INSTRUCTIONAL SYSTEMS DEVELOPMENT
STATE OF THE ART
AND
DIRECTIONS FOR THE FUTURE

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INTRODUCTION

The study which resulted in this paper originally started out as an effort to determine the state of the art of the Systems Approach to Training (SAT). However, during the course of the study, the Navy dropped the term "SAT" in favor of Instructional Systems Development (ISD). The Air Force also made this change. Previous to the use of "SAT," the Navy used the term "Training *Situation Analysis*" (TSA). *The Army has* retained the use of the term "Systems Engineering of Training" (SET).

SAT, SET, TSA and ISD are names of various methodologies which were developed for use by laymen (i.e., other than experienced training program developers) in producing maximally effective and efficient training programs. In the past when the military incurred problems which required maximally effective training programs or the use of the state of the art in training technology, expert training program developers were brought in from groups like the American Institute for Research, HumRRO, and Dunlap & Associates. Methodologies such as those listed above represent attempts to model the ways in which successful training program developers work. It was hoped that formalizing the behaviors of the experts would allow laymen to achieve the success of the experts by copying their behaviors.

The first step in determining the state of the art in ISD was the compilation of a *comprehensive bibliography and a review of* the literature. This process uncovered a large number of methodologies, in addition to those cited above, which constituted systematic techniques for training program development. To investigate any one in particular would not have produced generalizable, useful or interesting results. Thus, the study undertook to investigate the degree to which such methdologies, in general, could be used by laymen to replace experienced personnel in the development of maximally effective and efficient training programs.

The layman cannot be expected to make optimal decisions in training program development because he lacks the training and the experience to know what techniques are available and which would work best in each case. Thus, the degree to which these methodologies are successful is the degree to which they can be used algorithmically to select the best technique in each case, and to prescribe the steps to be used in implementing that decision. In the field of educational psychology such a methodology is referred to as a theory of instruction.

The existence of a method which would allow a layman to develop training programs with the same success as experienced personnel would indeed be a boon to the military. If a training program costs little and trains few, its efficiency is of little consequence. However, in the case of high-cost, high-volume programs, such as those found in pilot training, a small increase in efficiency can mean an enormous savings in dollars. The hiring of experts for the development of a pilot training program may cost in the neighborhood of a half million dollars. The use of an ISD manual by existing military personnel with little or no experience in training program design may cost a fraction of that. However, if the manual does not permit the layman to be as effective as the expert, the extra cost incurred in hiring the expert may be recovered many times over.

At first glance, it might seem the best way to evaluate ISD-type methodologies would be through experimentation. However, this does not turn out to be the case. Evaluating ISD presents the same problems as evaluating methodologies such as programmed instruction and computer-assisted instruction. Such methodologies are not amenable to evaluation by a single experiment or even by a group of experiments. The main reasons for this are: (1) they defy attempts at generally accepted definitions; (2) the cost of such an experiment would run into the millions; (3) the time it would take to complete would be prohibitive; and (4) they would have to be evaluated against "conventional" methodology, and that incurs further definitional problems.

Since innovative technologies such as ISD, PI, CAI, adaptive training and peer instruction are not amenable to definitive evaluation, they must undergo a continued process of mini-evaluations in the minds of those who are in a position to use them. They undergo a process of assimilation into that body of knowledge and of techniques generally referred to as "training technology." The degree to which they are assimilated, and their durability depend on their perceived usefulness relative to alternative techniques. As more experience is gained with such techniques, they become modified, refined and further articulated in directions in which they prove most useful.

Therefore, it was decided that this study could be most useful and most productive by reviewing the literature in an effort to determine how ISD-type methodologies, as defined above, are being assimilated by the training community, and also to determine, based on the problems being encountered with ISD, what future directions for modification of the technology are indicated. Since ISD methods are, as noted above, theories of instruction, the literature on theories of instruction generated by the academic community was also reviewed.

REVIEWS OF THE LITERATURE

To accomplish the goals of this study, a comprehensive bibliography was compiled and the literature was reviewed in four areas: (1) theories of instruction; (2) problems of ISD; (3) ISD manuals; and (4) reviews of the state of the art of ISD. The literature on each of the steps of ISD is being reviewed, but will not be complete for some time. Note that throughout this paper the term "ISD" is used generically to refer to SAT, TSA, SET, and all similar methodologies.

1. Theories of Instruction

A theory of learning seeks to explain how learning occurs. A theory of instruction seeks to explain how experience should be structured in order to promote learning. Willis and Peterson (1961) described the process necessary to translate research findings into a theory of instruction. This would be the same process involved in deriving an ISD-type manual. They stated, "The problem is to expand, elaborate, or otherwise refine such notions until they can be stated with sufficient clarity to be of potential value as tentative 'rules' or 'guiding principles.'...The process of

achieving the desired clarity of statement probably involves a substantial amount of subjective, creative activity for which detailed objective descriptions will likely remain unavailable for some time."

No information could be found concerning the process used in developing the ISD-type manuals or concerning the theories and/or research used in the basis for their conclusions. Thus, a search was made for the most accepted theoretical positions available on instructional design.

To attempt to collect and review all of the available studies concerning the development of instructional theory would have been outside of the scope of this project. Fortunately the literature in this area is reviewed almost every year in the Annual Review of Psychology. These reviews were relied upon.

McKeachie's 1974 article stated, "The past two years have been bad ones for those of use who have attempted to apply traditional principles of learning to instruction. Thorndike's principles of learning seem to be crumbling." He found, for instance, that the use of knowledge of results, immediate feedback, rewards, and small steps do not always result in more effective learning. McKeachie goes on to state, "In fact each one of the principles confidently enunciated by Skinner in The Science of Learning and the Art of Teaching now turns out to be untrue--at least in as general a sense as he believed at the time."

Glaser and Resnick, in the 1972 Annual Review of Psychology, stated that they considered the possibilities of a theory of instruction but concluded that the necessary prescriptive procedures for optimizing learning are not yet available for complex cognitive tasks.

In his 1971 Annual Review of Psychology article, Campbell stated that huge dividends could be reaped from a translation of Gagne's task analysis, Skinner's behavior modification principles, motivation theory, and systems theory to the field of training, but that efforts in such attempts have not been sufficient.

Based on these reviews of the state of the art in instructional theory development, there are no theoretical or empirical bases for a single set of algorithms which can be used to develop all programs of instruction.

This finding casts a cloud of suspicion over ISD-type manuals for it implies that the developers of those manuals either were aware of significant findings that were not available to these reviewers, who are acknowledged leaders in their field, or that the manuals were developed without an adequate empirical or theoretical basis.

The final proof, however, lies in the pudding. If the manuals can accomplish useful objectives, the absence of a theoretical or empirical basis is of little importance. This possibility is considered in the next two sections.

2. The Problems of ISD

Articles and papers concerned with problems incurred in the implementation of ISD are valuable in determining the directions in which ISD should be modified. However, such articles are rare for obvious reasons.

The Civil Service Commission (1969) published a candid account of their first ISD attempt. Their problems are best described in their own words.

"Immediate problems were encountered in determining the appropriate level of work to be described as a task. None of the published materials was significantly helpful."

"The next step of the process, that of developing a behaviorally stated terminal objective for each task, proved to be the most difficult, the most significant, and one of the most inadequately covered in available published material."

"The task force found that the sequence of events described in the training systems literature could not be literally followed."

The Civil Service team that undertook this project was undaunted by problems with the methodology. They took what they found useful, and developed the rest for themselves.

Another article of this type was prepared by the Air Force Tactical Air Command's A-7D ISD team. The article, which was undated, was probably written in 1971.

The first problem they encountered was with the task analysis. Their first attempt proved to be superficial because insufficient time was spent with the A-7D community. Later, problems were encountered in finding a useful format for the task analytic information. Secondly, they found it impossible to state specific behavioral objectives for tasks in operational missions, so they limited their analysis to the tasks found in the existing training program. Thirdly, they noted difficulty with media selection. In their evaluation of the ISD methodology, the team found the major problem to be the fact that it caused them to develop a highly rigid curriculum.

The A-7D ISD team, like the Civil Service ISD team, consisted of inexperienced training program developers, and they encountered many of the same problems. However, the A-7D decision to ignore the aircraft's operational mission would preclude it from qualifying as an ISD according to most, if not all, definitions of ISD. Their development of a rigid curriculum could only be attributed to a failure to understand the current methods and techniques of training technology.

The A-7D team was aware of the need for adequate training for their ISD personnel. They stated, "Without the initial inculcation and continuation of education of our training personnel, we find our systematic approach invaded by expensive gimmickry and overwhelmed by teaching trivia."

The most significant article concerning the problems of ISD is that of Ricketson, Schulz and Wright (1970), for it represents the only empirical evaluation of an ISD-type methodology. Their study was done at the request of USCONARC, who realized, after a year of attempting to have laymen use CONARCREG 350-100-1 to develop training programs, that significant difficulties were being encountered. As a result, they requested an outside agency to systematically evaluate the manual and their method of implementing it.

The resulting study comprised an analysis of the manual and the use of interviews and questionnaires to gather information from the personnel who had been attempting to use the manual. Their major conclusions can be summarized as follows. Even after an orientation training program, the personnel required a two-month breaking-in period on the job. After this, they required the close supervision of an experienced training program developer. They tended to develop training programs that employed the same techniques with which they had been taught, and they reported difficulty in using the manual to do so.

Other valuable articles on the problems and pitfalls of ISD include: Hartley (1968, 1969), Dragoo (1971), Carter (1969) and the June 1969 issue of Educational Technology. Two articles which describe problems that can

occur in the general field of systems analysis are those of Quade (1966, 1968). They are easily translatable to the field of training.

3. The ISD Manuals

The description of the ISD manuals is broken down into four sections: (a) similarities and differences, (b) the general applicability of the manuals, (c) the completeness of the ISD manuals, and (d) the skills of the ISD team leader.

a. Similarities and differences.

The manuals are similar in that they generally:

(1) contain in the neighborhood of seven (plus or minus two) major steps. Miller (1956) provides a possible explanation of this.

(2) are behaviorally oriented.

(3) constitute closed-loop feedback systems.

(4) seem to have been developed in isolation. They have relatively small reference sections and do not refer to each other or to the literature on instructional theories.

The manuals are similar in that they generally do not:

(1) place limitations on their applicability.

(2) offer more than one way of accomplishing each step.

(3) indicate the skills necessary for their successful applications.

(4) indicate the conditions necessary for their successful application.

(5) indicate the degree to which they have been validated.

The manuals differ in that they generally:

(1) include different steps.

(2) include different methods of accomplishing each step.

(3) provide different levels of specificity in the detail included under each step.

(4) provide different formats for reporting the work accomplished under each step.

b. The general applicability of ISD manuals.

By their failure to state the limits of their applicability, the ISD manuals indicate general applicability. However, the possibility of a single solution to all training development problems is unrealistic. The Civil Service Commission and the A-7D ISD reports demonstrated this.

Launor Carter, in his 1969 article "The Systems Approach to Education: Mystique and Reality" describes two applications of the ISD methodology in detail, and contrasts them to illustrate the differences that can occur.

Even within the field of pilot training, wide variations in methodology are called for. Consider the methods used in the development of: American Airlines pilot training program, the Air Force undergraduate pilot training program for 1975 to 1990, the Air Force's B-1 program by Calspan, the Navy's S-3A program by Courseware, the Coast Guard's H3 and H52 programs by HumRRO. The methods used to design any of these programs would not have been optimal for any of the others.

Large variations in ISD methodology are required by various content areas. Techniques useful in designing pilot training programs are of little use in the areas of leadership, reading, tennis, or sorting mail.

The possibility of a single methodology for designing all training programs was discussed at the recent NAVTRAEQUIPCEN Maintenance Training Conference. One of the participants, Thomas Roeder, stated, "If I make any impact in this conference, I hope it will be that there is no panacea in the training business. Let's look at each system individually and see what it needs."

The literature on task analysis contains numerous articles stating the impossibility of using the same method for all tasks. In 1960, Gustafson, Honsberger, and Michelson wrote that a universally applicable task analysis format could never be designed. Folley (1964) reviewed the literature on task analysis and stated that the variety of tasks, and the complexity of human behavior, would not permit the reduction of task analysis to a simple routine method. Eleven years later, Rankin (1975) found that many people still retained a "slavish commitment to the notion of a universal method (of task analysis)." His conclusion was similar to Folley's.

If a universal method cannot be developed for each of the steps of an ISD, one cannot be developed for the entire process.

c. The completeness of the ISD manuals.

The ISD methodologies vary in the steps they contain, and in the method of carrying out each step. They all fail to include some of the significant aspects of training program development. An example of an area in which most are lacking is the design of a management plan.

Fortunately this gap has been noted and work is being done to fill it. The Navy's Training Analysis and Evaluation Group (TAEG) is presently validating its Design of Training Systems (DOTS) model, which can be used to assist training program designers and managers in making decisions concerning training resource utilization, e.g., manpower, equipment, classrooms, student flow, etc.

The Rand Corporation is working on another model, MODIA, Method of Designing Instructional Alternatives, which will augment the Air Force's ISD model. It encompasses both administrative and training aspects of program design. Both DOTS and MODIA are computerized.

In the areas of cost determination and the use of cost information to aid in making training design decisions, RAND has developed the PPBS (Planning-Programming-Budgeting System) model (Carpenter, 1969; Dyer, 1969).

The ISD models have been found to be incomplete not only in their failure to include all necessary steps, but also in the degree of detail necessary to complete each step. Ricketson, Schulz and Wright (1970), in their evaluation of the Army's ISD manual, determined that the manual actually did not provide "how to do it" information. They concluded that although it told the user what to do, it did not tell him how to do it, especially in the areas of task analysis, specific behavioral objectives, testing, and quality control.

d. The skills of the ISD team leader.

The failure of the ISD manuals to explicitly state the skills required by the user of the manual for successful application represents a difference between word and deed. On the one hand the manuals instruct the user to employ task analysis, specific behavioral objectives, criterion referenced tests and a quality control system. On the other hand, the manuals themselves fail to do so.

As was described earlier, the Army and the Air Force have realized that the ISD team members must be provided training in the use of the manual. Further work is needed to determine what specific behavioral objectives a person must meet in order to qualify as a training program developer.

Some of the areas in which skills are necessary have been gleaned from the literature and are summarized here:

(1) Political skills (Hartley, 1968) - The ISD team holds an advisory position. The training program manager is the final authority who will accept or reject their advice. Unless the team leader is respected by the decision maker, and unless he can present his case effectively, the ISD can degenerate into a nominal effort.

(2) Innovation (Quade, 1968) - Innovation can provoke anxieties in those who have vested interests in the old way. Unless those anxieties can be dealt with effectively, the innovative program may never be implemented or may be shortlived. The fact that innovation is not a straightforward process is receiving attention in the literature (Chin, 1967; Lyons, 1966; Havelock, 1970; Klitgaard, 1973).

(3) Creativity (Koberg and Bagnall, 1972) - The application of training technology and educational psychology to the design of instruction is an engineering task. Science and technology do not dictate solutions to practical problems. While most ISD manuals ignore the problem of creativity, the systems analysis guide prepared by Koberg and Bagnall (1972) places the accent on creativity.

(4) Knowledge of educational psychology and training technology - Ricketson, Schulz and Wright (1970) found that users of the Army ISD manual tended to develop training programs which employed the methods and techniques with which they had been taught. The ability to design creative solutions to training problems requires not only a knowledge of the existence of various methods, but also a working familiarity with their strengths, weaknesses, and special requirements. The problems of translating research and technology into operational use are well documented: Willis and Erskine, 1965; Travers, 1962; Mackie and Christensen, 1967; Ricketson, Schulz and Wright, 1970.

(5) Manager - The ISD team leader must manage his team so as to accomplish the ISD as well as possible within the constraints imposed. He must provide his team with day-to-day guidance. The ISD manuals provide the strategy, but he must provide the tactics. In an ISD, the output of each step is judged by the degree of its usefulness in expediting the remaining steps. Ricketson, Schulz and Wright (1970) found that the team members did not know how each of the steps related to each other. They quoted an interviewee as saying, "The CONARC Reg does not prescribe how systems engineering is done. We've gone through the motions but we really don't know what we're doing." For example, the teams filled out the Job Task Data Cards as required by the manual, but little use was made of them after they were completed because it wasn't clear what they were to be used for.

(6) Knowledge of potential problems (Hartley, 1969) - The probability of success of an ISD is dependent upon the ability of the team leader to anticipate and cope with potential problems. Although many of these problems are well documented, they are not dealt with in the ISD manuals.

Hartley (1969) lists 18 potential problems of ISD relevant to the military: confusion over terminology, problems in adapting models, a wisdom lag, illusions of adequacy by model builders, inadequate impetus, centralizing bias, unanticipated increased costs, goal distortion, measuring the unmeasurable, cult of testing, cult of efficiency, political barriers, lack of orderliness for data processing, monumental computer errors, shortage of trained personnel, invasion of individual privacy, resistance to planned change, antiquated legislation, doomed to success, and imagery problems.

Hartley's discussion of these items is short but effective. A fuller discussion of the problems of systems analysis in general can be found in Quade (1968).

4. Reviews of the State of the Art of ISD

In reviewing the literature on ISD-type methodologies, two reviews of the state of the art were found: Campbell (1972) and Hartley (1968). While both presented their conclusions, neither included a review of the actual literature which led them to those conclusions. Although both were critical, Campbell was the most severe.

In his 1972 Annual Review of Psychology article, Campbell concluded that the systems approach to training qualifies as a "buzz-word." He found that although the term is widely used, the articles concerning it typically do not describe the features which distinguish it from other approaches. As was pointed out above, our study found that the ISD manuals failed to compare and contrast themselves to other methods or to point out their advantages and limitations relative to other approaches.

Hartley (1968) found the literature on the systems approach to training to be "long on persuasion and short on critical appraisal." He believed the problem to be overzealousness in attempts to use a new methodology without a clear understanding of what was supposed to result.

Our review also found a lack of agreement as to the goals of ISD. Hartley's (1968) goal was to put the budget in better focus. The TAC A-7D study emphasized the elimination of "nice-to-know" material from the course. LaPolt (1972) stressed the reduction of training cost. Beuker (1972) used the methodology to increase the relevance of training. Sugarman, Buckenmeier, and Johnson (1974) held that the primary goal of ISD is to account for the major factors that can affect cost and allocation of resources. Carter (1969) believed that the method forces a careful consideration of the varied factors that can affect the outcome of a particular project.

The conclusions reached by Hartley in 1968, and by Campbell in 1972 were generally in agreement with Ricketson, Schulz and Wright's findings in 1970, as well as with the findings of the present study.

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the state of the art of instructional systems development (ISD). The term "ISD" has been used generically in this study to refer to all systematic methodologies for the development of training programs. Specifically, the purpose of this study was to ascertain the degree to which these methodologies could be used by the layman to attain the same degree of effectiveness and efficiency as the expert (i.e., experienced and successful training program developers). A second purpose of the study was to determine the directions in which further research and development in ISD will prove most useful.

The conclusion of this study is that available ISD-type methodologies will not allow the layman to be as successful as the expert. In order for this goal to be reached, such a methodology would have to constitute an empirically validated theory of instruction. Our findings were that the state of the art of educational psychology will not support a theory of instruction at this time; and that the ISD methodologies have not been validated.

The available ISD manuals constitute | first-cut attempts at modeling the expert training program developer, but they have failed to model his flexibility in designing training programs, and have failed to model the complete range of his activities which are necessary for successful development of entire training programs.

This conclusion was supported by other reviews of the state of the art of ISD, an empirical and analytical evaluation of an ISD-type manual, and by studies which reported difficulties in attempting to apply such methodologies.

A brief review of the evolution of ISD will lend perspective to the conclusions and recommendations of this study.

In the 1940's, systems analysis, a methodology for generating solutions to problems not amenable to algorithmic solutions, was developed. Its main tools are the use of an interdisciplinary team of experts and the use of modeling.

In the 1950's, systems analytic techniques were applied to the field of training. The application was appropriate since training program design problems were not algorithmically solvable. Models of the methods used by expert training program developers were constructed.

In the 1960's, the possibility of having laymen use these models to achieve the success of the experts, by imitating their actions, was explored. The success of these attempts was dependent on the successful development of algorithms which could be used to solve training program design problems and thus eliminate the need for the expert.

In the late 1960's and early 1970's, the problems with such attempts found their way into the literature. In spite of this, the manuals used in such attempts continued to be refined, and their numbers grew.

Another conclusion of this study is that the problems with such attempts will not be solved through refinement of the models. They stem from the fact that the state of the art in theories of instruction will not permit the problems of training program design to be solved through the use of algorithms. Although such manuals, with modification, may be useful in the education of training program developers, they will not allow the layman to replace the expert. Until significant progress is made in theories of instruction, further refinement of ISD-type manuals for use by laymen cannot prove useful.

It is the recommendation of this study that all further research and development be directed not at replacing the expert training program developer, but at assisting him. For example, instead of attempting to refine universal models for each step of training program design, efforts should be made to collect available methods for each step and determine the circumstances in which each is superior to its alternatives. Work is needed in determining where such decisions can be made, and in determining where insufficient data is available to allow valid decisions.

The evolution of methods of training program design made a giant step forward in the 1950's when attempts were made to incorporate the techniques of systems analysis. However, with the attempts to use algorithmic models to replace the expert, the techniques of systems analysis were rendered inapplicable.

The essence of the recommendations made by this study is a return to the realization that training program design problems are not presently amenable to algorithmic solution. A fresh look should be taken at the field of systems analysis. Since the 1940's, significant advancements have been made in systems analysis techniques which may prove helpful in training program design.

The statement with which Jerome Bruner ended his 1966 treatise, Toward A Theory of Instruction is still valid, "I can only hope that in pursuing a theory of instruction, we shall have the courage to recognize what we do not understand and to permit ourselves a new and innocent look."

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