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ABSTRACT

A non-technical synthesis of the major developments in programed instruction serves as an introduction to the content of this paper. The paper includes some determination of the extent to which programed materials are being used by Federal agencies and how these uses compare with those found by Bryan and Nagay in an earlier study. The paper concludes with a chapter which gives guidelines to the trainer for the use and selection of programed materials. In appendices it lists programs in use by government training programs and provides background information on the methods of obtaining data for the study. A bibliography is appended. (JY)

Programmed Instruction: A Brief of its Development and Current Status

Training Systems and Technology Series: No. III

U.S. CIVIL SERVICE COMMISSION
BUREAU OF TRAINING

TRAINING SYSTEMS AND TECHNOLOGY SERIES PUBLICATIONS

No. I Instructional Systems and Technology: An Introduction to the Field and Its Use in Federal Training
No. II Application of a Systems Approach to Training: A Case Study
No. III Programmed Instruction: A Brief of Its Development and Current Status

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Programmed Instruction: A Brief of Its Development and Current Status

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INTRODUCTION

Programmed instruction (PI) is no new phenomenon to Government trainers. A recent survey conducted by the Bureau of Training found over 2,300 programs currently in use in agency headquarters, suborganizations and field offices. This represents a sixfold increase over the 382 programs in use 6 years ago as reported by Bryan and Nagay in their article "The Use of Programed Instructional Materials in Federal Government Agencies." [1]

This evidence of comprehensive usage indicates that programmed instruction has established itself as an accepted instructional method in Government-wide training. Although this usage is extensive in many agencies, in others its use is limited and still in some is nonexistent. In order to extend the usage of this approach, Government trainers will need to equip themselves with a knowledge of programmed instruction, its origins, applications, and utilization in Federal Government training.

This paper, a part of the training systems and technology series, offers a concise, nontechnical synthesis of the major developments in PI. In addition, the report includes some determination of the extent to which programmed materials are being applied in Federal agencies and how these applications compare with the results compiled earlier in the study by Bryan and Nagay. The paper concludes with a chapter which gives guidelines to the trainer for the use and selection of programmed materials.

The current emphasis on the "systems approach" to training increases the need to understand the theoretical basis of programmed instruction because it helped to foster the systems approach. The first paper of the series, *Instructional Systems and Technology: An Introduction to the Field and Its Use in Federal Training*, described the systems approach as consisting of seven essential steps:

1. Determining the need for training.
2. Stating the objectives.
3. Preparing measures of these objectives.
4. Identifying the knowledge already achieved by the learners.
5. Selecting content and media to attain final objectives.
6. Implementing the selected methods.
7. Evaluating procedures by measuring performance.

The steps of the programming process (exhibit A) adhere to the principles of the systems approach. Gabriel Ofiesh, a leader in the field of educational technology, has gone so far to state that: "Programmed instruction has emerged as the first valid system of educational and instructional technology that our society has ever had." [2] At the very least, it can be said that PI is a valid system of instruction and has proven effective partially due to its reliance on the systems approach.

The product of the programming process is the program itself, the means by which the student is led through a series of questions, responses, and confirmation of his responses until little by little he has progressed from small bits of relatively simple knowledge to more complex principles.

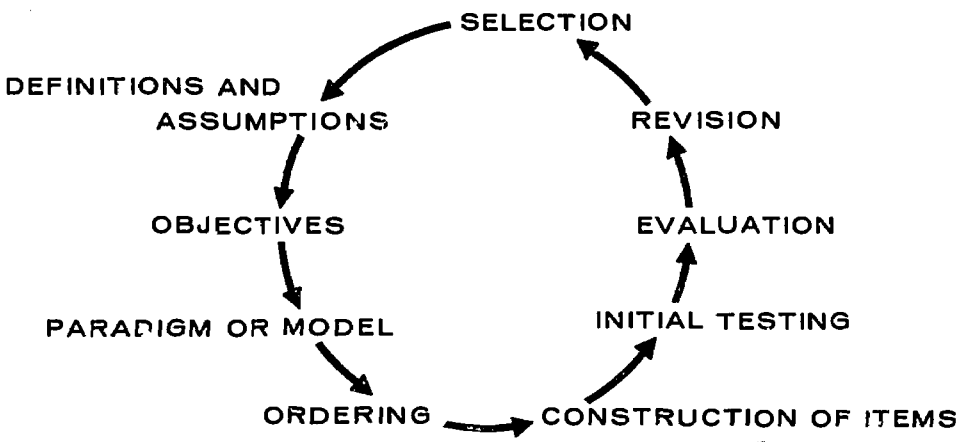
Many writers have noted the similarity between the PI approach and the tutorial system which asks selective probing questions of a student, and then lets him do the work of learning. The tutor must know his objectives and dissect the subject matter into small bits of information. Through a logical progression of elementary questions and answers and through reward or correction of answers, the tutor brings the student to a grasp of the whole concept. Thus the procedure may be likened to the building of a picture puzzle where the complete configuration comes only through the correct placement of individual parts.

The manner of the program presentation may be the programmed textbook, a teaching machine, a computer, or any variety of multimedia presentation. Regardless of the medium, the same programming process applies.

The growing use of PI has generated much research, but often without providing conclusive evidence to many pressing questions. One impor-

Exhibit A

ELEMENTS OF THE PROGRAMMING PROCESS



"The selection of the subject to be programmed requires an assumption by the program builder about the learner who will use the program. Next, he lists the objectives of the materials to be programmed. These factors then influence the programmer's choice of a paradigm for the arrangement of the items.

He can now order the subject matter in the best possible sequence and construct the items in accord with established learning techniques. As soon as short sequences have been completed they can be tested and revised on an initial basis. Later, after exposure to a large number of students, the sequences can be analyzed for errors and shortcomings. Besides, the sequences can be evaluated for effectiveness in terms of how the student learns from them, and this information can be used for revision of the program. The complete experience has a cyclical quality since it may be used as an aid in the selection of subsequent units of subject matter for programming.[3] "

The similarity of the programming process to the systems approach can be seen in the analytical procedure followed by each. However, the determination of the need for training as well as the selection of programmed instruction as the media must be made before the programming process begins. Such steps as forming objectives, identifying the learning group, and evaluation are inherent in the overall systems approach and the programming process for successful outcome.

tant area being researched is the evaluation of the programmed instructional effort. Schramm reported in 1964 that of 36 reports which compared conventional teaching methods to programmed methods, 18 showed no significant difference between the two when measured by results on a criterion test. Seventeen, however, showed a significant superiority for PI, with only one showing significant superiority for traditional methods.[4]

Of course, such qualifying factors as ideal physical conditions in the classroom or the novelty that new methodology presents to students, tend to affect the overall outcome. The crucial question to ask, however, is how well and how effective this method of instruction is as a common means of instruction, not just in laboratory situations. While the results of research such as Schramm's may not be taken as proof that PI is superior to conventional teaching methods, they may be regarded as indications that, at the very least, it is as effective as other methods and should be considered for operational use along with any of the other methods.

Despite its relatively recent emergence, programmed instruction should not be regarded as an entirely new venture, without roots in an established theory of the psychology of learning. Human behavior has remained virtually constant throughout recorded civilized history, however the ability of educators to recognize and direct the instructional process has been a comparatively recent development. Although PI is a relatively recent development, it is an application of well founded principles of learning.

ORIGIN AND DEVELOPMENT OF PROGRAMMED INSTRUCTION

One of the fundamental concepts on which PI is based is the concept of reinforcement in learning. This notion was introduced by Thorndike in the early 1900's as his famous "law of effect". Stated broadly, this law states that responses which are followed by satisfying states of affairs are selected and fixated (learned), while those that are followed by unsatisfying states of affairs are eliminated. Very soon Thorndike dropped the latter part dealing with the elimination of responses. "Satisfying states of affairs" has come to mean "rewards". Hence the law states that for responses to be learned, they must be rewarded. Because of the theoretical ambiguity of the notion of reward and the difficulty of defining it operationally, the law of effect has undergone many revisions in the hands of later learning theorists. Out of such efforts has emerged the modern notion of reinforcement, particularly as developed by B. F. Skinner, which has become so basic in PI, and to which we shall return later.

In the early 1920's, Sidney Pressey's observations of classroom instruction led him to the development of a device designed to apply the "laws of learning", defined by Thorndike, to classroom teaching. His original device was used for testing; however, later the teaching potential as well as the testing capability of the machine was also demonstrated. He produced his device to provide immediate knowledge of correct responses and practice of those responses thus simulating a learning situation of a tutor for each individual student.

Pressey's "teaching" machine worked in the following manner: when a question appeared in the window of the machine, the student responded by pressing a button corresponding to the answer he selected. If the choice was correct, the machine revealed a new question; if the answer was incorrect the question remained, giving the student another chance to respond. The machine also recorded correct and incorrect answers, allowing the teacher to keep track of individual student scores.

Despite the continued efforts of Pressey and others, the movement toward using teaching machines did not catch on. Lysaught and Williams offer two explanations for the lack of success in the program.

> First no provision was made for the systematic programming of materials to be used in these machines, and second, the onset of the depression and its impact on social conditions and education offered an unfavorable environment for an "industrial revolution" in the nation's schools.[5]

The revival of interest in programmed instruction did not come until the work of B. F. Skinner on operant conditioning in the 1950's. His first major work, *The Behavior of Organisms*, published in 1938, presented his theory based on animal studies.[6] However, it was not until 1954 that he published his article "The Science of Learning and the Art of Teaching", which applied his findings to education.[7]

Historically, Skinner's ideas are a continuation of Thorndike's research on the law of effect.

Skinner's research focused upon a particular and very important class of responses called *operants*. Operants are responses which are not made to any known external stimuli; rather, they are emitted by the learner and enable him to operate upon his environment. Voluntary acts are an example of operants, while reflexes are not. Skinner developed a technique, called operant conditioning, whereby a response which a person emits could be strengthened (made to appear more frequently) in the presence of certain cues called discriminative stimuli. The technique involves strengthening the desired response by a special class of events called reinforcers. A reinforcer is defined as any event following an operant which increases the tendency to emit the operant. Thus, to condition a response, one must discover a reinforcer for it, and arrange so that when the operant response is made, it will be followed by the reinforcer. In this way, making the response operates upon the environment thus producing the reinforcer.

In cases where the desired response is not already one which the learner can emit (not already in his "response repertory", as Skinner puts it), Skinner developed a technique called "shaping" whereby the desired response can be synthesized from other fragmentary or partial responses which already do exist in the learner's repertory—all by the use of an appropriate program of reinforcement.

Skinner demonstrated shaping in his animal studies. He showed that by reinforcing the subject at first for making just some motion in the right direction of the desired final response, and later for coming a bit closer and so on, the subject eventually attains the total correct behavior. Skinner illustrated this by instructing a pigeon to peck a key only when it was lit, not unlit. At first the pigeon was rewarded when his beak came near the lit key, and finally when he actually tapped the key only when it was lit. This same principle applies to a student learning a new process. Skinner believed that the principles of shaping and differential reinforcement could not only be used to teach a simple task or lesson but to develop an entire curriculum of study.

Like Thorndike, Skinner believes that punishment does not eradicate the tendency to make a wrong response, but rather leads only to a temporary suppression of the response and certain attending emotional difficulties. Such a view led Skinner to one of his biggest disagreements with the educational community which, he claimed, operates almost totally on the basis of punishment to "encourage" learning.

Note that Thorndike's old idea of "reward" has now become broadened into the notion of reinforcement. While it is true that many reinforcers look like rewards, many do not. Skinner himself has seen no need for the concept of reward, finding it both unnecessary and difficult to define satisfactorily. Nor has he concerned himself much with the theoretical questions of why reinforcers reinforce or what reinforcers really are psychologically. His view was that reinforcers can be identified only by empirical observation, but once identfied, can be used to train behavior. Certain reinforcers, however, are of sufficient cultural generality that they can be used to reinforce a great variety of responses; money and praise would be examples. But perhaps the most useful reinforcer of all is a class which has been variously called "knowledge of results" or "feedback." Feedback consists of information given to the learner concerning his performance in learning. Reinforcers of this type are not only powerful but also are the most available and programable. For these reasons feedback is virtually the only reinforcer used today in PI.

Skinner, in his own approach to designing automatic self-instruction devices, retained Pressey's use of feedback as the principal reinforcer, but added one important difference: the learner was not given the alternative responses to choose among, but instead was required to compose or construct his own response in spaces provided, and then as a printed tape advanced, the desired response appeared for comparison with the composed one thus providing immediate feedback. In building his devices, Skinner also took advantage of a principle which he had discovered in his work on operant conditioning; namely, the longer the delay between response and reinforcer, the less the reinforcing effect. And to avoid the possibility of the learner making incorrect responses (which would have to be unlearned), Skinner added the notion of prompts or guides so that only the correct response had a high probability of being emitted. In this way the learner could innovate the correct response on his own, emit it with a high probability, and have it reinforced. With the publication of these ideas in his classical article of 1954, the lagging revolution in educational technology reached a new level of activity.

APPROACHES TO PROGRAMMING

Two basic methods for the programming of materials for responses and reinforcement have emerged from the research done during the past 20 years. One is known as linear programming: "a sequential development of the material through which each student, regardless of his response, proceeds in exactly the same order".[8] It is a direct outgrowth of the work of Skinner. The other method is branching or intrinsic programming. As defined by Norman Crowder, the chief figure identified with its beginnings, intrinsic programming is "the technique of using a student's choice of an answer to a multiple choice question to determine the next material to which he will be exposed".[9]

The two methods have much in common but disagree on how to simulate the performance of an actual and effective tutor.

Linear Programming

The format of the linear program emerges directly from the training techniques of Skinner. Information followed by a related question is presented in small steps to the student. He responds after each step by composing and indicating the answer to a question. The student then receives immediate confirmation of the correctness or incorrectness of his response. Reinforcement for the learner using programmed instruction comes from the feedback or knowledge of results given immediately after each response. The same elements: instruction, response, and reinforcement are repeated in each step. (See exhibit B.) The same information, presented in different contexts, provides for maximum learning experience. Since only correct responses are practiced and reinforced, only correct responses are learned.

Skinner developed a machine designed more to teach than to test as Pressey's had done. Instead of using multiple choice questions and answers, Skinner allowed the student to construct his own response, write it down, and then compare it with the correct answer provided by the machine. The individual responses to the questions thus became an entire complex of behavior or knowledge, that is, the behavior was shaped according to the desires of the programmer or teacher. After the appearance of Skinner's machine, his theory was further applied in the development of programmed textbooks and other media.

Intrinsic or Branching Programming

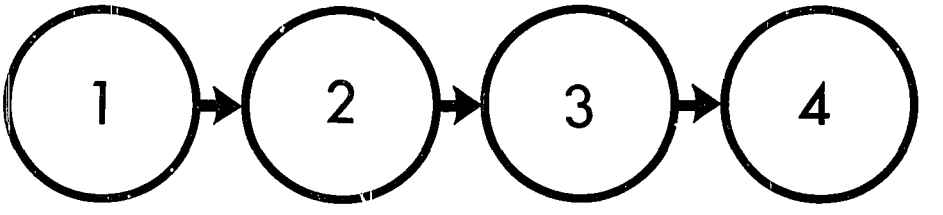
Although the intrinsic approach to programmed instruction maintains the same concerns about learning as the linear approach, it does not derive from a stated learning theory. Davey and McDonnell in their book, *Programmed Instruction*, describe Crowder's views on the theory of intrinsic programing in the following statement:

> Crowder says that the intrinsic programmers do not have access to any "philosopher's stone" which provides an understanding of human learning. He concludes that there is no infallible process for bringing learning about, and suggests to predictably achieve a desired result, one must either have an infallible process to bring about the result or one must have a means of determining whether the result has been achieved and of taking appropriate action on the basis of that determination.[10]

Crowder has applied his "theory" by devising a "means of determining whether the result has been achieved"; i.e., the multiple choice question. Additionally, and most important, the "taking of appropriate action" means that the student's response to previously presented material determines the next

Exhibit B

THE LINEAR PROGRAM - SCHEMATIC DIAGRAM



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step he takes; i.e., the program is determined intrinsically. Exhibit C represents a simple schematic drawing of this concept.

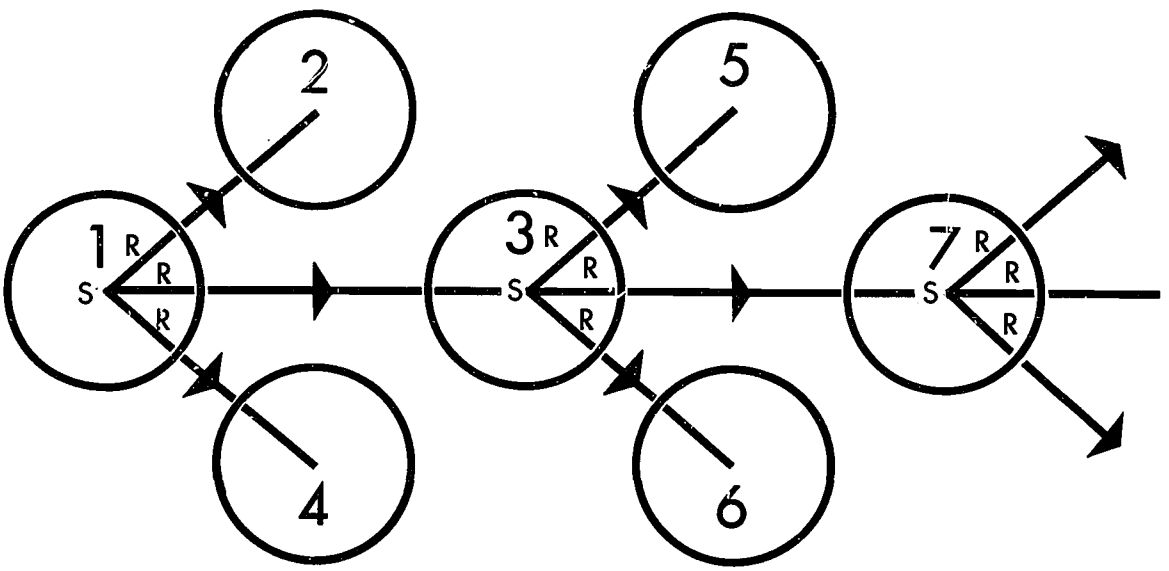
In item 1 the student is presented with information. His choice of answers will lead him to frame 2, 3, or 4. In this drawing, if the student has chosen the correct answer he will proceed to frame 3 where he will be presented with new information. If he choses a wrong answer in response to frame 1 he is directed to either frame 2 or 4 depending upon his response. The incorrect response frames in a simple program will give additional information to the student then direct him to return to the original frame and select another answer. In a more complex program, an incorrect response might lead the student through an entire subprogram before returning to the next frame.

The major difference between linear and intrinsic (or branching) programs is that linear programs simply inform the student of the correctness or incorrectness of his response while intrinsic programs use the student's response to determine where he will proceed in the program. According to the underlying theory of linear programming, the best learning situation is one in which no errors occur, and the program is designed to insure that the correct response is made with a high probability. If errors should occur, the student is simply informed of his error through feedback and he continues to the next frame. Intrinsic programming, however, does not try to completely eliminate errors. The student cannot go on to new information until he has demonstrated that he has understood or "learned" the concept already presented to him. When he makes an error he is reinstructed until he has learned the material, thus taking into account individual differences in the background of the students and assuming that they will not all have identical responses.

By testing the students' comprehension of the information presented, the intrinsic program can make the steps larger than those of the linear program. The steps in the linear program must of necessity be very small so that no mistakes will occur. The instrinsic can allow for mistakes to occur because it provides a learning mechanism for errors by reinstructing the student when errors occur and allowing him to make another choice.

Exhibit C

THE BRANCHING PROGRAM - SCHEMATIC DIAGRAM



Further Developments of Programming Methods

The linear and branching methods while remaining as the two basic programming techniques have been adapted for other forms of programs. These programs which are designed to achieve additional objectives in training sometimes combine elements of the two methods into one "new" technique. According to David Cram these developments can be grouped into two categories: self-organizing and criterion programming.[11] A self-organizing program, originated by Gorden Pask, is in essence a complicated form of a regular branching program. This type of program is run by a computer which adapts the program to the needs of a student as shown by the type of answers he gives. It supposedly has an infinite number of possible branches available and is therefore easily adaptable to differing abilities. Cram has identified another method as criterion programming. The name is derived from the process of pretesting the student on a criterion test to determine what his needs are. On the basis of the responses given on the pretest, it is decided what type of materials are best suited to an individual student and he is then directed to movies, books, or other teaching devices which will present the chosen material to him.

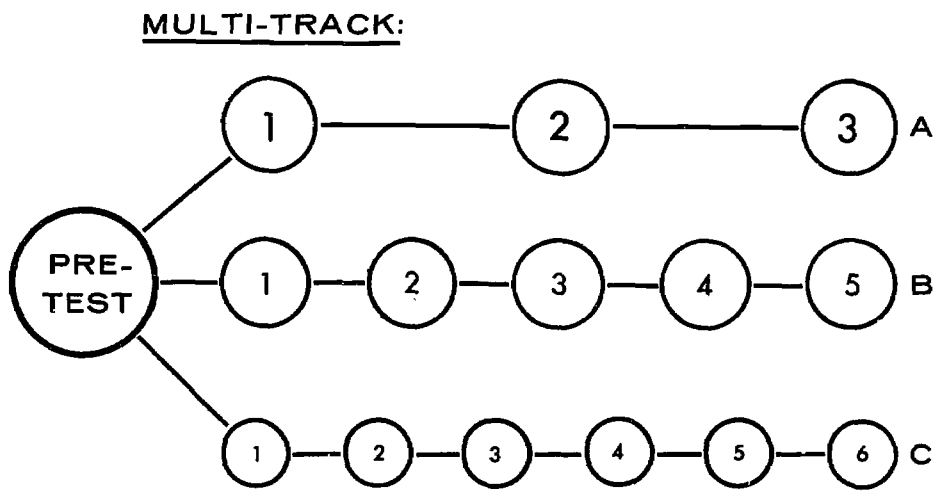
A derivation of simple linear programming is multi-track programming, a type of criterion programming, described by Davey and McDonnell.[12] As in branching, this method is adaptable to the needs and abilities of a range of students. By means of a pretest the level of student ability is determined. Dependent on these results he is directed to one of several linear programs (A, B, or C below), each of which presents the same material but does so in varying step sizes.

A superior student will be able to use a relatively short program with fairly large steps enabling him to remain interested in the material. A poorer student will be led through the same information in a longer program with very small steps in order to minimize his misunderstanding or "getting lost" in the program.

A paper by Susan Markle published in 1963 reported another derivation of the linear program which is quite adaptable.[13] Taking a cue from branching, it has provided frames which determine how well the student has understood some of the previous material. If his answer is incorrect it will refer him back to the earlier section which dealt with this information so that he will redo the program in this area and, hopefully, learn it the second time around.

Another grouping of approaches to programming varies according to the construction of the programmed sequence of materials. Among these are "pragmatic", "ruleg", and "mathetics" systems. Pragmatic construction is done by the placement of behavioral aims into a logical order. Presentation of material in terms of rules and examples is the approach used by the ruleg system. Mathetics "is characterized, largely, by its concern over using the largest response units possible as the beginning point of instruction and by its concern with the criterion of mastery".[14] It is a very complex ap-

Exhibit D



proach which systematically applies the principles of reinforcement theory to the analysis and reconstruction of learning.

Determination of the best type of program to be used in a given situation can only be determined by the nature of the topic to be programmed and the group of students for whom the program is intended.

THE ROLE OF TEACHING MACHINES IN PROGRAMMED INSTRUCTION

Along with the questions on what types of programs are best for which audiences, there is some controversy on the role of the machine in programmed instruction. The argument seems to be whether a machine or a programmed text can do a more efficient and better teaching job. Most of the statements have been inconclusive. For example:

> There is no psychological principle of which I am aware that would oppose the use of teaching machines. Conversely, there are several machines which would be an effective and efficient educational tool. Ultimately we have to develop better theories of behavior, particularly those of transfer and symbolic processes, in order to make the best use of teaching machines.[16]

Mechner and Cook cited nine published studies which show no significant difference in effectiveness between text or machine presentation of programs. Their conclusion is that ". . . no teaching machine has yet been developed that administers a program more effectively than does a programmed textbook." [16]

Although Pressey's machine did not succeed in starting a mechanical revolution, Skinner's machine began a wave of interest in this area. In fact, it caught on so well that many manufacturers developed a variety of new machines which were capable of teaching students material in novel ways. The problem was, however, that while all the research and money went into the technical development of the machines, no one bothered to write programs to put in them, and there was no "software" for the student to learn by means of these devices. More recently this disparity has been recognized and many more programs have been developed, which at least provide a rationale for the existence of the machines.

One of the main criticisms of machines is that they destroy the flexibility which programs should have. In most cases, early machines restricted the types of possible responses to multiple choice. On the other hand, with the adaptation of computers to this problem, much flexibility has been regained—such as in the branching technique where an infinite number of branches are available to the student who can be guided by the computer to the proper frames. A device of Crowder's known as the "Tutor" uses film and other teaching aids to present a program adapted to an individual student as he progresses through the program. There are, however, the warnings of men such as Gilbert who remarked on the dangers of beginning with a machine and developing a program which will fit it: the ingenuity of the programmer and the quality of the program may be sacrificed in the process of fitting a program to a machine.[17]

Teaching or testing by machine offers some prevention against cheating which a text cannot provide and also permits automatic scoring which may be of help to both teacher and student.

A machine can also provide greater control over the stimulus presented. The comparative cost of machines and programmed texts have caused some controversy because with most machines the initial investment will be large. However, if they can be used a great deal, the per student cost will decrease. Programmed texts are expensive to develop and publish but in most cases the texts may be used many times before replacement is necessary. Although cost is definitely a factor in choosing between equally good programming, the reader is cautioned that cost should not be the sole factor in deciding which method is most effective in a particular situation.

FUNDAMENTAL ASPECTS OF PROGRAMMED INSTRUCTION

So far this paper has covered the history of programmed learning and the development of the types of programs. There continues to be much research and controversy revolving around basic issues common to all types of programming techniques. Most of the controversy has centered on some of the very basic issues: the nature and role of stimulus, response, reinforcement, error, pac-

ing, and size of step. As well as mentioning some of the research which has been done, each of these items will be defined in relation to the whole concept of programmed instruction.

Stimulus and Response Devices

The stimulus items in programmed instruction can be either questions or incomplete sentences, and the response is the answer given by the student. Douglas Porter in his article "A Critical Review of a Portion of the Literature on Teaching Devices", classifies teaching devices into three types: stimulus devices, response devices, and stimulus-response devices.[18] Stimulus devices are those such as books, tapes, movies, or phonograph records which provide the information or "learning content" without any provision for determining whether the student has learned anything or for letting him know whether his impressions are correct. The second type, response devices, allows the student to practice responses, without providing any stimulus information. An example of a response device is the typewriter.

The most effective type of device for teaching is the third type, stimulus-response device. "Stimulus-response devices (or stimulus devices and response devices used in combination) are designed to present a sequence of stimuli (content) and provide the setting in which appropriate responses may be made and rehearsed (process)."[19] These might be any one of a number of programmed instruction devices: a machine such as Pressey's punchboard, a programmed text or any of the many "teaching machines" now being manufactured.

In S–R devices the stimulus is usually a question or incomplete sentence where the correct response is to be made or chosen by the student. Opinions and research findings vary on how much of a cue or hint should be given to the student to help him answer the question. (Should one or several letters of the missing word be provided or should there just be a blank?) Another common form used to elicit the correct response is the analogy. Here the correct answer is strongly hinted at by the context of the frame. For example, "If water must be heated to make steam, we can reason that steam must be ——— to make water." In this case it is unlikely that the student will miss the obvious answer of "cooled". One of the other important ways of evoking a correct response depends on the stimulus and knowledge provided in one of the preceding frames. Any of these methods, or more than one, may be used in a successful program.

The form of the response required in a program has generated much research. Here the problem has been whether the response should be overt or covert and if overt, whether it should be oral or written. Schramm reported that in most studies which compared overt or consciously made responses to covert or "thought" responses, no significant difference in amounts of learning was found; however, the covert response was usually found to be quicker.[20] "No significant difference" was also the finding in most comparisons of multiple choice and constructed response items although in individual cases, one might be more effective or faster than the other.[21] This finding is counter to what Skinner has espoused—that the act of the student constructing the response on his own is one of the most valuable assets in programmed instruction and one of the elements that makes it an effective method.

Reinforcement

It seems generally agreed that systematic reinforcement is one of the features which makes PI function as well as it does. However, there is no generally accepted theory among psychologists as to how reinforcers affect learning. Those of the Skinnerian school have little interest in this theoretical issue. Their approach is practical and empirical: discover by experience and experiment which events can reinforce and then use them in accordance with researched-derived principles of programming. The drive-reduction theorists, on the other hand, see a reinforcer as something which satisfies a drive or need. (It has been shown experimentally, however, that some reinforcers do not reduce any known drive.) According to this view, feedback reinforces because it satisfies such needs as the need for achievement, ego gratification, social approval, etc.

These theoretical issues aside, it has been well established experimentally that feedback is a very powerful reinforcer in human learning; in fact, it seems that no learning can occur without it. Most psychologists believe that feedback helps learning in ways beyond simply reinforcing or rewarding correct responses. Feedback may also serve as an incentive and an instrument to provide guidance. Regardless of the psychological processes involved, it is clear that feedback, if

effectively programmed, is one of the most influential and administratively manipulatable of all reinforcers.

Most psychologists agree that positive reinforcement is more effective than punishment in shaping behavior and also that the immediacy of the reward is important. The traditional classroom setting does not offer optimum conditions for the administering of reinforcement. Teachers cannot give individualized instruction nor can they provide immediate reinforcement for completed assignments. Besides the obvious value of eliminating delays in time, programmed learning has other advantages over traditional instruction. First, textbook reading often lacks positive reinforcement because the student finds the material uninteresting and has no way of actively responding to what he reads. He often reads meaninglessly only to get it done and avoid any unpleasant consequences which may result if he does not show outward progress. Second, traditional methodology usually allows for reinforcement only when a student gives a totally correct answer. Programmed instruction, on the other hand, rewards the student as he completes small steps in the total answer because it reinforces him as he progresses toward the total concept.

Size of Step

Some other issues related to programming are themselves somewhat interrelated. These include size of step, error and pacing, which all arouse some controversy and are all important in the two major programming techniques. Size of step is the amount of information to be learned in each "frame" or unit.

Some researchers believe that size of step is one of the crucial elements and that their size should be very small so that there is no opportunity for the learner to make errors which might lead to the reinforcement of incorrect responses. Skinner and the linear programming process follow this approach. Lumsdaine refers to a study by Evans, Glaser, and Homme in 1959 which shows that the smaller the steps, the more effective the program. But, they also pointed out there *must* be a point beyond which the principle of small steps will not hold true.[22]

The format of the branching program enables somewhat larger steps although it still adheres to the principle of small steps. The remedial work with erroneous responses means that the steps do not have to be so small that all errors are eliminated as in linear programming. Additionally, more complex intrinsic programs allow for varied step size depending on the type of individual and his ability to learn by providing alternate paths through the material.

Whether the step size should be very small and fixed or whether the latitude of a branching program will be worthwhile will depend on the projected subject matter and audience of the program.

Error

The role which error plays in PI is closely related to size of step. While linear programs try to avoid errors completely, branching programs treat errors diagnostically to give the student more information on a topic which he misunderstood so he can make a correct response. Intrinsic programs do not allow the prolonged existence of error, the student cannot go on to new information until he has demonstrated comprehension of what has already been presented.

On the other hand the linear programs, which have no provision for the correction of error, attempt to eliminate error so that a S–R bond is not formed to an incorrect response. A few errors, however, will occur even in the best programs. It is only where repeated errors appear on a single frame or extensively throughout the program that there is need for concern.

Pacing

Pacing is the speed at which the student progresses through the program. Self-pacing, or the student determining his own rate of progress through the program, has been identified as one of the characteristics of PI.

Summary

The reader has been presented with a concise, nontechnical synthesis of the major developments in PI. The origins, theory, approaches, and fundamental aspects have been reviewed.

The next section of the paper is a report on the extent to which programmed materials are being applied in Federal agency training programs. This report should aid trainers when considering the use of PI as a possible instructional method for their own training programs.

APPLICATIONS IN FEDERAL AGENCIES

To what extent is PI being used in the Federal Government? The Bureau of Training conducted a survey of Federal activities during the summer of 1969 to answer this question. The survey followed the approach first used in 1963 by Bryan and Nagay of the Office of Naval Research. Their survey was "of the extent to which programed instructional materials are being used in the Federal Government." [23]

The current survey identified over 2,300 different programs being used in some 121 headquarters, suborganizations, and field offices. (See app. E.) The compiled list of programs is not entirely inclusive of *all* programs in use in the Federal Government. An effort was made to be comprehensive but it would be difficult, if not impossible, to identify every instance of use. The training function in agencies is so widely dispersed that it was difficult for all training activities throughout headquarters and field offices to be identified.

As was illustrated in the "Origins and Development" section of this paper, programmed instruction has been around for quite sometime but has come into popular use rather recently. The Air Force reports that it began using PI as a regular instructional technique in 1954, 15 years ago. By 1962 the Army, Navy, Forest Service, and Social Security Administration were also using PI. Today its usage is widespread throughout Government agencies. Exhibit E illustrates the increase in the number of organizations using PI, particularly within the past 5 years.

Topics Covered

A look at the list ("Programs in Use"—Appendix E) will show that the topics of the programs are as diversified as the many functions for which the Federal Government must train its employees. The following list of program topics illustrates this diversity:

Air Force Traffic Control
Blue Print Reading
Basic Computer Systems
Day and Night Storm Signals and Their Meanings
Employer-Employee Relationships
Food Borne Disease Investigation
Instructor Training
Law Enforcement
Orientation to War on Poverty

A great number of programs are of a technical nature. This can be explained by the fact that the military, the largest user of PI, trains its men for many technical skills. Some of their programs are: A-7 Aircraft Fuel System Familiarization, Bomb Release Units, Jet Power Plant Designations, etc. Many of the programs used by organizations are developed to meet unique agency needs. For example: Forest Service Orientation, Analysis of Tax Returns and Coverage of Exemptions. These courses are used to train employees of the agency on how to administer their specific job task or mission. Other programs, more general in nature, often cover basic skills. One finds the same course being used throughout many agencies. Examples are: Algebra, Basic Statistics, Effective Listening, English 3200 and Introduction to PERT among others.

Length of Programs

Just as there is a great variance in the topics of programs, there is variance in the length of programs, which range from less than one-half hour to 270 hours. These figures represent only the *average* amount of time required to complete the program. For any given program, the completion time will vary because the pace of programmed instruction is determined by the student.

Data on program length was reported on 1,789 programs. Although there is a wide variance in program length, most of the programs are relatively short—94 percent are 15 hours and less. This is comparable to the 1963 study in which 86 percent of the programs average 15 hours and less.[24] However when comparing the figures for the number of programs of 1 hour and less there is a significant difference. Sixty-four percent of all the programs in the current study are 1 hour and less in length while the earlier study showed only 11 percent to be 1 hour and less. (See exhibit F.)

Both surveys show a prevalance of relatively short programs, however there appears to be a trend toward even shorter programs. The short program is generally characterized by the presentation of a single concept which has several apparent advantages:

(1) When using a short program, only the specific needed parts of a course are presented. For example, rather than an entire program on English usage, there might be individual

Exhibit E

INCREASE IN THE USE OF PI

(length of time using PI, by organization)

N=34

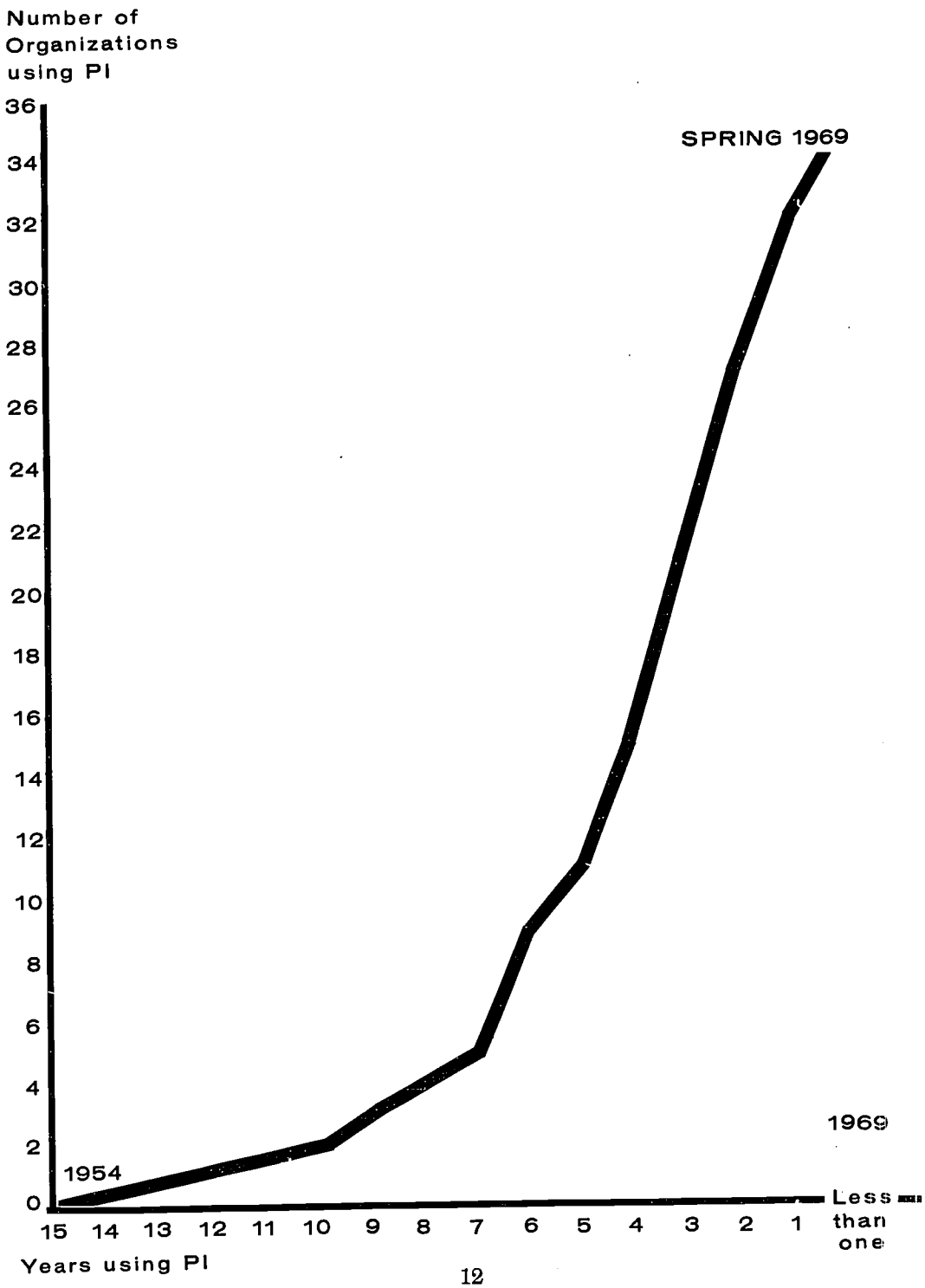


Exhibit F

FREQUENCY DISTRIBUTION OF LENGTH OF PROGRAMS

(in Instructional Hours)

N=1789

Length in Hours	Number of Programs	Length in Hours	Number of Programs
½ and under	262	16 - 20	33
½ - ¾	169	20 - 25	23
¾ - 1	136	26 - 30	6
1	589	31 - 35	4
2	237	36 - 40	17
3	85	41 - 45	—
4	44	over 45	26
5	38		
6	26		
7	12		
8	17		
9	6		
10	25		
11	12		
12	9		
13	1		
14	6		
15	6		

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programs on punctuation, commas, spelling, etc. The student will study only those specific programs for which he has a need.

(2) The shorter program requires a shorter span of concentration thus helping to eliminate boredom.

(3) The short program provides for easier use and coordination when it is used in a classroom setting. This is because the range of completion time for a 1-hour program is less than that for a 20-hour program. Thus short programmed segments can be coordinated well with other types of classroom instruction.

Sources of Programs

Each respondent was asked to indicate the source or sources of programs for his organization. Of 40 responding organizations, 29 purchase commercially prepared programs (off-the-shelf), 18 develop their programs in-house, and 11 have them developed under contract. (See exhibit G.)

It should be noted that these figures do not represent the number of programs from each of these sources. If the data had been collected for each program, it would probably be found that the greatest number of programs were developed in-house. Those organizations which are the largest users of PI have developed their own in-house capacity whereas the smaller and newer users of PI tend to purchase more off-the-shelf and contract programs.

Type of Instruction

Forty-one organizations reported on how their programs are used. (See exhibit H.) The most common use is for *standard* instruction, that is "training in its usual sense—regular training anticipated in the lesson plan to which all trainees are routinely exposed." Seventy-one percent of the respondents use programmed instruction in this manner. About half of the respondents use PI for remedial instruction and for preparatory instruction. *Preparatory* use is made of "programs covering material not previously learned and administered prior to an established course," and *remedial* programs are used to overcome deficiencies. *Refresher* programs are used as reviews given before a standard course, and *self-development* are programs which "are not specific to any particular course objective. They are usually voluntary." [25] The use of programmed instruction for these two purposes is somewhat less extensive. Each is used by 13 of the 41 respondents or 32 percent.

Presentation Format

Diversity of media for presentation of programmed instruction is increasing according to the agencies. Initially there were machines such as those developed by Pressey. Then the common format became the programmed text which is currently the most widely used media. All but one of the organizations reporting on their use of PI stated that they use the programmed text. In addition many agencies have added teaching machines and an increasing amount of other media such as tape-slide, tape-filmstrip and other devices. (See exhibit I.)

Where Used

Programmed instruction in Federal Government training is most generally administered, "usually on a scheduled basis, to individuals during their normal school or working hours in a more or less formal classroom setting." Sixty-six percent of the organizations surveyed reported that PI is administered as "homework", that is "individuals are made responsible for their own instruction and complete programs on a self-imposed schedule, either at home or in libraries, study halls, or the like." [26] On a somewhat smaller scale, PI is administered as correspondence courses, 27 percent of the organizations use it in this way. (See exhibit J.)

Exhibit G

SOURCES OF PROGRAMS IN USE

(by Organization)

N=40

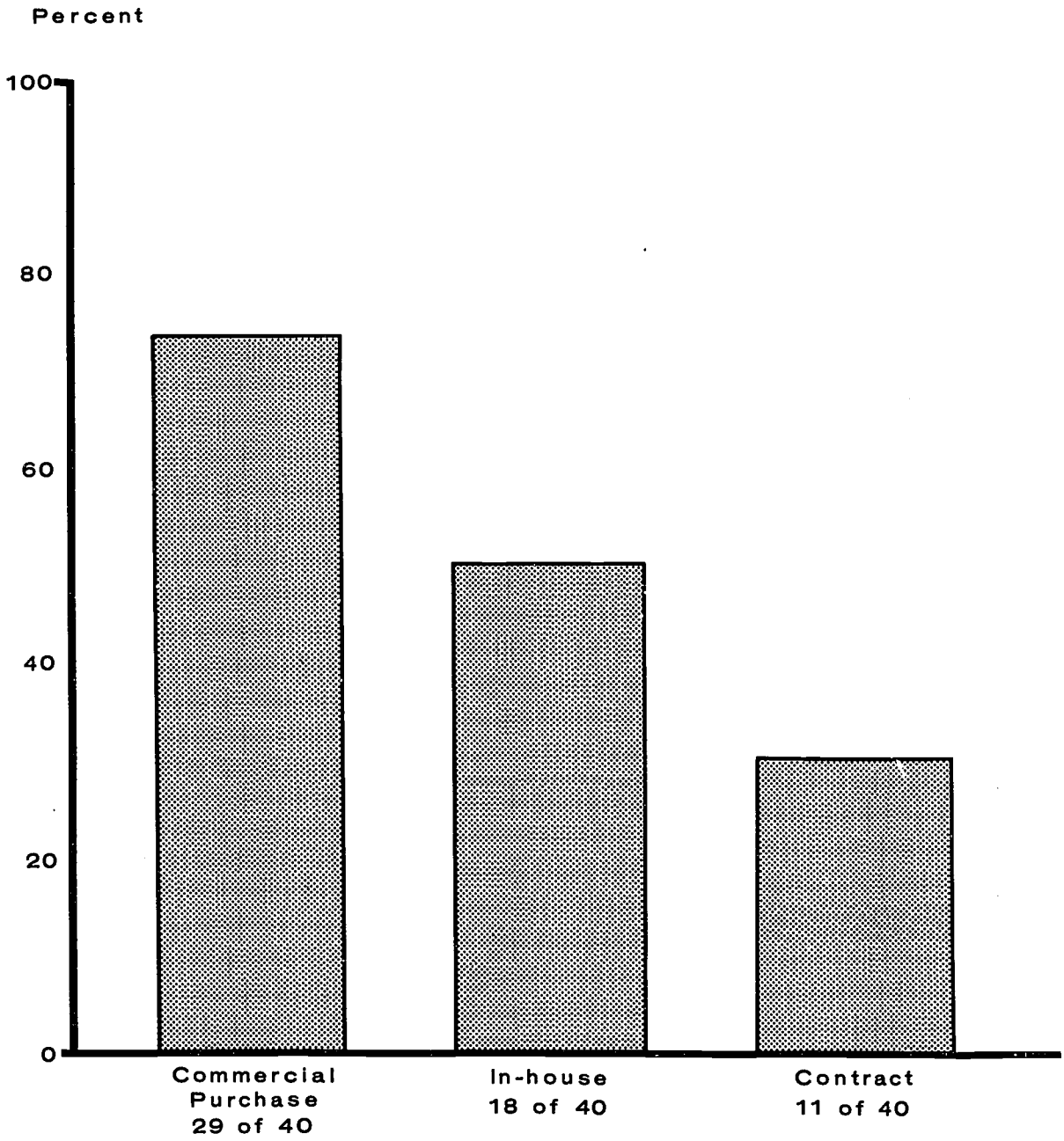


Exhibit H

TYPE OF INSTRUCTION

(by Organization)

N=41

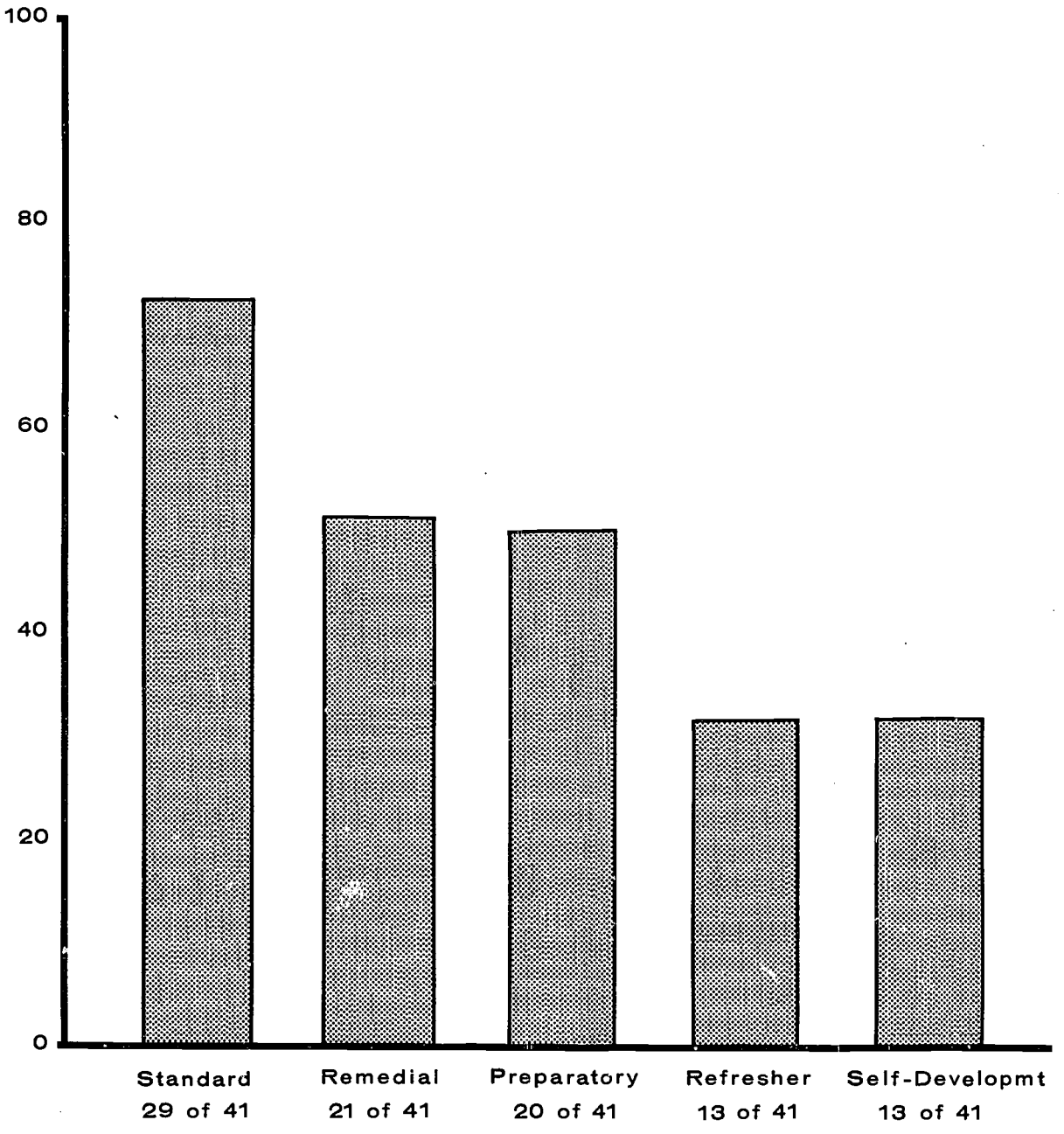


Exhibit I

PRESENTATION FORMAT

(by Organization)

N=41

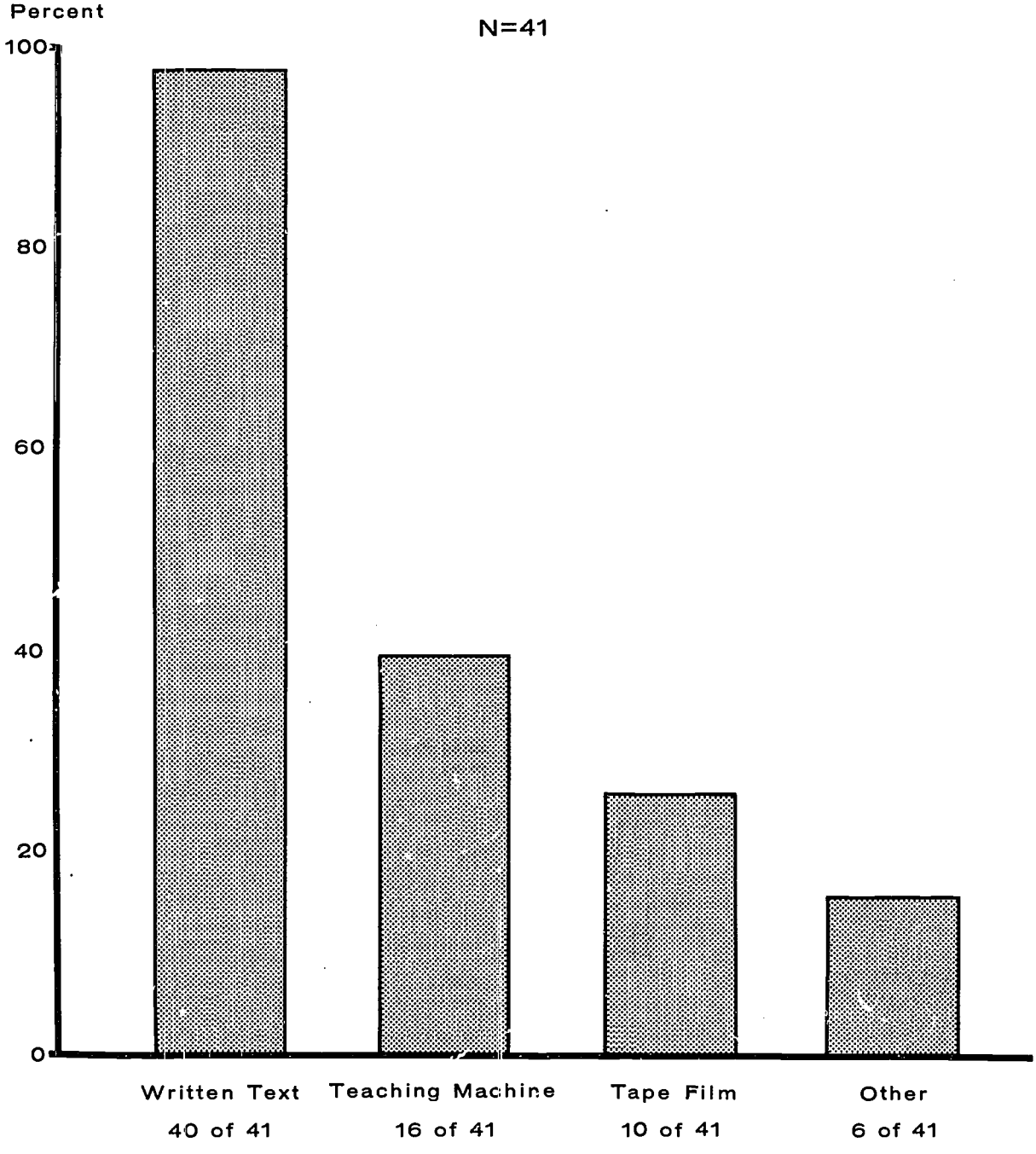
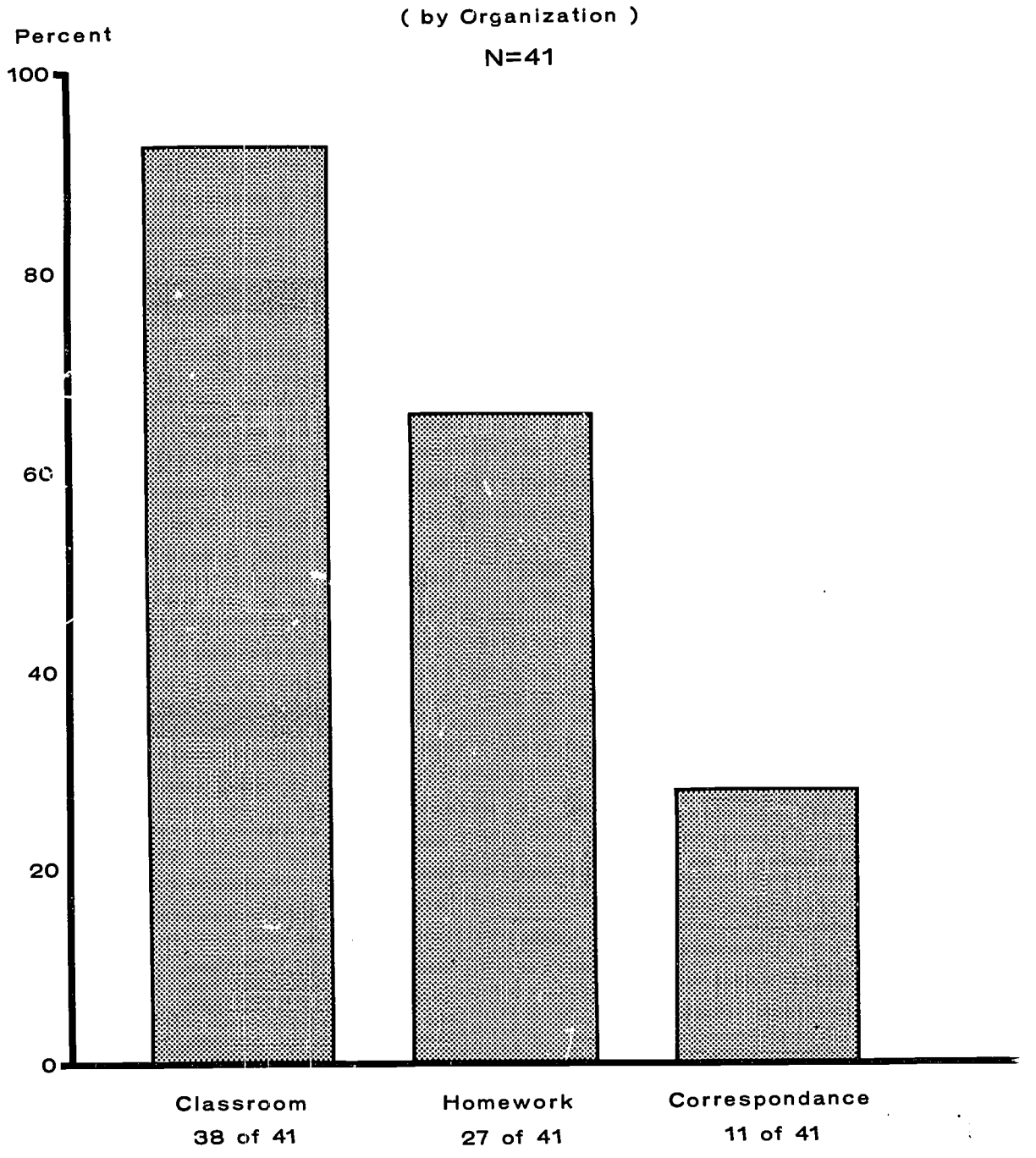


Exhibit J

LOCALES AT WHICH PROGRAMS ARE BEING USED



THE NEXT STEP

Does programmed instruction have a place in your training activities? The answer to this question is the next step.

The next step belongs to you. Hopefully the reading of this paper has led to some thoughts on your training activities and whether the implementation of programmed instruction is applicable to your training needs.

First and foremost, however, you must determine that the need for training really exists. After this initial step follow the steps of the systems approach described in *Instructional Systems and Technology: An Introduction to the Field and Its Use in Federal Training* and summarized in the introduction. You are then ready to select the best method of instruction to attain your objectives.

In order to make a well-founded decision to use programmed instruction, or any instructional method, you must make a preliminary evaluation of a method and of individual programs using that method to determine if they will meet your needs.

The reader might ask, "How can I learn more about programmed instruction?" This paper has given an introduction. Sources for gaining further knowledge might be:

1. Books such as those listed in the bibliography of this paper.
2. Courses such as those workshops sponsored by universities, given by the American Management Association or by the Civil Service Commission.
3. Visits to agencies which are already using PI in their training programs.

Making the Decision To Use PI

Consideration of the use of PI should include a review of some of the claimed advantages for programed materials listed below.[27]

1. First and probably most important is individualization of instruction. Students need not all go to courses at the same time nor for the same amount of time. Each is allowed to work at his own rate and only with that material which his need determines.
2. Programmed materials can reduce the amount of time required to teach. Because prior determination of objectives and student ability have been made, only essential elements are taught. Questions asked by one student need not be heard by all who understand the material.
3. Programmed materials are easily packaged and disseminated to dispersed training activities. This eliminates duplication of courses and the long-distance travel of students or teachers to and from courses.
4. A prepared program may be used by a single student when he needs the training. It is not necessary to wait until there are enough students to fill an entire class.
5. Programmed materials "can improve the level of performance and reduce the incidence of failure among students."[28] Students are measured on what they actually learned as based upon the objectives. Failure is reduced because the construction of the program demands that the student has "learned" material in one frame before he can progress to the next. Programmed materials provide a means of evaluating results by the preestablished criterion test. Due to this testing, weaknesses in the program may be overcome thus enhancing student learning.

Sources of Programs

If the advantages of PI are congruent with your particular needs, you have three sources of programs: off-the-shelf, contract, and in-house.

Off-the-shelf.—There are many off-the-shelf programs available covering almost every imaginable topic and their number is constantly increasing. Several references you can use are listed below.

1. *Programmed Learning; a bibliography of programs and presentation devices*, 4th ed., by Carl H. Hendershot (Bay City, Mich., 1967).
2. *Programmed Instruction Guide*, Northeastern University, Instructional Technology Information Center (ENTELEK, Inc., Newburyport, Mass.), Published every 6 months.
3. Appendix E of this paper, "Programs in Use".

There are a number of factors to consider in an off-the-shelf program to insure that it will be effective to meet the objectives and defined group of learners. Questions that must be asked about the off-the-shelf program under consideration include the following.[29]

1. Are the publishers list of objectives compatible with yours?

2. Is the target group of the publisher's program relatively the same as your group of learners? You need to know the educational level, job experiences, ages, and other relative facts about the students involved.
3. Does the publisher provide validation data? The publisher should make available validation data of results on criterion tests. You need evidence to assure that the students have learned from the program.
4. Is the cost comparable with other similar programs?
5. Do you need machines or other special equipment in order to use the program?
6. Is the format such that it can easily be updated or revised?

At this point you should have been able to narrow down the number of programs. A more careful study of the internal progam characteristics must be made at this point. As well as review by the trainer, it would be a good idea to have several students work through the program and give an evaluation of it. Points to consider in working through the program include:

1. The language and comprehension level.
2. The scope, depth, accuracy, and currency of the information presented.
3. The techincal construction of the program such as step size, logical ordering of steps, variety and relevency of responses, and frequency of review.
4. The writing style and whether information presentation is interesting or dry and dull.
5. The length of time required to complete the program.

Contract.—A second means of obtaining a program is through contract with a consulting organization. If there are subjects which are unique to your particular agency and are not covered in off-the-shelf publications, then a program must be developed to meet your specific objectives. A look at appendix E will illustrate that many of the courses already in use by agencies are of this nature. The following are points to consider in selecting a consulting organization to develop a custom-tailored program.[30]

1. Does the consultant have samples of his previous programs available for inspection?
2. Does he also have records of achievement and retention tests available for inspection?
3. Are the lists of his customers available for you to query?
4. What about the quality of his staff? Does it include reputable psychologists, along with subject matter specialists and task analysts? It should. And are their credentials available for you to inspect?
5. Does the consultant ask for access to your technical experts? And does he require subjects both for retesting and formal evaluation of his program? Any sound organization will make these requests.
6. Are his costs in line with those presented by other reputable consulting organizations?
7. Is the consultant's organization close to yours, physically? This last point is important because your staff will have to work closely and continuously with the staff of the consulting organization. No outside subject matter expert knows your special problems. You will have to provide a subject matter specialist to write a statement of detailed objectives for the program and to hold weekly conferences to read and discuss frames.

In-house.—The third alternative is in-house development. As with contract development, in-house development is used for those programs whose subjects are unique to an agency and not covered in off-the-shelf publications. The development of programs in-house requires a programming staff as well as the cooperation of the subject matter specialist.

Developing your own programs is desirable if:[31]

1. You have personnel on the payroll who can be used as programmers. The initial development of the programming capacity is a major and costly undertaking, however its existence may be valuable for large-scale program development and revision.
2. There is the possibility that you will need extensive programming in many subject areas.
3. You have gained enough previous experience with using PI to be able to evaluate the role of PI in your organization.

Cost.—One additional factor, ever present in decision-making, is that of cost. Actually there is no easy answer to how much programs cost. The cost is influenced by a variety of factors. The length and complexity of the program, as well as the medium and number of students using the program, are influencing factors on cost.

The cost of an off-the-shelf program is the least costly of any of the sources of programs. The price

per individual program can range from a few dollars for a paperback programmed text to somewhat more costly tape/slide or "teaching machine" programs.

The cost of custom programs is far more expensive than those available off-the-shelf. Stated prices range from $1,000 to $3,000 per hour of instruction.[32] Again prices depend on the complexity of the program, the salaries of programmers and other factors. Generally on a per program basis, in-house programming would be less expensive than contract but in a comparable price range. It is difficult to determine the exact cost of in-house programming particularly on a before-the-fact basis. Not only must the cost of the use of programmers and subject specialists be considered but also clerical costs and printing. The overall cost of training should be ascertained by not only the number of students who need training and how much effort is required to develop the program but also by how much value the desired outcome or performance has to the organization.

In the end, the choice to use programmed instruction, the decision on the sources of the program and the program format can only come from the trainer who is aware of his needs and has made a careful analysis of them. If this is done, and his choice is based on a solid understanding of the material with which he is working, his chances of having a successful outcome are very good.

SUMMARY

Programmed instruction is not new. It has been known and used in a limited sense for many years. In recent years it has experienced remarkable growth in use. The underlying theory can be traced back to Thorndike who in 1912 predicted the influence that learning theory could have on methods of instruction. Efforts to apply theory to instructional methods involving teaching machines followed. These early machines operated mainly on the principle of immediate reinforcement of correct responses. In spite of the apparent success of machine-based instruction, PI did not develop widespread support until the 1950's when Skinner began working in the field. His article, "The Science of Learning and the Art of Teaching", published in 1954, focused on the potential of PI and the failure to exploit this potential. Unfortunately, the newly found interest in programming was temporarily misdirected because most efforts went into developing machines instead of programs. By the early sixties the excitement over the machines had diminished and the demand for good programs resulted in a new emphasis on program construction.

Linear programmed instruction is usually considered to be a direct outgrowth of Skinner's operant conditioning theory. The central principles involved are the presentation of small pieces of material in an ordered fashion which lead the student to a predetermined goal of a specific behavior or piece of knowledge by immediately reinforcing the correct responses which are given to each succeeding question.

Another approach, known as branching, differs from linear programming by providing for the skipping or repetion of certain groups of steps—the path of the student being determined by the responses to the items. Not only can this make the program more interesting for a bright student, but it may also make it a more efficient teaching device for less bright students.

During the past few years, the differences between these two approaches to programming have diminished as each has been modified by new developments.

Programmed instruction has clearly proven itself to be an effective method of instruction. Its further use in the Federal Government will depend upon trainers having a grasp of the underlying concept and a working knowledge of the technique.

The reader is cautioned, however, that the implementation of the technique is not a cure-all for training problems. PI should not be used merely for the sake of replacing old "chalk and blackboard" techniques with modern technology. Rather, a decision to use this method should come only after systematic evaluation of the training needs.[27]

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FOOTNOTES

[1] Glenn L. Bryan and John A. Nagay, "Use of Programed Instructional Materials in Federal Government Agencies" in *Teaching Machines and Programmed Learning, II*, ed. Robert Glaser (Washington, D.C., 1965), p. 745.

[2] Gabriel Ofiesh, "The Emergence of Instructional Technology" in *Trends in Programmed Instruction*, eds. Gabriel Ofiesh and Wesley C. Meierhenrg (Washington, D.C., 1964), p. 7.

[3] Jerome P. Lysaught and Clarence M. Williams, *A Guide to Programmed Instruction* (New York, 1968), pp. 24–25.

[4] Wilbur Schramm, *The Research on Programmed Instruction; An Annotated Bibliography* (Washington, 1964), p. 5.

[5] Lysaught and Williams, op. cit., pp. 165–167.

[6] B. F. Skinner, *The Behavior of Organisms* (New York, 1938).

[7] B. F. Skinner, "The Science of Learning and the Art of Teaching", *Harvard Educational Review*, 24 (1954), pp. 86–97.

[8] Lysaught and Williams, op. cit., p. 71.

[9] Norman A. Crowder, "Automatic Tutoring by Intrinsic Programming" in *Teaching Machines and Programmed Learning*, eds. Robert Glaser and A. A. Lumsdaine (Washington, D.C., 1960), p. 286.

[10] D. Mackenzie Davy and P. McDonnell, *Programmed Instruction* (London, 1965), p. 18.

[11] David Cram, *Explaining "Teaching Machines" and Programming* (San Francisco, 1961), pp. 66–75.

[12] Davy and McDonnell, op. cit., p. 18.

[13] Susan Markle, "Programming '63: The Straight Line Bends", *Programmierter unterricht and Lehrmaschinen* (Berlin, 1963), pp. 368–386.

[14] David J. Klaus, *An Analysis of Programming Techniques* in Glaser, p. 153.

[15] Howard H. Kendler, "Teaching Machines and Psychological Theory" in *Automatic Teaching: The State of the Art*, ed. Eugene Galantin (New York, 1959), p. 184.

[16] Francis Mechner and Donald A. Cook, *Behavioral Technology and Manpower Development* (New York, 1964), p. 36.

[17] Thomas F. Gilbert, "On the Relevence of Laboratory Investigation to Self-Instructional Programming" in Lumsdaine and Glaser, pp. 475–485.

[18] Douglas Porter, "A Critical Review of a Portion of the Literature on Teaching Devices" in Lumsdaine and Glaser, pp. 114–132.

[19] Ibid., p. 117.

[20] Schram, op. cit., pp. 8–10.

[21] Edward B. Fry, "A Study of Teaching Machine Response Modes" in Lumsdaine and Glaser, pp. 469–474.

[22] A. A. Lumsdaine, "Teaching Machines: An Introductory Overview" in Lumsdaine and Glaser, p. 17.

[23] Bryan and Nagay, op. cit., pp. 743–767.

[24] Ibid., 748.

[25] Ibid., 752.

[26] Ibid.

[27] James W. Brown, Richard B. Lewis, and Fred Harcleroad, *AV Instruction, Media and Methods* (New York, 1969), pp. 114–115.

[28] Ibid., p. 115.

[29] Bureau of Business Prectices, Inc., *What You Should Know About Programmed Instruction* (Waterford, Conn., 1964), pp. 24–25, and Brown, Lewis and Harcleroad, op. cit., p. 125.

[30] Bureau of Business Practices, op. cit., p. 27.

[31] Ibid., p. 26.

[32] Francis Mechner and Donald Cook, "Behavioral Technology and Manpower Development" in *Managing the Instructional Programming Effort*, eds. Geary Rummler, Joseph Yaney, and Albert Schrader (Ann Arbor, Mich., 1967) p. 32.

[33] U.S. Civil Service Commission, Bureau of Training, *Instructional Systems and Technology: An Introduction to the Field and Its Use in Federal Training*, Training Systems and Technology Series: No. I and *Application of a Systems Approach to Training: A Case Study*, Training Systems and Technology Series: No. II. (Washington, D.C., 1969.)

[34] Naval Air Training Command, Lesson No. 1.5.6. *Programmed Instruction.*

[35] Cram, op. cit., p. 39.

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Appendix A.—SAMPLE OF A LINEAR PROGRAM [34]

	1. The objective of this section is to "LIST THE FIVE PRINCIPLES OF PROGRAMMING."
	2. You are now beginning a lesson on programmed instruction. The principle of SELF-PACING as used in programmed instructions allows each trainee to work as slow or as fast as he chooses. Since you can control the amount of time you spend on this lesson, this program is using the principle of self- _____.
PACING	3. People naturally learn at different rates. A program that allows each trainee to control his own rate of learning is using the principle of _____ _____.
SELF-PACING	4. If a self-pacing program is to be successful, the information step size must be small. A program which is self-pacing would also apply the principle of small _____.
STEPS	5. The average trainee will usually make correct responses if the correct size step of information is given. This is utilizing the principle of small _____.
STEPS	6. A program that provides the trainee information in a step size which allows him to be successful is applying the principle of _____.
SMALL STEPS	7. A trainee knows the material being taught, but has to wait for the remainder of the class. What programming principle is being violated? _____ _____.
SELF-PACING	8. Two principles of programmed learning are: (1) _____. (2) _____.
1. SELF-PACING 2. SMALL STEPS	

NOTE.—In this example for practical reasons the frames are arranged on 1 page rather than on succeeding pages. The answers should be covered until the preceding frame has been answered.

Appendix B.—SAMPLE OF A BRANCHING PROGRAM [35]

Page 39

Wrong answers, while not encouraged, are not avoided in a branching program as they are in a linear program, since they may be corrected before the learner moves on.

The assumption in branching programming is that a wrong response does not necessarily hinder the learning of a correct response. The response is useful mainly in guiding the student through the program. Each response is used to test the success of the latest communication to the student, and in that sense, it "lets the program know" where to take the student next.

The differences in approaches to programming, then, lie in what is considered to be the function of the overt or motor response. The advocates of branching programs believe that:

Page 41 The overt response *is not* fundamental to the learning process but it is useful as a means of supplying feed-back to the program.

Page 44 The *overt* response *is* fundamental to the learning process

Page 47 No answer is ever completely wrong.

Page 41

Your answer is correct. The overt response, according to Dr. Crowder, is a measurer rather than a fixer of learning.

Inappropriate responses can be used to uncover misconceptions and areas of weakness and, therefore, have great value.

Since errors or misconceptions are corrected before the learner proceeds, the step size can be larger and the main line (prime path) of the program may proceed more rapidly than in the linear program.

There is always the possibility of having the main-line items proceed in large, fairly difficult steps with shorter, easier stages moving side by side with the main line.

Given a student with the necessary prerequisites, which of the following, in your opinion, would be most dependent on his intelligence?

Page 42 Whether he gets through the program or not

Page 46 How long he takes

Page 45 How much he knows about the subject upon finishing the program.

Page 44

You've got them twisted around. The Skinnerian (constructed-response) programmers believe:

The overt response is fundamental to the learning process—learning takes place when the overt response is made.

The branching programmers believe:

The overt response is best used as a device for evaluation and direction, since learning may have taken place by the time the response is made.

(Please return to page 39 and select another alternative.)

Page 47

I just threw this one in to bring you up short if you're getting tired.

But don't be buffaloed into this kind of an opinion—of course some things are amenable to right and wrong answers—but not everything that we teach is—and the branching technique allows us to program, for automated instruction, subject matter in which shades of meaning or interpretations are essential.

(Please return to page 39 and select another alternative.)

Appendix C.—SURVEY PROCEDURE AND SCOPE

The survey conducted by Bryan and Nagay is reported in *Teaching Machines and Programmed Learning, II* published by the National Education Association.[1] A total of 125 organizations were surveyed, reporting the use of 382 programs.

Procedure

The format of the survey made by the Bureau of Training followed that of the earlier survey. The procedure was to develop a questionnaire which covered various aspects of the use of PI in training activities and to contact as many Federal Government organizations as possible by means of a telephone survey. Appendix A, "Federal Government Organizations Surveyed", in Bryan and Nagay served as a base for organizations to contact. Initial calls were made to headquarters of each agency asking for information about their use of PI or for recommended contacts in subordinate activities within the agency who might have the desired information. Leads for contacts were also solicited when talking with those in the subordinate activities. They were asked for additional contacts within their own agency as well as their counterparts in other agencies. This procedure was followed to insure thorough coverage.

The Bureau of Training's list, "Federal Government Organizations Surveyed", is not identical to the 1963 list due to changes in agency organization and the establishment of new departments and activities since that study was conducted.

As information yielding contacts were made, the surveyors asked predetermined questions and answers were recorded on standard questionnaire forms. In many cases additional information regarding courses was sent to us by mail. In a few cases the entire questionnaire was sent out, completed, and returned by mail.

[1] Glenn L. Bryan and John A. Nagay in "Use of Programmed Instructional Materials in Federal Government Agencies" in *Teaching Machines and Programmed Learning, II*, ed. Robert Glaser (Washington, D.C., 1965)

Scope

Forty-seven departments and agencies reported on the use of PI in their training activities in 121 headquarters, suborganizations and field offices. Of these 121 organizations, 69 were directly contacted. An additional 52 organizations were reported on by agency headquarters. All organizations contacted are listed in appendix D. Those not directly contacted are marked by an asterisk (*).

Of the 69 organizations directly contacted 61 percent (42 organizations) reported that they are currently using programmed instructional materials. Agency headquarters which reported on their own units reported only on those units where PI is being used and they reported on these activities as a whole, therefore the 52 organizations not directly contacted are not counted individually in tabulation of the questionnaires.

NOTE.—Bryan and Nagay state that 125 organizations were contacted in their survey, however they do not indicate how many were *actually using PI* in their training activities.

The survey identified over 2,300 different programs in use. Appendix E lists the "Programs in Use" in alphabetical order and gives a numerical code indicating the agency using the program. This type of listing is given because the purpose is to acquaint the reader with the vast number and variety of programs being used and illustrate the types of subject matter which can and have been programmed for use in agency training programs.

The "program titles" represent entire programmed units or courses and courses of which a segment is programmed. For example, English 3200 is a complete 40-hour programmed course, however, the course Position Classification and the Management Process, a 40-hour course given by the Civil Service Commission, uses a several hour supplemental programmed unit.

(Page 1)

TELEPHONE SURVEY

Name: _____ Address: _____

Position: _____

Agency: _____

Phone Number: _____

Do you use PI in your training programs?

A. Yes _____.
If so, how long have you been using it?

B. No _____.
Have you ever used it: Yes _____. No _____.
If so, why no longer?

*What percent of your *total* training is by PI?

How were your courses developed? Were they obtained by:

A. Contract _____.

B. Commercial purchase _____.

C. In-house _____.

If in-house, how were your programmers trained?

(Page 2)

Agency: _____

What specific PI courses do you have?

Program title	Length (hours)	Percent of PI

(Page 3)

What training objectives is your PI designed to meet, for example:

A. Standard-regular training _____.
B. Remedial-to overcome deficiency _____.
C. Refresher-quick review given before standard course _____.
D. Preparatory-not previously learned prior to standard course _____.
E. Self-development-not specific to any particular course objective _____.

Where is it used:

(a) Classroom: _____.
(b) Homework: _____.
(c) Correspondence: _____.

PI can be presented in many forms ,which of the following do you use?

A. Written text _____.
B. Teaching machines _____.
C. Tape/film _____.
D. Other audiovisual _____.

*Have you tested for results?

Yes _____. No _____.

If so how?

Pretest/post-test _____.
Other _____.

Do you anticipate further and new use of PI?

Yes _____. No _____.

Do you have printed information on your programs you could send us?

Yes _____. No _____.

*In implementation, these questions proved to be ambiguous and replys inconclusive, therefore were not used in reporting on the survey.

Appendix D.—FEDERAL GOVERNMENT ORGANIZATIONS SURVEYED

Agency for International Development
Agriculture, Department of
- Agricultural Research Service
- Agricultural Stabilization and Conservation Service
- Consumer and Marketing Service
- Farmers Home Administration
- Forest Service

Air Force, Department of
- Aerospace Defense Command*
- Air Training Command*
- Air Force Accounting and Finance Center*
- Air Force Logistics Command*
- Air Force Reserve*
- Air University*
- Military Airlift Command*
- Pacific Air Forces*
- Strategic Air Command*
- Tactical Air Command*
- USAF Academy*
- USAF Security Service*
- USAF Southern Command*

Army, Department of
- Office of Civil Defense
- Office of Civil Defense Staff College
- U.S. Army Training Centers*
- U.S. Army Medical Training Center*
- U.S. Army Adjutant General School*
- U.S. Army Air Defense School*
- U.S. Army Armor School*
- U.S. Army Artillery and Missile School*
- U.S. Army Aviation School*
- U.S. Army Chaplain School and Center*
- U.S. Army Chemical Center and School*
- U.S. Army Civil Affairs School*
- U.S. Army Combat Surveillance and Electronics Warfare School*
- U.S. Army Command and General Staff College*
- U.S. Army Engineer School*
- U.S. Army Finance School*
- U.S. Army Infantry School*
- U.S. Intelligence School*
- U.S. Army Management School*
- U.S. Army Military Police School*
- U.S. Army Missile and Munitions Center and School*
- U.S. Army Ordnance Center and School*
- U.S. Army Primary Helicopter School*
- U.S. Army Quartermaster School*
- U.S. Army Signal Center and School*
- U.S. Army Southeastern Signal School*
- U.S. Army Special Warfare School*
- U.S. Army Transportation School*
- U.S. Women's Army Corps School*

Atomic Energy Commission
Bureau of the Budget
Central Intelligence Agency
Civil Aeronautics Board
Civil Service Commission
- ADP Management Training Center
- Communications and Office Skills Training Center
- Financial Management and PPB Training Center
- General Management Training Center
- Personnel Management Training Center
- Executive Seminar Centers
- Personnel Division

Commerce, Department of
- Office of the Secretary
- Bureau of Census
- National Bureau of Standards
- Maritime Commission
- Patent Office
- Environmental Science Services Administration
- Domestic and International Business

District of Columbia Government
Equal Employment Opportunity Commission
Export-Import Bank
Federal Communications Commission
Federal Mediation and Conciliation Agency
Federal Power Commission
Federal Reserve Board
Federal Trade Commission
General Accounting Office
General Services Administration

*Not contacted directly.

Government Printing Office
Health, Education, and Welfare, Department of
- National Institutes of Health
- Public Health Service
- Social Security Administration

Housing and Urban Development, Department of
Interior, Department of
- Bureau of Indian Affairs

Interstate Commerce Commission
Justice, Department of
- Immigration and Naturalization Service
- Bureau of Prisons
- Federal Bureau of Investigation

Labor, Department of
Library of Congress
National Aeronautics and Space Administration
National Labor Relations Board
National Science Foundation
National Security Agency
- Commandant, Training School

Navy, Department of
- Bureau of Medicine and Surgery*
- Bureau of Naval Personnel*
- Fleet Anti-Air Warfare Training Center*
- Fleet Training Center*
- Landing Force Training Command Atlantic*
- Naval Air Advanced Training*
- Naval Air Basic Training*
- Naval Air Technical Training Center*
- Naval Air Technical Training Unit*
- Naval Post Graduate School*
- Service School Command*
- Training Command*

Peace Corps
Post Office, Department of
Securities and Exchange Commission
Selective Service System
Small Business Administration
Smithsonian Institute
State, Department of
Tax Court of the United States
Department of Transportation
- Federal Aviation Administration

Treasury, Department of
- Internal Revenue Service

United States Information Agency
United States Tariff Commission
Veterans Administration

Appendix E.—PROGRAMS IN USE

A–7 Aircraft Fuel System Familiarization 20
A–7 Aircraft Fuel System Operation 20
A–7A Aircraft Power Plant 20
A–7A Power Plant, Cold Section 20
A–7A Power Plant, Hot Section 20
ABO Grouping & Rh Typing 3
A.C. Bus System 3
A.C. Circuit Power Characteristics 20
A.C. Circuits, Characteristics, P–IX–1A, P–IX–1B 20
A.C. Distribution System 3
A.C. Electricity 20
A.C. Fundamentals 20
A.C. Meters 20
A.C. Theory—Alternating Current and Voltage Characteristics 20
A.C. Theory, Related Mathematics 20
A.C. Time Constants—RCL 3
ACL Form F (Aircraft Performance—C–141 and Air Transportation) 3
ADF Approach 4
ADF En route 4
ADF Flight 4
ADF Orientation and Tracking 4
ADF Procedures 4
ADF–VOR 4
ADP Procedures Training 27–1
AID Files and Records System 1
AMSE Statistical Data Reporting 20
AN Nomenclature System, Advanced Developments 20
AN/APN–141(V), Power Supply Operation 20
AN–M100A2 Series Bomb Tail Fuzes 20
AN–M103A1 Bomb Nose Fuze 20
AN–M123A1 Series Bomb Tail Fuzes 20
AN/PRC 8, 9, and 10 (Tuning and Calibration) 20
AN/SPM–4, Maintenance of Frequency—Power Meter 20
AN/UPN–12/5 Loran Receiver, Maintenance of 20
AN/WRT–1 Radio Transmitter, Maintenance of 20
AN–WRT–2 Radio Transmitter, Maintenance of 20
ASW Plotting, Symbols for the DRT 20
Acceleration and Takeoff 3
Accelerometers 20
Accelerometers, Aircraft 3
Accident Control System for Supervisors 2–4
Accidents, Maintenance Induced 20
Accounting 2–4
Accounting Machine Operation and Wiring 402–3, 407 12–2
Accumulator, Air Flask and Pressure Regulator 3
Actuator 3
Addition, Subtraction, Multiplication and Division (ASMD) 12–2
Adjunctive Program on AR 711–16 4
Adjunctive Program for AR 735–35 4
Adjunctive Program for Excess Property Procedures 4
Adjunctive Program for Property Records Adjustment 4
Administration Responsibilities 4
Administrative Forms Preparation 4
Administrative Office Procedures 4
Administrative Specialist Course 4
Administrative Training 5
Advance Oversea Returnee 4
Adverse Weather Operation 4
Aerodynamics 20
Aerodynamics, Applied 3
Aerodynamics, Drag 20
Aerodynamics—Helicopter (Introduction) 20
Aerodynamics, High Speed, Parts I and II 3
Aerodynamics of Sink Rate 3
Aerodynamics, T–28 20
Aeromedical Evacuation, Preparation of Patients for 3
Aeronautical Chart Symbols 4
Aids to Navigation, Buoys—Part I 20
Air Conditioning Principles Review 20
Air Conditioning System, Cargo 3
Air Equipment Support Company 4
Air Flow Control Valves 3
Air Force Mission and Organization 3
Air Force Technical Order Form 781 3
Air Intelligence 20
Air Mass Weather 4
Air Masses 4, 20
Air Movement Planning 20
Air Navigation Computer 3
Air Navigation, Earth 20
Air Navigation (TACAN) 20
Air Navigation (VOR, Part I) 20
Air Navigation (VOR, Part II) 20
Air Route Traffic Control, Approach Control 20
Air Route Traffic Control, Departure Procedures 20
Air Route Traffic Control, En Route Procedures 20
Air Route Traffic Control VFR Operations Part I 20

Army Maintenance System, The 4
Army Maintenance System, Combat Leader, The 4
Army Maintenance System, Vehicle Mechanics, The 4
Army Parachute Log Record, The 4
Artillery Call for Fire 20
Artillery Spotting and Adjusting 20
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Aseptic Technique, Medical 3
Associate Tow Target Equipment 20
Astronomic Coordinate Theory 4
Atmosphere 20
Atmosphere, Physics of 20
Atmospheric Circulation 4
Atom (Introduction to the) 20
Automated Instruction (Introduction to) 4
Atomic Structure 20
Atomic Structure and Radioactivity (Basic) 20
Atomic Structure and Static Electricity 3, 20
Attitude Indicator, J-8 3
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Automatic Data Processing, Vol. I, Vol. II 3
Automatic Direction Finder 4
Automatic Gain Control 4
Auto Pilot, E-4 (Set I-C-124) 3
Auto Pilot, E-4 (Set II-C-124) 3
Automobile Movement, Basic Physics of 3
Automotive Terminology and Hardware 3
Autorotation 4
Autorotation: Helicopter Aerodynamics 20
Autorotations 4
Aviation Enlisted Ratings 20
Aviation Fuels 20
Aviation Fuels and Oils 20
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Aviation Lubricants 20
Aviation Physiology (Vertigo and Illusions) 4
Aviation Toxicology 4
Aviation Weather Forecasts 4
Aviation Weather, Pilot Weather Reports 20
Awards 4
Axles, Front and Rear Driving 3
B-52 Flight Director System, An Introduction to 3
BI-A Basic Instruments 3
BI-B Basic Instruments 3
Bacilli, Gram Positive 3
Bank and Turn Indicator 3
Basic 1401 Programing 12-2
Basic Aerodynamics, Part I 20
Basic Arithmetic 4
Basic Arithmetic and Fractions 4
Basic Arithmetic (Ratio and Proportion) 4
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Basic Communications 15-1
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Boiler Types and Components 20
Bomb Arming Controls and Units 20
Bomb Release Units 20
Bomb Trucks, Skids, and their Adapters 20
Bomber Bleed Air Supply 3
Boresight Kit MK 3 MODO 20
Brake Assembly 3
Brake Booster System 3
Brake (Power) Control Valve and Brake Debooster 3
Brake System, Bomber 3

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Radiation Hazards for Firefighters 3
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S/360 DOS/TOS Operation (PI) 17
S/360 Introduction—PI 17
S–2D/E Aircraft, Power Plant 20
S–2D/E Aircraft, Systems Familiarization Hydraulics 20
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SAO, SA/C Calculator Guide 12–3
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Safety and Communications 3
Safety and Supervision 3
Safety, Electrical 3
Safety Familiarization, Nuclear 3
Safety, Fire 3
Safety, Ground 3
Safety Practices 3
Safety, Radiation 3
Safety, Shop 3
Safety (Shop) for Aerospace Ground Equipment Personnel 3
Safety Supervisor's Guide 3
Safetying Procedures 4
Sampling Plans 3
Saturable Reactors 20
Schedule X—Manpower and Workload Data 4
Schematic Diagrams 3

Agencies Using Programs, by Numerical Code

1 AID
Mr. Guido
Room 200
Washington Training Center
Thomas Circle
Washington, D.C. 20523 RE 7–6823

2–1 Agricultural Research Service
John Gore
Personnel Division
Room 711
Federal Center Building
Hyattsville, Md. 20782 GR 4–8223

2–2 Agricultural Stabilization and Conservation Service
Wayne Wang
Room 4746 South Building
Agricultural Stabilization and Conservation Service
USDA
Washington, D.C. 20250 388–6745

2–3 Agriculture Consumer and Marketing Service
Regina Flahie
Employee Development Branch
Consumer and Marketing Service
Room 243
Liberty Loan Building
Washington, D.C. 388–6235

2–4 Forest Service
Norm Gibbard
Room 907
1621 North Kent Street
Arlington, Va. 22209 557–4852

3 USAF
Mr. William R. Perry
Hq. USAF (AFPTRD)
Training Devices and Instructional Technology Division
Pentagon
Washington, D.C. 20330 OX 5–6956

4 Army
Thomas Gillespie
Fort Monroe
Hampton, Va. 23351 727–3237

4–1 Office of Civil Defense
Mr. Fred N. Brantlinger
Office of Civil Defense
P.O. Training and Education Program Division
Room 1E525
Pentagon
Washington, D.C. 20310 OX 5–6139

4–2 Office of Civil Defense Staff College
Max W. Doman
Office of Civil Defense Staff College
Federal Center
Battle Creek, Mich. 49016 962–6511

5 CIA
Miss Nancy Deaton
Office of Training
CIA
Washington, D.C. 20505 351–2193

6 CAB
Wayne Poland
1801 Connecticut Avenue
Washington, D.C. 20428 393–7625

7 Civil Service Commission—Herman Dorfman
1900 E Street NW.
Washington, D.C. 20415 632–6090

8 Commerce—Office of Secretary
Mr. Dave Larken
Department of Commerce
Office of Administrative Services, Room 6427
Washington, D.C. 20425 967–5720

8–1 Maritime Commission
David Sullivan
Code 170
Office of Administrator
Department of International Business
Room 1510
STOP 206 967–5955

8–2 Patent Office
Washington, D.C. 20230 557–3158

8–3 ESSA—Commerce
Mr. Paul Murphy
Chief of Career Development
Environment Science Services Administration
Career Development Branch—Room 215
Washington Science Center
Rockville, Md. 20852 656–8261

8–4 Commerce—Domestic and International Business
Room 1513—Personnel Division (OA/DIB)
Department of Commerce
Washington, D.C. 20230 967–2222

9 Federal Communications Commission
1919 M Street NW.
STOP 554 632–7120

10 Federal Reserve Board
Miss Sudella Rice
Room 1262
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20th and Constitution Avenue NW.
Washington, D.C. 20551 RE 7–1100 X404

11 Federal Trade Commission
6th and Pennsylvania Avenue NW.
Washington, D.C. 20580 EX 3–2293

12–1 HEW—Office of Education
Mrs. Shirley Slusser
330 Independence Avenue SW.
Washington, D.C. 20201 963–5280

12–2 Social Security Administration
Virgil Bowser
Office of Administration
6400 Security Boulevard
Baltimore, Md. 21235 944–5000 X2967

12–3 Public Health Service
Communicable Disease Center
Dr. John Olsen
Instructive Communications Unit
Atlanta, Ga. 633–3311

13 HUD
Mrs. Peggy Swift
Department of Housing and Urban Development
Room 2510, 451 7th Street NW.
Washington, D.C. 20410 755–5406

14 Interstate Commerce Commission
Mr. Samuel Bingman, Jr.
Constitution Avenue and 12th Street NW.
Washington, D.C. 20423 737–7116

15–1 Department of Justice
Bureau of Prisons
Mr. Joseph Burrell
Chief of Career Development Section
Room 400, Personnel Office
Washington, D.C. 20530 RE 7–2274

15–2 FBI
Mr. Richard E. Kohler
Training Division
Room 807, OPO
Washington, D.C. 20535 EX 3–2511

16 Department of Labor
Miss Mary Jo Bernau
Office of Personnel, Division of Departmental Programs
Human Resources Development Group
Room 6134
Washington, D.C. 393–5311

17 Library of Congress
Mr. Harvey Joiner
Training Officer
Room 310, Main Bldg.
STOP 303 783-0400

18 National Science Foundation
Mrs. Deering
Personnel Office/Secretary
Room 211, 1800 G Street NW.
Washington, D.C. 20550 632-4106

19 National Security Agency
Commandant, Training School
Mary Dunwiddie
National Cryptologic School
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Fort George G. Meade, Md. 20755 688-7451

20 Navy
Mr. Lawrence Mann
Bureau of Naval Personnel
Arlington Navy Annex, Room 3072
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21 Peace Corps
806 Connecticut Avenue NW.
Washington, D.C. 20525 393-2865

22 Post Office
Mr. Lopez
Craft Training Department
6900 Wisconsin Avenue
STOP 410 656-9125

23 Small Business Administration
Mr. Robert Stockment
Room 603
1441 L Street NW.
Washington, D.C. 20416 382-3544

24 Smithsonian
Mrs. Dorothy Lewis
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Room 1235, A&I Building
Washington, D.C. 20560 381-5226

25 State Department
Barbara Morlet
2201 C Street NW.
Washington, D.C. 20520 557-5518

26 Transportation
Mr. Howard R. Richardson/TAD-14
Chief, Training and Career Development Division
FAA Building
800 Independence Avenue
Washington, D.C. 20590 962-8662

27 Treasury
Internal Revenue Service
Jim Everett
12th and Constitution Avenue NW.
Washington, D.C. 20224 WO 4-2425

28 USIA
Mrs. Dorothy Blackburn
Room 952 USIA
Washington, D.C. 20541 RE 7-8340

29 Veterans Administration
Mr. James O. Brien (056C)
Training and Development Service
Veterans Administration
Vermont Avenue and H Street NW.
Washington, D.C. 20420 DU 9-2388

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