A RESEARCH AGENDA FOR TEAM TRAINING AND PERFORMANCE: ISSUES, ALTERNATIVES, AND SOLUTIONS

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ABSTRACT

Recent literature reviews indicate that there is a growing body of research dealing with team training and performance (see Denson, 1981; Dyer, 1984; and Salas, Dickinson, Tannenbaum, and Converse, in preparation). However, the available literature provides little guidance concerning the most effective and efficient ways to improve team training in real military settings. The purposes of this paper are to (a) summarize the major research issues associated with efforts to study and enhance team training; (b) propose an alternative approach to the study of these issues; and (c) outline a research agenda for using a standardized methodology derived from this approach to investigate team performance and the acquisition of teamwork skills. Suggestions are given concerning the direction for future research to develop and evaluate team training procedures.

INTRODUCTION

Over the past few years, several authors have documented in detail the status of current understanding concerning the problems of crew, group, team, and unit training (see Alluisi, 1977; Baum, Modrick, and Hollingsworth, 1982; Denson, 1981; Dyer, 1984; Goldin and Thorndyke, 1980; Hall and Rizzo, 1975; Modrick, 1986; Nieva, Fleishman, and Reich, 1978; Salas, Blaiwes, Reynolds, Glickman, and Morgan, 1985; Salas, et al., in preparation). The reviews reported by these authors reveal the existence of a large body of related literature. They also indicate that a great deal is known about the characteristics, dimensions, and properties of teams, and about the factors that influence team performance.

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It is also clear that this body of literature is improving with regard to its scientific sophistication and operational relevance.

However, there are also many theoretical and practical problems associated with this research. For example, gaps have been noted with respect to the conceptualization, definition, measurement, analysis, design, and evaluation of team training and performance (Salas et al., 1985). The available literature provides little basis for understanding the processes by which teams learn to work together, predicting the rates of acquisition and decay of team skills, or selecting (or designing) optimum team training approaches, programs, or devices (Swezey and Salas, 1987). That is, prior findings have limited applicability to the design of operational team training systems. In describing current approaches to team training, Modrick (1986) summarized this situation by noting that "the state of the art in team training is inadequate" (page 150). He further states that most team training exercises provide "virtually no explicit formal training or instruction on the skills of interaction and coordination that are central to 'teamness'" (1986, page 150).

RESEARCH ISSUES

Thus, technology necessary to support the design, conduct, and evaluation of team training is inadequate, and this inadequacy has been related to problems and shortcomings of prior research (e.g., Salas et al., 1985). If this situation is to be improved, research is needed to address issues related to team "learning," the acquisition of teamwork skills, and training that emphasizes the development of "teamness." The available literature indicates that these needs are particularly acute with respect to research in the following areas:

1. A recent meta-analysis of the team training and performance literature (covering more than 2300 studies; see Salas, et al., in preparation) indicates that there have been few empirical studies of team training since the Ohio State studies of the 1960s. Furthermore, findings from this meta-analysis are contrary to some of the results of the Ohio State studies, indicating that the results of those original studies must be interpreted with extreme caution. Although there have been many studies of teams over the past 20-25 years, most of these studies have failed to focus on issues that are critical to the training of teams. Indeed, because of problems associated with the lack of an adequate terminology and the inadequacy of available task analysis methods for describing team activities (Modrick, 1986), little is known about what actually constitutes team training. Thus, major research efforts are needed to provide a renewed focus on the unique problems of team training and performance.

2. Available measurement systems fail to provide complete and systematic assessments of team training and performance. As indicated by Dyer, the utility of many team measurement systems has been reduced by problems associated with "the unreliability of measurement procedures, failure to measure the appropriate variables, lack of measures for some variables, and/or errors in administration of measurement instruments" (1984, page 299). New measurement techniques need to be developed on the

basis of a sound theoretical conceptualization of team training and teamwork development. These techniques should combine the best available tools from laboratory and field approaches to the study of teams. Specifically, the precision of computerized assessment should be used to provide operationally relevant measures of team learning and development during training.

3. Present approaches provide few quantitative performance standards for the acquisition of teamwork skills. Modrick (1986) states that quantitative standards of performance on specific team training objectives "are rare, at best." New measures need to be developed to provide standard criteria for team training systems. Such measures should be developed so as to provide a basis for modeling and predicting team performance and the development of teamwork skills. These criteria must be significantly related to the major dimensions of teamwork and the relevant characteristics of operational performance.

4. Available training methods have not been adequately evaluated with respect to their applicability to team training. As Swezey and Salas (1988) point out, the results of previous studies fail to provide adequate guidance "in the domains of training device, and to some extent training program, development." Research is needed to evaluate the efficacy of available methods and strategies in terms of their contribution to effective teamwork, and to develop new training procedures that are particularly applicable to team training. Of particular interest in this regard are techniques such as Johnson and Johnson's (1978; 1986) cooperative (team) instruction.

5. Prior research provides little information concerning "what teams really do" during team performance, or about how team behaviors change during training (Dyer, 1984; Morgan, Glickman, Woodard, Blaiwes, and Salas, 1986). In order to develop more effective team training systems, it is important to develop a fuller understanding of the team behaviors and processes that contribute most to team performance, the developmental changes in these behaviors and processes during training, and the training strategies that are most effective in influencing these behaviors and processes. Recent progress in this regard has been reported by Glickman and his associates (Glickman, Zimmer, Montero, Guerette, Campbell, Morgan, and Salas, in press; Guerette, Miller, Glickman, Morgan, and Salas, in press; Morgan, Salas, and Glickman, 1987).

6. Related to the above, prior research has failed to focus on the ways in which teams "learn" teamwork skills (Dyer, 1984). Research is needed in order to explicate the processes involved in the acquisition, maintenance, and decay of critical teamwork skills. Of particular importance is the need to study the impact of team training strategies on the acquisition of teamwork skills during training (see Guerette et al., in press).

Based on this brief summary of the major research issues, it is clear that a systematic, problem-oriented, laboratory-based research program is needed to test the applicability to team training of many of the learning principles and other findings, hypotheses, and suggestions that have been reported over the past 25 years. Such an approach to the study of these issues is described below.

AN ALTERNATIVE APPROACH TO TEAM TRAINING RESEARCH

In collaboration with the Naval Training Systems Center, a program of research has been initiated at the University of Central Florida to develop and standardize procedures for measuring team performances, and to conduct a series of investigations of team performance, team decision-making, team training, and the acquisition of teamwork skills. The methodology to be employed in this research will center on the use of a "synthetic" (low-fidelity simulation) team trainer that will allow the manipulation of variables that are judged to be most important for successful team performance. In their review, Nieva et al. (1978) emphasized the need for such research to use standardized tasks that can be manipulated along a variety of dimensions (e.g., the degree of intra-team coordination) in a controlled setting.

Comprehensive reviews of the literature and operational team performance tasks (e.g., ASW training scenarios) are being conducted to identify candidate tasks for use in this research. Tasks will be reviewed and compared according to the criteria of validity, reliability, sensitivity, programming feasibility (adaptability to computer presentation), trainability, variability of important dimensions, and operational relevance and fidelity. On the basis of this analysis, a set of tasks will be selected for incorporation into a multiple-task Team Training (and performance) Assessment Battery (TTAB). The resulting battery will be tested and calibrated to ensure that that it is adequate with regard to the criteria mentioned above and to standardize the procedures involved in its use. The TTAB will then be used to investigate a variety of team training and performance variables.

The TTAB will be designed to be conceptually and functionally similar to the Multiple Task Performance Battery (MTPB) used earlier by Alluisi and his colleagues (see Alluisi, 1967, 1969; Morgan and Alluisi, 1972; Morgan, Coates, Kirby, and Alluisi, 1984). The MTPB consisted of six tasks that were originally selected to represent functions typically performed in almost any job. The time-shared tasks of the MTPB were combined so as to create a synthetic job, which operators were required to perform as they would any other job (for as much as eight hours per day over 15 successive days). For nearly 20 years, this "synthetic work" methodology provided a major testbed for the assessment of individual and group performances and for investigations of the performance effects of stress. Specifically, the MTPB was used to assess the effects of sleep loss, continuous operations, the circadian rhythm, infectious diseases, menstrual cycles, noise, inorganic lead, and team training loads (a partial listing of specific studies is provided in Alluisi, Coates, and Morgan, 1977). These studies provided some of the most systematic data available concerning the performance effects of temporal factors (see Alluisi et al., 1977; Alluisi and Morgan, 1982), illness (see Beisel, Morgan, Bartelloni, Coates, DeRubertis, and Alluisi, 1974; Coates and Kirby, 1982), and training loads (see Morgan et al., 1984).

The TTAB will differ from the MTPB in that (a) the TTAB will primarily provide measurements of team rather than individual performances, and (b) the TTAB will incorporate the display and measurement features of a state-of-the-art interactive network of microprocessors. It will be structured around a set of time-shared team performance tasks selected to provide measures of team decision making, problem solving, communication, coordination, procedural functions, etc. The battery is being designed to allow the manipulation of variables such as team-member interdependencies, leadership patterns, communication patterns and reliabilities, group composition and cohesion, workloads, task and teamwork demands, job/task characteristics, instructional strategies, information display and feedback characteristics, and training methods and schedules. In addition, tasks will be designed to allow manipulations along the dimension of "established" versus "emergent" performance conditions (cf. Alexander and Cooperband, 1965). Within a given training (or performance) session, tasks will added or deleted in order to vary the time-sharing and workload requirements within realistic limits.

The TTAB is being designed for operation by five-person teams. However, this approach could be used with teams of any reasonable size (within the limits of available hardware). Each team member will operate a separate computer terminal with a display screen and keyboard (and other input devices as necessary) through which he or she will interact with other team members in order to contribute to team decision making or the solution of team problems. The tasks of the TTAB will be integrated into a synthetic job, which team members will be required to perform as they would any real-world job. A scenario will be developed for training teams to perform this job, and baseline data will be collected using this control condition for training. Thus, team performances will be measured during training (the acquisition of teamwork skills) and during periods of asymptotic work performance.

PROPOSED RESEARCH AGENDA

During the first phase of this research program, efforts will be focused on developing and calibrating the TTAB methodology and tasks; physically setting up the research laboratory; conducting pilot tests of the system; evaluating and modifying the system; and performing an initial study using the TTAB. The basic hardware and software requirements for the TTAB have already been acquired.

Tasks will be selected to satisfy the criteria listed above and to provide a methodology that will enable researchers to develop and test quantitative performance models/algorithms, criteria, and predictive equations; investigate the cognitive aspects of team learning and decision-making strategies; and generate practical information about team performance that can be applied to the enhancement of team training in the military environment.

The development of the team training laboratory will require the purchase and installation of hardware; the development and debugging of software; and the "shake-down" calibration of the TTAB system. The final step in the establishment of the facility will involve a complete system test involving the integration of all system components, and the development of standardized operating procedures for guiding the use and operation of the facility.

Once the TTAB system is operational, a pilot test will be conducted to ensure that the full system and each of its components are adequate with regard to the criteria listed above. The results of the pilot test will provide the information required for objective evaluations of the system and for the development and implementation of effective modifications to the system, if any are required. This study will also provide an opportunity for the development of baseline training conditions for use in future studies.

An initial full-scale study will be conducted in order to provide (a) further testing of the complete system (particularly if modifications were made after the pilot test), and (b) complete baseline data concerning the acquisition of skill on the synthetic job of the TTAB under a standardized training condition. This study will provide data against which the results of all future studies can be compared. These data will also be used as the basis for initial efforts to develop models of team training and performance on the TTAB. In addition, these data will be used to develop and refine team performance measurement procedures and performance criteria. A variety of measures from the TTAB will be analyzed in order to define, quantify, and evaluate team performance. The relative utility and psychometric characteristics of the measures will be evaluated.

After development and baseline studies are completed, the TTAB will be employed to address a variety of basic team training and performance issues. The specific design of possible investigations can not be developed here. However, it is possible to illustrate the potential utility and versatility of the methodology by noting something of the variety of relevant studies that could be conducted as part of this program of research.

Several research topics seem to be uniquely suited to study with the TTAB. One such issue concerns those task situations that require training for both individual and teamwork skills (e.g., as required in a naval gunfire support team). As previously noted by Wagner and his colleagues (1977; see also Baum, Modrick, and Hollingsworth, 1981), the available literature provides little information concerning the sequencing of skills training, or of the interaction of such sequencing with task situations. These authors concluded that research is needed to determine which training procedure is most effective in established and emergent task situations.

To what extent should individual skills be trained prior to team training? Should certain team skills be trained before individual-skill training? Or, should both types of skills be trained concurrently? The sequencing of individual- and team-skill training to optimize the acquisition and retention of those skills cannot be specified on the basis of available information. Nor is it known whether the optimum sequencing

differs for established and emergent task situations. The TTAB methodology could be used to investigate the optimum sequencing of individual- and team-skill training along the continuum from established to emergent conditions.

This methodology could also be used to determine which team skills should receive special training, and what the optimum training schedule is for such training. These studies could concentrate on skills such as distributed decision making (cf., Kleinman, 1988), or investigate the interactions that occur when such skills are acquired concurrently with other team skills. Other studies might might be conducted to evaluate the relative efficacy of different team training methods or instructional strategies, or to test the utility of new team training interventions.

Another research topic that has direct relevance for military performance is the effect of continuous operations on team performance (Krueger and Fagg, 1981; Naitoh and Townsend, 1970; Woodward and Nelson, 1974). Discussions of military concepts and doctrine related to future engagements indicate that fighting units will be required to perform continuously for extended periods of time. The modern military force is technologically capable of sustaining high levels of combat intensity, day or night, for prolonged periods.

A great deal of research has focused on the human ability to perform effectively for prolonged periods (see reviews by Alluisi and Morgan, 1982; Horne, 1978; Krueger and Fagg, 1981; Naitoh and Townsend, 1970; Thompson, 1983; Webb, 1982; Woodward and Nelson, 1974). In reviewing this research, however, one notes the relative dearth of information on the team aspects of performance during continuous operations. The TTAB methodology could be used to study the unique factors that influence the ability of teams to perform effectively during periods of continuous, high-intensity operations. Procedures for enhancing this capability could also be examined. Variables that should be examined in this context include leadership, group structure, effects of individual and team skill levels on team performance, and the relationships among individual variables, team variables, and intervention strategies.

Another vital element of military team training and performance that could be studied with the TTAB methodology is the area of performance measurement and criterion development. Many criteria for operational teams are global, subjective evaluations of the "satisfactory-unsatisfactory" type, and the need for improved criteria is acute (Baum et al., 1981). The TTAB methodology will provide a unique capability for defining, quantifying, and evaluating team performance across several types of teams (e.g., combat control, damage assessment, or weapons launch) and environmental conditions. It will allow for the comparison of proposed and current team training and performance criteria in order to determine which are the most accurate and effective. This would be particularly useful for operational systems like the SSN-21/BSY-(2) Training System and the ASW Tactical Team Trainer (e.g., Devices 14A12 and 20A66).

Another potential area for research with the TTAB methodology concerns communication networks, protocols, and feedback (Baum et al., 1981; Thorndyke and Weiner, 1980). Traditionally, feedback during military training has been leader-centered, post-exercise, informal, negative, and primarily directed at errors in performance. Feedback issues that could be addressed with the TTAB include (a) effects of leadership role(s), (b) the impact and effectiveness of feedback from equipment, leaders, and other team members, (c) individual-versus group-directed feedback, (d) the timing features of feedback, (e) and other features such as the ratio of negative to positive feedback. Techniques for improving team communication and, thus, team effectiveness (see, for example, the time-sharing concept of Zimbardo, Linsenmeier, Kabot, and Smith, 1981) could be compared, contrasted, and developed.

Other studies might investigate the effects of group composition (i.e. number or type of team members) on the acquisition of team skills. Or the methodology might be used to extend the work of Glickman et al. (in preparation) from the field to a laboratory assessment of team evolution and maturation during team training. Such studies would provide valuable tests of the current theories of team training and teamwork development. Laboratory research of this sort will provide a valuable compliment to the field research that is currently under way.

CONCLUSION

The inadequacies associated with current team training technologies indicate the need for a variety of research approaches. Several research programs, with new and different research orientations, are needed in order to address the various issues outlined in this paper. Within this context, however, it is believed that the TTAB methodology will provide a highly flexible, efficient, and productive alternative for solving many of the problems associated with team training and performance. It will be a particularly effective approach for investigating the acquisition, maintenance, and decay of teamwork skills, the processes by which such skills are acquired, and optimum procedures for training such skills.

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