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AN EVALUATION OF TEN TECHNIQUES FOR CHOOSING INSTRUCTIONAL MEDIA

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Orlando, Florida

December 1973

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This report provides an evaluation of 10 fundamentally different techniques applicable for choosing instruccional media for proposed Navy training programs.

The method of evaluation used involved six training system designers each of whom applied the chosen techniques to a sample of seven representative Navy training tasks. The results of this application were then examined by a panel of experts who judged the appropriateness of the media chosen to the task's training requirements. This served as the basis for ranking the techniques in terms of their usefulness in the design of Navy training programs.

The ratings for each of the top three ranked techniques were essentially similar in value. Based on these ratings, no clear cut superiority could be ascribed to any of these three techniques. Further, none of the techniques was found adequate for direct application to the Navy. However, one of the three, the TAEG technique, was selected as the logical choice for further development. Guidelines for its modification are presented.

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Technical Report: TAEG Report No. 8

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AN EVALUATION OF TEN TECHNIQUES FOR CHOOSING INSTRUCTIONAL MEDIA

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December 1973

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TAEG REPORT NO. 8

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SECTION I

INTRODUCTION

Choosing a cost-effective mix of instructional media for a military training program has proved to be a difficult task. Existing formal procedures for media selection have been essentially ineffective. For one thing, the procedures are inexact; the selection criteria are too general for identifying specific media for specific training. The level of detail is also at issue. Some procedures are too simple to handle the selection problem; most are too complicated and cannot be adapted easily to a range of military needs. Various factors contribute substantially to the complexities of the media selection effort. The more prominent among these are outlined below.

a. An intrinsic difficulty in optimizing the media mix exists due to the nature of military jobs. Most people agree that the selection of training supports is most effective when unique media attributes can be associated with specific training objectives or subject matter activities. However, military operations demand a variety of skills and knowledges in job performance. Numerous activities are conducted simultaneously or interactively such that it is difficult to identify those task characteristics relevant to media selection. The frequent requirement for manual control activities throughout job performance further compounds the difficulty in analyzing job task requirements. Thus, job performance may involve relatively straightforward procedural and discrete acts (positioning controls, communicating), perceptual-discriminative acts (identifying, monitoring, anticipatory responses), and perceptual-motor acts (graded response in continuous interaction with stimulus changes). Emphasis is placed on the integration

of responses, coordination and timing, time sharing, decision-making and judgment. These activities are not easily partitioned and grouped for training. The inability to conveniently identify discrete beginnings and endings for behavioral processes hampers the selection of media appropriate to given job requirements.

b. It is difficult to correlate the employment of a specific instructional medium with success in task learning. While a medium provides known capabilities that can be exploited in training, it is the quality of the courseware and the utilization procedures that are major determiners of the success of the training effort.

c. The proliferation of instructional hardware during the past decade has resulted in a wide range of new equipments, yet unbiased information is lacking for evaluating the claims made for these innovations.

d. Cost is a factor in choosing media. Not only do competitive training media vary in initial and operating costs, but each has unique costs and requirements for facilities, personnel, and supplies. The time required to achieve the objectives of training also varies among media. Therefore, the cost of achieving instructional goals varies significantly from medium to medium. The training system designer must not only specify a training system capable of accomplishing the instructional goals but must also consider these decisions in terms of cost and lead time factors.

e. While various media selection techniques have been described and demonstrated, there is little evidence any of these have been experimentally evaluated or compared. No formal attempts have been made to establish the relative reliability and validity of these techniques for selecting instructional media for proposed training systems. The training

system designer is not provided the necessary basis for determining which technique(s) is suitable for his needs.

PURPOSE

The present report provides an organization of information pertaining to the utility of media selection techniques for training system design. It provides an evaluation of prominent media selection techniques and a comparison of the relative value of these techniques for the Training Analysis and Evaluation Group's (TAEG's)[1] use with Navy training. The specific objectives of the study are:

a. Review and place in perspective a representative sample of the published formal media selection techniques. The techniques chosen reflect fundamentally different approaches. As a condition for selection, each technique was required to produce at least two media options for each learning event. The techniques ranged from simple to complex in terms of the number of variables accounted for, the precision of the definition of terms, and the operations performed (factors integrated). They differed also in the way the analyses were performed, varying from wholly manual procedures to combinations of manual and automated modes.

Our review of these techniques provides a description of each approach, an examination of its logic, and an assessment of the practicality of the procedures for use in training system design.

b. Evaluate the usefulness of the techniques sampled and determine a rank-order priority of usefulness. Ten techniques were examined

[1] The Training Analysis and Evaluation Group of the Naval Training Equipment Center, Orlando, Florida, is a multi-disciplinary group tasked by the Chief of Naval Education and Training. One of its functions is to prepare training system specifications for proposed Navy training systems.

in terms of their power to aid Navy training system designers in optimizing media choices. A description of each technique is provided in appendix A.

One of the techniques chosen for evaluation was the recently developed Training Effectiveness and Cost Effectiveness Prediction (TECEP) Model developed by the TAEG (TAEG Report No. 1, 1972). Another technique chosen required the training system designer to choose media using only his intuitive judgment and experience, without the aid of formal media selection logic. This "Non-System" technique, which relies on the expertise of the individual, has been conventionally employed by training system designers. This intuitive approach was added to the nine formal techniques to serve as a control to determine the extent to which a given formal technique would influence the selection of media for defined training segments. The evaluation of the chosen techniques was undertaken to measure the usefulness of these techniques in dealing with a broad range of Navy training tasks. The selection of a representative sample of tasks for use in the evaluation was based on two sources: (1) 19 Categories of Navy tasks defined by Willis and Peterson (1961) and (2) the ranking of these task categories by their frequency of occurrence in a sample of critical Navy jobs by Bernstein and Gonzales (1971). From these categories and priorities, seven task categories were assembled which represent, in our opinion, the most common activities performed across a range of Navy jobs. Training objectives were written for each of these seven task categories.

c. <u>Provide design recommendations for improving the most promising media selection approach in our sample of 10 techniques for TAEG operations</u>.

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The ratings for each of the top three ranked techniques were essentially similar in value. Based on these ratings, no clear cut superiority could be ascribed to any of these three techniques. One of the three, the TAEG technique, was selected as the logical choice for further development. Guidelines for its modification are presented.

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ORGANIZATION OF THE REPORT

In order to organize and discuss the analytic procedures and the results of the evaluation, three major sections are presented in addition to this introductory section.

Section II describes the specific behavioral objectives, the media selection techniques, and the experimental procedures used in making the comparisons. It also presents the qualifications of the training system designers who employed the various techniques and of the experts who rated the output of these techniques.

Section III presents the results of the analyses and provides the opinions of the training system designers about the acceptability and utility of each of the 10 systems and of the time required to learn and then use each technique. Also, analyses are provided which indicate the significant relations between specific media selection techniques and specific behavioral objectives.

Section IV presents a statement of the usefulness of the media selection techniques and identifies the common characteristics found in the more useful approaches. The most promising technique for the TAEG's use is identified together with a set of criteria for improving this technique.

In addition, two appendices are provided. Appendix A contains a detailed description of the media selection techniques selected for study; appendix B contains the instructions used in briefing the training system designers prior to their use of the 10 media selection techniques.

SECTION II

APPROACH

The method of evaluation involved the direct application of each of the chosen media selection techniques to a sample of representative Navy training tasks. The results of this application were then examined by a panel of experts who judged the appropriateness of the media chosen to the task's training requirements. This served as the basis for ranking the techniques in terms of their usefulness to the TAEG's purpose.

The procedures employed required six training system designers to learn and then use 10 different media selection techniques. Each designer independently applied each of the techniques to seven standard training tasks. This produced a total of 420 sets of media choices. Examining this pool of media choices, two experts in training system design independently rated each media choice for its ability to meet the training objectives. The ratings of all media choices for each of the 10 techniques were then combined and the relative utility of each technique for media selection was determined.

The materials developed in support of the study, the personnel involved in the study, and the procedures employed in the evaluation are described next.

MATERIALS

The following materials were prepared for use in the evaluation:

a. Training Objectives. Based on the Bernstein and Gonzales (1971) ranking of common Navy task categories, the top seven categories were selected and modified for use in this study. In the order of their significance, these categories are:

(1) Recalling facts and principles

(2) Recalling procedures

(3) Non-verbal identification (classification)

(4) Detection (non-verbal uses)

(5) Using principles, interpreting, inferring

(6) Decision-making

(7) Static reaction and continuous movement

For each of these task categories, a sample training objective was prepared. A list of these objectives is shown in table 1.

b. Media Selection Techniques. Ten media selection techniques were chosen for this evaluation. Five criteria were established for determining the media selection techniques to be evaluated:

(1) Techniques that had been used in major training system design projects were considered as prime candidates for the study.

(2) The output of a given technique had to provide two or more useful media alternatives for a given training objective(s), not just a single best choice.

(3) Representative techniques involving military and civilian application were sought.

(4) Fully developed procedures, rather than just descriptions of a process used in a particular application, were sought. However, where the description was adequate, a given technique was considered a candidate.

(5) The techniques eventually selected should represent significantly different approaches to media selection.

Based on these criteria, an exclusive sample of 10 media selection techniques was chosen.

TABLE 1. SAMPLE TRAINING OBJECTIVES REPRESENTING HIGH PRIORITY NAVY TASK CATEGORIES

TRAINING OBJECTIVES	ENTERING BEHAVIORS
1. Upon request, student will write Ohms Law and define each symbol correctly.	Student can write English with adequate skill but is not familiar with the formula for Ohms Law and cannot provide the technical definitions for the factors in the law. He is not familiar with the formal concepts "voltage," "amperage," or "resistance."
2. Without coaching, a student will properly activate and calibrate an Ohm meter, and measure the resistance in an unmarked resistor within the range of 2000 to 100,000 ohms with a precision of ± 5 percent.	Student can write and define Ohms Law and can solve the Ohms Law equation for resistance when the other variables are given. He cannot set up the equipment nor collect the necessary data from a live circuit.
3. When presented with 10 pulse analyzer photographs of different search radars, four of which are long range air search radars, the student will correctly identify all the long range air search radars within 10 seconds.	Student can identify and measure pulse width, pulse length, and other elements of a radar signature and can recall the concepts basic to any signature configuration. He cannot identify specific classes of signatures.
4. When presented with random one-second pulses of a 5000 Hertz tone emerging slowly from a white noise background the student will detect the tone before it reaches a signal-to-noise differential of 15 DB, 80 percent of the time.	Student can identify the obvious tone with a signal-to-noise differential of 30 DB. He is physiologically capable of hearing the tone at a differential of 15 DB but cannot as yet detect it in the background noise.

TABLE 1. SAMPLE TRAINING OBJECTIVES REPRESENTING HIGH PRIORITY NAVY TASK CATEGORIES (CONT'D)

TRAINING OBJECTIVES	ENTERING BEHAVIORS
5. When presented with a paper and pencil exercise concerning the bringing of a Captain's gig alongside a pier in a two-knot cross current, the student coxswain shall diagram his approach to the pier and identify the changes in power setting and rudder he would make to correctly compensate for the cross current and to account for the power and turning characteristics of the boat.	The student can already recall the various individual principles required, but he has not attempted to apply one or more of these principles to realistic problems.
6. Given an EW mission objective to locate and analyze the long range air search radars on a specified island using a specified platform and equipment set, plan an EW mission capable of obtaining the required information without being detected by the long range radars.	Student can operate the EW systems required in the proposed mission and can identify the expected target signals. He has the required background in EW system management, but he has not seen mission plan formats nor has he prepared or evaluated mission plans.
7. While manning the ship control station on an SSN in an in-trim condition submerged at 80 feet with 10 knots, a ship control team shall execute a change in depth of 100 feet in two minutes and stabilize at ordered depth for two minutes with excursions of no more than five feet.	The team consists of an experienced diving officer and Ballast Control Panel Operator with trainee bow and stern plane operators that have not reached the required proficiency level. Excursions are in excess of five feet.

The techniques chosen are listed in table 2 with brief statements concerning the purpose of their development and where applied. More detailed descriptive information on each technique is given in appendix A.

As indicated earlier, one of the techniques, the Non-System approach, was added to represent the conventional approach to media selection. In this case the training system designer relies on his skill, past experience, and personal preference in selecting the media for a program without resorting to any formal procedure. This approach was included as a control to determine to what extent the use of a formal technique makes a difference in the choice of media.

Another of the techniques, the TAEG approach, was included to determine the usefulness of this locally developed prototype system in comparison to other formal systems.

The nine formal techniques differed substantially in the number of and kind of variables considered important to the media selection process. A total of 14 variables were identified, applicable to one or more of the techniques. Table 3 lists the 14 variables and identifies (by an "X" in a cell) which variables were involved in a given media selection technique. In addition, the last column of table 3 shows the total number of media candidates available in each technique. The variation among the chosen techniques is considerable, ranging from five media alternatives in one technique to 31 alternatives in another. In one case the media candidates were not listed, the choice(s) being left to the judgment of the training specialist. While some of the media selection techniques used similar variables, each technique employed a different combination of variables.

TABLE 2. MEDIA SELECTION TECHNIQUES USED IN THE EVALUATION

No.	Author	Sponsoring Organization	Purpose of Development	Notes
0	"Non-System"			Traditional approach. The training system designer used his own experience and preferences without the aid of a formal media selection technique.
1	"AF Manual 50-2" (31 Dec 1970)	Department of Air Force; Air Training Command	Part of a guide for applying the Air Force systems approach to the development of education and training programs; to be used by all personnel who plan, develop, approve, administer, or manage Air Force instruction and its supporting services.	Technique was developed by Dr. Wm H. Allen and was originally presented in a paper "Research in Instructional Media and Art Education" which was published in Final Report of the Uses of Newer Media in Art Education Project.
2	Brets (Feb 1971)	The Rand Corporation (for Headquarters, USAF)	Part of a large Rand investigation of systems for Air Force Education and Training; to be used in designing technical training programs to identify appropriate communication media.	Concerns telecommunication and recorded media.
3	Siegel & Federman (Jun 1970)	Applied Psychological Services, Inc. (for the Naval Training Device Center)	To recommend a new device and classroom aids to be used in a proposed training program for the Tactical Coordinators (TACCO) in ASW aircraft.	Based on J. P. Guilford's "Structure of Intellect" model.
4	TAEG (1972)	Training Analysis & Evaluation Group of the Naval Training Equipment Center	For use within TAEG in choosing cost-effective media for proposed training systems to be used in preparing training system specifications.	Partially based on Willis & Peterson, Deriving Training Device Implications from Learning Theory Principles, Vol. I.
5	Briggs(1970)	American Institutes for Research and Florida State University	For use in a handbook of resource materials and methods for teaching the systems approach to the design of instruction. Oriented to the teaching of academic subjects in classrooms.	Uses Gagné's 8 types of learning and related conditions of learning.
6	Armstrong, et al. (Aug 1971)	Bunker Ramo (for Air Force Human Resources Laboratory)	A component of the systems approach to training (SAT) to be used in designing training for the AF A-7D aircraft.	Media weights within system were designed for A-7D training, and cannot be considered appropriate for other tasks.
7	Rhode, et al. (May 1970)	Westinghouse Learning Corp. (for Air Force Human Resources Laboratory)	Initial study in the design of an advanced multi-media instructional system; to compare media in terms of function, flexibility and cost; for use with a broad range of Air Force training tasks.	Not intended to be a media selection technique, but provides a wealth of information to support the training system designer in choosing media.
8	Walker (1967)	Martin Company	A general method for use with a broad range of training tasks.	Based on the rating of training techniques by experienced training personnel. Basic approach being used by Army at HumRRO, Ft Knox, KY.
9	Boucher, et al. (Oct 1971)	Grumman Aerospace Corp (for Navy)	For use in selecting media for the Navy F-14 training system and other Navy training tasks.	Contains an extensive computer data bank of media, media characteristics, and costs, with automatic sorting to list all media with a given set of characteristics.

NOTE: Sources of these techniques are listed in bibliography and additional descriptive information is located in appendix A.

TABLE 3. VARIABLES CONSIDERED IN THE MEDIA SELECTION PROCESS

Media Selection Techniques	Learning Task Categories	Task Difficulty	Task Frequency	Stage of Learning	Learning Guidelines/ Strategy	Stimulus Characteristics	Student Response Modes	Student Feedback Characteristics	Individualization Capability	Economic Analysis	Sensitivity to Changing Requirements	Time to Achieve Criterion	Threshold for Media Requirement	Multiple Practical Factors	Number of Media Alternatives Available
AF Manual 50-2	X														10
Armstrong, et al.	X			X		X	X	X							5
Boucher, et al.						X	X								29
Bretz						X									31
Briggs	X				X	X									N/A
TAEG	X				X					X		X			20
Rhode, et al.						X	X	X	X	X	X				22
Siegel and Federman	X	X	X										X		16
Walker														X	16

X = Variable employed by the given technique

This indicates clearly that fundamentally different techniques were compared.

Separate folders were prepared for each of the media selection techniques. Each folder contained: (1) a copy of the original document describing the technique, and (2) step-by-step procedures developed by TAEG from the original documentation for carrying out the intent of the technique. Identification of the author(s) and the sponsoring organizations was removed from the folder to safeguard against influencing the evaluators.

c. Training System Designer Rating Scales. Three scales were prepared for the training systems designers to use in recording their overall evaluation of the utility of each of the competitive media selection techniques. The first scale concerns the detail in the media prescription and ranges from "broad media categories" on one end to "specific media categories with detailed specification data" on the other end. The intent here was to document the degree of detail to be found in the description of a proposed type of media. The second scale concerns the level of confidence the training system designer has in the validity of the media selected and, therefore, the media selection technique. It ranges from "no confidence" to "high confidence." The third scale concerns the training system designer's estimate of the suitability of the technique for use in TAEG projects. This is a general measure and includes ease of use, time to use, as well as the previously mentioned factors of validity and detail of media prescription. Scale values range from "under no circumstances should TAEG use this system" to "an ideal system for general use in TAEG." Figure 1 depicts these scales.

d. Expert Rating Scale. An additional rating scale was developed for use by the expert training system designers in rating the media choices

DETAIL OF MEDIA PRESCRIPTION:

0	25	50	75	100
Broad Media Categories	Specific Media Categories	Specific Media Categories with definitions	Specific Media Categories with general specification data.	Specific Media Categories with detailed specification data.

CONFIDENCE IN VALIDITY OF MEDIA SELECTION PROCESS:

0	25	50	75	100
No confidence - No significant factors considered.	Low Confidence - Significant factors not considered in a meaningful way.	Intermediate Confidence - Some but not many significant factors considered in a meaningful way.	Relatively High Confidence- A significant set of important factors considered in a meaningful way.	High Confidence - A comprehensive set of important factors considered in a meaningful way.

SUITABILITY FOR TAEG (based on estimated validity and ease of use):

0	25	50	75	100
Under no circumstances should TAEG-NTEC use this system.	Serious reservations concerning the general use of this system in TAEG-NTEC.	An adequate system for general use in TAEG-NTEC.	A superior system for general use in TAEG-NTEC.	An ideal system for general use in TAEG-NTEC.

Figure 1. Scales Used by Training System Designers in Rating the Utility of Media Selection Techniques for TAEG Use.

made employing the various media selection techniques. This scale ranged from "mostly poor media choices" to "comprehensive set of media alternatives." Figure 2 depicts the full scale.

PERSONNEL

Two groups of training specialists were involved in the evaluation. One group, designated as training system designers, employed each of the chosen media selection techniques in deriving an optimum media mix to achieve the training objectives for each of the seven designated tasks. The other group, designated as experts in training system design, evaluated and then formally rated the media choices selected by the training system designers.

TRAINING SYSTEM DESIGNERS. Six professional members of the TAEG were assigned as training system designers to employ the chosen media selection techniques. Three were psychologists, two were educators, and one was an operations research analyst. Except for one of the education specialists, all had previously worked as members of training system design teams. None had previously used any of the chosen media selection techniques.

EXPERT JUDGES. Two experts in training system design were selected to rate the complete set of media choices made by the training system designers. One was Dr. Alfred F. Smode, formerly the executive scientist for Dunlap and Associates, Inc., Darien, Connecticut, and presently the senior scientist of TAEG. Dr. Smode has more than 20 years experience in Human Factors consulting and in training research and application. The second expert was John D. Armstrong, who at the time was the senior education specialist with TAEG. Mr. Armstrong has 22 years experience as an advisor to Navy schools on the use of training equipment and has recently completed a Navy-wide

1	2	3	4	5
Mostly poor media choices; could result in imprecise training or could actually interfere with training purposes.	A mix of useful and poor media alternatives.	Useful media alternatives but list is limited in scope.	Useful list of media alternatives but list is incomplete.	Comprehensive set of media alternatives, as good as or superior to the expert solution.

Figure 2. Scale for Experts to Rate the Usefulness of Sets of Media Choices

survey on the products and services required to support Navy training.

PROCEDURES

USE OF MEDIA SELECTION TECHNIQUES. The training system designers were briefed on the general procedures to be followed. The scenario for this briefing is provided in appendix B. Following the briefing, the training system designers first employed the Non-System approach; then each of the other nine media selection techniques was utilized. The order in which these techniques were assigned to the training system designers was varied to insure that no two individuals would apply the techniques in a similar order.

Before applying a given technique, the training system designer studied the folder until he understood the process and recorded the time required to learn the technique. He then proceeded to use the technique to choose media for each of the training objectives, starting with objective number one. All the media types identified as useful by the media selection techniques were recorded. After using a media selection technique with all seven objectives, the training system designer recorded the time required to apply the given technique and then rated the technique according to the three scales shown in figure 1.

RATING OF MEDIA CHOICES BY EXPERTS. The experts independently reviewed the training objectives and used the scale shown in figure 2 to rate each of the media choices made by the training system designers. The ratings represented the experts' estimate of the usefulness of the media choices in enabling trainees to meet the specific training objectives. The rating values were assigned without knowledge of which training system designer had made the media choices or which media selection technique had been used.

SECTION III

RESULTS

Three types of data were obtained from the trials of the media selection techniques. First, the training system designers generated 420 sets of media choices which were rated by two experts in terms of their usefulness in achieving specific training objectives. Second, each training system designer rated each media selection technique in terms of his estimate of its usefulness in the design of Navy training programs. And third, each training system designer recorded the time used to learn each technique and the time required to apply each technique to seven training objectives.

Table 4 presents the experts' rating of the 420 sets of media choices. It also presents the rank order correlations (Rho) between the ratings of the two experts. The ratings made by the experts varied from a Rho of .97 on training objective 7 to a Rho of -.60 on training objective 5. A relatively high correlation was achieved between the scores assigned by the two experts on four of the objectives. On three of the objectives there was one low positive and two negative correlations. In these instances, the experts disagreed on what constituted a useful solution. While this variation can in part be attributable to ambiguity in the training objectives, it also highlights the feature of the artificiality of the rating task. The expert ratings were made with difficulty in that the training objectives were described out of context to any larger training effort and many of the media choices were described with insufficient detail to insure that the experts were considering and rating the same forms of media. Part of

TABLE 4. EXPERT RATINGS OF MEDIA SELECTION TECHNIQUES BY TRAINING OBJECTIVE (TO)

RATINGS

Media Selection Technique	TO #1		TO #2		TO #3		TO #4		TO #5		TO #6		TO #7	
	Rater A A.S.	Rater B J.A.	Rater A A.S.	Rater B J.A.	Rater A A.S.	Rater B J.A.	Rater A A.S.	Rater B J.A.	Rater A A.S.	Rater B J.A.	Rater A A.S.	Rater B J.A.	Rater A A.S.	Rater B J.A.
0 Non-System	3-4-4 5-5-5 M=4.3	2-2-2 3-3-4 M=2.7	4-4-4 4-4-5 M=4.2	1-2-4 4-5-5 M=3.5	2-3-4 5-5-5 M=4	2-3-3 3-4-4 M=3.2	4-4-4 5-5-5 M=4.5	1-2-4 4-4-4 M=3.2	4-4-4 4-4-5 M=4.2	1-1-1 2-3-5 M=2.2	4-4-4 5-5-5 M=4.5	1-1-1 3-3-4 M=2.2	4-4-4 5-5-5 M=4.5	1-2-2 3-4-4 M=2.7
1 AF Manual 50-2	2-3-4 4-4-5 M=3.7	3-3-4 4-4-4 M=3.7	3-4-4 4-4-4 M=3.8	2-2-2 2-2-3 M=2.2	3-4-4 4-5-5 M=4.2	3-3-4 4-4-5 M=3.8	2-2-2 3-4-4 M=2.8	1-2-2 3-4-4 M=2.7	4-4-4 4-4-4 M=4	1-1-1 2-2-3 M=1.7	1-2-2 4-4-4 M=2.8	1-3-3 3-3-3 M=2.7	4-4-4 4-4-4 M=4	1-1-2 3-4-4 M=2.5
2 Bretz	1-2-3 4-4-4 M=3	3-3-4 4-4-4 M=3.7	1-1-1 1-1-3 M=1.3	1-2-2 [illegible]-4-4 M=2.7	3-3-3 4-4-4 M=3.5	3-3-3 3-3-3 M=3	1-3-3 4-4-4 M=3.2	1-3-3 3-3-4 M=2.8	3-3-3 3-4-4 M=3.3	1-3-3 3-3-3 M=2.7	1-1-1 1-1-3 M=1.3	1-1-3 3-3-4 M=2.5	1-2-2 2-3-3 M=2	1-1-1 1-1-1 M=1
3 Siegel and Federman	1-1-1 2-3-3 M=1.8	1-1-1 2-2-2 M=1.5	1-1-1 1-1-2 M=1.2	1-1-1 1-2-2 M=1.3	1-3-3 3-3-3 M=2.6	1-1-1 2-2-2 M=1.5	1-2-2 2-2-2 M=1.8	1-1-1 1-2-2 M=1.3	1-3-5 5-5-5 M=4	1-1-1 1-1-3 M=1.3	2-4-5 5-5-5 M=4.3	2-2-3 4-5-5 M=3.5	1-3-3 3-4-4 M=3	1-1-1 1-1-2 M=1.1
4 TAEG	4-4-4 4-4-4 M=4	2-2-2 3-4-4 M=2.8	2-4-4 4-4-5 M=3.8	1-2-2 2-2-3 M=2	2-4-4 4-4-5 M=3.8	1-2-4 4-4-4 M=3.2	5-5-5 5-5-5 M=5	2-2-2 2-4-4 M=2.7	5-5-5 5-5-5 M=5	1-1-1 1-1-3 M=1.3	3-4-4 4-4-5 M=4	3-3-3 4-4-5 M=3.7	4-5-5 5-5-5 M=4.8	4-4-4 4-4-5 M=4.2
5 Briggs	3-3-4 4-4-4 M=3.7	2-2-3 3-3-4 M=2.8	2-3-4 5-5-5 M=4	2-2-3 3-4-5 M=3.2	3-3-4 4-4-4 M=3.7	3-3-4 4-4-4 M=3.7	4-4-4 5-5-5 M=4.5	2-2-4 4-4-5 M=3.5	3-4-4 4-4-5 M=4	2-2-3 3-4-5 M=3.2	3-3-4 4-4-5 M=3.8	1-2-2 3-3-3 M=2.3	1-4-5 5-5-5 M=4.2	1-1-1 3-5-5 M=2.7
6 Armstrong	2-2-3 3-4-4 M=3	1-2-3 3-4-4 M=2.8	1-4-5 5-5-5 M=4.2	1-1-1 2-2-2 M=1.5	4-4-5 5-5-5 M=4.7	1-2-2 3-3-3 M=2.3	4-5-5 5-5-5 M=4.8	1-2-2 4-4-4 M=2.8	5-5-5 5-5-5 M=5	1-1-1 1-1-3 M=1.3	4-4-5 5-5-5 M=4.7	1-2-2 2-2-2 M=1.8	4-5-5 5-5-5 M=4.8	3-4-4 5-5-5 M=4.3
7 Rhode	3-3-3 4-4-4 M=3.5	2-3-3 3-3-4 M=3	1-1-3 3-4-4 M=2.7	1-1-2 2-3-3 M=2	2-3-4 4-4-5 M=3.7	2-3-3 3-3-5 M=3.2	4-5-5 5-5-5 M=4.8	2-3-3 3-4-4 M=3.2	3-4-4 4-4-4 M=3.8	3-3-3 4-4-4 M=3.5	3-3-3 4-4-4 M=3.5	3-3-3 3-3-3 M=3	1-1-3 3-4-4 M=2.7	1-1-1 1-1-1 M=1
8 Walker	2-2-3 4-4-5 M=3.3	1-2-2 2-2-3 M=2	2-2-4 4-5-5 M=3.7	2-2-2 4-4- M=2.8	1-2-2 3-4-4 M=2.7	1-1-1 2-2-2 M=1.5	2-3-4 5-5-5 M=4	1-2-2 2-3-4 M=2.3	2-4-4 5-5-5 M=4.3	1-1-1 1-1-4 M=1.5	3-3-4 4-4-5 M=3.8	1-2-3 3-3-3 M=2.5	2-4-4 4-5-5 M=4	1-1-1 2-2-4 M=1.8
9 Boucher	2-4-4 4-4-4 M=3.7	2-2-2 3-4-4 M=2.8	1-3-4 4-4-4 M=3.3	1-1-1 1-1-2 M=1.1	1-1-3 3-4-4 M=2.7	1-1-2 3-3-4 M=2.3	2-2-2 4-4-4 M=3	1-1-1 2-2-4 M=1.8	2-4-4 4-5-5 M=4	1-1-1 1-2-3 M=1.5	2-2-2 2-2-3 M=2.2	1-1-2 3-3-4 M=2.3	4-4-4 4-4-5 M=4.2	1-2-2 3-3-4 M=2.5
Rho =	.13		.43		.62		.55		-.60		-.20		.97	

the variance is also attributable to the fact that the experts disagreed on the optimal solution.

Because of the marked differences between the two experts in the rating of the media choices for three of the training objectives, the ratings of the experts were combined for use in ranking the media selection techniques. Table 5 summarizes the ratings made by the experts. The sum and mean rating made by each and their combined ratings are shown. The combined scores provide a rank order of the various media selection techniques in terms of their usefulness to the Navy as broad purpose media selection techniques.

The highest ranked technique was the TAEG technique with a mean rating of 3.60. This was followed closely by the Non-System technique with a mean rating of 3.55; then Briggs with a mean rating of 3.51; Armstrong with a mean rating of 3.44; and AF Manual 50-2 with a mean rating of 3.18.

Table 6 shows the summary of an overall 2-factorial analysis of variance (ANOVA) performed on the data in table 4. The significant interaction between media selection technique and training objectives precludes any interpretation of the superiority of media selection techniques independently from the types of learning tasks represented by the training objectives.

The training system designers also reported the time required to read and become familiar with the various techniques. The average time required per technique is recorded in table 7. This time varied from 20.0 minutes for technique 1 to 84.3 minutes for technique 3 (with the obvious omission of technique 0). The mean time for all attempts to learn a technique was 52.5 minutes. The formal media selection techniques, which ranked highest

TABLE 5. RANKING OF MEDIA SELECTION TECHNIQUES

Media Selection Technique	Ratings						Ranks		
	Rater A		Rater B		Combined		Rater A	Rater B	Combined
	Sum	Mean	Sum	Mean	Sum	Mean			
0 Non-System	181	4.31	117	2.79	298	3.55	3	3	2
1 AF Manual 50-2	152	3.62	115	2.74	267	3.18	6	4	5
2 Bretz	106	2.52	110	2.62	216	2.57	10	6	9
3 Siegel and Federman	113	2.69	70	1.67	183	2.18	9	10	10
4 TAEG	183	4.36	119	2.83	302	3.60	2	2	1
5 Briggs	167	3.98	128	3.05	295	3.51	4	1	3
6 Armstrong	187	4.45	102	2.43	289	3.44	1	7	4
7 Rhode	148	3.52	113	2.69	261	3.11	7	5	6
8 Walker	154	3.67	84 (N= 41)	2.05	238	2.87	5	9	7
9 Boucher	138	3.29	87	2.07	225	2.68	8	8	8

TABLE 6. ANOVA SUMMARY OF EXPERTS' RATINGS OF MEDIA SELECTIONS

SOURCE	df	MS	F	P
Technique (A)	9	19.33	13.81	.01
Training Objective (B)	6	3.17	2.26	.05
AB Interaction	54	4.04	2.89	.01
Within Cells	770	1.40		
TOTAL	839			

TABLE 7. TIME TO LEARN AND USE MEDIA SELECTION TECHNIQUES

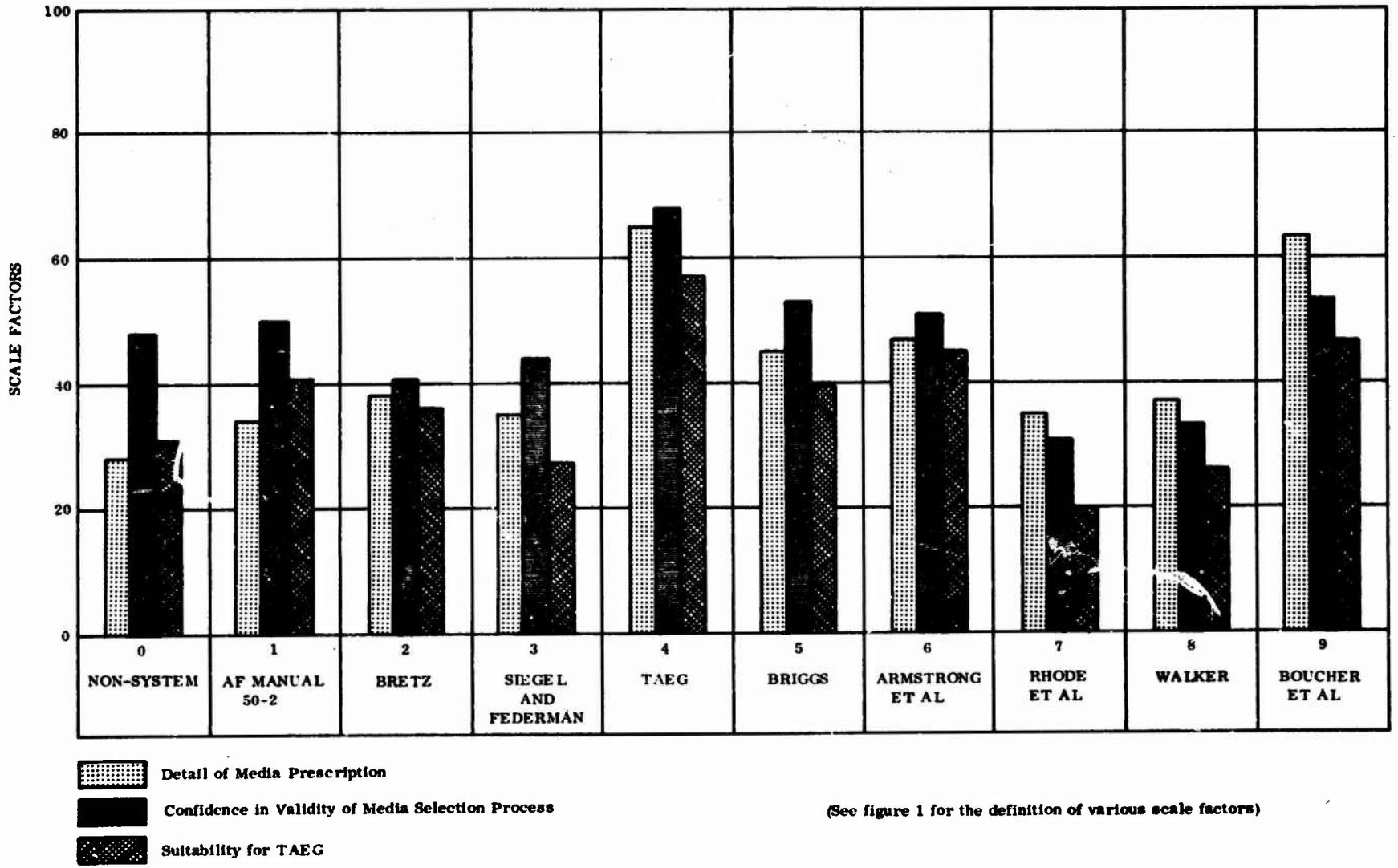
Media Selection Technique	Average Time to Learn System (in minutes)	Ranks	Average Time per Media Selection (in minutes)	Ranks
0	0	1	11.2	6
1	20.0	2	3.5	1
2	50.7	5	5.9	2
3	84.3	10	33.1	10
4	35.7	4	10.4	4
5	62.9	7	12.5	8
6	68.6	8	17.8	9
7	73.6	9	10.9	5
8	25.3	3	12.4	7
9	51.4	6	9.9	3

in the previous analysis, required 35.7 minutes (technique 4) and 62.9 minutes (technique 5).

The time required to make a media choice with the various media selection techniques also varied. The mean time to choose a set of media ranged from 3.5 minutes (technique 1) to 33.1 (technique 3). The mean time for all attempts to make a media choice was 12.8 minutes. The media selection techniques, which ranked highest in the previous analysis, required 10.4 minutes (technique 4), 11.2 minutes (technique 0), and 12.5 minutes (technique 5), per media choice. It should be noted that the six training system designers were not expert in the use of any of these techniques; the data reflects their initial use of these procedures.

The training system designers also rated each of the 10 techniques according to the three scales shown in figure 1 in an attempt to document their estimates of the utility of the various techniques. The means of the scores assigned by the six designers for each of the 10 techniques is presented in figure 3.

The training system designers ranked the TAEG technique highest on all three measures; however, the ratings never exceeded the mid-range on the scales.



(See figure 1 for the definition of various scale factors)

Figure 3. User Estimates of the Utility of Media Selection Techniques for Use in TAEG (Means of Ratings)

SECTION IV

CONCLUSIONS AND RECOMMENDATION

The combined ratings of the two experts for each of the three highest rated techniques are essentially similar in value, namely 3.60 (TAEG), 3.55 (Non-System), and 3.51 (Briggs). Based on these ratings, no case can be made for the superiority of any one of these three techniques to be used by TAEG in choosing media for proposed training systems. The experimental evaluation suggests that the TAEG technique is as good for the TAEG's use as any of the other techniques evaluated. Also, none of the techniques were found adequate for direct application by the TAEG. Since further development of any of the techniques would be required, the TAEG technique was selected as the logical choice for development consonant with the TAEG's needs.

It is worth noting that the Non-System technique was rated only slightly below the TAEG technique on all measures of usefulness. This traditional approach can only be expected to reflect and perpetuate the current state of the art. One would expect considerable variation in media choices since considerable intuition is demanded of designers in using the Non-System approach. There is also no potential for systematic improvement of this technique.

RECOMMENDATION - Expand and improve the existing TAEG technique for use in TAEG's media selection tasks. Guidelines for this development effort are presented in the following paragraphs. Some of these requirements have already been either partially or fully met by the TAEG technique or other existing techniques; other requirements will require significant development effort.

The required media selection technique should have the following characteristics:

a. A technique for professionals. The media selection technique should be designed as a tool to assist professional education technologists not to replace them. The choosing of instructional methods and media for proposed training systems remains a professional task that cannot be fully proceduralized. In this regard the technique should include the following:

- It should be a formal process with a set of terms operationally defined.
- The logic for media selection should be based upon theoretical concepts about the processes of teaching and learning.
- Human decisions required within the logic should involve variables of manageable size and complexity. Adequate information should be available to provide a basis for the decisions.
- The major task of the media selector should be decision making, with data retrieval and processing a minor aspect of the task, preferably automated.
- It can be expected that training in the use of the technique will be required for skillful use. In turn, the technique should be useful in a broad variety of current and emerging training situations.

b. Useful Variables. Variables to be incorporated into the media selection logic should be of two types. The first type includes those variables that describe a training program as a learning system, i.e., stimulus modes, response modes, feedback modes, learning strategies, and

learning styles. The second type includes those variables that are the major determiners of the cost of operating a training system, i.e., acquisition and operating costs and use rates.

Specifically the variables include:

- Task categories with associated learning guidelines.
- Stimulus characteristics of the tasks.
- Trainee response modes required by the guidelines.
- Trainee feedback requirements.
- Individual learning styles.
- Economic analysis based on:
  - life cycle costing
  - use rate projections
  - sensitivity to changing requirements
- Practical factors such as
  - suitability for local production
  - stage of training

c. Media Alternatives. Media should be selected from an extensive pool of alternatives. While none of the tested techniques had more than 31 media types, approximately 100 generic media types should be in this pool. This would cover traditional forms of instructional media, new forms being introduced into training programs, and theoretical configurations of media being discussed in the literature. It would include media for supporting classroom instruction and individualized instruction, telecommunication, and on-the-job training. Each medium should be carefully defined and examples provided. Cost data for the acquisition and use of the

media should be included in such a manner that tentative cost comparisons of alternative media can be accomplished.

d. Training System Descriptions. The media selection technique should support the preparation of descriptions of proposed training systems. Three levels of descriptions are required:

- Broad instructional strategies for general types of learning tasks.
- Specific mixes of media for specific learning tasks.
- Specific design and use parameters in such detail that the descriptions can be incorporated into training system specifications for the production or procurement of the media packages.

e. Growth Potential. The system should be capable of growth. This includes a capability for adding or changing media types, learning guidelines, and economic factors.

f. Interfaces. The media selection technique should interface smoothly with both the task analysis formats and training system specification formats to be used in the TAEG.

g. Data Manipulation. Manual computations and the mechanics of combining factors should be a simple task for the training system designer. No more than a few minutes per media selection should be required. Some examples of useful techniques include:

- Two-dimension tables
- Simple math models
- Automatic data processing
- Manual card sort systems

h. Cost Model. Preferably the computing of life cycle costs associated with the media selection process should be supported with tables of cost factors. The purpose of the cost model is media selection not the development of budget estimates. Budget estimates are to be made with an in-depth economic analysis. Only a small set of viable training system alternatives should be subjected to an economic analysis.

i. Testing. The media selection technique should be tested via application over a range of the TAEG projects. Appropriate modifications and further development should be accomplished resulting in a second generation media selection technique that yields optimum results.

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APPENDIX A

MEDIA SELECTION TECHNIQUES INCLUDED IN THE EVALUATION

1. Instructional System Development. AF Manual 50-2, 31 December 1970. Department of the Air Force.

The technique is presented on pages 5-13 and 5-14 under the heading "Selection Considerations." It consists of a simple grid type table with six types of learning objectives across the top and 10 types of instructional media on the left side. Each cell formed by this grid is classified as low, medium, or high to indicate the usefulness of the medium in achieving the learning objectives. The table was developed by Dr. William H. Allen, University of Southern California, and published in the Final Report of the Uses of Newer Media in Art Education Project, NDEA Project No. 5-16-027, National Art Education Association, August 1966.

2. Bretz, R. The Selection of Appropriate Communication Media for Instruction: A Guide for Designers of Air Force Technical Training Programs, R-601-PR. February 1971. Rand Corporation, Santa Monica, CA.

Based on a taxonomy of communication media, eight classes of media are identified. They are audio-motion-visual, audio-still-visual, audio-semimotion, motion-visual, still-visual, semimotion , audio, and print. Specific examples of each class are listed. In addition, a series of decision flow charts with decision points is presented. By making a series of "yes" or "no" answers to questions presented at these decision points, the designer is routed to the required media class. All the media in this system are telecommunication or recorded media.

3. Siegel, A. I., & Federman, P. J. Development of a Method for Deriving Required Training Aids/Devices and Applications to the Tactical Coordinator

Position in ASW Aircraft. Technical Report NAVTRADEVCEN 68-C-0212-1. June 1970. Naval Training Device Center, Orlando, Fl.

In this system, developed by Applied Psychological Services, Inc., the designer is required to use a scale, "Amount of Intellectual Operation," and rate five intellectual operations in a task or specific behavioral objective (SBO). These five operations are cognition, memory, divergent production, convergent production, and evaluation. He is also required to use a scale, "Taxation Level of Intellectual Activity," and rate each of the five intellectual operations in the task or SBO. These factors are combined with predetermined values of the suitability for each instructional medium to exercise each of the intellectual operations(values derived from the mean of a set of expert opinions). Numerical values that result from this procedure are used to determine if the training objective is above the difficulty threshold and requires media support. These values are also the basis for deriving a rank ordered set of media appropriate for the task. Sixteen media are considered.

4. Staff Study on Cost and Training Effectiveness of Proposed Training Systems. TAEG Report No. 1. 1972. Naval Training Equipment Center, Orlando, FL.

This report contains a two phase process with initial selection of media based on task categories with related learning guidelines and media capable of carrying out these guidelines. The second phase involves the

use of life-cycle costing of a small set of useful media. In the experimental study being reported, only the first phase was used. In addition, a special table was constructed which does not appear in TAEG Report No. 1 but is based on the 20 page media selection matrix in that report. It contains 13 task categories along the left side and 20 media alternatives across the top. Each cell contained the description "low," "medium," "high," or "not applicable" according to its usefulness in carrying out the learning guidelines associated with the task category.

5. Briggs, L. J. Handbook of Procedures for the Design of Instruction. 1970. American Institutes for Research, Pittsburgh, PA. p. 93.

A 14-step procedure is described. Central to this procedure is step six which requires the designer to classify the task according to Gagné's eight types of learning and then note Gagné's special instructional events or conditions of learning for the types of learning to be considered. Seventeen conditions of learning are identified and related to the eight types of learning. From his own experience, the designer is asked to choose media that meet the criteria established by the conditions of learning and other factors.

6. Armstrong, G., et al. The Systems Approach to Training (SAT) Training Analysis Guide. August 1971. Air Force Systems Command, Air Force Human Resources Laboratory (FT), Williams AFB, Arizona.

The technique, prepared by Bunker-Ramo, Electronic Systems Division, is presented on pages 43 to 62 under headings, "Media Selections" and "Application of the Media Selection Technique." It involves classifying the tasks according to: (a) three levels of learning, (b) four classes of activity, (c) four complexities of cognitive or psycho-motor behavior,

(d) three stimulus forms, and (e) three response modes. Five media options are available, i.e., the operational system, classroom, learning center, simulator, and part-task trainer. Media analysts have compiled tables of factors to indicate the usefulness of each medium in supporting each of the task factors listed above. Media selection is based on choosing media with relatively high overall ratings.

7. Rhode, W. E., et al. Analysis and Approach to the Development of an Advanced Multi-media Instructional System. AFHRL-TR-69-30, Vol. I, May 1970. Air Force Human Resources Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio.

Although not intended as a media selection technique, this study, conducted by the Westinghouse Learning Corporation for AFHRL, contained tabulated information including the ranking of media according to cost, flexibility, potential for individualized instruction, interaction capacity, and cost sensitivity to changes in student load. A simple media selection procedure was prepared using these tables.

8. Walker, R. W. "An Evaluation of Training Methods and Their Characteristics." Human Factors, 1967, 7, pp. 347-354.

A sizeable number of technical training specialists and supervisors were asked to list the selection factors they used in deciding which training techniques to use. Thirty-four factors were identified. Sixteen training techniques were also listed. Then a group of 20 training specialists rated each training technique in terms of the selection factors. A Selection Criteria Matrix was constructed which contained the mean values for each training technique and selection factor pair.

To use the matrix, the designer first establishes the real-life parameters that must be met in a training program, i.e., short development time, low budget, etc. He then examines the matrix to find the training technique that best meets the parameters.

9. Boucher, B. G., Gottlieb, M. J. & Morganlander, M. L. A Selection System and Catalog for Instructional Media and Devices. October 1971. Grumman Aerospace Corporation, Bethpage, N. Y.

This technique was developed in support of the Navy F-14 project. Media selection is accomplished through the use of a Media Capabilities Matrix. Across the top are 23 media characteristics listed under Presentation, Instructional Strategy, and Student Response. Along the left side are 29 media types. Each cell in the matrix contains one of 11 symbols indicating the degree to which the medium contains the media characteristics listed across the top of the matrix. To use the matrix, the training system designer first determines which of the 23 media characteristics he requires. Then by inspecting the matrix he determines which medium best meets these requirements. The system is designed for automatic data processing. The data processing can also be done by hand.

APPENDIX B

BRIEFING PLAN FOR MEDIA SELECTORS

One of the reasons the TAEG was established was to develop training system specifications. These training specifications incorporate a mix of instructional media. The mix might include classrooms, laboratories, simulators, and operational systems. The instructional media selected should be both adequate to accomplish the training and also be a sound choice from the economic analysis point of view.

The TAEG personnel need one or more techniques for use in selecting media for training system specifications.

Various training system designers have developed techniques for determining which instructional media to incorporate into their training system designs. They have developed these media selection techniques because choosing a training medium can be a perplexing problem. The designer must choose among hundreds of types of instructional media, each suited in varying degrees to various training tasks.

These different media selection techniques have been described in the training literature, but no one technique seems to be widely recognized as a superior approach to choosing instructional media.

Your task is to use some of these media selection techniques--ones that appear to be useful to the TAEG operation. You will record media selections, and rate each technique in terms of its potential usefulness to the TAEG in designing training systems.

You will use nine different systems and one non-system, or ten different methods. A self-contained package of directions, forms, and background information has been prepared on each of the methods.

Each package contains (1) step-by-step directions for selecting media, and (2) background information on the media selection technique. You will also be supplied with a set of training objectives and a worksheet. Each of these items will now be described in greater detail.

A set of training objectives is provided which describes seven specific training tasks. This same set of training objectives will be used in trying out each of the media selection techniques. Media selected for the seven training objectives will be recorded.

The "Worksheet for Media Selectors," figure 4, provides space for a media selector to record all his data generated during the trial of a single media selection technique. Each media selector, therefore, will fill out ten of these forms, one for each technique.

There are seven items on the worksheet: Item 1 provides space to log the number of minutes required to learn the technique prior to its use with the seven objectives. If, during the use of the technique, additional background study is required, this should be added to the figure originally logged in Item 1.

Item 2 provides space to log the total number of minutes of effort required to make media choices for all seven objectives, <u>excluding</u> the time logged in Item 1.

Item 3 provides space to log the set of useful media alternatives for each of the seven training objectives. Two or more of the most useful media options identified through the use of the media selection technique should be logged for each objective.

Items 4, 5, and 6 provide spaces to log a number between 0 and 100 representing your rating of the media selection technique on three different

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WORKSHEET FOR MEDIA SELECTORS

Media Selection Technique:_____ Name:_____

1. Time required to learn to use the system: ___ minutes.

2. Time required to prescribe media for all 7 Training Objectives: _____minutes.

3. Media Selections are:

   TRAINING OBJECTIVES:

   (1)

   (2)

   (3)

   (4)

   (5)

   (6)

   (7)

4. Detail of Media Prescription: _____.

5. Confidence in Validity of Media Selection Process: _____.

6. Suitability for TAEG: _____.

7. Comments: _____

_____

_____

_____

Figure 4. Sample of Worksheet Used for Media Selectors.

scales. These scales appear on the second page of the Worksheet for Media Selectors.

Item 7 provides space for you to log your comments on the technique--any strong impressions or gripes concerning the logic or lack of logic in the approach to media selection and things that should be changed to make it more useful.

Most of the authors of media selection techniques have described their processes in detail but have not prepared step-by-step procedures for others to use in replicating the method for their own use. Therefore, step-by-step directions were prepared for use in this experiment. These directions do not go beyond the descriptions prescribed by the originators of the systems. If a step appears vague or requires a judgment for which little background information has been assembled, it is probably because these qualities were in the original descriptions.

Background information is provided. This is material prepared by the original author and will provide the rationale and descriptions of the techniques needed for you to determine the level of confidence you have in the system. Media alternatives are frequently described. You will not be able to use a system without first making a careful study of the background information, although you may choose not to read every page. Study each system until you understand how it works.

All media selectors will first receive the non-system package. The task is to select what you intuitively feel are the best media alternatives without the aid of any form of selection technique. Read the training objectives and from your experience record the two or more media options you believe to be well suited to the training task.

To determine the order in which you will use the remaining seven packages, select a piece of paper from the box. The piece of paper will indicate which of the random sequences you will follow.

Use one folder each day until you have completed all the folders. Pick up a folder each morning between 0800 and 0815 and work on the task described in the folder until you have completed the task. Upon finishing the task, immediately return the folder and worksheet. Work independently. Do not receive help from other associates.

If you have a problem with any procedure and cannot solve it without help, discuss the problem with the principal investigator.

If you must make assumptions concerning the overall training system in order to select media for one phase of it, state your assumptions on the back of the worksheet.

Do not discuss the techniques or your media choices with others until after the experiment has been completed. You will be working on some of the packages before other media selectors, and we must not have your work influence their media selections.