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A CLASSIFICATION SYSTEM FOR NAVY TEAMS

FINAL REPORT

VOLUME I - TECHNICAL REPORT

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In order to provide researchers with a systematic method for selecting teams in Navy settings for research, it is necessary to have available a structure which shows similarities and differences between various teams. This research has developed a model of team member configuration and team interactive processes which can provide a basis for measuring the dimensions of team performance. The primary objective of this research, then, was to design a taxonomy, or classification system, for Navy teams.

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The final report addresses the delineation of Navy teams, the identification of key team dimensions, the generation of appropriate measures of these dimensions, and the application of these measures to a sample of 240 surface Navy teams. The applicability of this study to a comprehensive research program concerning Navy team performance is discussed and specific directions for future endeavors are suggested. Volume I is concerned with the theoretical development of the taxonomic model and corresponding measures, while Volume II includes the catalog of surface Navy teams.

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A Classification System for Navy Teams

Draft Final Report, 1 August 1981

Volume 1 - Text

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SUMMARY

This report documents research conducted by Litton Mellonics for the office of Naval Research under Contract N00014-80-C-0781. The work was performed in Litton's Washington Scientific Support Office.

The primary purpose of this research entails the development of a Navy team taxonomy. The taxonomy is designed to refine the notion of Navy teams, establish a framework for systematic military team research, aid scientists in selecting teams for research, and clarify the applicability of team and small group research to military team performance issues.

This report is published in two volumes. Volume I describes the development and application of the taxonomy to a sample of surface Navy teams. The initial chapter examines the nature of Navy teams and taxonomic structures, while chapter two employs a systems model to organize several team-related variables and examines relevant team research. From this literature review, the taxonomic model is generated. Subsequent chapters deal with the creation of operational measures of the team dimensions and demonstrate their applicability to seven representative Navy teams. In this regard, Volume II contains the remainder of the cataloguing effort, encompassing 238 teams. Finally, a discussion of the limitations and utility of the taxonomic model is provided and directions for future research are suggested.

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Chapter I

INTRODUCTION

Requirement for a Team Taxonomy

After reviewing the state of military training of crews, groups, teams, and units, the Defense Science Board Task Force on Training Technology (1976) asserted the importance of developing a Naval team taxonomy. Specifically, the Board indicated the need to

> initiate systematic R&D to develop a taxonomy of operational force elements (crews, groups, teams, and units), and on methods for controlling training variables in the context of process-control models. This R&D should have first priority to establish a framework for subsequent, programmatic R&D on CGTU training (p. 37).

Thus, this taxonomy is needed to refine the notion of Naval teams, to establish a framework for systematic military team research, to aid scientists in selecting teams for research, and to clarify the applicability of team and small group research to military team performance issues. In addition, this taxonomy represents an important step toward developing improved measures of the dimensions of Naval team performance.

There are two major objectives of this research effort. First, it is necessary to design a taxonomy, or classification system, which captures significant variations along pertinent dimensions of Naval teams. To accomplish this task, a workable operational definition of "team" and an examination of the relevant theoretical and experimental literature to identify salient team dimensions are required. Second, this taxonomic model must be applied to surface Navy teams to generate a catalog which facilitates team selection for diverse research purposes. The accomplishment of these task objectives entails an integration of the team performance literature with specific technical attributes of surface Navy teams.

This report describes the development and application of the Naval team taxonomy. As this research endeavor involves two specific objectives, the report is divided into two main sections. The first section, which depicts the development of the classification system, is comprised of three chapters. The initial chapter grapples with the issue of defining a "Naval team", describes the general nature of taxonomic systems, and illustrates the application of taxonomic procedures to military teams. The second chapter presents a systems (i.e., input-process-output) model used to organize the wealth of team-related variables and thoroughly examines relevant team research. Also, military documents concerning Naval teams are examined and the taxonomic structure is presented at the conclusion of this chapter. The third chapter details the methodology employed to devise, test, and refine the classification system. Here, measures of the taxonomic dimensions are generated and methods used to classify specific Navy teams are described. The second section presents the catalog of Navy teams, with particular attention devoted to similarities and differences between these teams. The catalog and accompanying team descriptions constitute the fourth chapter, while the fifth chapter explicates the utility of the taxonomic model, indicates methodological difficulties and limitations of the research effort, and suggests fruitful possibilities for future research using the classification system as an organizing structure.

Teams

An important feature of this research effort is the delineation of Naval teams. Although these teams can be isolated with varying degrees of specificity (e.g., the entire ship, functional areas, small designated units), the generation of operational procedures to identify them requires a level of analysis which is most manageable, informative, and useful to Naval team investigators. Meister (1976) captures this problem in the following manner: if the focus is too narrow, the definition of teams will exclude supervisory personnel, whereas if the scope is too broad, the team description will include outside influences. Thus, rules for including/excluding members in delimiting Naval teams must provide relevant differentiations without being overly encompassing. Unfortunately, the identification of teams within a Naval context is often difficult. According to Glanzer (1962), "a team is an arbitrary unit that must be analyzed out of a complex organization. It is not a simple given unit" (p. 34). Further, he reports several reasons why identification of Naval teams is an arduous process. For instance, team boundaries are often nebulous, with many overlapping team memberships and borderline members. Also, Glanzer notes the instability of team structure and composition, which typically vary according to changes in problems which confront the team. Similarly, Meister (1976) asserts that "a team is not necessarily a stable unit. Its composition and the distribution of its personnel may vary during different tasks or at different times" (p. 233). Another barrier to team delineation involves the existence of "distinct subsidiary teams" (i.e., subteams) within identified teams. For example, the Gunnery team studied by Glanzer consisted of a gun mount team, a director team, a plotting room team, and two handling room teams. Clearly, an inportant product of this research is the specification of appropriate levels of analysis to catalog and examine Naval teams.

As Naval teams can be discerned at many levels, a hierarchical delineation comprised of successively narrower units is most appropriate in depicting these teams. In other terms, Naval teams will be described at multiple levels, permitting researchers to select the breakdown of teams most relevant to their investigations.

At the broadest level, multi-ship teams are essential to the successful conduct of modern Naval warfare, and their training is an important aspect of fleet operations. However, these types of teams are extremely difficult to characterize due to the fact that they tend to be formed for specific operations or campaigns. Also, their composition, tasks and member interrelationships tend to be a function of the task commander's tactical plans and operational objectives. On closer inspection, the personnel aboard a single ship who might be viewed as members of a specific multi-ship team (e.g., a ship's ASW team personnel working as part of a task force ASW screen) can generally be found to comprise a team themselves (i.e. multi-ship teams are generally an aggregate of single ship teams). Due to these two factors, it was decided to limit the scope of this research to the single ship level. Indeed, under some conditions, the single ship can be construed as a team; hence, the cataloging effort allows for the identification of members and functions at this level.

The tasks required for operation of a Naval vessel can be grouped into several broad areas on the basis of such factors as interdependence, commonality of knowledge or skill requirements, or system commonality (i.e., a specific system is used in the accomplishment of several tasks). Based upon these commonalities, the personnel working in a specific "functional area" can be construed as comprising a team. However, care should be taken in identifying teams at this level. While the personnel working in some functional areas (notably engineering and damage control) possess the shared goals, coordinating structure, communications links, and task interdependence characteristic of teams, the personnel in other functional areas should be more properly considered as divided into independent teams. In any event, all functional areas can be subdivided into more specific teams. Six functional areas are common to all Naval vessels; we have labeled these common areas: seamanship, combat information, weapons, communications, engineering and damage control. A seventh functional area, support, is concerned with maintaining and sustaining teams in these other functional areas. Support teams possess the most variance of all seven functional areas aboard ship. Thus, grouping a ship's teams by functional area facilitates comparison of team operations on various ships.

As mentioned above, the functional groups can be regarded as sets of smaller teams. Properly delineated, these smaller teams tend to be the most useful units for research purposes. At this lower level, team tasks, procedures, member relationships, composition and structure are well defined and relatively constant when viewed over the various evolutions which require the team to form. As an example, within the seamanship area, one can identify conning, navigation, anchor handling, boat handling, boat operating and cargo handling teams. However, successful performance of the seamanship function rarely requires simultaneous operations by all these teams. Thus, the seamanship 'team' is seen to be quite fluid as it can be composed of almost any combination of the aforementioned smaller teams, depending upon the requirements placed on the team at any given moment. The smaller teams, on the other hand, are relatively stable; the conning team, for instance, takes two primary forms.

The specification of Naval teams can be facilitated by an examination of various definitions of teams in the theoretical literature. These definitions (Table I-1) illustrate key differences regarding the inclusion of critical elements and the emphasis attached to these elements by team researchers. Here, it should be mentioned that the terms "team" and "group" are considered to be synonymous for the purposes of this research. While some theorists have aptly suggested that differences may exist between these terms, their actual usage by most researchers renders them indistinguishable.

The major dimensions identified by these definitions are number of members, synergistic relationships, task interdependence, cooperation/coordination requirements, team structure, and normative prescriptions. As Nieva, Fleishman, and

Table I-1 - Team Definitions

Boguslaw and Porter (1962)	Relationship in which people generate and use work procedures to make possible their interactions with machines, machine procedures, and other people in the pursuit of system objectives.
Briggs and Naylor (1965)	Group of two or more operators working in a structured and task-oriented environment.
Klaus and Glaser (1968)	Teams are characterized by a rigid structure, organization, and communication network; well-defined assignments; and the necessity for cooperation and coordination.
McDavid and Harari (1968)	An organized system of two or more individuals who are interrelated so that the system performs some function, has a standard set of role relationships among its members, and has a set of norms that regulate the function of the group and each of its members.
Daniels, Alden, Kanarick, Gray, and Reuge (1972)	Three or more persons working in concert toward a common, identifiable and relatively immediate goal.
Dieterly (1978)	A distinguishable set of individuals who function together to accomplish a specific objective.
Nieva, Fleishman, and Reick (1978)	Two or more interdependent individuals performing coordinated tasks toward the achievement of specific task goals. This definition of teams has two major components: 1) a task orientation shared by all team members, and 2) a condition of task interdependence among team members.
Scanland (1980)	Synergistic set of individuals, the sum of whose purposes is the execution of a desired function in which no individual effort is redundant of another member's effort, with no gap in the total contribution of members in fulfilling the function of the team.
Thorndyke and Weiner (1980)	Set of individuals working cooperatively to achieve some common objective.

Rieck (1978) suggested, it is perhaps more productive to view these definitional criteria as occurring on continua rather than conceiving them as absolutes (i.e., in terms of presence or absence of attributes). Further, the taxonomic dimensions of Naval teams should correspond closely with the major definitional elements described above. As such, a consideration of taxonomic models is necessary to provide an integrative framework for these team variables.

Taxonomic Systems

A taxonomy is a "set of theoretical principles, procedures, and rules that serve as the basis for classification" (Ramsey-Klee, 1979, p. 6). In the biological sciences, taxonomies order plants, animals, etc., according to their underlying dimensions. This stratification (e.g., family, genus, species) is based on the subordination of plants and animals into an orderly and unambiguous system in which each item has an exact point or description. It assumes an ordered and static relationship of subgroups in a definable hierarchy. Thus, "a taxonomy involves the systematic differentiation, ordering, relating, and naming of type groups within a subject field" (Silverman, 1967, p. 2).

Taxonomies consist of the class names and the definitions of the relationships among the classes (i.e., the instructions for proper use). Theologus (1969) maintained that a "taxonomy is a prerequisite for classification. That is, the organization of tasks, or of any subject matter, into groups requires the previous development of a sound logic and rationale for the organization" (p. 25). According to Silverman (1967), development of a taxonomy consists of the following steps:

1. Collecting samples of phenomena
2. Describing essential features or elements
3. Comparing phenomena for similarities and differences

4. Developing a set of principles governing the choice and relative importance of the elements

5. Grouping the phenomena on the basis of essential elements into increasingly exclusive categories and naming the categories

6. Developing keys and devices as a means of recognizing and identifying phenomena

Taxonomies concerning the cognitive, affective, and physical/psychomotor domains of team performance have been created and applied in Naval and non-military settings. For instance, Bloom (1956) generated a taxonomy of cognitive objectives comprised of knowledge, comprehension, application, analysis, synthesis, and evaluation. Similarly, Sorenson's (1971) task behavior taxonomy includes structuring, generating, elaborating, evaluating, and requesting. In a Naval context, Powers (1977) designed the following taxonomy based upon hypothetical job tasks:

1. Basic - nomenclature, jargon, fundamental facts related to components of equipment, hardware, and technical symbols.

2. Conjoint - operating principles, functions, relationships of components of equipment/hardware systems.

3. Operational - operating steps for hand tools/testing equipment, and principal equipment/hardware.

4. Procedural - rules and procedures for assembling, disassembling, troubleshooting, aligning, etc.

5. Multifactual - lists, tables containing specific technical data, including descriptive information on calibrations, settings, etc.

6. Configurative - visual representations of functional/operational processes.

According to Powers, movement from basic to configurative involves less memorization and greater reliance on abstract processes of recognition. In the affective domain of team performance, Krathwohl, Bloom, and Masie (1964) focused on internalization processes to develop a taxonomy which incorporates receiving (i.e., attending to phenomena), responding, valuing, organizing, and characterizing by a value or value complex. Interestingly, they noted that each affective dimension has a behavioral counterpart. Finally, the physical/psychomotor domain has received attention by Fleishman (1967), who created the following taxonomies:

> Psychomotor Performance Factors - control precision, multilimb coordination, response orientation, reaction time, speed of arm movement, rate control, manual dexterity, arm-hand steadiness, wrist-finger speed, and aiming.
>
> Physical Proficiency - extent flexibility, dynamic flexibility, static strength, dynamic strength, explosive strength, trunk strength, gross body equilibrium, and stamina.

Dickinson and Naylor (in Naylor and Dickinson, 1969) offered perhaps the most complete taxonomy of team performance functions. Their model indicated that team performance is a function of task structure, work structure, and communication structure. Task structure, which entails the demands that are characteristic of the team task, includes complexity, organization, and redundancy components. Work structure, which refers to the manner in which task components are distributed among team members, incorporates the definition of operations to be performed, the sequence in which the operations must occur, and the manner in which interactions among members must proceed. Communication structure reflects the communication interrelationships existing between team members and is determined by the task structure and work structure.

These taxonomic systems are representative of attempts to categorize on the basis of similarity/dissimilarity along key dimensions and classificatory rules which govern the process. Although the science of taxonomy is inexact, various recommendations have been advanced to ensure the validity of classificatory efforts. Silverman (1967), for example, advocated the utilization of a numerical taxonomic system which can be enacted on an operational and quantitative basis. Further, Sneath (1957) identified a simple arithmetical approach to estimate the degree of similarity between various objects:

$$S = {}^{N_s}/N_f$$

where N_s = number of positive features possessed by both objects

N_d = number of features possessed by first but not second object, and number of features possessed by second but not first object

$N_f = N_s + N_d$

S = Similarity

Sneath also draws four conclusions regarding the science of taxonomy:

1. The ideal classification has the greatest content of information.
2. Overall similarity is the basic concept of such an ideal classification and it is measured in terms of the number of similar features possessed by two entities.
3. Every feature should have an equal weight.
4. Division into taxonomic groups is based upon correlated features.

While Sneath's focus entailed microbiology, Chiles (1967) provided evaluative criteria for complex performance taxonomies. Summarizing the conclusions drawn by conference members on the use of methodology in assessing complex performance, Chiles reported consensus on the following points:

1. A taxonomy of performance functions must facilitate communication among researchers and between researchers and applications people.
2. The taxonomy must yield agreement among the categories.
3. Performance functions included in a category of the taxonomy must prove to be homogeneous with respect to behavioral laws.

The taxonomy of Naval teams will organize and classify the teams' dimensions and characteristics. For example, it will classify the teams' member composition, task characteristics, team member processes, and other relevant parameters. Emphasis will be placed on the input and process variables which mediate team output (i.e., task performance). The team classification system will take the form of a multi-dimensional matrix rather than the successive stratification system of a biological or zoological taxonomy. This indexing system will involve the use of several global dimensions describing the most important aspects of team performance. Within each major component, subelements which reflect relevant and meaningful team features will be delineated. Here, the identification of these team components will be geared toward operational procedures for systematically measuring them. While this effort will be entirely verbal, the data will be presented in a form which facilitates computer coding for various research purposes.

Summary

This chapter has identified important considerations regarding the definition of a team and the development of the Naval team taxonomy. With the research objectives in mind, a theoretical model is needed to clarify the definition of these teams and their characteristics. Chapter II provides an examination of one such model in attempting to delineate key elements of surface Navy teams. A comprehensive review and analysis of the relevant team literature is offered as the basis for the generation of the Naval team taxonomy at the conclusion of the second chapter.

Chapter II

DEVELOPMENT OF THE NAVAL TEAM TAXONOMY

Introduction

The creation of an operative Naval team taxonomy is an important, yet difficult, research task. In fact, according to Meister (1976), "a satisfactory taxonomy of team dimensions has not yet been developed" (p. 237). While various theoretical models have been proposed to describe the relationship between team characteristics and performance, a systems approach seems to capture best the dynamic nature of teams and the variables which impinge on team productivity. As Meister noted, a system possesses the following characteristics:

- all elements interact
- each element has an effect on other elements and on the entire system
- energy is transformed from one form to another

Typically, systems models (Figure II-1) organize team variables into input, process, and output categories (Knerr, Berger, and Popelka, 1980; Nieva, Fleishman, and Rieck, 1978; Dieterly, 1978; Collins, 1977; Meister, 1976; Hackman and Morris, 1975; McGrath, 1964). Input variables describe the initial state of a task-oriented group and they include organizational/environmental/situational, individual member, and team-specific factors. Team interaction process entails "all observable interpersonal behavior that occurs between two arbitrary points in time..." (Collins, 1977, p. 3-39) and mediates between input and output. Output variables, which result from input conditions and team interactive processes, include task performance and interactive components (e.g., member satisfaction). Comprehension of a team's task-related productivity hinges upon assessing the impact of input and process variables on team output, with systems models depicting the effects of these factors singly and interactively. As Trussell

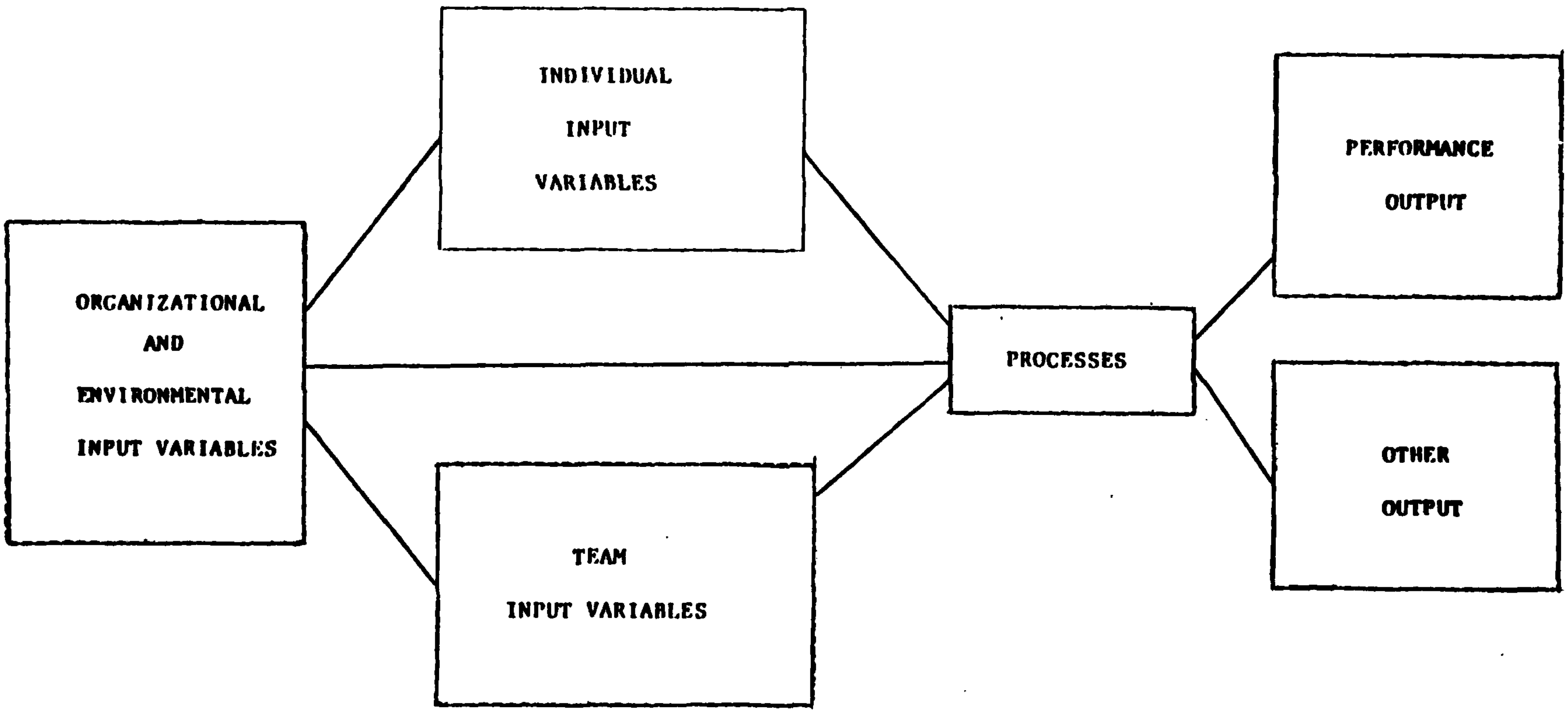

Figure II-1. A Systems Model of Team Performance et al. (1977) noted, however, "little attempt has been made to study how various input variables produce their ultimate effect in terms of intermediate processes and events" (p. 8). Fisher and Hawes (1971), who contended that an Interact System Model (ISM) addresses this problem, asserted that this model considers the various patterns of communication units as the systemic relationships that define the structure, function, and behavior of the system. Still, McGrath and Altman's observation concerning the application of a systems perspective to team performance possesses considerable merit. They maintained that

> we need a better understanding of the sequential linkages that begin with inputs in the form of member, group, and task characteristics, that become manifested in intermediate interactive processes, and that culminate in a performance output. Too little attention has been given to systematically establishing the links in this complex chain. What has been done is to explore relationships between initial inputs and final outputs, with insufficient attention to the ways in which input characteristics enhance or hamper final output via intermediate processes (McGrath and Altman, 1966, p. 65).

Thus, the Naval team taxonomy will cogently identify and describe salient input and process variables which impact upon team performance.

A major advantage of systems models of team performance involves their ability to synthesize many team variables into logical categories and describe the relationships among the categories. Thus, such models provide the grouping of the essential characteristics of teams, a grouping that is required for the design of a team taxonomy. Further, the taxonomic structure will describe essential features or elements of Naval teams and permit comparison of these elements to ascertain important similarities and differences. In this manner, the taxonomy will provide investigators with a systematic method of selecting Naval teams for various research purposes.

The systems model can also be used as an organizing structure for both the classification system and the measurement system. Indeed, Eddowes and

Waag (1980) suggested that measurement operationally defines the classification system. These researchers defined performance measurement as a set of rules that categorize and quantify behavior on some characteristic or attribute dimension. In this sense, measurement requires a set of rules to assign a specific category or number to a behavior. Thus, the systems model of team performance will be utilized to organize the team variables and the performance measures. The following sections discuss the location and nature of important team dimensions within the systems structure.

Naval Team Interdependence

Although many distinguishing attributes of teams have been identified, the overriding dimension, from a Naval perspective, appears to be the interdependence among team members. In fact, Wagner *et al*. (1977) recently concluded that interdependent, coordinated team performance is a predominant characteristic of most operational activities in the Navy. Further, Roby and Lanzetta (1956) contended that "it seems likely that the distribution of responsibilities among group members and the provisions for exchange of information among group members may be fully as critical in this respect as are individual abilities" (p. 107). Other researchers (e.g., Dieterly, 1978; Fisher and Hawes, 1971; Steiner, 1966) have also asserted the significance of team interdependence as a determinant of team performance.

Various perspectives have been advanced to describe the nature of interdependence among team members. For example, Dieterly (1978) stated that operationally, interdependence entails a positive ratio of the "total number of tasks... divided by the maximum number that could be accomplished by one member" (p. 486) and maintained that "a higher interdependency situation may require greater effort to accomplish than a lower interdependency situation" (p. 487). In this respect, interdependence involves the extent to which a member's performance of a task depends upon another member's completion of a prior task. Focusing upon communication channels and information relay, Shaw (1954) adopted a similar approach to team interdependence. Specifically, he posited that a team's interdependence index is a function of the following system states: the number of channels available to a person in a given position; the number of positions served by the individual as a relayer of information; and the total number of channels in a net relative to the number of channels in a totally interconnected net. Other team theorists have systematically examined specific types of team interdependence. For instance, Raven and Shaw (1970) distinguished between behavioral dependence and information dependence. The former concept refers to a situation where team member A depends upon member B to perform some behavior in order for A to proceed toward some goal, while the latter notion involves team member A's dependence upon member B to provide him with information necessary for A to approach some goal. Employing a triangle board task, which Raven and Shaw described as a difficult, conjunctive, problem-solving situation, the researchers studied uni-dependence and bi-dependence within 20 experimental triads. Finding that subjects accurately estimated their own level of dependence upon other team members, they reported that directive communication tended to flow in the direction of behavioral dependence (i.e., telling member B to perform some behavior). As Raven and Shaw observed, "a subject would communicate directions to the person who could affect his spirit level" (1970, p. 160). Further, they discovered that directive communication increases with dependence (i.e., bi-dependent versus uni-dependent situations) and that the work/talk ratio was greater for the uni-dependent versus bi-dependent task environment. O'Brien and Owens (1972) differentiated between collaborative task situations, in which team members cooperate with each other at all stages of task activity, and coordinative task situations, where different subtasks are allocated to different positions and the subtasks are then ordered by definite precedence relationships, such that all team members are required to contribute to the team product. These researchers found that in the collaborative situation, more comments were generated and more disagreements occurred, thus producing lower productivity than in coordinative situations. O'Brien and Owens noted that the personalities of team members, rather than their abilities, were more important in collaborative versus coordinative task situations. Another approach to interdependence involves Briggs and Johnston's (1967) distinction between serial and parallel tasks. Serial tasks entail sequences of team behavior, in which input to one member is based upon the output of another team member. Team performance can be predicted from the following equation (Meister, 1976):

$$p = f(x)(y)$$

where p = probability of correct team performance

x = probability of correct member x performance

y = probability of correct member y performance

Parallel tasks, which reflect the lowest level of team member interdependence, are related to team performance in the following manner:

$$p = f(x) + (y) - (x)(y)$$

where p = probability of correct team performance

x = probability of correct member x performance

y = probability of correct member y performance

Here, team members perform with minimal coordination in a simultaneous fashion.

In considering the relationship of interdependence to team performance, a thorough analysis of Roby and Lanzetta's research program is appropriate. As Glanzer (1962) observed, these investigations extensively examined the effects of member interrelationships upon military team functioning. Roby and Lanzetta (1956), viewing interdependence as the number of pieces of critical information member A needs from member B, generated an interaction matrix to illustrate interdependencies among team members. The total number of entries in their Observation-Personnel-Response (OPR) matrix is akin to task complexity, in that it reflects the number of different responses which the team must make to complete the task. Further, main diagonal entries represent information which a response agent can obtain autonomously, while off-diagonal entries depict a member's participation as a source and user of information and can indicate the degree of role specialization. Higher team interdependence is reflected by a larger number of off-diagonal entries in the OPR matrix, while greater independence is evidenced by a preponderance of main diagonal entires. The former task configuration entails low autonomy, while the latter situation involves high autonomy. Employing a task situation which required instrument readings and the relay of pertinent information, Roby and Lanzetta varied the amount and distribution of information units which had to be transmitted. They reported that highly autonomous structures, which necessitate minimal information relay, are less difficult and yield better performance than highly interdependent structures. Other studies (e.g., Lanzetta and Roby, 1956, 1957; Roby and Lanzetta, 1958; Meister, 1976) similarly demonstrated that as team interdependence increases, team performance declines. As Roby and Lanzetta noted, "the difficulty seems to lie in the inability of groups to set up an efficient system for phasing or actuating messages" (1956, p. 112). Also, Lanzetta and Roby (1956) indicated that communication problems stemmed from ignorance on the part of response agents as to when information bearing on their controls entered the group at some other station and on the part of information sources as to the relevance of new information that they received. As Naval team functioning is characterized by high interdependence, it is necessary to consider approaches to improving productivity.

As Rubin, Plovnick, and Fry (in Winsted, 1978) and Dyer (1976) suggested, team training is appropriate when coordinated action is required for mission performance. Further, Boguslaw and Porter (1962) argued that military teams must receive training concerning the nature of interdependencies. Hence, interdependence should be acknowledged as a key attribute of Naval teams and it can appropriately serve as the superordinate dimension in the development of the taxonomic system.

TASKS

Introduction

An important dimension of the productivity of Naval teams entails characteristics of the tasks which they perform. In discussing military groups, Roby and Lanzetta (1958) noted that

> Even a casual acquaintance with these groups indicates the diversity and complexity of their task environment and the high degree of dependence of group action on the nature of this environment. Thus the analysis and investigation of task characteristics becomes a basic requirement for research directed toward producing generalizable principles concerning the structure and functioning of military groups (p. 88).

Furthermore, the term "task" is more complex and multi-faceted when it is applied to a team than when it is applied to individuals. Hare (1976) defined the team task in the broadest sense as the requirement for the team to deal with the situation in which it finds itself. In combat, the military team's task is to deal with the enemy force.

Military research has been concerned with teams performing coordinated, structured activities to accomplish assigned missions. As such, the military has made extensive use of task analysis to define individual and team tasks, describe the relationship of tasks to military hardware, and specify responsibilities and roles. While task analyses have improved job descriptions for individuals, this research has not focused upon dimensions critical to Naval teams. Thus, this section examines relevant features of Naval team tasks.

Task Difficulty

Many research endeavors have demonstrated that task difficulty is a major determinant of member behavior and team performance. According to Meister (1976), task difficulty is a superordinate characteristic defined by the interrelationships among all other task characteristics. Task difficulty, described as the "amount of effort required for task completion" (Shaw, 1976), emerged as a significant dimension in Shaw's (1973) factor analysis of 104 group tasks. Daniels and Alden (1975), employing a systems perspective, presented a more detailed delineation of this important task variable. They suggested that task difficulty manifests itself differently during input (e.g., stimulus uncertainty), process (e.g., cognitive information-processing demands), and output (e.g., response complexity) activities. Daniels and Alden's study indicates that analysis of the difficulty of Naval team tasks should focus upon the various subtasks performed by these teams.

The research concerning task difficulty encompasses simple versus complex problems, team workload, and communication demands placed upon various teams. For example, Shaw and Blum (1965) found that easy tasks required less time for problem-solution than difficult tasks. Shaw also discovered this pattern, indicating that team morale was significantly higher in the simple task situation. Hackman (1968) noted, though, that team products were more original and issue-involved for difficult versus easy tasks. Some theorists have examined the dynamics of problem-solving situations to account for team performance differences between easy and difficult tasks. Mulder (1960), disagreeing with Shaw's (1954) assertion that information availability is most important for simple tasks and the possibility of member contributions is most significant for complex tasks, contended that "...irrespective of the complexity of the problem, integration of the group process is necessary" (p. 12). In other terms, he attributed superior team performance in the simple task situation to the easier formation of an appropriate organizing structure.

An examination of the empirical data concerning communication demands reveals similar results. For instance, Lanzetta and Roby (1956,1957) reported that errors increased linearly with the amount of information transmission required for task completion. They observed that

> In agreement with results previously obtained, the most difficult structure was that in which a larger proportion of information had to be relayed, and, more critically, in which a larger proportion of information had to be relayed from several different sources (p. 313).

Lanzetta and Roby did not believe, however, that the information processing demands were the only determinant of lower productivity. Instead, they posited that "the limiting factor in the performance of the groups was not their gross information capacity. Rather the difficulty seems to lie in the inability of groups to set up an efficient system for detecting and communicating information changes" (1956, p. 313). As increased interaction demands render the formation of a viable organizing structure more difficult, task performance is degraded considerably.

Other research concerning task difficulty has explored the work load confronting various teams. Lanzetta and Roby (1956,1957) reported that as time intervals between instrument readings decreased, teams committed significantly more errors. Further, Kidd (1961) varied work load (i.e., input intervals between aircraft arrivals in a radar air traffic control situation) and team size, finding that when input load is held constant and team size is increased, only a moderate upgrading of performance occurs. As such, Ryack (in Trussell et al., 1977) maintained that adding members to a team improves performance

only when the work load exceeds the capacity of the initial team members. Kidd also discovered that when work load and team size are both increased, thereby entailing a constant load per controller with greater coordination requirements, performance is markedly diminished. Generally, task overload results from an inadequate ratio of member resources to task demands. Thorne (in Trussell et al., 1977) also noted that it can occur when the task is incorrectly distributed among team members. Although work overload is an important aspect of task difficulty, Glanzer (1962) stated that it is not typically a significant problem for Naval teams.

Other research concerning task difficulty has explored the work load confronting various teams. Lanzetta and Roby (1956,1957) reported that as time intervals between instrument readings decreased, teams committed significantly more errors. Further, Kidd (1961) varied work load (i.e., input intervals between aircraft arrivals in a radar air traffic control situation) and team size, finding that when input load is held constant and team size is increased, only a moderate upgrading of performance occurs. As such, Ryack (in Trussell et al., 1977) maintained that adding members to a team improves performance only when the work load exceeds the capacity of the initial team members. Kidd also discovered that when work load and team size are both increased, thereby entailing a constant load per controller with greater coordination requirements, performance is markedly diminished. Generally, task overload results from an inadequate ratio of member resources to task demands. Thorne (in Trussell et al., 1977) also noted that it can occur when the task is incorrectly distributed among team members. Although work overload is an important aspect of task difficulty, Glanzer (1962) stated that it is not typically a significant problem for Naval teams.

This section has examined the theoretical and empirical bases of task difficulty. Within Naval teams, this variable exists and influences team performance in many forms. Task difficulty can involve the operation of highly automated equipment, the evaluation of complex tactical data, the utilization of highly technical symbolic coding in sending/receiving messages, etc. Thus, it is necessary to identify each task performed by Naval teams and to assess the difficulty level of these tasks.

Task Emergence

An important aspect of Naval team functioning involves the distinction between established and emergent task situations. Boguslaw and Porter (1962) specified these conditions in the following manner:

> An established situation is one in which (1) all action-relevant environmental conditions are specifiable and predictable, (2) all action-relevant states of the system are specifiable and predictable, and (3) available research technology or records are adequate to provide statements about the probable consequences of alternative actions. An emergent situation is one in which (1) all action-relevant environmental conditions have not been specified, (2) the state of the system does not correspond to relied-upon predictions, (3) analytic solutions are not available, given the current state of analytic technology (p. 395).

According to Winsted (1978), most military tasks are established, in that behavioral guidelines are almost completely specified. He acknowledged, though, that emergent tasks are an inportant part of Naval functioning and merit close attention. When unanticipated, emergent situations arise, the coordination demands placed on the team increase and may influence performance. As Knerr et al. (1980) noted, the emergent nature of operational settings "increases demands for coordination, communication, and cooperation within the team. These demands tend to complicate team functions and degrade team performance..." (p. II-6). To counteract possible process losses due to the unpredictability created by emergent situations, various researchers recommend the adoption of system training technology. For example, Winsted asserted that "training in team skills (e.g., coordination) is required when formal rules cannot be stated and procedures must be developed by the team" (p. 24). Further, Boguslaw and Porter (1962) suggested that such training should involve identifying kinds of environmental and system states which could occur, developing techniques of simulating emergency situations, offering practice in dealing with such emergencies under simulated conditions, and providing knowledge of results in connection with these practices.

Clearly, the established-emergent dimension of Naval tasks exerts significant influence on team performance and the appropriateness of specific team training procedures. As task emergence can result from various system conditions, identification of these factors should provide a better understanding of this dimension and facilitate the development of more useful methods for enhancing team performance. Among the system conditions most relevant to Naval team functioning are stimulus uncertainty/complexity (e.g., task overload), environmental states (e.g., weather conditions), equipment failure, and battle casualties which decrease manpower availability.

Task Type

According to Steiner (1972), team performance is determined by task demands, member resources, and interaction process requirements. In discussing team tasks, he delineated the following four characteristics:

1. Unitary-Divisible: Whether a task can be divided into parts or subtasks that can be performed efficiently by different individuals.

2. Maximizing-Optimizing: Whether a task requires the group to do as much as possible of something or to produce some specific, most preferred outcome.

3. Prescribed Process: Task demands that specify the process that must be employed to achieve maximum success.

4. Permitted Process: The degree to which members are permitted to combine their individual products.

In discussing permitted process, Steiner focused upon the degree of interdependence in the task situation. He explicated the relationship between team performance and task type for disjunctive, conjunctive, complementary, compensatory, additive and discretionary tasks. Disjunctive tasks require choosing among alternatives, with at least one team member possessing the necessary skill. As the team's performance depends upon the most skilled member's contribution, the identification of this most competent member and his motivation level are important task-related considerations. In presenting mathematical formulas to depict the relationship between task type and team performance, Steiner asserted that as adding members enhances the probability of the team's possessing a highly competent member, team size should be positively related to task performance. For instance, Waag and Halcomb (1972) demonstrated that maximum target detection performance resulted whenever only one simulated team member had to respond correctly. In this disjunctive task situation, increasing team size should strengthen the team's task resources, thereby improving detection performance. This relationship is especially pronounced for very difficult tasks and high ability heterogeneity.

Conjunctive task situations place quite different demands upon the team. Unlike disjunctive tasks, each team member must perform the task. As a result, the least proficient member determines the team's potential productivity. For instance, in Waag and Halcomb's (1972) research, team productivity was poorest when all members had to perform the detection task. Also, as increasing team size enhances the probability that the team will possess less capable individuals, adding members is likely to degrade team performance. This relationship is particularly strong under conditions of low task difficulty and low ability homogeneity.

In an additive task situation, the team's productivity is a function of the potential output of the team members. Specifically, team performance is an additive combination of individual products. As such, as adding team member augments the resources available to the group, team size is directly related to productivity for additive tasks. As Ringelmann's (in Dashiell, 1935) study indicated, though, process losses typically occur and limit the positive impact of adding team members. Also, ceiling effects can mediate against the simple summation of individual contributions.

Compensatory tasks entail averaging of member inputs, such that team members can overcome each other's weaknesses. In statistical terms, compensatory task situations permit reduction of the standard error of the mean. For instance, in a task setting where each member estimates the distance of a target and the team product is the arithmetic mean of these judgments, cancelling of individual errors or biases will ordinarily occur. Therefore, team performance is positively linked to group size for compensatory tasks. An important assumption concerning this prediction, though, is that team members are selected as a random sample from a universe in which biases are normally distributed (Steiner, 1966). An illustration of research concerning compensatory tasks is Johnston and Brigg's (1968) study involving air traffic control teams. Operationalizing compensatory activities as the capacity of team members to correct or counteract their partners' errors after they have been committed, they reported that these teams were able to offset partially their accrued time error. Johnston and Briggs noted, however, that the value of compensatory activity was an inverse function of system load.

While these four task situations prevent a division of labor regarding task demands, Steiner (1966) stated that complementary tasks necessitate that each team member perform that portion of the task for which he has the required skill. Thus, role specialization in performing subtasks exists and the ability to organize and distribute responsibility is very important. As Davis observed, though, "...there are strong social forces preventing groups from easily attaining such optimal organizations..." (1969, pp. 50-51). At any rate, it is not possible to advance unequivocal statements concerning the relationship between team size and performance for complementary task situations.

The final task type identified by Steiner (1972) involves discretionary task situations. Here, members are permitted to combine contributions as they wish; as a result, there is no specifiable relationship between team productivity and size for discretionary tasks.

Clearly, these task types differ in terms of the importance which interaction processes, team size, and other variables assume as groups perform diverse tasks. Frank and Anderson (1971) underscored the utility of understanding task types in suggesting that "models of group productivity must consider type of task, group size, and the interaction of size and task - especially when quantitative indexes of group performance are of primary concern " (p. 145). The interaction of task type and other variables (e.g., group size and team structure), as they impinge upon team performance, will be explored in later sections.

TEAM MEMBER CHARACTERISTICS

Within the systems model presented earlier, individual team member characteristics constitute the second category of input variables. According to Meister (1976), the proficiency of team members is intimately linked to effective team performance, accounting for as much as fifty percent of the variance in team productivity. Other researchers (e.g., Heslin, 1964; Thomas and Fink, 1961;

Chapanis, 1976; Dieterly, 1978) have also acknowledged the important role of member ability in influencing team performance. In fact, some theorists have suggested that team formation and role assignments should be predicated upon member capabilities. For instance, Blades (1974) recommended that highly intelligent members should be assigned to participative leaders, where their greater capabilities would be better utilized, while less intelligent individuals should be placed in team situations such that they exert little effect on team performance. Further, Zajonc and Smoke (1959) stated that role assignments within teams can be based on member abilities such that "individual differences are exploited by assigning fewer items to less able members and more items to the capable individuals" (p. 368). Also, O'Brien and Owens (1972) posited that "it seems to be inefficient to assign members of high ability to groups where the task allocation relationships are such that their contributions are going to be limited by the poor performance of relatively incompetent members" (p. 280).

Typically, the Navy attempts to match important member characteristics (e.g., technical skills and proficiency, leadership ability, and actual on-the-job experience) to team role requirements. To achieve this end, each serviceman receives codes denoting, at both general and specific levels, military skill and ability/proficiency levels. At the most general level, a member's pay grade can indicate a certain minimum level of leadership ability and work experience. There are nine enlisted, three warrant officer, and ten officer pay grades. For enlisted men, satisfactory completion of the appropriate Military Requirements Training course is a mandatory prerequisite for promotion to pay grades E4 and E5, E6 and E7, and E8 and E9. Significant portions of each of these courses deal with developing the leadership characteristics deemed necessary for each level.

Although Meister observed that other individual variables (e.g., age, sex, race, personality, motivation) probably have minor significance in system output, these factors are capable of affecting team performance. Meister noted that these variables can impact upon aptitude and indicated that they become increasingly important as mission requirements become more demanding. Additionally, Schutz (1958) reported that in situations involving collaborative organization (i.e., all members cooperate at all stages of the task activity with each other), personality factors are often better predictors of team productivity than task-related abilities. O'Brien and Owens (1972) contrasted collaborative and coordinated (i.e., different tasks are allocated to different positions and the tasks are then ordered by definite precedence relationships, thereby requiring all members to contribute) task situations in studying the impact of member personality on team performance. They reported that "task-relevant abilities were significantly related to group productivity only in those task organizations requiring coordination and then only for the summed abilities and the abilities of the dullest member in each group" (1972, p. 278). Thus, O'Brien and Owens succinctly concluded that "the significance of these results lies in the demonstration that the contribution of member intelligence to group productivity is dependent on both the ability of the member and the kind of task organization employed" (1972, p. 278).

Although team variables such as member compatibility, group cohesiveness, cooperative and competitive incentives, and homogeneity-heterogeneity of attitudes and personality are potentially strong determinants of team performance, the literature concerning these factors will not be reviewed for two reasons. First, Naval teams are not typically formed on the basis of personality dimensions. Also, these variables are highly team-specific; in characterizing unique teams, they do not really fit in a generalizable taxonomic model of Naval teams. It is apparent, though, that these variables are important and merit empirical attention by Naval team investigators.

Team Size

Many research efforts have been made to explore the relationship between the number of group members and team performance. As team size increases, "the range of abilities, knowledges, and skills that are available to the group increases...as well as the sheer number of 'hands' that are available for acquiring and processing information" (Shaw, 1976, p. 155). However, Hackman and Vidmar (1970) noted that increases in team size are frequently accompanied by greater communication difficulties, less intermember cooperation, and members' feelings of possessing less influence. The specific effects which team size has upon productivity are related to several other factors, including the nature of the task, group structure, and member proficiencies. Additionally, as team size impacts upon other group variables (e.g., member satisfaction, distribution of participation) which may be linked to team performance, these relationships must be considered.

Studying the relationship between team size and member satisfaction, Dawe (1934) reported that as the size of children's groups increased from 14 to 46 members, the total amount of discussion in the group declined. Similarly, Williams and Mattson (1942) discovered more communication in dyads versus triads and Indik (1965) found that organizational size is inversely related to the rate of communication. Hackman and Vidmar (1970) suggested these results are attributable to team members' feeling more inhibited as group size increases. Also, Indik indicated that as organizational size increases, the probability that communications will be adequate clearly decreases. Finally, several studies (e.g., Hare, 1952; Bales _et al_., 1951) demonstrated that increasing group size produces more variability in member participation. Specifically, team interaction is increasingly dominated by a few individuals, while the remaining members contribute proportionally less. Also, Bales _et al_. observed that as team size increases, there is a greater proportion of messages directed to the group in general rather than to specific members.

Hemphill (1950) discovered that increases in team size place greater demands on the leader's role, with tolerance for leader-centered direction of group activities becoming greater. Bass and Norton (1951) reported that leadership emergence is more definitive in larger groups. Apparently, the desire for effective organizational structure produces adaptive behaviors of the type just described. Interestingly, persons who occupy centralized positions are generally more satisfied than persons in peripheral positions (Shaw, 1976). This finding is consistent with other research examining the link between team size and member satisfaction. For instance, Katz (1949) found that smaller groups were more cohesive and the members of these teams were better satisfed than in larger groups. Several other investigators (e.g., Thomas and Fink, 1963; Golembiewski, 1962; Deutsch and Rosenau, 1963) have also concluded that the smaller the team, the greater is the member's satisfaction with the group discussion. As such, Hackman and Vidmar (1970) suggested that "many of the negative reactions of the members to larger groups may stem from the difficulties which these groups have in organizing themselves" (p. 39). Cleland (1955) and Baumgartel and Sobol (1959) indicated that this dissatisfaction with larger groups is reflected in greater absenteeism and personnel turbulence in organizational settings. While the relationship between satisfaction and productivity is unclear, the potential problems which accompany increased team size must be considered. This situation is further compounded by the results of several studies (e.g., Thelen, 1949; Barker, 1960; Barker, 1968; Wicker, 1969) which have reported an inverse relationship between team size and motivation.

The connection between team size and performance is complex and must be viewed in terms of key mediating variables. Gibb's (1951) research suggested that increasing team size enhances performance, but not in a manner proportional to the number of members in the group. Steiner (1972) posited that "if an increase in group size augments the group's potential without creating serious process losses, it will be responsible for improved performance" (p. 67). However, if the size increment is small and the decrement by process loss is high, lower productivity can be expected. As previously discussed, Ryack (in Trussell et al., 1977) noted that adding members to a team improves performance only when the work load exceeds the capacity of the initial team members. Also, Kidd (1961) demonstrated that increasing team size under constant load conditions produces only moderate gains in team performance. Again, increasing team size entails a tradeoff of more resources and abilities against coordination and organization process difficulties. Thus, Steiner (1972) asserted that understanding the relationship between team size and productivity requires consideration of the team task, the initial size of the team, and member resources.

Several studies (e.g., Cummings, Huber, and Arendt, 1974; Goldman, 1971; Waag and Halcomb, 1972; Ziller, 1957; Frank and Anderson, 1971) have provided evidence that group size is directly related to team productivity for disjunctive tasks. These studies employed a variety of task situations, including vigilance, brainstorming, concept mastery, and problem solving. Other research has yielded less definitive results concerning the interaction of team size, task type, and productivity. While Laughlin et al. (1975) reported a main effect for disjunctive tasks, they indicated that increasing team size did not enhance performance in low ability groups. Also, Cummings et al. (1974), though noting that the quality of solutions increased with size, observed no differences between groups regarding time taken to develop problem solutions. Steiner (1972) presented the following formula to predict the relationship between team size and productivity for disjunctive task situations:

$P = 100(1-Q^n)$ Where P = probability that at least one member has the skill necessary for task completion.

Q = proportion of people lacking the skill.

n = number of members in the group.

According to Steiner, because the likelihood of obtaining a member with the requisite skill increases with greater team size, performance and size are positively related for disjunctive tasks. This theoretical expectation corresponds with Lorge and Solomon's research, which generated the predictive formula upon which Steiner's work was based. Steiner further suggested that this relationship is particularly strong when task difficulty and ability heterogeneity are high. The slightly discrepant experimental results reported above are perhaps attributable to differences along these dimensions.

In considering conjunctive task situations, Steiner (1972) contended that team size and performance are inversely related. He generated the following predictive equation for conjunctive tasks:

$P = 100(1-Q^n)$ Where P = percent of teams unable to successfully accomplish the task.

Q = proportion of people who possess the necessary skill.

n = number of members in the group.

This negative relationship is especially pronounced when task difficulty and ability homogeneity are low. Various studies (e.g., Ziller, 1957; Frank and Anderson, 1971; Marriott, 1949) supported this relationship for conjunctive tasks, although performance decrements due to process losses were frequently smaller than the mathematical equation predicts. Also, Steiner observed that this negative relationship between team size and prouctivity holds only for conjunctive task situations which are unitary (i.e., all members must perform all subtasks).

As Nieva et al. (1978) noted, most studies reporting a positive relationship between team size and performance employed disjunctive or additive tasks (e.g., Taylor and Faust, 1952; Anderson, 1961; Bouchard and Hare, 1970). Further, they observed that many studies show either no connection between team size and performance (e.g., Morrissette, Switzer, and Crannell, 1965; Goldman, McGlynn, and Toledo, 1967; Shaw and Breed, 1971; Hackman and Vidmar, 1970; Kennedy, 1971) or a negative relationship (e.g., Buck, 1957; Ingham, Levinger, Graves, and Peckham, 1974). Nieva et al. accounted for this variability of results by contending that most experiments which obtained a positive relationship between team size and performance involved laboratory settings, while research showing a negative connection typically entailed field situations. Further, in observing that laboratory groups, besides being more artificial, are usually smaller than in field studies, Nieva et al. posited an inverted U-function to explain the relationship between team size and productivity. Of course, as previously noted, this connection is mediated by other task and team member characteristics (e.g., task type, level of task difficulty, and ability homogeneity-heterogeneity).

Group structure is another variable which affects the relationship between team size and productivity. Cummings and King (1973) found a positive connection between team size and performance only under conditions of high group structure. Other research, however, has unearthed either a positive relationship (e.g., Taylor and Faust, 1952; Anderson, 1961; Bouchard and Hare, 1970) or no link (e.g., Morrissette et al., 1965; Shaw and Breed, 1971; Felsenthal and Fuchs, 1976) for unstructured tasks.

While the team size research has yielded inconsistent results, these disparities are probably attributable to failure to control for key mediating variables. One fairly stable conclusion, though, is that increasing team size places greater process demands upon the group. Indeed, Ringelmann (in Dashiell, 1935) demonstrated that even when productivity is enhanced by adding team members, greater process losses result as actual productivity deviates further from potential productivity. Generally, teams achieve maximum productivity when they contain only as many members as are needed to supply the necessary task and interaction skills (Thelen, 1949). In other terms, teams are most effective when the number of members maximizes the positive discrepancy between potential productivity and process losses (Steiner, 1972). As Meister (1976) indicated, military teams must determine the minimum number of members required to maintain a satisfactory level of performance.

TEAM COMMUNICATION PROCESSES

Within the systems model of team performance, communication processes are intervening variables that mediate the effects of input factors on team output. In this section, various approaches to classifying interaction behaviors are examined. Also, the research concerning the relationship of interactive processes and team performance is explored. In this respect, particular attention is devoted to process gains and losses which occur during team functioning. Finally, analysis of phases of team interaction is provided, with special emphasis placed on qualitative changes in communication behavior which occur as teams progress from initial to latter stages of task achievement.

An early attempt to depict team communication behavior was made by Bales (1950), who created Interaction Process Analysis (IPA). According to Patton and Giffin (1978), IPA (Table II-1) provides a "standard method of classifying interaction to determine how decision-making groups function in different phases of meetings and how the members assume duties that contribute to the well-being of the group" (pp. 4-5). Basically, IPA entails the systematic classification of all acts of group participation, with trained observers placing each communication

Table II-1
Bales - IPA Chart

Norms				
2.6-4.8	A	1.	Acts Friendly	- shows solidarity, sympathy, harmony, praising
5.7-7.4	A	2.	Dramatizes	- tension release, often double meaning, joking
8.0-13.6	A	3.	Agrees	- accepts, concurs, understands information
3.0-7.0	B	4.	Gives Suggestions	- taking lead in task direction, guiding, persuading
15.0-22.7	B	5.	Gives Opinions	- offering beliefs, values, involving a moral obligation
20.7-31.2	B	6.	Gives Information	- factual, verifiable data reporting
4.0-7.2	C	7.	Asks for Information	- seeks factual, verifiable data
2.0-3.9	C	8.	Asks for Opinions	- seeks beliefs, values, involving a moral obligation
0.6-1.4	C	9.	Asks for Suggestions	- seeks guidance, concrete recommendations
3.1-5.3	D	10.	Disagrees	- rejecting another's statements - attached to content
3.4-6.0	D	11.	Shows Tension	- reflecting conflict between submission and nonconformity
2.4-4.4	D	12.	Acts Unfriendly	- shows negative personal reaction

a b c d e f

Key
A-Positive Reactions
B-Attempted Answers
C-Questions
D-Negative Reactions

Note
1-3, 10-12 - Socio-Emotional
4-9 - Task Related

Key
a. Problems of orientation
b. Problems of evaluation
c. Problems of control
d. Problems of decision
e. Problems of tension management
f. Problems of integration

Source - Adapted from Robert Freed Bales, Interaction Process Analysis: A Method for the Study of Small Groups Massachusetts: Addison-Wesley, 1950, p. 59.

act into one of the twelve categories. The twelve communication categories are evenly split into task and socio-emotional aspects of team behavior. Bales identified the "equilibruim problem", whereby a group must somehow balance the demands of task productivity and social relationships, as a major consideration for any work group. As Gulley (1968) noted, energy devoted to decision-making cannot also be spent reducing tension or keeping members satisfied. Further, he suggested that this problem is intensified

> because members are not generally as sensitive to the social climate as they are to the task assignment. Productivity is at the center of everyone's attention. The prevailing spirit in most discussion situations is: "Let's get on to the decision we gathered here to reach". Yet successful achievement, and commitment to the decision, are directly influenced by interpersonal relationships (1968, p. 290).

As such, Bales delineated task and socio-emotional communication into the following categories:

TASK	SOCIO-EMOTIONAL
Giving Suggestions	Acting Friendly
Giving Opinions	Showing Tension Release
Giving Information	Agreeing
Asking for Information	Disagreeing
Asking for Opinions	Showing Tension
Asking for Suggestions	Acting Unfriendly

The observation task involves placement of communication acts into these categories by trained observers, who typically focus on the interaction behavior of a single member and record the nature of the behavior as opposed to the content of the message itself. When observations have been completed, the data are tabulated and subjected to several analyses. For example, IPA permits identification of the percentage of each group member's contribution, the percentage of the group's participation in each IPA category (which can be compared with estimated norms emerging from several years of research), the percentage of total observed team participation in each IPA category for each group member, and individual IPA data compared with the estimated norms. Also, this procedure can accommodate the systematic observation and classification of temporal sequences of communication behavior (this will be examined later) and the study of specific interaction patterns between participants. Further, IPA can discern the amount of positive versus negative reactions, the extent of questions versus answers, and the team's relative concern for task and socio-emotional functions.

Interaction Process Analysis has yielded many important findings in the area of team communication. For instance, Gulley (1968) reported that only about half of a team's communication time involves substantive matters, with the remainder dealing with questions and positive/negative reactions. Further, network analyses have revealed that members who initiate the most communication tend to receive the most communication (Gulley, 1968). Finally, Bales' research (in Patton and Giffin, 1978) yielded the following results: there can be too many agreements and too few disagreements; an optimal balance between the number of positive reactions to negative ones is about two to one; a high rate of disagreement and antagonism leads to difficulty in decision-making; and team members do not seem strongly bound by a group decision unless they have participated in its generation.

Farace and Danowski (1973) adopted a similar categorization scheme concerning team interaction behavior. In recognizing that team researchers must make decisions regarding which categories of communication behavior to study, they identified three particularly relevant areas.

- Production Communication - the exchange of messages to accomplish the task.
- Maintenance Communication - the exchange of "people-oriented" messages involving the handling of personnel problems, maintaining self-identities and self-esteem of members, and group identity and cohesiveness.

- o Innovation Communication - the exchange of messages involving new alternatives for production and maintenance activities, generation of new ideas and their diffusion through the system.

Clearly, production communication is equivalent to Bales' task-oriented behavior and maintenance communication entails socio-emotional interaction processes. Also, the inclusion of innovation communication provides acknowledgement of important self-reflexive processes exhibited by ongoing teams.

Siegel and Federman (1973) developed a communication content scheme which focused on more specific types of messages. They identified four communication areas which accounted for 56% of the team performance variance in their study of ASW Helicopter teams. The first category, probabilistic structure, refers to the weighing of probabilities/likelihoods of alternative courses of action. Evaluative interchange entails the exchange of ideas, proposals, and data, while hypothesis formulation and leadership control (i.e., providing an atmosphere in which opinions of other crew members are allowed to emerge) constitute the other content categories.

Nieva, Fleishman, and Rieck (1978) developed a communication process typology which also examines specific team interaction patterns. They delineated the following four areas of communication process variables:

1. Orientation - processes of information distribution about goals, tasks, and team member resources and constraints
2. Organization - processes of coordination including division of labor (matching member resources to task requirements), activity sequencing and pacing, load balancing of subtasks among members and priority assignments among subtasks.
3. Adaptation - processes of cooperation by which team members complement each other by making mutual adjustments and carrying out accepted strategies.

Dimensions include mutual correction of error and critical evaluation, mutual compensatory performance, and mutual compensatory timing by which team members adjust their work pace so that the team's overall mission is accomplished smoothly.

4. Motivation - processes of defining objectives and energizing members toward those objectives. Dimensions include development and acceptance of team norms, establishing performance rewards, reinforcement of task orientation, balancing team orientation with individual competitive orientations, and resolution of informational, procedural, and other interpersonal conflicts within the team.

Chapanis (1976) conducted an interesting research program to explore the effects of communication mode upon team interaction behavior. In all nine studies, he found that problems were solved significantly faster in communication modes having versus lacking a voice channel, while performance time was approximately equal for voice and face-to-face communication modes. Further, modes with a voice channel were wordier than those without one, but again the difference between voice-only and face-to-face modes was not statistically significant. Chapanis reported that providing the freedom to interrupt did not affect problem-solution time or the number of words used, although messages were packaged differently in this situation. Specifically, more messages of shorter duration were exhibited when interruptions were allowed. Also, Chapanis discovered that communicators in more impersonal modes (e.g., teletype) were more likely to share equally in information exchange than in other communication modes. He found that oral communication was highly redundant and that most of it could be carried out effectively with a small, carefully selected set of words. Finally, Chapanis discovered different communication patterns for tasks requiring factual information exchange versus opinions and argumentation. In the former instance, only about fifty percent of a communicator's time was spent sending information, while in the latter context up to seventy-five percent was devoted to communication. The remaining time was occupied by making notes, handling parts, and searching for information.

Considerable research attention has centered around the relationship between communication processes and team performance. As Trussell et al. (1977) observed, "whether you study a commercial airline crew, bomber crew, tank crew, combat team, ship crew or management team, the interactions between individuals in accomplishing the required task determine task failure or success" (p. 4). Other investigators have focused upon the role communication plays in team goal achievement. Roby and Lanzetta (1956), discussing the pool of alternative response aggregates accessible to the team, noted that "the primary function of task-oriented communication is to contribute to an optimal selection from this pool" (p. 106). Thus, an examination of studies concerning the exhibition of specific communication behaviors is warranted.

Johnston (1966) and Federman and Siegel (1965) showed that non-task-related communications impair team performance. Utilizing an electrical apparatus task requiring sequencing of member responses, Lanzetta and Roby (1960) found a negative correlation between the number of requests for information and performance, and a positive relationship between amount of volunteered information and performance. Apparently, the magnitude of requests for information was symptomatic of poor coordination in the team, while volunteering of information reflected high group organization. Other studies have focused even more extensively upon the content of team members' communicative messages. For example, Haythorn (1953) noted that individual behavior patterns which include cooperativeness, efficiency, and insight are positively related to effective team functioning, as measured by productivity and interest in job completion. Further, communication behaviors displaying aggressiveness, interest in individual solution, self-confidence, initiative, and authoritarianism are somewhat negatively related to ratings of group cohesiveness and friendliness. McGrath and Julian (1963), studying negotiating groups, reported that successful groups had significantly fewer negative-affect and negative-feedback messages. Federman and Siegel (in Nieva _et al_., 1978), correlating different types of messages with productivity, discovered a positive relationship between performance activity (process) messages, evaluative messages, phenomenological messages, and requests for information. Overall, they reported a direct relationship between performance and information, opinion, and thinking messages and a negative link between performance and risk-taking messages.

While these studies have focused upon specific types of communication behavior, other research has addressed the more global issue concerning whether communication processes enhance or degrade team performance. For instance, Varney (1977) reported that if a team fails to transmit information necessary for its members to act productively, motivation to perform well deteriorates. Similarly, Frazer (1977) asserted that problems in intercommunication aboard ship are linked to member dissatisfaction and turnover. Several studies (e.g., Meister, 1976; O'Brien and Owens, 1972; Steiner, 1972; Roby and Lanzetta, 1956,1957) have indicated that the extent of communication is inversely related to team performance. In fact, Johnston and Briggs (1968) suggested that team functions should be minimal and individual functions maximal in the design of multi-man systems. Similarly, Kidd (1961) concluded that maximum performance can be attained from multi-man systems operations when the coordination demands are minimized. Other research, though, indicates that the relationship between team communication and performance is mediated by certain variables (e.g., task type, team structure) and is not always a negative one. For instance, Thibaut, Strickland, Mundy, and Goding (1960) found that groups which permitted intermember communication performed better on a numerosity estimation task. Cohen (1968) reported that when the bottom person in a decision tree has strong influence on the team decision, free communication improves performance. Other studies (e.g., Levine and Katzell, 1971; Shiflett, 1972) which also used problem-solving tasks and quantitative or qualitative measures, similarly discovered that communication is directly related to team performance. Further, Levine and Katzell (1971) and Shaw and Caron (1965) noted no significant differences between communication conditions regarding time, indicating that problem-solving communication permits better solutions without an appreciable loss of time. The results of studies employing vigilance or monitoring tasks (e.g., Briggs and Naylor, 1965; Johnston, 1966; Naylor and Briggs, 1965), however, do not display this relationship between team communication and performance. As Nieva et al. (1978) suggested, these tasks are highly structured, while problem-solving situations are not. Thus, these conflicting findings can be reconciled in that only relatively unstructured tasks, with the concurrent need for greater planning and coordination, benefit in performance from the availability and utilization of team interaction. In fact, Steiner and Dodge (1956) found that communication improved team output only for unstructured tasks.

Clearly, team interaction processes sometimes enhance and sometimes degrade performance. As Johnston and Briggs (1968) observed, "team communication hinders team performance most when there is the least need and the least freedom to communicate" (p. 93). An understanding of the conditions under which team performance improves or impedes performance may be facilitated by an examination of potential process gains and losses. Steiner's (1966,1972) theory of group productivity provides a basis for relating individual behavior to group behavior and identifies variables which may affect team performance. Here, task demands and team resources combine to determine the maximum level of productivity that the team can achieve. Frequently, however, team task performance is less than the sum of individual capabilities. Steiner thus distinguished between actual productivity, which refers to what the group in fact accomplishes, and potential productivity, which involves the "maximum productivity that a group can achieve when the group uses its resources to meet task demands" (Shaw, 1976, p. 33). The major contention of Steiner's theory, then, is that team processes can only degrade task performance. According to Steiner, process variables include not only actions that are directly relevant to the task, but also

> all those intrapersonal and interpersonal actions by which people transform their resources into a product, and all those nonproductive actions that are prompted by frustration, competing motivations, or inadequate understanding. In short process consists of the individual or collective actions of the people who have been assigned a task (1972, p. 8).

In mathematical terms, Steiner represents the relationship between actual and potential productivity in the following manner:

Actual Productivity = Potential Productivity - Losses Due to Faulty Group Process

Specifically, Steiner identified coordination and motivation difficulties as key process variables which increase the discrepancy between potential and actual productivity. Further, Davis and Restle (1963), responding to the contention that teams should outperform individuals because of the summed abilities of the members, noted that team interaction processes often degrade performance. They observed that "the simple pooling models pool the accomplishments but do not pool the disabilities and errors of the members of the group, i.e., the Lorge-Solomon model combines the wheat and leaves behind the chaff" (1963, p. 115).

While communication processes frequently reduce team output, group interaction can facilitate performance. At the simplest level, Kanekar and Rosenbaum (1972) indicated that "exposure to the responses of another person, a situation which exists in real groups, may provide such new sources of stimulation" (p. 332) when an individual exhausts his response repertoire. Further, Hackman and Morris (1975) reported that the recall of one team member could aid other members by a prompting effect. Davis (1969) delineated the following list of possible interaction process gains:

- o when some probability of individual error exists, then multi-person work provides a quality check or duplication (redundancy).
- o if each person possesses unique but relevant information and the task requires several pieces of information, then the pooling of this information will allow groups to solve problems that individuals cannot successfully attack.
- o questioning and debating during social interaction may stimulate new or different intra-individual thought processes that the uniform environment of the isolated individual might not provide; thus, other persons have a cue value in provoking new task approaches.

Shaw (1976) proposed a modification of Steiner's formulation to account for team process gains.

$$\text{Actual Productivity} = \text{Potential Productivity} - \text{Losses Due to Faulty Group Process} + \text{Gains Due to Group Process}$$

Utilizing a hypothetical mathematical problem, Shaw illustrated how "the behavior of one member may serve as a stimulus which allows another member to make use of some resources that are not always available to him when he is acting alone" (1976, p. 35).

This discussion has attempted to illustrate the role which communication processes assume in determining team performance. For Naval teams, this research could provide a systematic framework for training in interaction skills. First, it is necessary to ascertain whether various teams require training in this area. As Meister (1976) noted, "the more individual performance determines team output, the less important become the special dimensions of 'team processes', and the less necessary it becomes to provide special team training" (p. 236). Additionally, it is important to realize that the impact of team interaction behavior on performance is contingent upon task demands, team structure, member characteristics, and team size. For example, Jacobsen (1979) observed that "when an emergency arises it will be evident that only trained talkers, using standard phraseology, can get the correct word from station to station" (p. 44). In this instance, team training should stress the need for concise, efficient relay of technical information. As Hackman and Morris (1975) noted, the team researcher's challenge is "to identify, measure, and correct the aspects of team processes that inhibit output" (in Knerr et al., 1980, p. V-7).

Phases of Team Interaction

An important feature of team interaction processes involves the changes in communication patterns which occur as the team develops and adjusts in response to the task situation. Many small group researchers have acknowledged that teams exhibit fairly consistent phases of interaction over time. Although the labeling of interaction sequences varies, the underlying team activities which are described are remarkably similar. Further, these sequential patterns have been reported for experimental (e.g., Bennis and Shepard, 1974) as well as task-oriented groups (e.g., Bales and Strodtbeck, 1951; Morris and Sashkin, in Kell and Corts, 1980; Tuckman, 1965).

According to Shaw (1976), group development proceeds rapidly initially, with considerable structuring and organizing activity displayed. Team behavior in early developmental stages is primarily geared toward the formation of status and role relations, acquisition of task-relevant information, creation of team norms, and establishment of power relations. As these aspects of group functioning are resolved, other behavioral patterns (e.g., evaluation of information and assignment of members' responsibilities) occur.

The most systematic attempt to conceptualize and measure sequences of team interaction was performed by Bales and Strodtbeck (1951). Focusing upon problem-solving groups, they defined developmental phases as

> qualitatively different subperiods within a total continuing period of interaction in which a group proceeds from initiation to completion of a problem involving group decision (p. 485).

Bales and Strodtbeck studied twenty-two groups to ascertain the validity of their three-stage paradigm, which consists of the following phases:

- ORIENTATION - processes by which information possessed by individual members and relevant to the group decision is made available to the group and coordinated to the group problem. It is an exploratory stage which produces greater understanding of the group problem.
- EVALUATION - processes by which differences in values and interests regarding judgment of the facts of the situation and proposed courses of action are considered.
- CONTROL - processes by which group members and their common environment are regulated in reaching a group decision and implementing a plan of action.

Bales and Strodtbeck hypothesized that each temporal sequence would be characterized by a relative emphasis on interaction behaviors reflecting the appropriate phase of team development. Combining the results for the twenty-two groups, they reported that 47% of all interactions directed toward orientation occurred during the first period, 36% of all behaviors involving evaluation were exhibited in the second sequence, and 40% of all control behavior was displayed in the third phase of group interaction. The researchers concluded that significant support for their sequential framework was obtained from these studies.

Another classification system of team development phases was proposed by Tuckman (1965). Studying group structure (interpersonal interaction) and task activity, he maintained that all groups exhibit four stages of development.

GROUP STRUCTURE	TASK ACTIVITY
1. Testing and Dependence	1. Orientation to Task
2. Intragroup Conflict	2. Emotional Response to Task Demands
3. Development of Group Cohesion	3. Open Exchange of Relevant Interpretations
4. Functional Role-Relatedness	4. Emergence of Solutions

Tuckman suggested that the first stage invloves identifying boundaries of interpersonal and task behavior (forming). Next, polarization is exhibited in the form of resistance to group influence and task requirements (storming). The third stage entails the development of in-group feeling, new roles, and group standards (norming), while the fourth phase yields a structure supportive of task achievement (performing).

The categorization schemes of Tuckman and Bales and Strodtbeck are similar in many important respects. Both systems posit an initial orientation phase, which eventually gives way to evaluative responses to task demands, group members, and relevant information. While Bales and Strodtbeck employed one category to depict this evaluative sequence, Tuckman utilized two categories to reflect evaluative responses and the exchange of various interpretations. In the latter stages of phase three and the entirety of phase four, the team achieves interpersonal and task agreement, enabling it to successfully regulate group members' behavior toward task accomplishment. Bales and Strodtbeck's control phase seemingly parallels Tuckman's final stages.

Another typology of group developmental phases has been advanced by Morris and Sashkin (in Kell and Corts, 1980). They generated Phases in Integrated Problem Solving (PIPS) as a prescriptive method of employing sequential task structure in problem-solving situations. PIPS consists of the following six phases:

1.	Problem Definition	- explaining the problem situation; generating information; clarifying and defining the problem.
2.	Problem-Solution Generation	- brainstorming solution alternatives; renewing, revising, elaborating, and recombining solution ideas.
3.	Ideas to Actions	- evaluating alternatives; examining probable effects and comparing them with desired outcomes; revising ideas; developing a list of final action alternatives and selecting one for trial.
4.	Solution Action Planning	- preparing a list of action steps with the names of persons who will be responsible for each step; developing a coordination plan.
5.	Solution-Evaluation Planning	- reviewing desired outcomes and developing measures of effectiveness; creating a monitoring plan for gathering evaluation data as the solution is put into action; developing contingency plans; assigning responsibilities.
6.	Evaluation of the Product and the Process	- assembling evaluation data to determine the effects of actions and the effectiveness of the group's problem-solving.

Morris and Sashkin's classification is similar to the phases of team development previously discussed, in that information is generated, alternatives are evaluated, and a coordinated plan of action is enacted to accomplish the group's task.

TEAM STRUCTURE

According to Davis (1969), team structure is a "picture of the interpersonal processes among the positions taken at a particular point in time" (p. 88). Specifically, team structure incorporates the positions, roles, and interpersonal relationships manifested by the team members. As Cartwright and Zander (1968) noted, "it appears to be almost impossible to describe what happens in groups without using terms that indicate the 'place' of members with respect to one another" (p. 486). Team member roles, which differentiate individuals along task and social dimensions, refer to sets of expected behaviors associated with positions within the team. Bales (in Cartwright and Zander, 1968) identified four kinds of role differentiation within teams:

- the degree to which members have access to resources.
- the amount of control which members possess over other members.
- the degree of importance/prestige maintained by members.
- the extent of solidarity/identification possessed by members.

Further, Hare (1976) indicated that role functions vary in degree of explicitness and in the amount of freedom of choice which team members are permitted. Clearly, an important aspect of team functioning involves the ability to specify and integrate members' roles. As Guetzkow remarked,

> The possibility of an interlocked role system is increased: (a) when the activities comprising the tasks can be assembled into functional positions, (b) when the perception of the role differentiation processes by the members is more explicit, (c) when there is planning of a more specific nature, (d) and when greater intellectual ability is available in the group (in Cartwright and Zander, 1968, p. 525).

As roles involve the arrangement of relationships among team members, early research in group dynamics focused upon these structural links. Bavelas (1950) introduced the notion of internal distances among team members to quantitatively describe various aspects of group structure. For instance, relative centrality refers to the sum of the internal distances from a position to every other position in the team configuration. In this sense, the most central member is the individual possessing the lowest internal distance score. Further, dispersion represents the degree of variation among team members regarding relative centrality and indicates the extent to which a particular team structure, in terms of role functions and communication flow, is centralized or decentralized. The major variable of team structure research, then, is the degree of centrality, which entails asymmetry of communication availability among members. Leavitt's (1951) study supported the notion that a recognized leader will most probably emerge at the position of highest centrality. Also, regardless of the team's structural configuration, morale is generally higher in the more central positions. As Cartwright and Zander noted, "the average satisfaction among the members of a group is related to the average degree of centrality of the positions of the group's network" (1968, pp. 496-497).

Early studies of team structure involved experimental manipulation of communication networks within a laboratory setting. The research method typically imposed various team structures (e.g., circle, wheel, comcon) upon experimental groups. Team members were placed in individual cubicles which were connected by slots to allow written messages. Slots linking members were open or closed, depending upon the experimental condition, and the team task was assigned under conditions requiring communication for successful completion. Various tasks, ranging from simple identification problems to complex sentence construction and discussion problems, were utilized in this research. The findings of these research endeavors are described in the following sections.

Leavitt (1951), employing a symbol-identification task, demonstrated that a centralized team structure was more efficient for problem solution than a decentralized structure. Specifically, the circle network was less efficient than the wheel and Y pattern in terms of time required for problem solution, number of errors, and number of messages. Shaw (1964), however, argued that this pattern pertained only to simple tasks and replicated Leavitt's study, adding a complex task (i.e., arithmetic computations) to the research design. His research indicated that the decentralized team structure was more effective than the centralized structure for complex task situations. In contending that this finding is generalizable to teams comprised of three to five members, Shaw concluded that

> The results of this experiment support the original hypothesis that a communication pattern which places one person in a central position (the wheel) will require more time to solve relatively complex problems, but less time to solve relatively simple problems than will a communication net which places all persons in positions which are equally central (the circle) (1954, p. 215).

Apparently, team structure affects the communication processes which are permitted or necessary to accomplish the task. For simple tasks, the centralized structure is superior because it more easily satisfies the important condition that necessary information is available to the team, with the central person assuming this responsibility. In complex task situations, the decentralized structure, which facilitates gathering and organizing information, delegating responsibility, and error correction processes, is more efficient than a centralized pattern. Here, Shaw attributed the proficiency of the decentralized structure to the possibility of obtaining significant contributions from all team members. Collins and Raven (1969) supported this distinction in that they found the centralized network superior for common symbol problems and the decentralized structure better for mathematical problems. They asserted that the mathematical problems, in which various operations had to be performed and the central figure usually lacked the capability to solve the problem alone, were more complex than the symbol problems. Shaw succinctly summarized these findings in observing that "complexity of the task is a critical factor in determining the relative effectiveness of different communication networks" (1976, p. 143).

An interesting study by Gilchrist, Shaw, and Walker (1954) provided further support for the intervening effects of task complexity. They focused upon saturation, defined as

> The degree to which a communication network is overloaded by the total requirements imposed upon the group by such aspects of group process as communication demands, organizational decisions, and data manipulations (Shaw, 1976, p. 448).

These investigators identified two independent types of saturation: channel and message unit. Channel saturation refers to the number of channels with which a position must deal, while message unit saturation involves the number of messages with which a position must contend. Gilchrist et al. posited that saturation is more likely to occur to members in centralized positions. As such, a team which places large demands on central members may experience a decline in efficiency (and to a lesser extent, a decrease in satisfaction). As Gilchrist et al. reported, "...when the number of required message units passes a certain optimal output level, it begins to counteract the effects of individual centrality" (1954, p. 555). Saturation processes, which are more likely to occur and to influence team output in complex versus simple task situations, were thus advanced as a plausible explanation for the superiority of decentralized team structures over centralized configurations.

Although these studies provide a fairly convincing account of the relative merits of centralized and decentralized team structures, other research has generated conflicting results, necessitating the identification of other intervening variables. In addition to task complexity, organizational processes and leader capabilities mediate the relationship between team structure and performance. Guetzkow and Simon (1955), employing simple symbol-identification problems, reported that groups which organized themselves centrally displayed no differences in performance regardless of the original nature of team structure. Similarly, Guetzkow and Dill (1957) observed that teams which failed to organize themselves required more time for problem solution than better organized groups. Several team investigators have recognized the importance of having an opportunity to become organized in order to optimize performance. For instance, Davis (1969) stated that "the emergence of an operating structure within the imposed communication structure requires both time and opportunity" (p. 104). Further, Burgess (1968) examined organization opportunities within centralized (i.e., wheel) and decentralized (i.e., circle) team structures. Providing an extended time period to four-member teams, he required the solution of 1100 problems. Burgess discovered the exhibition of a substantial transition period in team problem-solving behavior, evidenced by an acceleration in the solution rate after approximately 500 problems. Also, while the networks differed during the transition period, such that the centralized structure produced better task performance initially, there was a decreasing order of difference in solution rates between the networks over time. In other terms,the learning exponent was larger in the decentralized structure, where organizational problems were more complex and a productivity loss occurred during the start-up period; however, regardless of the initial team configuration, a steady state was eventually exhibited in both structures.

Leader capabilities also influence the relationship between team structure and productivity. As previously discussed, the most central member assumes a critical role within the team. Meister (1976) aptly noted that a hierarchical team structure permits this central individual to coordinate and organize the team to perform efficiently. In fact, many studies (e.g., Bavelas, 1950; Leavitt, 1951; Shaw and Rothchild, 1956; Hirota, 1953) have indicated that leadership emergence by members in more central positions is more likely to occur as centralization increases. Here, members in relatively central positions make more decisions, send more messages, solve more problems and demonstrate more leadership behavior than individuals in peripheral team positions (Davis, 1969). If, however, the central member does not perform his job or fails to assume authority, the hierarchical structure is rendered ineffectual.

To this point, the discussion of structural centralization has only focused asserted, though, teams can be centralized in many respects, including communication, power/responsibility, and decision-making. Mulder (1960) distinguished between the topological structure, which entails formally designated communication links, and the team's decision structure, which refers to "who makes decisions for whom" (p. 2). He maintained that while the topological structure is constant over time, the decision structure develops in an independent manner. Mulder reasoned that

> with regard to the seemingly controversial results for "simple" and "complex" problems, it does <u>not</u> seem correct to state that "the wheel allows for better performance with simple problems, the circle with complex ones", but that the more centralized decision structures, which developed in Leavitt's groups solving 15 problems, enabled a better performance. Furthermore, the <u>gradual</u> differences between simple and complex problems has the <u>effect,</u> simply, that the development of the more centralized decision structure takes more time (i.e., problems) with the complex problems than with the simple ones (1960, p. 4).

Thus, he hypothesized that the more centralized decision structure would perform better because contributions of members could be more easily integrated by the central individual. Mulder required 13 four-person teams to solve five of Shaw's complex problems in centralized or decentralized topological structures to test his contention. He computed a Decision-Centrality Index (DCI) for each team member and obtained dependent measures of time, quality, and efficiency regarding problem solutions. Mulder obtained a significant interaction between team structure and problem sequence for time, such that the circle groups performed better initially, but the wheel groups caught up by the third problem and far surpassed the circle groups in the fourth and fifth team tasks. Mulder observed that "from these findings, it may be concluded that the decision structure is the primary determinant of the speed of performance" (1960, p. 10). In terms of quality of problem solutions, the circle groups made a consistent number of errors across the trials, while the wheel groups exhibited a significant decrease in errors from the first to the last problem. Treating the number of message units as a measure of team efficiency, Mulder found that the wheel groups were always superior to the circle groups, with this difference becoming more pronounced across problems. Additionally, for high versus low DCI wheel groups, the central member sent out and received fewer messages, prompting Mulder to assert that "the saturation hypothesis must be rejected" (1960, p. 11). Thus, he provided strong evidence that the decision structure is independent of topological structure and exerts strong influence on team performance.

Cohen (1968) also emphasized the importance of the decision structure as a determinant of team productivity. Focusing upon the congruence of the decision and topological structures, he contended that

> when the relative elimination power of group members is counterbalanced by their capability directly to affect the output of the group, the productivity of the group is lower than when these two dimensions concur in producing a clear-cut hierarchy among the group members. Those groups in which the 'top' member's power was enhanced by 'expertness' in foreseeing the consequences of his decisions for the group, were far superior in productivity (1968, pp. 312-313).

Further, he offered suggestions regarding achieving congruence between these structures to improve team performance. Specifically, Cohen asserted that

> when an organizational situation is such that the 'bottom' has a strong influence on the decisions regarding the direction in which the group is to move, the lower echelons should be allowed to communicate freely throughout the organization. More generally, the center of weight should have an easy communicative access and should be easily accessible to all parts of the organization (1968, p. 314).

Having examined the research concerning team structure, its relationship to team performance can be more explicitly discussed. For instance, in observing simulated Naval CIC teams, Tuckman (1967) reported that "groups having a tendency to structure will do better on tasks that require such structuring than groups who do not have a tendency to structure" (p. 38). He also noted that team structure assumes an even more important role when a division of labor is required to successfully complete the task. Further, Roby and Forgays (1956), varying the degree to which key group members had access to necessary information, discovered that team performance was heightened by the appropriate matchup between relevant information and team positions. Several other researchers have emphasized the need for congruence between team structure and task demands. Winsted (1978) posited, for example, that to be effective, a team must have "a particular type of team structure...that is appropriate to the task" (pp. 29-30). Similarly, Knerr, Berger and Popelka (1980) stated that "if teams alter patterns of interaction to adapt to the task at hand, and if they select a structure congruent with the task, then the team output is hypothesized to be higher than if they fail to adopt the congruent structure" (p. IV-13).

In applying the group structure literature to Naval teams, it is necessary to consider the nature of these teams. As Davis (1969) indicated, team structure in military organizations is formal and imposed. Upon entering the team, the new member is confronted with an existing organization of persons whose communication behavior is largely governed by pre-established regulations. Further, Glanzer (1962) observed that military teams are typically highly centralized, although not always in a communicative or interactive sense. For example, a team supervisor might only take action upon the commission of an error. Here, team member centralization is predicated on power/responsibility rather than actual communication patterns. Finally, Jacobsen (1979) described the configuration of Naval teams by noting that "as a basic function of command and control, communications aboard ship are centralized in key control spaces, including the bridge, CIC, and damage-control center" (p. 43). In analyzing the structure of Naval teams, then, attention must be devoted to member roles, interaction structures, power/responsibility allocations, and the locus of decision-making processes.

LEADERSHIP

The final important factor in group functioning involves leadership. According to Carter (1953), the team leader has been variously conceived as the major focus of team behavior, most capable of directing the team toward its goals, most frequently named through sociometric choice by team members, most able to exert demonstrable influence on group syntality (also, Cattell, 1951), and engaging in the most leadership behaviors. Schutz (1961) contended that the team leader is ideally the person possessing the best conception of the group's purpose, specific problem solving skills, concern for intermember solidarity, and power of social control. The predominant approach to studying the effects of leadership on team performance entails the differential examination of various leadership styles.

The classical research endeavors on leadership style (i.e., Lewin, Lippitt, and White, 1939; White and Lippitt, 1960) have focused upon autocratic, democratic, and laissez-faire situations. The results of these studies are summarized in the following manner:

1. Democratic leadership yields more and better productivity than laissez-faire leadership.
2. Autocratic leadership yields better short-term productivity, while democratic leadership obtains better long-term productivity, with consistently better quality of output in democratic leadership groups.
3. Less absenteeism and fewer dropouts exist under democratic leadership.
4. The absence of the leader does not affect democratic leadership groups, but causes autocratic leadership groups to fall apart.
5. Members are more satisfied in democratic versus laissez-faire leadership groups, and usually are more satisfied in democratic versus autocratic leadership groups.
6. The greatest amount of hostility and aggression or apathy occurs in autocratic leadership groups.

Another approach to studying the relationship between leadership style and performance involves contingency theory. According to Fiedler (1964, 1967), leadership effectiveness is a function of the interaction of situational and personal variables in a particular team situation. Specifically, he focused upon the leader's position power, the nature of leader-member relations, and task structure as three critical intervening variables. Performing extensive correlational research, Fiedler reported that directive (authoritarian) leadership is more effective when the task situation, along these three dimensions, is either very favorable or very unfavorable to the leader. Non-directive (participatory) leadership produces better team performance when the task situation is moderate along these dimensions. Other studies have identified and explored specific contingency variables in generating predictions linking leadership style to team performance. For example, Shaw and Blum (1966) noted that directive leadership is more effective for low solution multiplicity situations, whereas non-directive leadership is better suited to tasks entailing high solution multiplicity. Similarly, Ratzell et al. (in Hare, 1976) found that autocratic leadership yields better performance for simple tasks, while Dyson et al. (in Hare, 1976) demonstrated the superiority of autocratic leadership under conditions of high stress. Shaw (1955) reported that members in authoritarian leadership groups made fewer errors, needed fewer messages for problem solution, and used less time, but were less satisfied than members in democratic leadership groups. Morse and Reimer (1956) obtained similar results in a field setting, while Preston and Heintz (1949) found that members were more satisfied and liked the task more in participatory versus supervisory leadership groups. Thus, it appears that the most effective leadership style depends upon situational variables and often requires making a choice between maximizing productivity or member satisfaction. These output variables are not mutually exclusive, however, as a leader can achieve a balance along these dimensions. Blake et al. (1962) acknowledged the dual operation of task-related and maintenance (socio-emotional) factors in assessing managers along continua of both output dimensions. They provided illustrations of leader/manager profiles with their "managerial grid" to depict these two important variables. Further, Gallagher and Burke (in Hare, 1976) contended that groups require task-oriented and socio-emotional leadership to avert scapegoating and other dysfunctional interpersonal processes which may degrade performance. In fact, when the designated task leader does not adequately deal with maintenance functions, this role is frequently assumed, in an informal manner, by another team member.

An example of research which examined military leadership behavior was performed by Blades (1974). Stating that many organizational theorists (e.g., McGregor, 1960; Likert, 1961; Argyris, 1964) have asserted that participative leadership/management will improve team performance, he studied the relationship of leadership behavior to member intelligence as it impacts upon team productivity. Blades contended that a participative leader possesses the following characteristics: concern for team members' attitudes and feelings; ability to create a non-threatening environment; and, based upon ascertaining their abilities, the capacity to utilize members in planning and executing the team task. As such, he stated that "this suggests that we should find a correlation between member intelligence and group performance in those cases in which leaders are concerned with interpersonal relationships" (1974, p. 200). Blades studied Army personnel operating company mess halls and the findings supported his expectations. Blades (1974) concluded that "it is apparent from these results that the utilization of group member intelligence requires participative, non-directive management" (1974, p. 201). For less intelligent members, participation and initiative, as permitted by non-directive leaders, degraded team performance. Thus, leadership style and member characteristics exert an interactive effect upon team productivity.

Another military leadership study focused upon team decision-making processes. Ziller (1957) examined 45 aircrews in a survival/rescue situation under four types of leader influence: authoritarian (most influence); leader suggestion; census; and chairman (least impact). Ziller hypothesized that "group members respond more positively to the decision and the decision-making processes under conditions of 'self-determination'; that is, under the group-centered rather than the leader-centered techniques" (1957, p. 384). He discovered that in a conflict situation involving risk, the group discussion versus authoritarian approach tends to prompt greater understanding of the alternatives and their consequences. Also, member satisfaction with the decision-making method was significantly less in the authoritarian than the other conditions. Finally, although not statistically significant, Ziller suggested that "as the focus of the decision-making process shifts from the leader to the group - that is, moves from the authoritarian to the chairman technique - group members perceive greater problem difficulty" (1957, pp. 386-387). Ziller noted, though, that as military leaders occupy positions of power and are extremely likely to influence team performance, some of his experimental conditions, and therefore some of his comparisons, are not generalizable to most military teams.

The Navy recognizes the vital role which leadership plays in effective team functioning and has published many documents concerning this dimension. For instance, Winsted (1978) observed that "since the leader usually influences and is held strictly accountable for the team's behavior in the Navy it would be useful to study what behaviors in which situations could maximize group output through leadership styles and skills" (p. 19). In fact, behavioral prescriptions for Naval leaders have been explicitly incorporated into Navy doctrine. An examination of these writings will facilitate an integration of the theoretical literature pertaining to leadership behavior and the composition of actual Navy teams.

The Navy has devoted considerable attention to task and socio-emotional aspects of leadership behavior. Various Naval documents extensively address important aspects of task-oriented leadership. For instance, Article 0704 (Naval Regulations, 1948) states that a Navy leader must maintain his command in a state of maximum effectiveness for war service, report any deficiency which appreciably lessens the effectiveness of the command, and identify any excess or shortage of authorized allowances. As Sundt noted, "Naval leadership is appointive, institutional, and authoritarian" (1979, p. 39). He stated that authoritarian leadership does not imply that subordinates should not present alternative viewpoints or constructive feedback to their superiors; rather, it only suggests that after a decision has been made and an order has been issued, the subordinates must carry it out expeditiously and without further question. Additionally, Sundt observed that authoritarian leadership can be autocratic (i.e., leader-centered) or democratic (i.e., participatory). Comparatively, democratic leadership is time-consuming, two-way, and requires human relations skills in dealing with people. As such, Sundt contended that it is more conducive to achieving long-term objectives and is usually preferable in Naval settings. In contrast, Wolfe et al. (1959) identified certain conditions in which autocratic leadership is essential for proper military functioning. They asserted that

> In military matters, time is "of the essence". In battle, a few minutes or even a few seconds may make the difference between success and failure, victory and defeat. Because of the fantastic speeds attained by missiles and aircraft, even thousandths of a second may be decisive. A military organization, therefore, whether we like it or not, must be authoritarian (pp. 8-9).

Like Sundt, Wolfe et al. indicated that authoritarian leadership does not imply a brutal, callous, oppressive, or indifferent attitude toward the well-being of the team members. They succinctly captured this distinction in positing that the superior "must exercise leaderhsip that is authoritative in nature, yet still must do it in a democratic sort of way" (1959, p. 9).

Klemp, Munger and Spencer (1977) acknowledged that the amount of technical training alone is not sufficient to insure superior performance by military leaders. In addition to task achievement, skillful use of influence, and management control, they argued that a military leader must also provide advising and counseling. This concern for team members is even more specifically exhibited in Naval documents. For example, Article 0709 states that the commanding officer must promote morale, maintain health and physical fitness of the members, give recognition for noteworthy performance in a timely manner, provide an opportunity for personnel under his command to make requests and reports, and insure timely advancement in rating enlisted personnel. The concern for the welfare of personnel is also manifested in the Naval Junior Reserve Officers Training Corps Manual, which asserts that leaders should take an interest in their personnel, be responsive, and provide inspiration and motivation (NAVEDTRA 37075, 1976). Similarly, Naval Orientation indicates that "the officer must be personally concerned with their welfare; must know each individual - their background, capabilities, and limitations" (NAVEDTRA 16138-6, 1977, p. 194).

In addition to providing task and socio-emotional leadership, the Navy acknowledges the importance of leaders serving as role models for subordinates. Sundt maintained that "as leaders, naval officers and leading petty officers are the examples to whom their juniors look for guidance, inspiration, and a high standard of conduct" (1979, p. 39). General Order No. 21, issued by the Secretary of the Navy, formulates this role function in the following manner: in practicing their everyday routine and enacting effective organization and administration, leaders should pay particular attention to moral responsibility, personal example of behavior and performance, and established standards for personal development (in NAVEDTRA 37075, 1976, pp. C4-C5).

In analyzing Naval teams, various aspects of leadership can be examined. Identification of the team leader(s), understanding of his leadership style, appreciation of the nature of his relationships with other team members, and the influence of situational variables upon appropriate leadership behavior are important concerns. This analysis must consider the context in which these leaders operate. As Winsted (1978) noted, "Naval leadership and policies are highly structured and the tasks clearly defined. Leadership styles must fit into a Navy framework in order for team training to be effective" (p. 22).

SUMMARY

This chapter has provided a comprehensive examination of key components of a systems model regarding team performance. Input and communication process factors have been linked to team output, individually and interactively. At this point, the taxonomic model of variables which clearly distinguish between diverse Naval teams and significantly influence team performance can be introduced (Figure II-2). The major components of the taxonomy parallel the team factors considered in this chapter. Further, based upon the literature review and analysis, key subelements are identified and interactions of the components are depicted in a general manner. Having established the classification system, a detailed discussion of measurement procedures concerning the taxonomic dimensions is warranted. Also, an examination of data sources utilized to catalog Naval teams (e.g., Ship Manning Documents, interviews with Naval instructional personnel, team observations) is provided.

NAVAL TEAM TAXONOMIC MODEL

I N T E R D E P E N D E N C E

INTERACTIONS OF RELEVANT TEAM DIMENSIONS

	INPUT				PROCESS	OUTPUT
COMPONENTS	MEMBERS TO COORDINATE	NATURE OF TASK DEMANDS	TEAM STRUCTURE	LEADERSHIP	COMMUNICATION PATTERNS	TASK PERFORMANCE
SUB-ELEMENTS	TEAM SIZE (BY READINESS CONDITION)	TASK TYPE	SEQUENTIAL-PARALLEL STRUCTURE	LEADER IDENTIFICATION	INTERACTION PROCESSES	
	MEMBER EXPERIENCE LEVELS	TASK CONTENT	NONINTERACTIVE-INTERACTIVE (DIRECT, AUDIO, MACHINE INTERFACE)	LEADERSHIP STYLE	TASK-SOCIAL COMMUNICATION	
	MEMBER PROFICIENCY LEVELS	TASK EMERGENCE	DECISION-MAKING STRUCTURE	LEADER-MEMBER RELATIONS	TEAM COHESIVENESS	
	MEMBER CRITICALITY	TASK DIFFICULTY	INFORMAL STRUCTURE			
	MEMBER MOTIVATION LEVELS	MACHINE INTERFACE				
	MEMBER PERSONALITY ATTRIBUTES					

Figure II-2.

CHAPTER III

METHODOLOGY

The second chapter examined relevant theoretical and technical documents to identify important dimensions of Navy teams. From this literature review, a taxonomic model delineating major team components and their sub-elements was presented. As such, this section addresses the development of appropriate measures for the Navy team dimensions. First, criteria for the generation of the taxonomic measures are explored. After establishing these parameters, a discussion of data sources which were utilized to garner information regarding the catalogued teams is provided. Also, the representative sample of Navy teams which was employed to determine the efficacy and usefulness of the taxonomic measures is examined. Finally, operational definitions of the team dimensions and the taxonomic measures themselves are offered as a prelude to the cataloguing effort.

Criteria for the Measurement of Navy Team Dimensions

It is clearly important that the taxonomic measures correspond closely with the overall research objectives. As the team dimensions must be sufficiently general to be applicable to a sample of highly diverse Navy teams, the taxonomic measures must also satisfy this requirement. Also, these measures should permit critical variations between different teams and within the same team type across different ships to emerge. Further, the taxonomic measures should thoroughly capture aspects of Navy teams which are demonstrably related to the performance of these teams. A significant constraint on the achievement of these objectives involves the inaccessibility of specific teams in operational settings. Thus, a distinction between exogenous and endogenous team dimensions is warranted. Exogenous dimensions characterize teams without regard for the individual attributes and behaviors of the actual team members, while endogenous dimensions entail team-specific features. Although these latter factors are important descriptors of Navy teams, their measurement will be severely limited for a variety of reasons. First, they represent unique variance within teams, thus requiring detailed observation of ongoing team communications and performance. Also, this individual team variance limits the generalizability of results because extrapolations from observed teams to other similar teams involves considerable measurement error. Hence, this research will focus almost exclusively on exogenous team dimensions. Figure III-1 depicts the taxonomic model and distinguishes between exogenous and endogenous dimensions.

Data Sources and Sampling

The ship classes included in the sample are shown in Table III-1. These ships were chosen to provide a diversity of sizes, missions capabilities and systems within the sample. Also, we sought to select ships which are representative of the population of ships outside the sample. The DD 963 is an illustration of this approach. The DD 963 propulsion system is unique within the sample yet common to 50 ships outside the sample.

A variety of data sources was used to obtain the ratings for the measures of the taxonomy. Documentary sources included the battle organization documents of the ships in the sample (Ship Manning Documents), individual and team training course materials, system and equipment operation and maintenance publications, ship and system design studies, research studies, tactical doctrine publications, and Navy regulations and instructions. Other sources of information included subject matter experts within the Litton organization and at Navy team training sites, and direct observations of teams in training situations.

NAVAL TEAM TAXONOMIC MODEL

I N T E R D E P E N D E N C E

INTERACTIONS OF RELEVANT TEAM DIMENSIONS

	INPUT				PROCESS	OUTPUT
COMPONENTS	MEMBERS TO COORDINATE	NATURE OF TASK DEMANDS	TEAM STRUCTURE	LEADERSHIP	COMMUNICATION PATTERNS	TASK PERFORMANCE
SUB-ELEMENTS	TEAM SIZE (BY READINESS CONDITION)	TASK TYPE	SEQUENTIAL-PARALLEL STRUCTURE	LEADER IDENTIFICATION	INTERACTION PROCESSES	
	MEMBER EXPERIENCE LEVELS	TASK CONTENT	NONINTERACTIVE-INTERACTIVE (DIRECT, AUDIO, MACHINE INTERFACE)	*LEADERSHIP STYLE	*TASK-SOCIAL COMMUNICATION	
	MEMBER PROFICIENCY LEVELS	TASK EMERGENCE	DECISION-MAKING STRUCTURE	*LEADER-MEMBER RELATIONS	*TEAM COHESIVENESS	
	MEMBER CRITICALITY	TASK DIFFICULTY	*INFORMAL STRUCTURE			
	*MEMBER MOTIVATION LEVELS	MACHINE INTERFACE				
	*MEMBER PERSONALITY ATTRIBUTES					

* = ENDOGENOUS TEAM DIMENSIONS

Figure III-1.

Table III-1. SHIP CLASSES

CVN 68
CV 67
CG 26
CG 16
DD 963
DDG 37
DDG 2
DD 950
FFG 7
FF 1052
FFG 1
LCC 19
LHA 1
LPH 2
LST 1179
AOE 1

The Taxonomic Measures

The previous sections have discussed the taxonomic dimensions, criteria for measuring these team variables, the sample of Navy teams which will be studied, and the data sources for cataloguing these teams. Prior to the classification effort regarding surface Navy teams, it is necessary to generate operational procedures for measuring the theoretical taxonomic dimensions. The remainder of this chapter is devoted to accomplishing this task, with the classification form being presented at the conclusion of this discussion.

Teams

As team researchers acknowledge that Navy teams can be delineated at varying levels of specificity, a hierarchical scheme is advanced to permit alternative analyses of these teams. The three hierarchical levels included in this framework are the individual teams, functional areas, and the entire ship.

Entire Ship

The broadest hierarchical level for construing Navy teams involves the entire ship. Here, the seven functional areas are joined and a comprehensive picture of the whole ship is provided. Operationally, the ship type is identified to permit an analysis of taxonomic variations across ships. Each catalog sheet will identify all three levels of Navy teams, allowing investigators to study these teams at the chosen analytic level.

Functional Areas

At the next hierarchical level, individual teams are linked by common membership in a functional area. These functional areas subsume major shipboard activities, and include the following seven categories:

1. Combat Information - concerned with analyzing and making decisions regarding tactical data.

2. Communications - concerned with following standardized procedures for sending and receiving information.

3. Damage Control - concerned with maintaining the physical safety of the ship.

4. Engineering - concerned with operating and maintaining main propulsion equipment.

5. Seamanship - concerned with controlling the movement of the ship (including handling of deck operations).

6. Support - concerned with performing functions that contribute to the maintenance and sustenance of other teams.

7. Weapons - concerned with operating and maintaining the ship's weapon systems.

<u>Individual Teams</u>

This level of analysis entails the smallest meaningful unit of interdependent individuals within a Navy setting. Operationally, the team is designated by its primary function with the realization that it is part of the larger shipboard organization. The individual teams are identified by functional area in Table III-2.

Table III-2.

Combat Information

Electronic Warfare
Air Intercept Control
Underwater Battery
Surface/Subsurface Plot
Detection and Tracking

Weapons

Missile Launcher (various)
Gun Control
Ammunition Handling
BPD/NSS Missile System
Missile Control
Gun Crew (various)

Support

Helicopter Operations
Food Service
Stock Control
Tank Deck (various)
Debark
Bow Ramp
Meteorology
Aircraft Handling
Aircraft Arming

Damage Control

Helicopter Firefighting
Casualty Control
Repair Party
Damage Control Central
Secondary Damage Control Central
Main Propulsion Repair
Crash and Salvage

Engineering

Engine Room
Engineering Central Control
Fire Room
Emergency Gas Turbine
Auxiliary Diesel

Table III-2. (continued)

Communications

Secure Radio
Technical Control
Radio Central
Visual Signals

Seamanship

Bridge/Conning
Navigation
Boat Launch/Recovery
Boat Crew (various)
Anchor Detail

Team Tasks

The taxonomic model acknowledges the important role which task characteristics assume in determining team performance. Within this research, the following task dimensions are considered: content, type, emergence, difficulty, and equipment automation. Within this section, other unique task characteristics and a statement of the criteria for assessing a team's task performance are also considered.

Task Content

As the tasks performed by Navy teams included in the sample are extremely diverse, it was determined that a general, yet sufficiently detailed, task content taxonomy was beyond the scope of this research effort. Instead, it was decided that the best descriptor of task content for each Navy team is a concise statement of its primary mission. Thus, the team's task performance criterion is provided as a succinct description of the basis upon which the team's task performance would be evaluated.

It should be noted that the identifying data contained in the Navy team catalog (e.g., ship class and number, team name, and team member title, which is also known as watchstation title), is specific enough to allow researchers to gather task content data from sources such as team training courses. For many teams, individual job descriptions which give general information about both individual and team tasks can be obtained by looking up the team member NECs and NOBCs in the appropriate manual. For NECs, this manual is *Navy Enlisted Manpower and Personnel Classifications and Occupational Standards* (NAVPERS 18068D), while the appropriate manual for NOBCs is the *Manual of Navy Officer Manpower and Personnel Classifications* (NAVPERS 15839D).

Task Type

As discussed earlier, Steiner (1966,1972) cogently argued that team tasks differ in the extent to which they premit members to combine their individual capabilities. Further, Steiner distinguished between six basic task types: disjunctive (i.e., at least one member possesses the skill, with team performance determined by the most proficient member); conjunctive (i.e., each member must perform the task, with the least skilled member determining team performance); additive (i.e., a summation of individual products represents team performance); compensatory (i.e., the mean of independent products reflects team performance, as members can compensate for each other); complementary (i.e., a division of labor, in which team performance is determined by proper functioning within specialized roles); and discretionary (i.e., members can combine their contributions as they choose to determine team performance). Hence, the task type is identified for each Navy team in the sample. Further, as these team types are theoretically pure but not totally clear within a Naval context, it is necessary to indicate the degree to which a team's task is primarily characterized by one of these task types.

Task Emergence

According to Boguslaw and Porter (1962), task emergence reflects the extent to which a team's task situation is specifiable and predictable. As task emergence increases, the ability to specify and predict action relevant system states and environmental conditions decreases. Within Naval settings, various situational features can influence the extent to which a team's task is emergent or established. These situational aspects include environmental conditions (e.g., weather states), team battle casualties (or any other cause of manpower reductions), equipment failure, and stimulus variability. Thus, the degree to which these factors reflect a emergent task situation for each team will be assessed using separate, though identical, scales.

Task Difficulty

As Shaw (1973) indicated, task difficulty is a consistent determinant of team performance. Alden and Daniels (1975) maintained that task difficulty entails high stimulus uncertainty, cognitive information processing demands, and response complexity. For each Navy team, the task performance criterion will be identified and then assessed in terms of its difficulty level (relative to other teams of the same type).

Equipment Automation

As teams vary in the equipment they operate, the man-machine interface is an important concern. A major aspect of the equipment involved in mission accomplishment is its degree of automation. Equipment automation can impact upon information processing demands, communication processes, and other team features. As such, the extent to which the primary equipment operated by each team is automated is assessed.

Team Members

The composition of specific teams examined in this study derives from the watchstation listings in their respective Ship Manning Documents (SMDs). The SMDs were determined to be the only complete and readily available sources of such information. These documents list operational manning for readiness conditions I (battle) and III (wartime cruising), as well as special circumstances (e.g., amphibious ships set a special readiness condition for amphibious operations). Hence, team composition is identified for conditions I and III for most surface Navy teams in the sample. For the remaining teams, the appropriate special readiness condition is described.

The data listed in the catalog for each team member include: title, pay grade, suggested designator and NOBC for officers, suggested rating and NEC for enlisteds, and a criticality assessment. When no designator/rate or NOBC/NEC information is provided, this is because no data is given in the SMD. Ratings, NOBCs and NECs are associated with specific training courses or schools and thus indicate a requirement that those designated team members possess a specific set of skills. Additionally, certain team members must be qualified in accordance with various Navy instructions and regulations. The appropriate Personnel Qualifications Standards (PQS) for certain positions provide a task-oriented description of the requirements for qualification (see CNET notice 3500, 1978). Hence, some reasonable inferences concerning each team member's skill and experience levels can be made from these team member descriptors.

Team member criticality, which involves the extent to which the team is able to function in the absence of that particular member, is rated by assigning each member to one of five criticality categories. Table III-3 explains these categories, which are nominally-scaled. Finally, team size simply involves computing the number of members by readiness condition.

Team Interaction Processes

While the scope of this research does not permit extensive field observations of the communication behavior of various Navy teams, the importance of this team dimension cannot be ignored. Although actual interaction behaviors are not sufficiently attainable, it is possible to assess the extent to which different communication activities are necessary for successful task completion across Navy teams. Therefore, using Nieva et al.'s (1978) interaction process categories of orientation (i.e., information exchange), organization (i.e., coordination behavior), and adaptation (i.e., cooperation and mutual adjustment), measures

Table III-3. MEMBER CRITICALITY

Loss of member would:

1. Completely inhibit normal team functioning (i.e., remove qualities that are essential and that other members cannot replace).

2. Partially inhibit normal team functioning (i.e., remove essential qualities that the team can replace partially, or completely only with great difficulty).

3. Completely inhibit team functioning only in emergency/special circumstances (i.e., remove essential qualities that are redundant or not germane to normal team operations).

4. Partially inhibit team functioning only in emergency/special circumstances.

5. Not inhibit team operation (i.e., remove qualities that can be replaced with little or no difficulty).

concerning the relative importance of each communication category have been created and will be applied to the sample of Navy teams.

Team Structure

The formally designated team structure, which can be gleaned from the training and technical materials, reflects various aspects of Navy team performance. As team structure determines the decision-making focus, it is possible to identify which team member(s) is responsible for generating and implementing decisions. Also, the degree to which a team's communication structure permits interactions among members is an important consideration. As such, an assessment of whether this structure is *serial* or *parallel* will be made Also, an indication of whether these communication links entail direct (i.e., face-to-face), audio, and/or machine interface among members is provided.

Team Leadership

The one exogenous dimension of team leadership involves the formal designation of which member(s) assumes a leadership role within the team. Therefore, the team leader(s) is identified for the sample of Navy teams.

Summary

The set of measures for the exogenous team dimensions is presented in Figure III-2. This catalog sheet provides pertinent information regarding the teams and depicts the scales employed in the classification effort. It can be noted that for all continuous variables, seven-point scales are utilized. It is expected that employment of these scales permits the identification of meaningful variations across team dimensions in a broadly applicable manner. Having generated operational procedures for assessing the exogenous taxonomic dimensions, the following chapter contains the results of the cataloguing effort.

I. IDENTIFYING DATA

A. SHIP TYPE ______________________________

B. FUNCTIONAL AREA/TEAM TYPE ______________________________

C. TEAM NAME ______________________________

II. TEAM MEMBERS (NEC/PAY GRADE)

	READINESS CONDITION				
	I	III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
21.					
22.					
23.					
24.					
25.					
	N=____	N=____			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION ______________________________

____

____

B. TASK TYPE ______________ VERY MUCH 1 2 3 4 5 6 7 VERY LITTLE

Figure III-2

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS		___	___	___	___	___	___	___	
2. BATTLE CASUALTIES TO THE TEAM		___	___	___	___	___	___	___	
3. STIMULUS VARIABILITY		___	___	___	___	___	___	___	
4. EQUIPMENT FAILURE		___	___	___	___	___	___	___	

D. TASK DIFFICULTY	EASY	1	2	3	4	5	6	7	DIFFICULT
E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED	1	2	3	4	5	6	7	NON-AUTOMATED

F. OTHER CHARACTERISTICS ____

____

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

A. ORIENTATION	NECESSARY	1	2	3	4	5	6	7	UNNECESSARY
B. ORGANIZATION	NECESSARY	1	2	3	4	5	6	7	UNNECESSARY
C. ADAPTATION	NECESSARY	1	2	3	4	5	6	7	UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS ____

____

B. STRUCTURAL ARRANGEMENT ____

____

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) ____

Figure III-2 (continued)

CHAPTER IV

RESULTS

This chapter presents the information accumulated during the cataloguing effort. Each team is categorized along the following dimensions: identifying team and ship data, team member characteristics, team task variables, interaction processes, team structure dimensions, and team leadership functions. As the sample is quite large, most of the catalogued teams are included in Appendices A-G. This section illustrates the nature of the cataloguing effort by thoroughly depicting one team from each of the seven functional areas. Specifically, the completed catalog sheets and accompanying text are provided to explicate the measurement process and describe the sampled teams.

Seamanship

The bridge team is the controlling group for the entire seamanship area and is responsible for directing, coordinating and monitoring the actions of whatever other seamanship teams may be in action at a given time (e.g., anchor detail, boat crew, etc.). Additionally, the team operates in close coordination with the CIC and engineering main control to safely and effectively maneuver the ship. Figure IV-1 shows the bridge team of the Reeves, a Leahy class guided missile cruiser. The team composition is typical of frigate/destroyer/cruiser type ships. As the figure indicates, the overall levels of experience (as indicated by member paygrade) are relatively low. Indeed, although an officer is specified for the Officer of the Deck (O.O.D.) position, senior enlisteds often qualify for and stand this watch. There is a definite skill hierarchy within the team. Inexperienced personnel are assigned low responsibility positions such as messenger or after lookout. Through training and on the job experience, personnel qualify to perform the more demanding jobs, progressing from lee helmsman/engine order telegraph operator to helmsman to Boatswain's mate of the watch to Quartermaster of the Watch.

As noted in the figure, team size increases by six personnel in readiness condition I. This increase primarily reflects the increase in external communications capability necessary to coordinate ship operations during battle conditions. The criticality ratings reflect the skill/experience hierarchy mentioned above. The most experienced personnel are the most vital to the team.

The team's tasks are primarily concerned with maneuvering the ship in accordance with international rules of the road, tactical necessity, and sound judgement. Also, this team is responsible for ensuring the safe and proper conduct of deck operations such as anchoring and mooring, underway replenishment, boat and helicopter launch and recovery, weapons firing, and external maintenance evolutions. To conduct its operations, the team uses various equipment, including indicators, displays and readouts showing navigational and engineering data, sound powered telephones, radios and voice tubes, radar repeaters, and the helm and engine order telegraph for transmitting orders to the rudders and engines respectively. The equipment is typical of that aboard fleet warships and is neither the most automated nor the simplest in use. Division of labor tends to make the team tasks complementary; however the qualification procedure mentioned above tends to mitigate this effect by providing cross-training. Cross-training, proficiency qualification, equipment redundancy, availability of supporting maneuvering information from CIC, and decades of study and refinement all tend to offset the naturally emergent nature of controlling something as large and complex as a modern cruiser in a variable and often hostile environment. Overall task difficulty for the bridge team depends, in general, on the extent to which the ship is involved in operations which traditionally place high demands on the team. Factors considered in assigning task difficulty ratings for bridge teams were: the extent to which the ship is involved in anti-surface operations, anti-submarine operations, flight operations, underway replenishment, and amphibious operations such as beaching, flooding and landing craft launching.

The degree of training and inherent division of labor in the team tend to decrease the necessity for organizational communication. However, since the team must often perform several tasks simultaneously (frequently, in response to external stimuli), orientation and adaptation processes become important.

The Officer of the Deck is responsible for the bulk of the decision making for the team; however, critical decisions are made in consultation with the Commanding Officer, CIC Watch Officer and Engineering Officer of the Watch. The Boatswain's Mate of the Watch and the Quartermaster of the Watch are responsible for the general supervision of the team.

I. IDENTIFYING DATA

A. SHIP TYPE CG-16 (CG-24)

B. FUNCTIONAL AREA/TEAM TYPE Seamanship

C. TEAM NAME Bridge

II. TEAM MEMBERS (NEC/PAY GRADE)

	TEAM MEMBERS	READINESS CONDITION I	READINESS CONDITION III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Officer of the Deck	0	0			2
2.	Junior Officer of the Watch	0	0			5
3.	Quartermaster of the Watch	E-4	E-3	QM		2
4.	Helmsman	E-4	E-3	QM		5
5.	Aft Helmsman	E-4	E-3	QM		4
6.	Engine Order Telegraph Operator	E-3	E-3	SN		5
7.	Boatswain's Mate of the Watch	E-4	E-4	BM		2
8.	Messenger	E-3	E-3	SN		5
9.	Lookout Recorder	E-3	E-3	SN		5
10.	Lookouts	E-3(3)	E-3(3)	SN		5
11.	Mechanical Repair	E-4		MM		4
12.	Electrical Repair	E-3		EM		4
13.	Communications Net Talker	E-3		SN		5
14.	Plotter	E-4				5
15.	Sonar Information Records	E-3		SN		5
16.	Captain's Net Talker	E-5				5
17.						
18.						
19.						
20.						
21.						
22.						
		N= 18	N= 12			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION Safety, smoothness of ship movement and deck operations; ability to coordinate other teams to this end.

B. TASK TYPE Complementary

VERY MUCH ___ 1 ___ 2 X 3 ___ 4 ___ 5 ___ 6 ___ 7 VERY LITTLE

Figure IV-1

AD-A105 400 LITTON MELLONICS SYSTEMS DEVELOPMENT DIV ARLINGTON VA F/G 5/9
A CLASSIFICATION SYSTEM FOR NAVY TEAMS. VOLUME I. TECHNICAL REP--ETC(U)
SEP 81 L NADLER, L BERGER N00014-80-C-0781

UNCLASSIFIED NL

2 of 2
AD A105400

END
DATE FILMED
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DTIC

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS					X				
2. BATTLE CASUALTIES TO THE TEAM					X				
3. STIMULUS VARIABILITY				X					
4. EQUIPMENT FAILURE				X					

		1	2	3	4	5	6	7	
D. TASK DIFFICULTY	EASY					X			DIFFICULT
E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED				X				NON-AUTOMATED

F. OTHER CHARACTERISTICS ______________________________

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY		X						UNNECESSARY
B. ORGANIZATION	NECESSARY				X				UNNECESSARY
C. ADAPTATION	NECESSARY		X						UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS OOD, JOOW, Helmsman, BMOW, QMOW

B. STRUCTURAL ARRANGEMENT Parallel within serial; Interactive-Direct and Audio.

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) OOD, BMOW, QMOW

Damage Control

Repair parties are the backbone of the shipboard damage control organization. Each repair party is responsible for the control or repair of damage in a specific area of the ship. The efforts of the various repair parties are monitored and coordinated by Damage Control Central (DCC). The repair parties form only when there is the threat of damage or after damage has occurred. However, they drill constantly as befits their vital role. Figure IV-2 shows the composition of a typical repair party from the DDG-2.

As damage control is not a normal function, most team members are not dedicated damage control specialists. While team leaders are usually damage control specialists of the Hull Technician (HT) rating, other team members may be cooks or yeomen. The most critical team members possess special skills or epxerience, but effective team operations require a high degree of cross-training. Finally, the DDG-2 repair party consists of 18 members.

The team tasks are varied. Depending on the nature of the damage, the team may have to control flooding, repair breaks in high pressure water or steam pipes, construct emergency supports for weakened decks and bulkheads, or fight fires. Division of labor requires that the team tasks be classified as complementary, but the requirement for extensive cross-training is a mitigating factor. Continuous drilling and type commander requirements for periodic training under realistic conditions at the fleet training centers are intended to reduce task emergence. Task difficulty for repair parties depends, in general, on the complexity of equipment within their area and on whether additional functions, such as Secondary Damage Control Central, are assigned to the team. The repair party shown can be assigned to the least difficult category, but there is comparatively little difference between the least and the most difficult ratings. Equipment used by the team consists of such things as portable pumps, breathing apparatus, patching and shoring devices, and fire fighting equipment. The necessity for equipment reliability, survivability and redundancy tends to militate against any great degree of automation. Thus, the equipment operated by this repair party is typical of similar teams in the fleet.

The damage control function consists of several phases. The location and extent of damage must be determined. Decisions must be made concerning the criticality of the damage and the team's resources must be allocated accordingly. The team must attempt to maintain the flexibility to shift resources to control the most serious damage. The communication processes of orientation, organization and adaptation are vital to the effective conduct of damage control operations. Decisions concerning allocation of team resources are made by the Repair Party Leader, often through consultation with Damage Control Central. The Scene Leader provides primary on-scene supervision.

I. IDENTIFYING DATA

A. SHIP TYPE DDG-2

B. FUNCTIONAL AREA/TEAM TYPE Damage Control

C. TEAM NAME Repair Party

II. TEAM MEMBERS (NEC/PAY GRADE)

READINESS CONDITION

		I	III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Repair Party Leader	E-7				
2.	Scene Leader	E-5				
3.	Investigator	E-4(2)				
4.	Hoseman	E-3(4)		SN		
5.	Nozzleman	E-3(2)		SN		
6.	Electrical Repair	E-4		EM		
7.	Interphone Repair	E-3		FCFN		
8.	Damage Control Net Talker	E-3		SN		
9.	Utilityman	E-3(5)		SN		
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
		N= 18	N=			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION Swift, effective control/repair of damage.

B. TASK TYPE Complementary

VERY MUCH 1 2 X 3 4 5 6 7 VERY LITTLE

Figure IV-2

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS					X				
2. BATTLE CASUALTIES TO THE TEAM					X				
3. STIMULUS VARIABILITY					X				
4. EQUIPMENT FAILURE				X					

		1	2	3	4	5	6	7	
D. TASK DIFFICULTY	EASY	X							DIFFICULT
E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED				X				NON-AUTOMATED

F. OTHER CHARACTERISTICS ______________________________

____

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY	X							UNNECESSARY
B. ORGANIZATION	NECESSARY	X							UNNECESSARY
C. ADAPTATION	NECESSARY	X							UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS Repair Party Leader, Scene Leader, Investigator

B. STRUCTURAL ARRANGEMENT Parallel within Serial; Interactive-Direct and Audio

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) Repair Party Leader, Scene Leader

Weapons

The Basic Point Defense Missile System (BPDMS) is a short range anti-aircraft missile system found on a large and diverse group of fleet vessels. The system is comprised of three units: the fire control panel, the director/illuminator and the missile launcher. The team receives target assignment and location data from the weapons control officer through the weapons direction equipment. The team must acquire and track targets and use the radar director/illuminator to guide the missile to the target. In its most common configuration, the BPDMS is operated by a three man team. As may be noted from Figure IV-3, the system may also be operated by two persons. The launcher control panel operator's primary function involves assuming local control of the launcher in the event of a casualty to the servo link between director and launcher.

A high degree of role and skill specialization makes each member critical and makes the team tasks highly complementary. This specialization and the effects of the environment (the director optically tracks targets and is fully exposed to weather and hostile action) render the team tasks fairly emergent.

As there are only two types of point defense missile systems currently in use (the basic and the improved) the BPDMS is rated as least automated while the IPDMS is rated as most automated. The BPDMS can be considered more difficult to operate (especially against cruise missiles) due to its less effective optical tracker and lower slew rate.

Orientation and adaptation processes are very important to team operations, especially during the phase of operations where radar data must be converted to visual acquisition by the director/illuminator operator. One feature of this team is the high degree of information exchanged via electro-mechanical interface.

The fire control panel operator makes the major decisions concerning when to fire missiles; however, concurrence with the other members is necessary for safety.

I. IDENTIFYING DATA

A. SHIP TYPE FF-1052 (FF-1074)

B. FUNCTIONAL AREA/TEAM TYPE Weapons

C. TEAM NAME Basic Point Defense Missile

II. TEAM MEMBERS (NEC/PAY GRADE)

		READINESS CONDITION I	READINESS CONDITION III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Fire Control Panel Operator	E-6	E-4,5,6	FTM	1146	1
2.	Director/Illuminator Operator	E-4	E-3,4	FTM	1146	1
3.	Launcher Control Panel	E-3		GMG	0892	3
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
		N= 3	N= 2			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION Precise tracking of targets to intercept with missile.

B. TASK TYPE Complementary

VERY MUCH	1	2	3	4	5	6	7	VERY LITTLE
	X							

Figure IV-3

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS				X					
2. BATTLE CASUALTIES TO THE TEAM			X						
3. STIMULUS VARIABILITY					X				
4. EQUIPMENT FAILURE					X				

		1	2	3	4	5	6	7	
D. TASK DIFFICULTY	EASY							X	DIFFICULT
E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED							X	NON-AUTOMATED

F. OTHER CHARACTERISTICS ______________________________

____

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY			X					UNNECESSARY
B. ORGANIZATION	NECESSARY			X					UNNECESSARY
C. ADAPTATION	NECESSARY	X							UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS FCPO, LCPO, D/I

B. STRUCTURAL ARRANGEMENT Parallel within Serial; Interactive-Audio

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) FCPO

Communications

Radio communications form the vital links for the command and control structure of the fleets. At the single ship level, radio communications involve two types of operations. Message processing operations involve the reception, transmission and distribution of the actual hard copy messages. Technical (or facilities) control involves the operation and maintenance of the radio transmitters, receivers and antennas. On ships with small communications facilities, both operations are handled by a single team. On ships where there is a requirement for a high volume of communications traffic, the two operations are handled by separate teams. The radio center team shown in Figure IV-4 is concerned with message processing.

As can be noted from the figure, the range of team member experience levels is well distributed in this team. The more experienced or qualified members are assigned the more responsible positions, and team members progress in responsibility as their experience increases. The increase in size from Condition III to Condition I (17 to 19 members) reflects the need to maintain capability in the face of equipment casualty. The team member criticality ratings reflect the fact that the critical tasks are divided in such a way that there is little extra capability that could absorb the tasks handled by one critical member in a high traffic environment.

The team is organized to allow the simultaneous processing of incoming and outgoing message traffic. Outgoing messages reach the radio center via voice, messenger or pneumatic tube. The outgoing router receives these messages, inspects and logs them, and delivers them to an outgoing operator, who transmits the message via teletype, telegraph or voice. Incoming messages are received via teletype, telegraph, voice or pneumatic tube or from the visual communications team. The incoming router inspects, logs and routes these messages. The service clerk edits incomplete or garbled messages. Incoming message traffic is then duplicated, checked and distributed to the proper addressees. This routine is well established.

Since the CV-67 radio center handles a high volume of traffic, the overall job of the team can be rated as somewhat more difficult than average. The degree of equipment automation is average for shipboard radio centers.

Adaptation is the most important communication process, as members must closely coordinate the use of shared resources to maintain the smooth flow of traffic. The two routers make the minute-to-minute decisions concerning their respective traffic flows. The supervisor acts to maintain the overall efficiency of the operation and functions as team leader.

I. IDENTIFYING DATA

A. SHIP TYPE: CV 67

B. FUNCTIONAL AREA/TEAM TYPE: Communications

C. TEAM NAME: Radio Center

II. TEAM MEMBERS (NEC/PAY GRADE) — READINESS CONDITION

	TEAM MEMBERS (NEC/PAY GRADE)	I	III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Radio Control Supervisor	E-7	E-7	RM	2313	2
2.	Watch Supervisor/Sat Comm		E-5	RM		2
3.	Satellite Communications	E-4		RM		2
4.	Traffic Checker	E-5	E-5	RM		2
5.	Incoming Traffic Router	E-5	E-4	RM		2
6.	Outgoing Traffic Router	E-5	E-4	RM		2
7.	Service Clerk	E-5	E-4	RM		2
8.	Broadcast Operator	E-3	E-3	RM		5
9.	Teletype Operator	E-4,3(3)	E-4,3(3)	RM		5
10.	Tape Cutter	E-3(3)	E-(3)	RM		5
11.	Reproduction/Distribution Clerk	E-4,3(2)	E-3(2)	RM		5
12.	Circuit Operator	E-3	E-3	SN		5
13.	File Clerk	E-3	E-3	SN		5
14.	Teletype Repair	E-4		RM	2346	4
15.	Messenger	E-3		SN		5
16.						
17.						
18.						
19.						
20.						
21.						
22.						
		N= 19	N= 17			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION: Accurate, timely transmission, reception and distribution of radio communications

B. TASK TYPE: Complementary

VERY MUCH	1	2	3	4	5	6	7	VERY LITTLE
		X						

Figure IV-4

C. TASK EMERGENCE

	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS							X		
2. BATTLE CASUALTIES TO THE TEAM					X				
3. STIMULUS VARIABILITY					X				
4. EQUIPMENT FAILURE							X		

D. TASK DIFFICULTY

		1	2	3	4	5	6	7	
	EASY					X			DIFFICULT

E. DEGREE OF EQUIPMENT AUTOMATION

		1	2	3	4	5	6	7	
	FULLY AUTOMATED				X				NON-AUTOMATED

F. OTHER CHARACTERISTICS ________________________________

____

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY		X						UNNECESSARY
B. ORGANIZATION	NECESSARY			X					UNNECESSARY
C. ADAPTATION	NECESSARY	X							UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS Supervisor, Router

B. STRUCTURAL ARRANGEMENT Serial within Parallel, Interactive-Direct

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) Supervisor

Combat Information

Figure IV-5 describes the electronic warfare team of the Roark, a Knox class frigate. Electronic warfare teams operate electronic support measures equipment to detect, identify and track electronic emissions and operate electronic countermeasures equipment to jam or deceive hostile radars. Four of the five team members listed are critical to the team's ability to perform all of these tasks simultaneously. The team member experience levels are somewhat low. This is due to the high degree of automation inherent in the SLQ-32 electronic warfare system installed in the Roark and to the intensive formal training received by EW's.

The division of labor makes the task type complementary; however, there is the capability for a considerable amount of task overlap. The high degree of training and automation tend to make the team tasks fairly established. Of the four electronic warfare suites in general fleet use, the SLQ-32 is the most automated and easiest to operate.

Orientation processes are important during the classification and decision making phases of team operations, while adaptation processes are important during the employment of countermeasures. The E.W. Officer monitors team effectiveness and makes decisions about the employment and allocation of system resources, while the supervisor and operator make decisions concerning the operation of the system equipment.

I. IDENTIFYING DATA

A. SHIP TYPE FF-1052 (FF-1053)

B. FUNCTIONAL AREA/TEAM TYPE Combat Information

C. TEAM NAME Electronic Warfare

II. TEAM MEMBERS (NEC/PAY GRADE) — READINESS CONDITION

		I	III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Electronic Warfare Officer	O-2		1110	9283	2
2.	Electronic Warfare Supervisor	E-4		EW	1733	2
3.	Electronic Warfare Operator	E-3		EW	1731	2
4.	Electronic Warfare Repair	E-4		EW	1733	4
5.	Talker, Electronic D.C.	E-3		SN		5
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
		N= 5	N=			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION Accurate detection, classification, tracking and deception or jamming of electronic emitters.

B. TASK TYPE Complementary

VERY MUCH	1	2	3	4	5	6	7	VERY LITTLE
			X					

Figure IV-5

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS					X				
2. BATTLE CASUALTIES TO THE TEAM			X						
3. STIMULUS VARIABILITY						X			
4. EQUIPMENT FAILURE						X			

D. TASK DIFFICULTY	EASY	1	2	3	4	5	6	7	DIFFICULT
		X							

E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED	1	2	3	4	5	6	7	NON-AUTOMATED
		X							

F. OTHER CHARACTERISTICS ______________________________

____

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY		X						UNNECESSARY
B. ORGANIZATION	NECESSARY				X				UNNECESSARY
C. ADAPTATION	NECESSARY		X						UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS E.W. Officer, E.W. Supervisor, E.W. Operator

B. STRUCTURAL ARRANGEMENT Serial or Parallel; Interactive-Direct, audio and machine

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) E.W. Officer, E.W. Supervisor

Support

Figure IV-6 shows the crew for the UH-46 helicopter permanently assigned to LPH and LHA class ships. The helicopter is used primarily for support tasks such as transporting mail, high priority cargo, and personnel (to and from the ship), as well as for plane guard and sea-air rescue. For SAR missions a crew of four is used; for less demanding missions, a crew of three is used. The member criticality ratings reflect the fact that under normal conditions one person can operate the helicopter, with the other members being required primarily for safety reasons. Division of labor produces a complementary task situation; however, due to system redundancy and safety procedures, there is a high degree of task duplication.

The tasks involved in operating a helicopter (or any aircraft) are more emergent than established. The degree of emergence depends on the type and variability of the missions the crew must perform. In this case, the regularity and similarity of missions assigned tend to decrease emergence. Overall task difficulty is also a function of the type of missions assigned the crew. In comparison with other types of helicopters, the task difficulty here must be rated as somewhat less difficult than average. Finally, the degree of system automation must be considered average for helicopters in use within the Navy.

All of the interaction processes are important to the safe conduct of flight operations and the capability of the team to effectively carry out the various missions they are assigned. Team structure is flexible, with the team adopting the most appropriate structure to conform to specific mission objectives. The senior pilot is team leader and primary decision-maker.

I. IDENTIFYING DATA

A. SHIP TYPE LPH (LPH 7)

B. FUNCTIONAL AREA/TEAM TYPE Support: Air Operations

C. TEAM NAME Helicopter Crew

II. TEAM MEMBERS (NEC/PAY GRADE)

READINESS CONDITION

		I	III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Pilot	O				2
2.	Co-pilot	O				4
3.	Flight Engineer	E-6		AD	8215	4
4.	Aircrewman/Inflight Tech.	E-5		AT	8215	4
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
		N= 4	N=			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION Safe, efficient operation of helicopter for cargo and SAR missions.

B. TASK TYPE Complementary

VERY MUCH	1	2	3	4	5	6	7	VERY LITTLE
				X				

Figure IV-6

/

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS				X					
2. BATTLE CASUALTIES TO THE TEAM				X					
3. STIMULUS VARIABILITY							X		
4. EQUIPMENT FAILURE					X				

		1	2	3	4	5	6	7	
D. TASK DIFFICULTY	EASY			X					DIFFICULT
E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED				X				NON-AUTOMATED

F. OTHER CHARACTERISTICS ______________________

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY	X							UNNECESSARY
B. ORGANIZATION	NECESSARY		X						UNNECESSARY
C. ADAPTATION	NECESSARY		X						UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS Pilot

B. STRUCTURAL ARRANGEMENT Parallel or Serial; Interactive-Direct and Audio

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) Pilot

Engineering

Figure IV-7 shows the fire room team of the Guadalcanal, an amphibious assault ship of the Iwo Jima class. This team is responsible for the operation of the ship's two boilers and associated equipment. The boilers provide the steam to operate the ship's main electrical and propulsion turbines.

As noted, there is a fairly wide range of experience levels in the team. Team members having lower experience levels are assigned to positions of lower responsibility. The increase in size, from 7 to 10 members, with the increase in readiness condition, reflects an increase in the tempo of team operations. The criticality ratings reflect the fact that each member's tasks are so demanding that there is little extra capability to absorb extra tasks (presuming that both boilers are in operation).

Efficient and safe operation of the boiler requires that the proper amounts of air, fuel and water be fed to the boiler in accordance with the proper procedures so that enough steam will be produced to meet the demands of the main propulsion turbine. In addition to monitoring and controlling the burners, blowers, and feed water valves at the boiler, this also requires that the team monitor and ensure the proper operation of the main fuel and water feed pumps and the condensers and condensate pumps. These tasks are demanding enough to require considerable division of labor and role specilization; thus the task type is complementary. There is, however, a degree of task flexibility and overlap. These tasks are very proceduralized; thus they are generally more established than emergent. The boiler control system on this ship is less automated than the average. The predominance of more highly automated combustion control systems in the fleet renders the team tasks more difficult than average.

The interaction processes of adaption and organization are necessary for the effective performance of team functions during periods of high tempo operations. The boiler technician of the watch is responsible for making the decisions concerning team operations. He is also responsible for providing the leadership necessary to build a competent team.

I. IDENTIFYING DATA

A. SHIP TYPE LPH 2 (LPH 7)

B. FUNCTIONAL AREA/TEAM TYPE Engineering

C. TEAM NAME Fire Room

II. TEAM MEMBERS (NEC/PAY GRADE)

READINESS CONDITION

		I	III	RATE/ DESIGNATOR	NEC/ NOBC	CRITICALITY
1.	Boiler Technician of Watch	E-6	E-5	BT		2
2.	Console Operator	E-5		BT	4532	2
3.	Pump Operator	E-3	E-3	BT		4
4.	Checkman	E-4(2)	E-4(2)	BT		2
5.	Burnerman	E-3(2)	E-3(2)	FN		4
6.	Lower Levelman	E-4		BT		4
7.	Talker	E-3		BT		5
8.	Recorder/Messenger	E-3	E-3	FN		5
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
		N= 10	N= 7			

III. TASK DEMANDS

A. TEAM TASK PERFORMANCE CRITERION Efficient, safe operation of boiler.

B. TASK TYPE Complementary VERY MUCH 1 X 2 3 4 5 6 7 VERY LITTLE

Figure IV-7

C. TASK EMERGENCE	MORE EM THAN EST	1	2	3	4	5	6	7	MORE EST THAN EM
1. ENVIRONMENTAL CONDITIONS							X		
2. BATTLE CASUALTIES TO THE TEAM			X						
3. STIMULUS VARIABILITY					X				
4. EQUIPMENT FAILURE						X			

		1	2	3	4	5	6	7	
D. TASK DIFFICULTY	EASY					X			DIFFICULT
E. DEGREE OF EQUIPMENT AUTOMATION	FULLY AUTOMATED					X			NON-AUTOMATED

F. OTHER CHARACTERISTICS ______________________________

____

IV. TEAM INTERACTION PROCESSES

IMPORTANCE FOR TASK COMPLETION OF:

		1	2	3	4	5	6	7	
A. ORIENTATION	NECESSARY		X						UNNECESSARY
B. ORGANIZATION	NECESSARY			X					UNNECESSARY
C. ADAPTATION	NECESSARY	X							UNNECESSARY

V. TEAM STRUCTURE

A. DECISION-MAKERS Boiler Technician of the Watch

B. STRUCTURAL ARRANGEMENT Parallel or Serial; Interactive-Direct

VI. TEAM LEADERSHIP

A. FORMAL LEADER(S) Boiler Technician of the Watch

Summary

This chapter has presented the results of the cataloguing effort by thoroughly describing one team from each functional area. The catalog sheets have been ordered by major taxonomic dimensions and are standardized to facilitate a diverse array of data analyses. The next chapter discusses the utility of the taxonomic model and classifying effort and indicates some fruitful approaches to analyzing the data. Also, limitations of the present study are discerned and directions for future research are advanced.

CHAPTER V

DISCUSSION

Introduction

The previous section was devoted to the application of the taxonomic measures to a sample of surface Navy teams. At this point, it is necessary to reflect upon the nature of the cataloguing effort. Specifically, this chapter examines the appropriateness of the taxonomic model as an instrument for identifying and measuring salient aspects of Naval teams. Here, the utility of the classification system is assessed within the context of the original research purposes. As the transition from the theoretical taxonomic model to the operationalization of the team dimensions entailed various problems, limitations of the classification system are identified and discussed. Given the usefulness and limitations of the taxonomic structure, some potentially fruitful avenues for future research using this framework are explored.

Utility/Applicability of the Classification System

A consideration of the usefulness of the taxonomic structure must begin with an examination of the original purposes of this research. In this respect, the Rand Conference provided the initial focus concerning the necessity of developing a Navy team taxonomy. As Goldin and Thorndyke (1980) noted, the conference members aptly maintained that the development and application of this classification system should

- o enable researchers to identify and preserve critical features of the actual task environment in the research environment to study team performance.
- o facilitate isolation of potential team variables for examination based upon structural and operational features.

- allow researchers to judge the appropriate level of abstraction to which their research could be generalized.

- permit the selection of representative teams as vehicles for research.

The achievement of these research objectives entailed the accomplishment of various tasks. Specifically, the cataloguing of Navy teams required their operational delineation, the identification of salient team dimensions, and the generation of replicable measurement procedures regarding these dimensions. In providing a common focus regarding Navy teams, dimensions, and corresponding measures, this research offers an organizing framework for construing prior studies and designing subsequent research endeavors. Retrospectively, the taxonomic model allows any research effort to be understood in terms of the teams examined and the variables which were manipulated, controlled, or unaccounted for. Hence, the comparison of different team studies is facilitated by this organizing framework. Prospectively, future research can be predicated upon enhanced understanding of the critical features within a particular research environment. In other terms, the selection of teams and dimensions can emerge from this integrative framework. At this point, though, it should be realized that refinements of the classification system and the corresponding measures are anticipated as a product of future research endeavors.

A unique aspect of this research is that the classification system represents an integration of the massive team performance literature with the specific technical aspects of Navy teams. This direct application of relevant theory and empirically-derived results to existing Navy teams serves several purposes. First, it provides a fruitful approach to construing these teams based upon important characteristics, as well as in terms of more traditional Naval designations. Specifically, the analysis of the team performance literature facilitated the identification of dimensions which account for a significant proportion of the variance in diverse Navy teams and their performance. For example, based upon recent recognition of the importance of team interaction patterns and communication processes, this research involves an initial attempt to capture these features as they relate to Navy team functioning. Further, this integrative effort serves the important purpose of assisting Navy researchers in selecting teams based upon functional similarities/differences across various taxonomic dimensions. Finally, the application of the taxonomic measures to actual Navy teams generated an understanding of those dimensions which require more complex procedures to measure meaningfully. Within this research, the identification of endogenous team dimensions (e.g., member motivation levels, team cohesiveness, and leadership style) indicated that field observations are most appropriate for their measurement, while exogenous features can be assessed using manning documents.

The classification system possesses other forms of utility for team investigators. For instance, increased understanding of the ways in which Navy teams differ can facilitate the design of team-specific training programs. To the extent that current team training does not consider important differences between Navy teams, beneficial modifications could be made. For example, a Navy team which relies heavily on communication and coordination should receive training in these interactive skills. On the other hand, the taxonomic model could be used to identify Navy teams which would not benefit from team training. Another application of the classification system involves the hierarchical delineation of Navy teams. As Navy teams can be defined at various levels (e.g., the entire ship, functional areas, or smaller units), then team performance could also be examined and compared at each level. In this respect, the criticality of smaller teams within the overall ship organization could be addressed. Finally, while the catalogue output is represented verbally to facilitate assimilation of large amounts of technical information, the taxonomic system has been structured to lend itself easily to coding for computer purposes. Thus, the classification system can be more easily subjected to empirical analysis within given research designs. Although changes in Navy team situations (e.g., movement toward more automated equipment) and theoretical understanding of team behavior will occur, the taxonomic model represents an important initial step toward linking the large literature base with specific aspects of Navy teams to facilitate meaningful research geared toward enhancing the performance of these teams.

Limitations of the Classification System

Although the classification system possesses considerable utility, the results of the cataloguing effort are somewhat restricted by certain factors. For example, the research findings are influenced by the level of specificity employed to define Navy teams. While justification is offered for the breakdown of these teams, nebulous team boundaries, the instability of team structure and composition, and the existence of distinct subteams render unequivocal delineation impossible and permit alternative modes of identifying Navy teams. Also, the implications of utilizing Navy Ship Manning Documents and other technical materials to catalogue the teams must be considered. These documents specify ideal manning conditions aboard ship. As several instructional personnel and limited field observations indicated, however, discrepancies typically exist between ideal and actual manning conditions. Further, the exact nature of these disparities across different teams is unknown. As such, the inadequacy of these documents is acknowledged as a constraining factor of the classificatory effort.

Other limitations concerning the results of applying the taxonomic structure to Navy teams involve the lack of detailed observations of these teams. For instance, endogenous team dimensions (e.g., some team interactive processes, member personality attributes, leader-member relations) were not measurable within the scope of this research effort. Also, the limited team observations prevented a more accurate depiction of variations along taxonomic dimensions within similar team types. Finally, the paucity of actual Navy team observations prevented further refinement of the taxonomic model.

These pragmatic limitations do not necessarily impinge on the validity or reliability of the results of the cataloguing effort. Instead, they reflect methodological features which create a context in which the classification system can be employed and evaluated. In fact, various approaches which could be taken to overcome restrictions on the usefulness of the taxonomic model should be considered. The following section, which explores future research possibilities, includes a discussion of eradicating these limiting factors to enhance the utility of the classification system.

Future Research Directions

This research effort is most beneficially conceived as a starting point for subsequent study of Navy teams rather than as merely a final product. As this work represents an initial attempt to catalogue Navy teams, future research must be devoted to refining theoretical and operational definitions. Also, the previously mentioned limitations of this research effort must be considered.

In order to enhance the utility of the Navy team taxonomy, future research should fulfill various objectives. The refinement of the taxonomic dimensions, to more precisely specify current taxonomic components and to include endogenous team variables, is an important objective. In this respect, field observations are necessary to enhance the assessment of endogenous, team-specific factors. For example, future research is needed to develop team interaction process measures and to demonstrate the relationship of various team communication patterns to task-related performance. As previously noted, empirical attention might also be devoted to an examination of whether team training adequately considers important variations across different teams and within the same team type across different ships.

Another broad topic for future research entails refinement of the taxonomic measures. Here, the creation of new measures to assess endogenous team variables is necessary. Also, it is important to empirically demonstrate the reliability of results obtained using the classification measures. Multiple raters could apply the taxonomic measures to a sample of Navy teams and interrater reliability estimates could be computed to accomplish this task objective.

Finally, it should be realized that the sample for this study involved a representative selection of surface Navy teams. As such, subsequent research could be devoted to cataloguing other surface Navy, air, and subsurface Navy teams. Of course, this effort would most benefically follow the achievement of the first two research objectives. For all Navy teams, the importance and utility of this classificatory research depends upon the ability of the taxonomic model to provide a systematic frame of reference for researchers, explain current Navy team performance as it relates to salient team variables, generate interesting research hypotheses for subsequent study, and most important, suggest approaches to improving the functioning of Navy teams.

Conclusion

Within the limitations existent in this research, it appears that the cataloguing effort provides a fairly thorough picture of each Navy team and is accomplished quite easily. Of course, the true importance of this research rests upon the ability of team investigators to refine the taxonomic dimensions/measures and relate them more directly to Navy team performance.

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