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ABSTRACT

The report discusses the applicability of available advanced training technologies to the training of Navy tactical teams. An experiment was conducted to test whether there is sufficient commonality in team tasks performed in existing team tactics trainers to warrant development of a team training system for specific advanced technologies. Data were collected for team tasks learned in representative training devices for air, surface and subsurface tasks. These data were analyzed for commonality among and within training devices using a numerical taxonomy. Results indicated little commonality when total tasks were inspected, but more commonality when stimulus, cognition, and response elements were compared. A major recommendation is that the Navy concentrate on improving the effectiveness of existing devices rather than launching a program to develop a generalized training device. (RB)

Technical Report: NAVTRADEVCEN 70-C-0310-1

AUTOMATED OPERATOR INSTRUCTION IN TEAM TACTICS

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ABSTRACT

The report discusses the applicability of available advanced training technologies to the training of Navy tactical teams. Three questions are posed: Is there sufficient commonality in team tasks performed in existing team tactics trainers to warrant recommending development of a team training system incorporating specific advanced technologies, e.g., generalized and adaptive techniques? If yes, what techniques should be used? If no, what other approaches are feasible for increasing the effectiveness of team training?

Data were gathered on the team tasks accomplished in representative training devices for air, surface and subsurface tactical platforms. These data were analyzed for commonality among and within training devices using a numerical task taxonomy.

Results indicated little commonality of team tasks when total tasks were inspected. Significantly more commonality was found when the stimulus, cognition and response elements of the tasks were compared. A major recommendation is that the Navy concentrate on improving the effectiveness of existing devices rather than launching a program to develop a generalized training device. Further recommendations are made for the manner in which training-device development should proceed and for additional research.

FOREWORD

This report describes the results of a continuing effort of the Human Factors Laboratory at the Naval Training Device Center to identify and evaluate training techniques and principles for use in the design of devices which will enhance the training of Navy tactical teams. The principal goal of the effort reported herein was to determine the feasibility for application of advanced training technologies to the team training situation. Attention was directed towards determining the potentialities for generalized training and automated training principles to tactical team training.

The analysis of team-task data from three team trainers representing air, surface and submarine operations indicated that the development of a generalized training system would not improve tactical team training. This approach was indicated to be appropriate for exercising only the routine and less-complex procedural tasks required of tactic . team members. For those tasks of greater significance in the tactical environment, the findings suggested that more efficient use and greater effectiveness of existing tactical team trainers could be realized through the adoption of part-team training for certain operator categories when coupled with the development and use of measurable behavioral objectives of training. There is a discussion of selected principles and techniques which have been empirically demonstrated to offer increased training effectiveness. Also, several issues of theoretical and applied nature are discussed concerning the possible applicability of these alternative techniques to tactical team training. This discussion is aimed at stimulating the necessary effort which could lead to a demonstration of the application of advanced training technologies in the tactical team setting.

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INTRODUCTION

PROBLEM

The Navy has procured many training devices with the objective of improving the communication skills and adaptability of tactical teams. Typically, such devices have been developed for each major weapon system. The general approach has been to develop training hardware which very closely resembles that used operationally. The assumption underlying this procurement philosophy is that high levels of task fidelity in the training environment are necessary for the adequate transfer of skills to the operational world.

The major objective of team tactics training is the improvement of team coordination. An assumption which must be met, however, is that each individual team member possesses the requisite individual skills for his position on the team. For example, before team training can realistically be conducted, sonarmen must know how to operate their sonar equipment, navigators their plot boards, etc. Yet, it has been found that team members often lack these prerequisite individual skills (Jeantheau, 1969; Schrenk, Daniels and Alden, 1969). Consequently, team training devices are, of necessity, often used to develop individual rather than team skills. Although needed, such use compromises the major objectives of both the device and its intended use, i. e., training team skills.

Concern with the use, effectiveness, and cost of tactical team training systems has led to questions of whether advanced technologies such as generalized training, adaptive techniques, etc., are feasible for providing the skills required of Navy tactical teams. For example, if the generalized team training concept is feasible, a single generalized training device could be used to train the skills required of team members regardless of the specific platform or weapon system they operate. This training device might produce significant increases in training effectiveness while, at the same time, reducing developmental costs.

PURPOSE

The purpose of this study was to determine the applicability of advanced technologies for team training. Specifically, the following questions were asked:

- Is there sufficient commonality in the team tasks performed in existing team tactics trainers to warrant a recommendation for the development of a generalized team training system incorporating specific advanced technologies?
- If development is recommended, what techniques and technologies should be incorporated into such a training system?
- If not, what other approaches are feasible to provide more effective tactical team training?

To place these questions in clearer perspective, a selective review of generalized and team training research was conducted. The following subsections summarize information concerning the value of generalized training and the manner in which team training should be conducted.

REVIEW OF GENERALIZED TRAINING CONCEPTS

Generalized training has been proposed as a means of reducing the costs associated with high-fidelity simulation while maintaining or improving training efficiency. To date, research on the concept has focused primarily on individual operator and maintenance skills.

In the area of psychomotor behavior, such as tracking, Bowen, Hale, and Kelley (1962) developed and tested the concept of a General Vehicular Research Tool (GVRT). The feasibility of such a device, as noted by those authors, was based on the existence of a general tracking skill. The GVRT was proposed to provide the basic skill necessary for man to operate a dynamic closed-loop vehicle control system, yet not be specific, or necessarily sufficient, for any single vehicle. The GVRT was, therefore, proposed as a general trainer from which students would transfer to specific vehicles for final training once some minimum skill level had been attained.

DePauli and Parker (1969), under sponsorship of the Naval Training Device Center (NAVTRADEVCEN), evaluated the feasibility of a general-purpose device for sonar maintenance training. This device, unlike the general trainer described above, is proposed for use at a Navy "C" school where basic knowledge of circuitry, electronics, components, etc., is a prerequisite. Such maintenance training is normally performed on operational equipment which is expensive, not designed for training purposes, frequently a generation behind that used in the fleet, and in insufficient supply. Consequently, such maintenance training has usually consisted of demonstration, with little actual practice. The Generalized Sonar Maintenance Trainer (GSMT) was proposed as a solution to this problem. It incorporates all the basic circuitry and components found in operational sonar systems yet is organized in a fashion amenable to instruction on troubleshooting and corrective procedures.

DePauli and Parker performed studies comparing performance on two types of maintenance trainers. One group was trained on the AN/SQS-4 sonar (operational equipment, but no longer in fleet use) and the other group on the GSMT. Both groups were then transferred to the AN/SQS-23 sonar. The results indicated that GSMT trainees performed maintenance routines faster, made fewer procedural errors, and were as accurate as those trained on actual sonar equipment. An important additional finding was that training using the GSMT provided a means of equating end-of-training proficiency across differing trainee input aptitude levels.

DePauli (1970) has suggested the feasibility and desirability of developing a generalized underwater fire-control system maintenance trainer. Lamb, Bertsche, and Carey (1970) recommended that the development of a generalized submarine casualty control device for multiclass emergency ship control training is technically feasible and would be cost-effective.

The cognitive skills of problem solving and decision making require an ability to generalize from one situation to another. Sidorsky and his associates (Sidorsky, Houseman, and Ferguson, 1964; Sidorsky and Houseman, 1966) studied tactical decision-making behavior with an aim of identifying trainable, generalized decision-making skills. They concluded that similar decision-making processes were involved in both ASW and AAW situations. They further observed that training was needed for situations where the decision-maker was at a tactical disadvantage. Training was observed by these authors to be directed toward training of specific procedures, when a different emphasis was required, i. e., one stressing innovation and adaptability (Sidorsky, et al., 1964). Hammell and Mara (1970) reported that despite differences in decision tasks there appeared to exist common decision-making skills. It was recommended that these skills be trained in the team training environment.

Kanarick (1969), in reviewing the state of the art of decision-making research and training, suggested that decision making is a generalizable skill. Kanarick pointed out that, although decision-making training has been widely adopted by industry, its acceptance by the military has been somewhat limited. Training in diagnosis and action selection could beneficially complement the procedural knowledge, doctrine, and system-specific-information training Naval officers presently receive. Because such a Navy decision-making course does not currently exist, Kanarick recommended that research be conducted to determine the best way to teach tactical decision-making skills.

In summary, there exists a small body of literature which supports the feasibility of a generalized approach to training. However, all of the studies relate to individuals. Thus, although it can be shown that generalized training is effective for individuals in certain situations, the question remains as to whether this concept can be effectively applied to the training of teams.

REVIEW OF TEAM TRAINING RESEARCH

Training teams to effectively operate complex man-machine systems has been of concern to the military for the past 15 years. There is a significant, but unresolved, question of whether operation in a team setting requires unique skills that can only be developed and refined through team member interaction. Glanzer (1965), in discussing a series of studies of Navy team training and behavior, concluded that team training was inefficient and accordingly wasteful in terms of gain per trainee manhour. However, this same investigator stated that since the critical stimuli for individual tasks in the team context were difficult, if not impossible, to isolate, team training was necessary.

Studies directed toward determining principles of team training have produced conflicting results. For example, team-member replacement has been found in two cases to be relatively unimportant, with its effect at worst temporary and dependent on the skill level of the individuals involved (Horrocks, Krug and Heermann, 1960; Briggs and Johnston, 1967). Yet, Schrenk, Daniels, and Alden (1969), dealing with larger and more diffusely structured teams, found turnover (member replacement) to be the major variable degrading team performance. Conflicting findings such as these have made it difficult to determine optimum methods for team training. To resolve this problem, complexes closely resembling the operational environment have typically been built for the training of real-world teams. In such devices "free play" tactics and terminal "kill or be killed" objectives have been emphasized (Jeantheau, 1969). However, questions remain regarding the effectiveness of such devices and uses for significantly enhancing team performance. Therefore, research programs have been sponsored to address questions relating to team training and behavior such as: whether to train as individuals or in teams, the fidelity of simulation required, the optimal specificity of performance feedback, and the like. In this subsection, representative findings from three lines of research on team training (viz, System Development Corporation, American Institute for Research, and Ohio State University) are discussed with the objective of identifying results from which general principles of training technology might be derived.

SYSTEM DEVELOPMENT CORPORATION (SDC). Alexander and Cooperband (1965), in a review of team behavior and research variables, described a team as a synthetic organism with individuals as components. The major goal of a team training system was said to be development of system awareness within the team. This goal could be achieved through manipulation of the environment in an integrated fashion and through the provision of performance feedback information. A second goal of team training was to provide the skills for dealing with emergent, unstructured situations. Thus, training was depicted as a process of development from a task orientation, in which the environmental pattern must be recognized and the appropriate response procedure selected, to a "proceduralization" orientation, in which the teams applied creative responses to ambiguous situations. These investigators discussed the criticality of variables associated with the task environment (workload effects and knowledge of results) and task performance (practice schedules and degree of combination of individual and team practice) in the development of a team training technology.

With regard to the specific issue of team versus individual training, Alexander and Cooperband proposed that whole-team practice should be effective when: (a) the team training stresses the acquisition of coordinative skills, (b) the social facilitation provided has a beneficial effect on the acquisition of individual skills, (c) design of the tactical system is inadequate in that there is a discrepancy between the formal and informal rules of operation, and (d), most importantly, the tasks being trained are such that exhaustive formal rules cannot be stated and the procedures must be developed by the team in the process of task accomplishment.

Although Alexander and Cooperband did not report empirical findings, the sections that follow contain data which bear directly on their suggestions.

OHIO STATE UNIVERSITY. Horrocks and his associates performed a series of studies of team training for NAVTRADEVCEN (Horrocks, Krug and Heermann, 1960; Horrocks, Heermann, and Krug, 1961). Using three-man teams in laboratory tasks such as jumbled-sentence decoding and target-position estimation, they found no increase in proficiency for individual skills resulting from a team practice situation. Rather, for the tasks used, individual competence was found to be a critical prerequisite for effective team performance. When team coordination was emphasized early in training, individual skill acquisition was hampered. Horrocks, et al. suggest that teaching individual skills in a team context may be inefficient. These investigators recommended using part-task trainers with automated feedback devices for training individuals, an idea elaborated further in the Discussion section of this report.

Other researchers at Ohio State University continued and expanded the NAVTRADEVCEN-funded investigation of team training. Briggs and Johnston (1967) have summarized four years of work on team training and have also integrated these findings with those of other investigators. The results of this work will be discussed in some detail since it has important implications for the implementation of team training.

It should be noted that the teams Briggs and Johnston studied were generally small (two operators and a supervisor), and some of their conclusions must be tempered by this fact. They recommended a hierarchal structure for team organization. These authors pointed out that this organizational structure enables the hub, or decision-maker, of the team to elicit data exchange among team members, monitor the flow, and terminate communication when the team objective is achieved or communication becomes excessive. Additionally, they reported that teams which used a minimum of interaction were more effective than more communicative teams. They interpreted this finding in light of the fact that individuals have a limited channel capacity for information-processing. Communication requirements limit operator performance by occupying channel capacity which could otherwise be task-directed.

Briggs and Johnston also suggested that parallel team structures are preferable to serial structures. This was proposed because team performance with the parallel structure is not dependent on the least skilled member. Also, the parallel arrangement permits workload adjustment between operators in redundantly manned team positions. However, Klaus and Glaser (1970), in reviewing the American Institute for Research (AIR) studies of team performance (discussed below), reported that the redundancy of the parallel structure led to only a short-term gain and eventually to a decrement in team performance. They suggested that the less skilled operators will eventually interfere with their more skilled partners.

Briggs and Johnston emphasized, not uniquely, the criticality of performance feedback in the acquisition of both individual and team skills. Feedback was found to be particularly important when the adequacy of an operator's performance was not easily determined from the task itself (e. g., the task provided little intrinsic knowledge of results). A final conclusion reached by Briggs and Johnston concerned the appropriate mix of general and specific feedback for team training. They found that, if highly specific performance feedback were given too early in team training, it would actually interfere with skill acquisition. This was because trainees were not ready to use such specific information. The details of team performance should, according to these researchers, be provided only after a period of more general feedback. They also reported that teams tended to adjust their behaviors to maximize the incidence of specific feedback, even if such modified behaviors were inappropriate for attaining the team goal.

Briggs and Johnston 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 as well as providing team training.

AMERICAN INSTITUTES FOR RESEARCH (AIR). The third and final line of research to be reviewed is the work done for the Navy by AIR. This research was summarized by Klaus and Glaser (1970). These authors characterized a team, as compared with a small group, as being relatively rigid in structure and organization and as possessing communication networks with well-defined member assignments and tasks. They suggested that a team can be treated as an intact entity and that total team performance can be modified through the type and amount of reinforcement provided. Yet, since the team output is a function of specific member inputs, one cannot deal with the team as a whole to the exclusion of the individual team members.

Klaus and Glaser drew several general conclusions. They stressed that each correct response, whether team or individual, must be recognized in an explicit and prompt fashion. Performance monitoring and feedback, such as was observed by these researchers, however, was mainly oriented toward errors.

Consistent with previous findings, the work of Klaus and Glaser indicated that the keystone of effective team training is individual proficiency. The team setting was neither an efficient nor appropriate place to acquire individual skills. Given that each team member knows his own task, the team setting is the place to learn communication and coordination skills. Klaus and Glaser's data indicate that overall team performance levels predicted from individual proficiency scores tend to be overestimates. This suggests that even with team members who are competent individuals, the necessity for interaction in a team setting subtracts from individual task performance. Thus, individuals must be trained to deal with this interaction and to function as team members.

CONCLUSIONS. In summary, the literature cited above suggests the following conclusions:

- Effective team training can only occur when each team member possesses a requisite level of skill.
- Team training is a necessary adjunct to individual training.
- A team organized in parallel with hierarchical control is the more effective team structure.
- Performance feedback is critical to skill acquisition. A progression from general to specific and from extrinsic to intrinsic feedback is best for skill acquisition.

SECTION II

METHOD

To determine the feasibility of a generalized approach to team training, it was necessary to identify the extent to which tasks were performed in common within and among various team training environments. Additionally, information was obtained on current use of existing team training devices with the purpose of establishing how advanced technologies could be applied to increase training effectiveness.

This section describes how and which trainers were selected for study, the framework used to describe operator tasks, the conditions of use of these trainers, and the techniques used to collect and analyze the data.

TRAINER SELECTION

Because this study allowed the investigation of only three tactical team trainers, one each for air, surface, and submarine operations, it was first necessary to ensure the representativeness of those selected. To aid in the selection process, definitions of the following terms were developed:

- Team - Three or more persons working in concert toward a common, identifiable, and relatively immediate goal
- Team Skill - Behavior which directly affects or influences some interface or relationship between individual members of a team
- Tactics - The implementation of a cognitive plan or strategy; the key element is an action or inaction which attempts to optimize one's (vehicle) position within the environment or situation relative to an opponent or hazard

Existing Navy team training devices were considered for inclusion in the study based on their representativeness and the relative cost of data collection.

"Representative" was defined by a set of seven characteristics:

- Designed to train team tactics
- Designed to train three or more persons simultaneously
- Had stations which are not located side by side (e. g., as for a pilot-co-pilot trainer)
- Included facilities for training maneuvering and/or attack tactics (e. g., engaging or tactically evading an enemy or other entity)
- Represented a currently operational system with widespread use

- Controlled by a digital or hybrid computer
- Had a special station from which instructor or operator personnel can control problem parameters and monitor trainee performance

A review of existing Navy team tactic trainers identified a number of devices meeting the criteria of representativeness (see Appendix A). This list was rank-ordered in terms of relative representativeness and reviewed to determine the cost of including each device in this study. Emphasis was placed on selecting those for which access could be readily obtained and which had high levels of student use. Based on the above criteria and in consultation with NAVTRADEVCEN, a decision was made to study the following:

- Surface platform -- Emergency Ship Handling Trainer (Device 20A62)
- Submarine platform -- Submarine ASW Attack Teacher (Device 21A38)
- Aircraft platform -- P-3A Weapon System Trainer (Device 2F69B)

Only Device 21A38 represented an optimal choice based on relative representativeness. Top-ranked devices for the air and surface environments were not available for study. Consequently, it was necessary to select the next most representative weapon system or platform control trainers.

DESCRIPTION OF TRAINERS

EMERGENCY SHIP HANDLING TRAINER (DEVICE 20A62). Device 20A62 simulates the bridge environment for typical surface vessels. Each of its four bridge mockups can simulate the hydrodynamic characteristics of three classes of surface ships (DDG-2, LKA-112, and CVA-59). Device 20A62 provides a capability for bridge teams to be trained in the areas of emergency shiphandling, maneuvering in restricted and unrestricted waters, ship malfunctions, Rules of the Nautical Road, multiship maneuvers involving tactical formations, screens, search plans, etc., maneuvering in fog, relative motion and maneuvering board problems, and communication procedures. Each bridge mockup provides stations for five active trainees: Officer of the Deck (OOD), Helm, Lee Helm-Engine Order Telegraph Operator (EOT), Radar Operator, and Horizontal Plotter. Within-team interactions occur through face-to-face verbal exchanges. The instructor may communicate with trainees from his separately located station. The major instructor-trainee communication channel is a general intercommunication network or simulated radio telephone (RT). Trainees in bridge mockup cubicles can communicate with one another through simulated RT nets and whistle signals. The major difference between the training and operational settings is the presence of a bird's eye cathode ray tube (CRT) display in the training situation. This display is computer-generated and depicts the positions and/or motion of the ship units and land masses involved in each problem.

SUBMARINE ASW ATTACK TEACHER (DEVICE 21A38). Device 21A38 provides facilities for training submarine fire control and sensor system operation. This trainer has facilities r simultaneously training three 16-man attack teams. Each separate attack teacher contains a simulated submarine attack center, sonar room, problem operator station, and a classroom. The control complexes provide facilities for problem direction, control, and observation. The three attack trainers can be used for independent team training or may be used to provide simultaneous training for three teams. Device 21A38 has three basic purposes:

- Indoctrination and training of submarine fire control teams in a variety of situations
- Formulation of new tactical doctrine and limited evaluation of new theories of submarine warfare strategy
- Accumulation and evaluation of performance data over numerous problem runs

P-3A WEAPON SYSTEM TRAINER (DEVICE 2F69B). Device 2F69B is housed in two interconnected trailers, one containing the Tactics portion and the other the Operational Flight Trainer (OFT) portion. The two portions can be operated individually in an uncoupled mode or simultaneously as a Weapon System Trainer (WST). The Tactics portion provides a very-high-fidelity simulation of the systems for each of the five weapon system team members: Radar/MAD operator, Julie/ECM operator, Navigator (NAV), Tactical Coordinator (TACCO) and Jezebel/AQA-1 operator. The device uses government-furnished equipment (GFE) at each trainee station, thus providing exact faceplate and control simulation. Displays and functions of the various GFE equipment are controlled by a central computer. A 30-inch-square optical plotter displays aircraft, sonobuoy, weapon, and target events. A separate instructor/operator station is located immediately behind the trainee stations, providing instructors with direct (via a window) and indirect (via indicators) trainee monitoring capability. The instructor's station consoles provide controls, displays, and status indicators for monitoring and controlling the training situation.

Team positions for each of these three devices are shown in Appendix B.

DATA COLLECTION

Data was collected by a team of four Honeywell behavioral scientists (hereafter referred to as the Honeywell Study Team, HST). The data collection process involved four steps: liaison, staff briefings, data collection, and staff debriefings. Details of liaison, briefings, etc. are discussed in Appendix C.

The HST manually recorded verbal representations of the team tasks performed by all team members at each device. Later appropriate taxonomic classification was assigned to each task statement. Because these activities were based on a specific definition of a task and on a taxonomic structure for handling task descriptions, the following sections will discuss that definition and taxonomy.

TASK TAXONOMY

To organize team task information, a task classification scheme was used which permitted description of tasks in terms of a numerical code. A modification of Yaeger's taxonomy (1969) was used because it offered a relatively precise way to describe tasks. Other taxonomies considered (as reviewed by Ginsberg, McCullers, Maryman, Thomson and Witte, 1966) were too general for the purposes of meaningfully determining task commonality. A taxonomy was needed which would allow removal of the situation specific task aspects but which would indicate the general stimulus, cognition, and response characteristics of each task.

The structure of Yaeger's taxonomy centers on the three elements reflected in his definition of a task: stimulus (S), cognition (C), and response (R). Once these elements are identified for a task, each is transformed into a numerical representation reflecting the specificity of description being used. For this study, a seven-position numerical code was used to describe each task. Of the seven positions, the first two described the Stimulus Modality (1) and Stimulus Information Uncertainty (2). The next three positions were used for the Cognition categories of Perception (3), Information Processing (4), and Action Selection (5). The final two positions described Response Modality (6) and Response Complexity (7). Thus, all tasks for this study are described using a seven-position code with the characteristics shown in Table 1.

Categories, in turn, contain levels; e.g., the levels of the Stimulus Modality category, include visual, aural, tactual, etc. Each category (Modality, Information Uncertainty, etc.) is given a position in the numerical code description. Table 1 also shows the verbal description of a typical task along with its coded numerical representation.

The digits assigned to each position in the example code reflect the specific level of the appropriate S, C, R category. Digits in the example code shown in Table 1 show that the stimulus was received aurally (2X-XXX-XX) and contained one bit of certain information (X1-XXX-XX). The levels of cognitive elements for the example task indicate that the stimulus was recognized (XX-3XX-XX), and the data was analyzed for appropriate action (XX-X1X-XX) which was following a specified procedure (XX-XX2-XX). The resulting response was motor (XX-XX-3X) and quite simple (XX-XX-X1). Thus, the numerical code of 21-312-31 describes this example task.

TASK DESCRIPTION DATA

Verbal descriptions of team tasks were obtained for all team members in each device studied. Members of the HST observed the activities of the same single team member during the conduct of a training exercise (at least two HST members visited each device). They first recorded verbal descriptions of the response, then the stimulus, and finally inferred cognitive activity. When questions existed regarding the stimulus or cognitive aspects of a given task, this matter was reviewed with the appropriate trainee. Because data collection at each device often bridged a number of training exercises and different teams, the final listing of task description statements reflected a single list which was obtained for each trainee station, but not necessarily for only a single trainee in that position.

TABLE 1. TAXONOMIC STRUCTURE AND NUMERICAL CODING SCHEME

Task Element	Stimulus		Cognition			Response	
Categories Within Task Elements	Modality	Information Uncertainty	Perception	Information Processing	Action Selection	Modality	Complexity
Codes and Corresponding Levels of Categories	0 None	0 Noise	0 Unidentified		0 No action	0 None	
	1 Visual	1 Simple, one-bit, no uncertainty	1 Detection	1 Data analysis	1 Seeks information	1 Visual orienting	1 Simple discrete
	2 Aural	2 Simple, single-parameter, discrete	2 Discrimination	2 Problem diagnosis	2 Follow specific rule	2 Verbal	2 Controlled, single parameter, discrete
	3 Touch	3 Simple, multiparameter, discrete	3 Recognition	3 Concept formation	3 Follow general rule	3 Motor	3 Controlled, multi-parameter, discrete
	4 Combination	4 Complex, multi-parameter, discrete, continuous	4 Identification	4 Innovation/creation		4 Combination	4 Complex, skilled, continuous
	5 Other	5 Complex, multiparameter, continuous	5 Classification			5 Other	5 Compound, multi-parameter, continuous
		6 Complex parameter					6 High skill, fine control
Numerical Task Code Positions	X	X -	X	X	X -	X	X

Sample Verbal and Numerical Task Description

Type	Task Description
Verbal Task Statement	On verbal command, follows orders and turns on equipment by pressing ON pushbutton
Coded Numerical Representation	2 1 - 3 1 2 - 3 1

One problem encountered was that of collecting task-sequence data for the various team positions. Because the lists of verbal descriptions were often formulated from observing a number of operators in a single position, and since several different problem exercises were usually observed across operators, task-sequence information could not be reflected in the task description lists.

CONSOLIDATION OF INDIVIDUAL TASK DESCRIPTION LISTS

Once members of the HST had observed all operator positions and had formulated their respective individual task description lists, a single "master" list was prepared for each trainer. This master list resulted from consolidation of individual HST lists.

During the consolidation process, tasks were considered one at a time, affording an opportunity for the HST to discuss and ensure the accuracy of each task description. An attempt was made to eliminate duplication or repetition of tasks within the listing for each operator position. This process resulted in a single, exhaustive list of task descriptions for each position within a given trainer. This list of task statements was then reviewed with the trainer staff for completeness and accuracy. In the situations where a staff member had suggestions for modifying the list, further observation of the training situation was made to obtain information which could resolve the discrepancies.

DATA ANALYSIS

CODING OF TASK DESCRIPTIONS INTO THE NUMERICAL TAXONOMY. When a master list of verbal task descriptions was completed for each team position in each of the three trainers, numerical codes were assigned to the verbal task statements according to the taxonomy (see Appendix D). The same HST personnel who developed the verbal task statements assigned these numerical codes. Additionally, a coding system was devised for identifying each task according to the person who performed the task. This scheme was used to permit exact identification of tasks for later analysis. Based on the major task functions performed, trainees were assigned to one of five Operator Categories. The Operator Categories and assignments by device are shown in Table 2.

DATA PROCESSING. The coded data was analyzed to determine the commonality of tasks among the three training devices and among various categories of team personnel. The task commonality between any pair of devices was defined as the number of exact correspondences of numerical task codes for tasks accomplished in those devices. A commonality index was obtained for five different task code digit sequences. In addition to determining the number of total or seven-digit task codes common to the various devices, four other analyses were run using only selected elements of each seven-digit code. A shaded area is shown in Table 3 for those categories included in these five analyses. Thus, the second analysis shown in Table 3 indicates that only the Stimulus Information Uncertainty, Cognitive Information Processing, and Response Complexity task categories were required to match for commonality to exist. Other partial code analyses were run for stimulus elements only, cognitive elements only, and response elements only. Each of the five partial-code analyses produced a different number of unique task codes. This was

TABLE 2. OPERATOR CATEGORY ASSIGNMENTS BY DEVICE

Category	Device 20A62	Device 21A38	Device 2F69B
1 Decision Making	• Officer of the Deck (OOD)	• Conning Officer (CONN) • Fire Control Coordinator (FCC) • Sonar Supervisor	• Tactical Coordinator (TACCO)
2 Plotting	• Horizontal Plotter	• Plot Coordinator • Time-Bearing Plotter • Strip Plotter • Lynch Plotter	• Navigator
3 Sensor Operation	• Radar Operator	• BQR-2 Operator • BQR-7 Operator	• Jezebel Operator • Julie Operator • Radar Operator
4 Continuous Tracking	• Helm	• Attack Director Operator (ADO) • Analyzer Operator (AO) • Weapon Control Console Operator (WCCO)	
5 Discrete Tasks	• Lee Helm	• Expanded Time-Bearing Plotter • Time-Bearing Talker • Time-Bearing Recorder	

TABLE 3. TASK CODE ELEMENT COMBINATIONS ANALYZED

Code Digits	Stimulus: Modality	Stimulus: Information Uncertainty	Cognition: Perception	Cognition: Information Uncertainty	Cognition: Action Selection	Response: Modality	Response: Complexity
12-345-67	///	///	///	///	///	///	///
X2-X4-X7		///		///			///
12-XXX-XX	///	///					
XX-345-XX			///	///	///		
XX-XXX-67						///	///

true because fewer digits were required to match than in the case of the seven-digit analysis, and thus fewer digit combinations were possible. For a given task code sequence analysis (e.g., code position X2-X4X-X7) each task was identified as being: (a) performed within a single device; (b) performed within two devices; or (c) performed within all three devices. Similar analyses were made for Operator Categories, i.e., determining which tasks were performed by members of one, two, three, four, or five Operator Categories. A tabulation was also made specifying the devices and Operator Categories associated with each specific task code.

NONTASK DATA

Data were also collected to identify areas where new or different training technology could be applied to increase the effectiveness of current team training. These data represent a profile of practices currently used of the study devices, and include information pertaining to the following general areas:

- Training objectives
- Trainee evaluations
- Training methods, types, and materials
- Instructor personnel
- Trainee personnel
- Instructor-trainee interaction

SECTION III

RESULTS

TASK CODES

When codes were assigned to the 509 unique verbal task descriptions, 289 different seven-digit codes resulted. Based on the number of taxonomic levels used, 69,120 combinations of the seven digits were theoretically possible. Figure 1 shows the number of task descriptions and associated codes which were unique and common to the various devices. Only two codes, 14-212-22 and 23-312-23 were common to all three devices. These two codes accounted for eight of the 509 task descriptions. Thus, at this level of analysis, three-way or total device commonality was only 1.6 percent.

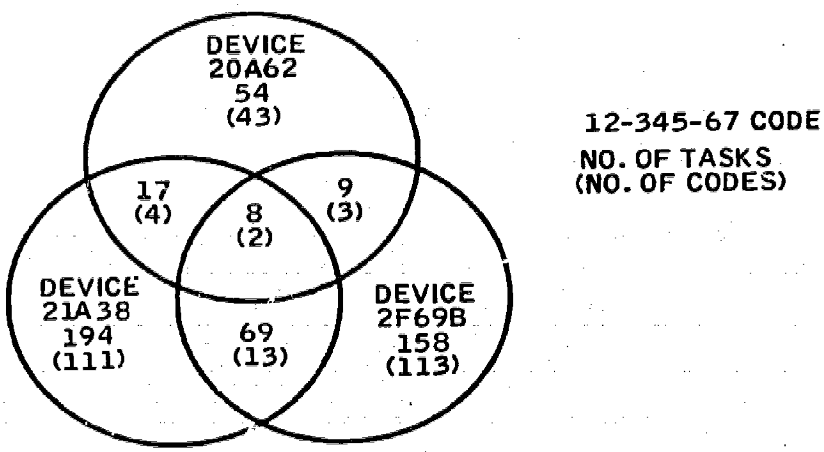

Figure 1. Task Frequency and Task Code Uniqueness and Commonality for Seven-Digit Code Analysis

COMMONALITY BY DEVICE

Little task commonality was found between Device 20A62 and Devices 21A38 and 2F69B (5.7 and 3.2 percent, respectively). However, commonality between Devices 21A38 and 2F69B accounted for 69 task descriptions (or 15.6-percent overlap). Approximately half of these descriptions (29) were coded as 12-312-34 or 22-312-34, differing only in Stimulus Modality. Beyond this difference, the character of codes common to Devices 21A38 and 2F69B may be depicted as involving discrete, relatively certain stimuli, procedure-following cognitive actions and a complex, skilled, continuous motor response.

Codes found to be unique to a single device contained a wide range of characteristics. Additionally, a single seven-digit code seldom accounted for more than one or two task descriptions. Those tasks appear less singular, however, when the specific code levels which describe the nature of various tasks were inspected more closely.

Table 4 shows the frequency with which the various S-C-R task element levels occurred in the 509 tasks. Based on these frequencies certain unique combinations of taxonomic levels were associated with specific study devices. For example, in Device 21A38 a stimulus modality level of 2 accounted for 141 of the 231 tasks (or 61 percent) accomplished in that device, while in Device 2F69B stimulus modality level 1 characterized 57 percent of its tasks. By using the most frequently occurring code element, the study devices may be characterized by the following S-C-R composites:

20A62: 13-212-23 or 13-312-23

21A38: 22-312-22

2F69B: 12-312-34

None of these composite codes contain code levels which are difficult or complex in and of themselves.

Four additional analyses were conducted to define more clearly the commonality of tasks. These analyses were concerned with specific parts of the seven-digit task codes. The partial analyses performed were: Complexity Index (Figure 2), Stimulus Elements (Figure 3), Cognitive Elements (Figure 4) and Response Elements (Figure 5). In these figures the number shown in the parentheses, indicate the number of task codes, while the numbers which stand alone show task descriptions accounted for by such codes.

COMPLEXITY INDEX ANALYSIS. For the Complexity Index analysis, three S-C-R elements from the taxonomy were used: Stimulus Information Uncertainty, Cognition Information Processing, and Response Complexity. As Figure 2 shows, a large number (254 of 509) of the task statements were found to be common to all three devices. The most frequently occurring Complexity Index codes were: X2-X1X-X2 (N=54), X2-X2X-X2 (N=25), X4-X1X-X2 (N=25), X3-X1X-X3 (N=22). These codes indicate some variety in the complexity of stimulus and response elements, but with a preponderance of discrete single-parameter or level 2 codes. The Cognitive Information Processing level, on the other hand, contained only two levels, Data Analysis and Problem Diagnosis.

TABLE 4. FREQUENCY OF TAXONOMIC ELEMENT LEVEL BY DEVICE

Element Level		Device 20A62	21A38	2F69B	Total
Stimulus Modality	0	0	0	0	0
	1	34	48	121	203
	2	29	141	52	222
	3	0	0	0	0
	4	0	35	26	61
	5	4	7	12	23
Stimulus Information Uncertainty	0	0	0	0	0
	1	4	17	11	32
	2	13	139	77	229
	3	22	31	41	94
	4	10	26	45	81
	5	14	10	29	53
	6	4	8	8	20
Cognitive Perception	0	9	4	0	13
	1	2	16	24	42
	2	18	42	12	72
	3	18	146	121	285
	4	13	13	48	74
	5	7	10	6	23
Cognitive Information Processing	0	1	52	0	53
	1	26	89	121	236
	2	15	49	56	120
	3	25	40	34	99
	4	0	1	0	1
Cognitive Action Selector	0	6	4	0	10
	1	11	25	31	67
	2	39	192	148	379
	3	11	10	32	53
Response Modality	0	0	0	0	0
	1	3	5	24	32
	2	48	155	55	258
	3	12	65	110	187
	4	4	6	22	32
	5	0	0	0	0
Response Complexity	0	3	5	0	8
	1	7	17	37	61
	2	21	130	60	211
	3	27	41	41	109
	4	4	34	61	99
	5	5	4	12	21
	6	0	0	0	0

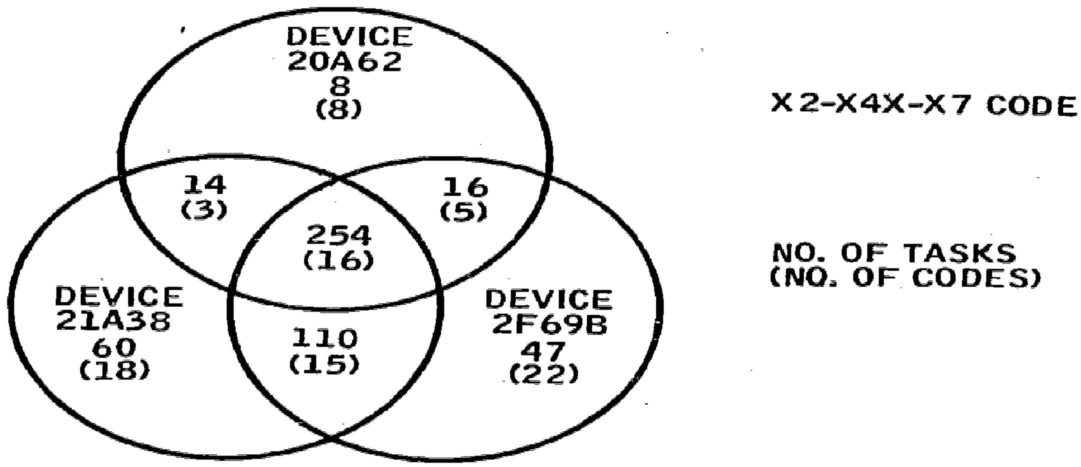

Figure 2. Task Frequency and Task Code Uniqueness and Commonality for Three-Digit Complexity Analysis

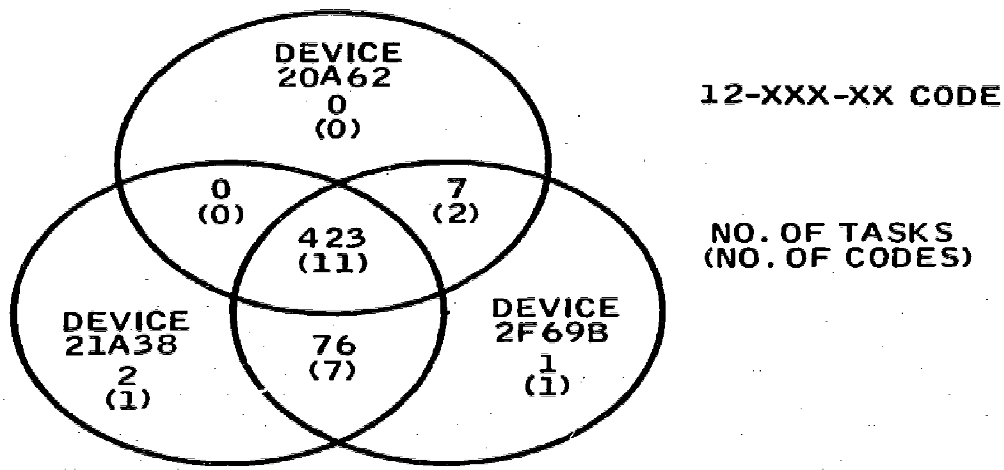

Figure 3. Task Frequency and Task Code Uniqueness and Commonality for Two-Digit Stimulus Analysis

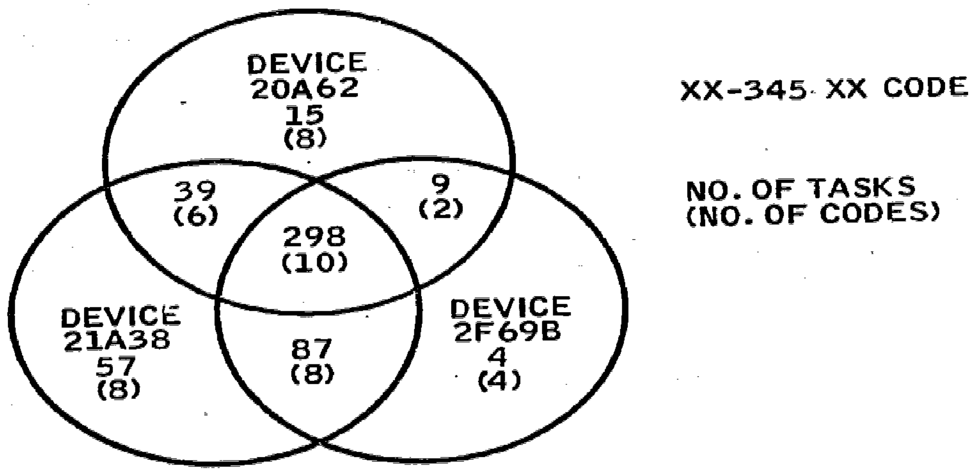

Figure 4. Task Frequency and Task Code Uniqueness and Commonality for Three-Digit Cognition Analysis

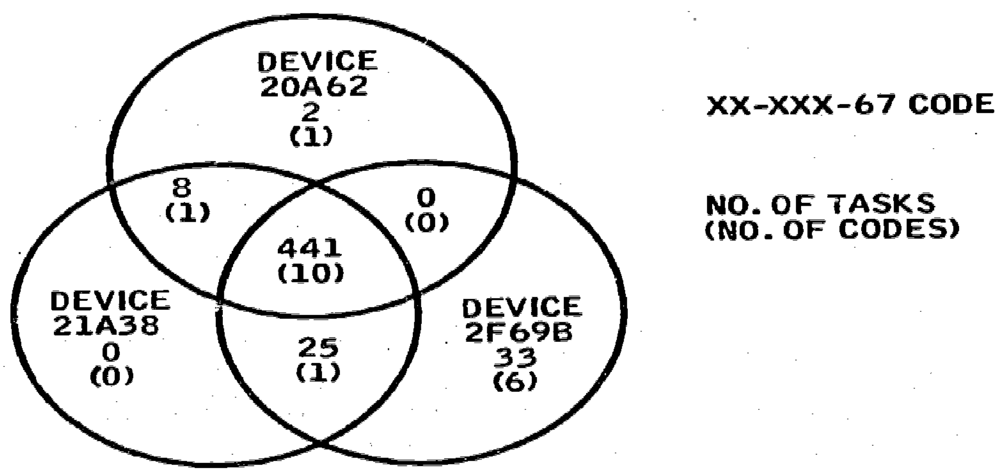

Figure 5. Task Frequency and Task Code Uniqueness and Commonality for Two-Digit Response Analysis

Complexity Index codes which were common to two devices revealed a situation similar to that found in the two-device overlap of seven-digit codes. That is, a much greater similarity between Devices 21A38 and 2F69B than between either of these devices and the 20A62 (i. e., 24. 9 percent overall versus 4. 7 and 5. 8, respectively). The Complexity codes found to be common between Devices 21A38 and 2F69B may be characterized by stimulus and cognition of fairly low complexity. Responses, however, covered a wider range of levels and were generally of higher complexity.

The Complexity Index codes unique to single devices accounted for only 23 percent of the task statements. This was true because each code normally represented only one or two task statements. For example, eight Complexity Index codes were unique to Device 20A62. Those codes represented eight different task descriptions of wide ranging complexity.

Of the task statements occurring uniquely in Device 21A38, 29 could be coded using only two codes. Those codes were X2-X0X-X2 and X2-X0X-X4. Thus, minimal stimulus and cognitive complexity but somewhat more response complexity characterized approximately half of the tasks observed uniquely in Device 21A38.

The characteristic complexity of tasks accomplished uniquely in Device 2F69B was found to be generally higher than for any other device. However, there was no single Complexity Index code which occurred significantly more frequently than any other.

STIMULUS ELEMENT ANALYSIS. The partial code analysis of stimulus elements also indicated large commonality among devices. In this analysis, 11 task codes accounted for 423 of the total 509 task statements (see Figure 3). Of the Stimulus codes which were common to all three study devices, a single code (22-XXX-XX) indicating a low-complexity auditory stimulus characterized 138 different task statements. The second most frequently occurring code was 12-XXX-XX indicating a visual as opposed to aural stimulus modality. The stimulus elements common to all three devices typically involved either visual or aural Stimulus Modality but covered the complete range of Information Uncertainty.

Stimulus elements found to be common to two devices occurred only between Devices 20A62 and 2F69B (2. 5 percent) and between Device 21A38 and 2F69B (17. 2 percent). The codes found in each of these common areas usually involved a combination aural-visual Stimulus Modality. The Information Uncertainty portion of these stimulus elements, however, covered the total possible range of case levels (1 to 6).

COGNITIVE ELEMENT ANALYSIS. Analysis of the cognitive elements alone revealed that the majority of the codes were again common to all three devices (see Figure 4). Of the 10 codes common to the three devices, a single code (XX-312-XX) accounted for 159 of the 298 task statements. Thus, most of the tasks observed in the study devices required procedure-following-type cognitions (-312-). When the minor variations of this cognitive combination, e. g., -212-, -302- and -412-, are included in the tally, nearly half (45. 6 percent) of the total number of descriptions were accounted for.

A similar result was obtained from inspection of the cognitions characterizing commonality between only two devices. Considerable variability was noted in the Perceptual and Action Selection cognitive elements, with the Information Processing category nearly always coded at level 1 or 2 (data analysis or problem diagnosis).

Cognitions unique to single devices typically included higher-level (i.e., Identification, Classification) perceptions. The Level 0 Information Processing code occurs here for the first time in Devices 20A62 and 21A38. A Level 0 Information Processing code indicates a task involving little or no processing of stimulus information, such as reflexive obedience to an order. Again, the Action Selection portion of these cognitions mainly involved the decision to follow a specified formal procedure.

RESPONSE ELEMENT ANALYSIS. In the analysis of response elements, a vast majority of task statements (86.6 percent) were found to be common to all three devices (see Figure 5). Codes representing the greatest number of task statements were XX-XXX-22 (N=168) XX-XXX-34 (N=87), and XX-XXX-23 (N=65). Verbal responses accounted for 58.5 percent and motor responses 36.3 percent, and the remaining 23 tasks involved a combined response modality. The complexity of these response codes ranged from Levels 1 to 5 with the highest frequency (45 percent) at Level 2, which is single-parameter, discrete.

Few response element codes were found to be common to only two devices or unique to a single device. Of those unique to a single device, the responses for tasks accomplished in Device 2F69B were often "visual orienting" in nature. This finding reflects the fact that Device 2F69B contains many redundant displays and that team members relied heavily on such displays for interacting with one another.

COMMONALITY BY OPERATOR CATEGORY

Table 5 shows the number of task statements and associated codes for each of the five analyses by operator category.

Inspection of the data in Table 5 indicates a level of task commonality among operator categories similar to that found when the data were analyzed on a device basis. For example, relatively few tasks (23 of 509) were found to be common to all five operator categories with the seven-digit task code analysis. Rather, a majority of the task statements and seven-digit codes were unique to single operator categories. Again, this finding parallels the results obtained in the device commonality analysis. When the specific number of codes unique to single categories were inspected, it was found that personnel in Category 1 (decision makers) and in Category 3 (sensor operators) perform the largest number of unique tasks: 133 and 131 respectively.

However, when the partial code analyses were done, a vast majority of the 509 task codes were common to more than one of the five operator categories. For the Complexity Index analysis, nearly all tasks were accomplished in common by the operators in two or more categories. Analyses of the S, C, and R elements alone showed that 499, 483, and 485 task descriptions, respectively, were done in common by persons in two or more categories.

TABLE 5. NUMBER OF TASK CODES AND DESCRIPTIONS UNIQUE TO AND IN COMMON AMONG OPERATOR CATEGORIES

Operator Category*	Task Codes									
	12-345-67		X2-X3X-X7		12-XXX-XX		XX-345-XX		XX-XXX-67	
	Codes	Tasks	Codes	Tasks	Codes	Tasks	Codes	Tasks	Codes	Tasks
1	104	133	17	29	1	2	12	19	1	2
2	31	45	3	4	1	1	2	2	0	0
3	97	131	21	43	1	7	3	5	4	22
4	20	22	1	2	0	0	0	0	0	0
5	3	4	0	0	0	0	0	0	0	0
1+2	6	11	2	9	1	3	3	14	0	0
1+3	4	15	14	64	5	45	8	49	2	15
1+4	2	7	2	5	0	0	2	9	0	0
1+5	1	3	0	0	0	0	0	0	0	0
2+3	3	15	1	3	0	0	0	0	1	4
2+4	0	0	0	0	0	0	0	0	0	0
2+5	1	2	1	2	0	0	0	0	0	0
3+4	5	23	3	18	0	0	1	11	0	0
3+5	1	2	0	0	0	0	1	2	0	0
4+5	0	0	0	0	0	0	0	0	0	0
1+2+3	1	17	4	36	5	93	4	68	0	0
1+2+4	0	0	0	0	0	0	0	0	0	0
1+2+5	0	0	0	0	0	0	0	0	1	5
1+3+4	1	8	4	26	2	20	5	45	1	5
1+3+5	0	0	1	6	0	0	0	0	0	0
1+4+5	1	7	0	0	0	0	0	0	0	0
2+3+4	3	15	3	24	0	0	0	0	0	0
2+3+5	2	17	0	0	0	0	0	0	0	0
2+4+5	0	0	0	0	0	0	0	0	0	0
3+4+5	1	5	0	0	0	0	0	0	0	0
1+2+3+4	0	0	5	104	3	79	2	41	4	69
1+2+3+5	0	0	0	0	0	0	0	0	0	0
1+2+4+5	1	4	0	0	0	0	1	17	0	0
1+3+4+5	0	0	0	0	0	0	0	0	0	0
2+3+4+5	0	0	0	0	0	0	0	0	0	0
1+2+3+4+5	1	23	5	134	3	259	3	227	5	387
Total	289	509	87	509	22	509	46	509	19	509

*1 - Decision makers
2 - Plotters
3 - Sensor operators
4 - Continuous tasks
5 - Discrete tasks

COMPLEXITY INDEX ANALYSIS. For the complexity index analysis, only 1+2+3+4 and 1+2+3+4+5 operator category common areas accounted for substantial numbers of tasks per code (Table 5). Codes found in these two areas of commonality contained the complexity level codes representative of 46.7 percent of the observed tasks. Yet, the coded levels in these intersections are all low to moderate complexity. This indicates that the higher levels of complexity and information processing are not common to all operator categories.

STIMULUS ELEMENT ANALYSIS. The analysis of the stimulus elements alone showed a large number of tasks (259) accounted for by three codes found in the 1+2+3+4+5 operator category overlap area. These codes represent both visual and aural, single- or multi-parameter, discrete stimuli. Stimuli with high levels of uncertainty (Code Levels 5 and 6) were normally found only in the intersections of Operator Categories 1 and 3. All of the five codes listed involved highly uncertain stimuli. Also, the full range of observed stimulus modalities are contained in codes found within this intersection.

COGNITIVE ELEMENT ANALYSIS. Analysis of cognitive elements above showed that 44.6 percent of the task descriptions occurred in the 1+2+3+4+5 area. The three codes in this area were all of a routine procedure-following nature. Examples of higher-level cognitive functions (i.e., perceptual classification, concept formation and action selection based on generalization) were found to be unique to Operator Category 1 (decision makers). However, the specific code, described verbally above (XX-533-XX), was observed only once. The only other examples of cognitions involving a combination of concept formation and generalization were in the codes common to Categories 1, 2 and 3.

RESPONSE ELEMENT ANALYSIS. The analysis based on the response elements alone indicates that the majority of the tasks (89.5 percent) were common to Categories 1, 2, 3, and 4 and to 1, 2, 3, 4, and 5 (see Table 5). These tasks included the full range of observed modalities and complexities.

CATEGORY PROFILES. The frequency with which levels of various S-C-R taxonomic categories occurred provided a more molecular description of team member behavior. Table 6 presents the modal profiles for each operator category based on this analysis.

TABLE 6. MODAL S-C-R ELEMENT LEVELS FOR OPERATOR CATEGORIES WITHIN DEVICES

Device	Category				
	1	2	3	4	5
20A62	15-232-22	23-312-33	13-312-33	23-212-22	23-332-23
21A38	22-312-22	22-312-32	22-312-22	22-312-32	22-312-33
2F69B	12-323-22	12-312-34	12-312-34	---	---

This table shows the most frequently occurring task code levels. In Devices 20A62 and 2F69B the most common task code levels for Operator Category 1 personnel indicate heavy reliance on visual stimuli. The decision makers in Device 21A38 (Category 1 personnel), on the other hand, rely much more heavily on aural stimuli. The primary use of visual stimuli by decision makers in Devices 20A62 and 2F69B reflect, to some degree, the environment within which these individuals function. For Device 20A62, the OOD predominantly used the bird's eye CRT as his tactical display. For the TACCO in Device 2F69B, the major display was again a CRT. For the decision makers in Device 21A38 (CONN, FCC and Sonar Supervisor), however, no such central display was available. Thus, verbal communication was the predominant method of interacting.

Table 6 also shows the high degree of similarity in the levels of task elements for the various operator categories. The preponderance of levels 2 and 3 for all S-C-R elements suggests that the majority of tasks accomplished by various operators in the study devices are neither difficult nor complex.

SECTION IV

DISCUSSION AND IMPLICATIONS

The objective of this study effort was to determine how advanced technologies such as generalized or adaptive training could be beneficially applied to Navy tactical team training. The team-task data were analyzed to determine whether sufficient commonality exists among tasks to warrant recommending a generalized approach to tactical team training.

TASK DATA

In this study, the degree of task commonality varied as a function of the molecularity of the analysis. At the most complete level of analysis, where each of the seven taxonomic elements had to match perfectly for commonality to exist, little commonality was found. The comparison of complete task codes did reveal, however, that there was more commonality of tasks performed in devices containing weapon systems (Devices 21A38 and 2F69B) than between either of these and the maneuvering trainer (Device 20A62). The apparent reason for this finding is the expanded role of the sensor operators as well as the presence of fire control equipment operators in the weapon system trainers.

The frequency of occurrence of task element levels was tabulated by device and by operator category within device. These analyses, which ignored the sequential relationship between task S-C-R elements, produced device and operator category profiles. Such information is useful for the design of any training system for it delimits each operator's task environment. Development of total and part-team trainers requires that appropriate task stimulus and response modalities be identified along with an estimate of their capability. In addition, the cognitions which mediate the task stimulus and response must be identified if they are to be effectively trained.

The device profiles obtained in this study differed from one another primarily in terms of stimuli and responses. Whereas tasks performed in Devices 20A62 and 2F69B had predominantly visual stimuli, the task responses were mostly verbal for Device 20A62 but motor for Device 2F69B. The modal task code profile for Device 21A38 showed correspondence between both stimulus and response elements (i. e., a discrete aural input and a discrete verbal output). Thus, if a generalized training scheme is considered, it should allow for the adjustment of the input and output task parameters to correspond to those relevant to the current training and presumably operational environments.

Contrary to the profiles for stimuli and responses, the modal task code profiles of all three study devices contain the same cognitive element levels (viz., -312-) corresponding to Perceptual Recognition, Data Analysis, and Rule-Following. These elements describe the characteristics of a procedure-following task. If the greatest commonality is that the devices all trained procedural skills, this suggests that generalized procedural-skill trainers might be feasible. However, before this can be recommended, three questions must be answered. First, do the partial code analyses indicate a similar commonality among operator categories? Second, is the acquisition of procedural skills the desired terminal objective of the tactical team training system? Third, what is the status and conditions of use of existing trainers? To answer the first question, the partial code analyses will be reviewed.

The Complexity Index analysis showed that task elements common to all five operator categories were of relatively low level, i.e., tasks at the level of explicit information exchanges, specific orders, or acknowledgements. Each of these is a highly specific event with minimal uncertainty. Tasks which embody high uncertainty, such as extracting a signal from a noisy background, were found to be common only to the decision maker and sensor operator categories. Thus, subsets of operator categories can be formed on the basis of the Complexity Index with decision makers and the sensor operators in one subset and the talkers, helmsmen, etc. (Category 4 and 5 personnel) in the other. Plotter (Category 2) personnel performed tasks which were most similar to operators in Categories 1 and 3, and are thus placed in the former subset. The nature of Operator Category 2 tasks, however, was heavily influenced by the large number of different tasks performed by the navigator at Device 2F69B.

Further support for establishing subsets of operator categories is provided by the analyses of the stimulus, cognition, and response elements. With the exception of environmental inputs to sensor operators, aural task stimuli were found to be quite specific in nature. These stimuli were common to all operator categories, indicating that verbal exchange was the primary medium of team interaction. Complex visual and indeterminate stimuli were common only in the decision maker and sensor operator categories. Thus, the objectives of and facility for training these personnel should include provision for complex patterns of stimuli, features typically associated with high fidelity of stimulation.

The analysis of response elements indicated a great deal of commonality among operator categories, with a predominantly verbal modality. Unique responses were associated only with the motor requirements of the sensor operators' and navigators' tasks.

Cognitions common to all operators were fundamentally procedure-following. The task codes involving cognitions thought to be involved in tactical decision making, such as the development of a unique battle plan or innovative behavior, were few in number. However, when these codes were observed, they tended to be associated with the decision-maker category, either uniquely or in common with the sensor operators. The fact that the higher-level cognitions congregate in one subset of operator categories further supports a concept of differential training.

Thus, the commonality observed in the device profiles is not completely supported by the partial operator category analyses. Based on the suggested division of operator categories, at least two types of training are indicated. The support personnel in Operator Categories 4 and 5 exhibited task behaviors which do not require a high-fidelity training device. The individual skills necessary for these tasks would benefit most from on-the-job training (OJT). Their preliminary team skills could also be trained aboard ship by means of talk-through problem scripts, cross training, as well as OJT. Decision makers, sensor operators, and plotters, however, perform tasks which could benefit most from training facilities and techniques currently not available except at shore-based training devices. Thus, a part-task trainer for these personnel appears warranted. Such a trainer should emphasize the ambiguity of the operational environment to enable the acquisition of individual and basic team skills prior to entering the team training situation.

The second question posed earlier is whether training teams to cope successfully with high-risk environments should culminate in the training of procedures. The literature (cf. Alexander and Cooperband, 1965; Sidorsky and Houseman, 1966) says that the answer should be "no." The emphasis of tactical team training should be upon generalizing from procedural skills to deal with novel and unexpected environments and contingencies. Yet, the emphasis of the training observed in this study never reached the level where teams were applying creative responses to ambiguous situations.

The third question posed at the onset of this study was what are current-use practices at existing devices. The following subsection answers this question in light of the observations made during this study.

CURRENT TRAINING

The data and observations of this study indicate that Navy tactical team training is not achieving its required or potential effectiveness. It was found that intact teams seldom appeared for training. Instead of the established teams who normally operate together as a unit, the majority of "teams" trained in the study devices were simply groups of individuals formed into ad hoc teams at the training device. Specifically, Device 20A62 was used to provide practical experience for personnel attending Rules of the Road courses and also for those in Officer of the Deck (OOD) school. Rules of the Road classes were composed of trainees from or enroute to operational ships. Students from the OOD school were junior commissioned officers, many of whom were preparing for their first assignment at sea. Generally, then, personnel being trained at Device 20A62 were assigned there to learn basic skills rather than to develop the team coordination which assumes this knowledge as a prerequisite.

A similar situation existed at Device 2F69B. The major user of this device was a Replacement Air Group (RAG) squadron. This squadron provided a 10-week course to prepare individual officer and enlisted personnel for operational billets. The secondary users of Device 2F69B were crews of operational aircraft. During the observations of this study, Device 2F69B was used either to qualify individual crew members or as an alternate site for required operational readiness inspections.

The use being made of Device 21A38 presented an exception. This device was observed to be used exclusively by teams who normally functioned together on FBM submarines. These teams used Device 21A38 on a regular schedule as a part of their required training cycle.

However, even when full teams did appear for training at a study device, team members often did not possess the prerequisite skills for the training of team tactics. The instruction provided in these trainers, rather, concentrated on teaching individual trainees how to operate their various equipments and the basic procedures necessary to interact in the team setting. These individual procedural skills must be part of the trainee's repertoire, at least to some reasonable degree, before the goals of team training can be undertaken.

An additional observation was that instructor personnel were normally not adequately prepared for their jobs. Each instructor observed was a subject-matter expert in his major area (e. g., shiphandling, ASW, etc.). Some instructors had taken courses at a special Navy school to prepare them for instructional duty. However, based on the training methods observed, it is concluded that these instructor's courses are not meeting the need of providing training specialists. Specifically, instructors were generally unaware of the influence of their actions on trainee behavior. Little thought appeared to be given to how the manipulation of problem parameters or the information provided during critique sessions could influence the effectiveness of a given training experience.

A major deficiency in the current use of study devices was that the basic materials required for an effective training program were either not available or not used. These materials should include well defined and validated:

- Objectives of training
- Criteria of performance
- Measures of performance
- Tests
- Problem scripts
- Data base for performance evaluation
- Evaluation procedures

The stated objectives and observed performance measures and criteria used at the devices in this study are shown in Tables 7 and 8, respectively. As may be seen from Table 7, the objectives were stated in the form of a course overview. In no case were specific end-of-training performance objectives enumerated. Furthermore, the criteria and measures of performance used in these devices changed as a function of what an instructor viewed as being most important. Observations made during this study also indicate that no formal performance testing is occurring at these devices. Without measuring trainee or team performance, it is not possible to assess the effectiveness of training provided.

These findings illustrate the current use being made of study devices and highlight some of the problems existing in the Navy team training environment. None of these findings, however, are unique to this study, as all have been reported by other researchers (cf. Schrenk, et al, 1969; Jeantheau, 1969). The point to be made is that such findings reflect problems which pervade the entire Navy training environment. It is suggested that to solve these problems, the orientation and use of the existing Navy training system be reexamined with the objective of determining ways to increase system effectiveness.

TABLE 7. FORMAL OBJECTIVES FOR DEVICES STUDIED

<u>20A 62 -- Emergency Ship Handling Trainer</u> "To present a comprehensive review of the Rules of the Road (nautical) and practical application of these rules in the Conning of a ship in various situations (Ordinary and Special Circumstances) which will aid Conning Officers in preventing collisions at sea" (Curriculum, COMTRAPAC COURSE K00-607, Rev. Jan. 1970)
<u>21A38 -- Submarine ASW Attack Teacher</u> "To develop the proficiency of Submarine Battle Station and Watch Station Fire Combat Parties" (COMSUBPAC INST 1500.15C)
<u>2F69B -- P-3A Weapon System Trainer</u> Specific course objective not available. General use objective available in: COMFAIRWINGSPAC INST 1500.3 and 1500.4 (Conf. Suppl.) COMNAVAIRPAC INST 3131,10 and 1510 series

TABLE 8. PROFICIENCY MEASURES AND CRITERIA

Unit	Device 20A62	Device 21A38	Device 2F69B
Team	Measures (per ship) Objective - signals (whistle) intership distance speed, course Subjective - hazards occurred, concurrence with "rules of good seamanship" Criteria (per ship) Subjective refei ence to rules of road. NWP-38.	Measures Objective - Hit/Miss target Subjective - team coordination to solve FC problem Criteria Objective - computer determined hit/miss Subjective - doctrine experience	Measures Objective - Hit (not often used) Subjective - none
Subteam	No Subteams in 20A62	Measures Objective - P/K solution for target range, bearing course and speed (fire control) Subjective - Successful tactical maneuver (OOD), evasive action (OOD), time to detection (sonar) plot accuracy and time (plot) Criteria Objective - computer P/K solution Subjective - doctrine experience	No Subteams in 2F69B
Operator	Measures None Criteria Same as team	Measures Objective - none Subjective - equipment operation communication Criteria Objective - none Subjective - doctrine/ experience	Measures Objective - target signature (JEZ) Subjective - operation of equipment (TACCO, NAV, JEZ, JULIE, Radar) -- -- Tactics (TACCO) -- Procedure (all) Criteria Objective - none Subjective - instructor expr 'ai ce

In sum, the data of this study indicate that total-team generalized training is appropriate only for routine, low-complexity procedural tasks. Importantly, these tasks are not the essence of those required in the tactical environment. Further, part-team training for different operator categories appears to be more beneficial. Finally, the most immediate and largest improvement in tactical team training would not be realized through development of a generalized training system. Rather, more efficient use of existing devices coupled with the addition of selected advanced technologies should produce the results desired. The balance of the report will discuss principles and techniques which offer significant promise or have been empirically demonstrated to increase training effectiveness as they relate to the study devices.

Perhaps the best documented finding relating to increasing trainee proficiency is in the area of performance feedback. Feedback, to be maximally effective, should be specific, overt, immediate, complete, and positive. However, this was an area where current practice was observed to be deficient. This deficiency was addressed during debriefings at Devices 20A62 and 21A38. In response to a request for suggestions from trainer staff personnel, recommendations were made for actions that would serve to improve the existing situation.

At Device 20A62, it was recommended that an additional trainee/instructor intercommunication system would aid instructors in coaching and/or critiquing single trainee teams. This suggestion was made because the hardware configuration at Device 20A62 incorporated but a single instructor/student intercommunication link. Additionally, instructors normally ran all problems from their separate station. Consequently, each time an instructor desired to communicate with a specific trainee bridge unit, that conversation was necessarily heard in all other bridge units. A number of instances were observed where instructors could have substantially increased the utility of a training problem by providing confidential, supplemental directions to a single trainee unit.

Because instructors were unable to determine the reason for various actions taken by trainees when problems were run from the instructors' station at Device 20A62, an additional suggestion was offered. Namely, that at least one instructor should roam the trainee bridge units during training. By so doing, actions critical in the problem solution could be determined and the critiques accurately directed toward these events.

Information received from the staff at Device 20A62 subsequent to the data collection phase of this study indicates implementation of these two suggestions has increased trainee performance. Unfortunately, objective performance measurement was not being used at Device 20A62, so there is no way to determine the extent of improvement.

A suggestion made in response to a request for inputs at Device 21A38 also related to the area of performance feedback. Here the suggestion was directed toward solving a problem which arose when enlisted instructors were required to critique the performance of officer trainees. The enlisted instructor was placed in a situation requiring frankness in identifying the errors made by senior officers. This situation was often handled by the instructor addressing such errors indirectly, thus avoiding direct confrontation, or by totally ignoring the error. Neither solution is appropriate or effective for providing the required performance feedback. It was suggested that such situations could be avoided by having either officer or civilian instructors lead critique sessions when officer trainees were involved.

The suggestions made at these two trainers were for actions which could be taken independently by trainer personnel, involved little or no cost and did not require lengthy development before implementation.

Perhaps the major problem faced by users of Navy team trainers is the lack of requisite training software. These include a specification of the objectives of training, performance criteria, evaluation tests, device-use guides, etc. Until such materials are developed and used there is no objective way to assess the adequacy of the training. Thus, a major improvement in the effectiveness of all team trainers can be expected from the development and use of measurable behavioral objectives of training. Performance criteria and associated test materials must also be developed to permit the assessment of that training.

Trainees were often not adequately prepared for team training. Our observations indicate that this situation could be substantially improved through the use of additional individual and/or part-team training. A variety of training media can be used both ashore and aboard ship for this purpose. In some cases media can be combined to produce a more efficient training program than any single medium alone might produce. Such multi-media approaches have received considerable attention (cf. Briggs, Campeau, Gagne, and May, 1967) but cannot be realistically implemented without careful study of the individuals to be trained and the skills to be acquired. Further, the sequencing of media has been found to be as important as their selection (Parker and Downs, 1961). As Rhode et al. (1970) have concluded:

> "Research and experience have failed to establish the sorts of definitive and meaningful relationships between media and general objectives that provide the basis for any firm and final conclusions in this regard." (p. 297).

Rhode et al. have compiled extensive information on the following instructional media:

- Portable instructor aids
- Television
- Student response systems
- Dial access information retrieval systems
- Learning laboratories
- Programmed texts
- Teaching machines
- Simulators
- Computer-aided instruction

Rhode et al. reviewed each of these media with respect to their instructional flexibility, support requirements, and relative costs. Such data can be used to define cost-effective approaches to the training of both individuals and teams in tactical skills. This, however, is beyond the scope and time limitations of the present program. Instead, possible applications of selected technology and media which offer significant promise to produce more effective tactical team training will be briefly discussed.

A review of the literature (military and civilian studies and applications) indicates few techniques immediately applicable to team training. The majority of training technology is geared toward individual instruction. However, it is obvious that enhancing individual trainee capabilities prior to their entering the team training environment will do much to further the efficient use of the team environment. Although many of the technologies reviewed here pertain to individual training, emphasis will be devoted to those techniques that offer the greatest potential for practical implementation.

One advanced training technology concept is Learner-Centered Instruction (LCI). LCI is characterized by course content and training devices developed from the job's behavioral requirements. State-of-the-art instructional media and methods are selected to provide maximum practice of the relevant behaviors. With LCI, trainees work at their own pace, with the instructor no longer the focal point of training.

Valverde and Pieper (1970) developed and evaluated an LCI course for Air Force electronics maintenance skills. As part of their program, they:

- Performed a task analysis and identified the learning objectives (training requirements)
- Developed a job performance test to measure the trainee's ability to perform the job behaviors
- Developed a job-specific simulator for testing and teaching job behaviors
- Designed a multimedia, job-specific course
- Compared performance on the LCI course which taught the required job behaviors with a conventional course which dealt primarily with electronic principles of equipment operation

Their evaluation indicated that significant performance and cost benefits were derived from application of the LCI program. The principal benefits occurred with high-aptitude trainees, both at the end of training and after five months in the field.

LCI appears to be most appropriate for training individuals prior to their entering the team training environment. Those tasks for which the job behaviors, stimuli, and the responses are well identified are most amenable to this approach. Therefore, due to the procedural nature of jobs accomplished by all team members observed in this study, significant benefit would probably result from application of this technique. Depending on where the training occurred (onboard ship or at a shorebased device), a variety of media might be used. These include programmed books, part- and whole-task simulators, nonfunctional mockups, lectures, and teaching machines. Certain of the more promising of these materials and techniques will be discussed with the intent of indicating how they could be applied.

Television, as an instructional medium was considered by the Navy as early as 1951 (Rock, Duva, and Murray). Recently, the Navy's Personnel and Training Research Laboratory conducted a thorough survey of training-related uses of television (Hansing and Matlock, 1970). This survey leads us to consider a number of applications of this technology to the problem of shipboard and shorebased team training.

The split- or multiple-screen technique procedure could be used to show team members their jobs in relation to other team members (cf. Krickel, 1964). A trainee (or trainees at a given station) could observe how a given action serves as a stimulus for some other team member. Similarly, a team member could determine the basis for some input that he receives from another station. Such training provides the trainees with a better appreciation for their role in the team and of the need for effective communication and interaction. For example, this technology appears to be especially appropriate when used in conjunction with video tape to show how members of "good" versus "bad" teams interact. Videotaped television can be used for establishing a team awareness in team training situations where portions of the team are physically separated from one another (e.g., Devices 21A38, 14A2, etc.).

The videotape lecture technique generally allows for uniform polished presentations, economy of instructor time, and scheduling flexibility. Most studies have shown that retention is at least as good with this method as with conventional lecture methods, and it generally is well-received by students (Hansing and Matlock, 1970). TV classroom training has already begun at the Fleet ASW School, San Diego (Hansing and Matlock, 1970).

The use of videotape also provides the capability to provide immediate feedback to a trainee after he has practiced some response or procedure. This is a unique advantage of this medium over motion pictures. The Air Force has recently applied this technique effectively for individual pilot training on the T-37 aircraft (Valverde, 1970). Videotapes permit comparison of different stages in a trainee's progress and can be used in the shore-based facility to refresh instructor's memories about an individual's or team's performance. Another application of the split-screen technique discussed earlier would be to display the trainee's (or team's performance) simultaneously with a "perfect" maneuver or task performance.

A further use of closed-circuit television and videotape techniques is the monitoring of training from aboard ship. This would permit the training facility to be extended to include additional subteams. For example, a bridge unit of the 20A62 could be linked to the team's own Combat Information Center aboard ship. Also, key personnel such as the Commanding and Executive officers could participate in or observe and critique training without having to be present at the shore facility.

Although the costs of such applications may be high, it appears that this technique has much to offer.

Many of the capabilities of the computer are highly applicable to team tactics training. Certainly, with the availability of digital computers in weapons systems trainers (e.g., Device 2F87 and the 14A2 series), the possibilities are great for allowing the computer to perform many functions presently done by the instructor.

Although individuals are ideally trained to operate as part of a smoothly operating team, their individual training seldom includes the acquisition of the interactive skills required in the team setting. One attractive approach to initiating interaction skills earlier in the training cycle is through the use of synthetic or simulated fellow team members. Here, the actions (inputs and responses) of other team members can be stored on magnetic tape and played to the trainee at the appropriate time in his operation (cf. Blake and Brehm, 1954). In this way the individual operator trainee can develop the required individual skills in a situation more closely paralleling that which will ultimately exist. Data from Klaus and Glaser (1970) indicate that such simulated team member training should be supplemented later by actual team interaction.

Another function the computer can perform is to administer proficiency tests to trainees when they enter the team training environment. These tests can help determine which members are deficient in skill, and allow the computer to match a program of instruction to the trainee characteristics. A computer-based individual training system for decision makers or Category 1 personnel (OOD, TACCO, Attack Officer) is described below.

The system might be composed of a computer-driven cathode ray tube (CRT) and function keyboard. On the CRT could be displayed a symbolic view of an ASW situation. Appropriate math models would be used to portray ship's motions, sensor capabilities, and weapons effects. Various scenarios of different predetermined problem difficulty could then be programmed and displayed to the trainee, allowing him to practice procedures related to sensor and weapon deployment. The trainee could also make tactical decisions required in the ASW or other tactical environment, while of course risking no loss of men or material. In effect, this advanced training concept compresses experience for an operator, yet offers many of the benefits of computer-aided instruction (e.g., low student/instructor ratio, immediate feedback, motivated trainee, provisions for branching). Siegel and Federman (1970) performed an analysis of the TACCO's intellectual functions and derived a conceptual device embodying many of the above characteristics. Additionally, Honeywell has developed as a test vehicle such a computer-based system for the ASW officer. In sum, this concept seems especially appropriate for use in improving individual skills prior to a team session. Here, after a predetermined level of individual proficiency has been attained, the decision-making team member could enter the team context with its greater ambiguity and uncertainty. Application of this technique, whether aboard ship or at a shorebased installation, could, for example, substantially reduce the problems caused by deficient TACCO trainees at Device 2F69B.

To avoid wasting the team training session because one or more team members come unprepared for team training, it may be advantageous to prompt individual operators within the team context. Prompting has been used effectively to train individuals in sonar discrimination (Annett and Peterson, 1967), visual identification (Weisz and McElroy, 1964), and auditory detection (Annett and Clarkson, 1964). The techniques developed for the experimental studies cited above could provide the basis for prompting in the team setting. As an example, all fire control solutions for weapon delivery systems depend heavily on the accuracy of the sensor operator's tracking ability. If a sonar operator were in error beyond some predetermined amount, the computer controlling the trainer could be preprogrammed to automatically prompt that operator. Such prompting could appear in the form of a more easily tracked brightened target trace, the appearance of a reference dot at the appropriate tracking cursor position, etc. As a result, the deficient tracking operator would be coached into accurate behavior, and the team training exercise would not be degraded. This concept is applicable to all operator categories, not just decision makers and sensor operators.

A capability of automatic monitoring of trainee proficiency and progress would allow the consideration of a technique known as adaptive training. In adaptive training, task or problem difficulty is automatically adjusted as function of trainee performance level. The requirements for an adaptive system are (Kelley and Wargo, 1968):

- Valid and reliable performance measures
- At least one system, task, or environmental variable that affects task difficulty
- Adaptive logic which automatically adjusts task difficulty on the basis of the relation of measured performance to present criterion of performance

To date, the greatest amount of research on adaptive techniques has been in the area of continuous perceptual-motor skills (cf. Kelley and Wargo, 1968). Research on detection -- identification tasks (e. g., Mirabella and Lamb, 1966; Swets, Millman, Fletcher, and Green, 1962) have yielded somewhat equivocal results.

Many problems must be solved before adaptive training can be effectively implemented in the team, or any training situation (Caro, 1970; Leonard, Doe, and Hofer, 1970). Particular problems involved in using adaptive techniques for the team tactics situation are: (1) establishing valid and reliable performance measures and (2) combining separate aspects of performance measurement into a single continuum for adaptation. These problems continue to receive much attention from workers in the field[1].

The concept of adaptive training could be implemented by a competent instructor. To do this, more adequate provisions must be made for monitoring and evaluating team performance. These provisions would require expansion of the computer capacity at the devices of the present study. Further, instructor personnel must receive appropriate training in adaptive techniques. Using the computer to collect and analyze performance data appears to be the only reasonable means of attaining truly standardized measurement in the

[1]Adaptive Training -- Discussion transcript conducted on 27 and 28 April 1970 at the University of Illinois Institute of Aviation.

team setting. Furthermore, two current problems can be solved through automation. First, automatically collected performance measures are less likely to be challenged for accuracy, thus removing the current need for instructors to defend their criticisms of team functioning. Second, instructors are freed from the task of manually recording performance data and can more fully use their system knowledge to assist the team in reaching proficiency. Some attempts at incorporating such real-time instructor aids have been made with the Army's Synthetic Flight Training Simulator (Prophet, 1970).

Certainly, the data base which could be collected with an automatic performance-monitoring capability could also have another important application, namely, to allow for evaluation and evolution of the training system. Any effective training system must remain open to refinement through evaluative feedback and validation. As trainees become more proficient, the training curriculum must be adjusted. Allowing the computer to record trainees' performance and to store and compare team data longitudinally would permit long-term changes in overall performance to be detected and acted upon. In addition, individual training exercises can be analyzed for their effectiveness in training requisite behaviors (i. e., item or scenario analysis).

This discussion has served to point out that the development of a generalized team-tactics training system is not appropriate at this time. Rather, significant improvements to the existing situation may be made by the application of advanced technologies. The next subsection offers specific suggestions for achieving these improvements.

IMPLICATIONS

A conceptual view of the process from individual to tactical team training is presented. At the level of individual operator categories there is much promise for general-skill trainers. The tasks required of sensor operators (pattern recognition, procedural following), and vehicle control operators (continuous or discrete tracking, procedure following) are amenable to training via computer-based, part-task trainers. Training the decision maker for tactical command involves a number of other skills (e. g., individual proficiency in situation recognition, knowledge of the procedures required to implement situation solutions, knowledge of his platform's capabilities and limitations, knowledge of enemy characteristics, etc.). Thus, the training of this individual skill involves task-oriented problem solving.

The next level of training would involve an assembled team. The emphasis would be on interaction and coordination and the development of a sense of team awareness. The training could occur either on the job if given the appropriate software, or at the training device. The objectives at this stage would be to learn what information should be transmitted to other team members and how it should be transmitted. Something as simple as a special earphone through which the instructor could prompt selected individuals so that the information flow could be maintained could be used as an aid in meeting this objective. The decision maker should be trained to exercise leadership control of the communication networks. From individual training both the decision maker and the sensor operator should have acquired knowledge of the basic stimulus patterns they will be exposed to and their associated procedural responses. Now they would acquire the ability to extract such stimulus information from a more noisy but still relatively unambiguous background and transmit it appropriately.

Once the individual skills are mastered, and a sense of coordination or team awareness acquired, training can be concerned with the essence of tactics, viz, dealing with uncertain, ambiguous, or emergency situations. This involves a whole team in the process of modifying and generalizing from established procedures to deal with an intelligent opponent or environmental hazard. When one thinks of training in this form, concepts such as the linking of a submarine and a surface and/or air ASW device are appropriate suggestions. This would require, however, a fine degree of exercise control if this situation is to be in fact training rather than "free play." Training tactics involves uniqueness. While general processes may be involved at an individual level, the team tactical setting requires new instructional techniques and specific hardware capabilities but not necessarily new devices.

Thus, the degree of device and operator-task commonality cannot be considered independent of the presently available equipment or conditions of training. It is concluded that currently available training hardware is more than adequate to train teams effectively, but that these devices are not being used as effectively as they might. Thus, rather than suggesting that the Navy embark on a costly developmental program for a generalized team tactics training system, it is recommended that better use be made of available facilities.

An effective training system reflects a planned and controlled learning environment. The planning of such an environment requires several steps:

- Task and function analysis
- Training requirements analysis
- Training program development
- Training device design
- Training program use and evaluation
- Training program revision

A number of approaches have been developed and are available to accomplish these program elements. Each of the steps outlined above are necessary for the development of a new training system or the modification of an existing one. Briefly, the goal of each of these developmental steps is:

- Task and Function Analysis -- Identify and reduce operator tasks, on a mission-oriented basis, into segments which can be analyzed to determine training requirements.

- Training Requirements Analysis -- Identify criterion tasks which should be incorporated into a training program to achieve desired terminal levels of performance.

- Training Program Development -- Define performance objectives; select subject matter and sequencing; define length and frequency of training; identify training methods; define instruments.

- Training Device Specifications and Design Development -- This step assumes that a new training device system will be developed to fill an existing need. Specify device characteristics and translate into hardware.

- Training Program and Evaluation -- Development of use procedures, guidelines, programs, evaluative instruments, etc., to support training system.

- Training Program Revision -- Based on a change in system objectives, availability of new technology, or indications of ineffective training from performance data base, revise training program to maintain or increase effectiveness.

These steps, then, reflect a recommended philosophy which is applicable for the development or revision of any training program.

SECTION V

RECOMMENDATIONS

The data and observations of this study combined with the findings of previous team and generalized training research, lead to the following recommendations.

1. The Navy should concentrate on improving the effectiveness of existing devices rather than launching a development program for generalized training systems. Significant improvements could result from:

   a. The establishment of formal, quantifiable behavior objectives of training. This would provide a framework for the selection of training media, the sequencing of instruction, and the evaluation of trainee progress.

   b. The development of performance criteria. This provides the yardstick against which training effectiveness can be assessed.

   c. The development of appropriate test materials and use guides. Diagnostic and achievement tests would assist instructors to assess trainee proficiency upon entering the team environment and to determine an appropriate set of problem exercises. The use guide is a definite requirement. The utility of the sophisticated training systems that have been developed is limited by the ability of instructors to use them.

   d. More adequate instructor training. The initial training of instructors should place greater emphasis on his role and impact upon trainee performance. Additionally, periodic critique and refresher training of instructors is warranted.

   e. Navy-wide evaluation procedures to assess the effectiveness of the materials, techniques, and utilization of team training devices. This would permit incorporation of new training techniques, identification of new training requirements, and an earlier identification of training problems and potential problems.

2. Specific recommendations for training device development and use include the following:

   a. Teams should be required to appear at the training device as a unit. Thus, training could progress more rapidly toward the goal of improving team tactical effectiveness and the skills acquired in the trainer would transfer more readily to the operational unit.

b. Provision for automated monitoring, evaluation, and selective prompting and cueing of operators on an individual basis, within the team training context. This feature is oriented toward making the team environment more productive and reduces the detrimental effects upon team training of deficient individuals.

c. Computer-managed instruction for decision makers, sensor operators and selected plotters. These could be general-purpose procedures trainers, with the provision for variable stimulus and response modalities and complexities. Further, these consoles could be used for both individual skill training and combined for subteam training.

d. Category 4 and 5 personnel should receive individual training on the job. It is inefficient to use the team training environment to teach steering and basic plotting skills.

e. Total team procedures training should be conducted on the job. These behaviors do not require high fidelity of simulation and, thus, represent an inefficient use of the team training device.

f. Team tactical training devices should be oriented toward the training of the innovative behaviors relevant for dealing with emergent situations. This requires that trainees possess a prior thorough understanding of basic operating procedures.

g. Training devices should be combined in terms of relevant adversaries, such as a submarine and destroyer combination. This training environment could be a highly effective way of simulating the operational tactical environment.

This program has raised a number of questions concerning team tactics training and the techniques available or suggested to implement such training which cannot be completely resolved from the current data. These questions range from those of a semitheoretical nature requiring considerable investigation to more applied questions relating to implementation of alternative techniques for increasing training effectiveness.

Perhaps a fundamental question to this program is whether generalized training can be effective for total teams. The literature review in the Introduction revealed no studies on this problem. The data of this study indicated that many tasks were common to different trainers and to operator categories across trainers. When such tasks are highly critical to the team's training and readiness, then the potential of generalized training is minimized. The criticality of these unique tasks must be determined empirically, based on data from the operational setting.

A second theoretical question is whether decision making is a generalizable skill, as suggested by Sidorsky and Houseman (1966) and Kanarick (1969). There is a paucity of data on this question, yet it too underlies the program objectives. What has hampered research in this area is the continuing need for an adequate criterion of decision-making performance. If decision making is a generalizable skill, then optimal ways to train the skill can and should be determined. One way to compress tactical experience for decision-makers has been suggested earlier, viz, individual decision-making trainers incorporating mathematical models of the operational situation combined with a CRT display. Whether this experience can be supplemented by generalized instruction in learning to diagnose a tactical situation and to select an appropriate set of actions must be empirically determined.

Much has been said in this report concerning the current role of instructors. The question remains, however, of the best use to which such highly qualified subject-matter experts can be put in the instructional process. Should they be required to initiate prompts and formulate performance critiques? Should they be on station with trainees or at their own consoles during the conduct of training exercises? How can they be better prepared for their duties as instructors? Although some suggestions for improvements have been made, questions remain unanswered as to the appropriate use of these personnel together with an indication of the man-hardware tradeoffs which must be made in designing the automatic versus manual features for future devices.

One training technique discusses as a possible solution to the problem of deficient team members was that of selective individual prompting. Questions remain, however, as to the specificity, schedule, and nature of such prompts. Similarly, it should be determined what effects prompts have on non-prompted team members and the influence of various prompting schedules on transfer performance. Briggs and Johnston (1967) concluded that specific feedback is detrimental early in training. Is the same true for prompting?

Simulating team members was suggested as one way to train certain interactive and communication skills, yet information is lacking on implementation. The hardware and software requirements must be determined as a necessary first step in evaluating the cost-effectiveness of such an approach.

The utility of adaptive training depends greatly on the measurement of performance. It has already been noted that adequate measure of team performance are lacking. Furthermore, the efficacy of adaptive training must be assessed for the highly proceduralized tasks observed in this study.

Finally, multi-media instructional techniques are thought to be highly effective. Which media should be selected for the training of which jobs? Further, what should be their sequencing and relative durations?

This set of questions is not meant to be exhaustive. Instead, it highlights those areas where well-conducted research could lead to the development (more effective utilization) of advanced technologies for future application to team tactics training.

REFERENCES

Alexander, L. T. and Cooperband, A.S. System training and research in team behavior. Technical Memorandum: TM-2581; August 1965; System Development Corporation; Santa Monica, California.

Annett, J. and Clarkson, J. K. The use of cuing in training tasks. Technical Report: NAVTRADEVCEN 3143-1; April 1964; U.S. Naval Training Device Center; Orlando, Florida.

Annett, J. and Peterson, L. The use of cuing in training tasks: Phase III. Technical Report: NAVTRADEVCEN 4717; August 1967; U.S. Naval Training Device Center; Orlando, Florida.

Blake, R. R. and Brehm, J. W. The use of tape recording to simulate a group atmosphere. Journal of Abnormal and Social Psychology, 1954, 49, 311-313.

Bowen, H. M., Hale, A. and Kelley, C. R. Tracking training V: Field study of the training effectiveness of the general vehicular research tool. Technical Report: NAVTRADEVCEN 955-1; December 1962; U.S. Naval Training Device Center; Port Washington, New York.

Briggs, L. J. Campeau, Peggy L., Gagne, R. M. and May, M. A. Instructional media: Procedure for the design of multi-media instruction, a critical review of research and suggestions for future research. 1967; American Institutes for Research.

Briggs, G. E. and Johnston, W. A. Team training. Technical Report: NAVTRADEVCEN 1327-4; June 1967; U.S. Naval Training Device Center; Orlando, Florida.

Caro, P. W. Equipment/device task commonality analysis and transfer of training. HumRRO Technical Report 70-7; June 1970.

DePauli, J. F. A study of the feasibility and desirability of developing a generalized underwater fire control system maintenance trainer. Technical Report: NAVTRADEVCEN 69-C-0152-1, January 1970; U.S. Naval Training Device Center, Orlando, Florida.

DePauli, J. F. and Parker, E. L. The introduction of the Generalized Sonar Maintenance trainer into Navy training for an evaluation of its effectiveness. Technical Report: NAVTRADEVCEN 68-C-0005-1; April 1969; U.S. Naval Training Device Center; Orlando, Florida.

Ginsberg, R., McCullers, J. C., Maryman, J. J., Thomson, C. W., and Witte, R. S. A review of efforts to organize information about human learning, transfer, and retention. Technical Report: AMRL-TR-66-23, March 1966, Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio.

Glanzer, R. M. Experimental study of team training and team functioning. In R. Glaser (Ed.) Training research and education. New York; John Wiley Science Editions; 1965.

Hammell, T.J. and Mara, T.D. Final Report: Application of decision making and team training research to operational training: A translative technique. Technical Report: NAVTRADEVCEN 68-C-0242-1, April 1970; U.S. Naval Training Device Center; Orlando, Florida.

Hansing, R.A. and Matlock, E.W. A survey of training related utilizations of television. Research Report SRR 70-19; February 1970; U.S. Naval Personnel and Training Research Laboratory; San Diego, California.

Horrocks, J.E., Heermann, E. and Krug, R.E. Team training III: An approach to optimum methods and procedures. Technical Report: NAVTRADEVCEN 198-3; August 1961; U.S. Naval Training Device Center; Port Washington, New York.

Horrocks, J.E., Krug, R.E. and Heermann, E. Team training II: Individual learning and team performance. Technical Report: NAVTRADEVCEN 198-2; August 1960; U.S. Naval Training Device Center; Port Washington, New York.

Jeantheau, G.G. The use of multi-man system trainers. Ergonomics, 1969, 12, 533-542.

Kanarick, A.F. The learning, retention and transfer of decision making. Paper presented at Learning, Retention and Transfer Conference; February 1969, U.S. Naval Training Device Center; Orlando, Florida.

Kelley, C.R. and Wargo, M.J. Adaptive techniques for synthetic flight training systems. Technical Report NAVTRADEVCEN 68-C-0136-1; October 1968; U.S. Naval Training Device Center; Orlando, Florida.

Klaus, D.J. and Glaser, R. Reinforcement determinants of team proficiency. Organizational Behavior and Human Performance, 1970, 5, 33-67.

Krickel, J.H. Multiple-screen instruction. February 1964; U.S. Army Aviation School; Fort Rucker, Alabama.

Lamb, J.C., Bertsche, W.R., and Carey, B.G. A study of a generalized advanced casualty ship control training device. Technical Report NAVTRADEVCEN 69-C-0117-1-1, August 1970; U.S. Naval Training Device Center, Orlando, Florida.

Leonard, J.N., Doe, L.H., and Hofer, J.L. Automated Weapon System Trainer. Technical Report NAVTRADEVCEN 69-C-0151-1; June 1970; U.S. Naval Training Device Center; Orlando, Florida.

Mirabella, A. and Lamb, J.C. Computer based adaptive training applied to symbolic displays. Technical Report: NAVTRADEVCEN 1594-1; March 1966, U.S. Naval Training Device Center; Orlando, Florida.

Parker, J.F. Jr. and Downs, J.E. Selection of training media. ASD Technical Report 61-463; September 1961; Aeronautical Systems Division; Wright-Patterson Air Force Base, Ohio.

Prophet, W.W. Synthetic flight training devices. In HumRRO Research in training technology; HumRRO Paper 21-71; June 1970; HumRRO; Alexandria, Virginia.

Rhode, W.E., Esseff, P.J., Rusin, C.J., Quirk, F.B and Shulik, R. Analysis and approach to the development of an advanced multi-media instructional system. HFHRL-IR-69-30; Vol. I; May 1970; Training Research Division; Wright-Patterson Air Force Base, Ohio.

Rock, R.T., Duva, J.S. and Murray, J.E. The effectiveness of television instruction in training Naval air reservists. Technical Report: SDC 476-02-S2; April 1951; Navy Special Devices Center; Port Washington, New York.

Schrenk, L.P., Daniels, R.W. and Alden, D.G. Study of long-term skill retention (U). Technical Report: NAVTRADEVCEN 1822-1; April 1969; U.S. Naval Training Device Center, Orlando, Florida. CONFIDENTIAL

Sidorsky, R.C. and Houseman, J.F. Research on generalized skills related to tactical decision-making. Technical Report NAVTRADEVCEN 1329-2; December 1966; U.S. Naval Training Device Center, Orlando, Florida.

Sidorsky, R.C., Houseman, J.F., and Ferguson, D.E., Behavioral and operational aspects of tactical decision making in AAW and ASW. Technical Report NAVTRADEVCEN 1329-1; August 1964; U.S. Naval Training Device Center, Port Washington, New York.

Siegel, A.I. and Federman, P.J. Development of a method for deriving required training aids/devices and application to the tactical coordinator position in ASW aircraft. Technical Report NAVTRADEVCEN 68-C-0212-1, June 1970, U.S. Naval Training Device Center, Orlando, Florida.

Swets, J.A., Millman, S.H., Fletcher, W.E. and Green, D.M. Learning to identify nonverbal sounds; An application of a computer as a teaching machine. Journal of the Acoustical Society of America, 1962, 34, 928, 935.

Valverde, H.H. Summary of the development and evaluation of the audio/video recording system for pilot training. March 1970; Air Force Human Resources Laboratory; Brooks Air Force Base, Texas.

Valverde, H.H. and Pieper, W.J. Summary of learner-centered instruction (LCI): A systems approach to electronics maintenance training. April 1970; Air Force Human Resources Laboratory, Brooks Air Force Base, Ohio.

Weisz, A.Z. and McElroy, L.S. Response and feedback techniques for automated training of visual identification skills. Technical Report: NAVTRADEVCEN 789-3; July 1964; U.S. Naval Training Device Center, Orlando, Florida.

Yaeger, B.W. A numerical task taxonomy. Technical Document No. 232-70; 1969; Honeywell Inc., Marine Systems Center, West Covina, California.

APPENDIX A

CANDIDATE STUDY DEVICES (LISTED IN ORDER OF REPRESENTATIVENESS)

<u>Surface</u>

14A2	Surface Ship ASW Attack Trainer
20A62	Emergency Shiphandling Trainer
20A61	Maneuvering Tactics Trainer
14A6	ASW Coordinated Tactics Trainer
16B13	Amphibious Operations Trainer
1BZ2	Maneuvering Tactics Trainer
14A1	Action Speed Tactical Trainer

<u>Subsurface</u>

21A38	Submarine ASW Attack Teacher
21B20	Advanced Submerged Submarine Casualty Control Trainer
21C4	Basic Submarine Diving Trainer

<u>Air</u>

2F87	P3C Weapon System Trainer
2F69B	P3A Weapon System Trainer
2F66A	S-2E Weapon System Trainer
2F84	A7A Weapon System Mission Trainer
SFTS	Synthetic Flight Training System

<u>Other</u>

15F6	CIC Tactics Trainer

APPENDIX B

TEAM MEMBERS BY POSITION NAME

Device 20A62	Device 21A38	Device 2F69B
Officer of the Deck	Conning Officer	Tactical Coordinator
Horizontal Plotter	Fire Control Coordinator	Navigator
Radar Operator	Sonar Supervisor	Jezebel Operator
Helmsmen	Plot Coordinator	Julie Operator
Lee Helmsmen	Time-Bearing Plotter	Radar Operator
	Strip Plotter	
	Lynch Plotter	
	BQR-7 Operator	
	BQR-2 Operator	
	Attack Director Operator	
	Analyzer Operator	
	Weapon Control Console Operator	
	Expanded Time-Bearing Plotter	
	Time Range Plotter	
	Time-Bearing Talker	
	Time-Bearing Recorder	

APPENDIX C

DESCRIPTION OF METHOD

LIAISON

Initial contact with the staff of each device studied was made by the local NTDC representative. These NTDC personnel also furnished information concerning the organizational structure of the training unit being visited and the appropriate military command personnel to be contacted in arranging for data collection visits.

TRAINER STAFF BRIEFINGS

At each trainer site, members of the HST (Honeywell Study Team) provided a comprehensive briefing to the training unit command, trainer staff personnel, and NTDC representative. These briefings consisted of a description of the study rationale, objectives, methods, and anticipated results. From information obtained by HST members following these briefings, existing trainer use schedules were established, and the specific times that study personnel would be in the trainer area were defined.

TRAINER DEVICE FAMILIARIZATION

Members of the HST familiarized themselves with the three devices studied through instruction in and/or operation of the hardware. These informal device familiarization sessions were conducted by instructor and maintenance personnel during periods when the devices were available for such activity. The familiarization process served two purposes. It allowed study team members to develop rapport with instructor and maintenance personnel as well as providing them with the required information.

TRAINING DEVICE DOCUMENT REVIEW

This activity consisted of a review of training curricula, historical data, and training device descriptions. Lesson plans and training schedules were analyzed to determine the extent to which training objectives were specified in behavioral terms. Historical data was reviewed to determine the extent to which performance records were obtained and/or maintained. Finally, information pertaining to the theory of operation and capabilities of each device was collected for future reference.

STRUCTURED INTERVIEW

An interview guide was specifically designed for use in collecting non-task data. Using this sheet as a framework, interviews were held with trainer personnel who were selected for their knowledge in areas of special concern. For example, device staff and instructor personnel were questioned regarding training objectives, evaluation, training methods, etc. Information concerning trainer equipment characteristics was generally obtained from the Training Devicemen (TD's) who were in charge of trainer maintenance. These structured interviews were quite detailed and generally required portions of two to three days to complete.

APPENDIX D

NUMERICAL TAXONOMY

ELEMENT: STIMULUS
CATEGORY I. MODALITY

Level	Code	Description
None	0	Not used
Visual	1	Stimulus perceived visually - seen.
Aural	2	Stimulus perceived aurally - heard.
Touch	3	Stimulus perceived tactually - felt.
Combination	4	Stimulus perceived with more than a single modality -- stimulus may have visual, aural and tactual components.
Other	5	No external stimulus present -- stimulus is internal to the man; e. g., passage of time, uncertainty, vestibular, etc.

ELEMENT: STIMULUS
CATEGORY II. INFORMATION UNCERTAINTY

Level	Code	Description
Noise	0	Only noise present as stimulus.
Simple, one-bit, no uncertainty	1	An "on-off" type stimulus providing one bit of information with no uncertainty. Examples: Light is on or off Bell is on or off One word commands: "Now", "execute", "fire"
Sample, single-parameter, discrete	2	Stimulus gives two or more bits of information from a small finite number of steps concerning one parameter with little uncertainty. Examples: Digital displays Discrete displays Verbal order for ship's course
Simple, multi-parameter, discrete	3	Stimulus provides two or more bits of information concerning each of two or more discrete parameters with title uncertainty. Example: Verbal order for course and RPM setting
Complex, multi-parameter, discrete and continuous	4	Stimulus provides two or more bits of information concerning each of two or more discrete or continuous parameters with moderate uncertainty. Examples: Moving, dynamic indicators Fuel consumption/rate Speedometer - speed/rate Altimeter Nonstandard verbal command Single aspect of a CRT display
Complex, multi-parameter, continuous	5	Stimulus provides two or more bits of information content about more than two dynamic parameters reflecting continuous steps from a very large finite number with unpredictable and moderate uncertainty. Examples: Ship's motion and transfer tables Multiparameter CRT or hardware displays (sonar, radar, OOD, TACCO) Aural sonar signals Discoursive verbal communication between two or more persons

ELEMENT: STIMULUS
CATEGORY II. INFORMATION UNCERTAINTY

Level	Code	Description
Complex, multi-parameter	6	Highly complex, multiparameter stimulus which provides more than two bits of information and may contain high uncertainty due to masking, incompleteness, intermittent reception, or not being displayed. A composite of discrete and dynamic information from an infinite number of possibilities with potentially high degrees of information when properly organized. Example: Tactical situation, "big picture".

ELEMENT: COGNITION
CATEGORY I. PERCEPTUAL PROCESSING

Level	Code	Description
Unidentified	0	
Detection	1	Monitoring, attention, vigilance and detection of the stimulus against background noise. Stimulus presence is sufficient to initiate a response. Stimulus must be simple and readily perceived.
Discrimination	2	Requires the simultaneous or sequential comparison of two or more detected stimuli in order to determine that they are the same or different; e.g., differentiation, distinction, compare and separate.
Recognition	3	Stimuli require familiarity or unidentified past experience for perception.
Identification	2	Requires a naming or labeling activity, but the name of the stimulus is relatively unimportant for task accomplishment. Name need not be specifically stated; e.g., specific orders for maneuvering in a fog situation.
Classification	5	Requires a specific name which isolates the stimulus as a member of a specific category of events. Specifying the name is critical to task success. Assignment of the name may involve judgment. Examples: Sonar classification -- submarine "Extremis" "Datum"

ELEMENT: COGNITION
CATEGORY II. INFORMATION PROCESSING

Level	Code	Description
None	0	No processing of stimulus information-conditioned reflex.
Data Analysis	1	Cognitive activities of filtering, reducing, analyzing and cross comparing perceived stimulus data resulting in a cognitive listing of processed data with no organization. Example: Placing a cursor on the contact which is marked by a "noisy" background.
Problem diagnosis	2	Requires identification of a problem through comparison of actual and desired state of affairs, weighting and enumeration of alternate states of affairs.
Concept formation	3	Organization of the information produced as an output of problem diagnosis (2) resulting in the formation of a specific plan, idea or thought solution.
Innovation - creation	4	Involves data analysis (2), concept formation (3) and the production of new information through generalizing from existing data. Example: Development of a unique battle strategy Development of unique plotting techniques from existing rules of geometry

ELEMENT: COGNITION
CATEGORY III. ACTION SELECTION

Level	Code	Description
No action	0	Selects no overt action.
Seeks information	1	Decides to actively seek additional information.
Follow specific rule	2	Decides to follow a specific existing rule or procedure in making a response.
Follow general principle	3	Decides to follow a generalized rule which may be based on existing guidelines for action; involves using common sense in selecting a response.

ELEMENT: RESPONSE
CATEGORY I. MODALITY

Level	Code	Description
Visual orienting	1	Looks at, using only head-eye movement.
Verbal	2	Spoken or verbal sounds.
Motor	3	All motor actions including eye-hand coordination.
Combination	4	The chaining or combination of various response levels.
Other	5	Used for responses which do not fit in other levels.

ELEMENT: RESPONSE
CATEGORY II. COMPLEXITY

Level	Code	Description
Simple, discrete	1	Simple on-off type response requiring little or no skill beyond knowing when to respond. Examples: Button push One-bit verbal response Switch flip
Controlled, single-parameter, discrete	2	Requires a controlled, discrete act on one parameter such as giving a verbal RPM order. This complexity is used when the response requires little skill beyond differentiating the relevant response from other similar response alternatives. Examples: Verbal RPM order Select single position of multi-position switch Look up information in a book
Controlled, multiparameter, discrete	3	Similar to Level 2 but requires a controlled, discrete act on two or more parameters. Examples: Giving a verbal order and setting a switch
Complex, skilled, continuous	4	Requires sensory-muscle coordination. Example: Tracking Aiming Plotting
Compound, multiparameter, continuous	5	Requires a long chain of discrete steps or a single continuous response. Examples: Procedure following Unstructured verbal discourse
High skill, fine control	6	Requires very high skill levels resulting only from extensive practice. Example: Piloting an airplane.

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13. ABSTRACT

The report discusses the applicability of available advanced training technologies to the training of Navy tactical teams. Three questions are posed: Is there sufficient commonality in team tasks performed in existing team tactics trainers to warrant recommending development of a team training system incorporating specific advanced technologies, e.g., generalized and adaptive techniques? If yes, what techniques should be used? If no, what other approaches are feasible for increasing the effectiveness of team training? Data were gathered on the team tasks accomplished in representative training devices for air, surface and subsurface tactical platforms. These data were analyzed for commonality among and within training devices using a numerical task taxonomy. Results indicated little commonality of team tasks when total tasks were inspected. Significantly more commonality was found when the stimulus, cognition and response elements of the tasks were compared. A major recommendation is that the Navy concentrate on improving the effectiveness of existing devices rather than launching a program to develop a generalized training device. Further recommendations are made for the manner in which training-device development should proceed and for additional research.

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Tactics training						
Advanced training technology						
Training device utilization						
Generalized training						
Adaptive training						
Task taxonomy						