The administrator would learn the progress of the individual student, and would be able to select study programs for him, in the nongraded school system environment.

This is an example of applying the total systems concept in the storing and retrieving of educational data. Present applications of EDP systems in education are much more limited in scope; but if the results of current research are applied to the future configuration of school systems, and if centralized data processing continues to expand, educators may expect major technological changes in their profession, as computers enable the educational process to become far more efficient.

Other developments in computer technology might be initiated for the realization of future goals. None of these developments, to be discussed below, were touched upon at the recent Workshop, nor are they likely to be for some time to come, since obviously many breakthroughs are to be made before the new developments are applied in educational practice. However, the futuristic look at new developments raises an interesting question of the readiness of the educator to utilize the technology when it does exist.

Effortless Learning and Attitude Changing

In 1960, Dr. S. Seshu, Professor of Electrical Engineering at Syracuse University, conceived of the "penultimate" teaching machine as an electronic transducer or input system which transfers factual information stored on punched cards or magnetic tape directly into human memory.[2] This would be accomplished without first having the information processed by the visual or aural senses. "All that we need to do," suggests Seshu, "is to find the input terminals in the human brain and the necessary code—the gadgetry is trivial." His contention is that the basic trouble with the teaching machine or any modern learning method is that the input is fed in at the wrong place. When the input to the brain arrives visually or aurally, it is often distorted or lost in the transference process. "What is needed is a transducer capable of transferring information to the human memory with the same ease and accuracy of data being transferred into the memory of an IBM 7090," asserts Seshu.

Although these are major barriers yet to be surmounted by the physiological psychologist, it is conceivable that such a machine may eventually exist. The question arises, should the effortless learning machine teach beyond the limits of factual data? If the student can take in information without error, shouldn't the teacher also steep him in the culture, train him in the proper professional attitudes, and thoroughly ground him in the scientific method as a way of life? It is difficult to know where a responsible instructor would leave off in the use of this effective tool.

Attitude-Changing

Another potential development in computers is the attitude-changing machine. Dr. Bertram Raven in the Psychology Department at the University of California at Los Angeles is in the process of building a computer-based device for changing attitudes.[3] It is planned that this device will work on the principle that students' attitudes can be changed effectively by using the Socratic method of asking an appropriate series of leading questions logically designed to right the balance between "appropriate" attitudes and "inappropriate" attitudes. For instance, after first determining a student's set of attitudes through appropriate testing procedures, the machine would calculate which attitudes are "right" and which are "wrong." If the student were opposed to lowering tariff barriers to foreign trade say, and a favorable disposition were sought, the machine would select an appropriate series of statements and questions organized to change the student's attitudes. The machine, for instance, might have detected that the student liked President "Williams" (say); therefore, the student would be told that President Williams favored increased foreign trade. If the student's liking for President Williams was sufficiently strong, Dr. Raven would argue that a change in attitude favoring increased foreign trade would be effectively brought about by showing the student the inconsistency of his views. There is considerable evidence that such techniques do effectively change attitudes. The question of course arises, what is the appropriate subject material, or "attitudes" in this instance, with which to indoctrinate the student?

Making Decisions

As a further example, at the Catholic University of America in Washington, D. C., a psychological research program is underway to study the problems of training a student in decision-making skills (see photo). A special-purpose computer and display equipment presents the student with a series of numerical problems designed to test the student's ability to make good decisions at maximum speed.

Training in the skills of deciding is of course a legitimate goal of education in this age of automation. But the problem remains: does the educator know what values to attach to the different alternatives of these decisions? For example, should students whose values are different from the acceptable values of democratic society be taught to conform to someone else's judgment of acceptable values? Training in decision-making is ultimately compounded with training in value judgment and, as such, becomes a controversial subject; some resolution of controversy is needed before programmed learning can be put to use. Progress must be made not only in data-processing technology, but in our knowledge of educational requirements. Automation requires a clear, operational statement of objectives to be accomplished by the system being automated. Desired student behaviors and attitudes need to be more precisely defined.

Trends in Hardware and Costs

The tools reported in the foregoing discussion are of course expensive. If the question were asked whether or not education could afford a medium- or large-capacity computer, the answer today would be "No." But multi-processing, miniaturized large-capacity computers are on the horizon, and it may be expected that the tools will become economically feasible in the next few years, even perhaps for the small school district.

If computer-based instructional systems are to be applied on any vast scale, they must be economically competitive with other systems performing similar functions. Some

(Please turn to Page 53)

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THE Bendix CORPORATION

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Programmed Instruction

PART I

PROGRAMMED LEARNING FOR COMPUTER PROGRAMMERS

Along with the evolution of the automatic computing machine came a new occupation now known as "programmer," whose job it was to prepare the instructions (or "program") for the machine. The rapid introduction of hardware in a few, short years generated a monumental requirement for programming, or "software," creating the need to obtain large numbers of sufficiently proficient computer programmers.

The number of programmers trained by older, conventional methods of human instruction is far from adequate. The frequently used practice of assigning a novice to a master programmer is quite inefficient. This report deals with recent efforts to develop computer programmers through the use of what is known as materials for "programmed instruction" or "programmed learning," where the word "program" in this phrase is used in a different though closely related meaning, referring to a carefully constructed sequence of specific instructions for teaching a human being rather than for instructing an automatic computing machine.

Conventional Programmer Training

The technique of changing a person's behavior is called *training.* A training program is successful if (a) its objectives are clearly defined in behavioral terms, and (b) its effect on a trainee results in his being able to perform the defined behavior within limits of proficiency previously specified.

Traditionally, training programs have been conducted in the classroom-laboratory format, and have depended upon expert human instruction and the use of carefully prepared course outlines, lesson plans, workbooks, textbooks, manuals, performance tests and similar conventional methods (Ref. 1). To what extent these formal training programs conducted across the nation have actually produced competent programmers is a matter of conjecture. The answer is partly obscured by disagreement about what a programmer really must know and do in the process of programming. The job analysis of "Programmer" is affected by differences due to the type of computer, kinds of problems to be solved, and many other factors. Also, there has been a less than acceptable evaluation, on a systematic basis, of the elements constituting a training program for computer programmers and the *transfer* of these learned elements to the real-life programming situation.

Training by Use of Self-Instructional Techniques

Following soon after the explosion of the computer field was the less momentous birth of the technology of the teaching machine and "programmed learning." The reader needs to be warned about the term "program" and the phrases in which it occurs. A *training* program, *computer* program, and *teaching machine* program are different forms of *different* things and should be differentiated rather than integrated! (Ref. 2)

It would have been unnatural if computer-oriented individuals had ignored the potentialities of the man-machine relationship known as "teaching machines and pro-

for Computer Programming

Gloria M. Silvern,
Research Specialist, Computer Center, Space and Information Systems Division, North American Aviation, Inc., Downey, California

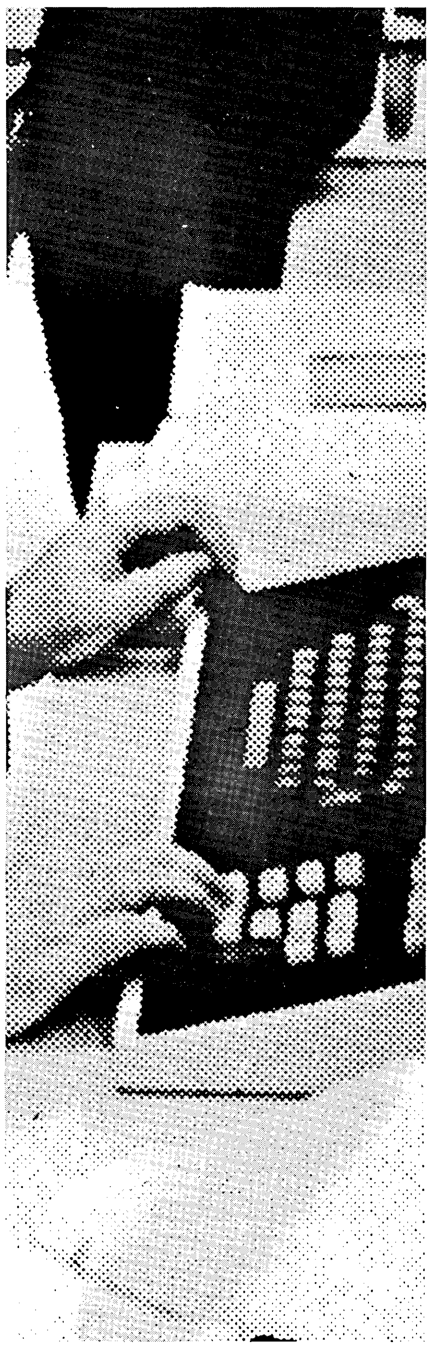
grammed learning." In fact, it would have been impossible. Consequently, a number of efforts were begun to fertilize human instruction with the forms of machine instruction.

This report will not attempt to outline the principles of programmed instruction nor to discuss its advantages or disadvantages. The nature of programmed learning has been set forth in a large number of texts, articles and papers, and the reader is referred to one of these for further information. (Ref. 3)

PART II

REVIEWS OF FIVE CURRENTLY AVAILABLE PRODUCTIONS OF PROGRAMMED LEARNING FOR TRAINING PROGRAMMERS

Part II of this report is devoted to five instances or productions of programmed learning for training people to become computer programmers. Three are in text format, and one in machine format, and these attempt to teach computer programming and are currently available. In addition a fifth program, in text format, will be examined but not reviewed because it has not yet been released for distribution. Several other programs which deal with training for the job of computer programmer are still being field-tested, are not yet available, and were not provided for review at this time. Programs written in-house by various companies for their own use, but which will not be made available outside the company, are not included. An examination of teaching machine and



programmed learning materials which merely *use* computers or which deal with computer-related skills and knowledge, such as PERT, matrix algebra and number systems, is beyond the scope of this report.

1. **Title:** "FORTRAN AUTO-TESTER," Document 186A
   Author: Control Data Corporation
   Publisher: Control Data Corporation
   Date of Publication: 1961
   Format: Text, loose-leaf, 176 pp., 3½" x 6"
   Type: Branching variant using the scrambled-book layout.

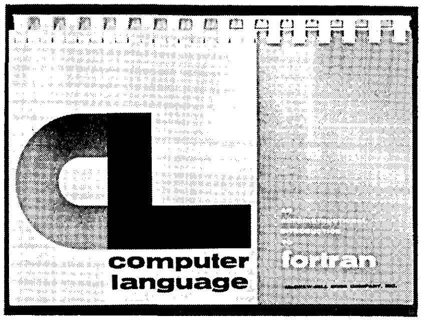
A casual, visual inspection of this program is deceiving. What appears at a distance to be a branching program turns out upon close examination to be mainly a combination of linear and two-alternative branching, although more alternatives appear occasionally. Except for the few points where branching occurs, the bottom line of each page directs the trainee to "Go to x" where x is the number of the following page. Thus, if each page is to be considered a separate step, few steps require any response from the trainee. If several pages are considered to comprise a step, then the size of step is invariably very great in contrast with programs in other subject fields. One such "step" covers three pages dealing with the concepts of arrays and subscripts, the use of commas and parentheses, the DIMENSION statement, and a problem; all of the instruction is new—it had not been instructed in any previous steps. Towards the end there are as many as ten consecutive pages on input-output before one in which a response is required.

The Preface states that "Every effort (through "humor," etc.) is made to keep you awake!" Consequently, this "self training device designed to emancipate the scientist and engineer from the need for the professional programmer" suffers from a large overdose of "go take a shower," "complete the limerick . . . ," "roses are red, violets are blue . . . ," and other irrelevant, distracting and adolescent trivia. The author(s) were unable to detect their inability to avoid prompting, and the trainee cannot escape cues which virtually give him the correct response. Many of the branches which should lead to *remedial instruction* instead direct the trainee to "try reviewing 80-84" or some similar vague, unstructured activity.

What is important, however, is the critical *evidence* that a trainee (engineer or scientist) who begins the text as a novice ends it with "*sufficient* skill, in a *minimum* of time, to enable him to *efficiently* program his own problems" as the Preface claims. The real-life test of *any* black box is its ability to modify the input and produce the output for which it is designed. This capability is the "figure of merit," "gain" or "efficiency" of the system. In the absence of such external criteria and in the presence of the program alone, one must regretfully conclude that FORTRAN AUTOTESTER receives an A for Effort (the first known program in its field) and an I (Incomplete) in the absence of evidence that those who complete it "can do a creditable job of programming *any* problem in Fortran." Anyone who is able to present systematic evidence will contribute to the conversion of the "Incomplete" to a higher or lower grade.

2. **Title:** "COMPUTER LANGUAGE —an Autoinstructional Introduction to FORTRAN"

Author: H. L. Colman and C. Smallwood
Publisher: McGraw-Hill Book Company
Date of Publication: 1962
Format: Text; plastic bound, 175 pp. + answers, references, index, coding forms, 6" x 9"
Type: "No-response" mode and exercises requiring written completion.



The Foreword describes the program as designed to *train* students at the UCLA Western Data Processing Center to use FORTRAN and produce "their first Fortran program." A "period of advanced training on the special features of any particular system" is deemed necessary to produce "useful computer programs for that system."

The Preface states that the program is based on B. F. Skinner's reinforcement theory of learning, yet nowhere in the text will be found the constructed response frames so characteristic of Dr. Skinner and his followers. Instead one finds two to 38 consecutive pages, each containing approximately five "frames" which do not require trainee response. These are followed by as many as twenty questions or problems lumped together which deal with the preceding statements. Correct "answers" to the exercises are traced to the rear of the text where they appear in a random but labeled array. The authors contend that "if the overt response and verification are omitted, the result is a program of instruction that is equally as effective and significantly more efficient . . . called the no-response mode."

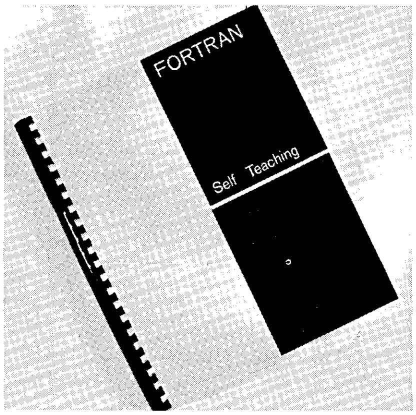
One way of describing the text is to visualize a standard, college textbook consisting of chapters with a set of exercises or problems at the end of each chapter. This college textbook also has an answer section in the rear so a student can check his solutions. "COMPUTER LANGUAGE" has the basic structure of the college textbook. It does, however, differ in one major respect: the college text is much more complete! The Colman-Smallwood text attempts to break down the text material into small steps by taking a significant statement (sentence or short paragraph), drawing a *rectangle* around it, and connecting the series of rectangles with arrows in flow-chart style. The layout has the advantage of squeezing in a maximum number of rectangles per page, but it is a very poor example of flow-charting. Since the mode is "no-response," the trainee merely reads the contents of each rectangle until the chapter is completed, then attempts to solve the exercises, checking his answers in the rear of the book.

The authors, in planning ahead for more able trainees, suggest that those who are confident that their answer is correct may omit verifying it. If this procedure is followed, incorrect answers may often go unnoticed! The rectangles, called "frames" by the authors, are drawn differently to denote the kind of information contained. The "essential facts" are represented by solid-line, black-bordered rectangles and require concentration, while the trainee may skim over the "explanations" and "examples" depicted by broken-line borders if he finds the subject-matter easy to understand. A careful analysis of the content of these broken-line rectangles reveals that they often contain essential facts. Skimming therefore would not contribute to proficiency. Besides, the trainee tends to read these frames to find out if he should skip them. Thus, the varying borders merely add confusion.

This is the only "programmed" text in any subject-matter field using the "no-response" mode combined with the rectangle-flow-chart style. It may be concluded that, despite the title and statements made in the Foreword and Preface, to say nothing of the advertising, this is *not* an example of *bona fide* programmed learning.

The authors state that "The program has never been experimental." It is contended that "early drafts underwent informal trials, which resulted in extensive revisions and retrials." No specific data is provided or even referenced in a bibliography to permit a prospective user to examine the conduct of the criterion tests.

What is missing, as usual, is any evidence to support the claims made that it is "a practical replacement for eight hours of traditional instruction." Therefore, "COMPUTER LANGUAGE" receives an I (Incomplete) on the grounds of insufficient evidence. So far as effort is concerned, the identification in the Preface with B. F. Skinner suggests that the authors might profit by making a more strenuous attempt to understand the Skinnerian point of view.



3. **Title:** "Self Teaching FORTRAN"
Author: S. C. Plumb
Publisher: Programmed Instruction Center, IBM, Poughkeepsie, N. Y.
Date of Publication: Third Edition —1962, not yet available
Format: Text; plastic bound 345 pp. + index, 8½" x 11"
Type: Written-completion involving constructed word responses and problem solution; some multiple-choice and simple branching.

This program is in the third edition and has not been made available to the general public or on a quantity basis to IBM groups internally. Therefore, the criteria normally applied will be withheld. It is expected that the final edition of the program will be supported by the evidence now being collected and evaluated.

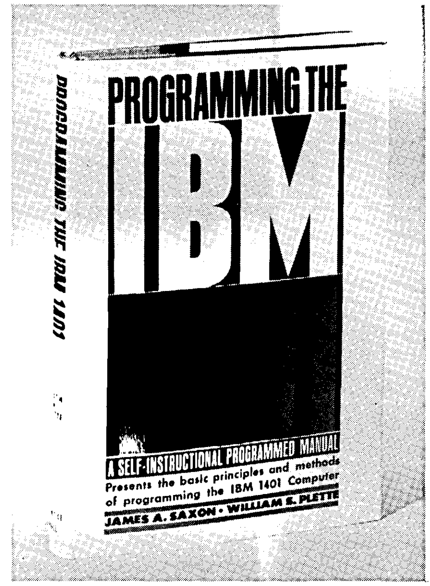
Each page is divided horizontally into three "tracks" or parts. The trainee receives a step of instruction and a question which calls for a written response on the page. Upon turning the page, in the corresponding section of the next right-hand page, the correct answer is stated along with the next increment of technical information. The trainee moves along a "track" until he is directed to change tracks or invert the book. When inverted, the three upside-down tracks on the left-hand pages become right-side up on the right-hand pages. In this way, all the space is used, even though the trainee, in the process of following one track, must disregard the others.

Additional exercises are located at the end of each chapter, and occasionally the trainee is directed to solve these and then check his answers with the ones provided. Each chapter also has an "examination" which is to be removed from the plastic binder and turned in; the solutions to these examination problems *are not included* in the text. At the end of the book is a final examination consisting of two problems which are to be programmed and run on the computer.

It is refreshing to find a text on FORTRAN which is *bona fide* programmed instruction. The writing style is informal yet retains its technical character. A few minor criticisms may be offered. The author tends to use T (true)—F (false) steps occasionally which reduce the value of the response; it is neither written-completion nor true multiple-choice and the element of chance or guessing is introduced. Some steps appear to contain excessive prompting. On the whole, however, the steps seem to be carefully constructed and the step size appears to be appropriate for the material and the intended trainee population.

Based upon a visual inspection and sampling of critical sections, the program receives A for Effort, A for Patience, and I (Incomplete) pending final publication after tryout with supporting evidence. The author has followed a systematic pattern of preparation and controlled administration which should aid in establishing minimum standards for similar efforts in business and industry. "Self Teaching FORTRAN" adheres closely to what is now identified by authorities as acceptable technique.

4. **Title:** "PROGRAMMING THE THE IBM 1401—A Self-Instructional Programmed Manual"
Author: J. A. Saxon and W. S. Plette
Publisher: Prentice-Hall, Inc.
Date of Publication: 1962
Format: Text; hard covered and bound, 194 pp. + index, answers
Type: Written-completion involving constructed word responses and written solutions. The answers are entered directly into the book.



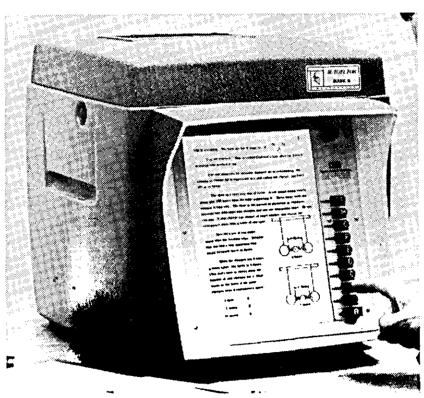
The Introduction describes the volume as a "self-instructional workbook." Its purpose is to teach a beginner to program for the IBM 1401. The objectives specify that the program "will not qualify the student as an *expert* programmer . . . it will teach him the fundamentals. . . ." The program consists of ten units, each of which contains from two to six lessons. The authors recommend that trainee sessions not exceed two hours each, with not more than two such sessions per day. However, no data is presented to explain the basis of their recommendation.

A typical lesson consists of instruction and examples, followed by a series of problems with space provided for written responses, and followed on the next page by the correct answers together with some reinforcement. Each unit has a quiz summarizing the lessons in that unit, with quiz answers and explanations on the following page. A final quiz covers highlights of the entire course, and the last lesson contains a fairly comprehensive flow-charted final problem which is to be coded by the trainee.

As the program progresses, the instruction step lengthens from half a page to about four pages due to the inclusion of more material, flowcharts and coding examples. This style avoids the less desirable method of having a trainee flip continually to the rear for flowcharts and examples. However, the size of the instruction step and the organization of the book places this program more in the text-workbook category than in the programmed text classification.

The program appears to have had careful, detailed preparation. The authors have not described the methods they might have used to revise the program or whether it was actually used to train programmers. Therefore, the claim that "it will teach him the fundamentals of programming for the IBM 1401" is without explicit foundation. The grade is A for Effort; the statements appear to be carefully made, page layouts utilize graphics and the instruction seems to be designed for use by a novice in a self-study environment. The program is somewhat technical but no effort is made to talk down to the trainee or humorize—the presentation is straight-forward. It captures and retains a technical style until the last page when, in Concluding Remarks, it wishes the trainee "good luck in your new profession."

This reviewer believes that the grade for Performance should be I (Incomplete). Again, no evidence in the form of data is provided. How many revisions were made prior to final publication? On what grounds were revisions made? How many trainees were used in the tryouts? What criterion tests were used? One can only accept the authors' word that it *will train* a programmer. While their intention that it *should* produce results is not questioned, the results it *did* produce are not described.



5. **Title:** "Computer Programming"
Subdivided into three parts:
Part I Computers—An introduction to Programming
Part II Computers—Techniques in Programming
Part III Computers—Advanced Techniques in Programming
Author: Theodore G. Scott
Publisher: U. S. Industries, Inc.; Educational Science Division
Date of Publication: 1962
Format: 35mm single frame film, black and white (usable only in the AutoTutor* Mark II), 3 reels
Type: Multiple-choice, branching
* Trademark

This program is presented to the learner in the form of a screen display of film frames projected through a special lens and controlled by an indexing system. Instruction is provided and a question or problem is given. In all instances, multiple choice alternatives are exposed to the learner who responds by selecting and pressing the appropriate button on the keyboard. The indexing mechanism searches the film and either reinforcement for correct responses or remedial instruction for incorrect answers is presented visually.

In examining the *content* of the course, a number of significant points are worth noting. This program is a *general* course in computer programming in which a fictitious computer, TUTAC, is used. All principles and the illustrative problems deal with TUTAC. This is in contrast with other programs which are written to develop programmers in an actual language. In essence, this is a practical extension of the classic differentiation between "training" and "education." Not only must a training director who plans to use it be satisfied that it successfully produces learning for the *general* case, but that a learner is able to *transfer* this general instruction to a *specific* case on the job. Obviously, the author can only be responsible for proving conclusively that learners do learn TUTAC programming. The training director as a purchaser must be sure the TUTAC programming is readily transferable to programming for the specific computer being used. The use of pseudo or fictional computers is a practice in education environments where machines are often not available, rather than in business and industry where *specific* hardware and software techniques exist.

The program presents very specific information and methods, implying to a novice that "this is the only way to do this." For example, a learner can easily believe that card read-in is the only way to enter data into computers, since lesson 1 does not mention the possibility of anything else. Not until lesson 13 is he informed of several other possible means of input. Had this program been developed for a real-life computer rather than TUTAC, the specific limited instruction would be praised rather than criticized.

The amount of material in a frame approximates that on a printed page. The answer to the previous step, together with reinforcement, occupies almost half the space in many frames. Following the new material presented, the question and choices occupy the rest of the space. At times several frames are required to develop the material before a question appears.

It is this reviewer's contention that since programmers must construct their programs, programmed learning in this field should require the trainee to answer most of the questions using constructed responses rather than multiple choice responses. Choosing the correct sequence of coding from about four possibilities supplied is a task which is quite different from composing a correct sequence.

The lessons in Part I include Memory and Input, Addition and Output, Subtraction, Multiplication, and Division. Part II contains Fixed Decimal Point (scaling), Decision Making, Address Modification, Flow Charts, and Loops. Part III consists of Indexing, Subroutines, Advanced Input-Output, Magnetic Tape, and Debugging.

The elapsed time for a trainee will depend upon individual reading and comprehension rates as well as incorrect (error rate) responses and accompanying remedial instruction (branching). The reviewer and a colleague played the roles of novice and experienced programmer, alternatively, to study remedial techniques as well as subject-matter treatment, with an elapsed average time of about 2½ hours for each of the three parts. The remedial branches seem to be well designed.

The author deserves an A for Effort. In the absence of documentation of tryout and revision data, the program receives an I (Incomplete). Any evidence to change this grade will be most welcome.

PART III

QUALITY CONTROL FOR PROGRAMMED LEARNING MATERIALS

It is obvious that a method as important as programmed learning should not have its growth or decay left to chance alone. Because of the agressive nature and unbridled enthusiasm of many practitioners, the early days of development were pockmarked with claims and assertions without foundation. The AERA-APA-DAVI Joint Committee, under the leadership of Dr. Arthur A. Lumsdaine, was formed and, in consultation with the Committee on Programmed Learning of the American Society of Training Directors, guide lines have been established. (Ref. 4) The ASTD Committee has prepared a digest, based upon the Joint Committee recommendations, which is designed for training applications of programmed learning in business, industry and government. (Ref. 5)

More recently, ISPIC (the Inter-Society Programmed Instruction Council, consisting of the Association for Computing Machinery, (ACM) American Society of Engineering Education, Electronic Industries Association, and the American Society of Training Directors) was formed. In this way, to recommendations may be produced which, when translated into terms most meaningful to computer people, will gradually develop into an *instrument of quality control* for programmed instruction of computer programmers. Some of the more significant recommendations appear below:

1. *Programs compared with textbooks:* Internal and external characteristics as criteria for evaluating programs may be examined by comparing programs with conventional textbooks. Despite the similarities, programs *differ* from textbooks in several important respects:

a. programs require frequent trainee response
b. trainee responses generate a source of data useful for program revision
c. programs require the testing of specific effects produced
d. programs require more sharply focused objectives or specified behavioral outcomes
e. programs generate a more predictable pattern of trainee behavior
f. books have a less specialized purpose, serving as a reference source as well as for instruction

2. *Programs compared with educational and psychological tests:* Although programs aim primarily to *instruct* trainees rather than to test them, programs and tests share important attributes:

a. both generate trainee response
b. both are developed through empirical procedures
c. the difficulty of each step in a program, or item in a test, can be investigated using samples of learners
d. both have limited ranges of usefullness which can be described to the computer-programming training director using empirical evidence
e. both specify an external criterion
f. both describe how well an intended outcome is achieved by describing the behavior developed or differentiated

3. *Program availability:* Programs are becoming commercially available in a variety of subject-matter areas, but mere availability is no guarantee of quality. Programs are sometimes announced long before they are actually available.
There is little empirical basis at present to favor one type of program over another. Different types of programs will eventually prove to be useful for different kinds of training objectives, and different styles of programming may be combined effectively in a single program. At present, one type or another may be followed without serious concern in the absence of systematic evidence.

4. *Critical reviews:* These furnish one basis for evaluation. Reviews are beginning to appear in professional journals along with reviews of textbooks. Some include data on achievement attained as well as the reviewer's opinion.

5. *Assessing a program:*

a. *Inspecting the subject-matter content*—to determine if content is appropriate.
   (1) program titles often are not definitive
   (2) programs labeled as a particular subject can vary widely in content objectives
   (3) inspect the content at least as carefully as that of a textbook
   (4) go through the entire program
   (5) determine what topics of the subject are included or omitted
   (6) determine depth of sub-topic development
b. *Limitations of visual inspection*
   (1) training director may be inappropriately influenced by particular structural features
   (2) certain steps may seem too difficult or too easy
   (3) difficulty and appropriateness of steps cannot be judged accurately by inspection alone
   (4) visual inspection cannot substitute for actual tryouts using individuals representative of the intended trainee population
c. *Using test data to assess effectiveness*
   (1) find out empirically what trainees learn
   (2) determine which sequences have too much or too little repetition, review, prompting or overlap of steps
   (3) accurate prediction based upon scientific evidence does not yet justify recommending specific rules of program construction for evaluating programs
   (4) evaluate effectiveness using test data obtained by tryout under specified conditions
   (5) determine the measure of gain in trainee achievement and time required
d. *Assessing program use.* Programs have a variety of uses:
   (1) they may provide the main source for trainees to learn certain facts, principles or skills
   (2) they may be used only to review previous instruction
   (3) programs will probably be interspersed with other methods of instruction
   (4) training director should determine what the program *itself* actually contributes to trainee knowledge and proficiency
   (5) effects revealed through empirical tryout are limited by the content of achievement tests or other measures used for assessment
   (6) visual inspection supplemented by professional reviews may suggest uses or kinds of effects not indicated by field-test data because they were not contemplated in the author's original purpose
e. *Inspecting achievement test.* Aside from data obtained in testing under laboratory or field conditions:
   (1) inspect the author's or publisher's statement of the program's purpose
   (2) examine in full the achievement test items which purport to exemplify what the program is intended to instruct
   (3) examine *criterion* test items and responses called for by the program
   (4) determine what the trainee is required to be able to do

(5) compare whether (4) reflects the competence the training director wishes to achieve
(6) analyze test content in (3) to determine program objectives

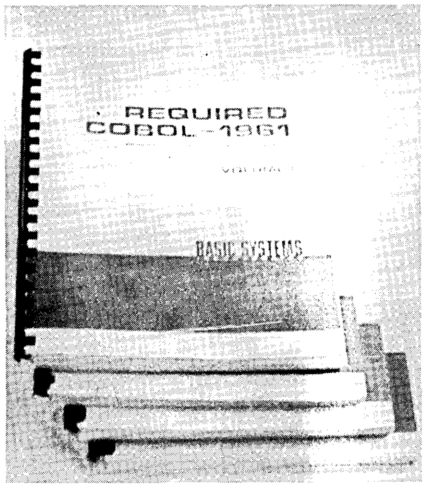
References

(1) Silvern, G. M., "Selection, Training and Evaluation of Computer Programmers," *Journal of the American Society of Training Directors*, Vol. 16, No. 4; April 1962.
(2) Silvern, G. M., "Non-Programmed Curriculum Materials for Computer Programmer Training Programs," North American Aviation, Inc., SID 62-1410, 21 January 1963. Summary appears in *Digest of Technical Papers*, 1962 National Conference, Association for Computing Machinery, 4-7 September 1962.
(3) Lumsdaine, A. A., and Glaser, Robert, Editors, "Teaching Machines and Programmed Learning—a source book," Department of Audio-Visual Instruction, National Education Association, July 1960.
(4) Lumsdaine, A. A., "Criteria for Assessing Programmed Instructional Materials," *Audio-visual Instruction.* Prepared by the AERA-APA-DAVI Joint Committee, 17 January 1963.
(5) Silvern, L. C., "Quality Control Recommendations for Teaching Machine and Programmed Learning Materials," *Journal of the American Society of Training Directors*, 1963 (in press). Prepared by the ASTD Committee on Programmed Learning, 24 January 1963.

Ed. note: *Dr. Silvern is also Chairwoman of the Association for Computing Machinery's Special Interest Committee on Digital Computer Programmer Training, which is also known by its jaw-breaking acronym SICODCPT.*

EDITORS' APPENDIX

"Required COBOL—1961," a new programmed-instruction course of interest to computer programmers, was not available when Dr. Silvern prepared the above article for C&A this past month. However, a complete copy of the training course did arrive in our editorial offices just a few days before going to press, and a review by our staff of it appears below:



6. **Title:** "Required COBOL—1961"
Author: Developed by the Auerbach Corp. of Philadelphia, Pa.
Publisher: Basic Systems, Inc., 2900 Broadway, New York 25, N. Y.
Date of Publication: February, 1963
Format: Four spiral bound manuals, 8½" by 11", with a total of 990 pages. Also included is a Student Manual of 250 pages, with coding forms and examinations.
Type: Linear program. Some say-aloud and some written-completion responses involving constructed word answers and problem solutions based upon flow diagrams and charts provided. Answers, when written, are placed directly in the book. Course books come with a vinyl plastic holder with a sliding blind for concealing answers.

This programmed-instruction course in COBOL has been in development for over two years. The editors first examined a preliminary version of it in the Fall of 1961. This new edition, greatly expanded and improved, is now being marketed by Basic Systems, Inc., for the Auerbach Corp. under arrangements similar to those for Auerbach's EDP Reports. Unfortunately for many, the pricing is also similar! At the present time, the most economical way a person can use "Required COBOL—1961" to appraise its effectiveness is to rent an evaluation kit with training materials for ten students for $600. And all training materials must be returned to Basic Systems, under this plan, within 45 days. Pity the procrastinating student!

For $9,000 (sic) one can license use of "Required COBOL—1961" with right to unlimited use of the training materials within the licensed organization. 150 training units are included with the license. Additional units can be ordered by licensees only in lots of 50, for $750 per 50 units.

The mission of the "Required COBOL—1961" course is to enable trainees to prepare computer source problems for actual operations. The trainee is given basic instruction, practice problems, and reviews, in the features of "Required COBOL—1961." He writes a COBOL program on a comprehensive final examination, and is provided with a permanent reference manual upon completion of the course.' Procedure, concepts and terms of COBOL—1961 are taught in operational detail.

The course has been evaluated on a range of trainees, with and without computer programming experience, at the Auerbach Corp., Shell Oil Company, U. S. Steel Corp. and the U. S. Army Signal Corps. Basic Systems provides the following information on trainee performance in the evaluation study of "Required COBOL—1961":

"Trainees averaged 94.5% on a comprehensive final examination which required writing a useable computer program."

"On completing the course, trainees were able to prepare programs for actual operations which successfully compiled on the first or second pass—in contrast with the eight to ten passes required by conventionally trained students."

"Senior programmers who were unable to pass the examination after study of the Department of Defense manual and appropriate manufacturers' manuals wrote excellent COBOL programs after this self-instruction."

"Mastery of every feature of 'Required COBOL—1961' after 45 hours of programmed instruction."

Based upon the editors' visual examination and sampling of critical sections, "Required COBOL—1961" receives an A+ for Effort, a B for the statement of Evaluation Studies with the suggestion that studies with better control groups be carried out, and F for Fair Pricing that might otherwise make this useful set of manuals available to *individuals* among the ever increasing numbers of students, teachers, systems analysts, accountants, retailers, and other new members of the EDP fraternity who desire to learn in an efficient way a commercial computer programming language.

Teaching Machines and Programmed Learning

Roster

of Organizations and what they are doing

Neil Macdonald
Assistant Editor
Computers and Automation

Following is the third cumulative edition of a roster of organizations in the field of teaching machines and/or programmed learning. Additions, corrections, and comments are invited.

Abbreviations

M -- teaching machines, auto-instructional devices
P -- programmed learning, programs
C -- using computers
B -- books expressing teaching machine philosophy
R -- research and development in the area
S -- simulated teaching machines and simulators to teach skills

*C This organization has kindly furnished us with information expressly for the purpose of the Roster and therefore our report is likely to be more complete and accurate than otherwise might be the case. (C for Checking) / 63: information furnished in 1963 / 62: information furnished in 1962 / etc.

Roster

A: A-ALPHA PATTERN & MANUFACTURING CO., 2523 E. 4th St., Los Angeles 33, Calif. / M,S / *C 63

AMERICAN INSTITUTE FOR RESEARCH, 410 Amberson Ave. Pittsburgh 32, Pa. / R, particularly in the preparation, use, and refinement of auto-instructional materials and techniques. Has had several grants from the U.S. Office of Education and other sponsors on programming skills such as independent thinking and judgment, and other advanced areas. Has had numerous contracts with industry and the military on training programmers, preparation of specialized programs, and development of programmed materials in prototype form to meet unique training requirements. Has cooperated with the DuKane Corporation of St. Charles, Ill., in design and development of flexible 35mm program presentation devices. / *C 63

AMERICAN MANAGEMENT ASSOCIATION, INC., 1515 Broadway, New York 36, N.Y. / This organization is active in two areas: (a) it is holding seminars, workshops and conferences on the general subject of programmed instruction. One was held in Los Angeles in November of 1961. The next is planned for the Hotel Astor, New York, N.Y. in August, 1962. (b) it is holding special evening programs which will incorporate the orientation and demonstration of programmed learning materials for management. This program is expected to begin in April or May, 1962. It is called PRIME -- "Project -- Programmed Instruction for Management Education." / *C 62

AMERICAN SEATING CO., 9th and Broadway, Grand Rapids 2, Mich. / M Electronic learning centers featuring magnetic tape recording equipment for instruction in subjects that must be heard or spoken to be learned. / *C 63

AMERICAN SYSTEMS, INC., 1625 E. 126th St., Hawthorne, Calif. / Presently developing an audio-visual type machine without a response mechanism. / *C 62

AMERICAN TEACHING SYSTEMS,INC., 12902 So. Broadway, Los Angeles 61, Calif. / M,P / *C 62

ANIRAMA COMPANY, 385 East Green St., Pasadena, Calif. / Developing audio-visual type machine without a response mechanism. / *C 62

APPLIED COMMUNICATIONS RESEARCH, Culver City Airport, Culver City, Calif. / A training station is available with an audio-visual desk console. The trainee sits in the middle of a semi-circular desk facing a screen on which is shown filmed programs. The device has been successfully applied to training for production assembly line work and testing inspection and quality control among other areas. / *C 62

APPLIED COMMUNICATIONS SYSTEMS, Div. of Litton Systems, Inc., 8535 Warner Dr., Culver City, Calif. / Developing audio-visual type machine without response mechanism. / *C 62

ASTRA, INC., 19 Burton Ave., Norwich, Conn. / Presently marketing a multiple choice teaching device of the Pressey type, called AUTOSCORE. It presents punched cards with ten questions, each question having up to five possible answers. An error counter keeps track of wrong answers and a digital clock keeps track of time expended on each card. Designed expressly to reinforce material already presented rather than to present new material. / *C 63

AUERBACH CORP., 1634 Arch St., Philadelphia 3, Pa. / P Developers of "Required COBOL -- 1961", a programmed instruction course on the computer programming language COBOL. The course is contained in five volumes including a student manual. A description of this course appears as an appendix to the article by Dr. G.M. Silvern in this issue of Computers and Automation. / *C 63

AUTO INSTRUCTIONAL DEVICES, INC., 12 Manheim Rd., Essex Fells, N.J. / Markets a multiple choice question box with three possible responses selected by a stylus. Correctness of response indicated by colored lights, and a counter keeps student's score. A number of programs available. / *C 62

AUTOMATED INSTRUCTIONAL MATERIALS CORP., 124 W. 55 St., New York 19, N.Y. / P / *C 63

AVTA (Audio-Visual Teaching Aids) CORP., 3450 Wilshire Blvd., Los Angeles 5, Calif. / M Marketing a learner paced, constructed response, paper roll, separate answer strip teaching device called AVTA 440. The device has a variable display area. Programming is being done by the International Research and Development Co., Lovelock, Texas. / *C 62

B: BASIC SYSTEMS, INC., 2900 Broadway, New York, N.Y. / P,R This group of over 100 employees, includes five Columbia Ph.D.'s specializing in the application of behavioral science to industrial training systems. In addition to custom contract and consulting services, BSI presently offers off-the-shelf programs in "PERT" and "Required COBOL-1961". Clients include IBM, Univac, AT&T, Sperry-Polaris, Du Pont, Monsanto, and twenty other major corporations. / *C 63

BATTELLE MEMORIAL INSTITUTIONS, Columbus, Ohio / P, R / *C 63

BELL LABORATORIES, INC., Murray Hill, N.J. / P,C,R / *C 63

BILLERETT COMPANY, 1544 Embassy St., Anaheim, Calif. / M / *C 62

BOLT BERANEK AND NEWMAN INC., 50 Moulton St., Cambridge, Mass. / M,P,C,R,S Programming grades one to twelve curriculum subjects including mathematics, language arts, social sciences, and science. Additional programming work for industry includes programs for training technicians, salesmen, and for product information. Programs constructed both for standard format and for use in BBN teaching machine. The teaching machine is a relatively inexpensive, automatic, portable and book size machine which will be available commercially in 1963. / Computer centered teaching work is also being carried out for a number of government agencies. A PDP-1 computer is used as the teaching device. Research contracts include application of the computer to automated teaching, use of the computer to study human ability to perceive events under stress, and other studies of computer operated teaching systems. / *C 63

BUCKNELL UNIVERSITY, Dept. of Psychology, Lewisburg, Pa. / M,P,R Several grants from U.S. Office of Education on motivational properties of PI, cross-media approach to PI, and nature of reinforcement in PI. Offer consulting services on application of programming in industrial training. Have developed 10 programs in modern mathematics for school use. / *C 63

BURGESS CELLULOSE COMPANY, Grade-O-Mat Division, P.O. Box 560, Freeport, Ill. / Test scoring device, for punch out answer cards / *C 63

BURTEK, INC., 7041 E. 15th St., Tulsa, Okla. / M,C, R,S / *C 63

C: CENTER FOR PROGRAMMED INSTRUCTION, INC., 365 West End Ave., New York 24, N.Y. / P Non-profit educational organization supported by grants from the Carnegie Foundation, the Ford Foundation for the Advancement of Education, has been extending the activities of the New York Collegiate School Teaching Machine Project. It has been translating research findings into classroom application by programs for beginning French, spelling, French via pictures, beginning German, and in elementary and intermediate mathematics. A programmed physics course incorporating the materials created by the Physical Science Study Commission will be tested at schools in 1962. / *C 62

CENTRAL SCIENTIFIC COMPANY, Division of Cenco Instruments, 1700 Irving Park Rd., Chicago 13, Ill. Main interest in developing, sponsoring or adapting programs in science, technology and related areas for educational use, grades 1-14. Also interested in responder and presenter devices with a mass market. / *C 63

CHESTER ELECTRONIC LABORATORIES, INC., Chester, Conn. / A mechanical teaching center is being developed in cooperation with the University of Michigan and Yale University. The device will probably have a modified language laboratory set-up employing programmed materials with a dialing system at each student's position to allow him to select different programs. / *C 62

COLUMBIA UNIVERSITY TEACHERS' COLLEGE, New York, N.Y. / An experimental test run using the IBM 650 computer to teach business and marketing procedures employing game playing techniques. The rules of economic theory were programmed into the machine and various teams of students were given hypothetical business assets. They independently developed their businesses and fed the data into the computer for analysis of the final results produced. The experiment ran 20 hours consecutively and demonstrated the versatility of the computer as a self-instruction device. Work also being done in programming mathematics courses. A summer institute course in program instruction and programming technique is planned. / *C 62

COMPARATOR, P.O. Box 452, Petaluma, Calif. / M / *C 62

CONSOLIDATED SYSTEMS CORPORATION, Space Science Department, 1500 South Shamrock Ave., Monrovia, Calif. / R,M / *C 62

ROBERT E. CORRIGAN AND ASSOCIATES, 8701 Adah St., Garden Grove, Calif. / M Students watch the program on a television display screen and make multiple choice responses on an individual response panel. Colored lights provide feedback. Scoring is automatic. / *C 62

CORRIGAN COMMUNICATIONS, INC., 1111 Ash St., Fullerton, Calif. / P / *C 62

CREATIVE EDUCATION RESOURCES, INC., 1544 Embassy St., Anaheim, Calif. / P / *C 62

CYBURTEK CORPORATION, 102 Mt. Auburn St., Cambridge, Mass. / P / *C 62

D: DAVIS SCIENTIFIC INSTRUMENTS, 12137 Cantura St., Studio City, Calif. / R,M (for psychological research only) / *C 63

DAYSTROM, INC., Control Systems Div., 4055 Miramar Rd., La Jolla, Calif. / R / *C 63

DIGITAL EQUIPMENT CORPORATION, 146 Main St., Maynard, Mass. / M,C / *C 63

DORSETT ELECTRONICS, INC., 119 West Boyd St., Norman, Okla. / M Telescholar. Students watch the program displayed on a screen and indicate their answers by pressing 5 buttons on a response panel, with colored lights providing feedback information. / *C 62

DOUBLEDAY & CO., INC., 501 Franklin Ave., Garden City, N.Y. / The publishers of the TutorText, a scrambled book using an unsequential arrangement of pages in order to achieve a branched program. Developed in cooperation with Dr. Norman A. Crowder of the Educational Science Div. of the United States Industries, Inc. / *C 63

DOUGLAS AIRCRAFT CORP., 300 Ocean Park Blvd., Santa Monica, Calif. / R Auto-instructional devices using a visual display and button-panel input. / *C 62

DUKANE CORP., St. Charles, Ill. / Produces a number of teaching machines, all utilizing 35 mm filmstrip. The Model 576-65 is a flexible rear screen projection device for use with a program having linearly programmed frames. The Model 14A525 has a similar projection device and also an audio capability. Through the use of the patented DuKane 30/50 cycle system, the audio portion may be stopped at a predetermined spot requiring the student make an active response. / *C 63

E: EDEX, 3940 Fabian Way, Palo Alto, Calif. / M,P, R Producers of a group teaching system that provides for simultaneous presentation of slides, magnetic tape, filmstrips, and movies. System provides individual student scoring in multiple choice mode and machine-pacing or pacing to last respondent. System acts as classroom communicator when not used in automated teaching mode. Firm has produced programs for industrial and commercial clients; is currently developing educational series for schools. / *C 63

THOMAS A. EDISON RESEARCH LABORATORIES, West Orange, N.J. / Presently doing device research in areas such as the teaching of typing and reading to pre-school children. Has a publication called "Program Learning in the Educational Process" edited by Annice L. Mills. / *C 62

ED-U-CARDS MANUFACTURING COMPANY, 36-46 33rd St., Long Island City, N.Y. / M,P,R,S / *C 63

EDUCATIONAL AIDS PUBLISHING CORP., Carle Place, Long Island, N.Y. / M,P,R,S / *C 63

EDUCATIONAL DESIGN OF ALABAMA, INC., 1428 University Ave., Tuscaloosa, Ala. / R,P / *C 62

EDUCATIONAL DEVELOPMENT CORP., 200 California Ave., Palo Alto, Calif. / M Utilizing paper tape and offering a flexible programming capacity; expected to be available in the late Spring or early Summer, 1962. / *C 63

EDUCATIONAL DEVELOPMENTAL LABORATORIES, 284 E. Pulaski Rd., Huntington, N.Y. / Producers of reading instruments: Tach-X, Flash-X, Controlled Reader, Controlled Reader Jr., and Skimmer; series of recordings and accompanying workbook to improve listening and reading skills; programmed vocabulary workbooks; other skill-building materials in language arts, arithmetic, and business education. / *C 63

EDUCATIONAL ENGINEERING ASSOCIATES, 3810 Pacific Coast Hwy., Torrance, Calif. / Producers of a slide display device, using multiple choice responses and feed back supplied directly by the program, i.e., a correct response changes the question. / *C 62

EDUCATIONAL TELEVISION AIDS, 111 Hampton Rd., West, Williamsport, Md. / Presently designing an instructor controlled teaching device. Unit uses linearly programmed frames with a constructed response elicited from the student. / *C 62

ELECTRONIC TEACHING LABORATORIES, 5034 Wisconsin Ave., N.W., Washington 16, D.C. / Producers of language laboratories, electronics circuit trainers, programmed magnetic tape language courses, programmed courses in electronics. / *C 63

ENCYCLOPEDIA BRITANNICA FILMS, INC., 1150 Wilmette Ave., Wilmette, Ill. / M,P Programs in the areas of mathematics and modern foreign languages, in the elementary and secondary level of education. / *C 63

ENTELEK INCORPORATED, 42 Pleasant St., Newburyport, Mass. / P PERT/CPM, Economics, and Probability and Statistics. Customized training packages for bank tellers, department store sales personnel, and airline agents. Consulting to business and industry -- clients include Chemical Bank New York Trust Co., KLM-Royal Dutch Airlines, and the Liberty Mutual Insurance Co. Government-sponsored development of program in U.S. Navy ship's store management. / *C 63

EPSCO, INC., 275 Massachusetts Ave., Cambridge 39, Mass. / Self-contained logic demonstrator of digital circuitry for industrial laboratory and training applications. / *C 63

EXECUGRAF CORPORATION, 113 No. San Vicente Blvd., Beverly Hills, Calif. / M,R / *C 63

E-Z SORT SYSTEMS, LTD., 45 Second St., San Francisco 5, Calif. / P,S / *C 63

F: FAIRCHILD CAMERA AND INSTRUMENT CO., Syosset, Long Island, N.Y. / R / *C 62

FIELD ENTERPRISES EDUCATIONAL CORPORATION, Merchandise Mart Plaza, Chicago 54, Ill. / M,P / *C 63

FORBES PRODUCT CORP., 6255 Goodwin St., Rochester 3, N.Y. / M Consists of large display window, typewriter roller operation, and detachable answer unit. Teaching devices are being field tested in the Rochester Public School System. / *C 62

FORINGER AND CO., INC., 312 Maple Drive, Rockville, Md. / Produce simple teaching device consisting of a projected film strip with one or two levers on which the student indicates his response to a question. Physical reinforcement includes presentation of marble upon a correct answer. Other experimental teaching devices concerned with the field of applied psychology, i.e., controlled environment boxes for training animals. / *C 62

G: GENERAL ATRONICS CORP., 1 Balla Ave., Bala-Cynwyd, Pa. / Producers of the Atronics Tutor, Model 580. This machine is a portable, mechanical, multiple-choice teaching device. It operates by allowing pages of programmed material to fall by gravity when an operator selects correct answers by pushing a button at the base of the machine. Also, produces the TAG System which is a modified punch board device used mainly for recording answers in scoring. The company indicates a general interest in industrial training with accent on electronic data processing in programmed form. / *C 62

GENERAL EDUCATION, INC., 96 Mt. Auburn St., Cambridge 38, Mass. / P,M 3000 frame program in Fundamentals of Finance & Investment in self-contained cardboard machine. Probability Models of Random Processes for Harvard Business School. 190 frame program on Salesmen's Call Reports for Monsanto Chemical Co. Other programs for World Book Encyclopedia, J. J. Little & Ives, Science Research Associates. Offering in February, 1963, a 36 program Kit, with five plastic machines, for elementary and secondary schools on sentences, words, and references. / *C 63

GENERAL ELECTRIC CO., Schenectady, N.Y. / R / *C 62

GENERAL ELECTRIC CO., Educational Technology & Products Project, 212 W. Division St., Syracuse, N.Y. / B Publication of technical and scientific subjects. / *C 63

G. E. CONTROL, INC., Minneapolis 20, Minn. / R,M / *C 62

GENERAL PROGRAMMED TEACHING CORPORATION, Box 4235, Albuquerque, N. Mex. / M,P / *C 63

GINN AND COMPANY, Statler Building, Boston 17, Mass. / P Investigating the publication of programmed materials. Program completed: earth-sun relations; 8 programs in the process of development. / *C 63

GRAFLEX, INC., 3750 Monroe Ave., Rochester 3, N.Y. / M,P The Koncept-O-Graph uses the rolled paper strip technique for a linear program, having two display areas, one for the program material itself, and the other for the constructed response. / *C 63

GRAPHICS, INC., 3750 Monroe Ave., Rochester 3, N.Y. / The Graphics Audiographic System is a coordinated slide and audio presentation unit used for training in industrial assembly procedures. The audio record is repeatable at the request of the student. / *C 62

GRAY MANUFACTURING COMPANY, Special Products Division, 16 Arbor St., Hartford 1, Conn. / *C 62

THE GROLIER SOCIETY, INC., 575 Lexington Ave., New York 22, N.Y. / Currently distributes various models of self-instructional devices for Teaching Machines, Inc. Example is the Min/Max machine. See Teaching Machines, Inc. / *C 63

H: HAMILTON RESEARCH ASSOCIATES, 4 Genesee St., New Hartford, N.Y. / M,P This company has recently withdrawn its Visitutor, a 35 mm microfilm program device. It is developing a 3 x 5 card model Visitutor and microfilm unit using a film sort card. The unit is expected to be available in July, 1962. / *C 62

HARCOURT, BRACE & WORLD, INC., 750 Third Ave., New York 17, N.Y. / P / *C 63

HARWIL CO., 1009 Montana Ave., Santa Monica, Calif. / R Science teaching devices. / *C 63

D. C. HEATH, INC., Boston, Mass. / P,B / *C 63

HOLT, REINHART, AND WINSTON, INC., 383 Madison Ave., New York 17, N.Y. / P Presently publishing program materials for the Center for Programmed Instruction; also looking into the development and writing of other programs. / *C 62

HRB-SINGER, INC., Science Park, State College, Pa. / STAR, a general purpose device which electronically scores and records a student's performance during tests; teaches using feedback or reinforcing principle. / *C 63

HUGHES AIRCRAFT CO., VIDEOSONIC (Trademark, Hughes Aircraft Co.) Systems Div., P.O. Box 3310, Fullerton, Calif. / Developers and producers of the VIDEOSONIC System. The equipment consists of portable self-contained audi-visual devices incorporating slide projection with synchronized tape recordings. It has direct application in industrial training procedures and as an on-the-job performance aid. The device can be programmed incrementally and the subject matter can be presented visually and orally through slide displays and automatically coordinated tape instructions. Standard and custom programs may also be obtained from the VIDEOSONIC Systems Division. / *C 63

HUNTER MANUFACTURING CO., INC., P.O. Box 153, Coralville Branch, Iowa City, Iowa. / Producers of the Model 340 Cardmaster. This is a control circle card display device for paced-practice learning. Other automated instructional devices being developed. / *C 62

I: INDUSTRIAL EDUCATION CORP., 1 E. Wacker Dr., Chicago 1, Ill. / P Programs are prepared on a custom basis for clients for training purposes and are normally linear, constructed response type. / *C 63

INFORMATION PRODUCTS CORP., 156 Sixth St., Cambridge 39, Mass. / M,C An interrogator and display unit which allows selective correction, deletion, and addition of alphanumeric characters on a cathode ray tube display. Expected to allow a ready means of student constructed response to questions on a computer-based teaching machine. Ready by the summer, 1963. / *C 62

THE INSTITUTE FOR BEHAVIORAL RESEARCH AND PROGRAMMED INSTRUCTION, P.O. Box 302, Ann Arbor, Mich. / P / *C 62

INSTITUTE FOR INSTRUCTIONAL IMPROVEMENT, INC., 110 E. 30th St., New York 16, N.Y. / P / *C 62

INSTITUTE OF BEHAVIORAL RESEARCH, College Park, Md. / R, in the field of programmed learning, program writing, evaluation, and field testing. / *C 62

INSTITUTE OF INTERNATIONAL RESEARCH AND DEVELOPMENT, INC., P.O. Box 4456, Lubbock, Texas / P *C 62

INSTITUTE OF INTERNATIONAL RESEARCH AND DEVELOPMENT, INC., Educational and Training Methods Div., 4910 13th St., Lubbock, Tex. / This unit does research and development work in educational testing and preparation of self-instructional programs. Evaluation and testing of programs also done. Plans call for the design of materials and training methods for use in underdeveloped countries. The unit is already publishing a newsletter to serve as a clearing house for information on programmed learning: AID. / *C 62

INSTRUMENT RESEARCH CO., 12031 Euclid Ave., Garden Grove, Calif. / Producing a self-instructional device using 3 x 5 inch cards with a linear program. Provides for multiple choice response, and feedback is by colored slides. / *C 62

INTERNATIONAL BUSINESS MACHINES CORP., Thomas J. Watson Research Center, P.O. Box 218, Yorktown Heights, N.Y. / Has been pursuing a research program on computer based teaching machine for several years. Has programmed a small curriculum of courses including Stenotypy, German Reading, Psychological Statistics and 1410 Autocoder computer programming. / *C 63

INTERNATIONAL TEACHING SYSTEMS, 457 Washington, S.E., Albuquerque, N. Mex. / P / *C 62

ITEK CORP., 10 Maguire Rd., Lexington, Mass. / R,P, M Emphasizes advances in the field of optics. For example, work being conducted on use of a light pen for the construction of student responses on the surface of a cathode ray tube for direct input into a computer. / *C 63

J: JENSEN, GERALD J., 1267 Wensley Ave., El Centro, Calif. / P / *C 62

K: KUNINS ENGINEERING COMPANY, 1730 Popham Ave., New York 53, N.Y. / M / *C 62

L: LABELLE INDUSTRIES, Oconomowoc, Wis. / Developing audio-visual type machine without response mechanism. / *C 62

LEARNING, INCORPORATED, 1317 W. Eighth St., Tempe, Ariz. / P / *C 63

LEARNING MACHINES, INC., Box 613, Silver City, New Mexico / M,P,B,R Consulting. / *C 63

LEARNING RESOURCES INSTITUTE, 680 Fifth Ave., New York, N.Y. / Presently conducting an evaluation of currently available programs and teaching machines for professional educational organizations. / *C 62

LECTRON CORPORATION OF AMERICA, 9929 W. Silver Spring, Milwaukee 18, Wis. / M,P,R / *C 63

M: THE MACMILLAN COMPANY, 60 Fifth Ave., New York 11, N.Y. / P / *C 62

MANAGEMENT RESEARCH ASSOCIATES, Rm. 1300, 185 No. Wabash, Chicago 1, Ill. / Currently producing a pull-tab, multiple choice teaching machine. / *C 62

THE MARQUARDT CORPORATION, 2771 No. Garey Ave., Pomona, Calif. / M,S,C,/ *C 63

WILLIAM BARTON MARSH CO., INC., 18 East 48 St., New York 36, N.Y. / P, with emphasis on LP records and programmed textbooks. / *C 62

MAST DEVELOPMENT COMPANY, INC., 2212 E. 12th St., Davenport, Iowa / M / *C 62

McGRAW HILL BOOK CO., INC., 330 W. 42nd St., New York 36, N.Y. / The company is presently selling the Holland-Skinner book "The Analysis of Behavior" with nearly 2,000 linearly programmed frames. They claim to have under development nearly 40 other kinds of teaching machine type programs, some intended for the program books, others for both books and machines. Also developing machines using fan-folded paper tapes. First unit expected to be available in May 1962 / *C 62

MERIT ASSOCIATES, 2037 Harrison Ave., Eureka, Calif. / P Producers of a sequential teaching program to be placed on a punched card. The student procedes from one frame to another by a coded sequence of holes punched along the border of the programmed card. / *C 63

MINNEAPOLIS-HONEYWELL REGULATOR CO., Ordnance Div., 1724 So. Mountain Ave., Duarte, Calif. / Currently developing an experimental audio-visual teaching machine, with linear and branching capability, for demonstration purposes and use in research work. Specialized programs being developed. Machines or programs are not currently available. / *C 63

MOTOROLA CORP., 4545 Augusta Blvd., Chicago 51, Ill. / R,M / *C 63

MULTI-MATICS MACHINES, INC., 6782 La Jolla Blvd., La Jolla, Calif. / M / *C 62

N: NATIONAL BLANK BOOK COMPANY, 2829 Water St., Holyoke, Mass. / Producing "Learn-Ease" devices using our slide mask principle. Largest producer of programmed learning devices. / *C 63

NATIONAL COMMUNICATION LABORATORIES, 507 Fifth Ave., New York 17, N.Y. / R,P,M / *C 63

NATIONAL EDUCATION ASSOC., Div. of Audiovisual Instruction, 1201 16th St., N.W., Washington 6, D.C. / This division of NEA, the American Psychological Assoc., and a committee of the American Educational Research Assoc. are cooperating in the evaluation of teaching devices and programmed learning. Criteria are being worked on to determine the effectiveness of programmed learning techniques. The Association also sponsors the publication of books and periodicals concerned with teaching machines and programmed learning. One such is its "AV Communication Review" which appears bi-monthly. An "Occasional Paper No. 3" has appeared which surveys the current industrial activities in teaching machines and programmed learning. It is written by Dr. James D. Finn and Donald G. Perrin. / *C 62

NATIONAL EDUCATIONAL SYSTEMS, INC., 9250 Wilshire Blvd., Beverly Hills, Calif. / R,P,M / Developing programs and teaching machines. / *C 62

NATIONAL TEACHING MACHINES, P.O. Box 4016, El Paso, Texas / R,P / *C 62

NAVIGATION COMPUTER CO., Valley Forge Industrial Park, Norristown, Pa. / Experimenting with computer centered teaching device. Work being done in investigating programming methods for teaching in various disciplines. / *C 62

NORTH AMERICAN AVIATION CORP., Columbus, Ohio / R, M / *C 62

NORTRONICS, Div. of Northrop Corp., 222 N. Prairie Ave., Hawthorne, Calif. / R,M An audio-visual training device with visual student response under development. / *C 63

P: PALMER LEARNING AIDS, 600 So. Michigan Ave., Chicago 5, Ill. / Produces the Slide-a-Mask, a flexible plastic sliding mask which fits over a programmed text page showing the correct answer after the student has constructed his answer. / *C 63

PAROMEL ELECTRONICS CORPORATION, 3956 Belmont Ave., Chicago 18, Ill. / Serving as an electronics trainer. / *C 63

PERCEPTUAL DEVELOPMENT LABORATORY, 6767 Southwest Ave., St. Louis, Mo. / Making a modified movie projector for training purposes. Can be used for a flash projection of individual frames or superimposing two different films upon one another. An adaption allows 10 possible multiple-choice panel for student reaction to the questions and ideas in the film. / *C 62

PHOENIX ASSOCIATES TEACHING MACHINES, 13012 Willamette St., Westminster, Calif. / P, consulting / *C 62

PICTURE RECORDING COMPANY, 1392 W. Wisconsin Ave., Oconomawoc, Wisc. / Developing a 35 mm slide projector with synchronized aural presentation. Student unit provides multiple-choice push button response. / *C 62

POLAROID INC., 730 Main Street, Cambridge, Mass. / R Developing a computer-based teaching machine which provides spoken answers to informally phrased questions about a subject. / *C 63

PRENTICE HALL, INC., Englewood Cliffs, N.J. / P / *C 62

PROGRAMMED LEARNING ASSOCIATES, 700 Font Blvd., San Francisco 27, Calif. / P and consulting / *C 63

PROGRAMMED TEACHING AIDS, INC., 3810 S. Four Mile Run Dr., Arlington 6, Va. / R,P,M / *C 63

PRUDENTIAL INSURANCE CO. OF AMERICA, 763 Broad St., Newark 1, N.J. / R,P / *C 62

THE PSYCHOLOGICAL CORPORATION, 304 E. 45th St., New York 17, N.Y. / M,P,R / *C 63

PSYCHOLOGICAL RESEARCH ASSOCIATES, 507 So. 18 St., Arlington, Va. / Currently working on an audio-visual training device for research purposes. It is designed as a modified sound film projector which would allow for forward branching review. / *C 62

PSYCHOTECHNICS, INC., 105 West Adams St., Chicago 3, Ill. / P,R,S / *C 63

PUBLIC SERVICE RESEARCH, INC., 91 Prospect St., Stamford, Conn. / R,P Recently completed traffic safety teaching program. / *C 63

PUBLISHERS CO., INC., 1106 Connecticut Ave., N.W., Washington 6, D.C. / M,P Marketing "Teachall" teaching machine, with programmed learning, direct to home and schools, and through distributors. 16 basic short programs come with Teachall. Two full courses on word recognition and arithmetic ready for distribution early 1963. To follow: French and Spanish, then higher levels. / *C 63

R: RANDOM HOUSE, INC., 501 Madison Ave., New York 22, N.Y. / P,B / *C 63

RECORDAK CORP., Subsidiary of Eastman Kodak Co., 770 Broadway, New York 3, N.Y. / R Pursuing a program of equipment development for the industrial and military training field. Only units to date are prototypes. / *C 63

RENNER, INCORPORATED, 1530 Lombard St., Philadelphia 46, Pa. / P Developing masking device. / *C 62

RESOURCES DEVELOPMENT CORPORATION, Programmed Learning Div., 2736 E. Grand River Ave., E. Lansing, Mich. / M,P,R Industrial and governmental training. 7-day training seminar for programmers offered each month. Also a wide range of consultant services in programmed learning, including preparation of programs and supervision of programming. / *C 63

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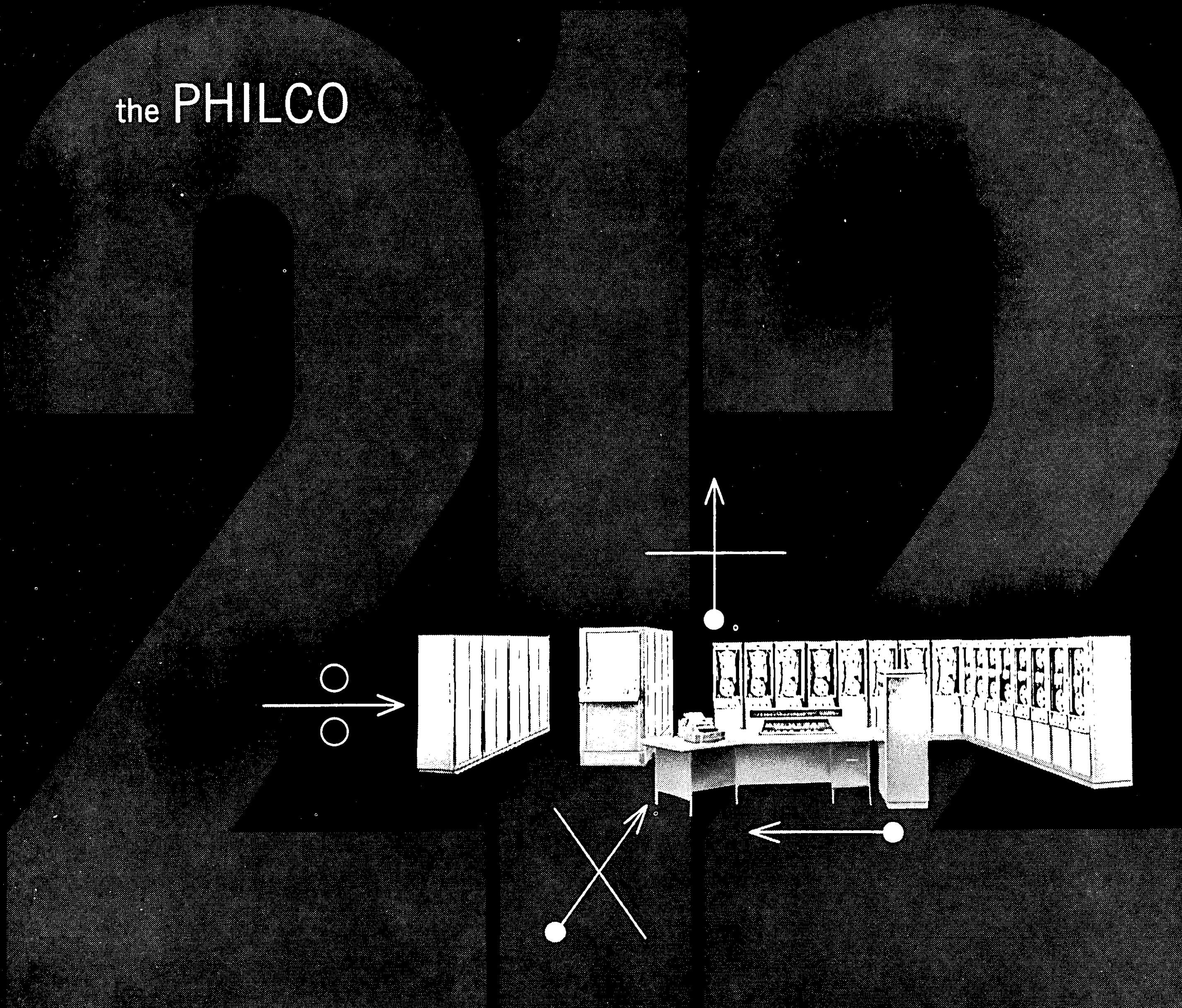

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RHEEM CALIFONE CORPORATION, 5922 Bowcroft St., Los Angeles 16, Calif. / M,P,R Didak constructed response teaching machines; programs for Didak. / *C 63

RHEEM ELECTRONICS CORP., 5200 W. 104th St., Los Angeles 45, Calif. / R / *C 63

ROTO-VUE, 1212 Holland Bldg., 211 No. 7th St., St. Louis, Mo. / R,P,M / *C 63

ROYAL McBEE, 850 Third Ave., New York 22, N.Y. / Has conducted experiments on the use of a typewriter as a "teaching machine" in four teachers' colleges in the United States. / *C 63

S: SANFORD ASSOCIATES, 159 Crescent Dr., Menlo Park, Calif. / P, consultant. / *C 62

SCIENCE RESEARCH ASSOCIATES, 259 Erie St., Chicago 11, Ill. / R,P(modern math course and vocabulary building course available), B("Programmed Instruction for Schools and Industry," by J. L. Hughes) / *C 63

SCIENTIFIC EDUCATIONAL PRODUCTS CORP., 30 E. 42 St., New York 17, N.Y. / M, the Minivac 6010, a unit suitable for self-instruction in the basic principles of digital computer operation. This device uses relays and switching circuits for binary addition and subtraction. Texts accompany the unit to guide the student. / *C 63

SCOTT, FORESMAN, AND COMPANY, 433 E. Erie St., Chicago 11, Ill. / P / *C 62

SEMINAR INC., 480 Lexington Ave., New York 17, N.Y. / Part of an industrial programming group / *C 62

SHOE CORPORATION OF AMERICA, 35 N. 46th St., Columbus 16, Ohio / Presently using several semi-automatic devices in program materials and sales training. / Device research being conducted using a programmed projector as a central display unit. A three-button response panel operated by the student. This device provides for both forward and backward branching in the program. / *C 62

SHOENTGEN, BRANDT & ASSOCIATES, 385 E. Green St., Pasadena, Calif. / B,P, distributing an audio-visual device made by the Anirama Company of Japan. / *C 62

SIGMA PRESS, 2140 K. St., N.W., Washington 7, D.C. / P / *C 62

STANDARD PROJECTOR AND EQUIPMENT CO., INC., 7433 N. Harlem Ave., Chicago 48, Ill. / M Using specially prepared filmstrips with a push button response unit. / *C 63

STANFORD RESEARCH INSTITUTE, Menlo Park, Calif. / R,P / *C 62

STAPLES-HOPPMANN, INC., 500 East Monroe Ave., Alexandria, Va., / This is a rear-view projecting device for the presentation of film and slides, both individually and simultaneously. The instructor has individual control of the microphone audio for the materials that accompany the film. / *C 62

STATEN, J. B., Box 44, Bay City, Tex. / R,M and roll or tape duplicating processes / *C 63

SYNCHRO-MAT EQUIPMENT CORP., 1316 Wildwood Ave., Jackson, Mich. / Presently developing a synchronized audio presentation device for training purposes. / *C 62

SYSTEM DEVELOPMENT CORPORATION, 2500 Colorado Ave., Santa Monica, Calif. / R,M / *C 63

T: TEACHING MACHINES, INC., 221 San Pedro Dr., N.E., Albuquerque, N.M. / Producers of MIN/MAX III, Wyckoff Film Tutor, and Multi/Max teaching machines, and the TMI-Grolier series of Self-Tutoring courses and Programed Textbooks. The Self-Tutoring courses are used in conjunction with the MIN/MAX III and are of the constructed response type. The Wyckoff Film Tutor and Multi/Max are 35mm and 8mm rear screen projection devices using filmstrip programs. The Wyckoff Film Tutor has a typewriter keyboard response panel; the Multi/Max response panel is part of the viewing screen. Both advance upon the students selection of the correct response. The Programed Textbooks include constructed response programs and are used independent of a teaching machine. / *C 63

TEACHING MATERIALS CORP., A Division of Grolier, Inc., 575 Lexington Ave., New York 22, N.Y. / Distributors of the Min/Max and other teaching devices produced by Teaching Machines, Inc. / *C 63

TEACHING MATERIALS CORP., Sales Organization for Teaching Machines, Inc., 575 Lexington Ave., New York 22, N.Y. / *C 63

TELEPROMPTER CORP., 50 W. 44 St., New York 36, N.Y. / R,M / *C 63

THOMPSON RAMO WOOLDRIDGE, Cols Divisions, 6325 Huntley Rd., Columbus 24, Ohio / M,P Producers of TRW Language Laboratories. / *C 63

THOMPSON RAMO WOOLDRIDGE, INC., Intellectronics Division, 8344 Fallbrook Ave., Canoga Park, Calif. / R The unit being developed uses a synchronized audio-visual display, a six button multiple choice response panel and is controlled by a small analog computer. Educational Electronics Division includes Dage (educational television), Magnetic Recording Industries (language laboratories) and the Intellectronics Division. / *C 62

TOR EDUCATION, INC., 453 Main St., Stamford, Conn. / P,R,S / *C 63

TRAINING RESEARCH BRANCH, BEHAVIORAL SCIENCES LABORATORY, Wright-Patterson AFB, Ohio / Conducts applied research on programmed learning and automated instruction. In field trial of U.S. Industries' Mark I Auto-Tutor and scrambled books, found a time saving when compared with conventional electronic course. Research program includes evaluation of full courses, conduct of laboratory experimentation on fundamental parameters, integration of multiple instructional techniques, application of computers, design and use of individual audio-visual devices, and emphasis on development of performance rather than verbal knowledge. / *C 63

TRAINING SYSTEMS INC., 12248 Santa Monica Blvd., Los Angeles 25, Calif. / P Programs in management development, sales training, chapter writing, etc. expected to be available by June, 1962 / *C 62

TUCKER, Dr. J.A., 508 W. 19th St., Wilmington 2, Del. / P, consultant, educational methods / *C 63

U: UNITED STATES ARMY / Teaching device and programing research now being conducted at: (a) U.S. Signal Corps School, Fort Monmouth, N.J. (b) U.S. Southeastern Signal Corps School, Ft. Gordon, Ga. (c) HUMRRO Human Resources Research Office, U.S. Infantry Human Research Division, Ft. Benning, Ga. / *C 63

U.S. ARMY ORDNANCE SCHOOL, Aberdeen Proving Ground, Md. / P,R The application of programmed learning primarily through the scrambled text approach to military education and training. Seven texts have been developed, and are actually being used in local courses. / *C 63

U.S. INDUSTRIES, INC., Educational Science Division, 250 Park Ave., New York 17, N.Y. / Producers of the AutoTutor® teaching machine. The machine fully automates programmed instruction of the branching type. The student sees new material and is then questioned about it. He responds by pushing a button corresponding to an answer. If he chooses the right answer he is immediately advanced; if he chooses a wrong answer, he is given correctional material before being allowed to advance. The program thus adapts to the student through an evaluation of the student's responses. In addition to many off-the-shelf programs in such fields as English grammar, computer programming, electronics, the company develops programs for all branches of the armed forces, many areas of government, industry and public and private schools. The AutoTutor is now being used to train insurance agents over the nation. The company also offers a programming school. / *C 63

UNIVERSAL ELECTRONICS LABORATORIES CORP., 510 Hudson St., Hackensack, N.J. / M,P,R / *C 63

UNITED STATES NAVAL TRAINING DEVICE CENTER, Port Washington, N.Y. / M,P,R,S Main aims are towards training programs in electronics for technical personnel, radio men, computer programmers, and guided missile maintenance crews. / *C 63

UNIVERSITY OF CALIFORNIA, Los Angeles 24, Calif. / Western Data Processing Center, Graduate School of Business Administration has produced a book "FORTRAN: An Auto-instructional Introduction to Computer Programming". The book provides no response frames but optional forward skimming. Exercises with immediate feedback and programming coding tasks and diagnosis. Published by McGraw-Hill Publishing Co. in 1962. / *C 63

UNIVERSITY OF CALIFORNIA, Los Angeles, Engineering Dept., Engineering Unit I, Rm. 3046, Univ. of Calif., Los Angeles 24, Calif. / R Research in computer-based teaching machines; developing low-cost logic-type teaching machines. / *C 63

V: VAN VALKENBURGH, NOOGER & NEVILLE, INC., 15 Maiden Lane, New York 38, N.Y. / M,P,S Linear programs, TRAINER-TESTER printed programming devices and printed training equipment simulators in the area of electronic technician training and evaluation. / *C 63

VARIAN ASSOCIATES, 611 Hansen Way, Palo Alto, Calif. / R,S,M,P Research in devices and programs being continued. Programming department prepares materials for in-plant training, and for other industries. / *C 63

VIEWLEX, INC., Holbrook, L.I., N.Y. / M Viewlex, a film strip, or slide device from which the program advances with the correct choice. Additional material can be produced when errors are made. / *C 63

W: WEBSTER PUBLISHING COMPANY, St. Louis 26, Mo. / P / *C 63

WESTINGHOUSE CORP., 3 Gateway Center, Pittsburgh 3, Pa. / Teaching machine device research in its initial stages. / *C 63

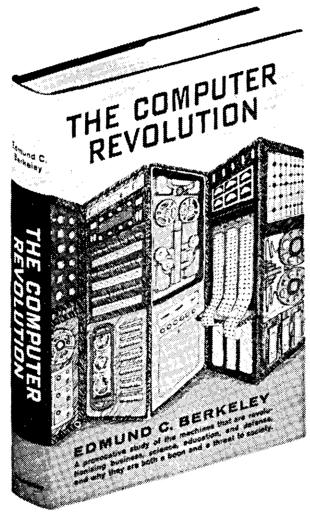
WESTREX CO., Division of Litton Industries, 335 North Maple Drive, Beverly Hills, Calif. / Producing a portable audio-visual unit called the Communicator. It is about the size of a desk typewriter. It contains a 35mm automatic 36 frame slide viewer and a synchronized sound tape playback mechanism. It is especially suitable for military field service where self-contained battery supply is needed. The unit has an optional voice control panel for direct student pacing. / Development is under way in a film strip teaching device expected to be available by the end of 1962. / The company has entered into an arrangement with the Prentice-Hall Publishing Co. to offer a variety of teaching devices for programs in the near future. / *C 62

JOHN WILEY & SONS, INC., 440 4th Ave., New York 16, N.Y. / P, publishing / *C 63

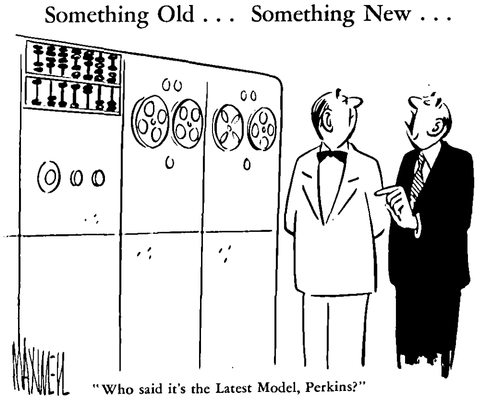
WILLIAMS RESEARCH CORP., P.O. Box 95, Walled Lake, Mich. / Producing a 16mm film projection unit with a four-button response panel. Immediate automatic scoring is provided on a separate piece of paper and feedback is by light above the question buttons. It is called the Science Desk. Standard 16mm film can be coded. / *C 63

ROGER WURTZ COMPANY, 1306 Third St., San Rafael, Calif. / S,M, Consultant / *C 63

Z: ZEUGMA CORP., 355 Walnut St., Newton 60, Mass. / P, R Research and development of programmed instruction tests for industrial training and sales promotion. / *C 63



Something Old . . . Something New . . .



"Who said it's the Latest Model, Perkins?"

Artificial Intelligence: P

Arthur L. Samuel, *Director of Research Communications,*

ARTIFICIAL intelligence is an apparently self-evident phrase which has come into common usage without having a well-defined and generally accepted meaning. Unfortunately, this term also carries with it certain anthropomorphical implications which tend to arouse emotional responses on the part of the reader that have little or no bearing on the actual state of affairs. To some people, the concept of artificial intelligence is a scientific aberration defined as the Myth of Thinking Machines; to others, it relates to man's first stumbling attempts to develop machine methods for dealing with some of the perplexing problems that should, in all justice, be delegated to machines but which now seem to require the exercise of human intelligence; and, finally, to some easily frightened individuals, artificial intelligence refers to the impending danger of man's domination by the Machine. This divergence of opinion and of feelings, with respect to a subject that should be capable of scientific evaluation, bespeaks of a general lack of knowledge, which this discussion will attempt to correct.

As a matter of fact, a revolution is in the making with respect to the manner in which digital computers will be used to solve the problems of business and industry. This revolution has its beginnings in a variety of apparently unrelated research studies. Some of these studies seem to be directed toward quite uneconomic ends, such as programming computers to match pennies, play tic-tac-toe, play checkers and chess, write poetry, compose music, and solve high school problems in plane geometry. Other studies are concerned with more practical problems—programming computers to read hand-sent telegraph signals, to recognize handwriting and speech, and to translate from Russian into English. Still others are concerned with learning machines, the mechanization of cognitive processes—yes, even with thinking machines. Some idea of the magnitude of the effort on these topics may be gained from the fact that a recently published bibliography[1] to the literature on artificial intelligence contained 559 references to individual papers by some 400 different authors and 26 additional references to symposia, proceedings, and other special collections concerning artificial intelligence, and this tabulation did not include mechanical translation, for which an earlier bibliography—1959—listed 645 papers. A large and growing body of workers, largely in the United States but with many members scattered throughout the civilized world, is attempting to write programs for existing machines or to design and build special machines all for the expressed purpose of performing tasks which, if done by human beings or by animals, would be described as involving some use of the intelligence. Regardless of our personal feelings as to the moral consequences of this form of automation, we cannot afford to ignore the revolutionary effect on our society which it portends.

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RANDOM NETWORKS

HEURISTIC PROGRAMMING

PERCEPTRONS

CYBERTRONS

ADAPTIVE SYSTEMS

LEARNING SYSTEMS

NEURAL NETS

AUTOMATA

On the Fringe

As always, with any revolution, there is a lunatic fringe—people who believe in magic, or those who are carried away with their enthusiasm for a new cause and who make wild claims which tend to discredit the entire undertaking. The field of artificial intelligence has, perhaps, had more than its share of these people. Norbert Wiener, who certainly does not belong in this category, has, nevertheless, fostered some of the loose

Progress and Problems

ns, *International Business Machines Corp., Yorktown, N. Y.*

KS SELF-ORGANIZING SYSTEMS

NG GENERAL PROBLEM SOLVER

NS NEURODYNAMICS

NS HILL-CLIMBING

MS EXPERIMENTAL EPISTEMOLOGY

MS BIONICS

TS PATTERN RECOGNITION

TA COGNITIVE PROCESSING

thinking by maintaining, as a basic tenet of cybernetics, that a rather complete analogy exists between control functions in men and in machines and by insisting that machines can possess originality and that they are a threat to mankind.[2] In a contrary vein, Mortimer Taube[3] of Columbia University discounts the entire field of activity and, in effect, charges the workers in the field with "writing science fiction to titillate the public and to make an easy dollar or a synthetic reputation." Can we cut through a morass of detail and this mishmash of conflicting claims and, somehow or other, identify the true nature of artificial intelligence and of the revolution which is upon us?

To simplify our task, we will have to be quite arbitrary and exclude certain usages of digital computers such, for example, as calculating the stresses in an airplane wing, or computing a payroll, even though these usages do reduce the amount of human thinking which must be done. In a sense, the human thinking in these situations is done in advance by the people who write the set of instructions—the "program," in computer jargon—which spell out the series of individual steps that are to be taken in the computational process.

Run-of-the-Mill Computing

Since even these commonplace uses may seem a bit mysterious to the uninitiated, we might pause for a moment and point out that a digital computer is, after all, only an inanimate assemblage of mechanical and electrical parts that functions in a completely mechanistic fashion. As Lady Lovelace remarked over a hundred years ago in describing Charles Babbage's Analytic Engine, nothing comes out of the computer which has not been put into it, barring, of course, an infrequent case of malfunctioning, and the computer can only do what we know how to instruct it to do.

The magic of the computer resides not in what it can do but only in the speed and accuracy with which it performs a sequence of very simple computational steps, a sequence which, as we have said, has been specified in advance by the person who wrote the program and which derives its complexity and its utility from the involved relationships existing between the individual steps. Let us characterize these commonplace uses of digital computers by the fact that the answers which the computer is called upon to produce are all derived from the input data by the application of a strict set of rules that are known and that have been written down in advance by the programmer. These rules may be strictly logical, as in scientific problems, or as illogical as our income-tax laws, but they are definite and woe be it to him who violates them. In a sense, we may say that the answers are all contained in the input data and that the computer's function is that of rearranging the input data in a more convenient form by the application of certain rules.

Programming a computer for such computations is, at best, a difficult task, not primarily because of any inherent complexity in the computer itself but, rather, because of the need to spell out every minute step of the process in the most exasperating detail. Computers, as any programmer will tell you, are giant morons, not giant brains. By way of contrast, when one assigns a computational task to a human assistant, one tells the assistant what to do; when one writes a computer program, he must, in effect, tell the computer how to do the problem. This distinction between how and what is far from trivial. It distinguishes the poor employee from the good one, and, to a much greater extent, it differentiates between the digital computer, as a very efficient but extremely stupid computing aid, and an intelligent human being.

While the digital computer is a device for manipulating symbols of any kind, its genesis, as Allen Newell of Carnegie Institute of Technology has so aptly pointed out, lay in the desk calculator and in the business machine. Just as Babbage had earlier proposed, several innovations have been made to increase the usefulness of the device. In particular, three special types of units have been introduced in addition to the arithmetic unit. The first of these is the memory (more correctly, a storage unit) in which instructions and data can be retained until needed. Input and output devices are also added which enable the operator to introduce instructions and data into the machine and to obtain a record of the desired output. Finally, there is a central control unit which interprets the instructions one at a time and initiates three basic types of operations: moving information from one place to another, doing simple arithmetic, and transferring control to an instruction taken from one of two or more specified locations, depending upon a comparison that it makes between the signs or relative magnitude of specified numbers. These instructions are in the form of imperative statements, for example, move X to location A; add X to Y; skip an instruction if X is negative, and so on. The sequence of these statements which constitute the program is, as we have said, a specification as to how to do the problem rather than a statement as to what to do. Once this specification has been made, it is then only a matter of routine to use the computer to solve many of the problems of the workaday world.

As everyone knows, these commonplace uses of computers are of very great economic importance, so important, in fact, that they are already causing a revolution in our way of conducting research, of running mills, and of doing business. The important point to remember, however, is that these changes are brought about, not by some mystical process that can be known only to the elect few, but by the straightforward but detailed application of quite elementary procedures to problems that are essentially routine in nature.

On the Frontier

In contrast with these routine types of problems, there are many mental processes that people are called upon to perform that cannot be, or at least have not been, reduced to a simple set of rules. Take the process of playing a game of chess, not of simply adhering to the rules of the game, but rather the process of playing a good game against an intelligent opponent. There are no known procedures for guaranteeing a win, and yet people learn to play the game and some few become very proficient. Still another example might be the problem of proving theorems in plane geometry. Ignoring for a moment the Tarski decision procedure, which high school students do not know, it is still possible to develop a proficiency in proving theorems without involving the exhaustive process of writing down all possible strings of logically derived statements that might lead to a proof. Instead, one adopts a technique in which a number of more or less arbitrarily chosen procedures are explored in a rather incomplete fashion, each yielding some clue as to whether or not one is on the right track, until, through a series of hunches, one is led to a formulation of a satisfactory proof. In both of these cases, one can sometimes arrive at a correct or, at least, a very good answer in a remarkably short period of time, but there is a concomitant uncertainty as to whether or not a solution will ever be obtained and as to whether or not an apparent solution is the best solution.

Such a method of solving any problem has come to be known as a "heuristic" procedure, as contrasted with the use of an "algorithm," a term that is used in this connection to mean a completely specified solution procedure which can be guaranteed to give an answer if one but takes the time to follow through the specified steps. It should be noted that an attempted, but imperfect, algorithm is not per se an heuristic program. Heuristic problem-solving, when successful, must, obviously, be rated as a higher mental activity than the solving of problems by some more or less automatic procedure. We are, therefore, probably justified in attaching the label of artificial intelligence to machine methods and machine programs that make use of heuristic procedures.

There are two fundamentally different approaches to this problem of artificial intelligence. One approach, and this is the one that we will first discuss, consists in analyzing problems that seem to require the exercise of human intelligence and then devising a machine, or writing a program for an existing machine, which we hope will solve these problems. The specific mechanisms that the human brain employs in solving the problem do not here concern us; we analyze the problem, not the device that solves it. To call to mind a rather trite analogy, when man first attempted to fly, he studied the birds, and the early, unsuccessful flying machines were mechanical birds. It was not until man stopped studying the birds and began to study aerodynamics that much progress was made. The modern jet airplane must cope with the same aerodynamical problems with which birds contend, but the mechanisms used in the solution of the problem of flight are quite different.

Bird-Watching

The alternate approach—that of studying birds, not aerodynamics—does have its virtues, and, in the case of artificial intelligence where so much is still unknown, some very interesting results are being obtained by this route. I am referring to the general type of studies based on Donald Hebb's work at McGill, pioneered by Nathaniel Rochester of International Business Machines (IBM), by Farley and Clark of Massachusetts Institute of Technology, and, more recently, made popular by Frank Rosenblatt of Cornell University under the name of the Perceptron. The argument goes something like this. The brain of man, like that of the animals, is made up of many cells of a certain type called neurons. These cells have rather unusual properties; they react on an all-or-none basis ("fire" in the jargon of the trade) and transmit a pulse to other neurons through synaptic connections. Each neuron is connected to many others, and a number of input signals are, in general, required before a neuron will "fire." As far as we can determine, there is a certain amount of order in the over-all pattern of interconnections between the neurons, but there also appears to be a degree of randomness in the precise connections. Learning seems to consist of alterations in the strength and even perhaps in the number of these synaptic interconnections. Now it is possible to devise a variety of mechanical, chemical, and electrical devices which simulate the behavior of individual neurons in a crude sort of way, and we can interconnect these devices in some random fashion to simulate the synaptic interconnections that exist within the brain, and, finally, we can arrange for the automatic strengthening or weakening of these interconnections using a training routine.

While the degree of intelligence achieved to date is indeed at a very low level, these devices have some very interesting properties. For one thing, they can be utilized in the solution of problems for which we do not have a complete mathematical formulation. A second and equally important attribute is that they are reasonably general purpose devices. As an example, a device built for the purpose of recognizing characteristic marks on paper might be trained to recognize English letters. The training would consist of presenting a sequence of inputs to the device, in this case the letters of the alphabet, and of strengthening those particular internal interconnections which would cause the device to give the correct response and of weakening connections leading to incorrect responses. This is quite analogous to the reward and punishment technique used in training animals. The important characteristic is that this device could equally well be trained to recognize Chinese or, for that matter to identify distinctive geographical features on an aerial survey map.

We will have space to mention only one additional characteristic, this being the apparent economy of elements, at least in terms of information storage, an economy which seems to result from the fact that the information is stored in the interconnections between the elements rather than in the elements themselves. We will return to this interesting subject after we have considered the "aerodynamics" of the problem.

Back to Aerodynamics

Marvin Minsky of Massachusetts Institute of Technology, in discussing the subject of artificial intelligence,[4] chose to divide the discussion into five different areas, these being Search, Pattern Recognition, Learning, Planning, and Induction. Although there is a degree of arbitrariness in this division, it seems to segment the problem in a way that enables one to come to grips with the essential features, and it demonstrates that there is no magic involved here. Instead, we are going to discuss a series of rather simple steps that can be mechanized. As an encapsulated summary, we can hardly do better than to quote Minsky:

"A computer can do, in a sense, only what it is told to do. But even when we do not know exactly how to solve a certain problem, we may program a machine to search through some large space of solution attempts. [That is, try many, many solutions, one after another.] Unfortunately, when we write a straightforward procedure for such a search we usually find the resulting process enormously inefficient. [There are just too many of them.] With Pattern Recognition techniques, efficiencies can be greatly improved by restricting the machine to use its methods only on the kind of attempts for which they are appropriate. And with Learning, efficiency is further improved by directing search in accord with earlier experience. By actually analyzing the situation, using what we call planning methods, the machine may obtain a really fundamental improvement by replacing the originally given Search by a much smaller, more appropriate exploration."

Minsky concluded his summary by mentioning what he called some rather more global concepts relating to Induction, and it is perhaps here that we will go our separate ways.

To bring the discussion down to earth, let us consider what might be thought of as the more or less trivial problem of programming a computer to play checkers. I have chosen checkers rather than chess partly as a matter of personal bias (having written such a program myself[5]) and partly because of the apparent simplicity of the game which highlights the problem of search. To get a computer to play checkers we must, first of all, represent the pieces on the checkerboard in a fashion which can be stored in the computer. Then the consequences of each of the available moves are to be analyzed by looking ahead, much as a person might do, considering each initial move in turn, then all of the opponent's possible replies, and, for each of these, all of the counterreplies, and so on. The average person is only able to continue this look-ahead process for two or three moves in advance, but one might argue that, since computers are so very fast, it should be possible to search through all possible moves clear to the end of the game and so determine, unambiguously, the relative worth of the different possible first moves. Unfortunately, computers are not that fast. Projecting ahead to the fastest possible computer, subject only to such limitations as the size of the universe, the molecular nature of matter, and the finiteness of the speed of light, it would still take many centuries, perhaps more than the total age of the universe, for such a computer, using this procedure, to make its first move.

Hill-Climbing

A person solves this problem by stopping the look-ahead process at a convenient point and by evaluating the resulting board position in terms of some intermediate goals: has he been able to capture one of his opponent's pieces without losing one in turn? has he been able to "king" a man? or, even, has he been able to develop an opening which will lead to the king row? This analysis cannot, by the nature of things, be exhaustive, and these secondary goals are not foolproof as indications that one is proceeding in the right direction. This general procedure is known as hill-climbing, and its shortcomings can be seen if one attempts to use it to get to the top of Mount Everest by always going uphill, starting, say, at Garden City, Long Island. There are two difficulties, the first being the existence of local peaks (if West Hill at 380 feet above sea level justifies such an appellation) and the second being the existence of flat regions subject to local perturbations (the surface of the ocean, for example) in which aimless meandering will occur unless very large steps are taken and the attendant danger that the desired peak may be completely missed unless the steps are small. Needless to say, a variety of different techniques have been developed to cope with these problems, but they may always be present to some degree, just as they always seem to plague man.

Having terminated a particular hill-climbing excursion, or a particular look-ahead process in the game of checkers, we must then determine the elevation, or evaluate the board position, to see if we are any nearer our goal. In the case of physical hill-climbing, there exist such things as altimeters with which we can measure our precise elevation, but, in the checker analogy, there is no simple measure of the goodness of a checker position. Of course, there is the possibility that we have encountered precisely the same position in some previous game, but this is highly unlikely except, perhaps, for opening positions and for the end game, so, instead, we must categorize the board situation, or classify it as belonging to some general class of board situations. The problem is not unlike that of recognizing a pattern of ink spots or smudges on the printed page which we identify as a printed character, an A, for example. This is the problem of pattern recognition.

Two steps are involved in pattern recognition. The first is the creation of a number of concepts, for example, roundness used in identifying *O*'s, straightness and the directionality of lines, and similar concepts. The second step is the assignment of weights to these various properties as they are used in identifying or classifying unknown characters. Attempts have been made to mechanize both of these steps, but, to date, very little progress has been made with respect to the concept-formation step, and most of the workers have been content to supply man-generated concepts and to develop machine procedures for assigning weights to these concepts.

Machine-Learning

It is here that we encounter the idea of machine learning. Suppose we arrange for some automatic means of testing the effectiveness of any current weight assignment in terms of actual performance and provide a mechanism for altering the weight assignment so as to maximize the performance. We need not go into the details of such a procedure to see that it could be made entirely automatic and to see that a machine so programmed would "learn" from its experience. As a bit of corroborative evidence, the checker-playing program (to which I have alluded) does have this feature, and it is fairly easy to demonstrate that this program "learns" from its playing experience and that it gets to be a better and better checker player with time. An amusing consequence of this characteristic is that the program soon becomes able to beat the man who wrote the program, not because it makes use of any information or techniques not known or knowable to the man, but only because of its infallible memory, fantastic accuracy, and prodigious speed which enables it to make a detailed, but quite unimaginative, analysis in a few seconds which would take years for the man to duplicate.

We have gone into all of this detail not to make professional programmers out of our readers but, rather, to demonstrate how very prosaic the entire matter really is and how very far away from approximating the behavior of an intelligent human being our intelligent machines seem to be. I need only remind you that a checker master can still beat the best checker program, in spite of his pitiful memory by machine standards and a difference of more than one million in relative calculating speeds. Learning procedures have yet to be applied to anything more complicated than checkers, and the real problems to which we would like to address ourselves are many orders of magnitude more complicated.

A Paradox

Perhaps we have said enough on the negative side. Progress is being made in machine learning, and we will someday understand why it is that a man can outperform a machine, and, as a result of this understanding, we will be able to devise better machines or even to program existing ones so that they can outperform man in most forms of mental activity. In fact, one suspects that our present machines would be able to do this now were we but smart enough to write the kind of programs. The limitations are not in the machine but in man.

Here, then, is a paradox. In order to make machines which appear to be smarter than man, man himself must be smarter than the machine. A higher order of intelligence, or at least of understanding, seems to be required to instruct a machine in the art of being intelligent than is required to duplicate the intelligence which the machine is to simulate.

When we have at last achieved that degree of understanding required to write a program which will ape people in most of their mental activities, we will then feel the need to write a more generalized program for a machine which will cause it to write its own programs or to write programs for another machine. This, in turn, will require still greater understanding on the part of man. There is no end to this process, but, apparently, man as the originator will always be on top.

Our point, then, is that we have nothing to fear from the machine, at least in so far as there is any danger of the machine becoming more intelligent than man. The machine's intelligence is prescribed by man, and a higher intelligence is demanded for the prescription than for the execution.

On Second Thought

But, there is a fallacy in our argument. We have been assuming that man will not be able to construct an intelligent machine until he thoroughly understands the inner workings of such a device. Nevertheless, throughout history, man has discovered many properties of nature which he has not understood, and he has proceeded to use these properties both for good and for evil in spite of his lack of comprehension. We must, therefore, reckon with the possibility that man may yet create a Frankenstein monster in the form of an intelligent machine more or less by accident and long before he has developed the detailed knowledge required to control his own creation.

This brings us back to the alternate approach to the artificial-intelligence problem which we mentioned earlier, that of studying birds, not aerodynamics, since it seems reasonable to assume that, of the two alternatives, this approach is the more likely to lead to discovery without understanding. It will be recalled that the procedure is to simulate the brain by means of a randomly connected net of neuronlike devices in the hope that such an assemblage will possess intelligence. We might further argue that, since the details of the interconnections between the elements would be unknown, there would be a degree of uncertainty in our knowledge of the capabilities of the ensemble and in our ability to predict its behavior and, to this extent, the device might develop an intellect superior to that of man, its creator.

Such a development is, however, extremely unlikely. In the first place, there is the matter of relative size. It becomes increasingly difficult to interconnect neuronlike devices when the number gets much larger than, say, 10^6 or 10^7 elements, and, under these conditions, the individual devices must, of necessity, be quite simple. By way of contrast, the brain of man contains perhaps 10^{10} neurons, and the individual neurons have many processes which connect them in a very complicated way to other neurons. There are perhaps a hundred such connections on the average per neuron. In the face of this complexity, our feeble attempts at simulation resemble the nervous system of the flatworm more nearly than they duplicate the brain of man. This situation will not always prevail, and, with some of the newer computer-fabrication techniques, we may someday be able to make devices which approach the brain in complexity.

One Chance in a Million-Million

A second factor has to do with our lack of knowledge concerning the detailed ordering of the interconnections in the brain. The brain certainly is not connected at random, although one can advance arguments to support the thesis that chance must play a part. For example, with a complexity measured by something like 10^{20}, it is hard to see how the entire specification can be contained in a germ plasm. There is also evidence of a great amount of redundancy, for there are cases in which relatively large portions of the brain have been damaged, or even removed, without any serious long-range impairment of the mental faculties.

Arguing on the other side, there is an observable gross ordering common to all brains. Above and beyond this, there is the ordering which is obviously necessary to provide the newborn child with the many reflexes and instinctive behavior patterns so necessary for his survival. Order is also betrayed by the many detailed mental quirks which we inherit. Finally, while men of genius, on the average, appear to have larger brains than their less fortunate brethren, this is certainly not universally the case, and the chief difference between prodigies and the mentally deficient seems to reside more in the detailed structuring of their brains than in mere bulk.

Of course, since we know substantially nothing about the ordering of the brain, an assumption of randomness is as good a place to start as anywhere else, but our chance of constructing a device resembling the brain of man is then something like one in 10^{12}. It will only be through an increased understanding of the basic mechanisms involved that we will be able to increase these odds, and, to the extent that we increase our understanding, we also increase our ability to control.

We can, therefore, reaffirm our previous conclusion that we have nothing to fear from the machine in terms of domination. This does not mean that man may not use the computer to harm mankind. The digital computer of today and the intelligent machine of the morrow are tools, just as the typewriter, the steam shovel, and the thermonuclear bomb are tools, and most, if not all, of man's tools may be employed by both saints and sinners. The digital computer may lack some of the destructive power of the bomb, but then the bomb owes much of its effectiveness to calculations made by computers and, in a sense, the computer will have to share the blame if man succeeds in destroying himself. It will be man, however, who must bear the ultimate responsibility, and attempts to assign blame to an inanimate collection of mechanical and electrical parts which man assembles, or causes to be assembled, constitute a shabby form of buck-passing.

Musical Chairs

The entire threat of the intelligent machine is not so easily dismissed as one might judge from these remarks. While the machine may never be more intelligent than man, men vary in their intellectual capabilities, and the machine may and undoubtedly will surpass some men. The threat, then, is more one of technological unemployment than of domination. In a sense, this is but a continuation of the process which has been going on ever since man made his first invention. Such a statement does not solve the problem, but, in terms of its gross effect on employment, the intelligent machine should be looked on as just another form of automation and should not be singled out for especial approbation. Artificial intelligence is, of course, something more than another labor-saving device, since it augments man's brain rather than his brawn. In fact, it is quite apt to be that added factor in our economy which will enable man to solve the entire problem of technological unemployment, including that portion, if any, caused by its own introduction.

Programming computers to play games, to write poetry, and to solve high school problems is but one stage in the development of an understanding of the methods which must be employed for the machine simulation of intellectual behavior. We are still in the game-playing stage, but, as we progress in our understanding, it seems reasonable to assume that these newer techniques will be applied to real-life situations with increasing frequency and that the effort devoted to games and other toy problems will decrease. Perhaps we have not yet reached this turning point, and we may still have much to learn. Nevertheless, it seems certain that the time is not far distant when most of the more humdrum mental tasks, which now take so much human time, will be done by machine. Artificial intelligence is neither a myth nor a threat to man.

[1] Marvin Minsky, "A Selected Bibliography to the Literature on Artificial Intelligence," *IRE Transactions on Human Factors in Electronics*, Vol. 2 (March 1961), pp. 39-55.

[2] Norbert Wiener, *Cybernetics; or, Control and Communication in the Animal and the Machine* (New York: John Wiley & Sons, 1948) and "Some Moral and Technical Consequences of Automation," *Science*, Vol. 131 (May 1960), p. 1355. See also Arthur L. Samuel, "Some Moral and Technical Consequences of Automation—A Refutation," *Science*, Vol. 132 (September 1960), p. 741.

[3] Mortimer Taube, *Computers and Common Sense—The Myth of Thinking Machines* (New York: Columbia University Press, 1961).

[4] Marvin Minsky, "Steps Towards Artificial Intelligence," *Proceedings of the I.R.E.*, Vol. 49 (January 1961), pp. 8-30.

[5] Arthur L. Samuel, "Some Studies in Machine Learning Using the Game of Checkers," *IBM Journal of Research and Development*, Vol. 3, No. 3 (July 1959), p. 211.

Computing and Data Processing Newsletter

"Across the Editor's Desk"

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NEW APPLICATIONS

ELECTRONIC COMPUTER AID FOR STORM OBSERVATION

A new electronic device that "may revolutionize methods of short-range storm observation and forecasting" has been announced by Dr. David Atlas, chief of the Air Force Cambridge Research Laboratories' Weather Radar Branch. The electronic device is a special-purpose digital computer; it was designed and built by Budd Electronics, a division of The Budd Company, Inc., Long Island City, N.Y., according to ideas originally set forth by Dr. Atlas.

The device is called STRADAP (for Storm Radar Data Processor). It operates automatically, converting rapidly fluctuating weather echoes (as received by a Weather Radar Unit) into two storm maps made up entirely of numerals, one showing storm intensity, and the other height. In the STRADAP intensity map, numerals from one to 7 indicate the degree of storm intensity in increasing order. The numerals in the height map indicate storm tops in 10,000-ft. categories. Height and intensity displays can be transmitted anywhere in less than 15 seconds; locally through the use of a high-speed display printer, or at a remote site, through the use of high speed telephone lines. A network of 100 radars would be able to transmit all their data to a national center in less than 20 minutes, allowing an entire national storm display to be updated two or three times an hour in rapidly developing situations.

The STRADAP has been successfully tested by the AFCRL Weather Radar Branch at its laboratories near Sudbury, Mass. After one week of operation and in its first test in severe storm conditions, the device on October 12, 1962, detected and displayed a storm which produced a tornado in Charlton, Mass., the first time radar observations of storm intensity and height have been made completely automatically and have been available within minutes of the observation time.

The machine may become a revolutionary aid in (1) increasing air safety, by vastly speeding weather information to pilots and air traffic controllers, (2) providing warnings and alerts to the public on tornadoes, hurricanes, squall lines and hailstorms, (3) giving advance warnings on flash floods, and (4) producing up-to-the minute information for national weather forecasters.

OUTER SPACE "ANCHORAGES" DESCRIBED BY MATHEMATICIAN

A General Electric mathematician is applying an extensive program of modern computer techniques to a two-centuries astronomical old theory. He has specified two areas in outer space where space platforms could be "anchored" between earth and the moon. At such "anchorages" space platforms would orbit the earth at the same relatively slow speed as the moon. This would provide stable bases for scientific observatories of the earth, moon and sky. They could also be used as relay stations in a communications satellite system or as way stations for trips to Venus and Mars.

J. Pieter de Vries, manager of astrodynamics in G-E's Space Sciences Laboratory, Philadelphia, Pa., explained that these "anchorages" occurred where the gravitational forces of the earth and moon balanced the centrifugal force of a space vehicle. In applying his computer program, de Vries analyzed the motions of a space ship and its reaction to the actual forces in the solar system, such as the earth and moon's gravitational fields. He also considered the guidance and propulsion necessary to place a vehicle at or near one of these "anchorages". A space ship rocketed to either location would hang suspended there and require only small amounts of thrust to correct any tendencies to drift out of position.

De Vries based his modern work on a theory announced in 1772 by the European mathematician-astronomer Joseph Louis Lagrange. Lagrange's theory grew out of his investigations of the mutual effects of three bodies moving in space. He determined that a small object moving under the gravitational forces of two larger bodies would encounter five positions where the forces exerted by the larger bodies would cause the smaller body to move in specified orbits related to the larger bodies. The development of this theory at G-E as applied to a space ship under the influence of the earth and moon indicated that a space ship would stay permanently only at the two locations described by de Vries.

G-E began its study in 1961 under contract to the Air Force's Rome Air Development Command (RADC). Shortly afterward, a Polish astronomer, after ten years of telescopic research, reported he had discovered two cloud-like natural satellites slowly circling the earth at these same "anchorages". American astronomers are trying to verify his report.

De Vries' group has carried an analysis of the three-body problem further by introducing into it the effects of the Sun's forces. First results of this analysis indicate that the Sun would have only a small effect on the motion of space craft at an "anchorage" location.

READING MACHINE CONVERTS ADDRESSOGRAPH PLATES TO PUNCHED CARDS

The Rabinow Engineering Co., Inc., Rockville, Md., has completed the conversion of addressograph plate impressions directly into computer language by means of a reading machine, for the Potomac Edison Co., Hagerstown, Md.

Potomac Edison customer address plates were imprinted in Cumberland, Md. The impressions were sent to Rabinow in Rockville; there they were optically scanned by the Rabinow Reader. The machine converted the human readable information into computer language, in the form of IBM punched cards. The reader also picked up edit code marks. The final output can be arranged to meet the special computer program requirements of the customer. The time required to convert by means of the reader is much less than that of conventional key-punch methods; and the method has a high degree of accuracy.

GROUPS OF COMPUTERS SIMULATE CATASTROPHES

At the Aerospace Development Center of Lear Siegler Instrument Division, Grand Rapids, Mich., engineers program "disasters" into their computers: a test pilot, in a screaming dive, strives desperately to pull back the control column -- and fails; a guided missile streaks across the sky and scores a direct hit. From such simulated catastrophes as these, information is obtained which will aid the design and improve the expected performance of products before any actual construction is begun.

DIGITAL COMPUTER USED IN NEW TEST METHOD

The Aeronutronic Division of Ford Motor Company, Newport Beach, Calif., has developed a new technique for testing the reliability of components and equipment used in weapons and space systems.

The method tests safety margins for short-lived components such as rocket motors, thermal batteries, switches, and similar items. Reliability is established normally by operating equipment under increasingly severe environmental stress conditions until failure occurs. In the case of short-lived or "one-shot" items, it is possible only to anticipate a stress level, then operate the specimen under this environment to see if it functions successfully. The new technique includes a procedure for selecting environmental test levels and a method for analyzing test data, using a digital computer to calculate the statistical properties of equipment strengths. The method has been used successfully in performing reliability tests for the Shillelagh missile program.

NEW CONTRACTS

AWARDED $2.9 MILLION FOLLOW-ON CONTRACT

Documentation Inc., Bethesda, Md., has signed a $2.9 million contract with the National Aeronautics and Space Administration for the second year of operation of NASA's Scientific and Technical Information Facility located in Bethesda. This facility is concerned with the collection, processing and distribution of technical information for the nation's aeronautical and space community.

BLANCHE TO COMPARE FEDERAL-D.C. '62 TAX RETURNS

Ernest E. Blanche & Associates, Inc., Kensington, Md., has been awarded a contract, by the D.C. Finance Office, to compare by high-speed computer the Federal and District of Columbia income tax returns filed last year by Washington residents. The contract calls for the 1962 Federal tax receipts from 325,000 Washinton residents to be matched with only 270,000 returns for city taxes filed by D.C. citizens to find out why there was a disparity of 55,000 local filings in 1962.

AWARD $528,000 CONTRACT FOR CANCER DATA PROCESSING

The National Institutes of Health (NIH) have awarded a $528,000 contract to Documentation Inc., Bethesda, Md., for processing test data of drug effects on cancer. The new one-year contract is a continuation of work which DOC INC has conducted for the Cancer Chemotherapy National Service Center of NIH for five years. The NIH-DOC INC program, one of the nation's most highly-automated systems of medical data processing, so far has enabled cancer scientists to mobilize test data from a master file on 500,000 chemical components and 26 different cancer systems.

U. S. AIR FORCE AWARDS $8 MILLION CONTRACT TO PHILCO

Philco's Communications and Electronics Division has been awarded an $8 million contract by the U.S. Air Force to furnish data processing and display equipment for the Alaskan Air Command Data Processing and Display System. The contract is to engineer and install an automatic system to provide continuous tracking and display of enemy aircraft penetrating U.S. northern defense lines. The system provides almost instantaneous data displays at local control centers as well as at NORAD headquarters in Colorado Springs, Colorado.

RCA UNDER CONTRACT TO DEVELOP NEW FAMILY OF THIN-FILM CIRCUITS

A new family of thin-film circuits is being developed by the

Radio Corporation of America under a contract funded by the U.S. Navy Bureau of Weapons and administered by the Office of Naval Research. The circuits, comprised of active and passive elements evaporated as a film on glass, are being built by RCA Laboratories, Princeton, N.J., and the Applied Research activity of RCA Defense Electronic Products, Camden, N.J. Initial application of the circuits will be in aircraft cockpit displays.

LIBRASCOPE RECEIVES CONTRACT FROM DOUGLAS AIRCRAFT CO.

The Librascope Division of General Precision's Information Systems Group has received a $468,000 letter contract from Douglas Aircraft Co. to design and produce an airborne digital computer system for use in Army tactical aircraft. The lightweight digital system will be capable of performing as the computing center of a cockpit display system being developed for the U.S. Army by the Douglas Aircraft Division at Long Beach, Calif. Librascope's computer system, built around a modified 37-pound AN/ASN-24 digital computer, will monitor the aircraft's navigation sensing devices and compute the in-flight data at high speeds to control the visual displays.

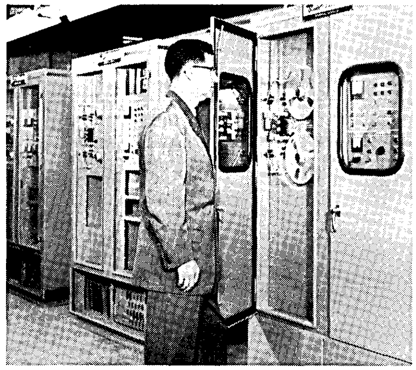
NEW INSTALLATIONS

FRENCH INDUSTRIAL FIRMS TO INSTALL CONTROL DATA COMPUTER

Société d'Informatique Appliqué (S.I.A.) and Société d'Economie et de Mathématique Appliquées (S.E.M.A.), of Paris, France, have ordered a Control Data 3600 computer. S.E.M.A. is a European industrial management firm; S.I.A. provides computing services for the firm and its customers. Operation of the CDC 3600 by S.I.A. as part of S.I.A.'s Paris Computing Center, is scheduled to begin by November of this year.

100TH DYNAPATH-20 DELIVERED

The 100th transistorized DynaPath-20 numerical contouring system for machine tools has been delivered, by The Bendix Corporation, Industrial Controls Division, to the Boeing Airplane Co. of Seattle, Wash. The system, shown



above, will operate a 3-axis Pratt & Whitney Numeric Keller machine at Boeing.

FOOD PACKING ORGANIZATION TO INSTALL COMPUTER SYSTEM

A Burroughs B280 magnetic tape computer system is scheduled for installation this spring in the San Francisco headquarters of the Tri-Valley Packing Association, a large grower in Northern California. The computer will be used to pinpoint critical cost areas, speed customer service, and assist the company to supervise inventory more closely.

WEST GERMAN TECHNICAL INSTITUTE WILL INSTALL UNIVAC 1107

A UNIVAC 1107 Thin-Film Memory Computer, purchased by the Ministry of Culture of Baden-Wurttenburg (West Germany), is scheduled to be installed in Stuttgart this summer. It will be delivered to the Department of Aerostatics and Aerodynamics of the Stuttgart Technical Institute but will also be used by other aeronautical organizations in the area.

COLGATE UNIVERSITY INSTALLS IBM 1620

Colgate University, Hamilton, N.Y., has installed a desk-size IBM 1620 for use by the students and faculty members in the liberal arts college. The 1620 is operated for research purposes, chiefly by faculty members during the day and by student teams in the evening.

PAPER INDUSTRY FIRM ACQUIRES COMPUTER

The Mead Corporation, Dayton, Ohio, a paper industry firm, has placed in operation a National Cash Register 315 computer. The computer has been installed in Mead headquarters in downtown Dayton. It has been programmed and will be used for the company's business data processing.

NEWSPAPERS USE COMPUTERS

The Palm Beach Post-Times, West Palm Beach, Fla., is using an RCA 301 electronic data system, which is installed in quarters adjoining the city room, to set news stories and classified advertising type. (Application of the RCA 301 system to newspaper typesetting technique was reported in the November 1962 issue of "Computers and Automation".) The Los Angeles Times also is using an automatic typesetting system built around an RCA computer.

A second manufacturer's equipment also has taken up the task of automatic typesetting. An IBM 1620 has been installed in Oklahoma City where it is preparing punched tapes that activiate Linotype machines for the preparation of the Oklahoma Times and the Daily Oklahoman. A second 1620 serves as a back-up system.

RALEIGH BANK INSTALLS B251

The First-Citizens Bank & Trust Company, Raleigh, No. Carolina, has installed a Burroughs B251 computer system. The system will take over all demand deposit accounting operations. The bank operates 75 offices in 41 communities in the state.

NASA INSTALLS GE COMPUTER

The National Aeronautics and Space Administration has installed a GE-225 computer to analyze launches of the Saturn booster vehicle, at Cape Canaveral, Fla. This latest installation is used to plan and analyze the instrumentation which tracks the Saturn during flight.

During the past few months four other GE-225's have been installed at NASA's Marshall Space Flight Center headquarters in Huntsville, Ala., for aid in designing the Saturn. A sixth unit was recently installed at NASA's new computer facility at Slidell, La., where it is helping develop, fabricate and test other Saturns being built at NASA's Michoud, La., operation.

NAVY TESTING TORPEDOES BY COMPUTER

The United States Naval Torpedo Station, Keyport, Washington, has leased a Control Data 160-A computer system from the Control Data Corporation, Minneapolis 20, Minn. The station is responsible for conducting proofing runs on torpedoes issued to the Fleet. Extensive research and development tests on advanced types of torpedoes or other underwater devices are also conducted here. The CDC 160-A is used in conjunction with the Navy's three-dimensional acoustic underwater tracking range located about 10 miles from Keyport in Dabob Bay, a tributary of Puget Sound.

ORGANIZATION NEWS

LITTON ACQUIRES SWEDISH FIRM

Litton Industries has acquired virtually all remaining outstanding capital stock of Svenska Dataregister AB of Stockholm, Sweden.

Since November 1959, Litton has owned a controlling 50.17% interest in the Swedish company, which manufactures Sweda and Monroe/Sweda point-of-sale recorders and cash registers for worldwide distribution. Distribution of Sweda products in the United States and abroad has been done through Litton's Business Machines Group.

The formal transfer of the additional shares of Svenska stock to Litton Industries occurred on January 15. Since Svenska joined Litton Industries in 1959, worldwide sales of its cash registers are reported to have more than doubled.

ASI PURCHASE BY ELECTRO-MECHANICAL RESEARCH PROPOSED

Electro-Mechanical Research, Inc., Sarasota, Fla., has made an agreement to purchase the assets of Advanced Scientific Instruments, Inc., Minneapolis, Minn. The agreement calls for a purchase price of $825,000 plus an amount equal to the cumulative net operating expenses of ASI from Jan. 28, 1963, to the date of closing. ASI is the two-year-old firm which produces the ASI 210 and ASI 420 medium scale computers. According to latest available figures, five 201s and one 420 are already installed in the U.S.

The companies must seek approval from their stockholders on the transaction. EMRI is a wholly-owned subsidiary of Schlumberger, Ltd., Houston, Tex., ASI is said to be in a weakened financial condition since additional financing from a potential investor was not available.

ASI officials indicate that present plans call for them to continue to operate the firm in Minneapolis as an autonomous division of EMRI.

MERGER PLAN FOR GENERAL CONTROLS COMPANY

The Boards of Directors of International Telephone and Telegraph Corp. and General Controls Co. have approved an agreement for the merger of General Controls Co. into ITT, subject to approval by stockholders of both companies. Stockholders of General Controls are expected to act on May 7; ITT stockholders on May 8.

General Controls Co., Glendale, Calif., is a manufacturer and supplier of automatic controls for residential, industrial and aerospace users.

ADVANCED TECHNOLOGY LABORATORIES ESTABLISHED BY GE

General Electric Company has established its Advanced Technology Laboratories, Schenectady, N.Y., for developmental work leading toward new opportunities for American business and industry. The new laboratories -- chemical, materials, electrical, information, and mechanical -- succeed the company's 67-year-old General Engineering Laboratory. Examples of the kinds of new technologies which the Laboratories will study are new materials for information systems, chemical energy conversion systems (fuel cells, gas bearings, etc.), application of semiconductors for conversion of DC to AC power, and new sensors.

SDS DIGITAL COMPUTERS FOR HONEYWELL

An agreement between Scientific Data Systems and Minneapolis-Honeywell Regulator Company has been concluded, under which SDS will provide general-purpose digital computers for integration by Honeywell into high-speed process-control computer systems. The systems, along with SDS 910 and 920 high-speed computers, will use all-silicon semiconductors. Integration of systems equipment will be made by the Honeywell Special Systems Division.

SCRIPTOMATIC BECOMES INDEPENDENT FIRM

Scriptomatic, Inc., Philadelphia, Pa., manufacturer of high-speed automatic-addressing and data-writing equipment, has been purchased by a group of investors. The company was formerly a subsidiary of Fischer Machine Company, Philadelphia. Scriptomatic has 47 offices in 21 countries providing sales and service.

The Board of Directors of the newly independent company are: Walter Mann, Chairman of the Board; Herbert W. Leonard, President; George Kooch, Vice President; and Rolf A. Merton and Eugene M. Lang.

AUSTRALIAN SUBSIDIARY OPENED BY EAI

Electronic Associates, Inc. has formed an Australian subsidiary to handle sales of its complete product line in Australia and New Zealand. The new subsidiary will be known as Electronic Associates Pty., Ltd., and will be responsible for sales of large, medium, and small general-purpose analog computers, digital plotting boards, transistorized digital voltmeters, and other related instruments. Offices will be at Sidney, N.S.W. where a small computation center will also be operated.

SCI BUYS COMPUTER LABS IN STOCK DEAL

Scientific Computers, Inc., Minneapolis, Minn., has acquired Computer Laboratories, Inc., Houston, Tex., through a stock exchange. An undisclosed number of shares of SCI stock acquired all of the stock of the Houston firm. It will be operated as a wholly-owned subsidiary of SCI. President Robert O. Young, and Vice President, A. Scott Kelso will continue in their positions with the subsidiary. SCI's existing Houston branch will be closed and consolidated with Computer Laboratories' quarters.

INFORMATION PROCESSING BUSINESS FORMED BY GENERAL ELECTRIC

A new organization, called the Information Processing Business, has been formed by General Electric. It will provide computer services to small- and medium-sized businesses and government agencies throughout the nation. The new organization will be a part of the GE Computer Department, Phoenix, Ariz. Six computer centers in major metropolitan areas will be operated by the Information Processing Business.

Current activities of the new organization are centered in Information Processing Centers in Schenectady, N.Y.; Washington, D.C.; Dallas, Tex.; Chicago, Ill.; and Phoenix, Ariz. Another branch is scheduled to open in New York City. In addition, the Information Processing Business operates the Government's computer complex at Redstone Arsenal, Huntsville, Ala., and provides programming services for government space work at Whippany, N.J.; Falls Church, Va.; White Sands, N.M.; and in Kwajalein and Ascension Islands.

Dr. H. M. Sassenfeld has been appointed as general manager of the new organization.

COMPUTING CENTERS

LITTON INDUSTRIES OPENING FOUR NEW CENTERS

Four new Business Equipment Centers are being opened by the Litton Industries, Business Machines Group. The new Centers are, or will be located in Sioux Falls, So. Dakota; Pensacola, Fla.; Midland, Texas; and Binghamton, N.Y. The new branch office facilities will be patterned after the first Business Equipment Center which opened last July in Scranton, Pa.

STANFORD COMPUTATION CENTER HAS NEW HEADQUARTERS

Two newly completed Computation Center buildings are the first at Stanford erected specifically for big computers and computer users. Present data-handling capacity will be increased more than 50 times when both the new machines are installed, giving Stanford University one of the West Coast's largest computer centers. An IBM 7090/1401 was installed in late January. A Burroughs B5000 is scheduled for installation in late spring.

Students will make up the bulk of the users, both for education and research purposes. Other users will include the Stanford Linear Accelerator Center, Stanford Research Institute, the Graduate School of Business, the School of Engineering and various University departments.

ASTIA SPEEDS INTERCHANGE OF INFORMATION

Technical questions on specific subjects telephoned to ASTIA, the Armed Services Technical Information Agency, Arlington, Va., a central agency of the Department of Defense, are now answered within one hour. This service is available to the 300,000 scientists and engineers working directly or indirectly for the Department of Defense whose organizations have been authorized to use ASTIA services.

Semiconductor devices are the first subject for this service. Nearly 500 documents on the subject have been indexed in depth using a new "microthesaurus" of specific retrieval terms. Other subjects will be added to the rapid answering service within the next few months. They will include: radiobiology, lasers & masers; ultraviolet, visible & infrared radiation; metals & metallurgy; oceanology; plasma physics; biological warfare; rocket motors; and bionics.

Answers consisting of unclassificed and unlimited-release information pertinent to DOD problems will be given by telephone within one hour. Classified information, bibliographies and reports, will be forwarded by the most rapid means available. This rapid-answering service is one of a number of improvements which ASTIA is making to speed the interchange of scientific and technical information related to defense.

RADC MULTIMILLION DOLLAR COMPUTER FACILITY

A large computer facility is in operation at the Rome Air Development Center, Rome, N.Y., in its Intelligence and Electronic Warfare building. RADC's computation engineering branch planned and organized the new facility. Both military and civilian scientists will use the equipment for research and development work in support of the general Air Force mission and other USAF requirements.

The equipment includes a general purpose computer worth more than $1 million; an analog computer; a system involving a number of computers functioning within a computer; several small desk-size computers; and an automatic print reader which can scan a printed page and convert it to paper tape in 20 seconds.

ON-CAMPUS COMPUTING CENTER PLANNED AT BRADLEY UNIVERSITY

Bradley University, Peoria, Illinois, has completed plans to establish a Computing Center on the campus. It will be equipped with an IBM 1620 computer leased from the International Business Machines Corporation. A $20,000 grant from the National Science Foundation, recently received by the University, will offset some of the operating expense of the Center.

The computer will be used as a laboratory device for some of the courses now offered; and new courses also will be offered. The computer will be used by the whole university, for administration, instruction, and research. Installation is expected to be accomplished during the spring with the Center ready for use when classes open in September.

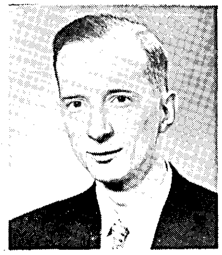
PEOPLE OF NOTE

DR. CAR HAMMER APPOINTED BY UNIVAC

Dr. Car Hammer has been appointed as Director of Scientific Computer Government Marketing by UNIVAC Division, Sperry Rand Corporation. Dr. Hammer was for 3 years director of the Univac European Computing Center in Frankfurt, West Germany.

DR. TUCKER RECEIVES PROMOTION

IBM Corp., New York, N.Y., has promoted Dr. Gardiner L. Tucker to IBM director of research. Dr. Tucker was formerly director of development engineering for the IBM World Trade Corporation. In his new position, he will be responsible for the company's research activities at its laboratories in Yorktown, N.Y., New York, N.Y., San Jose, Calif. and Zurich, Switz.



AIEE FIRST PRIZE AWARDED TWO AMERICAN RESEARCH ENGINEERS

Two American research engineers, who helped to develop the theory of Russian mathematician A. M. Liapunov (1892) into a method for testing the safety and stability of automatically-controlled machinery, have been awarded a prize for their contribution from the American Institute of Electrical Engineers.

Drs. John E. Gibson, director of the Automatic Control and Information Systems laboratory, Purdue University, and Donald G. Schultz, formerly a Purdue graduate student who is now an associate professor at the University of Arizona, were awarded the first prize for the outstanding paper published in the AIEE journal (Applications and Industry) during the past year. The award was made at the AIEE annual meeting in the Statler-Hilton Hotel, New York.

As developed by Gibson and Schultz, the theory has been expanded from previously limited and specialized applications so that it can now be applied to a wide class of engineering systems.

NEW EXECUTIVE OFFICER AT CLARY

Paul I. Stevens has been named Executive Officer at the Clary Corporation. In his new capacity Mr. Stevens will be chief operating executive supervising all line and staff functions of the Corporation. He is now Executive Vice President and a member of the Board of Directors.

VP'S AT GENERAL PRECISION

Sidney L. Briggs has been appointed vice president of administration for General Precision's Information Systems Group. Mr. Briggs will be responsible for employee relations, organization and systems planning, and plant telecommunications. The newly formed Information Systems Group includes: the Librascope Division, Glendale; Commercial Computer Division, Burbank; and a new Research Center in Glandale. Mr. Briggs has been assistant to the president of Librascope Division.

Robert O. Vaughan, formerly director of marketing, has been appointed as vice president of marketing for the Librascope Division of General Precision's Information Group. Mr. Vaughan will direct the marketing of Librascope's computers and data-processing systems for military and space applications. His responsibilities cover market planning and the operations of nationwide regional marketing offices.

FIVE NAMED TO NEW POSTS BY SIMULMATICS CORPORATION

Two new VP's and three other executives have been named by The Simulmatics Corp., New York, N.Y.

James H. Marshall, a director of Creative Marketing Analysts and of Alto, Inc., has been named a Vice President. He was formerly an executive with Grand Union Co.

James L. Tyson, a director of Media Mix, has also been named a Vice President. He was formerly director of Statistics at C-E-I-R, Inc.

Ernest Heau, formerly Supervisor of Business Systems Programming at the I.T.T. Data Processing Center, has been named Director of Programming. He also served as analyst for the Strategic Air Command's Computerized Command System and has been associated with the IBM Service Bureau Corporation.

Henry D. Sedgwick has been named Promotions Manager. He was formerly a sales executive with Aluminium, Ltd., and President of Trig-A-Tape Corporation.

Marjorie La Neve, named Senior Director, was formerly Media Director at Sudler & Hennessey Inc.

CHAIRMAN-ELECT OF THE AFIPS

Mr. J. D. Madden, director of information processing and associate director of research at System Development Corporation, Santa Monica, Calif., has been named chairman-elect of the board of governors of the American Federation of Information Processing Societies. Mr. Madden will assume his duties at the Spring Joint Computer Conference in Detroit in May.

BURROUGHS APPOINTMENT

Paul S. Mirabito has been appointed corporate vice president — administrative programming of Burroughs Corporation. Mr. Mirabito was Vice President — Defense prior to receiving this appointment to the newly created position.

NEW PRODUCTS

Digital

SECOND IN FAMILY OF GENERAL ELECTRIC COMPUTERS

General Electric Company
Computer Department
Phoenix, Arizona

A new medium-class general purpose computer has been announced by this company. It is known as the GE-215 and is second in the line of a planned family of General Electric computers. The GE-215 is designed to allow smaller businesses and industries to convert to electronic data-processing at minimum start-up costs.

-- Senior programming analyst Joan V. Cannon with General Electric's new GE-215.

The new machine has complete compatibility with the larger GE-225 and with all programming packages presently used with that computer. Programs are available for simplified transition from punched card systems to the GE-225.

The GE-215 has a magnetic core memory of 4000 or 8000 words. Additional memory needs are available through a disc-type Mass Random Access Data System. Instruction time is 35.6 microseconds. Short word lengths are 20 bits; long words, 40 bits.

The magnetic tape subsystem used with the GE-215 includes one controller and up to eight tape handlers. Inputs may be punched cards, magnetic tape, MICR documents, punched paper tape, Mass Random Access Data System and Datanet-15. Outputs are by punched cards, console typewriter, printer, magnetic tape, paper tape and Datanet-15.

A basic system includes, in addition to a central processor with console typewriter, a 400-cpm card reader; 100 cpm card punch; two dual tape handlers; MICR document handler; and a 450-line-per-minute printer.

DUAL-PURPOSE COMPUTER

Honeywell EDP
60 Walnut Street
Wellesley Hills 81, Mass.

A medium-price, dual-purpose data-processing system has been introduced by this company. The system has scientific and business capabilities, high internal operating speeds, and many large scale computer features. It is called the Honeywell 1400, and has floating point arithmetic and multiply-divide options for scientific data processing, a memory cycle time of 6.5 microseconds, and an internal speed of 14,000 three-address binary additions per second.

The 1400 has priority processing, permitting the simultaneous operations of peripheral devices, such as card reading-computing-printing, simultaneous magnetic tape reading and writing at full tape speed, and operation of two high speed printers at the same time.

The memory capacity of the new system ranges from 4096 words to 16,384 words, expandable in 4096-word modules. A Honeywell word is 12 decimal digits.

Up to 16 magnetic tape units can be connected to the Honeywell 1400. Three models are available with transfer rates of either 48,000, 96,000 or 133,000 decimal digits per second. The tape units have Honeywell's Orthotronic automatic error-detection-correction system.

The basic configuration of the system includes a central processor with a 4096-word memory, eight magnetic tape drives, a printer, card reader, card punch and operator's console. Arithmetic and control units for the system are contained in the central processor. Paper tape equipment, disc storage units, optical scanning and Orthoscanning devices and communications control units can also be used with the Honeywell 1400.

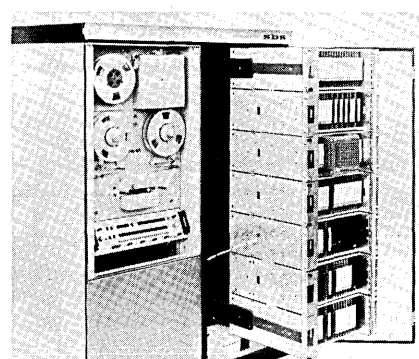
Programming aids for the system are compatible with the Honeywell 400 system. EASY assembly language, COBOL, and the AUTOMATH scientific (algebraic) compiler form the basic software package. Honeywell 1400 programs can be run and tested on the H-400 or the large-scale H-800 computers.

VAN-MOUNTABLE VERSIONS OF SDS COMPUTERS

Scientific Data Systems
1649 Seventeenth St.
Santa Monica, Calif.

This company has made van-mountable versions of the SDS 910 and the SES 920 general-purpose digital computers. All parts of the computers have been mounted on pull-out slides so as to provide complete accessibility from the front of the cabinets.

The picture shows an SDS 910 computer and peripheral equipment



which have been mechanically modified for slide mounting in a van. The entire computer slides in and out of its rack as one assembly. Also, the paper tape punch, spooler, reader, and the power supply are mounted on slides. The machine may have extra long cables (some as long as 40 ft.) in order that the paper tape equipment, typewriter a and control panel may be physically removed from the computer itself when mounted in a van.

SAAB MARKETS NEW COMPUTER

Svenska Aeroplan Aktiebolaget
100 Waterfront St.
New Haven, Conn.

A new digital computer has been introduced to this country by SAAB (Svenska Aeroplan Aktiebologet). The system, called the D21, is a general-purpose, parallel-sequence, binary computer. Its versatility is reported to make it useful in small offices and laboratories as well as in large data processing and plant process control centers.

The solid state computer has a minimum core memory of 4000 words which can be enlarged to 32,768 words. Word structure is flexible with semi-variable word lengths of 1, 12, 24 (basic word size), and 48 binary digits. Clock frequency is 2.5 megacycles per second. The memory-core cycle time is 4.8 microseconds. A complete central processor consists of an arithmetic unit, two control units, memory unit or units, and a power unit.

Modular design is used electrically, as well as mechanically, in the system. Circuit components are easily accessible and functional units (memory, control, etc.) can be quickly replaced. All malfunctions are located and reported to the central processor.

An autocode called DAC is used in programming the D21. This symbolic language allows direct computer instruction as well as many pseudo-instructions. An instruction list of 45 operations permits technical computations such as floating point arithmetic, multiplication and division, matrix calculus, equations and functions. Commercial data and plant process control are also programmed.

PLANT POWER MAINTAINED WITHIN SET LIMITS BY COMPUTER

Bailey Meter Company
1050 Ivanhoe Rd.
Cleveland 10, Ohio

A special-purpose digital computer has been developed by this company; it continuously monitors total power consumed by a plant or process. The computer, called a Power-Demand Computer, may be installed in any plant where economic use of electrical power is desired.

Information supplied by the computer permits the plant operator to obtain maximum use of power available without exceeding a preset demand limit. Demand is based on either an analysis of plant needs or on the terms of a contract with the utility. The computer is a self-contained device that uses solid-state digital components of modular, plug-in type. Demand rate is set by three ten-position tap switches mounted on a plug-in module within the system cabinet. Indicator lamps show if the existing rate of power consumption is above, below, or at the preset demand rate.

Data Transmitters and A/D Converters

DATA ACQUISITION SYSTEM

General Electric
Schenectady 5, N.Y.

This company has developed a 600-channel input, medium-speed data-acquisition system capable of automatically scanning up to 600 sensing instruments. The system converts analog voltages representing any combination of functions, such as temperature from a thermocouple, pressure from a gage, etc., into precise digital form. Measurements and auxiliary data are concurrently recorded on punched paper tape and on a digital printer, or fed directly into a general purpose computer.

The system will print only, punch only, or print and punch at any rate up to 40 points per second. Its output can be coupled directly to a digital computer. In this arrangement scanning speeds up to 60 points per second are possible by setting a selector switch.

The data logger is designed for use in testing jet engines, space simulators, airplanes and rockets and for use in the chemical, petroleum and utility fields.

MAGNETIC TAPE TRANSMISSION TERMINAL

Tally Register Corp.
Seattle, Wash.

The Mark 63, a new magnetic-tape data-transmission terminal, has been introduced by this company. It can convert magnetic tape to paper and paper tape to magnetic during transmission.

The Mark 63 is a bi-directional device, designed for use with a paper tape terminal. It has lateral and longitudinal parity checking, and automatic back-up and re-transmission of blocks upon detection of any kind of transmission error. The system uses a Datamec D2020 Magnetic tape terminal (Computers and Automation, October 1962). Paper tape may be in any 5, 6, 7 or 8 level code. The standard magnetic tape format is 1401 but other formats may be specified.

Software News

H-400 "PERT" PROGRAM

Honeywell Electronic Data Processing, Wellesley Hills, Mass., is developing a PERT package for use with the Honeywell 400 computer. This package will be available to users in the third quarter of this year. PERT, for Program Evaluation and Review Technique, is a management planning and control program.

The basic H-400 configuration required for using the PERT package is a central processor with 2K memory, 5 magnetic tape units, a high-speed printer and a card reader. This configuration can handle up to 700 events and 900 activities using the new PERT package.

DATATROL "FORTRAN DIAGNOSTIC LOADER"

Datatrol Corporation, Silver Spring, Md., has written a program for diagnosing certain errors in FORTRAN coding. The program is called the Datatrol FORTRAN Diagnostic Loader (DFDL), and it is being offered to interested computer installations at no charge. The DFDL was written to check FORTRAN statements during the normal card-to-tape loading pass on the IBM 1401. The maximum checking possible is done on the FORTRAN statements during card-to-tape load time, with the purpose of reporting errors quickly to the programmer and also producing a job tape for processing on the IBM 7090, free of errors detectable by the Loader.

When an invalid statement is encountered, it is listed on the 1401's printer, together with a notation specifying the nature of the error. The first error found causes the magnetic tape to be repositioned to the beginning of that job. After the first error, the remaining statements are checked but transcription to tape is not resumed until the beginning of the next job. All control cards are listed on the 1401's printer for identification purposes.

All tape conventions required by the 7090 FORTRAN Monitor have been followed, such as the insertion of look-ahead bits into the tape records. No restrictions have been placed on the FORTRAN programmer.

NEW COBOL MANUAL

The U.S. Government Printing Office, Washington 25, D.C., now has available a revised edition of COBOL, called "COBOL 61 Extended". The publication represents months of effort on the part of that group of volunteer programming experts, the COBOL Maintenance Committee. Headed jointly by Gregory M. Dillon of the Dupont Company and John Jones of the Air Force Logistics Command, this group is responsible for improving and clarifying the rules which constitute this programming language, previously published as "COBOL 61."

The new publication extends the language but does not change essential features. Those who have already started using COBOL need have no fear that their work is obsolete.

Many users have started to make use of COBOL. The advantages expected are threefold:

1. With a problem stated in COBOL the user is able to use any computer for which a compiler program is available merely by compiling an operating program for that computer. Heretofore an operating program was written for the user's main machine at a cost of many weeks or months of effort by his programmers; then, if he wanted to use a different machine in another location or wished to replace his computer by a new model, he had to spend many more weeks manually rewriting the program.

   Recompiling the COBOL statements into a program for the new machine is a matter of minutes or, at the most, a few hours. For the Department of Defense with different computers in different locations, all on the same job, this is an important factor. Some private corporations have branches in different locations where the same situation applies. And many companies feel much better not to be "locked in" to a situation where an obsolete computer will be used rather than stand the cost of reprogramming for a new model.

2. Some users report that over-all time of writing a program is reduced by use of COBOL. This will, no doubt, depend largely on the relative familiarity of programmers with COBOL as compared with other programming methods. It appears that new programmers can be trained in the use of COBOL more quickly than for other systems.

3. Another advantage of writing programs in COBOL is that those who come after can understand more easily. This is to be expected since COBOL is composed basically of English words and phrases. There is no doubt that COBOL affords a clearer back-track than previous systems.

All things considered, the future of COBOL seems bright. With the support that computer manufacturers have shown by their rapid production of compilers and with improved methods of training programmers in the use of COBOL being developed, it seems likely that its use will grow rapidly. Discussion is going on about adoption of COBOL, by the American Standards Association, as the standard programming language for commercial problems. This may lead to similar adoption by the International Standards Organization.

With greater use will come more suggestions for improvement, both of COBOL itself and of the compiler programs. Admittedly, there is plenty of room for improvement in both areas but the development has been a cooperative effort -- an astoundingly successful one considering the competitive situation -- and must remain so. Too rapid improvements in the language might waste millions of dollars worth of compiler programs. Hence, a period of slow, evolutionary improvement is to be expected.

Input - Output

MAGNETIC TAPE UNIT BC 422

Burroughs Corporation
Equipment & Systems Div.
Detroit 32, Mich.

In the magnetic tape unit BC 422, recently developed by this company, static skew has been completely eliminated, and dynamic skew held to less than one microsecond. The unit is solid-state and has been designed for use with data acquisition and processing systems. The device is completely self-contained, including power supplies and circuitry for logic, error detection, and skew corrections.

The BC 422 has a maximum tape speed of 120 inches per second, and a maximum density of 555 bits per inch. The tape speed is kept within 1% of the nominal rate by a pair of specially designed hysteresis synchronous, belt-driven capstan motors. The start and stop times are less than three milliseconds.

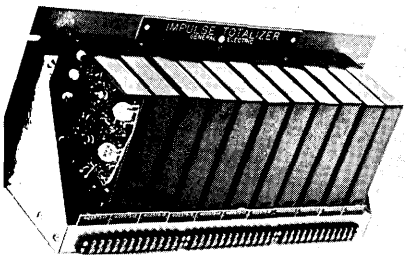
The magnetic tape unit may be used with any digital computer.

SOLID-STATE TOTALIZER

General Electric
Schenectady 5, N.Y.

A totalizer designed to provide the connecting link between metering devices and associated recording and billing equipment has been developed by this company; the device is called PULSCRIPT SST-1. The solid-state totalizer, type SST-1, is designed to be joined with and meet the accuracy of electronic data loggers and digital computers.

The SST-1 can be used to receive, count, add, subtract, divide, or integrate impulses representing electrical energy, or gallons of water, or feet of wire, paper, or steel, etc. Signals fed into the SST-1 originate from pulses generated by various forms of commercial contact-making devices, such as the meters of production-counting signals. The

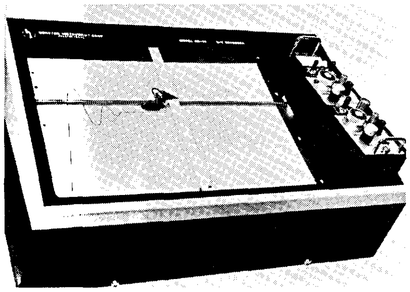


device transmits the total or net amount of these impulses to any one or a combination of the following: computer, data logger, telemetering equipment, printing demand meter, or other totalizer.

NEW X-Y RECORDER

Houston Instrument Corp.
P.O. Box 22234
Houston 27, Texas

This company has developed a simplified 11" x 17" X-Y recorder, designated the HR-97. The recorder has 1 mv/in. basic sensitivity, 0.25% of full-scale accuracy, 15 in/sec. pen speed, zener reference voltages, snap-on pen assembly, and vacuum paper holddown.



The HR-97 has interchangeable plug-in control modules. All of the plug-in modules have precision ten-turn input attenuators, full-scale zero adjustments and automatic pen-lift controls. A load-operate switch automatically picks up the pen and positions it away from the chart area for easy loading of paper.

Components

DECADE COUNTER TUBES

Sylvania Electric Products Inc.
Electronic Tube Division
Emporium, Pa.

Two new bi-directional decade counter tubes for use in digital computers have been developed by this company. The tubes can accomplish a variety of purposes, including coding, scaling, frequency-dividing, multiplexing, addition, and subtraction. Type 8035 will operate in high-speed computers from 0 to 50 KC; type 8353 will operate from 0 to 4 KC for low-speed computers. Both tubes have ten individual cathodes to allow for multiple or sequential output pulses. Read-out of the count is from the top of the tube.

"BUILDING BLOCK"
CHECKOUT SYSTEM

Northrop Nortronics
Anaheim, Calif.

A "building-block" automatic checkout system has been developed by this company. The automatic test equipment, called the Datico/SP-5, is built upon a family of individual, drawer-type subsystems and modules. Their plug-in-capability gives complete flexibility in meeting "all possible" test requirements. (Datico is an acronym for digital automatic tape intelligence checkout.)

With the SP-5, it is possible to choose only those functional modules needed for a particular checkout problem, substituting alternate modules rapidly if checkout requirements change. The SP-5 is a completely solid-state system which can be either tape-controlled or computer-controlled. Under tape control, the system uses a 500-foot reel of Mylar tape that can be read at a speed of 250 frames a second. Any equipment whose outputs can be transduced to electrical units can be checked out with the SP-5.

LOGIC ELEMENTS

Intercontinental Instruments Inc.
123 Gazza Blvd.
Farmingdale, L.I., N.Y.

A set of NAND logic elements, covering frequency ranges up to 10 mc, has been developed by this company. Each of the different logic elements may operate at 3 mc or 10 mc. The devices include general-purpose flip-flops, DC-set-and-reset flip-flops, digital gates, free running multivibrators, Schmitt Triggers, crystal oscillators, etc., each in a variety of configurations.

The 3 mc and 10 mc elements both use diode-coupled inputs and provide 3 volt clamped outputs. Both types have an operating temperature of -20°C to 55°C and noise rejection is 0.5 v. Rise and fall time is 17 nanoseconds and 8 nanoseconds, respectively, for the 3 mc and 10 mc units.

NEW OPTICAL SCANNING SYSTEM

The National Cash Register Co.
Dayton 9, Ohio

The new NCR 420 optical scanner "reads" the "Sales Journals" of conventional NCR cash registers equipped with NCR's optical type font, and thus makes input for the automatic preparation of merchandise reports. The type 420 scanner may be linked "on-line" with an NCR 310 desk-size computer. It is also compatible with the NCR 315 and 390 computer series. It can be used with a tape punch to produce punched paper tape, and then if desired, punched cards, for off-line applications. The Type 420 can read accounting and adding machine tapes as well as those from cash registers.

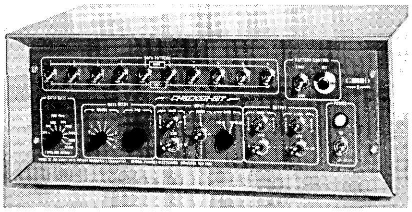
A changeable program board controls its operations to suit the format of the sales journal. The machine can be programmed to read only those entries from tapes or journals which may be needed for a specific report. Data is read at the rate of 520 characters a second.

DIGITAL PATTERN COMPARATOR

General Dynamics/Electronics
1400 North Goodman St.
Rochester 1, N.Y.

This company has developed a digital pattern generator and comparator for checking the performance of binary data transmission systems. It is called the SC-310

"Checker-Bit". It generates a ten-bit binary data pattern



(which is selected by switches on the front panel) and presents this pattern in serial form. The rate can be set at 75, 150, 300, 600, 1000, 1200, 2000, 2400, or 4800 bits per second. The SC-310 can be clocked or timed by an external source at any data rate up to 50,000 bits per second.

The digital pattern generator operates with either a polar or impulse digital data signal. Sufficient internal delay is provided to permit compensation for system propagation time so that time coincidence between transmitted and received data can be established for error detection. Errors are totaled on an external recorder.

Front panel switches and controls provide selection of functions, and are used to change input and output signal characteristics to permit operational compatibility with most equipment.

RCA DEVELOPS SOLID-STATE COMPUTER ELEMENT COMBINING PROPERTIES OF TRANSISTORS AND VACUUM TUBES

RCA Laboratories
Princeton, N.J.

Development of a new solid-state element, combining some desirable properties of transistors and vacuum tubes, is reported by the Radio Corporation of America.

Called a metal oxide semiconductor transistor, the new device can be fabricated in large interconnected arrays. It may be regarded as a "new fundamental building block" of integrated, microelectronic circuits for a broad range of future electronic systems, according to Dr. James Hillier, Vice President, RCA Laboratories, Princeton, N.J.

Among future products that should become practical with such circuits, he said, are portable, battery-operated, high-speed computers; lightweight, high-performance communications systems; and a new generation of tactical and industrial equipment operating over wider temperature ranges and with greater resistance to nuclear radiation.

"With development of this new device we have, for the first time, a circuit element that combines the flexibility and simple circuitry of a vacuum tube and the small-size and low operating power of a transistor, while offering certain features of its own," he said.

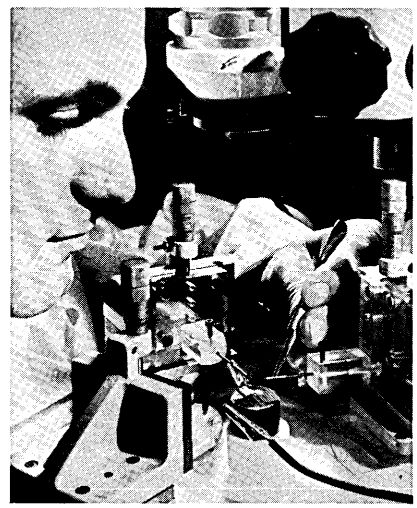
-- Revolutionary solid-state elements developed by RCA scientists to combine the properties of transistors and vacuum tubes are seen here built into a complex "logic" circuit for computers. The actual circuit is held in a pair of tweezers by Steven Hofstein, of the RCA Laboratories technical staff, and its details appear in the enlargement on the viewing screen in the foreground.

The new unit is described as an "insulated-gate, field-effect transistor. It is a semiconductor device made from silicon and capable of amplifying electric voltages. By varying the input voltage on the insulated gate, the device as a whole can be made to switch, amplify, or otherwise regulate its output of electric current in a manner analogous to a pentode vacuum tube. In conventional transistors, similar results are achieved by making changes in the magnitude of the input current.

Circuits using these new elements are made by producing conducting paths in a slice of high-resistivity silicon, leaving gaps wherever an active element is desired. An insulator is produced by oxidizing the silicon over the gap. A metal electrode or "gate" is deposited on top of the insulator and connected into the circuit. By applying proper voltage on the insulated gate, the gap becomes conducting and the circuit is closed.

Both "n" (negative) and "p" (positive) type devices have been made. RCA states that the nature of their electrical characteristics is such that complete digital (computer) circuits can be constructed from them without the need of other components. The switching speed of the new units is 10-20 nanoseconds.

While voltage-controlled transistors are not new in principle, RCA explains their great promise has gone largely unrealized due to high production costs, technological difficulties and the commanding role assumed early by current-controlled transistors.



-- A scientist at the David Sarnoff Research Center positions an electrical probe over a silicon wafer containing 2,200 newly-discovered insulated-gate, field-effect transistors.

Arrays of up to 850 of the new components have been produced in an area the size of a dime. Experimental microcircuits being built from these arrays include electronic switches and counters for computers, amplifiers for military and commercial communications systems, and control networks for a variety of industrial and military applications.

EDUCATION NEWS

BEHAVIORAL SCIENTISTS INVITED TO PARTICIPATE IN RESEARCH TRAINING COURSE

Bert F. Green, Jr.
Dept. of Psychology
Carnegie Institute of Technology
Pittsburgh 13, Pa.

A summer research training institute in the Simulation of Cognitive Processes will be held at The RAND Corporation, Santa Monica, California from June 17 to July 26, 1963. The Social Science Research Council and the RAND Corporation, under a grant from the National Science Foundation, are sponsoring the institute. The Institute will cover recent developments in constructing computer programs that serve as models of complex processes of human thinking, such as problem-solving, concept formation, rote memory, decision-making, and verbal communication. Intensive insturction will be given in techniques for constructing such computer programs.

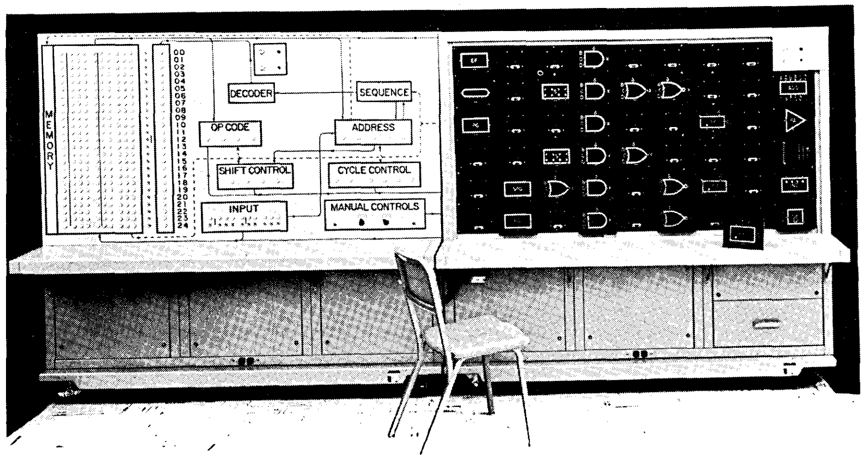
The Institute is intended primarily for post-doctoral behavioral scientists who are affiliated with universities. Well qualified advanced candidates for the doctorate will be considered. Further information may be obtained from the writer.

TEACHING MACHINES

DIGITAL COMPUTER TRAINER AND LOGIC DEMONSTRATOR

The Naval Training Device Center (NTDC), Port Washington, N.Y., is using a Digital Computer Trainer and Logic Demonstrator developed by the Computer Control Company, Inc., Framingham, Mass. This device, designated "6B4", was produced to meet military requirements for a versatile classroom device to teach students various aspects of computer theory, operation and maintenance.

elements of the Trainer, are displayed continuously on the front panel flow diagram. The device operates in parallel and uses: ten-bit binary words; and a repertoire of thirteen commonly used instructions. Program routines may be run continuously, or sequenced through one instruction at a time; or else each instruction may be executed in a series of sequential steps.



The 6B4 consists of two training demonstrators combined in a single unit: a realistic small-scale digital computer; and a flexible logic demonstrator. As a Digital Computer Trainer, the operation of a small-scale general-purpose computer is displayed on the twelve-foot face of the system in flow diagram form. The contents of the special twenty-five word memory, as well as all major

The removal of three display panels converts the device to a Logic Demonstrator. The panel removal exposes a module mounting panel which can accommodate up to 53 independent logic demonstrator modules. By simple patchcord wiring between modules, students can be introduced to the basic digital logic building blocks of flip-flops, gates, delays etc., a and can learn to implement such logic sub-assemblies as counters, shift registers, and decoders.

DI/AN CONTROLS OFFERS PROGRAMMED MAGNETIC CORE LOGIC COURSE

The editors have noted with interest the increasing use by companies of programmed instruction materials to educate potential customers on the uses of their products, with a goal of increased sales.

One of the more interesting such presentations we have seen, is a Programmed Magnetic Core Logic Course entitled "Do You Have This Man's Problems?" put out by DI/AN Controls, Inc.

The presentation is in the form of a 114 page scrambled textbook where the reader advances through the text at a pace determined by his ability to answer questions on various pages which test either his prior knowledge, or his uptake of the text material. The text is humorously and interestingly illustrated, and the course is designed to provide a painless way to get up-to-date on the hows, whys, and whats of magnetic core logic modules and circuits.

Engineers with an interest in this area are invited to write to DI/AN Controls, 944 Dorchester Ave., Boston 25, Mass., for a copy of their programmed textbook.

STANDARDS NEWS

X3 COMMITTEE BY-PASSES BEMA IN SENDING 7 BIT CODE TO ASA

The X3 Committee on Computers and Information Processing of the American Standards Association voted in a meeting on January 24th to transmit the proposed American Standard Code for Information Interchange to the Miscellaneous Standards Committee of ASA for approval as an American Standard without the recommendation of the sponsor, the Business Equipment Manufacturers' Association (BEMA).

The code transmitted, pASCII, is a 7 bit code for the representation of alphanumeric characters and symbols used in automatic computation, data processing, and data transmission.

pASCII has been a controversial subject. At the September 10th meeting of the X3 Committee, it was voted twenty to four to send pASCII through the Sponsor to ASA for approval as an American Standard. BEMA formed and convened a Standards Review Board which at its first meeting voted to return pASCII to X3 for further work in adopting it to media, i.e., paper tape, punched cards and magnetic tape; and also to consider de facto standard codes for recognition as American Standards.

The latter recommendation of the BEMA Standards Review Board appeared to be in conflict with an interpretation of ASA Regulations, and at a second meeting of BSRB on January 4th, the Sponsor withdrew the recommendation on de facto standards but issued the following resolution: "The sponsor accepts the principle of a single code for information interchange. This code will be universally useful only when it can be adopted to the common methods of machine to machine communication, i.e., paper tape, punched cards, and magnetic tape. The sponsor, therefore, believes submission of the pASCII to ASA is premature. It is recommended to X3 that they institute a scheduled program of developing such adaptations with the objective of submitting to ASA a family of pASCII codes by the end of 1963, that will meet the needs of the industry and that X3 provide the organization and manpower needed for this task."

Under ASA procedures, the pASCII will now go before the ASA Miscellaneous Standards Board for their consideration and determination as to whether or not a "consensus" exists for adoption of the code as an American Standard. Final action is represented by a review of the recommendation of the Miscellaneous Standards Board by the ASA Board of Review.

To bring out all the facts bearing on the case, either board may hold a hearing and ask the different parties at interest to appear and testify. On routine matters the action by both boards would be completed in about six weeks but the controversial character of the pASCII makes it probable that a longer period will be required for final determination.

BUSINESS NEWS

IBM NOTES 12% REVENUE GAIN

Gross income and earnings for 1962 were 12% higher than those for the previous year reports International Business Machines Corporation in its recent annual report.

IBM's gross income in the U.S. for the year ended December 31, 1962, was $1,925,221,857, an increase of $230,926,310 over 1961. Net earnings after federal taxes were $241,387,268, an increase of $34,159,671 over the previous year. IBM's total assets at the end of the year amounted to $1,984,540,202.

The IBM World Trade Corporation, a wholly-owned subsidiary which carries on IBM's business through its subsidiaries outside the U.S., had earnings of $86,679,086 last year, an increase of 26% over the year before. IBM earnings included $24,555,899 of IBM World Trade's results in 1962, compared with $18,540,853 in 1961. The undistributed net earnings of IBM World Trade's foreign subsidiaries continue to be excluded from IBM's reported net earnings.

The report notes that among new products introduced in 1962 was the low-cost 1440, the 7010, the 7094 data processing systems, and the IBM 6400 Magnetic Ledger Accounting Machine.

Also the report noted IBM engineers were successful during the year in utilizing television channels to transmit computer information experimentally at the rate of 20 million bits a second — the fastest speed yet reported.

Expansion of IBM facilities continued in 1962 with the completion of development laboratories in Poughkeepsie, N.Y., and San Jose, Calif.

At the year's end, IBM had 127,468 employees in its worldwide operations. Of these, 81,493 were domestic employees and 45,975 were abroad.

CONTROL DATA REPORTS INCOME RISE; ITS STOCK IS ACCEPTED BY NYSE

William C. Norris, President of Control Data Corporation, reported recently for the six months period ended December 31, 1962 that his company's sales, rentals and service income was $24,916,998, up 44 per cent compared with $17,308,142 in the same period of the previous year. Net profits after provision for taxes were $954,291, up 50 per cent compared with $636,990 for the corresponding six months of 1961.

Other highlights of the Midyear Report included an announcement that the first delivery of the CONTROL DATA 3600 Computer System will be made in April 1963. The 3600 is the largest commercially available computer in the world, and orders for several have been announced, including Michigan State University, University of California's Lawrence Radiation Laboratory at Livermore, California, and an industrial installation jointly for Societe d'Economie et de Mathematique Appliquees (S.E.M.A.) and its subsidiary Societe D'Informatique Appliquee (S.I.A.), Paris, France.

The common stock of the Company was approved in February for listing on the New York Stock Exchange. 4,706,956 shares are to be listed, of which 3,902,454 shares are outstanding among some 18,000 stockholders.

President Norris commented that "listing on the New York Stock Exchange is an important event in the history of Control Data. It should provide our present and potential broad distribution of shareholders a dependable, closely regulated market in which to deal in our shares as well as widen the Company's image in the business and investment community."

Control Data was founded in the summer of 1957 with an original capitalization of $600,000. Currently its net worth is approximately $24,500,000.

In addition to producing computer systems, Control Data designs and produces industrial data processing equipment which includes control systems, data communication systems, and data collection systems for business applications. The Company's manufacturing operations are carried on in the Minneapolis-St. Paul area. In addition, Control Data operates computer service centers in the Twin Cities, Palo Alto, California, and Washington, D.C. The Company's computer service centers offer versatile high-speed data processing facilities for business and industrial purposes on a service bureau basis.

BURROUGHS REVENUES UP 6%; EARNINGS FALL 10%

Burroughs Corp.'s 1962 net income trailed 1961 results despite record revenues. The computer manufacturer blamed foreign currency devaluations and a new leasing program for the lower earnings.

Revenues climbed 6% to $424,681,000 last year from $401,210,737 in 1961, the 13th consecutive year of record revenues. Net income fell to $9,493,000, down nearly 10% from $10,489,369.

Ray Eppert, president, said the devaluation of foreign currencies had an after-tax effect of $1,710,000. In addition, a leasing program for general business machines implemented in 1962 had the effect of deferring approximately $1,900,000 of earnings into future years, he said.

Mr. Eppert said while leasing of the general business machines, as well as electronic data processing systems, defers revenue and profit in the short term, it builds a high, stable foundation of future revenue and earnings less susceptible to fluctuating economic conditions.

In the first nine months of 1962 Burroughs reported revenue rose to $303,500,000 from $282,318,000 a year earlier.

Indicated fourth quarter net fell to $3.6 million from $4.9 million a year earlier. Revenue rose to $121.1 million from $118.8 million.

Mr. Eppert said new orders received last year totaled $487,076,000 up 14% from a year earlier.

PHILCO REPORTS 13% SALES INCREASE; ORGANIZATION CHANGES

The Philco Corporation, a wholly-owned subsidiary of the Ford Motor Company, has reported sales for fiscal 1962 of $475,000,000, a 13% increase over 1961's sales of $421,000,000.

Philco's Computer Division announces plans to establish four regional U.S. offices, each competent to handle sales and support activities, and to offer improved services to the consumer. They are designed to promote the sale of the company's new 212 and 4100 electronic data processors.

Two of the offices will be located in the Philadelphia area — Eastern Regional and a Federal Systems Office; one in San Francisco and one in Los Angeles. Philco also has a computer office handling intra-company affairs in Dearborn, Mich., home of the parent firm.

MONTHLY COMPUTER CENSUS

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

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

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

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

AS OF FEBRUARY 20, 1963

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	10	12
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	6	3
	ASI 420	Y	$12,500	2/63	1	0
Autonetics	RECOMP II	Y	$2495	11/58	130	7
	RECOMP III	Y	$1495	6/61	28	19
Bendix	G-15	N	$1000	7/55	352	2
	G-20	Y	$15,500	4/61	19	6
Burroughs	205	N	$4600	1/54	78	X
	220	N	$14,000	10/58	58	X
	E101-103	N	$875	1/56	170	X
	B250	Y	$4200	11/61	44	38
	B260	Y	$3750	11/62	25	47
	B270	Y	$7000	7/62	12	26
	B280	Y	$6500	7/62	9	17
	B5000	Y	$16,200	2/63	0	12
Clary	DE-60/DE-60M	Y	$675	2/60	88	1
Computer Control Co.	DDP-19	Y	$3500	6/61	1	2
	DDP-24	Y	$3000	-	0	1
	SPEC	Y	$800	5/60	10	2
Control Data Corporation	160/160A	Y	$2000/$3500	5/60 & 7/61	267	55
	924/924A	Y	$11,000	4/62	5	11
	1604/1604A	Y	$35,000	1/60	42	10
	3600	Y	$52,000	4/63	0	5
	6600	Y	$120,000	2/64	0	1
Digital Equipment Corp.	PDP-1	Y	Sold only about $175,000	12/59	37	10
	PDP-4	Y	Sold only about $75,000	8/62	8	9
El-tronics, Inc.	ALWAC IIIE	N	$2500	2/54	32	X
General Electric	210	Y	$16,000	7/59	69	8
	215	Y	$4000	-/63	0	3
	225	Y	$7000	1/61	110	86
General Precision	LGP-21	Y	$725	12/62	4	32
	LGP-30	semi	$1300	9/56	410	15
	L-3000	Y	$4500	-/63	0	2
	RPC-4000	Y	$1875	1/61	67	18
Honeywell Electronic Data Processing	H-290	Y	$3000	6/60	11	3
	H-400	Y	$5000	12/60	37	68
	H-800	Y	$22,000	12/60	50	8
	H-1400	Y	$14,000	-/63	0	1
	H-1800	Y	$30,000 up	-/63	0	2
	DATAmatic 1000	N	-	12/57	5	X
H-W Electronics, Inc.	HW-15K	Y	$500	3/63	0	2
HRB Singer, Inc.	SEMA 2000	Y	$700	1/62	21	19

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
IBM	305	N	$3600	3/62	850	X
	650-card	N	$4000	11/54	700	X
	650-RAMAC	N	$9000	11/54	210	X
	1401	Y	$2500	9/60	4850	3900
	1410	Y	$10,000	11/61	156	385
	1440	Y	$1800	4/64	0	580
	1460	Y	$9800	10/63	0	5
	1620	Y	$2000	9/60	1300	300
	701	N	$5000	4/53	4	X
	7010	Y	$19,175	2/64	0	30
	702	N	$6900	2/55	4	X
	7030	Y	$300,000	5/61	4	1
	704	N	$32,000	12/55	79	X
	7040	Y	$14,000	6/63	0	42
	7044	Y	$26,000	6/63	0	11
	705	N	$30,000	11/55	151	X
	7070, 2, 4	Y	$24,000	3/60	320	240
	7080	Y	$55,000	8/61	43	28
	709	N	$40,000	8/58	40	X
	7090	Y	$64,000	11/59	240	125
	7094	Y	$70,000	12/62	2	6
Information Systems, Inc.	ISI-609	Y	$4000	2/58	20	1
ITT	7300 ADX	Y	$35,000	7/62	6	4
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only–$5800	3/58	165	5
	Monrobot XI	Y	$700	12/60	230	140
National Cash Register Co.	NCR - 102	N	–	–	30	X
	- 304	Y	$14,000	1/60	30	0
	- 310	Y	$2000	5/61	33	45
	- 315	Y	$8500	5/62	45	135
	- 390	Y	$1850	5/61	315	224
Packard Bell	PB 250	Y	$1200	12/60	133	24
	PB 440	Y	$3500	9/63	0	10
Philco	1000	Y	$7010	–/63	0	27
	2000–212	Y	$68,000	1/63	1	14
	-210, 211	Y	$40,000	10/58	23	10
	4000	Y	$6000	–/63	0	10
Radio Corp. of America	Bizmac	N	–	–/56	4	X
	RCA 301	Y	$6000	2/61	201	300
	RCA 501	Y	$15,000	6/59	90	12
	RCA 601	Y	$35,000	11/62	2	7
Scientific Data Systems Inc.	SDS-910	Y	$2190	8/62	11	11
	SDS-920	Y	$2690	9/62	4	5
TRW Computer Co.	TRW-230	Y	$1800	9/63	0	8
	RW-300	Y	$6000	3/59	32	2
	TRW-330	Y	$8000	12/60	6	19
	TRW-340	Y	$10,000	–/63	0	4
	TRW-530	Y	$2500	8/61	16	6
UNIVAC	Solid-state 80, 90, & Step	Y	$8000	8/58	532	155
	Solid-state II	Y	$8500	9/62	2	33
	490	Y	$26,000	12/61	4	13
	1107	Y	$45,000	10/62	2	16
	III	Y	$20,000	8/62	4	67
	LARC	Y	$135,000	5/60	2	X
	1100 Series (except 1107)	N	$35,000	12/50	32	X
	I & II	N	$25,000	3/51 & 11/57	60	X
	File Computers	N	$15,000	8/56	72	1
	60 & 120	N	$1200	–/53	890	17
	1004	Y	$1500	2/63	0	1250
				TOTALS	14,166	8791

X — no longer in production

CALENDAR OF COMING EVENTS

Mar. 6-7, 1963: Disc File Symposium, Hollywood Thunderbird Inn, Hollywood Calif.; contact Dr. Walter F. Bauer, Informatics Inc., 8535 Warner Dr., Culver City, Calif.

Mar. 15-16, 1963: Pacific Computer Conference, California Institute of Technology, Pasadena, Calif.; contact Dr. E. J. Schubert, Systems Division of Beckman Instruments, Inc., 2400 Harbor Blvd., Fullerton, Calif.

Mar. 19-21, 1963: Symposium on Bionics, sponsored by Aeronautical Systems Div. of the Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, Biltmore Hotel, Dayton, Ohio; contact Commander, Aeronautical Systems Div., Attn.: ASRNEB-3, Lt. Col. L. M. Butsch, Jr., Wright-Patterson Air Force Base, Ohio

Mar. 23, 1963: 7th Annual Symposium on Recent Advances in Computer Technology, Battelle Memorial Institute, Columbus, Ohio; contact R. K. Kissinger, Publicity Chairman, c/o Nationwide Insurance Companies, 246 No. High St., Columbus, Ohio.

Mar. 25-28, 1963: IRE International Convention, Coliseum and Waldorf-Astoria Hotel, New York; contact Dr. D. B. Sinclair, IRE Headquarters, 1 E. 79th St., New York 21, N. Y.

March 28-30, 1963: Symposium on Biomathematics and Computer Applications in the Life Sciences, Auditorium of The University of Texas M. D. Anderson Hospital and Tumor Institute, Texas Medical Center, Houston, Tex.; contact Office of the Dean, Univ. of Tex. Postgraduate School of Medicine, 102 Jesse Jones Library Bldg., Texas Medical Center, Houston 25, Tex.

Apr. 16-18, 1963: Optical Masers Symposium, United Eng. Center, New York, N. Y.; contact Jerome Fox, PIB Microwave/Res. Inst., 55 Johnson St., Brooklyn 1, N. Y.

Apr. 17-19, 1963: International Conference on Nonlinear Magnetics (INTERMAG), Shoreham Hotel, Washington, D. C.; contact J. J. Suozzi, BTL Labs., Allentown, Pa.

Apr. 17-19, 1963: Philco 2000 Computer Users Group (TUG) Meeting, Antlers Hotel, Colorado Springs, Colo.; contact E. D. Reilly, Jr., General Electric Co., Knolls Atomic Power Lab., Box 1072, Schenectady, N. Y.

Apr. 17-19, 1963: Southwestern IRE Conference and Elec. Show (SWIRECO), Dallas Memorial Auditorium, Dallas, Tex.; contact Prof. A. E. Salis, E. E. Dept., Arlington State College, Arlington, Tex.

April 23-25, 1963: The Eleventh National Conference on Electromagnetic Relays, Student Union Bldg., Oklahoma State University, Stillwater, Okla.; contact Prof. Charles F. Cameron, Technical Coordinator of the NARM, Oklahoma State University School of Electrical Engineering, Stillwater, Okla.

April 24-26, 1963: Power Industry Computer Application Conference, Hotel Westward Ho, Phoenix 4, Ariz.; contact E. J. Lassen, 453 E. Lamar Rd., Phoenix 12, Ariz.

May 7-9, 1963: 1963 Electronic Components Conference, International Inn, 14th & M Sts., N.W., Washington 5, D. C.; contact J. E. Hickey, Chilton Co., Chestnut & 56th Sts., Philadelphia 39, Pa.

May 13-15, 1963: National Aerospace Electronics Conference (NAECON), Biltmore Hotel, Dayton, Ohio; contact IEEE Dayton Office, 1414 E. 3rd St., Dayton, Ohio.

May 16, 1963: Western Systems Conference, Statler-Hilton Hotel, Los Angeles, Calif.

May 17-18, 1963: Symposium on Artificial Control of Biology Systems, Univ. of Buffalo, School of Medicine, Buffalo, N. Y.; contact D. P. Sante, 4530 Greenbriar Rd., Williamsville 21, N. Y.

May 20-22, 1963: National Symposium on Microwave Theory and Techniques, Miramar Hotel, Santa Monica, Calif.; contact Irving Kaufman, Space Tech. Labs., Inc., 1 Space Park, Redondo Beach, Calif.

May 20-22, 1963: National Telemetering Conference, Hilton Hotel, Albuquerque, N. M.; contact T. J. Hoban, NTC Program Chairman, Sandia Corp., P. O. Box 5800, Albuquerque, N. M.

May 21-23, 1963: Spring Joint Computer Conference, Cobo Hall, Detroit, Mich.; contact Dr. E. Calvin Johnson, Bendix Aviation Corp., Detroit, Mich.

June 11-13, 1963: National Symp. on Space Electronics and Telemetry, Los Angeles, Calif.; contact John R. Kauke, Kauke & Co., 1632 Euclid St., Santa Monica, Calif.

June 19-21, 1963: Joint Automatic Control Conference, Univ. of Minn., Minneapolis, Minn.; contact Otis L. Updike, Univ. of Va., Charlottesville, Va.

June 23-28, 1963: ASTM 66th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 25-28, 1963: Data Processing Management Association's 12th International Data Processing Conference and Business Exposition, Cobo Hall, Detroit, Mich.; contact DPMA Headquarters, 524 Busse Highway, Park Ridge, Ill.

June 26-27, 1963: 10th Annual Symposium on Computers and Data Processing, Elkhorn Lodge, Estes Park, Colo.; contact W. H. Eichelberger, Denver Research Institute, Univ. of Denver, Denver 10, Colo.

July 15-17, 1963: 3rd Annual Rochester Conference on Data Acquisition and Processing in Medicine and Biology, Whipple Auditorium, Univ. of Rochester Medical Center, Rochester, N. Y.; contact Kurt Enslein, 42 East Ave., Rochester 4, N. Y.

July 22-26, 1963: 5th International Conference on Medical Electronics, Liege, Belgium; contact Dr. L. E. Flory, RCA Labs., Princeton, N. J.

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

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

Aug. 27-Sept. 4, 1963: 2nd Congress, International Federation of Automatic Control, Basle, Switzerland; contact Dr. Gerald Weiss, E. E. Dept., Polytechnic Inst., 333 Jay St., Brooklyn 1, N. Y.

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

COMPUTERS IN EDUCATION

(Continued from page 10)

increase in equipment costs can be justified by improving teaching efficiency and the subsequent reduction in training time and operational waste. It seems clear that computer-based systems must approach the over-all cost of more conventional equipment if they are to be used for more than specialized military or industrial training applications. This development seems to be the trend, however, in miniaturized, large-capacity systems.

There appear to be other avenues by which the cost of computer-based instructions might be reduced. The first is through development of special-purpose computers and associated equipment designed for specific educational applications. Such computers could be highly simplified, since they would need to incorporate only storage capacity and the operating speed and flexibility necessary for the specific job of teaching.

The special-purpose computer offers the advantage of greater efficiency in a particular task. On the other hand, a special-purpose computer is inflexible, and this may prevent it from spreading electronic techniques to other areas of educational operations.

A multitude of practical problems must be solved if computers are to be widely useful in education. If these problems can be solved, and if the full potentials of high-speed data processing can be realized, throughout the educational system, we may expect some of the greatest improvements in education for hundreds of years.

A summary of "Computers in Education" by Don D. Bushnell, a monograph prepared for the Technological Development Project of the National Education Association under contract #SAE—9073 with the U. S. Office of Education and published by the Audio-Visual Communication Review, Vol. 11, #2, Supplement No. 7, March-April, 1963.

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[1] *This workshop was co-sponsored by the American Educational Research Association, Association for Educational Data Systems, California Educational Data Processing Association, and System Development Corporation on February 7-9, 1963.*

[2] *Seshu, S., "The Penultimate Teaching Machine," in* IRE Transactions on Education, *Vol. E-3, #3, September, 1960, pgs. 100-101.*

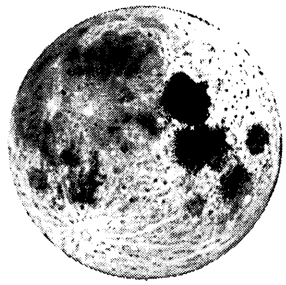
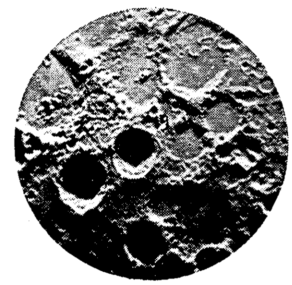
[3] *Personal correspondence.*

ADVERTISING INDEX

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

Systems Analysts
Programmers
Mathematicians

Men are planning to walk on the moon before this decade is over. And when a human sets foot for the first time on a celestial body other than earth, the consequences may be far more profound than Columbus' opening of the New World.

APLL

IBM has been assigned a crucial role in this vast undertaking—developing and programming the ground-based, real-time computer system for NASA's Project Gemini and the Apollo lunar program.

Information from many sources, from tracking sites around the globe, all to be processed in real time . . . thousands of mission problems to be anticipated and solutions programmed into the system . . . constantly updated orbital information and computer recommendations to be displayed to NASA flight controllers as the basis for command decisions. . . . This is the challenge—and the opportunity—facing analysts, programmers, and mathematicians who want to play a vital role in history's greatest venture.

If you share this vision . . . if you enjoy the challenge of large-scale computer-based systems . . . if you want to know more about the advantages of joining the group of outstanding professionals in IBM's Federal Systems Division . . . you are invited to submit your résumé to:

James H. Burg
Professional Placement, Dept. 539C-1
IBM Federal Systems Division
7220 Wisconsin Avenue
Bethesda 14, Maryland.

There are immediate openings at IBM's new space systems facility in Houston, Texas, near NASA's Manned Spacecraft Center. Assignments are available at intermediate and senior career levels.

Other career opportunities in large-scale command and control systems are also available at Washington, D.C.; Omaha, Nebraska; and Los Angeles, California.

IBM® FEDERAL SYSTEMS DIVISION

An Equal Opportunity Employer