# APPLICATION OF INSTRUCTIONAL SYSTEM DEVELOPMENT TECHNIQUES TO TEAM TRAINING

Dr. Frederick M. Ball
Principal Analyst/Group Manager
Analysis & Technology, Inc.
New London, CT

## ABSTRACT

Current instructional systems development (ISD) techniques are not well equipped to identify and effectively provide for team training requirements. While much research aimed at extending the ISD model to team training development is in progress, a systematic approach to meet near-term team training development needs is necessary. This paper provides an overview of an approach we have formulated and used successfully to this end. The approach is based on a functional analysis of the system goals/objectives which the team performance in question supports. The results are then represented systematically in a process model designed to capture the dynamic relationships between system conditions, and categorical team performances. The model is used to develop scenario-based exercise guides, similar to instructor guides for classroom use, but designed to provide instructor guidance regarding training device employment in the administration of effective team training.

## INTRODUCTION

Methods for the systematic determination of individual skills are currently available. Training objectives (i.e., objective behavioral statements, conditions of performance, and performance standards/criteria) derived using these methods tend to be well defined. Subsequent training system development and implementation on this base is relatively straightforward. Collectively, these methods constitute the instructional systems development (ISD) model in all its manifestations (e.g., NAVEDTRA 106A/TRADOC 350, MIL-T-29053B(TD), MIL-STD-1379B, NAVEDTRA 110, NAVSEA OD 45519). Application of the ISD model to team skill determination, however, has not been equally effective. The literature attests to this observation repeatedly [1][2][3][4]. The principal difficulty, encountered early in the ISD process, lies in identifying team skills (or training requirements, or training objectives) with the same precision and objectivity as is possible with individual skills. As a result, the systematic measurement of team performance is elusive. Without systematic performance measurement, the provision of adequate feedback to the team is hampered. This inability to close the so-called training cycle by means of adequate performance feedback leads to inefficient and in many cases ineffective team training.

So saying, however, it is noted that the ISD model is one of the more useful developments of instructional technology. The intent underlying the model is to ensure the development of an effective training system. That is, one which provides trainees through its operation, the knowledges and skills necessary to meet the initiating training requirement. This is accomplished by the systematic application of defined planning, analysis, development, implementation, and evaluation procedures. The ISD model, however, is only a guide. Its virtue lies in the fact that it forces the systematic consideration and orderly development of each training system component. The principal drawback lies not within the model, but in the literal interpretation or uninformed application of the procedures described. This is particularly true with respect to team training development.

To counter this drawback, many efforts to formally extend the ISD model to team training have been reported (e.g., 4). For the most part, these have concentrated on the fundamental problems of team performance definition and measurement. Progress in these areas is apparent. For example, recent reconceptualizations of team performance [4][5] explicitly recognize the dependencies among individual and team performance, team tasks and the situation in which that performance occurs. However, while these efforts are promising, researchers in the area acknowledge that further conceptual work is required before specific team skills and their interrelationships can be isolated with the precision necessary for the derivation of explicit training requirements. Progress in the area of team performance measurement has also been reported. For example, Connelly and his associates have developed an approach which permits the evaluation of both team and/or individual team member performance in an ongoing mission context [6]. This includes specific tasks and task types. Again while the methodology appears promising, they point out that additional work in the area of generic task specification is required. Therefore, the systematic development of team training in the classic sense continues to be an elusive goal.

In the meantime, the quantity of resources which have been and are being committed to team training system and device development is large. The need for an ISD-based approach was never clearer. Our efforts in the area of submarine team operational training have made this point particularly clear to us. The lack of an ISD-based approach has led us to the formulation of an ISD-like process for team training material development, an overview of which is presented in this paper. The approach we took was pragmatic. Our intent was that it be based on ISD principles, that it accommodate findings of research yet to be completed, and at the same time that it provide a useful tool for the development of team training materials to meet the near-term requirement. It is based on the following four considerations.

## BACKGROUND CONSIDERATIONS

First, ISD analytical processes grew out of a behavioral psychological tradition, focused on individual performance, and originally addressed operator and maintenance activities in well-defined (established) situations. While the distinction may not be exclusive, team performance in military systems is more accurately described as operational in nature, focusing on the functional objective the system (the equipment and the team personnel) was designed to meet. As such, team performance involves problem solving, resource allocation, and decision making processes on a different scale and in less structured, dynamic situations than for isolated individual activity. The atomization of performance when employing classical analysis methods tends to obscure the relationship of each component task or element to the overall system objective. This observation suggests an approach based on a functional analysis of the system and system objective of which the team to be trained is a part.

Second, the requisite individual skills collectively required to support successful team performance (in terms of the system functional objective) may be, and usually are, distributed differently among individual team members in different teams. Further, this distribution changes with experience. From the training development point of view, this makes it extremely difficult to specify generic team training requirements which are valid for all teams. That is, what is a correct procedural training requirement for one team may not be for a second team, though the second team may evidence the same summative performance deficiencies. The ISD model is not currently constituted to provide for this type of variability. Consequently, we formulated our approach to provide a training requirements structure within which team-to-team performance differences could be addressed flexibly. In so doing, however, greater emphasis is placed on the instructor's role. This consideration was also addressed in the formulation of our approach.

Third, the decision-making tasks at various levels within a team structure are action oriented, finite in number, and emphasize resource management. The key variables are associated with the information available (static and situational) on which to base a decision: amount, quality, rate, timeliness, and the set of alternative decisions they define. These are task conditions, not tasks per se. This suggests that an ISD-like development of team task listings should be relatively circumscribed with greater emphasis placed on the delineating conditions (operational situations) affecting the information flow and individual responsibilities/authority (formal and informal) within the team structure. (This is indirectly consistent with the observation that the stimulus-response behavioral basis of classical ISD analysis may not be suited to team performance analysis. Instead, a cognitive basis may be more appropriate. This mirrors the growing recognition of the shift in the field of learning psychology away from behaviorism toward a cognitive basis [7][8].)

Fourth, the administration of team training because of the dynamic, operational aspects of team performance, generally depends on an operationally realistic training environment. This is typically provided by conducting training exercises using a simulator or training device. These have become complex and costly, driven by the belief that team training transfer to the operational context is particularly sensitive to the fidelity of the training situation to the operational context. Certainly, the ISD process should play a significant role in balancing optimum trainer capability against cost. The process should not only define trainer functional requirements, but also provide a basis for prioritizing them, first in terms of the initiating training requirement, and second in terms of trainer/training effectiveness. This interaction is a rather sophisticated aspect of the ISD media selection process which is not fully documented. However, the instructor who must use the training device is, from our perspective, more important. As noted above, the instructor's role in team training is of considerably more significance than for individual training. The team trainees will be dynamically exercising previously learned knowledge and skills in support of the system functional objective. Student training materials are not a part of this process. Instead, the instructor monitors, evaluates, and critiques the team's performance and in general mediates the training process. This includes employment of the training device to best effect. For this, he requires guidance of a different nature than that found in instructor guides supporting classroom instruction. Further, it is not sufficient to train instructors to operate the training device only. In the same sense that, for example, a sonar operator must be trained in the operational employment of his equipment (i.e., in addition to Operator & Maintenance training) to realize its functional capability in the tactical context, so must the instructor be trained in the employment of his training device to deliver effective operational training. Therefore, the material provided for his support should guide his employment of the training device for effective team training during each training session or exercise. This aspect of team training system development is crucial. Further it can become quite involved, in effect requiring a mini-ISD development depending on the complexity of the team/system function, training device, and the number of instructors involved in its operation during a training session. Uninformed application of the ISD process often fails to adequately treat this aspect of operational training system development. Consequently, we formulated our approach to focus on supporting the instructor in his administration of effective team training.

## PROCESS DESCRIPTION

Our approach to team training development recognized these factors. In particular, it explicitly recognizes the role of the instructor as the catalyst for effective team training and focuses on providing him with the necessary support. Accordingly, the principal product is an exercise guide, similar to an instructor guide, but differing in context and format. The approach involves seven steps:

- Data base establishment
- Exercise goal/objective development
- Process model development and operation
- Exercise selection
- Exercise development
- Quality control
- Validation

Activities involved in each step are described below in terms of a specific application to submarine piloting team training.

Data Base Establishment

Information on which the team training development process depended was gathered and consolidated in a data base. This information was organized in terms of general and platform-specific piloting procedures and guidelines, platform-specific navigation equipment as it pertains to piloting, the associated trainer capabilities and operation, training material requirements and specifications, and platform-specific piloting pipeline training. Analysis of these data established initial starting points for material development in three critical areas: (1) exercise goals and objectives, (2) material format and organization, and (3) instructional guidance. Subsequent development drew on this data base as required.

Exercise Goal/Objective Development

Exercise goal/objective development began with a top down, functional analysis of the piloting team/system objective. That is, navigation has been defined as the process of safely (standard) directing (activity) a ship from one point to another (platform operation). The activity of directing involves three categories of general team activities: planning own-ship track, repetitively fixing own-ship position, and evaluating fixed position against intended track as a basis for recommending own-ship maneuvers. While the general standard, team activity, and platform operation remain the same, the manner in which each general activity is performed varies as a function of details regarding the platform operation and conditions under which it is to be performed. For example, specifying that the platform operation is to be carried out in restricted waters (condition) identifies those specific activities which must be performed in each category associated with piloting, as well as the detailed standards to which each activity must be performed in order to safely complete the platform operation. As the first step in the exercise goal/objective development process, this type of general-to-specific analysis was performed on the data base, beginning at the piloting (rather than the more general navigation) level. Piloting team activities/standards in each of the three general categories, platform operations, and conditions were identified and organized. The process resulted in the following organization of information.

a. Platform Operation. The principal platform operation to be accomplished in a piloting situation is transiting from point A to point B. At point B the operation is completed at a specific geographic location such as an anchorage or a destination.
b. General Team Activity. The performance of a general team activity is required in accomplishing a platform operation. As for navigation in general, there are three of these executed repetitively during piloting operations: planning own-ship track, fixing own-ship position, and deriving recommendations for own-ship maneuvers from an evaluation of fixed position against intended track.
c. Condition. A condition is a factor affecting the manner in which the general team activities required to successfully accomplish a platform operation are carried out. Conditions were organized into three categories:

    i. Conditions affecting the accuracy with which own-ship's position is fixed such as bearing error, radar degradation, etc.
    ii. Conditions causing own-ship to deviate from intended track in the course of an operation, such as set and drift, contact encounters, propulsion malfunction, etc.
    iii. Conditions requiring accelerated performance rates and/or greater precision such as warnings of approaching danger, proximity to shoal waters, submerged operations, etc.

d. Exercise Goal. An exercise goal described the general training content. It is a descriptive statement which specifies the team to be trained, the platform operation which training supports, and the conditions under which the operation is to be conducted.
e. Specific Team Activity. A specific team activity is one that is required in accomplishing the exercise goal under the specified conditions. It falls within one of the three general team activity categories.
f. Exercise Objective. Satisfactory performances of the required specific team activities in an exercise are the exercise objectives. Satisfactory performance is determined by appropriate standards.
g. Standard. A statement of the precision, timeliness, and/or sequence with which a specific team activity must be performed under the specified conditions in order for the platform to safely and successfully complete the operation.

Process Model Development and Operation

The next critical step in the process involved development of a general model of the piloting process. The model, constructed during the analysis of operational information in the data base, describes the essential interrelationships among (1) platform piloting operations, (2) piloting team activities in each category, and (3) conditions. If a platform piloting operation (transit from point A to anchorage at point B) and a set of conditions (low visibility) are selected and provided to the model as inputs, the model will select the appropriate team activities which are required. Satisfactory performance of the selected activities thus becomes the behavioral objective of training. The standard for satisfactory performance is derived from successful accomplishment of the operation. In terms of an exercise, the selected platform operation and conditions determine the exercise goal and the exercise scenario. The model, operating on these same data, will identify the associated team activities required in order for the platform to attain the exercise goal. These activities, together with standards for their satisfactory performance, become the exercise objectives. The process thus resulted in the following organization of information.

Exercise Selection

Unlike the ISD model which addresses the selection of tasks for training at this point, our approach next focused on the selection of exercise goals, as defined above, for exercise guide development. This approach was taken because the team activities identified are recurrent and are common to most piloting situations. Therefore, the intent was to ensure that the resulting exercise set (22 as it turned out) was sufficiently broad to ensure the trainee team the opportunity to exercise specific team activities under all important piloting circumstances identified by the piloting process model.

Exercise Guide Development

*The fifth step* in the process was to choose an exercise goal from those selected in Step 4. An operational scenario was then constructed based on the goal and the associated conditions such that during the course of the exercise those team activities related to the objectives would normally be expected to occur. The scenario was then modified with respect to training device capabilities/limitations and annotated with required device control information. Training and performance evaluation information was then added with respect to scenario events. This information consisted of the required team procedures/performances, interactions, and outputs related to the selected exercise objectives. The draft exercise guide was then entered into word processing, reviewed for compliance with approved format specifications, and retyped in preparation for review.

Quality Control

The sixth step provided for quality control of the exercise guide materials. The draft exercise guide was independently reviewed for operational accuracy with respect to general submarine piloting procedure, platform operating information and operational training information contained in the data base. This review was performed by operationally qualified personnel whose only connection with the entire development was in the context of this review. The draft exercise was then reviewed for compatibility with the training device information. Modifications resulting from these reviews were incorporated, the exercise guide draft retyped as required, reviewed again for specification compliance, and prepared in final format for validation.

Validation

The final step in the development process involved exercise guide validation, as distinguished from verification. The purpose was to ensure that events controlled by the exercise scenario, display data, event sequencing, and data provided for training and assessment in the exercise guide corresponded to the actual data generated on the training device during exercise execution. Procedurally, this was accomplished by setting up the training device as required by the exercise guide and stepping through the exercise scenario in event sequence. At each step the training device was allowed to run in its normal training mode long enough to check the accuracy of the information presented in the exercise guide draft. The final activity involved incorporating all required changes determined in the validation process and preparing the exercise guide in final format for verification (pilot course training). In addition to actual exercise validation, this period was exploited for the purpose of definitizing instructor information requirements in the course of an exercise and definitizing the format in which the materials in general, and the exercise guides in particular, provided that information for instructor use. The materials were then piloted in an actual course, minor modifications incorporated, and subsequently delivered for Navy use.

## DISCUSSION

The process described herein is presented as an approach not a model. It represents an extension of ISD principles. Further documentation of guidance regarding tailoring of the approach to particular applications (e.g., other teams) is required. For example, the procedure for developing process models, a key feature of this approach, requires full explanation. What is presented here represents only an overview. Further, our approach does not intend to answer outstanding questions regarding the theoretical aspects of team performance as related to training. It does, however, provide a workable framework within which these answers can be incorporated into team training development as they become available. In the interim it provides a basis for developing effective support for the team training instructor. The approach has proven useful in eight different applications to date involving the development of instructor materials supporting both shorebased and shipboard team operational training. The products -- exercise guides -- have been well received as indicated by feedback from the end user.

## REFERENCES


1. Hall, E.R. and Rizzo, W.A. "An Assessment of U.S. Navy Tactical Team Training: Focus on the Trained Man." TAEG Report No. 18. Orlando, FL: Naval Training Equipment Center, March, 1975.

2. Defense Science Board. Summary Report of the Task Force on Training Technology. Washington, DC: Director of Defensive Research and Engineering, February, 1975.

3. Wagner, H., Hibbits, N., Rosenblatt, R. & Schulz, R. Team Training and Evaluation Strategies: State-of-the-Art. (HUMRRO-TR-77-1). Alexandria, VA: Human Resources Research Organization, February, 1977.

4. Thurmond, P. & Kribs, H.D. "Computerized Collective Training for Teams." Final Report (DAHC 19-76-C-0042-03). San Diego, CA: Sensors, Data, Decisions, Inc., August, 1977.

5. Nieva, V.F., Fleishman, E.A. & Rieck, A. "Team Dimensions: Their Identity, Their Measurement and Their Relationships." Final Technical Report (DAHC 19-78-C-0001). Washington, DC: Advanced Research Resources Organization, November, 1978.

6. Connelly, E.M. & Johnson, P. "Team Performance Measures for Computerized Systems." Proceedings of the Third Interservice/Industry Training Equipment Conference and Exhibition. American Defense Preparedness Association, November, 1981.

7. "Developments in Learning Psychology: Implications for Instructional Design and Effects of Computer Technology on Instructional Design and Development." An Interview with Robert M. Gagne. Educational Technology, June, 1982.

8. Miller, G.M. "The Relevance of Cognitive Psychology to Instructional Technology." Proceedings of the Second Interservice/Industry Training Equipment Conference and Exhibition. American Defense Preparedness Association, November, 1980.

## ABOUT THE AUTHOR

Dr. Frederick M. Ball is a Principal Analyst with Analysis and Technology, Inc., where he manages the Analysis and Evaluation Group of the Training Systems Department. He received his PhD degree in Experimental Psychology from Stanford University and has been involved in the areas of human information processing, system design, and operational training for the past 12 years.