DEVELOPMENT OF INSTRUCTIONAL DESIGN GUIDELINES FOR INDIVIDUAL AND TEAM TRAINING SYSTEMS

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ABSTRACT

Both the research literature and practical experience indicate that persons involved in the design and development of individual and team training programs have inadequate access to human factors and instructional design principles during the development process. This paper discusses a project that has resulted in the identification and classification of over 500 guidelines which address issues relevant to training program and training device development.

INTRODUCTION

Although substantial literature exists in the domain of team training, little behaviorally oriented guidance is available to actually develop and model individual and team training programs in applied situations ([3],[2],[8]). General guidance does exist in the team and small group literatures on such topics as leader roles, group cohesiveness, concurrent activity, inter-member communication, and task urgency; however, concrete statements which provide prescriptive applications for use in team training programs and training device design are virtually nonexistent. Similarly, in the human factors domain, although detailed specifications and guidelines exist, they are not typically used in the design and development of training devices, particularly team training devices. Meister and Farr ([6]), and Meister and Sullivan ([7]) identified and discussed this issue from the perspective of product development engineering over twenty years ago. They suggested that, despite the proliferation of guidelines documentation available, "very little is known about the manner in which that information is applied to design" ([7]).

In the context of training programs and devices, this problem continues today. Recent research efforts by Swezey, Perez and Mirabella ([11]) have confirmed that instructional principles are still not typically used in the design and acquisition of Army training programs and devices. Further, recent discussions with training developers and device design engineers have indicated that their actual use of human factors and instructional guidelines in training program, and training device development is minimal.

Many of the existing guidelines documents suffer from two types of problems. First, in many cases the guidelines are not sufficiently prescriptive for actual use by design engineers or instructional developers. They are often written in the language of psychology and/or education, and do not provide "what to do and how to do it" statements. Second, many guidelines do not contain adequate information on the direct application of instructional principles to the design of training programs or devices. This is particularly acute with the proliferation of computer-based training devices, including videodisc, expert system, CAI, intelligent CBI, and other instructional technologies. A glaring shortfall is the almost total lack of existence of prescriptive design guidance on the "courseware" aspects of computer based training ([1]). Courseware, in this context, may be defined as the instructional material that accompanies a training device. In the case of computer based devices, this term is often applied to the specific software programs which direct the delivery of instruction.

Taxonomic Development

Swezey and Salas ([12]) have discussed the issue of taxonomic development in the context of team training guidelines and characteristics. They argued that a need exists to create a classification system for team training (and team training device) design categories and issues; and to identify and classify within the taxonomy, actual team training guidelines for use by training development and engineering personnel. Such an approach can help to reduce costs associated with training development activity by eliminating unnecessary training practices that drive costs up but do not contribute to the learning of relevant skills. It may also help to reduce costs associated with poor team performance in operational environments resulting from inadequate training of team skills. These costs tend to be especially high, since the performance effectiveness of individuals depends on the quality of teamwork. Laughery ([5]) has commented that mere lists of guidelines are of little use to designers; and Meister and Sullivan ([7]) have indicated that the format and context in which such information is presented, is a matter of considerable importance (and inadequacy).

The establishment of a taxonomy which is sufficiently generic yet comprehensive to support the many training and instructional guidelines is in itself a considerable task. To the extent that such a taxonomy might be statistically based, the task becomes even more substantial.

Recent work by Swezey, Streufert, and Mietus ([13]) has resulted in development of a factor-analytically based methodology for use in taxonomic development of organizational and systems theories. Similarly, a number of empirical taxonomies have also been developed in the individual task area by Fleishman and his coworkers (see Fleishman and Quaintance, [4], for a review of this literature). Although development of such a quantitatively derived taxonomy has not been feasible in the

present context, such an "empirical" taxonomy may later be developed for use in the area of team training device development.

Objective

The objective of this project was to identify instructional design guidelines which may be used in the design and development of team training programs and devices. Such guidelines may be used to generate hypotheses for team training research and/or for the design of team training tools for use by the Navy.

METHOD

To identify and classify instructional principles and guidelines which may be useful to both training developers and training device design personnel, a two part approach was taken. This involved: (a) the generation of a proximal (i.e., preliminary and heuristically based) taxonomy for use in classifying the instructional guidelines and principles, and (b) the identification and classification of the guidelines themselves.

Generation of the Taxonomy

In generating a taxonomy for guidelines classification, a review of relevant literature was undertaken in which approximately 30 documents (i.e., technical reports, journal articles, book chapters) were identified as having taxonomic and/or classification-based systems which addressed topics of specific relevance to the purposes of this effort.

From these documents, it was determined that six distinct varieties of classification systems were of interest. These follow:

(a) Systems which identify steps or activities involved in the process of developing training and instructional programs,

(b) Systems which identify and classify learning and instructional strategies and characteristics,

(c) Systems which identify stages involved in the process of designing and developing training devices,

(d) Systems which identify and classify human factors guidelines as applied to training devices,

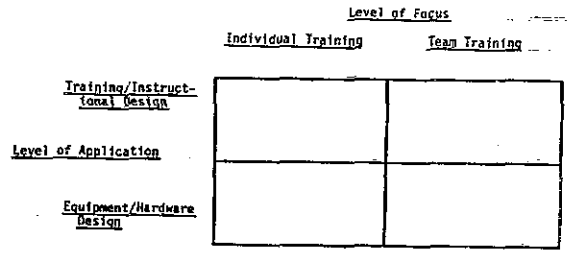
(e) Systems which identify unique team training characteristics,

(f) Systems which identify unique team characteristics as applied to the design and development of training devices.

Accordingly, a 2 x 2 model was devised for use in conceptualizing the types of guidelines which were appropriate for use in the project. This model, shown in Figure 1, identifies two primary classes of user applications on the vertical dimension and two classes of focus on the horizontal dimension.

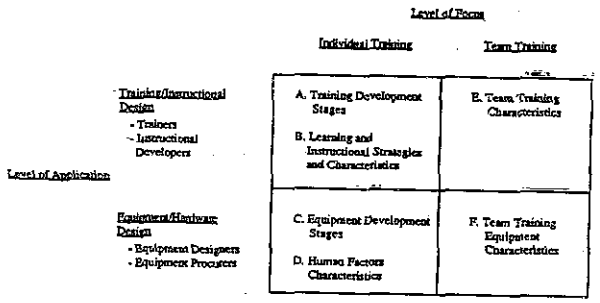
Use of this simple model provided a framework for defining categories of guidelines appropriate for use in this project. On the vertical dimension, the Training/Instructional Design application was defined as including persons who are involved in training, per se; both design and development personnel, and training delivery personnel. Similarly, the Equipment/Hardware Design application was defined as including individuals involved in training device development, both from an engineering design perspective, and from the perspective of individuals who develop specifications for a device prior to actual design activity. On the horizontal dimension, focus on both individual and activities were considered applicable.

Figure 1. Conceptual Model.



Using this preliminary model, the six classification systems listed above were located within the cells. Figure 2 shows the expanded model.

Figure 2. Expanded Model.



Although the primary area of our interest is team training, many guidelines also address individual training. As a result, many of the guidelines may be applicable to both individual and team domains. Although training and instructional development were of interest; engineering oriented guidelines were also included in the guidelines data base. The following classes of guidelines were of initial interest to the guidelines development effort:

A. training development stages,

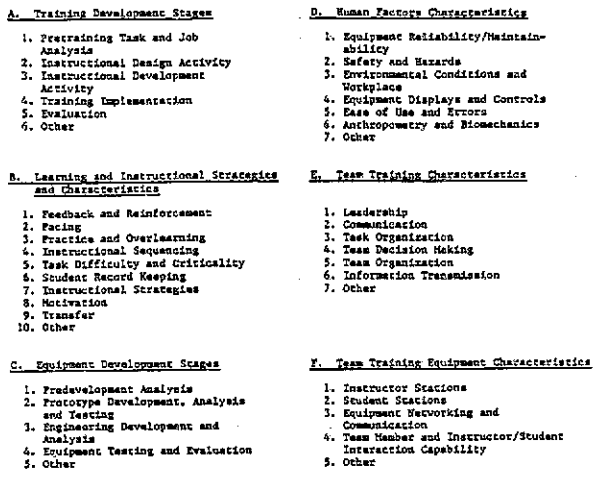
B. learning and instructional strategies and characteristics,

E. specific team training characteristics.

From this approach, subclassifications for each category were extracted from review of the articles. These subclassifications are shown, for each primary category, in Figure 3.

The intent in establishing the subclassification categories was to be comprehensive, yet generic. Undoubtedly, substantial additional precision of specification is possible within both primary and subclassification categories.

Figure 3. Overall Preliminary Taxonomy.



RESULTS

Approximately 2000 documents were acquired, primarily from categories B (Learning and Instructional Strategies and Characteristics), and E (Team Training Characteristics) as identified in the 2 x 2 model shown in Figure 2. During the process of reviewing and identifying this literature, documents which addressed other topic categories (i.e., A, C, D and F in the Model), were also reviewed.

The documents were scanned to determine the existence of so-called "Guidelines" and "Principles" which conformed to the requirements of the project and which could be classified within the primary (or secondary) categories of interest. In this context a "Guideline" was defined as: "A brief statement that prescribes action(s) or condition(s) which, if correctly applied, would improve or facilitate either instructional or training device design and development activity."

Applying this criterion, approximately 150 articles were identified as having such guidelines (although large numbers of cross references existed among the articles). Accordingly, a total of over 1200 guidelines were identified and extracted for classification. However, given time and resource constraints of the present effort, it was necessary to terminate the guideline extraction and classification process after approximately 1200 such items were identified. No claim is made as to the comprehensiveness of the resulting list of guidelines. Without doubt, many additional documents could be identified and reviewed, and numerous additional guidelines could be developed. This area is a fertile ground for additional work and development.

Two primary problems were uncovered during this process. These were: (1) redundancy of stated guideline information, and (2) lack of adequate prescription. As guidelines were identified and extracted from the literature, many were considered redundant in that they essentially addressed the same guidance. When this occurred, the guidelines were combined and referenced separately to all relevant references. Additionally, many theoretically useful guidelines were identified which, in the opinion of the authors, were not sufficiently prescriptive to justify inclusion in the taxonomy. Although potentially helpful theoretically, such guidelines were omitted. This winnowing process resulted in a reduction of the number of guidelines from the original list of approximately 1200, to approximately 500.

As all guidelines included were extracted from one or more cited source documents, each was necessarily removed from it's embedded context. Therefore it was necessary to exercise editorial license in reporting the guideline. Care was taken not to manipulate the meaning of the guideline as offered by the original author(s), yet virtually all guidelines were edited. Further, key topics (or "keywords") were extracted and listed in the space above the actual guideline.

Additionally, if a guideline was considered to be in need of clarification, a separate "Comments" section was included with the guideline as appropriate. This approach, which had been successfully utilized in previous work ([9]), was included to provide additional clarity.

Guideline Format

Figure 4 shows an example of the preliminary guideline format. This can be compared with Figure 5, which is an extract from MIL-STD-1472-C.

Figure 4. Selected Guideline Format.

E. TEAM CHARACTERISTICS (TRAINING)

3. TASK ORGANIZATION

E.3.16 Keywords: Interactions, Goals, Cohesion

Guideline: In order to improve team performance, it is important to understand the degree and nature of group interactions, recognize the differences in individual and group goals, foster cohesion and a commitment to the group, and acknowledge individual contributions as integral and essential parts of total team performance.

References: 41

Comment: These should be specified prior to training development via a functional analysis of individual and team interactions.

The format employed in our guideline data base was established in large part on the basis of a survey of potential Navy user personnel. (Swezey, Llaneras and Salas, [10], provide a detailed report on this survey and its outcomes.)

This format was selected based upon ratings of the respondents of nine candidate formats on the following seven attributes of Guideline construction: spacing, page design, type size, type style, precision, level of detail, and applicability. Figure 6 shows some additional results of the survey, based upon a sample of 17 Navy personnel, in terms of Guideline use.

As can be seen from Figure 6, the two most frequently used Guidelines documents were the DoD Instructional Systems Development (ISD) guidelines, and the MIL-STD-1472-C Human Factors Guidelines. Figure 7 shows the percentage of respondents who considered various guidelines aspects as major problem areas. Figure 7 shows that seven potential

Figure 5. Example Format: MIL-STD-1472C.

d. Operators should normally not be able to remove the key from the lock unless the switch is turned OFF.

e. Activation of an item by a key operated switch should be accomplished by turning the key clockwise from the vertical OFF position.

5.4.2.1.3 Discrete Thumbwheel Controls.

5.4.2.1.3.1 Application. Thumbwheel controls may be used if the function requires a compact digital control-input device (for a series of numbers) and a readout of these manual inputs for verification. The use of thumbwheels for any other purposes is discouraged. Detent indexing units should provide 10 positions (0 - 9) in digital or binary (3 or 4 bits and complement) outputs.

5.4.2.1.3.2 Shape. Each position around the circumference of a discrete thumbwheel shall have a concave surface or shall be separated by a high-friction area which is raised from the periphery of the thumbwheel. The thumbwheels shall not preclude viewing the digits within π/6 rad (30°) viewing angle to the left and right of a perpendicular to the thumbwheel digits.

5.4.2.1.3.3 Coding. Thumbwheel controls may be coded by location, labeling, and color (e.g., reversing the colors of the least significant digit wheel as on typical odometers). Where used as input devices, thumbwheel switch OFF or NORMAL positions should be color coded to permit a visual check that the digits have been reset to their normal position.

5.4.2.1.3.4 Direction of Movement. Moving the thumbwheel edge forward, or upward, or to the right shall increase the setting.

5.4.2.1.3.5 Numerals.

Figure 6. Guideline Use.

Guideline Document	Percentage of Respondents Who Use Particular Guidelines			
	Often	Frequently	Infrequently	Never
DoD ISD Guidelines	25.0	25.0	18.8	31.3
MIL STD 1472C	0.0	25.0	43.8	31.3
NUREG CR-4227	0.0	6.3	12.5	81.3
AAMI Human Factors Guidelines	0.0	6.3	18.8	75.0

Figure 7. Guideline Problem Areas.

Guideline Aspects	% of Respondents Who Considered Aspect as a Major Problem
Complexity	75%
Applicability	64%
Generality	64%
Scope	64%
Level of Prescription	60%
Inconsistency	50%
Relevance	50%

aspects of guidelines were considered to be major problem areas by 50% or more of our respondents.

Uses of the Guidelines

Team Training Checklist

One use of the guidelines data base has been the development of a checklist for use in analyzing team training programs and devices. The checklist is composed of a total of 102 items extracted and modified from the guidelines, and divided into 3 sections as follows:

(1) A Team Training Characteristics Checklist - 31 items

(2) An Instructional Characteristics Checklist - 42 items

(3) A Training Equipment Characteristics Checklist - 29 items.

The checklist may be used to determine how a team training program or device compares with known guidelines from the research literature. Sections (1) and (2) apply generally to all team training programs, whereas Section (3) applies to training devices or equipment.

If a team training program or device includes a guideline characteristic, users are instructed to place a check in the appropriate box beside each statement. If it does not, they are instructed to leave the box blank. Second, users are instructed to rate each characteristic in terms of its importance to improving team performance in their specific situation according to a five-point scale, by circling an appropriate number in the second column on each page of the checklist. An example of the scale, ranging from zero to four, is shown in Figure 8.

Figure 8. Example Page: Team Training Checklist.

TEAM TRAINING CHARACTERISTICS (page 1)

Does your team training program include the following team training characteristics? If YES, check box. If NO, leave blank		How important is this characteristic for enhancing team performance? Please rate each issue using the following scale: (Circle One) 0= not important 1= slightly important 2= moderately important 3= very important 4= extremely important				
1) Provides clear communication of instructional objectives to all team members	☐	0	1	2	3	4
2) Provides training on the organizational chain of command	☐	0	1	2	3	4
3) Provides training on the responsibilities of all team members	☐	0	1	2	3	4
4) Provides training on the responsibilities of team leaders	☐	0	1	2	3	4
5) Specifies interdependencies in the performance of team activities	☐	0	1	2	3	4
6) Provides training and testing on all team operations and tasks.	☐	0	1	2	3	4

The Navy Field Manual

In a second effort, the guideline data base was also used to develop a Navy Field Manual in the area of Team Training. Selected guidelines were extracted from the data base, rewritten in simplified format, and incorporated into this document. The field manual was designed to acquaint Navy personnel with information about team training, since many Navy jobs require teamwork and interdependence among people. The Field Manual provides basic information on the following team training topics:

(1) Things which every member should be able to do - regardless of the particular job or task involved,

(2) Characteristics of successful team leaders and instructors,

(3) Aspects of team performance evaluation,

(4) Characteristics of successful team training methods.

Figure 9 provides an example of a page from the Field Manual.

Figure 9.
Navy Team Training Field Manual Extract.

WHAT IS TEAM TRAINING?

Team training instructs a group of individuals in team skills required to accomplish a mission. Roles of the team members can differ yet are interdependent. Each team member is trained to work together effectively with other team members in order to accomplish specific functions that fulfill the team's mission.

As our effort continues, we hope to expand the guidelines data base, and to computerize and cross reference it so that information may easily be added. Further, we intend to validate the guidelines by applying them in actual situations, and by *collecting opinion data from both users and experts* in applied contexts. Finally, it is our intention to use the guidelines data base as a source of information for designing future Navy Specifications for team training programs and devices.

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