Teaching Machines and . . .

Automated Instructional Methods

An Advanced Technology for Industrial and Military Training Applications

ROBERT E. CORRIGAN

The problems of the contemporary and the future training director are indeed formidable as they relate to existing and future training requirements and the development of training methods necessary to satisfy these requirements.

On one hand the training director must provide an effective training program to prepare each individual for a specific job as represented by definable skills and knowledges. This objective must be accomplished regardless of the problem of individual differences in trainees, and the prospect of ever increasing numbers of trainees with no comparable increase in available training personnel.

On the other hand, the predicted trend is the demand for more specialized skills and knowledges resulting from complexity in technology. These advances in technology require the development of more efficient training methods—methods which must continue to establish maximum positive motivation

ROBERT E. CORRIGAN *is Director of Robert E. Corrigan and Associates, Industrial Consultants, Garden Grove, California, who has previously consulted for Rheem Manufacturing Company to provide psychological service and direction in the development of a teaching machine program. He is under contract with North American Autonetics Division as a human factors specialist in ground support and training devices. Dr. Corrigan has also been associated with Douglas Aircraft Company and the American Institute for Research, as a human factors specialist in various ground support and training concepts. He has served as an associate professor of Psychology at the University of Southern California teaching Industrial Psychology and as an instructor at Tulane University. Prior to his work as a human factors specialist, he was associated with Southeast Louisiana Hospital, Mandeville, Louisiana, as senior research psychologist. Dr. Corrigan received his B.S. and M.S. degrees from the University of Wisconsin and his Ph.D. from Tulane University. He is certified as an Industrial Psychologist in the State of California. Dr. Corrigan has done extensive research in the field of Subliminal Communication and is Vice-President in charge of Subliminal Research and Application and is co-inventor for the Precon Process and Equipment Corp., New Orleans, Louisiana. Dr. Corrigan has developed for Robert E. Corrigan and Associates the "Teletest* Communications System," which closes the loop between the Television Teacher and the Trainee or Student and is for use in Instructional Television and Films.*

**Trademark*

for the learner, efficient acquisition of the material to be learned, and the highest level of proficiency in the application of the skills and the knowledges acquired regardless of the availability of training personnel, and the increased complexity of skills and knowledges. Further, these goals must be accomplished with a minimum investment in training time, personnel and/or money.

In summary, the training picture of the future is one of increasing diversification and complexity of training requirements; of increasing emphasis on individual training to meet these requirements; and of an increasing load on training personnel to devise methods to meet these requirements without incurring undue increases in cost or in trainer personnel.

These predicted trends emphasize the need for evaluating the factors of: (1) individual differences in trainees; (2) quality control of training methods and procedures; and, (3) training effectiveness.

Individual Differences In Trainees

The most significant trend for the training director is the increased complexity of training requirements. When activities to be taught are simple in nature and the trainees have been selected carefully, individual differences present little difficulty. However, the more complex the behavior to be developed and the less carefully the trainees are selected, the more important are the problems arising from individual differences.

Variations in learning performance among different workers take several forms. There are differences in initial performance which extend beyond simple variations in the aptitude or ability to learn. These differences may be attributed to differences in motivation, in the ability to understand what is to be learned, and, in the ability to follow directions.

A second difference is the general rate of improvement due to dissimilarity in learning rates among individuals in all types of situations.

A third characteristic in which individual differences are evident is the level of proficiency attained at the completion of training or at any other later time after the worker has had some practice on the job.

These individual differences make it necessary for training directors to adjust training programs to individual needs. Adjusting the instruction to the worker's abilities has many aspects including the following: (1) starting the instruction at a level of difficulty consistent with the worker's readiness; (2) relating the new training experiences to previous experiences familiar to the worker; and (3) adapting the rate of instruction to the rate and quality of learning of the individual worker.

Quality Control of Training Methods and Procedures

The requirements for more individual instruction in the future raises several important problems. It has been stated that the ratio of training personnel to the number of trainees is continuously decreasing. This trend is contrary to the predicted requirement for more individual attention to each trainee since the instructor is required to handle more and more individuals in any specific training situation. An obvious solution to this problem would be to increase

training personnel in proportion to the need for more individual instruction. Unfortunately cost factors would, in most cases, prohibit this practice.

A further problem exists in standardizing the quality of instruction provided by individual instructors. It is recognized that certain instructors have more ability than others in organizing instructional materials, and in presenting materials more effectively. With the need for more individual instruction and a limited training staff, it will be extremely important to standardize training materials to insure optimal acquisition. Careful consideration must be used in the preparation of materials to establish meaningful progression geared to the individual's capabilities.

Evaluation of Training Programs

Two crucial factors must be considered in determining the success of a training program: (1) establishing objective measures of performance or proficiency of individual trainees *during* sequential phases of *training;* and (2) measuring and relating the effectiveness of the instructional process to performance *on the job.* Significant strides have been made in this area. This problem will be magnified, however, in future training programs where cost of training must be carefully evaluated in terms of on-the-job proficiency.

How can the problems of evaluation of training and those previously discussed be dealt with meaningfully?

I will briefly discuss one advanced concept of communication and instruction which may resolve several of the problems mentioned—the concept of automated instructional methods and instructional devices.

Automated Instructional Methods

The concept of automated instruction relates more specifically to a new philosophy or theory of learning and/or teaching than to the implements or equipment used in effecting its goals. The word *automated* has been accepted in the vernacular since the greater portion of the experimental work has been performed using mechanical or electromechanical devices. I will briefly discuss the general principles of automated instruction and classes of automated instructional machines. My primary objectives are: (1) to establish some basic definitions and ground rules, which, I hope, will result in avoiding the development of misconceptions concerning the nature and applications of automated instructional methods, and (2) to show the effectiveness of automated instructional methods in solving the training problems of today and tomorrow.

A Definition of Automated Instruction

The term *Automated Instruction* refers to a new method of teaching and learning which is specifically geared to an *individual's* learning capabilities. It involves new concepts in preparing training materials, new methods of presenting this material using automated instructional machines, and significant advances in determining that *each individual* has mastered the subject that he is to learn.

The key points in which automated instructional methods differ from conventional teaching methods are: (1) the individual is required to be continuously active in the learning process; (2) the individual progresses step-by-step in the learning task, proceeding only at a rate

consistent with his demonstrated understanding; (3) the individual is not allowed to proceed to more difficult or different material until he has completely mastered all sequential steps required for complete comprehension and application; and (4) at every step in the learning process he is given immediate knowledge of results informing him whether he is correct or incorrect—and, in certain applications, the reasons why.

The Principles of Automated Instruction

Just how do automated instructional methods function to train in the manner specified? The answer is not found in machines, but in the principles of automated learning and teaching developed by psychologists over the years.

Two men in particular have pioneered the work in automated teaching. These men are Dr. Sidney L. Pressey, formerly of Ohio State University, who started research in the early 1920's, and Dr. B. F. Skinner, Harvard University, who has continued and expanded these principles of learning and teaching. What do these and other prominent psychologists offer?

To begin with, the complete emphasis of this teaching method is on the *individual* trainee. The primary concern is the development of each individual in terms of his or her own capacity—and then only as fast and as advanced as each individual can develop. Point No. 1, therefore, is individual control and supervision.

The second major concern of these teaching principles is the method by which each individual is taught. Here the emphasis is on the successive understanding of each segment in the lesson to be learned before the trainee goes forward. This means that errors in understanding and/or application are corrected immediately before going on. To accomplish this, it would be necessary, obviously, to rewrite our conventional textbooks, or prepare new materials in a new form represented by many, many individual learning steps leading up to complete understanding of a particular lesson, idea, or concept.

This, in effect, is what is done. The training materials are broken down initially into many separate steps. The progression of these steps and the information contained in them is carefully planned and written according to special rules. The initial principles set down for accomplishing this task already have been established and are in a continual process of refinement. Training materials when reformed in this manner, are called "programs." It is the program which is put into the teaching machine to present to the trainees—and which represents the core of the automated instructional method.

Extensive research has been performed comparing conventional teaching methods with automated teaching. Automated methods have been shown to be significantly effective in terms of degree of comprehension, speed of learning and the ability to remember the material taught.

Automated Instructional Devices

In conjunction with the careful programming of subject material is the method of communicating the desired information. This may be accomplished using automated teaching machines. These devices can be defined as electromechanical machines which present a

sequence of problem materials to an individual, require that he respond to these materials and provide him with knowledge of results.

Several classes of machines have been conceived for automated instruction. These general classes relate specifically to applications for the development of manual skills and mental skills.

The development of MANUAL (PSYCHOMOTOR) SKILLS pertains directly to the learning of motor or muscular tasks involving minimal emphasis on special logical or conceptual learning. This concept does not, however, discount the requirements for cognitive organization and learning in the instructional task. Classes of skills included in this category and their respective automated instructional devices are:

Automated key punch instructional machines

Automated adding instructional machines

Automated typewriter instructional machines

The development of MENTAL (CONCEPTUAL) SKILLS relates directly to the learning of concepts involving progressive constructive thinking and reasoning which requires minimal or no motor skills. Classes of skills included in this category may be all subject materials normally included in the conventional cognitive portion of the training program for an individual.

The words "instructional machines" may conjure up in your minds grim pictures of complex electronic brains or computers with many wires leading to an individual's body, the pulsating of lights, the background hum of electrical equipment, and the individual staring into space as if hypnotized as the machine pours knowledge into him. Nothing could be further from the truth.

Automated instructional machines are not products of science fiction writers, but in fact, are the developments of qualified psychologists working over the past 75 years. The student is not wired into the machine, but actively operates the machine in a manner comparable to using a typewriter or a similar device. Teaching machines are not complex, but may be especially simple in design and operation. They are not massive in size, but are about the size of a conventional typewriter. They are not vastly expensive machines, but may be in the price range of a good typewriter or tape recorder.

Each class of instructional devices presently designed can be an efficient and effective teaching "instructor." Each machine is uniquely designed to handle a different programming philosophy—represented both in terms of the techniques of preparing materials to be learned and the required task of the student in the learning process. In one case the student is required *to recall,* construct, and write down the appropriate answer. This format involves the

Next month's *Journal* will feature an article by Norman A. Crowder, of Western Design. Mr. Crowder originated the "scrambled book" technique and Western Design is producing the "Tutor" teaching machine.

technique of sentence completion. In another case, the student is required *to recognize* the correct or most appropriate answer, and, to indicate his choice by depressing the desired button, lever, etc. In the latter case the programming format involves the technique of multiple-choice selection.

Operational Principles of Automated Instructional Devices

How do these machines operate to teach an individual? This is the most important question. To begin with, the instructional machine is modeled after the *tutor* rather than the lecturer. The tutoring method of teaching has been found to be the most successful in conventional education and training. The lecture situation is used primarily because of the realistic inability to teach each trainee separately. Tape recorded lectures, closed circuit television, and motion pictures are but a few attempts to automate the lecture situation. In each case the trainee plays a passive role. The fact that the trainee, in a lecture situation, neither is required nor is able, to respond to each point as it is presented means that neither the lecturer nor for that matter, the trainee, has any positive way to measure progressive understanding. This is because the lecture situation is a *one-way communication system.* Compare this conventional method with automated instructional or teaching methods in which the individual is continuously active in the learning situation with continuous interchange going on between the student and the "instructor." The latter situation provides closed-loop communication between the instructor and the student.

The trainee and the machine "instructor" work as a team. The "instructor" presents a question or statement to the individual, he examines the information and decides on an answer. He may tell the "instructor" his answer by writing it down in an allotted space on the machine, or, he may select the most appropriate answer from a series of multiple choices presented with the statement or question. The machine "instructor" compares the trainee's answer with the correct one. The "instructor" informs the individual he is right or wrong and records his error. For multiple choice answers, the "instructor" may not only tell the student he is wrong but with certain devices may proceed to tell him why he is wrong or right and redirect him back to the original statement or proceed to the next step.

The teaching machine "instructor" acts as a tutor capable of infinite patience and completely without bias in the instructional process. The automated teaching "instructor" is able to present specific information to the student, examine the student on each piece of information as it is presented, correct the student's errors immediately, give additional explanation on points where the student has erred, verify the correctness of an answer, proceed to the next point when the student has mastered the preceding point, and keep detailed records of the progress of each student during all phases in the training or educational program.

What are the applications of automated instructional methods and instructional or teaching machines to the training problems of today and tomorrow?

The concept of automated teaching methods incorporated with automated instructional devices can resolve several significant training problems associated with both industrial and military training programs.

A. The principles of automated teaching are specifically designed to accommodate individual differences in trainees. Each individual proceeds at his own rate of comprehension. The problem in establishing levels of initial performance, rate of improvement, and ultimate levels of achievement are completely dependent upon the individual's own performance. The trainee can proceed no faster than his indicated understanding of the training concept. He provides completely objective measures of performance based on his own capabilities. He learns only at a rate consistent with his comprehension of the verbal material or his demonstrated skill with the psychomotor skill involved. Each trainee must proceed at his own rate until he exhibits complete comprehension before meeting pre-established standards determined by the training director. This is accomplished for each individual without affecting the performance of his fellow students.

B. As for the training staff—the use of teaching machines can provide a method of standardizing important aspects of training with *continuous* attention to each trainee. Thus, the instructor can function more effectively to guide, direct, and develop the individual student as needed with sufficient time to accomplish the job.

C. The training materials can be standardized by instructors according to their specifications as to what should go into the teaching curriculum and when. The quality of training material can be fixed, methods of instruction can be standardized and each individual's progress can be established and evaluated meaningfully.

D. Automated teaching can provide for the first time, not only the assurance of uniform understanding by all individuals of defined training principles, but also direct methods for evaluating measures of on-the-job performance in conjunction with the established training program.

What is provided is a *closed loop between the individual, the training program, and the individual's performance on the job.*

In summary, the use of automated instructional methods provides both for industrial and military programs the following advantages for *each individual.*

1. Common standards in establishing specified levels of comprehension of training principles and their intended applications.

2. Common standards or quality control in the preparation of training materials to be taught and learned.

3. Common methods for measuring and evaluating levels of proficiency in the comprehension and application of training principles—both initially and for periodic checks.

4. Common methods for determining the bases for on-the-job deficiencies, safety infractions, etc., based on standard scoring and recording techniques of individual records.

Conclusion

The training problems of today and tomorrow require the maximum utilization of every technique which can in-

crease the efficiency of the instructional process.

A summary of automated teaching advantages is as follows:

1. Quality control of the subject material presented.
2. Continuous trainee activity by providing a closed loop between the student and the "instructor" for each step in the learning process.
3. Immediate correction of errors thereby removing the possibility of misunderstandings that would impede a student's progress.
4. Pacing of material to be presented consistent with an individual's learning capabilities.
5. Standardization of levels of achievement specified for each trainee.
6. A significant bonus in time for the instructor which can be applied to individual instruction and direction.
7. Continuous testing of the trainee's progress instead of widely spaced examinations.

The use of automated instructional methods for individual instruction should be thoroughly investigated and tried as a more meaningful and efficient method of instruction. The use of automated instructional devices should be incorporated as the means of communication and instruction on a research basis of sufficient magnitude to establish their effectiveness. These methods can provide common standards in the dissemination of and comprehension of training concepts and principles.

You Can't Afford To Miss The . . .

16th Annual ASTD Conference in St. Louis, Mo., May 2-6!

See last month's *Journal* for this year's exciting program. On page 67 of this issue you'll find registration details.

TIME IS SHORT. MAKE YOUR RESERVATIONS TODAY.