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ABSTRACT

Educational Resources Information Center (ERIC), the Defense Documentation Center (DDC), National Technical Information Service (NTIS), Psychological Abstracts, HumRRO Library, and industrial training publications were surveyed to analyze instructional and evaluative techniques relevant to team training. Research studies and team training practices underway within the military were also examined. From this review was developed a classification scheme for team training and evaluation to be used by the Defense Advanced Research Projects Agency (DARPA). Training situations were categorized as emergent or established and team training was distinguished from multi-individual training. Research needs in team training were identified using this classification scheme. Ninety-seven references on training and evaluation published between 1952 and 1976 are provided. (CH)

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Team Training and Evaluation Strategies: A State-of-Art Review

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SUMMARY

BACKGROUND

This review of team training and evaluation was undertaken by HumRRO in order to provide an information base that could be used by DARPA as a foundation to facilitate decisions regarding future research program support. In order to pursue their mission of operational readiness, the Services conduct most of their training in the operational commands. However, in the past, most training research has focused on individual training at schools and at other institutional locations. Considering the amount of team training that goes on in the Services, either formally recognized as training or combined with operations, the funds committed to R&D support are relatively small. There is a need, therefore, for increased research emphasis on team training and evaluation.

PURPOSE

The purpose of this literature review was to provide information to DARPA which would be useful for planning research and development programs in the area of team training. Such programs are needed to develop improved team training methods and technologies, as well as to provide new measurement techniques and procedures for evaluation. The specific objectives in preparing this review were to address the following questions:

- What state-of-art gaps are there in team training strategies and evaluation techniques?
- What new team training strategies appear to hold promise for application to the DoD environment?
- What new evaluation techniques can be used to assess team training?

METHOD

A thorough search was made of the major documentation sources for publications which were relevant to team training/evaluation. Initial sources searched included the Educational Resources Information Center (ERIC), National Technical Information Service (NTIS), and Defense Documentation Center (DDC) indices. In addition to DoD-sponsored research reports, publications from the social psychological areas such as group dynamics and the industrial training field were surveyed. Secondary sources and cross-references were then identified and reviewed. HumRRO personnel with experience in the team training area were consulted for information about current military team training methods. The most recent military doctrine regarding team training procedures was obtained and reviewed. Military personnel were contacted in all the Services to identify team training approaches now in operation. Current team training and evaluation studies underway within the Army Research Institute and the other Services were examined and described.

FINDINGS AND IMPLICATIONS

A classification scheme was introduced in which the training techniques and situations discussed in this review were categorized along two dimensions. On one dimension, a distinction was made between "team" training and "multi-individual" training. Multi-individual training occurs in a group context but focuses on the development of individual skills. On the other hand, the focus of team training is on developing team skills (e.g., coordination, cooperation, etc.). The type of task situation was the other dimension used to classify the training techniques reviewed in this study. Task situations were categorized as either "established" or "emergent." Established situations are those in which the tasks and the activities required to perform these tasks can be almost completely specified.

Emergent situations are those in which all tasks and activities cannot be specified and the probable consequences of certain actions cannot be predicted. This type of situation allows for unanticipated behaviors to emerge.

Team training studies and practices were categorized according to the classification scheme described above. These studies were described in this review as having followed two conceptual models of team behavior--Stimulus-Response (S-R) and Organismic. The S-R model adherents tended to study team training in laboratory settings derived from established task situations. More realistic environments were used by other researchers who attended to emergent factors in the job situation (the organismic approach). It was this latter group of investigators who demonstrated the need for training in team skills, even though individual skill proficiency was found to be a prerequisite for effective team training and performance. Other conclusions which were drawn from the literature are:

- The team context is not the proper location for initial individual skill acquisition.
- Performance feedback is critical to the learning of team as well as individual skills.

Current military team training practices were described as varying in cost, in degree of fidelity to the operational site, and in the variety and complexity of the tasks trained. Subjective methods of evaluation were found to be predominant.

Evaluation of team training effectiveness depends upon the development of objective team performance measurement instruments and procedures. This review of the literature and current practice support the conclusion that this area contains many problems which must be solved before substantial improvement in team training evaluation can occur. The production of standardizable, replicable test conditions and the establishment of accepted performance criteria are two such problems.

A phased research program was suggested as warranting support in order to overcome gaps in the current state of knowledge. *The major factor in this program is the need for methods which differentiate individual, multi-individual, and team skills and training requirements.* Such techniques, which could be integrated with job/task analyses, would discriminate between isolated and interactive behaviors. Possible techniques to study for this purpose are variations of interaction analyses and other unobtrusive measures. Successful development of this methodology will provide an opportunity to establish team performance standards criteria as part of training requirements analyses. Development of these techniques would then permit other research studies to be accomplished effectively.

Issues identified in this review which merit research support include the following:

- Team Feedback

  What changes in training methods or content result from feedback? Which method of providing team feedback is most useful (e.g., video recording versus post-exercise debriefing)?

- Assessment Training

  Will training of team members to assess their own performance result in greater team proficiency than if no self-assessment training was provided? Will training to assess the performance of other team members affect proficiency?

- Simulation Fidelity

  What degree of simulation fidelity is critical for effective team training? Can two-sided engagement simulation techniques be applied to the training of team skills? Although low fidelity simulations were found to be ineffective in established task situations, would they be more useful in emergent situations?

- Team Composition/Structure

What are the effects of degree of team member familiarity on the acquisition of team skills? Will the length of time that a team functions together effect proficiency?

- Skill Training Sequencing

Is it more efficient to train individual skills first and then team skills, or team skills first, or both concurrently?

Combined studies are feasible which deal with more than one of the above research issues. For example, feedback or skill sequencing issues can be studied in environments which vary in their degree of simulation fidelity, or in task situations which are established or emergent.

The studies that were suggested above point out the considerable research and development effort needed in the team training/evaluation area. With further support, our state of knowledge in the area should expand considerably.

PREFACE

This report contains a critical review of the literature relevant to team training. Current instructional and evaluative techniques within the Services were surveyed and described. State-of-art gaps were identified and research needs documented.

This study was performed in HumRRO's Eastern Division, Dr. J. Daniel Lyons, Director. The work was performed under the general direction and supervision of Dr. Robert J. Seidel, Program Director, Instructional Technology Group. The authors of this report gratefully acknowledge Dr. Seidel's assistance in the identification of potential team training research areas.

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Chapter I: INTRODUCTION

Interdependent, coordinated team performance is a predominant characteristic of most operational activities within the Services. Training of teams in operational units is the transition between initial training and combat. The influence of effective team behavior upon system performance underlines its consequences for training. This training is more difficult and assumed to be more costly to do than is individual training. It is usually performed in operational environments or in high fidelity simulations of them. For these reasons, there is a need for sound data to determine the relative effectiveness of alternate training concepts as a means for improving team training.

BACKGROUND

In order to pursue their mission of operational readiness, the Services conduct most (up to 90%) of their training in the operational commands. However, in the past, most training research has focused on individual training at Schools and at other institutional locations.

MG Gorman, Deputy Chief of Staff for Training, TRADOC, recently stated [94] that there is a need for increased research emphasis on what is called "collective training" (team or crew tactical training in a unit context). A recent Defense Science Board task force report [74] stated that in view of the amount of team training that goes on in the Services, either formally recognized as training or combined with operations, the funds committed to R&D support for team training are relatively small. In fiscal year 1974, the Army Research Institute (ARI) spent less than $2 million on research in unit training. Although it was the largest such program of research in history, it amounted to only 11%

of the human resources research program in that year. Most of the money went for improved institutional training or exploration of other individual training issues.

This review of the team training area was undertaken by HumRRO in order to provide an information base that could be used by ARPA and the Services as a foundation to facilitate decisions regarding future research program support.

PURPOSE

The purpose of this review was to provide information to DARPA which would be useful for planning research and development programs in the area of team training. Such programs are needed to develop improved team training methods and technologies and to provide new measurement techniques and procedures for evaluation. The following objectives were established to guide the preparation of this review:

1. *Describe existing instructional strategies and evaluation techniques relevant to team training.*
2. *Identify state-of-art gaps in team training and evaluation and suggest new team training strategies and evaluation techniques which warrant further study.*

APPROACH

Review of Technical Literature

An extensive search was made of the major documentation sources in order to amass an initial listing of publications which were relevant to team training. The emphasis was on the applicability of the document to tactical training of teams. However, instructional strategies and evaluation techniques which had been used in other contexts were examined for their possible relevancy. The following major sources were searched:

1. Educational Resources Information Center (ERIC). These indices were searched for relevant titles over the preceding 10-year period. The descriptors used in this search included: team training, military training, industrial training, group dynamics, group effectiveness, group instruction, small group instruction, training techniques.

2. Defense Documentation Center (DDC). The indices of the preceding 10-year period were searched using the following descriptors: team training, group dynamics, group problem solving, training crews.

3. Psychological Abstracts. The descriptors used to search these indices were: group dynamics, training, training/industrial, training/military, and group/small. Here too, a 10-year period was selected for the in-depth search.

4. National Technical Information Service (NTIS). The general area of "military sciences" was canvassed for appropriate literature. Also, team training, group dynamics, group problem solving and group training were used as descriptors.

5. HumRRO Library. This library specializes in publications which are relevant to military training and evaluation. A sizeable number of documents were thus obtained "in-house" for this review.

Following the development of an initial list which contained many hundreds of titles, a brief review of each document's abstract was performed to insure that the review would focus only on those publications which were relevant to <u>team</u> training and evaluation. Relevant documents were then obtained and reviewed.

Once the search in the initial sources was completed, secondary sources (i.e., *Journal of Applied Psychology, Training in Business and Industry*) were canvassed for relevant articles. In addition, "key" documents that were more than 10 years old were identified from the cross-references in documents already reviewed. These "key" documents were also obtained and reviewed. All these items are listed in the References Section of this report.

Sample of Current Military Team Training Techniques

The most recent military doctrine regarding team training procedures was obtained and reviewed. Current studies underway within the Army Research Inst ute and the other Services were examined. Military personnel were contacted in all the Services to identify team training approaches currently in operation. HumRRO personnel with experience in the team training area (e.g., Dr. Joseph Olmstead) were consulted for information about current military team training methods. Examples of current techniques were then chosen for inclusion in this report and are described in Chapter IV.

DEFINITIONS

As can be seen from the variety of sources chosen for the initial literature search described above, a clear conceptual delineation of the team training area had not been made at the time by HumRRO reviewers. Team training research was viewed as part of the more general subject matter of small group research or group dynamics. This larger field had generated literally thousands of empirical studies and theoretical papers, most of which were only tangentially relevant to the sub-area of team training. An understanding was needed of what makes the team context unique.

Before a state-of-art review on team training could be accomplished, one needed to define what constitutes a "team." In size, teams may e two or more individuals with no upper limit defined. Teams also may be characterized by virtually any degree of formal organizational structure and permanency [41].[1]

[1]This document by Hall and Rizzo provides an excellent description of how definitional problems have troubled the team training field and the various ways the research literature has dealt with these difficulties.

Rather than attempting one more definition, the authors viewed the description given by Glaser, Klaus and Egerman [33] as providing the most meaningful distinction of small groups and teams considered in this review. "Teams," have the following characteristics:

"1. They are relatively rigid in structure, organization, and communication pattern.

2. The task of each team member is well defined.

3. The functioning of the team depends upon the coordinated participation of all or several individuals.

In contrast, 'small groups' differ in that they generally:

1. Have an indefinite or loose structure, organization, and communication pattern.

2. Have assignments which are assumed in the course of group interaction rather than designated beforehand.

3. The group product can be a function of one or more of the group members involved depending upon the quality and quantity of their participation."

These definitions were used to guide the final selection of studies and papers for in-depth review.

Instructional strategies and evaluation techniques which are relevant to "teams" should take into consideration the dimensions described above. In addition, teams are goal- or mission-oriented [41] and so the specific context in which the team will operate must be considered before any training or evaluation technique can be applied.

The question of whether "team" or "multi-individual" behaviors are involved in a given context has not been adequately studied. As derived from the above discussion, team training can be defined as:

- The training of two or more individuals who are associated together in work or activity. The team is relatively rigid in structure and communication pattern. It is goal- or mission-oriented with the task of each team member, well-defined. The functioning of the team depends upon the coordinated participation of all or several individuals. The focus of team training and feedback is on team skills (e.g., coordination), activities, and products.

On the other hand, multi-individual training can be defined as:

- The training of two or more individuals who are associated in a group context. The trainees may or may not be part of a team. However, the focus of the training and feedback is on individual skills, activities, and products.

Methods are needed by which one can analyze given task situations and derive individual and team training requirements.

In the chapters that follow, a distinction will be made on this dimension of whether the study or technique reviewed is pertinent to multi-individual or team contexts.

Chapter II: REVIEW OF TEAM TRAINING RESEARCH

Research in the area of team training has been going on for approximately 20 years, albeit at a relatively low level of effort [21, 22, 37, 55, 62, 64, 70, 71]. Glanzer and Glaser [35] stated that despite the importance of the area, relatively little formal knowledge existed concerning methods of describing and analyzing team performance. The complexity of team training problems was cited as contributing to that situation--"In the investigation of the areas of team as opposed to individual training and performance, problems appear of an entirely new order of magnitude" [35].

In 1975 the Defense Science Board described several difficulties in performing team training research which have prevented significant breakthroughs:

> This kind of R&D must be piggybacked on operations in the field, large numbers of R&D personnel are required, the opportunities for data collection during the exercise are marginal, inferential statistics and psychometrics were not designed for this order of complexity, there are limited opportunities for repeated trials, the ultimate test of team training is combat, which cannot be simulated. [74]

The difficulties cited in doing team training research have prevented a thorough study of the problems and research needs identified during the intervening years. However, there has been some definite progress and certain research trends identified and described [36].

Research findings on some major team training problems and issues will be described in the eight sections that follow. The first section describes the "Stimulus-Response" and "Organismic" models which underlie different approaches to the study of team training [1]. Next (Section 2), the components of emergent versus established situations and their effects on team training research are described. A discussion of the relative importance and interactions of individual training and team training (Section 3) is followed by descriptions of and problems involved in studying team skills (Section 4). In Section 5 the degree of simulation fidelity in conjunction with its influence on effective training is examined. This is followed by a description (Section 6) of the effects of feedback on team performance and techniques used to present knowledge of results (KOR) to team members. Section 7 examines team structure and composition and their effects on team training. Finally, in Section 8 the benefits of a systems approach to the development of effective team training is discussed.

1. TWO CONCEPTUAL APPROACHES TO TEAM TRAINING RESEARCH

Alexander and Cooperband [1] have distinguished between two team training models based on the situations in which team behavior takes place. The variables and environment selected for study by researchers depend upon the team model chosen. The "Stimulus-Response" model is applied to teams which operate primarily in <u>established</u> situations, whose tasks, and the activities required to perform these tasks, can be almost completely specified, and the assignment of functions among team members and their equipment is relatively rigid. This viewpoint underlies attempts to apply certain principles and techniques of individual learning (e.g., operant conditioning) to research on team training. Studies performed at the American Institutes for Research Team Training Laboratory are illustrative of the model [53]. For example, in one study reinforcement of team response was manipulated to measure differences in team member proficiency.

In the "Organismic" model [1] the team is considered to be a synthetic organism of which individuals are components. This model is oriented toward teams operating in environments which include a significant proportion of emergent situations. Although there are defined task assignments, the individual has a considerable degree of discretion in how to perform the task under various contingencies. Consequently, proficient team performance can depend upon the development of appropriate team procedures for coping with the environment by its members. Thus, adaptive innovations are required and decision-making and problem-solving skills are emphasized [1]. An example of this is the work done by Chapman, et al [97]. Teams in a simulated air defense direction center were presented with sudden disruptive changes in their environment and were required to react to the new stimuli quickly in order to solve given problems precisely.

2. ESTABLISHED VS. EMERGENT SITUATIONS

The two conceptual approaches described in Section 1 take as their basis the situational context in which team behavior occurs. This context is actually a continuum of situations, the end points of which are described as established or emergent. Boguslaw and Porter [10] define these situations as follows:

> An established situation is one in which (1) all action-relevant environmental conditions are specifiable and predictable, (2) all action-relevant states of the system are specifiable and predictable, and (3) available research technology or records are adequate to provide statements about the probable consequences of alternative actions. An emergent situation is one in which (1) all action-relevant environmental conditions have not been specified, (2) the state ofthe system does not correspond to relied-upon predictions, (3) analytic solutions are not available, given the current state of analytic technology [10].

An established situation was the primary focus of a research program of the Team Training Laboratory of the American Institute for Research [54]. The advantages of such a situation for research are:

- it is relatively easy to abstract key characteristics of real-world team tasks and represent them in the laboratory;
- experiments can be done relatively inexpensively;
- studies can be conducted in reasonable time periods; and
- monitoring of team activities can be feasibly accomplished.

On the other hand, simplifying the representation of team functions can mask or omit possible important variables which influence behavior in the real world. By abstracting the situational context in the laboratory, there can be a loss of opportunity for trainees to react to breakdowns and problems which may arise in an operational setting.

Providing skills to deal with emergent, unstructured situations was seen as a major goal of team training in studies by the System Development Corporation (SDC) [1]. The development of coordinative skills was stressed although it was recognized that these are based upon a certain minimum attainment of individual skill. Team training devices and techniques were seen as requiring orientation toward the training of innovative behaviors and skills necessary to adapt to unforeseen problems [11, 23].

An emergent situation permits a more realistic, less abstract, approach to the investigation of team training variables than does an established situation. When a team was formed in the laboratory, its prior motivational characteristics were important determinants of performance. But, when teams were studied while carrying out face valid activities, prior motivational states appeared to be less important [29]. What was important in this case was training in coordination such that team members became fully aware of their responsibilities to compensate for the inabilities of others, or to overcome temporary problems when the situation called for it.

By viewing task situations as established or emergent, one can classify the training techniques and research studies discussed in this review as pertinent to either type of context. Similarly, the distinction between team and multi-individual training requirements discussed earlier comprises a second classificatory dimension. The resulting 2 × 2 matrix constitutes a classification scheme which will be used in the remaining sections of this chapter and in later chapters to categorize the research studies and training procedures surveyed.[1]

3. INDIVIDUAL VS. TEAM TRAINING

The studies in this section were classified as shown in Table 1. Although the focus of this literature review was on *team* training, there were some studies surveyed that dealt with individual skills training in a multi-individual context.

TASK SITUATION	TRAINING FOCUS: TEAM	TRAINING FOCUS: MULTI-INDIVIDUAL
ESTABLISHED	Klaus & Glaser [51,52,54] Hall & Rizzo [41] Briggs & Johnston [11,14]	Horrocks [43,44]
EMERGENT	Kanarick, et al [49] Johnston [47] McRae [59] Williges [87] Alexander & Cooperband [1]	Kanarick, et al [49]

Table 1. Classification of studies reviewed in Chapter II, Section 3, "Individual vs. Team Training."

[1] The classification of studies throughout this document represent the judgments of the authors. No formal rating system was used.

One common conclusion of the research on team training, regardless of whether it was based on an "Organismic" or "Stimulus-Response" viewpoint, is that individual proficiency is the basis for an effective team [49]. Thus, in emergent situations, developing team awareness or abilities to deal with unexpected problems requires that each team member has attained the requisite job skills. Team training is likely to proceed most efficiently when the team members have thoroughly mastered their own specific assignments beforehand [54]. Horrocks, et al [43, 44] found that when team coordination was emphasized early in training, it interfered with acquisition of individual task competence.

The question could then be asked if team training was of any benefit at all and, if so, to what degree and in what manner. Is it possible to predict when individual training will be superior to team training? [14] Briggs and Johnston [11] concluded their review finding no direct evidence for the superiority of team training over individual training. They interpreted this finding as indicating a need for team training devices to include provisions for either refreshing or augmenting individual skills. In other laboratory investigations (derived from established situations) which compared individual with team training, equivocal results were produced. Horrocks, et al [44] found that if a member of an intact team was replaced by another equally competent person, there was no detriment in team performance. This implied that there did not appear to be a generalized "team skill" which operated independently of specific task competencies [11]. Evidence supporting this finding came from other AIR laboratory studies [51, 52]. In these studies only the proficiency level of the members at the start of team training determined team performance. As these task situations were routine and well-established, team performance was seen to be the sum total of individual performances [41].

On the other hand, Johnston [47] studied two-person teams working in a simulated radar situation where the objective was to track and intercept incoming aircraft. The amount of coordination and communication in the training task was varied and demonstrated that team training was better than individual training when the criterion task required coordination between individuals. In such emergent situations, training in "team skills" (e.g., coordination) was required and effective performance was regarded as something more than the sum of individual skills [59].

Verbal communication training was found not to be useful when the task did not require the skill [47]. In a study by Williges, et al [89] it was concluded that verbal communication played an insignificant role in team work and this role was not enhanced by verbal training. In this study, two-person teams were required to coordinate interception of two planes on a simulated radar screen. In one condition team members received only verbal communication concerning the performance ofthe other team member; in another condition, the team members were given verbal communication and visual access to the radar screen of the other member. It was found that verbal communication facilitated performance of the team only when there was no other more efficient communication channel available. In the conditions where verbal and visual communication both were allowed, verbal communication had no effect on team performance.

Alexander and Cooperband [1] proposed that team training should be effective when: the training stresses the acquisition of coordinative skills, and the tasks being trained are such that formal rules cannot be stated and procedures must be developed by the team in the process of task accomplishment. Kanarick, et al [49] proposed three phases for team training:

Initially, there is the need to train individuals in the procedural aspects of their jobs, doctrine, and the process approach to decision making. This training should be followed by a phase in which team members are instructed as a unit, learning the interactive and communicative requirements of team functioning. The final phase is devoted to tactical training where teams are taught to apply their procedural and interactive skills to certain situations requiring innovative and creative behaviors.

4. TEAM SKILLS

Studies in this Section are classified in Table 2.

TASK SITUATION	TRAINING FOCUS: TEAM	TRAINING FOCUS: MULTI-INDIVIDUAL
ESTABLISHED		
EMERGENT	Sidorsky & Simoneau [80] Sidorsky & Houseman [81] Alexander & Cooperband [1] Federman & Siegel [27] Boguslaw & Porter [10] Kanarick, _et al_ [49]	Hausser, _et al_ [42]

Table 2. Classification of studies reviewed in Chapter II, Section 4, "Team Skills."

As can be seen, training in team skills is important for application to _emergent_ situations [80,81]. What are these skills and how should they be trained?

With respect to one such skill--cooperation--Alexander and Cooperband [1] have described it as follows:

> Learning to cooperate means learning the strengths and weaknesses of one another, learning when the others want help and when they do not want it, learning to pace one's activities to fit the needs of all, and learning to behave so that one's actions are not ambiguous.

Nonetheless, one of the problems in the area of "team skills" is a lack of unambiguous, operational definitions of skills such as coordination, interaction, cooperation, etc. [27]. As there are conflicting views regarding these terms, so too are there problems in training and evaluation of these skills [91].

One of the most difficult skills to train, yet one of the most important in dealing with team functions, is skill in the analysis of one's own errors. Boguslaw and Porter [10] reported that it did not appear possible to specify how to train this skill. It was hypothesized that it would help to present trainees with numerous unusual situations which could not be handled by simple adherence to standard operating procedures. Problem-solving discussions (rather than didactic presentations) also could have helped. An effective team performer must learn when he/she is reaching the point of being overloaded and needs assistance. Studies are needed to examine the kinds of "self-evaluative" skills which can enhance team performance and to identify techniques which could be used to train these skills.

The training of team awareness, a skill considered of importance to performance in emergent situations [49], can benefit from the application of a number of existing technologies. The split- or multiple-screen technique of television can be used to show team members their jobs in relation to other team members. Using this technique, a trainee could observe how a given action serves as a stimulus for some other team member. Such training provides the trainees with a better appreciation of their individual roles in the team and of the need for effective communication and interaction.

A study was conducted to investigate the application of the PLATO IV Computer Assisted Instruction (CAI) system to training interpersonal skills [42]. The content areas chosen included: feedback, communication, goal setting, problem solving, decision making, and reinforcement. Training had a positive effect on some of the skill performances of company commanders in leading recruit companies through a nine-week training period. However, in most of the behavioral measures of company commander performance, CAI training did not have a discernible effect. Further investigation of the usefulness of CAI as an approach to training team skills appears needed.

5. SIMULATION FIDELITY

Studies discussed in this Section are classified as shown in Table 3.

		TRAINING FOCUS	
		TEAM	MULTI-INDIVIDUAL
TASK SITUATION	ESTABLISHED	Briggs & Johnston [11-14]	
TASK SITUATION	EMERGENT	Bachrach [3] Alexander & Cooperband [1]	Madden [60] Prophet & Caro [73]

Table 3. Classification of studies reviewed in Chapter II, Section 5, "Simulation Fidelity."

In training teams or studying their behavior in emergent situations, high fidelity simulations may be contemplated [60, 73]. High-fidelity simulation can be both costly and time consuming; space, equipment, and staffing constitute substantial investments in money and time. The problems of measurement are great because of the interactions of the many variables involved. Once a large-scale simulation exercise has begun, the experimenters have little control over the events which follow [3].

High-fidelity simulation of complex team tasks are exemplified by those which simulated air traffic control tasks and air defense operations which utilized teams ranging from 30-40 people. These tasks approached very closely the complexities of the operational task, and task fidelity was very high since in some cases an operational system itself was used in training [1].

Can low-fidelity simulations be used adequately for team training? A series of experiments by Briggs, et al [11, 12, 13, 14] have led to the conclusion that team training did not transfer well to the operational environment when the training simulation was of low fidelity. However, these studies were all performed in contexts derived from established situations. No studies were found using low-fidelity simulations in emergent situations. Recent techniques used in the Army to simulate two-sided combat engagements have employed low-cost, high-fidelity procedures in emergent contexts. These techniques will be discussed further in later chapters of this report.

6. FEEDBACK/KNOWLEDGE OF RESULTS

Studies on performance feedback discussed in this Section were classified as shown in Table 4. Most of this research was performed in laboratory settings.

TRAINING FOCUS

TASK SITUATION	TEAM	MULTI-INDIVIDUAL
ESTABLISHED	Egerman, et al [25,26] Glaser, et al [33] Klaus & Glaser [51,52,54] Short, et al [77] Glanzer [34] Cockrell [18] Cockrell & Sadacca [19] Burnstein & Wolff [15] Klaus, et al [53] Marra [61] Wolff, et al [90,92]	Nebeker, et al [65] Burnstein & Wolff [15] Wolff, et al [90,92]
EMERGENT	Kanarick [49] Alexander & Cooperband [1]	

Table 4. Classification of studies reviewed in Chapter II, Section 6, "Feedback/Knowledge of Results.".

"Performance feedback is unquestionably the single most critical parameter in team or individual training," concluded Kanarick, et al [49] in a review of the research literature on feedback. The series of studies by AIR [25, 26, 33, 51, 52, 54, 77] considered an important characteristic of teams to be the fact that regardless of how a correct team response was made, every member of the team was exposed to the same reinforcing event. This was true even when some team members made errors or were idle. These studies demonstrated that team reinforcement might also foster unwanted, inappropriate responses that could create a significant decrement in team performance. The results of this program of research suggested several guidelines which should be employed for team training.

> . . . it appears essential that team practice result in clear and immediate reinforcement following each correct team response; practice in the absence of team reinforcement for criterion-level performance is more than likely to lead to a decrement in team proficiency [54].

An approach used to provide team members with feedback or Knowledge of Results is the post-exercise debriefing. Debriefing sessions following team training sessions are an opportunity for the team to examine individual proficiencies and to explore alternative ways of organizing the task so as to develop more efficient and proficient team performance. However, the post-exercise discussion as feedback may have an undesirable characteristic--a large time gap between the response and the feedback [24]. The amount of elapsed time before feedback is given should be studied systematically to determine the effects of delayed feedback.

In a study by Nebeker, et al [65], the results showed that although individuals performed better with feedback than without, it did not matter whether the feedback was raw or percentile scores or whether it concerned the individual, his/her group, or both. The results underscored the importance of feedback as a general factor which augmented and sustained performance. Other studies of feedback have demonstrated that reinforcement contingencies affect team performance, and have illustrated the effectiveness of feedback or Knowledge of Results to sustain performance [15, 53, 61, 90, 92].

Team members receive feedback information from intrinsic and/or extrinsic sources. Extrinsic feedback is provided by a source external to the system, such as an instructor. Intrinsic feedback is received while the team is performing its tasks and is inherent in the task itself. The effectiveness of intrinsic feedback has been shown in a variety of studies [18, 19].

Providing feedback in team training presents problems beyond those encountered in training individuals.

> These problems arise from three considerations. (1) There may be several criteria of effective team performance with no clear-cut tradeoffs among them; these criteria may be vague and difficult to state objectively and may change during system operations. (2) In order for a team to operate effectively, it is necessary for its members to develop and maintain individual skills as well as skill in working together; there is a possibility that these skills may require different feedback procedures which may mutually interfere. (3) When a complex system operates, there is usually a large volume of information available about the state of the environment, the state of the system, and the performance of system personnel; some of this information may be conducive and some inimical to effective learning [1].

A major source of difficulty in team training is the identification and correction of individual errors. In many complex team tasks, there are often many possible correct procedures, making error identification difficult. These conditions give rise to the problem of monitoring or supervision of team responses to evaluate their adequacy.

Although the studies cited above discuss the general effectiveness of feedback, more work needs to be done to systematically investigate the methods which might be used to deliver feedback information. Various techniques such as videorecording and post-training debriefings are now used to inform team members about their responses. These and other methods need to be studied regarding their effects on team performance.

7. TEAM STRUCTURE AND COMPOSITION

Studies discussed in this Section were classified as shown in Table 5.

TRAINING FOCUS

		TEAM	MULTI-INDIVIDUAL
TASK SITUATION	ESTABLISHED	Briggs & Johnston [11,13] Klaus [54] Bolin [9] Egerman, et al [25,26] Johnston & Briggs [48]	Bolin [9] Nebeker [65]
	EMERGENT	George [30] Moore [63]	Baldwin, et al [6]

Table 5. Classification of studies reviewed in Chapter II, Section 7, "Team Structure and Composition."

Although not directly related to team training techniques, questions regarding the effects of group structure and composition upon training are important for understanding the effects of training upon team performance [6]. Two types of team structure were identified and studied in a series of laboratory experiments [11]. In a serial or vertical structure activities are sequential with input from one team member based on output of another. Parallel team structures (e.g., rowing team) do not have the same member interactions.

Briggs and Johnston [13] suggested that parallel team structures are preferable to serial structures. This was because team performance in the parallel structure was not dependent on the least skilled member. However, Klaus [54] reported that the parallel structure led to only a short-term gain and eventually to a decrement in team performance.

A variety of studies on team structure, workload allocation, physical arrangement, and member replacement yielded conflicting results [38, 39]. For example, Bolin, et al [9] found in studying task size and team performance that fully cooperative three-man teams performed better than individuals working alone on image interpretation. Moore [63] and George [30] studied the effects of task characteristics on team performance in emergent settings. Moore found that increasing the task load on teams did not affect team performance when all the information necessary for task completion was furnished to the team. George showed teams performed better when they were required to use a communication network which included all of the team members. In a study conducted in an established task context to test the effects of team arrangement on performance of radar controller teams [48], investigators found that team communication inhibited team performance in some cases. In several studies occurring in established task situations, team member replacement was found to be relatively unimportant and dependent on the skill levels of the persons involved [24, 25, 26, 39]. Yet, personnel turnover was considered to be a major factor degrading team performance in an operational setting. For example, a tank commander reported that with 40% turnover in crews every 90 days, one cannot expect acceptable levels of team proficiency [74]. There is a need to systematically investigate the effects on team proficiency of the length of time a team performs together under established or emergent conditions.

With such conflicting findings, the search for superior team training methods has been slow. Task- or situation-specific characteristics may account for many of the conflicting findings obtained in team training research. A more systematic approach to the research area appears necessary. This suggestion is amplified in the section below.

8. SYSTEMS APPROACH TO TEAM TRAINING

The most common framework for research in the team training field has been to study team behavior in the same manner in which individual behavior was investigated. The team was viewed by the "Stimulus-Response" adherents as a "single response unit" [54]. The team product as a whole was the focus of research rather than its component parts. This made it feasible to investigate the effects of various conditions of feedback upon team proficiency. The fact that the team response might have been quite complex and result from the integration of separate responses of several team members was of interest only to investigators who followed the "Organismic" viewpoint.

Both sets of researchers favor the application of a "systems approach" or instructional system development (ISD) model to the design and development of team training exercises, materials, methods, and devices. Implementing such an approach could yield information necessary for the identification of critical variables to be studied as part of an extensive program of team training research.

Teams are created or defined to accomplish certain goals or missions [28]. The relationships among team members are meaningful only to the extent that they are involved in attainment of the goals. Thus, before any team training is undertaken, an in-depth analysis of the system should be performed [72]. The task characteristics need to be identified and training objectives derived [40, 46]. The members of the team should be made aware of the team's goals and objectives. Exercises and instructional materials should be structured with respect to the objectives, and the training situation should be made as similar as possible to the operational criterion situation [8, 34]. Finally, the quality control components of the system should provide feedback data to trainees and trainers for the purpose of improving the training system and team proficiency.

The major difficulties to overcome in order to implement an ISD approach to team training are its expense, the need for qualified personnel, and obtaining the resources and authority to carry out the training research and development deemed necessary.

SUMMARY

Two approaches to the study of team training were described. These research trends were based upon what was termed the "Stimulus-Response (S-R)" and "Organismic" models. The former model led to laboratory investigations which addressed team training problems occurring in established task situations. Adherents of the Organismic model tended to study team training in more realistic surroundings, as they were more interested in the emergent phenomena present in the task situation. The studies performed by both group of investigators cited above suggested the following conclusions:

- Team training is a necessary addition to individual training for tasks which require interaction and other "team skills."
- Effective team training can only occur if the team members enter the training situation with the requisite individual skill competencies.
- The team context is not the appropriate location for initial individual skill acquisition.
- Performance feedback is critical to team as well as individual skill acquisition.

The research findings discussed above which show that a particular team structure is "better," or that one type of reinforcement schedule is more effective than another, are quite fragile results. They can be largely obviated by such things as lack of fidelity in the training situation [16]. The nature of the training situation is a critical element to be concerned with for future team training research. Up to now the tasks used to study team training, with some notable exceptions, have been quite limited.

Recent programs in the Army have demonstrated the possibility of developing high fidelity, yet low-cost simulations which may provide team training researchers with the controls they need to study "team skills" in realistic environments rather than in the laboratory [74]. Other implications for research generated by the review above will be discussed further in Chapter V. Finally the research literature has shown that weaknesses exist in conceptual definitions of such terms as "team," "coordination," "fidelity," "interaction," etc. Efforts are needed to provide a more precise taxonomic underpinning to this field to serve as a basis for more generalizeable and comparable research.

Chapter III: REVIEW OF EVALUATION TECHNIQUES FOR TEAM TRAINING

The importance of methods for systematically evaluating team training effectiveness and the difficulty in developing such methods has been widely acknowledged for a number of years [32, 33, 34, 67, 74]; Glanzer and Glaser in 1955 [35] noted that there was an absence of satisfactory proficiency measures for team performance. In 1962, Glaser [31] remarked:

> With respect to proficiency measurement, less work has been done in this area than has been carried out with individual performance, yet the importance of developing proficiency measures for multiman systems is being more frequently considered.

By 1974, Obermayer, _et al_ [67] reported that an economically acceptable means of objectively measuring behavioral skills in the team training setting was an elusive goal. This conclusion was echoed by the Defense Science Board's 1975 review [74] of research and development programs in military training. Their review stated that the team performance measurement problem, was a "fundamental stumbling block to progress" in improving team training.

While a systematic widely applicable methodology for team training evaluation is not yet at hand, there appears to be a reasonable consensus as to what the methodology ought to accomplish [8, 17, 50, 67]. The literature reviewed suggested that any team performance measurement system must address the following areas:

1. The definition of team performance objectives in terms of specified, observable outcomes to include criteria for acceptance and conditions of performance.

2. The definition of a metric or range of values applicable to each specified observable event.

3. The detection, measurement, and recording of the value of an observed event at each occurrence.

4. An evaluation of the team as having attained or not attained the objective--based on discrepancies between outcome criteria and observed event values.

5. The feedback of team performance data to the training environment.

The remainder of this chapter will discuss current developments in team training evaluation in terms of the first four areas listed above.[1] In terms of the two-dimensional categorization of training focus and task situation, Table 6 shows that most of the studies reviewed from this chapter are related to the evaluation of team training in emergent task situations.

The Definition of Team Performance Objectives

Much has been written on procedures for deriving training and performance objectives [2, 82]. The actual statements of objectives are the end products of a series of steps in a systems approach to training development. Under this approach, the resulting objectives have three characteristics: they must describe behaviors which are to be demonstrated in the test situation; they should indicate the conditions under which these behaviors are to be demonstrated; and they should include criteria or standards of performance. The absence of performance criteria, usually stated in terms of accuracy, time, casualties taken, tolerance limits, etc., appear to be a seriously deficient aspect of team training and performance evaluation.

The Army Training and Evaluation Program (ARTEP)[2], a body of training reference literature stressing a mission-oriented, performance-based approach

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[1] The feedback of team performance data was discussed in Chapter II.

[2] See Chapter IV for a more detailed description of ARTEP.

TRAINING FOCUS

TASK SITUATION		TEAM	MULTI-INDIVIDUAL
	ESTABLISHED	Project IDOC (tank gunnery)	
	EMERGENT	ARTEP Validation Studies [93] Obermayer's study of Combat-Ready Crew Performance [67] TACDEW System [83,86] Project NORM [76] Biel's description of SAGE studies [8] REALTRAIN (crew-served weapons) [84] MASSTER METTEST (investigation of types of aggregate models) UPAM (casualty assessment method) CARMONETTE (computer simulator models) [20]	SCOPES [85,87] REALTRAIN (rifle studies) [84] MILES [84]

Table 6. Classification of studies/procedures reviewed in Chapter III.

has been under development since 1974. In 1974-75, the 9th Infantry Division and the 1st Cavalry Division trained and tested under prototype Army Training and Evaluation Programs (ARTEPs) as part of an extensive examination of the feasibility of ARTEP implementation. One of the primary objectives of the effort was to "assess the effectiveness of the ARTEP as an instrument for evaluating unit proficiency" [93]. It was concluded that the standards of performance stated for Army Training and Evaluation Program missions required revision. Army Training and Evaluation Program standards were inaccurate in some instances and too general and vague in many others, requiring individual rater judgment to a greater extent than necessary. Army Training and Evaluation Program standards, while ostensibly stated in specific performance terms, contained many indefinite terms such as "on time," "excessive," "sufficient," "promptly," "proper," etc. Interpretation of such terms is bound to vary widely without some guidance. One major difficulty relates to the use of multiple standards and the lack of guidance as to the relative value of each component. Such heavy reliance upon judgments of individual evaluators can lead to diminished Army Training and Evaluation Program validity and reliability.

Obermayer [67] described a highly sophisticated, semi-automated system for evaluating air crew performance. He stated that in some areas, such as air combat maneuvering, combat readiness determination is purely subjective. Chesler [17] asserted that standards for many combat situations--simulated or real--are often matters of widely differing opinion. Larson [57] described a possible way to overcome these differences. In his survey of team performance effectiveness measures he suggested the use of the Delphi technique--a method for systematically extracting expert opinion--to elicit subjective indicators of team performance from senior Marine Corps personnel. These performance indicators could then be used in field exercises by less experienced evaluators.

Definition of Observable Event Metrics

The critical concern in proficiency evaluation is whether or not a team has gotten the job done. It is the objective of evaluation indices to measure data that indicate whether the defined mission has been successfully performed. Precise specifications of events to be assessed could be advanced with the implementation of the Instructional System Development (ISD) approach which subsumes the use of job/task analysis procedures. However, much performance evaluation in training situations today is still highly subjective [17].

Upon examination, this problem inevitably boils down to a lack of criterion performance variables which are objective, recordable, discriminatory, and--most important--acceptable to a consensus of persons familiar with the tasks and skills of concern. This is the criterion dilemma, which is especially severe for team training. Acceptable indices of good and poor performance for military operations are difficult to define [17]. Nonetheless, techniques for the systematic identification of measurable, related events have been developed. [8, 17, 67]

Adoption of such methods may well provide the kind of comprehensive, detailed information necessary to the development of valid performance criteria, but which at present is generally not available to training and evaluation personnel. The Tactical Advanced Combat Direction Electronic Warfare (TACDEW) System appears well thought out and could readily serve as a model approach for other team performance evaluation efforts.

The basic events in the TACDEW evaluation approach [17] are the "performance variable" and the "situational variable."

A performance variable is a measure of the accuracy or timeliness of a trainee response. A situational variable is a measure of some aspect of the embedding environment for the trainee's response. Performance variables derive from two types of data elements: actual trainee response, and the response considered correct. The performance variable is the quantitative difference between or qualitative comparison of the two. For example, reported bearing (trainee response data element) for a target is 320 degrees; the true target bearing (correct response data element) is 300 degrees; the performance variable, error in reported bearing, is 20 degrees. This performance variable is a measure of accuracy of response [17].

Performance variables relating to timeliness of trainee response are derived from the actual latency of the trainee's response and a reference or ideal response latency.

A set of performance (and situational) variables is then related to an event. Once the event occurs, preliminary lists of performance variables are generated which identify any and all variables that show promise of serving as measures of training objective attainment. The developers of the Tactical Advanced Combat Electronic Warfare (TACDEW) system anticipate that their approach will help clarify the relationship among the various measurements and their relevance as criteria for making adequate judgments regarding team training outcomes.

Using similar, but perhaps less clearly articulated methods, training evaluators in other Services are attempting to define objective-related events. For example, in Project REALTRAIN,[1] an Army-supported approach which uses realistic two-sided, free-play exercises, a casualty assessment technique was developed for the basic infantry weapon, the M16A1 rifle. The development of the casualty assessment technique for the M16A1 and the development of similar techniques for other infantry and armor weapons was considered a breakthrough necessary in simulating the tactical environment [79, 84]. As part of the REALTRAIN procedures a sequential record of events is kept during each engagement at the controller's

[1] See Chapter IV for a further discussion of REALTRAIN.

station. This record includes each casualty, the time at which it occurred, and the weapon used.

Statistical analysis can help to reduce the number of possible variables. Some variables may correlate highly with others, and can be eliminated. Other variables may show very little spread in range of scores, so that they do not differentiate among trainees. Project NORM (Normative Operations Reporting Method), was an effort by the System Development Corporation to identify valid performance variables for SAGE [17] team evaluation, and to determine how situational variables affected team performance [76]. A basic concept of Project NORM was that situational variables were measures of exercise difficulty. An exploratory pilot study provided data for 41 variables--24 performance and 17 situational variables. Correlational, linear multi-variate regression, and factor analysis techniques were used to reduce the original number of 41 variables to 13. [96] There were six situational variables (related to the task at hand) which were potential contributors to performance. In addition, seven performance variables (e.g., detection latency) were considered as relevant for evaluating system performance. Whereas the variables selected appear to be useful primarily to the study content, the analytic methodology employed to derive these variables is applicable to emergent task situations, in general.

Biel [8] described another SAGE (Simulated Air-Ground Environment) study in which all measures used to evaluate team performance in a simulated environment were collected during a series of specially prepared simulated exercises. Correlations among team performance variables with measures of overall system performance in detection, identification, tracking , interceptor commitment, and interceptor guidance were computed and the resulting matrix factored. The results of this study recommended the deletion of those measures which did not have a significant relationship to overall-all system performance. It also recommended that a small number of systematically obtained observations be used to make judgments about team performance.

In Army tank crew training a large number of performance objectives have been developed for tank gunnery training and proficiency assessment. Project IDOC (Identification of Test Doctrine for Cost-Effective Qualification of Tank Crews) is concerned with the identification of a reduced set of tasks on which to base the development of cost-effective performance measures that are applicable to the entire set of objectives. Accordingly, a joint HumRRO/American Institutes for Research effort was undertaken to determine the component team behaviors for each objective, and the commonality of behaviors across objectives.[1] Plans are currently being formulated to analyze data obtained so far of generalities across tank gunnery tasks, psychometric problems, and practical constraings on performance assessment.

Detection, Measurement, and Recording of Observable Events

A problem of some concern is the unreliability and inaccuracy of trainers and observers in evaluating team performance in the field. Since there is no fixed doctrine of what to observe and how to evaluate it for various team activities, the tendency is for inter-rater reliability to be quite low.

Larson's 1971 review [57] of the team performance measurement literature concurs with this assessment. He stated that there was a shortage of objective, quantitative methods available for application in field exercise environments caused by an inherent difficulty in the measurement of complex human performance in a field environment. In REALTRAIN field exercises, detection and measurement of observable events (casualty assessment) is performed entirely by human

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[1] Interview with Army Research Institute staff.

controllers [76]. The light anti-tank weapon (LAW) and 90mm recoiless rifle (RCLR) are equipped with range-calibrated sighting plates which a controller looks through during a simulated engagement to determine hits. Casualties with the anti-tank weapon (TOW) are determined by a controller sighting through an accessory telescope mounted on the outside of the weapon. In a recent field tryout of the REALTRAIN method for combined arms tactical training, it was reported that the data collected were limited due to the methodological problems of quantitatively measuring team performance [79].

Some team training evaluation efforts attempted to circumvent the "unreliable" observer problem by automating detection and measurement as much as possible. This is particularly true in areas where sophisticated electronic and computing technology are employed in mission fulfillment[4, 8, 17, 67]. The Army is presently investigating the use of laser technology for this purpose. Project MILES (Multiple Integrated Laser Evaluation System) involves the integration of lasers with a variety of weapons types. "Firing" of a weapon emits a weak laser beam which, if aim is accurate, activates a recording device on the target. The MILES (Multiple Integrated Laser Evaluation System) is still experimental and has not been subjected to field trials, yet it has good potential for solving the problem of unreliable human measurement. Even though MILES was developed for use in multi-individual training settings, the concept could be applicable to the evaluation of crew-served weapons systems training.

Where such technological solutions are not to be used, other techniques for minimizing rater effect are being explored. To support the development of systematic methods of criterion-referenced performance assessment, the Army Research Institute through project METTEST (Methodological Issues in Criterion Referenced Testing) is funding several investigations into the applicability of psychometric methods to the requirements of combat team performance measurement. One such effort addresses the question of which tasks, given limited time and resources, should be assessed via high fidelity operational simulations, which may be measured "synthetically" (via paper and pencil instruments), and which may be assessed by inference from performance on related, more inclusive tasks.

Evaluation of Objective Attainment

Attempts to evaluate team performance during field performance tests have varied considerably. In some cases, it is assumed that if a given team completes an exercise successfully, the team received training in relevant vehaviors.

The most common means of evaluating performance is overall subjective evaluation. Where detailed checklists are used, each individual team member receives a numerically weighted score. The team score, then, is arrived at through some weighted combination of individual scores--generally a simple sum.

The ability of human evaluators to effectively judge the success of teams in complex field exercises is generally considered unsatisfactory. In the Army Training and Evaluation Program (ARTEP) validation report [93] cited earlier, it was concluded that the ARTEP in its present form is not a standardized test instrument. There is no reason to expect that different teams would be evaluated under the same conditions when using Army Training and Evaluation Program guidance and standards. The standards are too subjective and evaluator performance is too erratic. There is no explanation of how to relate task performance to overall mission performance or how to adjust standards to account for varying test conditions [93].

The Modern Army Selected System Test Evaluation and Review (MASSTER) attempts to evaluate weapons systems training by employing a combination of checklists, associated logic trees, and expert judges in the field environment. The checklist logic tree evaluation uses field observers to check off the team's performance in specified situations. The team passes or fails progressively larger tests as a result of their performance on previous examinations. MASSTER also assigns officers to subjectively evaluate large teams during an exercise [57].

Currently experienced difficulties in making reliable and accurate judgments about team performance is in large measure due to the multiplicity of potentially influential factors. Chesler [17] stated:

> . . . single performance measures are inadequate for making overall evaluations of system effectiveness, presumably because multiple factors are involved in the determination of mission success or failure. Combining measures into overall indices, has, so far, not seemed to help much, probably because the relationship between them is not clearly understood. Thus, lumping them together does not necessarily improve the quality of system evaluation.

Recognition of this complexity has led to a number of investigations of analytic or modeling approaches to the evaluation problem. A study within the Army Research Institute's METTEST (Methodological Issues in Criterion Referenced Testing) project is concerned with the applicability of traditional measurement models to the need for team performance indices. Measures are needed that give valid representation to the many team-related and environmental factors which influence mission attainment. Preliminary work has suggested that the predominantly linear additive models of psychometrics are not applicable in this context--that non-linear (e.g., exponential) and "multiple-cutoff" models may be more appropriate. In "multiple-cutoff-models," team activities are structured in a manner related to the sequence in which they would occur in the field, and each is evaluated on a GO/NO-GO basis. Within this approach "compensatory" and "non-compensatory" activities can be identified. It is non-compensatory if one particular component will abort the attainment of the mission if it is not performed properly. If some other component can successfully pick up the slack left by the failed component, then it is compensatory.

The UPAM model (Unit Performance Assessment Model) developed at the Army Research Institute employs casualty data as a measure of both the achievements of a team (casualties inflicted on an opposing force) and the cost to the team (casualties sustained) during its efforts to fulfill a mission. Measurement of a team's accomplishments is obtained by inputting to the model data from REALTRAIN field exercises and deriving a single value reflecting both cost and achievement. A criterion value for assessing the empirical result is obtained by having the unit commander provide estimates of these values that in his judgment are indicative of a successfully accomplished mission. The difference between empirical output and the commander's "expected" output (on a scale from -1 to +1) is viewed as an index of the team's success in attaining its goal. The UPAM model has been applied to both infantry and armor units. However, in its present state of development, the model does not provide evaluative information concerning team activities which contribute to or detract from mission accomplishment.

The most detailed and sophisticated analytic model found in this survey is the CARMONETTE ground close combat computer simulation [20]. Its parameters include detailed descriptions of team size, team type, firepower, vulnerability, mobility and sensing capabilities. Data on terrain ranges from elevation and height of vegetation to trafficability. Additionally, a set of "orders" can be transmitted to each team of opposing forces (i.e., a mission). Further, each team can acquire information and relay it to equivalent teams or to its command HQ. While the output from CARMONETTE provides only descriptive data, it could, if provided with field data, provide valuable clues concerning the effect of performance and situational variables on mission outcomes.

Summary

There is still a major unsolved problem in the development of evaluation methods and tools for team training--namely, there is a need for reliable, objective-based, team performance measures. The literature reviewed indicated the difficulties of doing research in this area in spite of its acknowledged importance to the improvement of team training. The current support within the Army Research Institute for R&D in this area demonstrates their realization of its criticality. Most of this research is still in progress. Findings gleaned from the studies surveyed suggested the following:

- A systems approach to team training development should alleviate some of the problems associated with the establishment of criteria/standards.
- Much performance evaluation in team training today is highly subjective and unreliable.
- Lacking an adequate team performance measurement system, alternative team training programs and team proficiency cannot be properly evaluated.
- Automating the monitoring and/or data recording process is needed in order to solve the problem of unreliable human observers.

Recent innovations in team training methodology discussed in Chapter II promise significant improvements in operational performance. A strong emphasis on R&D in the area of team performance measurement is required in order that this improvement be detected and operationally realized.

Chapter IV: CURRENT MILITARY TEAM TRAINING APPROACHES

Examples of team training techniques currently in use in the Services are presented in this section. It is not intended to be an exhaustive presentation of such training methods. Rather, the examples were chosen to represent the variety of methods now employed to conduct team training. The training devices and systems discussed in this chapter are categorized in Table 7. They were all classified as pertaining to emergent task situations because they stress the realistic requirements of operational environments.

ARMY TEAM TRAINING

Army team training is predominantly a unit training function with no formal institutional training requirements. The great majority of personnel who complete Military Occupational Specialty (MOS) training at Army schools and training centers are assigned to units as replacements. They receive team training in the units in the form of individual on-the-job training, augmentation, cross-training, and collective (team) training. Most training is performed on operational equipment with the objectives of maximizing proficiency or readiness [41, 88].

In the Army, Advanced Flight Training is considered team training. Graduates of Undergraduate Pilot Training receive supplementary training in the specific aircraft they will fly on operational missions. The supplementary training is provided by the operational unit. The new pilot is integrated into the operational unit where he undergoes transitional training as part of normal unit training [74].

Much of the team training conducted in the Army is based on information contained in Army Training and Evaluation Program (ARTEP) publications. That is, ARTEPs "drive" the Army's team training system. ARTEPs are developed to assist training managers and trainers in the preparation, conduct and evaluation of team training.[1] They consist of a series of training and evaluation outlines

	TRAINING SITUATION	
	TEAM	MULTI-INDIVIDUAL
ESTABLISHED		
EMERGENT	CATTS (Combined Arms Tactical Training Simulator) [74] WST (Device 2F87, Weapons System Trainer) [41] Device 14A2, Surface Ship Anti-submarine Warfare(ASW), Early Attack Weapons Systems Team Trainer [41] Device 14A6, ASW Coordinated Tactics Trainer [41] Device 21A37/4, Submarine Fleet Ballistic Missile (FBM) Training Facility [41] TACDEW (Tactical Advanced Combat Direction and Electronic Warfare System) [41,83] TESE (Tactical Exercise Simulator and Evaluator) [75] FIST (Functional Integrated Systems Trainer) [74] C-5 MissionFlight Simulator C-141 Flight Simulator C-130 Flight Simulator WST (B-52 Weapons Systems Trainer)	SCOPES (Squad Combat Operations Exercise, Simulation) [85,87] REALTRAIN [84] MILES (Multiple Integrated Laser Engagement System) [84] TWAES (Tactical Warfare Analysis and EvaluationSystem) [74]

Table 7. Classification of Training Contexts

[1] See Chapter III for a discussion of ARTEP as an evaluation mechanism.

which specify for a particular element of a battalion/task force, or separate company, the following information:

a. The unit (i.e., crew, squad, platoon, company/team or batallion/ task force) for which the outline is applicable.

b. The mission to be performed.

c. The general conditions (situation) under which the mission will be performed.

d. The primary training and evaluation standards upon which the unit will be evaluated as either satisfactory or unsatisfactory (Go/No Go).

e. The collective training objectives applicable in the performance of the mission; guidance for estimating support requirements necessary to conduct formal evaluations, and tips to trainers and evaluators [85].

Inasmuch as the Army Training and Evaluation Programs (ARTEPs) outline the basic missions that teams should be able to perform to be combat ready, they are a valuable source of information in preparing the scenarios for training strategies/ exercises such as SCOPES (Squad Combat Operations Exercise, Simulation), MILES (Multiple Integrated Laser Engagement System), REALTRAIN and CATTS (Combined Arms Tactical Training Simulator) which are discussed below.

1. SCOPES (Squad Combat Operations Exercise, Simulation)

SCOPES was originally designed to teach movement techniques to rifle teams and squads. It has been successfully used to train and/or evaluate soldiers or small teams on a wide range of battlefield skills, tasks, or missions.

Briefly, SCOPES works in the following way. Trainers first develop a tactical scenario based on specified training objectives. Six-power telescopes mounted on each rifleman's M16A1 rifle are used to identify numbers worn on the helmets of all participants in opposing forces. When a number of an "enemy" soldier is identified, the soldier making the identification fires a blank round and calls out the number he sees. Controllers in the vicinity in turn pass the number over a radio net to controllers operating with the opposing force. If the number is correct, the controller immediately "kills" the man wearing the number seen.

In this technique, "battles" may be conducted with real outcomes. Depending on the tactics selected and the individual techniques used, it is possible to objectively determine "winners" and "losers."

After each engagement, troops on both sides are brought together for an after-action review to discuss errors made and lessons learned. In this manner, the correct techniques to avoid being "killed" can be brought out, learned, and practiced in subsequent engagements [85, 87].

2. REALTRAIN

The REALTRAIN program permits the conduct of larger scale exercises using opposing forces than does SCOPES (Squad Combat Operations Exercise, Simulation). To simulate the effects of other weapons systems, optical devices including telescopes and plastic sighting plates are mounted or used with light anti-tank weapons (LAWs); 106mm RCLR (recoilless rifles); anti-tank weapons (TOWs); tank man guns; DRAGON (medium anti-tank weapon); and 90mm RCLR. These devices are aligned with the weapon's sight picture thereby allowing controllers to see the same sight picture as the gunners. This permits them to verify a gunner's aim during a target engagement. Gunners "shoot" at targets by announcing the identification numbers worn by the soldiers aligned in their sights. Each optical device is correlated with the maximum effective range of the particular weapons system with which it is used [84].[1]

Field tests conducted using SCOPES and REALTRAIN exercises have proven that engagement simulation techniques work for training multi-individual groups. Both soldiers and units reach higher levels of tactical proficiency more rapidly, and soldiers are motivated to train because the tactical exercises present a real challenge.

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[1] A more complete description of REALTRAIN can be found in Army Training Circular 71-5 [84].

3. MILES (Multiple Integrated Laser Engagement System)

MILES is a group of experimental training devices which uses an eye-safe laser beam to simulate the effects of weapons expected on the modern battlefield. The system will permit conduct of day and night tactical exercises and will improve the integration of gunnery techniques into tactical training. Some of these subsystems are:

- Vehicle Engagement System (VES). The VES will be used by armor units and anti-armor weapons such as TOW (tube-launched optically tracked wire guided missile), DRAGON (medium anti-tank weapon), and the 106mm recoiless rifle.

- Target Engagement Simulator (TES). The TES will be used by Infantry troops to provide engagement realism. It consists of a laser transmitter and a hit indication device which signals "kills" and "near misses."

- Machine Gun Laser (MGL). The MGL simulates machine guns both unmounted and mounted on tanks.

MILES will permit conduct of tactical exercises involving battalion and task force size teams [84]. It is scheduled for testing in 1978.

The MILES procedure (as well as SCOPES--Squad Combat Operations Exercise, Simulation--and REALTRAIN) focus on individual skills training in emergent task situations. The feasibility of using these techniques for training team skills needs to be determined.

4. CATTS (Combined Arms Tactical Training Simulator)

The purpose of the CATTS system which is still under development is to provide Battalion Commanders and their staffs with simulated combat situations operating from a ground command post.

The CATTS system has several features desired for training. It allows realistic, real-time ground combat simulation; realistic mockups of command post vehicles; actual field radios for communication; on-the-spot command decisions and critiques; extensive automation to assist controllers; and cost-effective software and hardware.

The simulator utilizes a Xerox Sigma 9 computer to meet the following training objectives:

a. Identify the relationships that exist among various elements and with the enemy.

b. Identify alternative courses of action, appropriate formation maneuvers and fire support applications.

c. Communicate decisions to subordinates using tactical orders so that decisions can be effectively interpreted.

d. Manipulate and monitor the variety of tactical radio networks available at the battalion level. [74]

NAVY TEAM TRAINING

As in all of the Services, team training in the Navy consists of training which is provided to organized teams for the performance of a specific mission. The Navy discusses team training in terms of five categories: Pre-team Indoctrination Training; Subsystem Team Training; System Sub-team Training; System Level Operational Training; and Multi-unit System Operational Training [74].

Pre-team Indoctrination Training is conducted in a team context with emphasis on increasing the skill levels of the individuals who will later be assigned to operational teams.

In Subsystem Team Training teams vary in composition under different conditions of shipboard readiness. The teams are divided into three departments: Combat System Teams (e.g., Search Radar Detection and Tracking); Unit Operations Teams (e.g., Navigation); and Engineering Systems (e.g., Firefighting/Damage Control).

System Sub-team Training involves the training of two or more sub-system teams and generally an entire ship.

System Level Operational Training is accomplished by at-sea-training because existing pierside facilities do not have the capability of handling an entire crew of a ship in all facets of an operation. This type of training is best described as a battle problem which is conducted by underway training units and fleet training groups.

Multi-unit System Operational Training is in-port exercises utilizing shore-based trainers for the purpose of training crews prior to getting underway for the exercise operations area. Major in-port exercises utilize the Tactical Advanced Combat Direction and Electronic Warfare (TACDEW) Trainer [74].

The following major team training devices used in the Navy are described below: Device 2F87 (Weapons Systems Trainer), Device 14A2 (Surface Ship Anti-Submarine Warfare Early Attack Weapons Systems Trainer), Device 14A6 (Anti-Submarine Warfare Coordinated Tactics Trainer), Device 21A37/4 (Submarine Fleet Ballistic Missile Training Facility), and TACDEW [41].

1. Device 2F87, Weapons Systems Trainer (WST)

The WST duplicates the interior arrangement and appearance of the P-3C aircraft. Five trainee stations simulate corresponding stations in the aircraft. The purpose of WST training is to teach team coordination. Students are organized into teams according to positions for which they are being trained. The trainees "fly" simulated anti-submarine warfare (ASW) missions. These missions are graduated in difficulty from very simple scenarios early in training to more complex exercises toward course completion.

2. Device 14A2, Surface Ship ASW (Anti-Submarine Warfare) Early Attack Weapons System Trainer

Device 14A2 is used to train surface ship teams in the proper utilization of operational ASW systems. Training emphasizes the procedural, tactical decision making, and team coordination activities in operating and employing ASW weapons systems. The device provides for indoctrination of personnel in ASW procedures and evaluation of tactical situations. The trainer is also used in developing and planning advanced Naval undersea defense tactics.

The trainer occupies over 3000 square feet of floor space and duplicates the physical configuration of major operational compartments and equipments of surface ship Anti-Submarine Warfare (ASW) attack weapons. It simulates their functional operation and responses such as target detection, fire control solution, and weapon launching and tracking.

3. Device 14A6, ASW Coordinated Tactics Trainer

Device 14A6 is designed to train decision-making personnel in the tasks they must perform when engaged in coordinated ASW tactics. Simultaneous operation of 48 vehicles of various types and a multiplicity of sensors can be simulated. Communications facilities simulate the various radio channels employed operationally to coordinate all phases of an ASW mission from search through attack. Device 14A6 provides a synthetic environment within which ASW personnel can practice collecting and evaluating ASW information, making decisions, and implementing the decisions based on this information. The device is not intended to train equipment operators; therefore, simulated equipment does not resemble fleet equipment. Functional characteristics of the simulated equipment are similar to fleet equipment.

Virtually any exercise at sea which requires communication, coordination, maneuvering, and decision making may be practiced in the 14A6 trainer prior to going to sea.

4. Device 21A37/4, Submarine Fleet Ballistic Missile (FBM) Training Facility

Device 21A37/4 provides training in offensive and defensive tactics for nuclear attack center teams. Surface or subsurface maneuvers may be accomplished, and training may be given independently or in coordination with other units. Instruction of senior command and staff officers in direction and coordination of submarine task groups with surface support units may also be given.

A central digital computer provides problem generation, position and motion data generation. Up to 41 different vehicles can be included in training problems. A projection system in the attack centers permits both in-progress monitoring and post-fire analysis of training problems. Attack centers can be operated independently or operation can be coordinated to provide submarine versus submarine training. Fifteen different classifications of targets are currently available, 12 at any one time.

5. Tactical Advanced Combat Direction and Electronic Warfare System (TACDEW)[1]

TACDEW is a highly sophisticated computer-based simulationfacility having three primary missions: individual and team training, tactics evaluation, and testing of operational computer programs for Navy Tactical Data System (NTDS) ships. Training is conducted in 23 Combat Information Center (CIC) mockups typical of the ships on which trainees serve [41]. Team and multi-team training are accomplished. The purpose of TACDEW training is not so much to establish team interactive skills as it is to maintain or enhance these skills in simulated mission contexts. Training typically consists of exercising a given team, or some combination of teams, in a series of scenarios of graded difficulty. The scenarios are designed to model tactical situations which might be encountered in an operational environment.

[1] A more detailed description of the TACDEW system is presented in the TACDEW Information Pamphlet [83].

MARINE TEAM TRAINING

The Marine Corps has recently initiated two tactical exercise projects whose objectives are to develop and integrate computer-driven systems into ongoing field and school training programs. The computer-driven simulation which is the heart of these training systems, can handle a greater number of factors with greater precision and finer resolution than was previously possible in any manually conducted model [75].

The two team training systems associated with these projects are briefly discussed below: TESE (Tactical Exercise Simulator and Evaluator); TAWES (Tactical Warfare Analysis and Evaluation System).

1. TESE (Tactical Exercise Simulator and Evaluator)

TESE is used to train Marine Corps officers in combat decision making. The project seeks to define procedures for war gaming. The goal is to get both computer-based individual and team measures during amphibious warfare exercises, and to increase the number of trainees who can be processed.

2. TWAES (Tactical Warfare Analysis and Evaluation System)

TWAES is a computer-assisted system to control tactical field training exercises. The system offers potential improvements in maneuver control and simulation of indirect fire [74]. The current TWAES research effort is studying the exact role that the post-exercise session will play in the total tactical exercise. The question being addressed is whether this feedback session will be a training vehicle to further extend the game's learning effectiveness or whether it will be merely a post-exercise debriefing during which administrative information about game procedures is passed on [75].

AIR FORCE TEAM TRAINING

In the Air Force, there is very little formal team training being conducted. All such formal courses surveyed were used in training strategic missile teams. Students are provided training in the responsibilities and necessary technical procedures of the appropriate weapons system, but their proficiency upon graduation from team training courses is less than that required for combat-readiness. Thus, additional upgrade training is required at the unit/base prior to actual job performance [74].

Similarly, there are few team training devices. One device uncovered in this survey is the Functional Integrated Systems Trainer (FIST). The purpose of FIST is to provide a better means for training four members of the fire control team on the AC-130E Gunship. The second objective of FIST is to refine and promote the use of the technology for developing low-cost, interlinked, functional, part-task trainers [74].

Similarly, most team training devices deal with the training of aircraft flight crew members. Representative training devices are available for the B52, C5, C130 and C141 aircraft as described below.

1. B52 (G & H models) Weapons System Trainer (WST)

The WST is presently under development. It will permit the integration into a single team training device four individual devices presently being used. The four devices are: (a) The Mission Trainer used for training pilots and co-pilots; (b) Navigator Trainer used for training radar navigators and navigators; (c) Electronic Warfare Officer Trainer (EWO); and (d) Gunnery Trainer. The WST when developed will permit simultaneous team training of the entire six-man B52 crew.[1]

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[1]Personal communication with COL Roy L. Ripley, LTC Walter D. Black III, Instructional Systems Branch, Audiovisual and Instructional Systems Division, US Air Force, Washington, DC.

2. C5 Mission Flight Simulator

This team training device consists of three training stations which permit integrated team training pilots/co-pilots, navigator and flight engineer.[1]

3. C130 Flight Simulator and C141 Flight Simulator

Both of these training devices are similar to the C5 Mission Flight Simulator except that training is not provided for the navigator station. However, the C130 Flight Simulator is scheduled to add the navigator station as part of the device in 1981.[2]

4. Functional Integrated Systems Trainer (FIST)

The purpose of FIST is to provide a better means for training four members of the fire control team on the AC130E Gunship. The second objective of FIST is to refine and promote the use of the technology for developing low-cost, interlinked, functional, part task trainers [74].

SUMMARY

The emphasis in this survey has been on formal team training. Much informal team on-the-job-training occurs in the daily operations of the Services. It is extremely difficult to delineate, in such activities, the training mode from the operational. This is especially true in areas such as flight training, air defense, etc.

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[1] Personal communication with LTC C.R. Philbrick, MAC/DOTF, Scott AFB, IL.

[2] Ibid.

However, various methods of team training are currently underway in the Services. These include the following:

- Large-scale opposing forces tactical exercises
- Devices which simulate effects of weapons
- Computer simulations of tactical decision-making problems
- Simulations of mission-specific hardware and software (e.g., anti-submarine warfare vehicles.

The above methods are tailored for both initial team training and maintenance of already acquired team skills. They vary in cost, simulation fidelity, and generalizeability. Although these devices are now being used, there has been relatively little programmatic R&D performed upon them considering the cost of such systems.

Chapter V: RESEARCH IMPLICATIONS

A number of implications for research in team training/evaluation are presented in this chapter. These implications resulted from a comparison of current military practice with the findings of the literature review. In addition, HumRRO staff relied on their experience in the training research area to identify the most critical areas for support. The specific questions addressed in this report were the following:

(1) *What state-of-art gaps are there in team training strategies and evaluation techniques?*

(2) *What new team training and evaluation strategies appear to hold promise for applications to the DoD environment and warrant further study?*

The literature reviewed for this report support the contention of the Defense Science Board [74] that there is a great need for R&D in team training, considering the magnitude of such training in the Services. One major problem to overcome is the tremendous diversity of terms, concepts and operations which are used. A "team" is <u>not</u> a simple fixed unit, it is arbitrary, has unclear boundaries, and an unstable structure and composition. A team should be defined on the basis of its criterion situation, not on the basis of administrative convenience. [34] Describing team training in the Services, the Defense Science Board [74] resorted to an awkward abbreviation, CGTU, for <u>C</u>rew, <u>G</u>roup, <u>T</u>eam, and <u>U</u>nit to accommodate users of each of these terms. There is a need for more standardization and sharing of terms. Efforts should be supported to develop a reasonable taxonomy upon which to build research programs in team training.

A classification scheme was introduced in Chapter 3 which was used to categorize the studies and techniques discussed in this review along two dimensions. The training focus can be either team or multi-individual -- depending upon the skills to be trained. The task situation can be classified as established or emergent.

Methods are needed for differentiating individual, multi-individual, and team skills. Techniques need to be developed which can be used to identify individual and team skill training requirements as part of job/task analyses. Such techniques would discriminate between isolated and interactive behaviors and will provide the opportunity for establishing criteria/standards of team performance as part of training requirements analyses. Variations and/or combinations of observational interaction analyses and other unobtrusive measures which have been used in non-classroom settings should be studied for their possible application. A recent compendium [95] of such methods provides detailed information about techniques which are of potential value such as:

- Interaction Process Analysis -- Robert F. Bales
- Sequential Analysis of Verbal Interaction (SAVI) -- Anita Simon · Yvonne Agazarian
- CERLI Verbal Behavior Classification (CVC) -- Cooperative Educational Research Laboratory, Inc.

The development of such analytic techniques is a critical first step in any research program which seeks to use realistic team performance standards as effectiveness criteria.

There is a considerable need for measures of team performance to apply both during and following training. As described in Chapter III this problem has resisted solution for the past 20 years. The difficulties of observing team member interactions, the great costs in money and time to conduct studies in this area, and the unclear relationships between task or training variables and team performance, have all contributed to the unsuccessful search for measures of team proficiency. The production of standardizable, relatively invariant test conditions for evaluating dynamic and interactive team behavior remains one of the major problems in team evaluation.

It is only in recent years that considerable research support has been provided to arrive at measures of team performance. Critical problems to overcome are:

- The criterion problem--Without agreed-upon criteria or standards of team performance, evaluation of training or team proficiency cannot occur.
- The measurement problem--Stated succinctly, what to measure, where, when, and how, are still all unanswered questions in the evaluation of team performance.

Considering the current lack of information in this area, the potential heuristic value of the analytic or modeling approach is worthy of continued support. Of course, the usefulness of any model depends on its ability to generate information and ideas which lead to the development of practical and worthwhile evaluation tools and techniques.

For example, the CARMONETTE simulation outputs predictions of team performance based on hypothetical values for a number of performance and situational variables pertinent to the team and to an opposing force (e.g., size/vulnerability, firepower, mobility, and/terrain features). <u>Empirical</u> values gathered from field exercise data for the variables could then be input to the simulation and outcomes compared. Continued systematic iterations of the model would suggest the specific variables that made a difference. If validated in further field exercises, these variables could guide the refinement of test situations and the development of better measurement techniques.

It is probably true that teams operate in situations which have a combination of both emergent and established characteristics.

This underlies the importance of performing a thorough analysis of the criterion task situation prior to developing team training programs. An application of the systems approach to the development of team training should permit identification of the interactions, communication, coordination, decision making and other activities required in the task performance of each team member. The information gathered with the appropriate analytical tools should include standards and relevant conditions of performance. This would provide a major step toward obtaining clearly stated, objective criteria and procedures for evaluating team performance.

One consistent finding of this literature review was that individual proficiency has been shown to be a major determiner of team performance. This had led investigators such as Hall and Rizzo [41] to conclude that more emphasis should be placed upon individual rather than team training. The authors of this review disagree. Although certain laboratory studies showed that when the tasks required only individual skills, team training was superfluous, other investigations, primarily in more realistic, "emergent" situations showed the importance of team training. When "team skills" (e.g., interaction), even though poorly defined, were important in the task situation, team training was more effective than individual training. Further research into this area should provide information which can impact on the issue of where and when to conduct team training. For example, individuals in air squadrons are trained within a team context. They are then individually assigned to operational units. If team skills are relevant to a given task situation and can be learned during a limited training period it may be more efficient to assign the team intact rather than disband it following training [41].

A need exists for studies which explore the issue of skill training sequencing. After individual and team skill requirements for a given task situation have been idenitified, the sequence in which component skills are trained can be systematically varied and the resulting effects compared. For example, individual skills can be trained prior to team skills training; training of team skills can occur first; or both individual and team skills can be integrated within the training program and taught concurrently. The results of such studies which can be performed in either established or emergent task situations will help determine when and under what conditions team training can be administered most effectively.

Some types of team training are so costly that one cannot conduct them in an operational environment. Other types of training have logistic or safety factors which preclude operational, full fidelity training or testing. High fidelity simulations which were common in individual training for many years has been shown to be effective for team training. However, such simulation techniques, though costly, provide little generality beyond a specific training mission. A substantial research and development effort is needed to determine the degree of simulation fidelity required for effective training in different situations. Relatively low-fidelity simulation techniques have been effective and economical in individual training. However, the review of the literature indicated that high fidelity simulations were needed for effective team training. The studies surveyed were performed in established laboratory settings. The search should continue for effective low fidelity devices or methods to apply to team training in emergent task situations because of their potential cost savings.

The second question addressed in this review involved the identification of team training/evaluation techniques which warranted further study and support. One of the most promising new approaches is two-sided engagement training. Current implementations of this technique were described in Chapter IV in discussions of SCOPES, REALTRAIN, and MILES. The two-sided engagement simulation provides a low cost, high fidelity framework for developing individual skills. It provides a situation in which there is high motivation fostered by competition in a natural, realistic environment. This approach, which can be classified as situational or contextual training is an outgrowth of the effective "functional context" approach to individual training [78]. Up to now, two-sided engagement training has been used to teach individual skills within a group context. Support is needed to study the feasibility of applying these methods to train team skills. There is a need to study how effective the techniques are, analyze the factors which produce favorable training outcomes and study how these methods can be transferred to other training situations. Thus far, post-exercise debriefings have been used to discuss individual performances. Team performance information needs to be fed back to trainees in a more timely and effective manner both during and after training.

A systematic investigation of feedback effects upon team training is needed. Support is required to do research on the following issues:

- Need for feedback - What changes in training methods or content result from feedback? Will there be differences if remediation is contingent or non-contingent upon feedback?

- Feedback mode - Methods should be available for giving both trainees and trainer feedback of how well the team is performing. Determining what are the appropriate methods for giving performance feedback to team members is an area requiring further R&D (e.g., Compare video recording with post-exercise debriefing procedures -- Hypothesis: Clarity and objectivity of observation will provide more useful feedback). The use of television and video recording to provide relatively responsive performance feedback has been used successfully in a variety of contexts (e.g., sports, teacher training). Its potential value to military team training appears great, but needs considerable R&D support to identify its most appropriate applications.

- <u>Delay of feedback</u> - A systematic study is needed to determine under what conditions is provision of feedback immediately after a training exercise, superior, equal to, or inferior when compared to delayed presentations--1, 2, or more days following the event.

Another issue which merits study concerns the effects of team member familiarity on the acquisition of team skills. Does the length of time that a team functions together affect team performance. One could systematically vary this time parameter, re-allocate team members, set up new teams, and then study transfer effects.

The ability to evaluate oneself accurately is a skill which should help to produce effective team performance. Analysis of one's own errors, as well as awareness that one is overburdened and needs other team members' help are two specific components of this ability which should be trained. There is a need for a program supporting the development and evaluation of training packages which would provide generalizable instruction in these self-assessment skills. One could compare subsequent team performance with or without prior self-assessment training. Greater proficiency would be expected from those teams who have had such self-assessment skill training.

Another possibility is that prior training of team members to assess the capabilities of others will result in better subsequent team performance. By having the ability to assess other team members' strengths and weaknesses, it is hypothesized that the individual team member best suited to take over or help out on a given activity can be selected adequately--and thereby enhance overall team performance.

It may be more efficient to do research on a combination of some of the issues discussed above within the same study. For example, groups feedback or skill sequencing issues can be studied in environments which contain established or emergent task situations and which vary in their degree of simulation fidelity.

The research and development implications mentioned in the paragraphs above are merely the foci of what should be considered programmatic efforts in the team training/evaluation area. Considering the importance and extent of this area, the current state of knowledge is quite meager. Studies and techniques such as those mentioned above, if supported, should help to ameliorate this condition.

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