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COLLEGE OF SCIENCES
OLD DOMINION UNIVERSITY
NORFOLK, VIRGINIA 23529

TEAM EVOLUTION AND MATURATION

By

Albert S. Glickman, Principal Investigator

and

Seth Zimmer

Final Report

For the period July 16, 1987 to December 15, 1988

Prepared for
Office of Naval Research
800 N. Quincy Street
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Dr. James Lester, Scientific Program Officer
Attn: Code N00014

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This report represents culmination of three years of research on Team Evolution and Maturation (TEAM) in the Navy. Participants in this research during a period of three years were ships' team members engaged in training and their instructors at Naval Gunfire Support, Anti-Submarine Warfare, and Guided Missile schools in the Norfolk area. The primary objectives of this research were to: (1) delineate the process variables that comprise "teamwork"; (2) develop a set of instruments to measure these variables; (3) increase the understanding of how teamwork develops (i.e., how teams evolve and mature) over the course of training; (4) develop ways to diagnose, correct, and enhance team performance in training; and (5) examine the generalizability of the findings when compared to previous efforts. These objectives were organized into two sequential phases of research. In Phase I, a longitudinal model of team evolution and maturation was incrementally refined and empirically validated. The model was then used as a framework for construction and validation (OVER)			
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of instruments used to obtain data at several points in the course of training from team members and their instructors on behaviors exhibited, performance levels attained, and perceptions emerging. Phase II research utilized the products of Phase I to identify dimensions of team behavior that were: (1) critical to team work development and (2) reveal patterns of team training needs across a substantial portion of teams. Six intervention strategies were designed to address those team development needs for which cost-effective and performance-enhancing opportunities had been identified.

It has been made evident that a recognizable process of team evolution and maturation does exist. Changing patterns of trainer observations and trainee perceptions bear this out. The transformation of a set of individuals into a cohesive, motivated, and effectively functioning unit requires that they acquire certain specific teamwork knowledge and skills to be coupled with their taskwork knowledge and skills. Team leaders and instructors need to be specifically trained to recognize and impart these knowledges and skills. Preliminary trials show promise that these gaps can be filled with interventions that are cost effective.

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Submitted by the
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P. O. Box 6369
Norfolk, Virginia 23508-0369

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EXECUTIVE SUMMARY

This report represents culmination of three years of research on Team Evolution and Maturation (TEAM) in the Navy performed by the Center for Applied Psychological Studies at Old Dominion University in collaboration with the Human Factors Division of the Naval Training Systems Center (NTSC), Orlando, FL. Participants in this research during a period of three years were ships' team members engaged in training and their instructors at Naval Gunfire Support, Anti-Submarine Warfare, and Guided Missile schools in the Norfolk area.

The primary objectives of this research were to: (1) delineate the process variables that comprise "teamwork"; (2) develop a set of instruments to measure these variables; (3) increase the understanding of how teamwork develops (i.e., how teams evolve and mature) over the course of training; (4) develop ways to diagnose, correct, and enhance team performance in training; and (5) examine the generalizability of the findings when compared to previous efforts.

These objectives were organized into two sequential phases of research. In Phase I, a longitudinal model of team evolution and maturation was incrementally refined and empirically validated. The model was then used as a framework for construction and validation of instruments used to obtain data at several points in the course of training from team members and their instructors on behaviors exhibited, performance levels attained, and perceptions emerging. Phase II research utilized the products of Phase I to identify dimensions of team behavior that were: (1) critical to team work development and (2) reveal patterns of team training needs across a substantial portion of teams. The following intervention strategies were designed to address those team development needs for which cost-effective and performance-enhancing opportunities had been identified.

Behavioral troubleshooting. Provides a methodology for instructors to apply the same logic and techniques employed in equipment repair troubleshooting to the diagnosis and improvement of the functioning of a team.

Sound level monitoring. Involves the use of an inexpensive noise level analyzer to record sound levels, in decibels, generated by verbal interactions during training exercises, and to provide posted feedback to teams that leads to better organization, less confusion, and better overall performance.

Sound powered communications. Involves monitoring and recording of communication exchanges, followed by posting of feedback, directed at reducing the amount of procedurally incorrect or extraneous transmissions.

Back-up behaviors. Involves monitoring and recording of communications, followed by posting of feedback, directed at increasing the frequency of suggestions and corrections exchanged by team members.

Leader prebrief. Guidelines are specified in order to encourage the team leaders to prepare the short briefings at the start of team exercises that are vital to clear understanding of roles, responsibilities, task assignments and performance goals, and to generating motivation.

Trend tracking. A procedure is outlined for development and implementation of a trend tracking system for use in training and operational settings that would add to the utility of currently available data, computers, and programs for improving team performance.

In brief, it has been made evident that a recognizable process of team evolution and maturation does exist. Changing patterns of trainer observations and trainee perceptions bear this out. The transformation of a set of individuals into a cohesive, motivated and effectively functioning

unit requires that they acquire certain specific teamwork knowledge and skills to be coupled with their taskwork knowledge and skills. Team leaders and instructors need to be specifically trained to recognize and impart these knowledges and skills. Preliminary trials show promise that these gaps can be filled with interventions that are cost effective.

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INTRODUCTION

Programmatic goals

Since April 1985, the Center for Applied Psychological Studies of Old Dominion University in collaboration with the Human Factors Division of the Naval Training Systems Center (NTSC), Orlando, Florida, has been engaged in cooperative research in order to study the processes involved in the evolution and maturation of Navy teams. The ultimate goal of this research was to formulate concepts, principles and procedures that could be applied to enhance the effectiveness of future team training systems by: (a) providing greater understanding of the changes in technical, social, and psychological factors that characterize and influence performance of teams during the course of training, and (b) developing and evaluating interventions (e.g. strategies, techniques, tools, and instruments) that could improve methods of instruction and design of training devices and equipment.

The work covered by ONR Contract No. N00014-86K-0472, Team Evolution and Maturation, began on 16 July 1986 and ended on 15 December 1988. This final report to the Office of Naval Research (ONR) represents a synthesis and summary of the project reports and memoranda, and the presentations at professional meetings, that have been prepared during that contract period. The technical reports and memoranda have been submitted to NTSC and are transmitted to ONR upon publication by NTSC.

Preliminary work

This work followed an initial contract, administered by the Battelle Columbus Laboratories, that documented the changes that occur as team members learn about their task, each other, and the demands of the training scenarios confronted by naval gunfire support teams undergoing

weeklong training at the Naval Gunfire Support School, Little Creek Amphibious Base, Virginia Beach, Virginia. Also during this contract period the existing literature on team performance and team training was reviewed, and a preliminary version of the Team Evolution and Maturation (TEAM) model was constructed. Upon completion of the preliminary model, initial data collection forms and other types of data collection methods were employed to record and measure the changes in team behaviors that occur during training. In this developmental stage, interviews were conducted with school personnel, actual training sessions were observed, questionnaires were administered, and data collection instruments were tested and refined.

The full report of this effort can be found in the following technical report:

Morgan, B.B. Jr., Glickman, A.S., Woodard, E.A., Blaiwes, A.S., & Salas, E. (1986) Measurement of team behaviors in a Navy environment (NTSC Tech. Report TR86-014). Orlando, FL: Naval Training Systems Center.

Organization of the report

The organization of this report corresponds to the objectives of the two phases of the ONR contract. That is, the objectives of Phase I are presented along with summaries of the efforts and reports completed in fulfilling the stated objectives. Following this, the objectives of Phase II are presented along with summaries of the efforts and reports completed during that period. Complete references to the resultant reports are found at the end of each effort described.

During the contract period, a number of professional papers were written and presented. A complete list of these are found following the Phase II portion of this report. The next section provides a complete list of research participants, both at ODU and elsewhere, who have provided

valuable inputs to this research effort. Finally, a general summary is provided.

PHASE I

Objectives of Phase I of the ONR Contract, which began in July 1986, encompassed the refinement of a longitudinal model of team evolution, the continued development of techniques and instruments to measure the development of teams during training, and the testing of these procedures using different types of teams. The specific tasks in this phase of the research were:

1. Refine the TEAM model and measurement procedure.
2. Select teams to study based on a list of desired characteristics, availability, and potential for longitudinal study.
3. Apply the TEAM model and measures longitudinally to teams engaged in training.
4. Analyze the results and revise the TEAM model and procedures based on outcomes.
5. Develop hypotheses for team training interventions based on the model, literature, and longitudinal results.
6. Develop team process measurement tools for use in the field by trainers.
7. Prepare Phase I deliverable, a final report which would include the final TEAM training model, user-oriented measurement tools, and preliminary recommendations for team training interventions.

Data were collected at three Norfolk area sites in order to accomplish these Phase I tasks. The first site was the Naval Gunfire Support (NGFS) School, the second was the Anti-Submarine Warfare (ASW) School, and the third was the Guided Missiles School (GMS). The training programs involved

offered three different sets of characteristics. Thus, the TEAM model and data collection instruments could be put to a good test of generalizability.

A major factor in the choice of NGFS as the first site was the high degree of accountability imposed upon ships to do well in the training. Ships have to obtain a passing grade in training before they can engage in live-shoot exercises and be certified as qualified to meet operational readiness requirements. In the event of failure, the Navy command echelons and the Congress are notified. Thus, the ramifications of poor performance for all concerned, including the team members are obvious and serious. Behavioral observations, team member self-reports, and performance measures were obtained for Combat Information Center (CIC) teams at each session of the course. This was a 4 to 5 day training course.

ASW presented a new situation to the research staff in that there was not just a single team (CIC) being studied, as was the case at NGFS. ASW teams consisted of four subteams; CIC, Sonar, U/B Plot, and Passive Sonar. Thus, not only was the evolution and maturation of a single subteam of interest, but also the effects on the process of having four interdependent teams. At this site it was possible to replicate many aspects of the NGFS study, and the data for ASW CIC subteams could be compared more or less directly with data for NGFS CIC subteams because ASW was also a 4 to 5 day training course. Finally, it was possible to evaluate further the data collection forms that had been refined and modified based upon the NGFS experience.

The last site, GMS, was chosen for two reasons. First, it presented the opportunity to test the TEAM model in a submarine environment, and second, it made it possible to determine whether or not manifestation of

evolution and maturation could be identified during a much shorter training course (approximately 4.5 hours instead of 4-5 days). Data collection was possible only once per team. To adapt to these constraints, a cross-sectional analysis was resorted to, involving comparisons between teams who came to training with different degrees of earlier development. This was in contrast with the analysis of changes within teams over time carried out for NGFS and ASW teams. These efforts have provided an unparalleled set of observations concerning the nature of training-induced changes in team behaviors.

Naval Gunfire Support School. The study conducted at the Naval Gunfire Support School represents the first component of the research program seeking to articulate the processes involved in team evolution and maturation.

The model of team evolution and maturation that emerged drew upon models and methodologies reported in the team performance/team training literature, observations of teams undergoing training on a NGFS simulator, and interviews with the instructional staff. This model postulates that a team progresses through several distinguishable stages of development during the course of training (e.g., forming, storming, norming, and performing), and that the time of emergence, and rate and efficiency of passage through these stages can be affected by the design of the curriculum, the methods of instruction, and other characteristics of the training system as a whole. The model distinguishes between two separate tracks of evolution and maturation of team behaviors -- a "taskwork" track and a "teamwork" track -- that ultimately converge in a fully mature and effective team. In order for the group of individuals to become a skilled and cohesive team, and for successful performance outcomes to eventuate,

training programs must insure that teaching and learning include both teamwork and taskwork components shaped to fit each stage of a team's development. In the past, in most instances training has been concentrated on taskwork, and training to effect good teamwork has been largely neglected.

Initial activities at NGFS involved the development and refinement of instruments designed to record and measure teamwork behaviors and the changes that occur during the course of training. The products of these efforts were a series of forms and procedures used repeatedly to obtain data during each session of training on the simulator for the NGFS Combat Information Center (CIC) team. These included a Critical Team Behaviors Form, a Trainee Self-Report Questionnaire, a Gunnery Liaison Officer's (GLO) Individual Performance Form, an Instructor's Individual and an Instructor's Overall Performance Form. In addition, a Demographics Form was filled out once at the beginning of the course.

Data were collected over a period of 4 1/2 months on a total of 13 teams from the team members and their instructors. These were categorized as more and less effective teams according to an independent criterion (i.e., scores on a standard final examination). All 13 teams passed the test. Findings gave empirical support to the TEAM model that had been conceptualized, and demonstrated the sensitivity of the instruments as measures that could discriminate between the more and less effective teams as well as differentiate teams at the several stages of evolution and maturation. Thus, in addition to the evidence of changes in perceptions and observable behaviors over time, the findings indicated the presence of a "taskwork" factor, a "teamwork" factor, and a "jelling" factor, which occur as separate factors early in training and then converge during the final stages of training. These results gave encouragement to plans for

further research in other team training settings to determine the generalizability of the NGFS findings. They also provided the basis for suggestions that preliminary work be initiated on several interventions designed to improve team training effectiveness.

For a complete report of the findings at NGFS, see:

Glickman, A.S., Zimmer, S., Montero, R.C., Guerette, P.J., Campbell, W.J., Morgan, B.B. Jr., & Salas, E. (1987). The evolution of teamwork skills: An empirical assessment with implications for training (NTSC Tech Report TR87-016). Orlando, FL: Naval Training Systems Center.

Instructional Processes Model. Another effort that took place while research was going on at NGFS involved a detailed analysis of instructional processes and strategies. This effort was undertaken to examine the instructional processes that occur and instructor strategies that are employed during the various phases of training, and to determine how such processes and strategies relate to, and impact upon, the success of NGFS teams in training. NGFS instructors were interviewed, with particular emphasis placed on uncovering those characteristics of a given team which impact the instructional approaches used with that team, as well as determining the factors which cause the instructor to change instructional approaches during training.

These efforts culminated in a model of instructional processes, with special attention given to the factors affecting decisions regarding the techniques and strategies employed by instructors, over time, while training teams with different levels of skill, knowledge, and attitude of various kinds. The model has proven useful for describing and facilitating communication about team-oriented methods assessments, decisions, strategies, and feedback mechanisms employed by instructors in a training setting. Through these process-oriented descriptions, the model has made

salient several areas in which team-training interventions are likely to enhance the quality of specific instructional processes in operational training systems. Recommendations for interventions based on the information gleaned from the model and the expertise of the instructors and researchers were additional outcomes of this work.

For a complete report of the instructional processes model, see:

Guerette, P.J., Miller, D.L., Glickman, A.S., & Salas, E. (1987). Instructional processes and strategies in team training (NTSC Tech. Report TR87-017). Orlando, FL: Naval Training Systems Center.

Anti-Submarine Warfare School. The next study was conducted at the Fleet Anti-Submarine Warfare (ASW) Trainer, Norfolk Naval Base, Norfolk, Virginia. ASW operations involve the examination of several subteams (i.e., CIC, Sonar, Passive Sonar, and Underwater Battery Plot). This study represented a second component in the research effort seeking to document the variables and processes involved in team evolution and maturation. The degree of generalizability of findings bearing upon TEAM processes was examined by comparing the results of the study of ASW training with those obtained earlier at the Naval Gunfire Support School.

In general, the same approaches were followed at ASW and NGFS training sites. Initial activities at ASW involved refinement of the data collection forms previously used. The modifications made combined inputs from the researchers' previous experience with data collection at NGFS and from the collaborating staff at ASW. Special attention was given to the interrelationships among the four subteams. The data collection instruments again included a Demographics Form, Critical Team Behaviors Form, a Trainee Self-Report Questionnaire, a Team Leader Individual Performance Form, an Instructor's Individual Performance Form, and an Instructor's Overall Team Performance Form.

Data were collected over a period of 3 months on a total of 11 Navy teams from instructors and team members. Overall performance of these teams was categorized as more and less effective based on final criterion test score; i.e., Training Exercise (TRAEX) or Selected Exercise (SELEX). Data were analyzed for the two largest subteams, CIC and Sonar. The findings lend added support to the conceptual model of team evolution and maturation previously formulated. They again demonstrate the sensitivity of the measurement instruments in discriminating between teams that differ in performance level and between perceptions and behaviors manifested in the several stages of team maturation. Lessons learned from the research and recommendations for modifications and innovations designed to improve team training and trainer design were again articulated.

In conjunction with the efforts at ASW, TEAM research personnel exchanged visits with members of Sanders Associates in Merrimac, New Hampshire to view the new 14A12 ASW simulator prototype being built, to discuss TEAM research results, and to generate ideas as to how each might contribute enhanced utility to the use of the other in the operational setting. Several of the interventions and recommendations referred to in this report stem from these exchanges.

For a complete report of the ASW study, see:

Glickman, A.S., Zimmer, S., Montero, R.C., Guerette, P.J., Morgan, B.B., Jr., & Salas, E. (1988). The evolution of teamwork skills: A comparative assessment (NTSC Tech. Report TR88-XXX). Orlando, FL: Naval Training Systems Center.

Guided Missiles School. The study conducted at the Guided Missiles School (GMS) Detachment, Norfolk Naval Base, Norfolk, Virginia was the third component of this programmatic research on team evolution and maturation. The degree of generalizability in TEAM findings was examined further by

comparing the GMS results with those obtained earlier at NGFS and ASW. Although the same conceptual approach governed research activities at GMS, as previously noted, some substantial changes had to be made in order to accommodate the fact that whereas NGFS and ASW involved a weeklong course of training with a fairly standard curriculum prescribed for all ships, in the case of GMS there was only a half-day session of training, the contents of which were selected by the ship sending people to the simulator.

Initial activities at GMS involved further refinement of existing data collection forms and the creation of a revised form designed to measure changes in teamwork and taskwork behaviors that occur during the course of training. The changes in the forms were the result of three things. First, there were the experiences of previous data collection efforts. Second, was the short duration of training that allowed for only a single data collection effort per team. Finally, they were the inputs from the GMS staff. Because of the time constraints, data collection had to be reduced in scope. The data collection instruments used here that were much the same as had been used before included a Critical Team Behaviors Form, a Trainee Self-Report Questionnaire, a Team Leader Performance Form, and an Instructor Performance Form. Just two of the demographic items were used. They were inserted in the Trainee Self Report Form.

A new component was the Stage of Team Development Form, which was developed especially for use by GMS instructors. It consisted of two items. One item measured teamwork development (an understanding of how positions relate to each other, providing information to proper people). The other item measured taskwork development (knowledge of tasks, accomplishment of tasks effectively and efficiently). These items were necessary because data could be obtained for a team only one time. Multiple data collections, like at NGFS and ASW, were not possible.

Data were collected on a total of 31 Navy teams over a period of 4 months. These teams were placed in four stages based on their level of development at the time that they reported to the school, as assessed by the instructors using the Stage of Team Development Form. Data were separately analyzed for teams in each of the four stages. Despite the considerable differences between the situation at GMS and the situation at NGFS and ASW, the findings once more provided support for the TEAM conceptual model. Also they again demonstrate sensitivity of the measurement instruments in discriminating between teams at different stages of development and between perceptions and behaviors manifested in the four stages of development. Recommendations and interventions designed to enhance team training were again offered.

For a complete report of the findings, see:

Zimmer, S., Blacksher, J.D., Glickman, A.S., Montero, R.C., & Salas, E., (1988). The evolution of teamwork skills: Further tests of generalizability (NTSC Tech. Report TR88-XXX). Orlando, FL: Naval Training Systems Center.

PHASE II

Objectives of Phase II of the ONR contract consisted of using what was learned regarding team evolution and maturation and translating this knowledge into usable interventions designed to facilitate team training. During the intervention development phase, instruments were developed to assess the effectiveness of each intervention. The specific tasks in this phase of research were:

1. Conduct additional efforts related to the analysis of team training needs.
2. Develop a list of suggested interventions.
3. Derive and apply the criteria for evaluation of these suggestions leading to the choice of training interventions

holding the most promise.

4. Experimentally implement and evaluate the chosen interventions for their effectiveness.

During this phase, quite a few intervention possibilities were suggested based on the previous findings, the suggestions from key personnel at the three data collection sites, the time available to implement and evaluate the intervention, and the resources available to the research team. Of these, six interventions were selected for development beyond the idea stage. At the conclusion of the contract period, several of the interventions had been pilot tested at ASW and evaluated, with the remainder to be tested when further funding becomes available.

Summaries of the reports on the interventions generated from the Phase II research follow. Where try-outs occurred, data analyses were presented in the technical reports in support of the interventions' effectiveness. In addition, recommendations were given for modifications and future use of the interventions.

Behavioral Troubleshooting. The armed services have extensively developed "troubleshooting" techniques for maintenance and repair of equipment. The aim of the Behavioral Troubleshooting intervention is for instructors to apply the same logic and techniques to the diagnosis and improvement of the functioning of a team. The intervention is one outcome of the investigation conducted as part of the TEAM research program, which explored potential methods of identifying and correcting team performance deficiencies exhibited during formal training. The investigation included a search for similarities between the analysis of faults in complex machine systems (troubleshooting) and the process of identifying deficiencies in

the teamwork skills of those engaged in complex group tasks. The Behavioral Troubleshooting intervention strategy borrows heavily from the maintenance and fault isolation techniques applied to military hardware. In the present case symptoms of team deficiencies are systematically evaluated. When a deficiency appears, it is entered into a computer-based program where the behavior is traced through a set of logical steps to the source. The logical steps involve a series of yes/no type questions, ultimately leading to the appropriate corrective action.

A demonstration version has been developed and shown to instructors at several different sites. Their overall impression has been positive. They see the intervention as particularly useful for new instructors who do not have as much experience as the more senior instructors in dealing with team performance deficiencies.

For a complete report of the findings, see:

Blacksher, J. D. (1988). Behavioral troubleshooting (NTSC Tech Report TR88-XXX). Orlando, FL : Naval Training Systems Center.

Trend Tracking. At ASW school, and at other locations, computers and programs are in place to aggregate data on the performance of teams taking part in training. The potential utility of these resources has not been fully realized because no one has yet taken a long term view of the data to identify the existence of any trends. In light of this, the Trend Tracking intervention was prompted by a request from members of the staff of the Fleet Anti-Submarine Warfare Center, Atlantic.

The study explored methods of identifying the sources of systematic variance or fluctuation in performance across teams over time. Variations in TRAEX/SELEX performance scores across teams or over time provide indications of gross changes in the nature of training or of the operational environment rather than of changes affecting individual team or

team member performance. Instructor attitudes, instructional technique, curricular faults, documentation errors, faulty tactical doctrine, hardware design deficiencies, and system performance problems are all potential sources of systematic variance in performance level across teams. These potential problems in the training or operational environment are not currently assessed in a systematic way at most Navy training facilities or by operational readiness inspection units. Often, performance deficiencies are incorrectly attributed to shortcomings of individual teams, while the real systems problem goes undetected until the effects become obvious and widespread. The costs of not identifying the problems or attributing them to an incorrect source are substantial.

Fortunately, the performance data and the computer equipment needed for monitoring and early identification of non-team sources of training or operational performance deficiencies currently exist within nearly all training and operational readiness assessment facilities. The techniques recommended here can be easily incorporated into the current assessment and evaluation function of many training sites and operational readiness inspection units at low cost and with no additional manpower. A general procedure is outlined for development and implementation of a trend tracking system for use in training and operational settings.

For a complete report of the findings, see:

Blacksher, J. D. (1988). Trend tracking (NTSC Tech Report TR88-XXX).
Orlando, FL: Naval Training Systems Center.

Leader Prebrief. It is common knowledge, validated by much research, that if team members have a clear understanding of their roles, responsibilities, task assignments and performance goals, they will do better than when they do not. It is likewise taken for granted that a team

leader should provide the information necessary. The research data and the complaints of instructors at the training facilities show that all too often this does not happen. When it happens at training sites, the training moves along more expeditiously and the teams attain higher performance outcomes. The leader prebrief intervention was designed to "make it happen" more often and better. "Leader Prebrief" refers to a short briefing conducted by the team leader before beginning training exercises or operations. Typically, information is given on the objectives of the task and special requirements of the specific situation, and the group is then expected to commence functioning as a team.

Discussion with instructors at Naval Guided Missiles School Detachment, Norfolk revealed that few teams are prebriefed, and no guidelines exist to help leaders prepare for prebriefing. However, those few leaders who do prebrief their teams see better team performance results.

This intervention involves the specification of guidelines for the leader which outline important elements of an effective prebriefing. Such elements include the leader's role at the beginning of training, the use of feedback, group involvement and cohesion, and the relation between leader and team performance. A work plan is given for implementation of the leader prebrief strategy in a variety of team training environments. Implementation is expected to benefit the team leader and contribute to a team's successful performance.

For a complete report of the findings, see:

Quinn, K. D. & Blacksher, J. D. (1988). Leader prebriefs (NTSC Tech. Memo TM88-XXX). Orlando, FL: Naval Training Systems Center.

Sound Level Monitoring. Instructors at team training sites who have been participants in the TEAM research have volunteered the observation that

teams found to perform less effectively were generally characterized by more "noise" in their communication activities than those who had performed more effectively. This observation led to development of this pilot study in which the sound level of voice communication exchanges was monitored.

A noise level analyzer was installed in the Combat Information Center of the 14A2 simulator at the Fleet Anti-Submarine Warfare Training Center, Atlantic, to record sound levels, in decibels, generated by verbal interactions of teams during training exercises. Data were collected over a period of 16 weeks for 9 teams, who completed from 4 to 19 exercises during the week of training. Analyses were based on observations of 99 exercises.

These data supported the hypothesis that increased voice level noise is related to poorer performance. Teams with higher average sound volume levels did not perform as well as those which were less noisy. Noisy teams appeared to be more distracted and disorganized, causing their performance to suffer. It was also found that those teams with high variability in average sound volumes across training sessions were less successful in mission accomplishment. These preliminary results suggest the advisability of the development of an inexpensive sound monitoring device that would emit "warning" signals at preset decibel levels, with the expectation that, when installed in Navy simulator trainers and in shipboard command and control centers, they would prompt teams to reassess their behavior and regroup their communication behaviors, and that this would result in better organization, less confusion, and better overall performance.

For a complete report of the findings, see:

Quinn, K. D., & Blacksher, J. D. (1988). Sound level monitoring (NTSC Tech. Report TR88-XXX). Orlando, FL: Naval Training Systems Center.

The next two interventions -- Sound Powered Communications and Back-up Behaviors -- were introduced at the ASW training site according to the

following plan. A between-subjects after-only research design was utilized in a sequential assignment of teams in training as A - Control, B - Sound Powered Communications, or C - Back-up Behaviors groups in the order A-B-C-A-C-B..., with the control group serving as a control for both experimental intervention strategies. Specific teams were confined to a single control or experimental group for the duration of the one week training period.

Sound Powered Communications. Instructors at team training sites who have been participants in the TEAM research have offered the observation that teams with less "professional" communication behaviors (i.e., procedurally incorrect or extraneous communications) tend to have less effective overall team performance. This observation led to the development of this pilot study in which communication exchanges of Navy teams in training simulators were monitored, recorded, and posted for the team members' benefit.

Data were collected in the Combat Information Center of the 14A2 simulator at the Fleet Anti-Submarine Warfare Training Center, Atlantic, in Norfolk, VA. Data were collected for a period of 16 weeks on 8 teams, who completed from 4 to 19 exercises during the week of training. Results are based on observations of more than 500 exercises. After completion of each set of exercises, percentages of "correct" to "total" communication behaviors for each team member were posted conspicuously for four "experimental" teams but not for four other "control" teams. The proportion of effective communication behaviors increased significantly more for the "posted" teams during the last phase of training. There were insufficient data to establish predictive correlations between communication behaviors and team performance scores.

For a complete report of the findings, see:

Peron, R. M., Blacksher, J. D., & Zimmer, S. (1988) Sound-powered

Back-up Behaviors Instructors at team training sites who have been participants in the TEAM research have offered the observation that teams whose members provide fewer suggestions or corrections to other team members during performance exercises also tend to exhibit less effective overall team performance. This observation led to the development of this pilot study in which the frequency of team member mutual support, "back-up" behaviors, were monitored, recorded, and posted by the instructors for the team members' benefit.

Data were collected in the Combat Information Center of the 14A2 simulator at the Fleet Anti-Submarine Warfare Training Center, Atlantic, in Norfolk, Virginia, on 7 teams, each of whom completed from 4 to 19 exercises during a week of training. Results are based on observations of 764 exercises. After completion of each set of exercises, percentages of "occurred" to the "total possible" back-up behaviors for each team member were posted in a conspicuous place. Analyses of the data indicate that the occurrence of back-up behaviors was consistently more prevalent for the three posted "experimental" teams than the four unposted "control" teams. Predictive correlations between back-up behaviors and team performance scores (both session scores and final scores) were found to be significant, as was the correlation between the session scores (instructors' subjective impression of overall team performance for each session) and the final objective performance score (one composite score, TRAEX/SELEX, used as a pass/fail criterion, based on performance in the last training session). Implications and recommendations for further research and development of interventions are considered.

For a complete report of the findings, see:

Peron, R. M., Blacksher, J. D., Zimmer, S., & McIntyre, R. M. (1988). Back-up behaviors (NTSC Tech. Report TR88-XXX). Orlando, FL: Naval Training Systems Center.

PROFESSIONAL PAPERS

The following is a list of papers prepared for professional meetings that have drawn upon concepts, methods, and findings of the Old Dominion University TEAM research program.

Glickman, A. S., Morgan, B. B., Jr., Blaiwes, A. S., & Salas, E. (July 1986). Team evolution and maturation (TEAM). Paper presented at the International Association of Applied Psychology, Jerusalem, Israel.

McIntyre, R. M., Morgan, B. B., Jr., Salas, E., & Glickman, A. S. (November 1988). Teamwork from team training: New evidence for the development of teamwork skills during operational training. Paper presented at the 10th Interservice/Industry Training Systems Conference, Orlando, FL.

McIntyre, R. M., Morgan, B. B., Jr., Salas, E., & Glickman, A. S. (April 1989). Teamwork in the Navy defined: Relevance for the non-military environment. Paper to be presented at the Society for Industrial-Organizational Psychology, Boston, MA.

Miller, D. L., Guerette, P. J., & Morgan, B. B., Jr. (October 1987). Instructional processes in team training. In J. T. Lester (Chair), Team development in operational team training systems. Presented at the Human Factors Society, New York, NY.

Montero, R. C., Campbell, W. J., Zimmer, S., & Glickman, A. S. (October 1987). Changes in team behaviors during operational training. In J. T. Lester (Chair), Team development in operational team training systems. Presented at the Human Factors Society, New York, NY.

Morgan, B. B. Jr., Salas, E., & Glickman, A. S. (November 1987). Teamwork from team training: An assessment of instructional processes in operational team training systems. Paper presented at the 9th Interservice/Industry Training Equipment Conference and Exhibition, Washington, D. C.

Salas, E., Montero, R. C., Glickman, A. S., & Morgan, B. B., Jr. (August 1988). Group development: Teamwork skills and training. Paper presented at the Annual Meeting of the American Psychological Association, Atlanta, GA.

Salas, E., Morgan, B. B., Jr., & Glickman, A. S. (October 1987). The evolution and maturation of operational teams in a training environment. In J. T. Lester (Chair), Team development in operational team training systems. Symposium presented at the Human Factors Society, New York, NY.

Salas, E., Morgan, B. B., Jr., & Glickman, A. S. (August 1987). Examination of team behaviors in a training context: a model of team development. In E. Salas & J. T. Lester (Co-chairs), Approaches for understanding team training and performance: Synthesis, models and applications. Symposium presented at the Annual Meeting of the American Psychological Association, New York, NY.

Swezey, R. W. & Salas, E. (October 1987). Development of instructional design guidelines for team training devices. In J. T. Lester (Chair), Team development in operational team training systems. Symposium presented at the Human Factors Society, New York, NY.

Woodard, E. A., Morgan, B. B., Jr., & Salas, E. (March 1987). An investigation of the relationship between individual and team biodata and team performance. Paper presented at the Southeastern Psychological Association Annual Meeting, Orlando, FL.

RESEARCH PARTICIPANTS

The achievements of this project are the result of the energies and creativity of the people who shared in this effort:

Principal Investigator: Dr. Albert S. Glickman, July 1986 - Dec. 1988

Co-principal Investigators: Dr. Robert M. McIntyre, June 1987 - Dec. 1988
Dr. Ben B. Morgan, Jr., July 1986 - May 1987

NTSC Collaborator: Dr. Eduardo Salas, July 1986 - Dec. 1988

ONR Monitors: Dr. James T. Lester, July 1986 - July 1988
Dr. John J. O'Hare, Aug. 1988 - Dec. 1988

Research Associates: James D. Blacksher, April 1987 - Dec. 1988
Wanda J. Campbell, Aug. 1986 - Dec. 1987
Monique Grelot, Oct. 1987 - May 1988
Paula J. Guerette, Aug. 1986 - Dec. 1987
Douglas L. Miller, Aug. 1986 - July 1987
R. Craig Montero, Aug. 1987 - Dec. 1987
Rosalynn M. Peron, Oct. 1987 - Dec. 1988
Kerrie D. Quinn, Jan. 1988 - Dec. 1988
Elizabeth A. Woodward, Aug. 1986 - May 1987
Seth Zimmer, Aug. 1986 - Dec. 1988

Consultants: Dr. Glynn D. Coates, Old Dominion University
Dr. Lawrence R. James, Georgia Institute of Technology
Dr. Robert W. Swezey, Science Applications International Corporation

Navy Personnel:

Naval Gunfire Support School: LT Thomas Grafton and staff.
Anti-Submarine Warfare School: LCDR Walsh, LT Robert S. Teufel,
Sr. Chief Cook, Sr. Chief Moore,
Chief Peoples, Chief Hough and staff.
Guided Missiles School
Detachment: LT William Cheney and staff.

Secretaries: Sol Hatz, Dec. 1986 - April 1987
Nancy Hite, Sept. 1988 - Dec. 1988
Sandra Jacobson, April 1987 - Aug. 1987
Teri Pedigo, Aug. 1987 - Sept. 1988

GENERAL SUMMARY

In this research program that has extended over three years and three Navy team training facilities, it has been made evident that a recognizable process of team evolution and maturation does exist. Changing patterns of trainer observations and trainee perceptions reported in the course of training bear this out. It has also become evident that the transformation of a set of individuals into a cohesive, motivated, and effectively functioning unit does not "just happen" through "natural" evolution. It is not enough to train for taskwork and hope that teamwork will develop. To achieve high levels of performance requires that team members acquire certain specific teamwork knowledge and skills to be coupled with their taskwork knowledge and skills. Team leaders and instructors need to be specifically trained to recognize and impart these knowledges and skills. The result of preliminary trials offer promise that these gaps can be filled with interventions that are cost effective.