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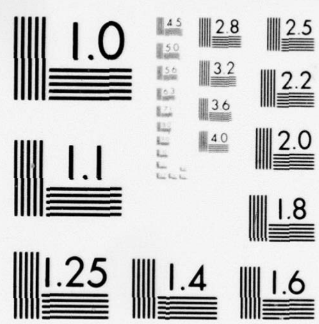

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THE IMPACT OF COMPUTER-BASED DECISION AIDS ON ORGANIZATION STRUCTURE IN THE TASK FORCE STAFF

FINAL TECHNICAL REPORT

September 1976

Prepared for:
Operational Decision Aids Project
Office of Naval Research (Code 452)
Department of the Navy
Arlington, Virginia 22217

Prepared by:
Policy Sciences Division
CACI, Inc. — Federal
1815 North Fort Myer Drive
Arlington, Virginia 22209

Contract N00014-76-C-0072
Project NR 170-813/8-8-75 (452)

U.S. DEPARTMENT OF COMMERCE
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The Impact of Computer-Based Decision Aids on Organization Structure in the Task Force Staff

Caci Inc-Federal Arlington Va Policy Sciences Div

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This report develops a set of operational hypotheses concerning the potential impact of computer-based tactical decision aids on task force command organization structure. Empirical and theoretical literature on this topic is surveyed, but yields inconclusive results. A descriptive and prescriptive contingency model of organization structure is developed to project organization structures that maximize decision aid exploitation. The model is applied to task force decision environments and effective organization structures are derived. Case studies of four Navy organizations are also described.-

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PREFACE

This report documents research undertaken by CACI, Inc.-Federal to evaluate the impact of computer-based decision aids on organization structure in the task force staff. The project staff consisted of

Dr. Bertram I. Spector, Principal Investigator
Dr. Richard E. Hayes
Ms. Mary Jane Crain

We would like to acknowledge the help and guidance received from Dr. John J. Hayes and Dr. James R. Brownell of CACI. We are also grateful for the assistance and suggestions of Dr. Martin A. Tolcott, Dr. John A. Nagay, and Mr. James R. Simpson of the Office of Naval Research, and Dr. H. Wallace Sinaiko of the Smithsonian Institution. Mr. Andrew W. Spisak and Ms. Teresa E. Spisak contributed much hard work in tracking down the relevant literature. We also wish to thank Ms. Nancy Streeter and Mr. Eric Shaw for editing the report and Ms. Sharon O'Rourke for typing it. Finally, we extend our gratitude to the officers who assisted us in developing the case studies. Their conscientiousness and receptivity to the research proved invaluable.

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LIST OF ABBREVIATIONS

AAW	Antiair Warfare
ADP	Automated Data Processing
AMC	U.S. Army Materiel Command Board
ASIS	Auxiliary Ships Information System
ASW	Antisubmarine Warfare
CAI	Computer-Assisted Instruction
CCTV	Closed Circuit Television System
CIC	Combat Information Center
CNA	Center for Naval Analyses
CO	Commanding Officer
ComCarGru One	Commander Carrier Group One
CRT	Cathode Ray Tube (Terminals)
CTF	Commander of the Task Force
ESM	Electronic Support Measures
EW	Electronic Warfare
FCC	Fleet Command Center
FCF	Flag Correlational Facility
FWC	Force Weapon Coordinator
L-Tran	Lesson Translator
LGD	Large Group Display
MIS	Management Information System
MSCF	Multi-Source Correlational Facility
NTDS	Naval Tactical Data System
ODA	Operational Decision Aids Project
OIC	Officer in Charge
ONR	Office of Naval Research
OpCon	Operation Control
RimPac	Rim of the Pacific
S/S Surveillance	Surface/Subsurface Surveillance
SWC	Ship Weapon Coordinator
TAO	Tactical Action Officer
TSC	Tactical Support Center

CHAPTER 1. EXECUTIVE SUMMARY

STUDY OBJECTIVES

This report develops a set of testable hypotheses concerning the potential impact of computer-based tactical decision aids on task force command organization structure. These hypotheses will enable knowledgeable testing of the optimal allocations of responsibility and authority within the commander's staff.

The subgoals of this report are threefold.

- The scholarly literature concerned with the impact of computer-based decision aids on organization structure is reviewed. A descriptive and prescriptive model is also developed to assist in projecting organization structures that are likely to maximize decision aid and group performance.
- Case studies of four Navy organizations that have already introduced computer-based decision aids are reported. The purpose of the case studies is to assess the organizational impact of decision tools in the Navy context.
- Based on the first two phases, training and implementation strategies that may ease the transition to a computer-based decision system in the task force are suggested and compared.

There are three key products of the study.

- A model that integrates existing knowledge on organizations in a new way, constituting a novel tool for organizational planners in the Navy.
- A set of testable hypotheses that prescribes the organization structures for Navy task force staffs that are likely to maximize decision aid exploitation and decision-making performance effectiveness.

- A discussion of training and implementation strategies that can assist in successfully introducing decision aids into the task force.

BACKGROUND

This study deals with the sociology of technological innovation. Sophisticated technology cannot be introduced into an organization without having some impact on the organization and its personnel. Organizational planners attempt to foster a harmonious match between incoming technology and the ongoing system of human relationships in an organization. If left alone, dynamic organizational processes and structures will eventually adapt and evolve to meet the demands and opportunities of new technologies. However, the process can be manipulated and shaped to provide management with a degree of control, saving time and avoiding unnecessary disruptions. The techniques for control are embodied in the growing field of organizational development in which deliberate strategies are used to alter organizational processes and structures to make them more flexible, responsive, and effective in rapidly changing circumstances. This study considers certain of these techniques in depth, as they relate to the Navy context generally, and the Office of Naval Research project on operational decision aids specifically.

The technological innovation of concern in this study is computer-based tactical decision aids being developed for Navy task force commanders and their staffs. In its broadest sense, a decision aid is any technique or procedure that restructures the method by which problems are analyzed, alternatives developed, and decisions taken. It usually involves the systemization of procedures that assign values to action alternatives and calculate utilities for their probable outcomes. The term "decision aid" in this study is restricted to procedures that have been implemented using a computer, though a paper and pencil might also be called a decision aid. The employment of such decision aids in the task force is likely to differentiate and reallocate functions, integrate and coordinate various tasks, and enhance the quality and quantity of mission performance in general. This study involves a search and analysis for the best ways of organizing the task force command staff to maximize decision aid exploitation.

At present, there are approximately 20 staff officers who advise the task force commander. Their roles as advisors are highly flexible, depending on the tactical mission at hand and the personal preferences of the commander. The organization of the task force is highly individualized and ad hoc. With the implementation of computer-based tactical decision aids, particular ways of organizing the task force staff may be found to ensure the most efficient and effective employment of these tools. Thus, to achieve the most satisfactory performance of both men and machines, organizational change from the present formal or informal staff structures and processes may be required.

Some of these organizational changes may be resisted due to the personal styles and preferences of individual commanders or members of their staffs. However, they can be considered as guidelines and recommendations for Navy planners. Moreover, if commander styles can be categorized into types, it may be possible to specify the organization structures most suitable to the style of the commander and the situation. The present study takes leadership style into account in deriving suitable organization configurations, and thus helps to customize the organization to fit the commander.

ORGANIZATION STRUCTURE: DEFINITIONS AND CHOICES

Organization structure is concerned with the internal system of social relations within functioning groups. It has two major components, formal and informal structures, that exist side by side. Formal structure defines the officially prescribed patterns of authority, responsibility, and accountability relationships in organizations. Informal structure describes the system of dynamic interpersonal transactions that identify the reality of organizational behavior. This study analyzes the impact of decision aid implementation on both formal and informal structure.

Three aspects of formal structure may be affected by the introduction of computer-based decision aids, offering certain choices to management. They include

1. The appropriate placement of the decision aids;

2. The assignment of new organizational roles -- technicians to operate the decision aids, analysts to interpret their output, or coordinators to integrate differentiated functions; and

3. The appropriate placement of the decision aid operator staff in the formal hierarchy.

Among the formal structure choices to be made by management as a result of these technological impacts are whether to (1) establish divisional or pyramidal decision aid installations; (2) assign specially skilled Navy personnel from outside the task force or train existing professional staff, and (3) place the decision aid operators in an existing division, a support unit, a new division of equal status with others, top management's exclusive personal staff, or assign divisional staff to double-duty.

Implementing computer-based decision aids may also cause certain changes to the dynamics of informal organization structure. Established processes and relationships will be altered. The decision aids will cut across the traditional division of duties and can be expected both to merge and differentiate roles and functions. These events will yield an acute need for integration within the organization.

The informal structure choices available in dealing with these consequences of technology can be specified as points on a continuum. They range from leader-centered structural types such as centralization and consultation to subordinate-centered structures such as decentralization and partial delegation. Between these extremes is another structural form -- transaction -- that maximizes vertical and lateral communication and emphasizes shared authority relationships between leader and subordinates.

MODEL DEVELOPMENT

A general literature review of the impact of computer-based decision aiding systems on organization structure yielded ambiguous and inconclusive results. Analysis of a wide range of studies showed that almost equal numbers endorsed centralized structures and decentralized structures. Moreover, an equal number of studies concluded that, in terms of performance, it made little difference what type of organization structure existed.

The inconsistent and inconclusive findings in the literature result from a lack of experimental control for the impact of organizational environments and the differences in decision aid capabilities or functions that may affect structure. To remedy this, a contingency model of organization structure in technological environments was developed to assist in projecting appropriate organization structures for the task force (see Figure 1). The major premise of this model is that different organizational environments demand different internal organizational arrangements. The model was built to assess the coordinated impact of the three basic dimensions of organizational environments:

1. The mission to be accomplished.
2. The personnel required to perform mission tasks.
3. The technology available to assist personnel in performing their functions.

The model combines mission, personnel, and technological factors in weighted configurations or profiles that describe the "ideal" environmental conditions necessary to support the various organization structure choices. These ideal profiles are derived from 22 interrelated assumptions based on secondary analysis of the experimental, experiential, and theoretical literature. The model is descriptive in that it draws profiles of organizations that elaborate their operational environments. The model is also prescriptive in that it recommends organization structures which ought to maximize decision aid exploitation and group effectiveness given particular organizational profiles.

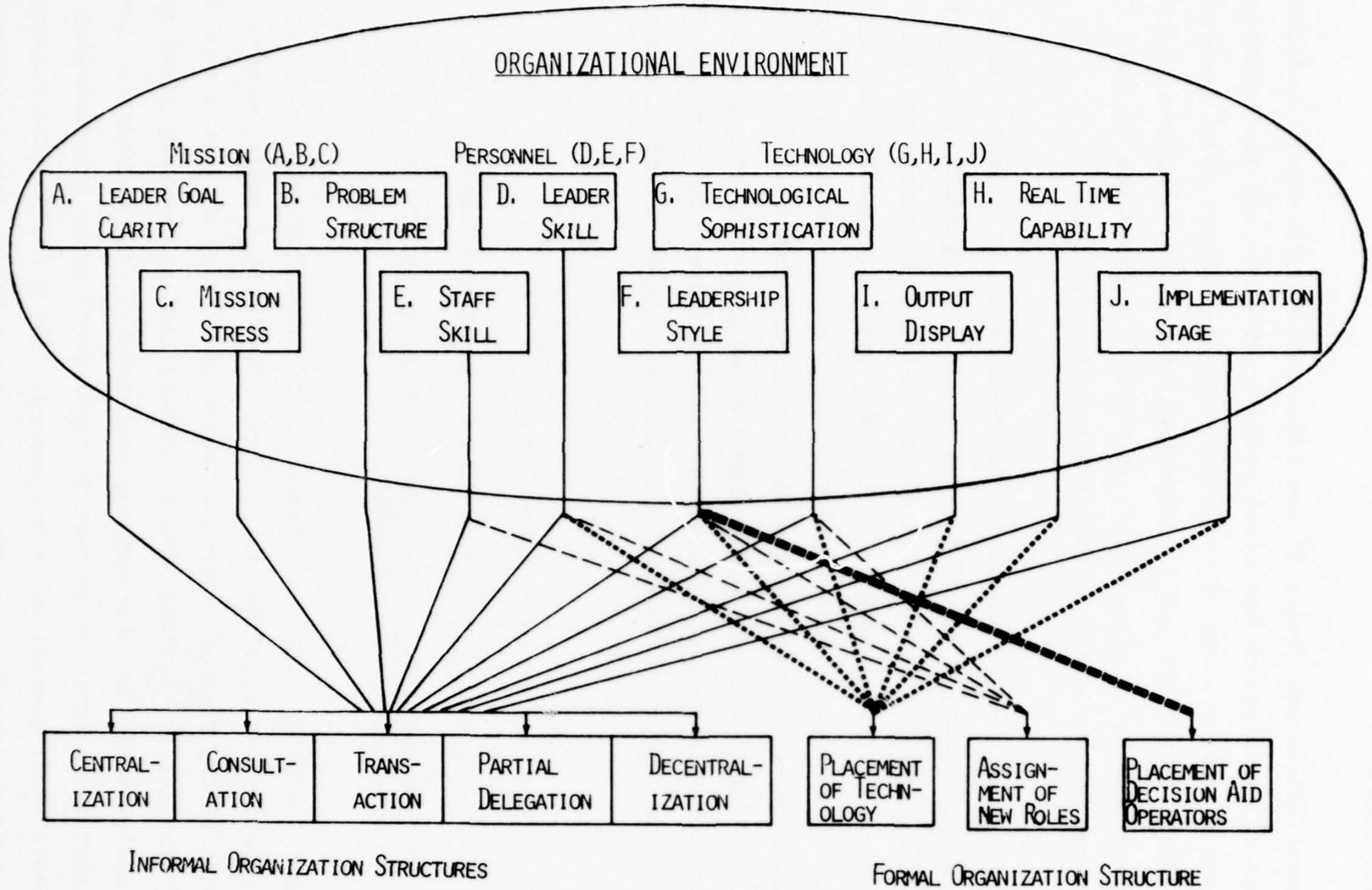


FIGURE 1. A CONTINGENCY MODEL OF ORGANIZATION STRUCTURE IN TECHNOLOGICAL ENVIRONMENTS

Direct implementation of the model's prescriptions may be difficult to achieve. Organization structures and processes tend to evolve and much depends on the leader's preferences and personality. However, the model's prescriptions can assist in shaping organization structures, even indirectly. For example, if centralization is projected as an effective structure, a decision aid console can be installed at the commander's station to provide the hardware requirements for centralized organization.

By comparing the similarity of ideal environments derived from the model with actual organizational environments, such as the task force, recommendations or hypotheses about appropriate organization structures are systematically generated. These hypotheses are customized for each organizational environment or context. The model is sensitive to change in organizational operation. For instance, stressful missions end, giving way to more routine functioning. New leaders with different personal styles of command may be assigned. The organizational context is dynamic, and its changing parameters can be accommodated by the model. To be responsive to change in the situation, flexible and adaptable organization structures are hypothesized by the model as optimal strategies.

By far, the preeminent environmental factors influencing the choice of organization structure are the personal preferences of the leader. His style of command, degree of trust in subordinates, and acceptance of the decision aids will be crucial in determining the shape of informal decision processes and formal structures with which he will be comfortable. Thus, leadership style has been included in the model as a crucial criterion. The degree of staff and leader skills and training in the use of decision aids are also heavily weighted.

HYPOTHESIS GENERATION

The contingency model was applied to 16 projected task force decision environments in which the implementation of computer-based decision aids is forecast. A set of rules was devised to compare the similarity of the task force environments to the ideal environments derived from the model. The outcome of these comparisons is 16 sets of hypotheses concerning the most effective organization structures for each projected task force environment which can be tested empirically in laboratory simulations.

Each set of hypotheses specifies the organizational conditions under which different types of organization structures are believed best suited. The hypotheses prescribe organization structures that maximize decision aid exploitation and decision-making performance given various profiles projected for the task force. They easily translate into operational and testable propositions because each consists of organizational descriptors set by the experimenter (independent variables), organization structure types (mediating variables), and measures of performance effectiveness (dependent variables). These hypotheses are generated in Chapter 5 and fully explicated and made operational in Chapter 12.

The 16 sets of hypotheses in the report provide complex, multivariate profiles of the task force environment that interact with effective organization structures. Several major threads run through the hypotheses. These commonalities can be stated as simple bivariate relationships between an environmental descriptor and a maximizing organization structure:

- If the commander is skilled and knowledgeable in decision aid operation and analysis, and rapid, cost efficient decisions are required, centralized informal organization structures provide maximum performance.

- If the decision aids are fully operational, entrenched, and accepted in the task force, and rapid, cost efficient decisions are required, centralized or consultative informal organization structures provide maximum performance. Also, decision aid operators should be formally placed in the personal staff of the commander.

- If the commander employs a relations-oriented style of command, that is, he gives little direction to the staff, encourages them to actively participate in setting decision-making parameters, and values the development of personnel responsibility, decentralized informal organization structures provide maximum performance.

- If the commander is skilled and knowledgeable in decision aid operation and analysis, formal placement of the decision aids under his direct personal control (a pyramidal formal structure) provides maximum performance.

- If the commander employs a relations-oriented style of command, formal placement of the decision aids and decision aid operators in a particular division of the task force staff provides maximum performance.

- If the commander possesses few skills and little knowledge about decision aid operation or analysis procedures, it is preferable to assign Navy specialists from outside the task force staff to coordinate and operate the system.

CASE STUDY PROCEDURES AND IMPLICATIONS FOR THE TASK FORCE

Four case studies of Navy organizations in which computer-based decision aids have already been implemented were conducted. The organizations and their decision aids are:

- Combat Information Center
  Decision Aid: Naval Tactical Data System

- U.S.S. Kitty Hawk Flagship Command Center
  Decision Aid: Outlaw Hawk

- Bureau of Naval Personnel (PERS 4)
  Decision Aid: AMIS

- Operation Control Centers
  Decision Aid: Fleet Command Center

A discussion guide was developed to assist the interviewers in covering each designated topic in the open-ended discussions that were held.

Several general themes in the cases analyzed can be applied to the task force. First, computer-based decision aids create a decision environment of information centralization that facilitates the potential for total centralization of authority and decision-making in the commander. While at first this might appear to offer improved efficiency, a more participative organization structure, in which the task force staff is actively included by the commander in the problem-solving process, might provide the best personnel arrangement for maximum decision aid exploitation.

Second, as the decision environment changes, so does the appropriateness of the organization structure. Under planning phase conditions in the task force, which are neither stressful nor excessively time restrictive, partially delegated informal structures provide the most effective team performance using computer-based decision aids. However, under execution phase conditions, task force informal structures that are more centralized but allow for adequate consultation between commander and staff may be most effective in yielding rapid decisions. Third, a new organizational role that coordinates employment of the task force decision aids may increase their efficient utilization.

Fourth, the introduction of computer-based decision aids that previously relied on expert human judgment alone may cause initial resistance to new procedures and techniques. This reaction may result in inefficient use of personnel and low morale. Intensive training in the algorithms used by the decision aids, and the sources and processing of their data should help to instill trust and alleviate resistance. In addition, early involvement of task force commanders and staff members in developing these decision aid algorithms would increase their legitimacy. Fifth, the transition to a computer-based system can be eased by developing planned training and implementation strategies. One of the most successful plans involves demonstrations of full-scale prototype decision aids for task force commanders followed by intense, formal on-the-job training. Proving the utility of the decision aids to the top of the hierarchy in which they will be employed ensures the initial support required for successful training and acceptance. Table 1 summarizes the specific organizational hypotheses derived from the case studies.

OPERATIONAL HYPOTHESES FOR FURTHER TESTING

One of the major objectives of this research is to develop operational hypotheses that can be tested in controlled laboratory simulations of tactical

TABLE 1

Organizational Hypotheses Derived From the Case Studies

1. The availability of information centralization caused by computer-based decision aids is likely to encourage decision-making centralization.

2. Under combat conditions, effective task force performance is maximized by consultative organization structures.

3. Under non-combat conditions, effective task force performance is maximized by partially delegated organization structures.

4. Effective task force performance is maximized by decision aids that can adapt to changing circumstances and individual preference.

5. Effective task force performance is maximized if an administrative and authoritative coordinating role is established.

6. Effective task force performance is maximized and potential resistance reduced if the commander <u>and</u> staff are trained in the operation and internal workings of the decision aids.

7. Effective task force performance is maximized and potential resistance reduced if decision aid designers consult task force personnel in the developmental stage.

8. Decision aid implementation to the task force is maximized if efforts are made initially to convince the commander through demonstration of the systems's practicality and value, and thus, obtain his support.

9. Decision aid implementation to the task force is maximized if training of system managers and operators takes place at an onshore facility where trainees are isolated from their regular duties.

10. Decision aid implementation to the task force is maximized if computer-assisted instructional (CAI) materials or programmed instruction is employed.

11. Decision aid implementation to the task force is maximized if individual training of operators is supplemented by intensive team training.

12. Decision aid implementation to the task force is maximized if instructors and hardware experts continue training aboard ship under exercise conditions.

planning and execution by task force commanders and their staffs. These hypotheses should enable knowledgeable testing of various organization structures that results in maximum decision aid exploitation and decision-making performance. The following aspects of organization structure are optimized in these hypotheses:

- The allocation of responsibility and delegation of authority within the commander's staff (informal structure).
- The formal placement of the decision aids and operator staff in the organizational chart.
- The assignment of new organizational roles to manage and coordinate the decision aids.

Complex, multivariate relationships among organizational environments, organization structure, and measures of performance effectiveness are developed on the basis of the 16 sets of hypotheses derived from the model and the four Navy case studies. Each of these relationships is then operationalized to provide measurable hypotheses for future laboratory experimentation which are elaborated in the final chapter.

THE STRUCTURE OF THIS REPORT

This report is organized into 12 chapters and four appendices. Chapter 1 is the executive summary. Chapter 2 describes the study objectives. The literature review, model development, and application to the task force are documented in Chapters 3-5. Chapter 3 defines and describes several properties of organization structure, analyzes the potential impacts of computer-based decision aids on structure, and enumerates the various structural options available to managers and planners in coping with the consequences of technological implementation. The theoretical and empirical literature in this area is reviewed and assessed in Chapter 4. Unfortunately, the aggregate findings of this literature are ambiguous and inconclusive. As a result, a contingency model of organization structure is developed to integrate several important determining factors into one comprehensive descriptive and prescriptive framework. In Chapter 5, the model is applied to several future task force environments given the implementation of tactical computer-based decision aids. Hypotheses are developed on the basis of this application concerning appropriate organization structures for various task force contexts.

Chapters 6-11 deal with the case studies and evaluations of training and implementation strategies. In Chapter 6 the methodology employed to conduct the case studies is described. Chapters 7-10 constitute the indepth analyses of four computer-based decision aids and their organizational impact on the Navy. The implications of the case study findings for the task force are elaborated in Chapter 11. Finally, in Chapter 12 hypotheses concerning the effects of computer-based decision aids on task force organization structure are described and operationalized to enable testing in experimental contexts.

CHAPTER 2. STUDY OBJECTIVES

This report constitutes research performed by CACI, Inc.-Federal on the organizational consequences of implementing computer-based decision aids for Navy task force commanders and their staffs. It is part of a multi-contractor effort conducted for the Operational Decision Aids (ODA) project of the Office of Naval Research (ONR).

ONR'S OPERATIONAL DECISION AIDS PROJECT

To put the present research into proper context, a brief description of the aims of the ODA project is useful. Its prime objective is to assess the feasibility and potential effectiveness of computer-based decision aiding tools in improving and enhancing tactical decision-making in task force command and control systems (ONR, 1975). The project employs an interdisciplinary approach, focusing the fields of decision analysis, operations research, computer science, systems analysis, and organizational research on the problem at issue. The application of advanced man-machine system technologies at the task force level is analyzed by examining the task force command decision environment, man-machine interfaces, promising decision aid techniques, measures of decision aid effectiveness, organizational implications of decision aid implementation, typical problem scenarios, data base requirements for the scenarios, simulation experiments, and team performance employing the decision aids.

CACI RESEARCH OBJECTIVES

CACI's effort in the ODA project is concerned with evaluating the potential impact of computer-based decision aids on task force command organization structure. The implementation of such tactical decision aiding tools for the task force commander and his staff is likely to integrate, systematize, and speed task performance. Particular organization structures and decision-making processes can help to maximize task force productivity and decision aid exploitation. The search and evaluation of appropriate organization structures for the task force command staff constitute our research domain.

The research objectives are threefold. In Phase 1, current literature on the impact of management information systems (MIS) and other computer-based decision aids on organization structure is integrated and evaluated. The effects of various structures on effective and efficient organizational performance are assessed. A contingency model of organization structure in technological environments is developed. On the basis of this model and projected task force decision environments, a set of testable propositions is prepared concerning organization structures most appropriate to the use of operational decision aids by the task force commander and his staff.

In Phase 2, several indepth case studies are conducted of naval organizations that have already implemented computer-based decision aids. This phase develops further testable propositions concerning the organizational consequences of technological innovation in the task force, with emphasis on lessons learned rather than theoretical modeling.

On the basis of open-ended discussions with Navy officers, Phase 3 evaluates the potential effectiveness of various training and implementation strategies the Navy can employ to introduce computer-based decision aids successfully in the task force. The objective of this research phase is to help Navy planners ease the organizational transition to a changed operational environment.

RESEARCH METHODS

To attain Phase 1 objectives, the theoretical and empirical literature on the impact of computer-based decision systems and MIS on organization structure was reviewed; a predictive contingency model of organization structure in technological environments was developed; tactical and procedural publications concerned with task force level organization and decision-making situations were examined; task force environments projecting decision aid implementation were elaborated; and the contingency model was applied to the projected task force environments to develop a set of researchable propositions for further testing.

For Phases 2 and 3, open-ended discussions with Navy officers were conducted to gather empirical data on Navy organizations have have already introduced computer-based decision aids. A discussion guide to help develop organizational profiles was designed. Organizations for analysis were screened and chosen, and onsite discussions were held.

CHAPTER 3. CHARACTERISTICS OF ORGANIZATION STRUCTURE AND COMPUTER-BASED DECISION AIDS

SUMMARY

This chapter discusses and interrelates fundamental concepts that help to define and distinguish among various properties of organization structure. An attempt is made to clarify terminology, integrate several major concepts and relationships, and augment the theoretical framework of organization structure. By doing so, analyses of the impacts of technological innovation on organization structure become more comprehensible, and planning for such changes becomes more orderly. Organization structure is categorized into two component types, formal and informal structures. The potential effects of implementing advanced technology on these formal and informal types are examined. Finally, the organizational alternatives available to cope with the consequences of technological innovation are enumerated.

FORMAL AND INFORMAL ORGANIZATION STRUCTURE

Organizations have been broadly defined as "intricate human strategies designed to achieve certain objectives" (Argyris, 1971: 264). There is, however, no single strategy that is appropriate to the universe of organizations which varies in terms of goals, tasks, and operational environments (Galbraith, 1973; Lawrence and Lorsch, 1967b; Chandler, 1966; Hall, 1962). One component characteristic that can be employed to distinguish among different organizations is organization structure.

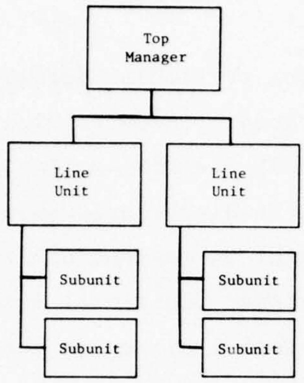
> Organization structure is concerned with the role and personnel arrangements within an organization that specify authority, coordination, and communication relationships. These arrangements link functions and physical factors to manpower requirements and availability.

More simply, organization structure describes the internal system of social relations within functioning groups -- the social processes by which organizational operations actually are or should be accomplished.

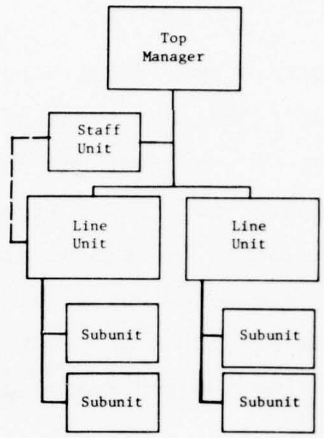
Every organization structure possesses two major characteristics, formal and informal aspects. Formal structure is concerned with the official pattern of authority relationships and the location of responsibility and accountability in the organization. It consists of authoritative rules, regulations, and procedures that prescribe the place of each organizational member in the hierarchy: to whom they are accountable, for what they are responsible, and over whom they have authority (Blau, 1974; Bureau of Naval Personnel, 1964).

All formal structures can be defined by a particular role enumeration and hierarchical shape. One purpose of officially charting an organization is to assign specific types of tasks to certain personnel. Each organizational member serves a particular role function. Thus, formal structure creates a division of labor within an organization to achieve group objectives. The formal structure also organizes a hierarchical configuration or differentiation in command levels. Tall or multilayered structures, having numerous levels of assigned authority and responsibility, can be created. In contrast, flat, formal structures can be developed that assign few levels of authority and control.

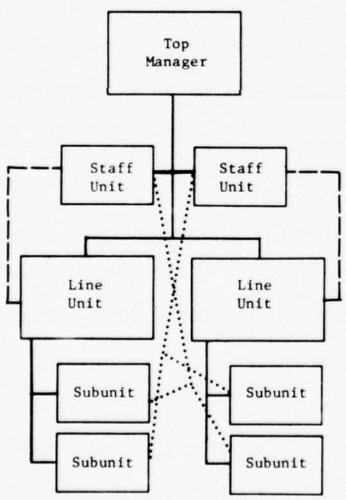
Active military and business usage has resulted in the identification of four basic types of formal structure, each defining different lines of command and control, advisory, and functional relationships (Bureau of Naval Personnel, 1964). Figure 1 charts these four fundamental structures. Line structure emphasizes direct chains of authority and unity of command principles. Line and staff structure includes informational and advisory staff to assist and guide line or operational personnel. Functional structure arranges personnel by functional activity or type of task such as planning, logistics, communications, and intelligence functions. Lastly, project manager structure draws personnel from across departmental lines to achieve extra- or interdepartmental project



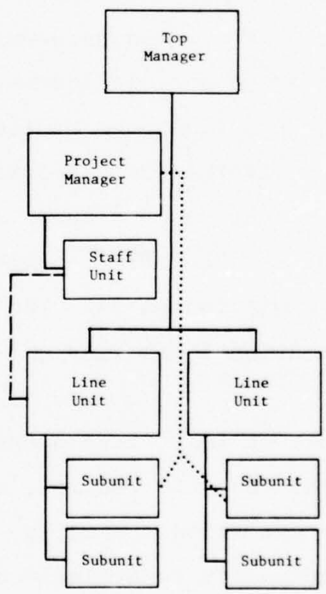
a. Line Organization Structure



b. Line and Staff Organization Structure



c. Functional Organization Structure



d. Project Manager Organization Structure

Key: ———— Line of Direct Authority

– – – Line of Advisory and Information Contact

·········· Line of Functional Authority

Source for a, b, and c: Bureau of Naval Personnel, 1964

Figure 1. Types of Formal Organization Structure

or program goals; such projects are integrated and commanded by independent managers.

This report is specifically concerned with particular formal structure aspects of functional types of organizations. These generally comprise the subset of organizations that are solely decision-making bodies. Authority over particular types of tasks is distributed among various personnel in the functional staff who maintain responsibility for developing plans and decisions within their assigned functional area. However, the actual execution of these plans and decisions may be performed by line units outside the functional organization.

Informal organization structure describes the system of dynamic, interpersonal transactions that occurs in an active organization. Informal processes, patterns, and relationships naturally develop among organizational personnel to help them handle the problems and requirements of their roles according to their own personal styles. While the formal structure establishes the official norms, an informal structure develops among staff members that defines the manifest activity patterns practiced, which may or may not diverge from official prescription (Blau, 1974). Depending upon the situation, the rules and procedures of formal structure may be superceded by the unique chemistry of interpersonal relations required to accomplish mission goals. Thus, informal structure identifies the reality of organizational behavior and performance.

In concept, at least five generic types of informal structure can be identified. But, in reality, as with the formal types, they are open to unlimited variation. Briefly, a centralized structure employs a focused flow of authority to a single source at the top of the organizational hierarchy. A consultative structure also maximizes patterns of central control, but encourages vertical, upward communication of advice and guidance from the professional staff. A transactional structure stresses open communication, deliberation, and negotiation, not only vertically among hierarchical levels but laterally within levels. However, authority for the final decision may still remain with top management.

A partially delegated structure distributes authority among professional staff while increasing the need for coordination of effort. In this structural type, staff may possess authority to develop a set of action alternatives, but management retains the right to reject or modify these options, and thus manage by negation. Finally, a decentralized structure delegates and disperses full decision-making power to staff at lower levels of the hierarchy.

Formal and informal structures represent organizational arrangements in theory and reality, respectively. Formal structures define a set of decision methods and procedures that are designed by management to optimize organizational performance. The choice of formal structure is based on management's prior experience and expectations of the configuration of personnel that it feels will operate best given the circumstances. Thus, the decision to implement a particular formal structure is essentially a theory of organizational optimality based on specific anticipations and assumptions. The reality of organizations can be specified by attending to the informal structure. It defines the actual decision methods and dynamic problem-solving processes that behaviorally motivate organizations.

While theory and reality -- formal and informal structure -- exist concurrently, they may not be entirely consistent with each other (Blau, 1974; Genensky and Wessel, 1964). The interpersonal dynamics that activate an organization in performing its tasks may not necessarily conform with formal prescriptions of that process. People do not always follow official formulas, nor do they always find them most advantageous in the day-to-day exercise of their tasks. However, minor incongruities between formal and informal structures need not hinder organizational operations. On the other hand, as theory becomes further removed from reality, a restructuring of one or the other is necessary to maintain rational and effective performance.

Focus

Within the military generally, and naval task force staff in particular, clear, formal organization structures exist. Official authority relationships, duties, and procedures have been carefully documented. (See, for example, The Navy Staff, (NWP-12(B)) (Office of the Chief of Naval Operations, 1971)). In naval task forces, as in all organizations, there is also an informal organization structure. These formal and informal structures are interactive -- each constrains and facilitates the shaping of the other -- and, thus, they cannot be considered independently from one another.

The objectives of the following section are twofold:

- To explore the nature and shape of formal organization structure in technological environments.
- To examine the appropriateness of various informal organization structures in situations of technological innovation.

THE POTENTIAL EFFECTS OF TECHNOLOGICAL INNOVATION ON FORMAL AND INFORMAL ORGANIZATION STRUCTURE

Some Traditional Decision Aids

In the absence of automated assistance, organizational decision-making processes are basically judgmental and highly subjective, motivated by expertise, professional skill, and prior experience. Certain methods are usually prescribed, and others develop in the social interaction process that aids in making decisions. For instance, the Navy publishes tactical doctrine documents that provide formal guidelines and standardized procedures to help decision-makers cope with operational problems. These publications do not attempt to preprogram all possible decision environments; they merely suggest guidelines for action in routine and nonroutine problem situations. The development of explicit processes or solutions is left to the commander's judgment.

Sometimes decision-making can be facilitated by informal and interpersonal contacts. A naval task force commander may find, for example, that a series of analytical discussions with the chief of staff, whom he respects and trusts and who has had extensive experience dealing with similar operations, is the most efficient means to decide among various alternative actions. Thus, personality and the chemistry of group relations can also provide an informal, ad hoc procedure for decision-making.

Computer-Based Decision Aids

The introduction of technological advancements in the decision-making process may modify reliance on these tried and tested methods. Management information systems (MIS) and computer-based decision aiding systems are revolutionary instruments that can assist decision-makers in handling routine and complex problems. They can drastically alter the traditional procedures of problem-solving by relieving tedious tasks, providing innovative approaches to complex problems, and creating an entirely new spectrum of functions to be performed.

In essence, a decision aid is any technique or procedure that restructures the method by which problems are analyzed, alternatives developed, and decisions chosen. It usually involves the systemization of procedures that assign values to action alternatives and calculate utilities of their probable outcomes. In versions that are most useful in decision-making, the computer-based systems are of an interactive mode. That is, the substantive expert interfaces with the machine to produce results. Decision aids do not decide on their own (total decision automation), nor do they eliminate the need for expertise and professional judgment. Rather, these tools augment and enhance the capabilities of decision-making personnel to perform effectively and efficiently.

Decision aids maintain a vast memory of past occurrences and situational data that can be brought to bear on particular problems. They not only store these data for later retrieval, but can also consider the impact of many simultaneous factors that impinge on a problem based on statistical or mathematical algorithms. Thus, the decision-maker can obtain an integrated picture of the facts that define the entire decision-making environment. Moreover, the analytical capacity of decision aiding systems interfaces with the expert's knowledge and ability to derive alternative paths of action and decide on the best option within contextual constraints. In combination, the expert and computer-based decision aids can yield more accurate and rapid probabilities and projections concerning future alternatives than were previously possible.

The Impact of Computer-Based Decision Aids on Organization Structure

Computer-based decision aids are not only new instrumentalities; they are likely to have direct consequences on official organization procedures and relationships or formal organization structure, and organizational interaction patterns or informal organization structure. The implementation of these technological advancements can be seen as a catalytic event, altering decision-making procedures and the human relations involved in that process. Just as formal prescriptions and guidelines and informal, improvised mechanisms that assist in decision-making can influence the formal and informal structure of organizations, so technological innovation may impact on the organization structure involved in formulating decisions.

The Effects on Formal Structure. Computer-based decision aids are likely to have an impact on three formal structure aspects of functional decision-making organizations:

- The appropriate placement of decision aids.
- The assignment to new organizational roles.
- The appropriate placement of decision aid operators in the formal hierarchy.

Each of these items will be treated in turn.

a. Placement of decision aids

A decision must be made at the outset by top management concerning the location of the computer system in the organization. In this choice, two alternatives are considered:

1. The placement of authority in each division for independent systems (divisional installations), or
2. The placement of authority at the top for one supersystem to service all divisions (pyramidal installations).

Figures 2a and 2b are formal organization charts depicting these divisional and pyramidal options. In divisional installations, the decision aids are located at the level where task performance and information originate (Colbert, 1974). Authority over these systems is delegated to each division individually. The proximity of computer staff to divisional problems and needs makes application of the system more efficient and focused. Special requirements of each division can be met with fewer bureaucratic tie-ups using independent, divisional systems rather than a central, pyramidal supersystem. However, divisional installations may be costly, may necessitate sharing computer personnel among divisions as an economy measure, and may result in inbred and biased solutions. Moreover, divisional structures may evoke resentment within certain departments if the responsibility for computer services is concentrated in a single department (Kanter, 1972b).

A pyramidal installation establishes focused and central control over one system that can support all divisions (Colbert, 1974). In this type of structure, the various divisions of an organization transmit data input and analysis requirements to a central point controlled by top management that provides computer processing services. This option provides integrated control to benefit overarching organizational goals as opposed to chauvinistic divisional objectives. Moreover, it enables top management to monitor current situations closely. By their very nature, pyramidal installations can

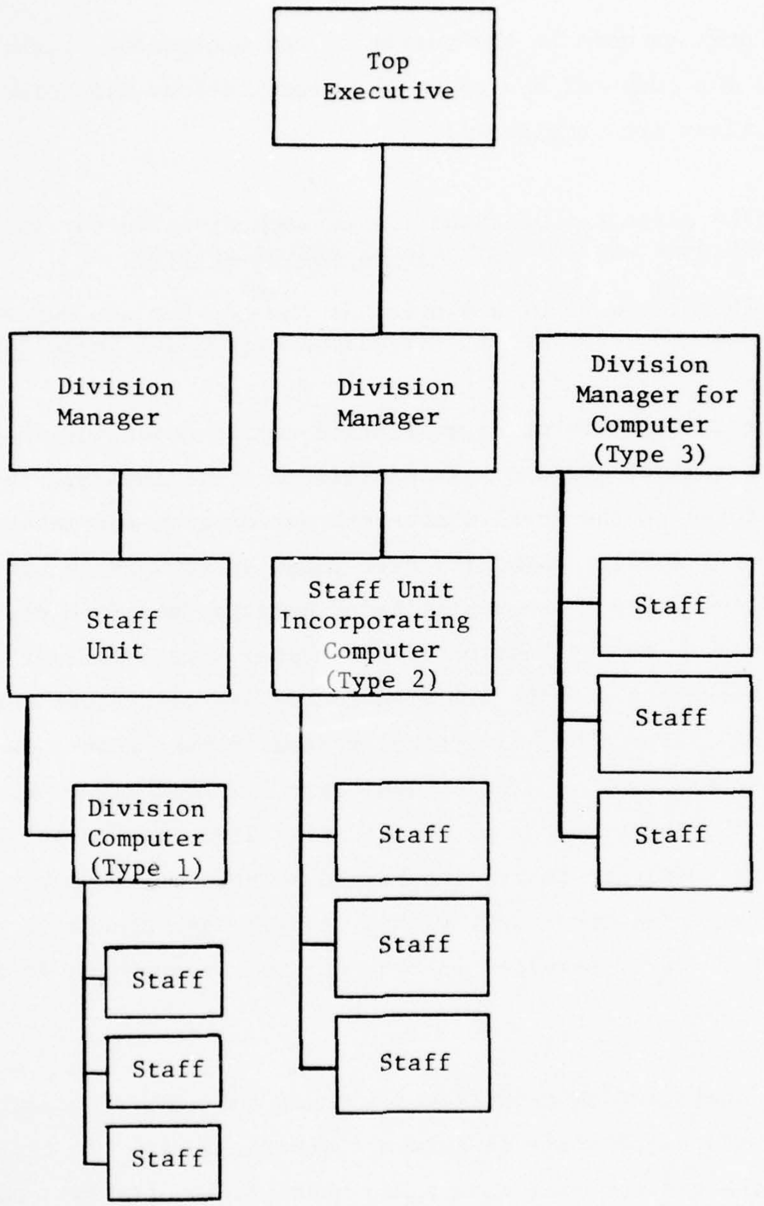
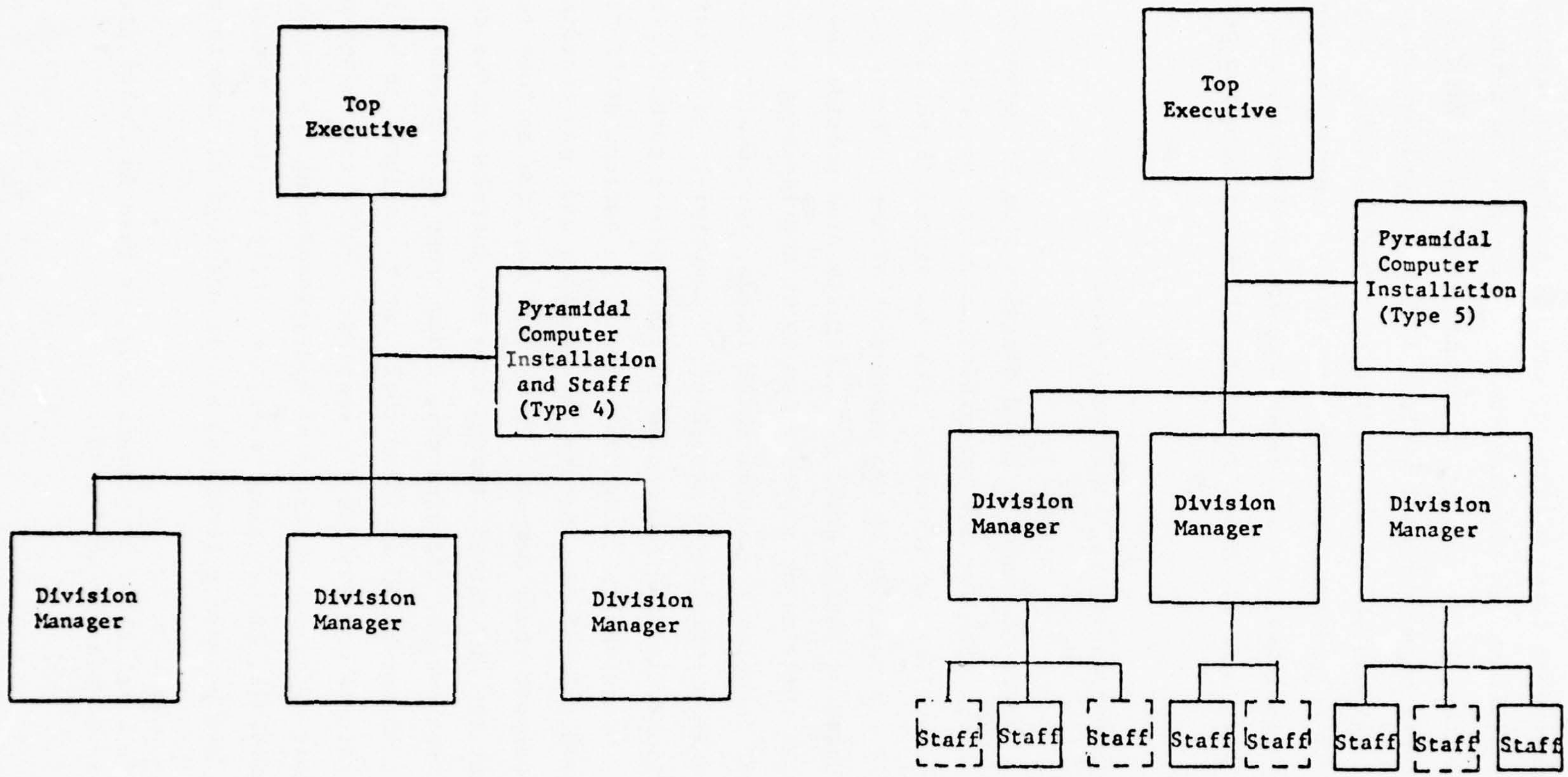


Figure 2a. Three Typical Divisional Computer Installations



Key: Dashed box indicates that division staff serves double-duty in pyramidal computer installation.

Figure 2b. Two Typical Pyramidal Computer Installations deal with interdependent tasks of various divisions in an integrated fashion. These installations can simultaneously collaborate and resegment traditional functions, thus enabling functional areas to be tackled as they relate to total organizational goals. Although coordination problems become more obvious and taxing in pyramidal installations, computer capacity is likely to be maximized. However, while economies in central processing may be realized, the increased complexity of scheduling and programming for the needs of an entire organization may mushroom personnel costs.

b. Assignment to new organizational roles

Another possible impact of computer-based decision aids on formal organization structure is the need for new organizational roles of technicians, coordinators, and analysts to interface with the system (Rose, 1969; Harris and Erdman, 1967). A decision by top management either to train current staff in these roles or assign skilled specialists from outside the organization hinges upon three major suppositions about the incoming technology and current staff potentials -- staff skill levels, adaptability, and training. The skills required to manipulate a computer-based decision aid vary proportionately with the degree of the system's technological sophistication. Conceivably, management and/or the current staff already possesses the needed skills to operate the decision aids and coordinate, analyze, and interpret their output. If they do not, two options remain. Present personnel can be trained, though this may introduce undue delay in implementing the system. Alternately, a new group of personnel that is specialized in computer-based decision tools can be assigned to handle the system, and coordinate and analyze its results.[1] While the second option appears to be most efficient in terms of operationalizing the system in the quickest time possible, it may also be highly costly to the organization. These personnel are primarily technical and methodological experts and are

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[1] This option is more likely in private industry than in the military where training is constantly conducted.

not fully acquainted with the substantive and functional questions with which the organization must cope. In the short run, their lack of knowledge about organizational policy and direction can disrupt normal functioning toward organizational objectives.

The ability of the current staff to adapt to changes in organization structure is another important factor determining the need for outside personnel. If specialists are assigned, many decision-making functions formerly performed by existing personnel are transferred to the new personnel. These modifications in task and role functions may evoke feelings of animosity and resistance toward the technicians/analysts/coordinators and the decision aids. In reaction to these changes, present staff may come to resent and distrust the newcomers and their tools and may continue to conduct traditional decision-making procedures in duplicate effort (Selleck, 1971).

Finally, because of the staff's learning capacity, it may be more economical, in the long run, to assign specially skilled personnel only during the initial phases of system implementation and withhold formal training of the present staff (Stewart, 1971). Over time and with continual reinforcement, professionals can become acclimated to the new decision tools and, through informal, on-the-job training, become proficient in their use. Thus, the supplemental personnel costs incurred by assigning specialists can be justified in terms of their transitional status in helping the organization to overcome the initial technological hump. However, depending on the degree of decision aid sophistication, on-the-job training may prove to be insufficient for effective computer utilization (SRI, 1974).

c. Placement of the decision aid operators

The third formal organizational concern of top management involves the official placement of the decision aid operator staff. In terms of the formal charting of the organization, top management must decide where to place the decision aid operators vis-a-vis the present professional staff and whether the present staff ought to operate the decision aiding system itself. Should the decision aid operators populate a new level that personally assists top management? Should they have lower status than the professionals? Should they share the same hierarchical level? To a certain extent, as discussed earlier, these questions are determined by the formal location of the decision system in the organization structure. Nevertheless, placement of the decision aid operators in the hierarchy will have important implications for their status and power in the organization (Colbert, 1974).

Formal procedures can be implemented that extend or limit the power of the decision aid operators. They can be assigned merely as information processors, empowered only to manipulate the decision system, answer specific requests, and forward all of the results to other staff for analysis and evaluation. On the other hand, the decision aid operators can be delegated explicit authority to interface with the system in the name of top management, interpret and assess results, and ultimately recommend policy options. Obviously, in this case, a certain degree of authority and responsibility would have to be transferred from existing professional personnel.

The decision aid operators require data input and requests for analysis. In return, they supply support to management and professional staff for planning and executing policy decisions. Congruence between formal placement of the decision aid operators and informal structure is a crucial factor. Depending upon the tasks performed by the system and the informal requirements for close interaction among personnel to iterate to a decision point, lateral communications flow may be more efficient than vertical flow. If these communication factors are taken into account when the aiding system is implemented, the formal organization structure can be designed to complement vital group processes.

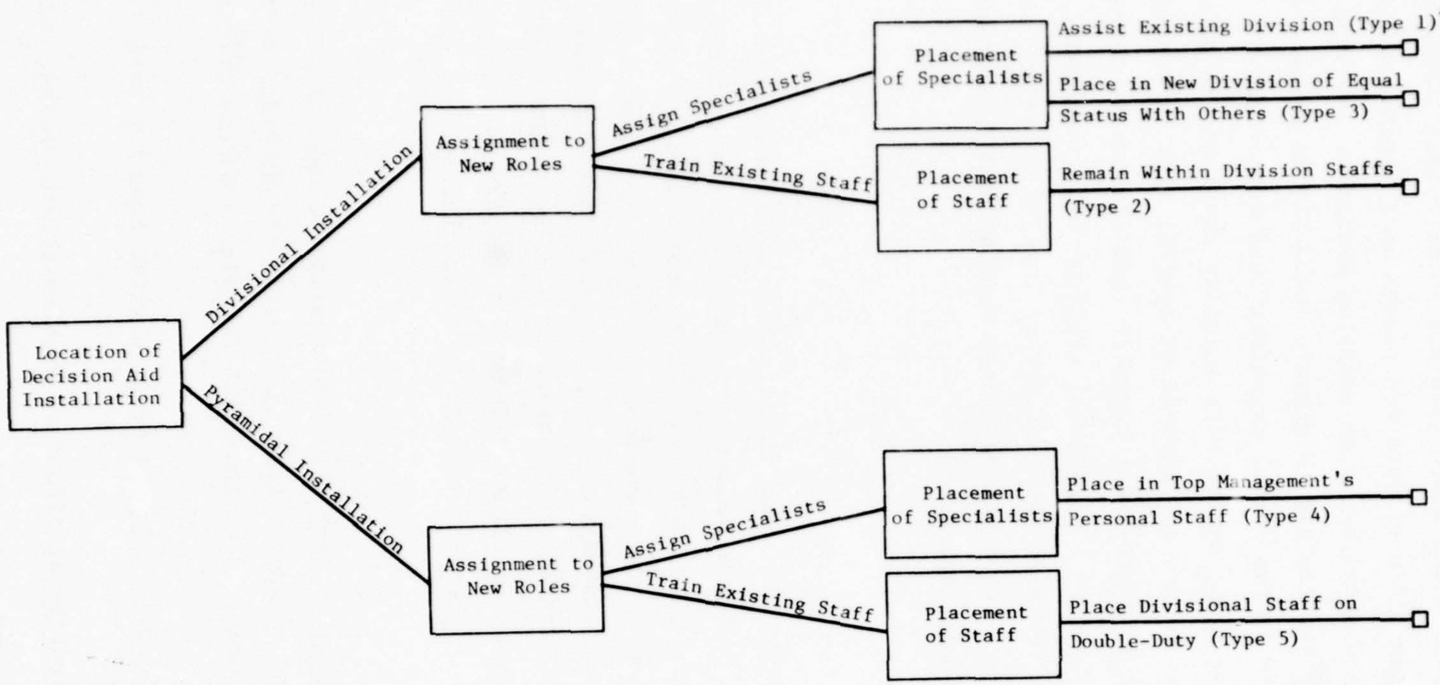
Figures 2a and 2b (see above) indicated five possible locations for the decision aid operators. Types 1, 2, and 3 are appropriate to divisional installations. Types 4 and 5 are feasible in pyramidal installations. In Type 1, the decision aid operators are placed in a formal unit that provides assistance and services to an existing division. In Type 2, existing professional staff are trained to operate the decision system, reducing the need for any change in the formal organizational structure. In Type 3, a new division having equal status with existing divisions is established; decision aid operators are assigned to it specifically to provide computer services. In Type 4, a pyramidal computer installation is formed employing decision aid operators in the personal staff of top management. Alternatively, in Type 5, if existing staff are trained, a pyramidal installation can be maintained by divisional personnel serving double-duty as both decision aid and divisional staff.

d. Focus

The potential redesign of formal organization structure always involves a conscious effort by top management to anticipate a new situation that will make the present structure obsolete or inefficient. The introduction of a computer-based decision aiding system to an organization can certainly be seen as a catalytic event that would activate management in this regard. Consideration of the shape of a revised formal structure primarily depends upon the expected impact of the new technology and personnel requirements. Figure 3 represents these choices as a sequential decision network.

The Effects of Informal Structure. Implementing an operational decision aiding system may also cause certain changes in the dynamics of informal organization structures. Computer-based decision aids can affect

- Role differentiation and cause a vital need for task integration,
- Standardization of effort in problem-solving tasks, and
- The requirement for particular types of informal organization structure to handle standardized analyses and data processing.



[a] These types refer to the types in Figures 2a and 2b.

Figure 3. Formal Organization Structure Choices in Technological Environments

a. Role differentiation and task integration

The introduction of technological advancements may cause a change in established processes and relationships and thus require a fairly high adaptive capacity on the part of an organization and its members. Technology provides the ability to transcend previously compartmentalized structure by cutting across the traditional division of duties and merging activities by function. Thus, a totally new segmentation of tasks is likely to evolve, determined more by the computer's requirements and special perspective on the problem and less by traditional or habitual methods (Burns and Stalker, 1961; Lipstreu and Reed, 1964; Mann and Williams, 1966; Garrett, 1965). Functionally, decision aiding systems strain existing organizational forms because of the simultaneous push and pull of two antagonistic forces that they activate -- <u>differentiation</u> and <u>integration</u> needs. To achieve continued satisfactory organizational performance and productivity, these two forces may have to be reconciled by institutionalizing a new system of informal structural relationships.

Technology results in increased task differentiation and, hence, specialization of functions. Utilizing computer-based decision aids may help to define precisely the functional boundaries and responsibilities among staff members. As personnel functions become more definitive and specialized, the interdependence between each, in relation to the total system, will become accentuated. The decisional outputs of each separate unit in the decision-making process become increasingly important as inputs to other units.

Coordinating and integrating these specialized and interdependent functions are essential to enable organizational unity of effort in an increasingly dynamic organizational environment (Lawrence and Lorsch, 1967a). To achieve the needed organizational coordination, improved information, communication, and feedback systems can be developed, administration procedures and guidelines instituted, and changes in informal organization structure recommended.

b. Standardization of effort

Improved technology can make decision-making more efficient, not only by providing new procedures, but also by standardizing the techniques of decision-making. Given a certain class of problem, information processing and problem analysis are undertaken in a comparatively standard fashion: the decision system has a particular set of data, demands particular types of input from analysts, and outputs particular kinds of solution alternatives. This is not to suggest that computer-assisted problem-solving is a deterministic effort. The expert serves a crucial role in developing the criteria and parameters that mediate computer analysis of the problem. The results are also open to varying interpretations by analysts. But essentially, computer-based decision aids provide the analyst with a standard approach to coping with problems.

c. The requirement for particular types of informal organization structure

A vital question that arises from this discussion is whether increased standardization of procedures, as a result of decision aid technology, demands particular types of informal organization structure to deal with the new methods. If the question is answered in the affirmative, the implication is that particular types of decision aiding systems require certain kinds of informal organization structure to operate efficiently. Interpersonal dynamics must be structured in a particular fashion to interface successfully with the computer-based system. If the answer to the question is negative, it suggests that a wide variety of organization structures may be equally capable of maximizing the standard procedures developed by the decision aids.

A secondary question, if the answer to the first is affirmative, deals with specifying the informal organization structure that would be most appropriate and efficient in maximizing a decision aid exploitation. In a <u>centralized</u> organization, the staff would feed the increased flow of information and analytical output derived from the system to top authoritative management. Data would flow from many different points within an organization to a central point for decision. A transactional structure would immerse all levels equivalently in problem-solving tasks, regardless of status in the hierarchy. Decision-making would be a matter of total group interaction based upon total group understanding of the facts, alternatives, and goals. In a decentralized organization, the staff who directly interface with the computer system and have a clear understanding of organizational objectives would be authorized to make decisions. However, their decisions would not be made in complete isolation from the rest of the organization; coordination of effort would prevail among those who share the delegated authority.

d. Focus

Which type of informal structure would enable the maximum utilization of a decision aiding system? The answer lies in the particular situation within which an organization operates. While the shape of formal structure depends largely on anticipating technological impact and personnel characteristics, the feasibility of various types of informal organization structure depends on the combined interaction of technology, personnel, and mission variables in the organizational climate.

An analytical framework is developed in Chapter 4 that provides a logical and practical approach to studying formal and informal organization structure in various environments. It incorporates the mediating impacts of several situational dimensions and can assist the analyst and practitioner in determining optimal organization structures.

ORGANIZATIONAL CHOICES IN TECHNOLOGICAL ENVIRONMENTS

Management must make certain choices concerning the shape of formal and informal organization structure given the exigencies of a technological environment. That a rethinking, and perhaps a restructuring, of organizational structure is necessary in such situations has been demonstrated amply in the previous section. The specific alternatives available to management in organizational planning efforts are described below.

Formal Structure Choices

Three elements of formal organization structure must be specified by management as a result of the implementation of decision aids:

1. Create a divisional or pyramidal decision aid installation.
2. Assign specially skilled personnel from outside the organization or train existing professional staff.
3. Locate decision aid operators in an assisting subunit, a new division, an existing division, personal staff of top management, or have them serve double-duty.

The rationales supporting each of the organizational alternatives were discussed in the previous section.

Informal Structure Choices

Five basic types of informal structure can be specified as potential organizational alternatives: centralization, consultation, transaction, partial delegation, and decentralization. These structures can be placed on a continuum based on the combined values of three fundamental organizational properties: authority, coordination, and communication.

Organizational Properties. Prior to a discussion of the five informal structures, a brief description of the three organizational properties is necessary. These elements pinpoint how and why organizational subunits relate to each other in performing their functions. The combined interaction of these characteristics help to define different modes of informal organization processes. Although each is definable analytically, these properties are, in reality, continually interactive. Thus, variation in one always has consequences for each of the others.

Foremost among all organizational relationships is the property of authority. It incorporates the power to command and the duty to obey (Weber, 1947). Authority involves a certain minimum of unconditional voluntary submission and compliance to a superior due to shared beliefs in the superior's legitimacy to impose his will. The possession of authority provides influence over the direction of organizational policy and activity. Operationally, managers who possess formal authority may conclude that satisfactory performance can be achieved by delegating some of their authority to subordinates (Galbraith, 1973). Thus, various types of authority patterns may yield very different types of informal structure.

The design of complex organizations requires the coordination of many interdependent tasks to achieve a successful unity of effort. The increasingly dynamic environment of highly differentiated organizations usually demands the adoption of some form of integrative mechanism. In fact, a study by Lawrence and Lorsch (in Galbraith, 1973) supports the proposition that integrating mechanisms are developed in direct proportion to the degree of differentiation within an organization. The "integrator" is often actualized as a manager who assumes the role of mediator among highly specialized functions (Lawrence and Lorsch, 1967a). Coordination can also be achieved by developing rules and standard operating procedures that formalize methods in a prescribed fashion. In addition, various informal organization structures can be designed to foster increased coordination among interdependent departments.

Communication is the vehicle that enables the exercise of authority and the coordination of activity. Kuntz (1967), studying military organization, wrote that "...from the commander's point of view, his organization is primarily a communications network." Communication linkages are concerned with information flow, both vertically and laterally. Information from top management in the form of policy perspectives is required by lower echelons so that tasks are performed in accordance with organizational objectives. Too, incoming data from the external environment, which are usually received and processed by low hierarchical levels, must be transmitted upward for management to maintain a clear, integrated, and current picture of the organizational status. In addition, horizontal communication paths are often necessary for maximum efficiency. For instance, the head of the operations division of a naval task force should be aware of current logistic support and intelligence information, incoming directives from superior commands, and crucial data from other divisions of the task force to make suitable and feasible tactical plans.

A Continuum of Informal Structures. Table 1 enumerates various values of these three fundamental properties and the results of their combined impact on informal organization structure. Thus, each of the five identified points on the continuum is defined in relation to these three dimensions. Other organizational analysts (Lewin, Lippitt, and White, 1939;

TABLE 1

A Continuum of Informal Organization Structures

		Values of:		
	Informal Structure	Authority	Coordination	Communication
Leader-Centered	Centralization	Concentrated	From Top	Basically Downward
↑	Consultation	Concentrated	From Top	Upward Sought
	Transaction	Shared	Total	Vertical and Lateral
↓	Partial Delegation	Partially Delegated	From Below	Lateral
Sub-ordinate-Centered	Decentralization	Totally Delegated	From Below	Lateral

Vroom and Yetton, 1973; Galbraith, 1973; Heller, 1971; Likert, 1967; Maier, 1955) have attempted to develop similar continua of informal structures, but they have failed either to identify as many points or to employ as many dimensions as the present conceptualization. This continuum provides a foundation for an integrated theory of informal organization structures and should assist managers in making pragmatic decisions concerning informal organizational planning.

Choices on the Continuum. Each informal structure on the continuum is described briefly in terms of its characteristics, advantages, and disadvantages.

a. Centralization

In a centralized structure, total authority and responsibility for making decisions and allocating resources are concentrated at the top echelons of the organization (Carlisle, 1974; Simon, 1954). Problems are solved, plans made, and orders issued by top management alone on the basis of available information. Thus, informal processes are essentially autocratic. Communication networks are primarily vertical: orders and directives flow downward from positions of authority, and incoming data are transmitted upward from low level staff. In centralized structures, coordination of operations is also a function of top level officials. Although this type of informal structure appears to be appropriate in combination with tall, multilayered formal structures, it is also compatible with flat, formal hierarchies (Burlingame, 1961).

Centralization offers distinct advantages and disadvantages to organizational performance. It ensures that decisions are made by highly experienced personnel and are in the best interests of the entire organization. Concentrating authority at the top also helps to achieve organizational consistency, coordination, and balance among functional divisions. Moreover, centralized structures help to eliminate potential duplication of effort and assist in allocating resources where they are most needed (Carlisle, 1974). On the other hand, overdependence on centralization may result in transmitting inaccurate information to top level decision-makers due to excessive filtering in vertical communication links. It also limits the range of direct contribution by competent specialists (Blau, 1974). Those who possess professional expertise may find their creativity squelched by excessive management and direction. Finally, centralization encourages fixed and deterministic response patterns that may inhibit flexible reactions, especially in stressful situations (DeCarlo, 1967).

b. Consultation

This structure is a less extreme form of total centralization. It possesses many of the same advantages and disadvantages, but their impacts are somewhat modified. In consultative structures, top management involves knowledgeable subordinates, to a limited extent, in the decision-making process. The manager presents problems to staff specialists and receives briefings from them to obtain their collective ideas and suggestions. Ultimately, the final decision is made by the top levels (Vroom and Yetton, 1973). In this type of informal structure, the professional staff can exercise a certain degree of influence over major decision-makers by the nature of the information and action alternatives they provide.

c. Transaction

In transactional informal structures, problems are handled jointly by leaders and subordinates. Together, information is coordinated, alternatives generated and assessed, and attempts made to reach agreement and consensus on a solution. The leader acts as both chairman and mediator and as member of the group. Top managers participating in this type of structure do not seek to influence the group directly so that their pet solutions are adopted. The preferred solution, supported by the entire group, is usually the one implemented by top echelons (Vroom and Yetton, 1973).

Hollander and Julian (1970) and Potter (1974) view transactional structures as systems of exchange and reciprocation between leaders and subordinates. These systems are activated by extensive interactive communication networks among all organizational subunits -- *within* levels (lateral) and between levels (vertical). The objective of this type of structure is to maximize the flow of data, ideas, suggestions, and policy orientations among top management, middle management, and professional staff by reducing the rigidity in communications sometimes imposed by formal hierarchical rank and status. By opening communication paths among personnel at all levels, the organization can draw upon all of the administrative, informational, and analytical resources at its disposal and thus optimize decision-making efforts. Individual creativity and initiative at lower hierarchical levels are not stifled, and top management can maintain its formal decision-making authority.

Blau (1974) concludes, on the basis of two surveys, that transaction is the most appropriate informal structure for increasingly professional organizations. In this type of structure, greater contact between management and professional staff increases communication and collaboration, stimulates professional productivity, involvement, and satisfaction, and channels expert consideration expeditiously onto policy alternatives that are important to the organization. Burns and Stalker's (1961) concept of organic organization structures is also similar to transaction. They argue that greater interaction and involvement by all levels in problem-solving efforts will yield greater commitment to group objectives and, thus, higher levels of performance. Moreover, organic structures can easily adapt to new and complex decision environments.

There are also associated costs and difficulties in implementing transactional structures. It is often hard to shake the aura of executive status among subordinates and executives. Despite the desire to share problems equally, it may prove difficult to free communication to the point of complete and uninhibited openness. Top echelons may also feel uneasy about delegating authority to a team, even one in which they are members. Although management may consider transactional structures to offer the most comprehensive and innovative decision-making methods, it should be willing to accept the team consensus, whether or not that is management's chosen solution. Moreover, transactional structures are prone to excessive deliberation and negotiation that slow reaction time and make decision-making somewhat cumbersome in immediate and stressful situations.

d. Partial Delegation

In a partially delegated informal structure, lower level staff members are usually responsible for particular types of decisions or certain functional areas in which management does not actively participate (Carlisle, 1974; Simon, 1954). However, the amount of authority delegated to them to perform their duties is limited. Staff members may deliberate on a problem, formulate action alternatives, and select a single proposed solution, but management retains veto power over its implementation; it manages by negation. Thus, partial delegation results in a highly participative, democratic, and lateral system of interaction, integrated at low hierarchical echelons, but circumscribed in authority by top management desires. This type of informal structure is similar to, though less extreme than, totally decentralized organizations. The basic characteristics of partially delegated structures can be understood from a description of decentralization.

e. Decentralization

A decentralized informal structure approximates a system of laissez-faire management. In this structural form, a problem is delegated to a group of subordinates that is given complete responsibility and authority to solve it alone. The group may or may not be requested to report back on its solution and implementation; thus, a veto power by top management is not retained. Managers who employ this structure must have explicit confidence and trust in their staffs to perform duties properly and in accordance with organizational objectives. Of course, all problems need not be delegated to subordinates, and the ones that are delegated may be of a routine nature. In essence, decentralization is identified by the distribution of authority and control rather than their concentration in the hands of a few.

Communication patterns in decentralized structures are basically horizontal; discussion and information flow occurs among personnel at equivalent hierarchical levels to maximize interdepartmental coordination of effort. Vertical communication in these types of structures consists less of orders and directives from above and more of reports of actions taken at lower levels. In this sense, vertical communication reflects the distribution of authority and responsibility that binds lower levels to higher echelons.

Decentralized organizations often present complex coordination problems because of the increased span and distribution of authority over interdependent tasks. Several methods can be employed to coordinate activities. Group or consensus decision-making can be used in which representatives of all affected departments assemble, analyze the situation, and arrive at a common solution. In this technique, the obligation to integrate functions rests at the lower levels. Another fundamental method of coordinating interdependent organizational elements is through the use of an integrator (Lawrence and Lorsch, 1967a; Galbraith, 1973). The integrator serves as a mediating function to collabcrate efforts toward common organizational goals. The integrator gains authority by remaining neutral, establishing trust, equalizing power differences, and maintaining contacts at top levels.

Decentralized organizations can be formally structured in several ways. Complexity in coordinating a decentralized structure is greatest in large organizations with tall, pyramidal structures, and in organizations with long, flat structures and many divisions of equal status at each level. There are a large number of interdependent elements to consider and coordinate in these two types of formal structures. On the other hand, in smaller organizations and those with few formal levels and departments, major coordination problems usually do not exist since there are fewer decisions and activities to integrate.

Decentralized organizations possess certain advantages and disadvantages for successful performance of mission tasks (Carlisle, 1974; Simon, 1954). This structural type reduces the workload of top management, resulting in more time to address broad policy issues affecting the future of the entire organization. It also brings about innovative solutions, a greater sense of efficacy, and increased job satisfaction and efficiency among lower level personnel. Moreover, it provides management experience to future executives. Decentralization can enhance organizational performance by reducing reaction time for routine and planning problems. When authority rests with a staff that is aware of the local situation and close to the immediate facts, multiple hierarchical levels need not be consulted and response time is shortened. Conversely, decentralized structures can obscure formal lines of control and create leadership problems and role conflicts among staff personnel. Moreover, effective performance may be inhibited if extensive coordination efforts are required at the expense of problem-solving tasks.

CONCLUSION

This chapter has provided the foundation for a comprehensive analysis of organization structure in technological environments. The terms that describe organization structure have been distinguished and clarified. The potential effects of decision aid implementation on the structure of organizations have been assessed and the organizational choices available to cope with these projected changes enumerated. The concepts and relationships discussed in this chapter are now employed in Chapter 4 to develop an integrated contingency model of organization structure in technological environments.

CHAPTER 4. DEVELOPMENT OF A CONTINGENCY MODEL OF ORGANIZATION STRUCTURE IN TECHNOLOGICAL ENVIRONMENTS

SUMMARY

How can management choose the optimal decision method -- the most appropriate organization structure -- to solve its problems, achieve organization objectives, and improve organizational performance? Moreover, does the implementation of computer-based decision aids in an organization influence this choice? Any of the formal and informal structure types enumerated in the previous chapter are viable candidates. But which is "the best" vehicle for efficient and effective performance within technological environments?

A contingency model is developed in this chapter that can assist management in choosing the appropriate organization structure. The relevant literature concerning the organizational consequences of technological environments is evaluated and integrated. The disjointed and often contradictory generalizations found in this literature directed the study team to develop an approach that coordinates various important determining factors into a single comprehensive framework. Several researchers have dealt with these determining factors on an individual basis. Their work has also been reviewed and employed to support the assumptions of the model.

The objective of this section is to derive a model that not only simulates reality and is theoretically pleasing, but also aids in making crucial organizational choices in the task force environment. In this regard, a set of integrated, operational assumptions and rules is devised that can assist in choosing appropriate organization structures given technological innovation and other situational conditions. Essentially, the model prescribes a set of preferred structures that will facilitate necessary choices in planning organizational change. These prescriptions can be tested in real or simulated settings.

ORGANIZATIONS AND THEIR ENVIRONMENT

All organizations operate within an environment that both inhibits and facilitates performance of mission objectives. If these environmental relationships can be generalized into valid assumptions, and if the parameters of particular organizational environments can be specified, it may be possible to eliminate from active consideration certain organization structures that appear unfeasible or inappropriate. In others words, from our knowledge of the push and pull of certain types of environments, specific organization structures can be pinpointed that are likely to be the most practical, efficient, and effective within particular situations.

The demands and rewards of the environment can be viewed from two perspectives. Perhaps the most obvious is the environment outside the organization -- the physical, economic, social, political, and military stimuli that facilitate or impede organizational efforts to reach goals. Equally important is the within-organization environment or "climate." Climate describes the enduring characteristics of an organization, its "personality," the internal situation that motivates activity (Forehand and Gilmer, 1969). The dimensions of organizational climate for a decision-making body are classified into three broad categories:

- Properties inherent in the mission to be performed.
- Properties inherent in the personnel that must perform the mission.
- Properties inherent in the technology that can be employed to assist personnel in problem-solving (Sells, 1963).

Climate defines the internal states of an organization that are closest to determining the behavioral performance of a group; the extra-organization environment often has a temporal and less immediate effect on behavior.[1]

[1] In this report, unless otherwise indicated, the term "environment" refers to the inner climate of an organization.

The viability of various types of organization structures is contingent upon the nature of this organizational climate. The three environmental categories listed above play an especially crucial role, as attested to by the Bureau of Naval Personnel (1964: 1): "The organization structure is an index of the relationships between functions, physical factors, and personnel..." Different values of these three climatic factors combine to define specific types of environments in which particular organization structures are feasible, appropriate, and effective. A contingency model emphasizing environment as a determining factor is developed and explicated in this chapter to help predict the viability of various organization structures.

CHARACTERISTICS OF CONTINGENCY THEORY

No organization structure is universally applicable; only under certain conditions do particular structures help to improve organizational performance. Thus, organization structure is situationally relative. Different situational configurations demand different structural designs and, thus, structure is contingent upon context. By ignoring the situation or by oversimplifying it, one can neglect a fundamental dynamic that motivates effective organizations and the development of particular organization structures (Carlisle, 1974).

Contingency theory enables observation of the complex interaction of stimuli in a situation. It is unrealistic to analyze the effects of individual environmental factors in isolation from each other. Instead, the analyst should focus on the configuration of the total situation -- the system of relationships -- that varies in the organizational setting and facilitates or inhibits organizational behavior. Contingency theory provides a modeling methodology to assist in analyzing this situational complexity (Lawrence and Lorsch, 1967b). Moreover, given the objectives of this study, contingency theory focuses attention on the practical concerns of delineating what ought to be the best organizational strategies and procedures for dealing with the demands of particular situations. The contingency approach is normative in orientation and provides prescriptive advice to managers and other users.

SOME RELEVANT CONTINGENCY STUDIES IN LEADERSHIP AND ORGANIZATION STRUCTURE

The contingency approach has been discussed and employed by several researchers in the areas of organizational leadership, management, and structure. Tannenbaum and Schmidt (1958), Forehand and Gilmer (1969), Sells (1963), and Spector (1972) inventory a large number of environmental factors that influence organizational effectiveness, and the viability of different types of informal structures and leadership patterns. Among the climatic variables identified are organizational norms and values, goal directions, group effectiveness and sense of efficacy, group identification, task nature, time pressures, stressful atmospheres, leadership style, and group size.

Fiedler (1965, 1967) is among the few who has developed integrative hypotheses of the impact of multidimensional environments on leadership effectiveness and analyzed these relationships empirically. He found a curvilinear pattern between types of within-organization situations and effective leadership styles. Task-oriented leaders are most effective in highly favorable and unfavorable climates; relations-oriented leaders are effective in moderately favorable environments.

Several researchers have recently applied a contingency perspective to the study of organization structure. Carlisle (1974) enumerates 13 situational factors that determine whether centralization or decentralization will be effective in particular circumstances. He explicates several normative assumptions that suggest which of these organization structures is likely to be most appropriate. Managers must evaluate the status and significance of each of these variables in their organizations and coordinate all of the assumptions to determine which structure should be chosen. Unfortunately, Carlisle merely provides a framework for analysis and stops short of testing the validity of his assumptions.

Analyzing the problems of conflict resolution and integration in increasingly differentiating organizations, Lawrence and Lorsch (1967b) conclude that organizations should develop formal and informal structures that are consistent with the demands and pressures of the environment. Unlike the focus of this report, however, the environment for Lawrence and Lorsch centers on the external factors surrounding an organization rather than its internal climate. After conducting case studies of three organizations, they found that those operating within dynamic, diverse, uncertain, and complex situations require elaborate integrating devices, such as formalized cross-functional teams, to provide linkages to middle and lower managerial levels. In such unstable, innovative, and competitive environments, there is a tendency to design more participatory organizations so that the lower and middle echelons become more involved in decision-making. The organization structure is organic, flexible, and adaptable in the face of changing and ambiguous circumstances. Other organizations function within more stable and homogeneous environments. Although a certain degree of functional participation in decision-making can be observed, influence is basically fixed in a centralized fashion. The lines of authority in these structures are definite, mechanistic, and resistant to change.

Vroom and Yetton (1973) focus more closely on the problem discussed in this report. They develop a contingency approach and test a model that narrows the range of appropriate informal organization structures. Their model suggests that different configurations of organizational climates determine the relative effectiveness of particular forms of participatory management structures. Through empirical testing, they conclude that a leader's choice of a highly participatory decision method, similar to a transactional structure, is most effective when (1) the quality of decision is important, (2) acceptance of the decision is required by subordinates for effective implementation, (3) there is low probability that subordinates will accept autocratically derived decisions, (4) information and expertise of subordinates are critical, (5) conflict among subordinates is low, and (6) subordinates are trusted. Highly centralized structures are most effective in situations where managers possess all of the necessary information to generate high quality decisions, the problem is well structured, and subordinates are basically unaffected by the decision.

While many of these studies are concerned with questions similar to those posed earlier in this report, none focus on the additional environmental impact of technological innovations on both formal and informal organization structure. The remainder of this chapter deals specifically with the potential influence of a computerized environment on organization structure. A contingency model of organization structure is developed that analyzes the combined situational effects of technology, mission, and personnel.

THE GENERAL IMPACT OF COMPUTER-BASED DECISION AIDS ON ORGANIZATION STRUCTURE

Implementing computer-based decision systems in an organization certainly modifies a crucial aspect of the environment that may require new decision methods and personnel arrangements. However, decision tools alone comprise only one element of a complex, multifaceted environment. Many researchers have speculated on and empirically analyzed the influence of computers on organization structure to the exclusion of other important situational factors. They have not employed a contingency approach and, as a result, their aggregate findings have been simplistic and inconclusive.

There are several reasons for the failure to predict the organizational consequences of computers that also satisfy the argument for an integrated contingency approach. Despite the likely catalytic impact of computers on organizations, one cannot explain a large degree of variance in the dependent variable, organization structure, by analyzing the effect of just one of many independent variables. Other environmental components also maintain sway over structural design. Also, by isolating the situational influence of computers from other factors operating in the environment, analysis of the interaction effect among situational variables is lost. Computer-based decision aids are introduced into situations that possess many properties, but, as those properties vary, so does the impact of the decision aid. Implementation of similar decision aiding systems aboard a naval vessel and in a permanent command headquarters in port, for example, would have different impacts on organization structure since these two facilities possess a host of different situational components. Without observing the complexity of an interactive environment, one fails to account for the modifying and contingency effects of important situational factors. Thus, similar decision aid installations may yield very different organization structures due to the impact of other situational variants that remain unanalyzed.

Finally, these researchers have measured decision aids in a gross, undifferentiated fashion. They make no distinction among such variables as the sophistication of the system under discussion, whether it has real time capabilities, the nature of its output display, and whether it is in a transitional or fully operational stage of development. Without distinguishing among the types of decision systems that are analyzed, one incorrectly assumes that all are identical and thus influence organization structure similarly. Since, in reality, many of the decision systems analyzed probably possess differing properties, it is again not surprising that the aggregate results are inconclusive. Despite the problems that plague these research efforts, a brief review of their methods and findings is useful to prevent similar theoretical and design errors.

Literature Review

The literature reviewed in this section concerns the effect of computers and automation on organization structure. Whichever term is used to describe the stimulus, the focus on technological innovation covers a broad range of divergent factors. Management information systems (MIS) and computer-based decision aids are only two of the technologies examined. Widely discussed automations are also included such as improved production methods and mechanizations in industrial settings.

Studies dealing with all aspects of technological innovation are included in this review. It is assumed that analyses of the mechanistic types of automation have implications for organizational consequences in computer-based settings. Whenever possible, the type of technology under discussion is cited (see Table 1). However, many studies are speculative and fail to relate the type of innovation upon which their generalizations are based. Ultimately, this consideration may be a major cause of the general ambiguity in the aggregate results of this literature.

Researchers can be grouped into three basic schools of thought depending upon their perspective of the effects of automation and computers on organization structure (Kanter, 1972a). The "futurists" believe that the computer will enable centralization of informal structure and adoption of a pyramidal formal structure because of the emergence of new technology. "Traditionalists," on the other hand, argue that the introduction of computers will facilitate decentralized informal processes by allowing decision-making responsibility to filter down to middle and operating level managers. The third group sees no inevitable organizational impact as a result of implementing computer-based systems; by themselves, computers neither facilitate nor impede movement toward change in organization structure. Table 1 summarizes the aggregate results of this literature.

Leavitt and Whisler (1958), speculating on the effects of future advancement in information technology, belong to the futurist school: Computerized techniques ought to enable recentralization of organization structure. Simon (1965) also argues from this perspective. He feels that automation is likely to provide a push toward more centralization and hierarchical formal structures because it minimizes cost and efficiency. Moreover, the advent of automation may change the relationship between manager and subordinates; greater impersonalization and objectivity in decision-making may cause a reduction in the amount of authority delegated to lower echelons. As a result of computerizing tasks, middle management may move downward in status, losing much of its decision-making functions, and a sharp line may be drawn between top and middle level management (Scanlan, 1973; Paine and Hykes, 1966).

In a case study of the implementation of automated data processing (ADP) equipment in a light and power company, Mann and Williams (1966) clearly

TABLE 1

Results of Studies on the Organizational Impact
of Technological Innovation

Studies Predicting Centralization	Studies Predicting Decentralization	Studies Predicting No Difference
Aldrich, 1972[a]	Emery and Marek, 1966[a]	Anshen (in Lee), 1967
Burck, 1965	Holt, 1970[a]	Burns and Stalker, 1961[a]
Hoos (in Lee), 1967	Khandwalla, 1974[a]	Colbert, 1974
Leavitt and Whisler, 1958	Lipstreu and Reed, 1965[a], 1964	Dearden, 1967a, 1967b
Mann and Williams, 1966	Wilkinson, 1965	Garrett, 1965
Michael, 1966	Woodward, 1965[a]	Gilman, 1966
Payne and Kykes, 1966		Harvey, 1968[a]
Scanlan, 1973		Kanter, 1972a, 1972b
Simon, 1965		Mohr, 1971[a]
Vergin, 1967		Sanders, 1969
Wermuth, 1972		Selleck, 1971
		Shaul (in Lee), 1967

[a] These studies deal with the effects of automation in industrial settings on organization structure. The other studies are concerned with the impacts of computers or management information systems.

reinforce the futurist argument. While the spread of responsibility and authority was on the increase during the transitional conversion period, a recentralized informal structure subsequently evolved when the system became fully operable. Less teamwork and more coordination from above were required once the new technology was firmly instituted. Burck (1965), Vergin (1967), Aldrich (1972), Michael (1966), and Hoos (as cited in Lee, 1967) also concur that centralization is the inevitable consequence of computer implementation. Finally, Wermuth (1972), while shying away from a firm stand on the organizational impact of computerization in the Navy, predicts that the computer is likely to strengthen top leadership and weaken the bureaucracy -- characteristics of a centralized informal structure. He does not expect information specialists to displace traditional leadership elite in government, but sees them as support personnel who will assist in using the increased capabilities of computers.

Within the traditionalist camp, Woodward (1965) found that, as industrial automation techniques increased in complexity, the span of managerial control widened, and greater responsibility and authority were delegated to lower echelons. As a result, a more flexible, organic, and decentralized organization structure developed. Emery and Marek (1966), Khandwalla (1974), and Holt (1970) concur that, in varying degrees, as the level of industrial automation increases in complexity, a general flattening of the hierarchy and the formation of decentralized structures can be observed. On the basis of direct observation, interviews, attitude surveys, and analyses of personnel statistics, Lipstreu and Reed (1964, 1965) reach similar conclusions about the effects of automation on the relationships between supervisors and workers within a baking plant. As the level of automation increased, there appeared to be a movement toward group decision-making structures. Foremen were given greater responsibility and authority over their particular tasks. Increased interdependence among foremen resulted in more cooperation and teamwork, and thus decentralized structures.

Wilkinson (1965) detected more intimate interactions among staff officers in the evaluation, recommendation, and decision processes when computers were introduced into naval command and control systems. Prior to implementing the Pacific Command (PACOM) ADP system, information flow and communication were primarily vertical and coordinated by the commander (centralization). The new system established a common understanding of operations in the naval command staff and tended to decentralize the decision-making structure by increasing horizontal as well as vertical interactions. In describing the development of the PACOM system, Wilkinson emphasizes the need to formalize the structure of commander-to-staff and staff-to-staff relationships, enabling optimal design and use of future naval command and control systems.

A third group of researchers finds that technological innovation has no identifiable effect on organization structure. In empirical studies of industrial technology, neither Harvey (1968) nor Mohr (1971) finds a strong relationship between technological complexity and organization structure. Gilman (1966) argues that computers need not change the structure of an organization but can substantially assist in making tasks easier to accomplish. Computers will not threaten the existence of middle management and thus alter formal structure; rather, they will give middle managers more time to devote to leadership, worker problems and motivation, and coordination functions (Gilman, 1966; Colbert, 1974). As a result, increased use of computers can potentially halt the trend of depersonalization in large organizations.

Several authors agree that, in a computer-based environment, different types of organization structure may be equally appropriate. When both centralization and decentralization are equally feasible, the best choice depends upon analyses of the tasks, functions, and circumstances of the organization (Kanter, 1972a, 1972b; Garrett, 1965; Anshen as cited in Lee, 1967; Shaul as cited in Lee, 1967; Sanders, 1969). Burns and Stalker (1961) concur, in their theoretical treatise, that rational, structural forms should not be chosen solely on the basis of the technological situation; consideration should also be given to the organizational mission and personality of top management. While implementing computers and MIS, may result in centralization of information, it does not necessarily demand centralization of authority and control (Selleck, 1971; Dearden, 1967a, 1967b). Therefore, although information networks may change, organization structure remains constant.

Summary. Several implications can be drawn from the summary of findings presented in Table 1. First, slightly more weight is given to a centralized outcome or a no difference outcome. Studies predicting decentralization appear to be in the minority. However, the amount of evidence for all three points of view is substantial.

Second, studies dealing with the effects of automation in industrial settings cluster primarily in the decentralization camp. Research concerned with the impact of computerization concludes that either centralization is the maximizing organizational strategy or the choice of group structure makes no difference on decision aid effectiveness. Why is this so? Computers facilitate the development of a central information source that can be directly employed by the organizational leader if he has the time and inclination. Processing and integrating information in a single, accessible source enable the leader to make decisions in areas where data and expertise were previously dispersed and authority was delegated.

The literature has indicated that computers help to centralize authority that was previously delegated. In large part, this is due to the computer's central data bank that facilitates decision-making recentralization by the top of the hierarchy. However, each of the studies that deal with computer impacts analyze nonstressful business situations in which time and threat to life and property is not a major constraining factor. The highly stressful conditions that characterize tactical military planning and execution tasks are very different. When rapid and riskful responses are essential, it is probable that recentralization and the bypass of mid-level officers in the decision process are dysfunctional. Even if computer-based decision aids are operational under such circumstances, disturbance of the normally delegated decision process by centralization would probably lower the effectiveness of group performance because the team's expertise and contact with the local situation would be largely ignored. Thus, if research was conducted on the impact of computer-based decision aids on military organizations under stressful conditions, it is likely that decentralized, rather than centralized, authority patterns would be best suited. This hypothesis is demonstrated by the case studies documented in Chapters 7-10 of this report.

On the other hand, industrial automation generally does not centralize information. Rather, it increases the differentiation of tasks, division of labor, and reallocation of functional boundaries. Decentralized structures, which are supported by the literature, appear appropriate under these circumstances.

In aggregate, the conflicting conclusions of the futurists and traditionalists, and the ambiguous results of the third school, suggest a degree of futility in pursuing further research along these lines. This sense of futility is shared particularly by those in the third group. Their suggestions for future research point to the need for a contingency model of organization structure. Simon (1965: 104) summarizes their perspective on the problem:

> Organizational form...must be a joint function of the characteristics of humans and their tools and the nature of the task environment. When one or the other of these changes significantly, we may expect concurrent modifications to be required in organizational structure -- for example, in the amount of centralization or decentralization that is desirable.

A CONTINGENCY MODEL OF ORGANIZATION STRUCTURE IN TECHNOLOGICAL ENVIRONMENTS

As the preceding literature review has shown, determining the most effective and efficient organization structure in technological environments is left indeterminate if other equally important and interactive situational factors are not considered. What is required is a model that relies on the contingency approach and incorporates several technological aspects of the situation, as well as climatic factors dealing with mission and personnel dimensions.

Attributes of the Model

Much literature on leadership and organizational behavior and structure (see, for example, Tannenbaum and Schmidt, 1958; Lawrence and Lorsch, 1967b; Carlisle, 1974; Galbraith, 1973) emphasizes the influence of various situational aspects on the chosen method of decision-making. These authors suggest, in a very general fashion, that given different organizational environments in which various configurations of forces are involved, particular types of organization structure are most appropriate. A sensitive manager, so they assert, can assess the task confronting him, place it within the organizational context in which decision-making must proceed, and determine the structural model that will be the most practical method for approaching the mission. However, these researchers offer a framework for choosing an organization structure that is essentially analytic and somewhat complex to apply in a practical manner. What is required in operational organizations are <u>operational tools</u> that enable managers to determine <u>pragmatically</u> the most functional informal and formal structures given the contingencies of the particular situation -- the combined interaction of the mission to be accomplished, the personnel available to perform goal-oriented tasks, and the technological resources present to assist personnel.

A model that is both analytical and applicable by managers in an operational sense to help solve their structural problems is explicated in this section. This framework is strongly influenced by the work of Vroom and Yetton (1973) who focus on the impact of various situational configurations in choosing appropriate decision methods or informal structures. The model developed here incorporates some of their original ideas -- that the organizational environment includes matters dealing with decision quality and personnel attributes and perceptions -- but supplements their conception of organizational climate by including crucial situational variables concerned with the mission and computer-based decision instruments. Unlike Vroom and Yetton's model, the one presented here concentrates on the environment of a decision-making group, where line functions are performed <u>outside</u> the organization. In addition, a modified continuum of informal structures and several characteristics of formal structure are developed as the dependent variables to be prescribed by the model.

The model is <u>descriptive</u> in that it offers a comprehensive profile of the organization and its operations within particular multifaceted contexts. The model is also <u>normative</u> in that it prescribes, on logical grounds, the types of structures that ought to be appropriate given different situational configurations. Experimental evidence and/or theoretical speculations are provided to reinforce the prescriptive assumptions of the model. If these assumptions are shown to be congruent with those made by actual managers, the model will have construct validity. The recommendations or hypotheses that are generated from applications of the model to actual organizations will provide guidance to leaders and organizational planners concerning structures that maximize decision aid exploitation. The case studies documented in Chapters 7-10 test the validity of the hypotheses in the real world and help to revise the model. The most rigorous test of the hypotheses will be undertaken in simulation exercises that attempt to replicate the task force decision environment using sophisticated subjects and realistic physical surroundings. Such experiments are projected to occur during FY77.

Components of the Model

Figure 1 graphically represents a contingency model of organization structure. The organizational environment is conceptualized as the factor upon which formal and informal structure is contingent. Climate is composed of three interactive dimensions -- the mission, personnel, and technology available. The interrelationship of these situational properties is depicted by the ellipse that encompasses them.

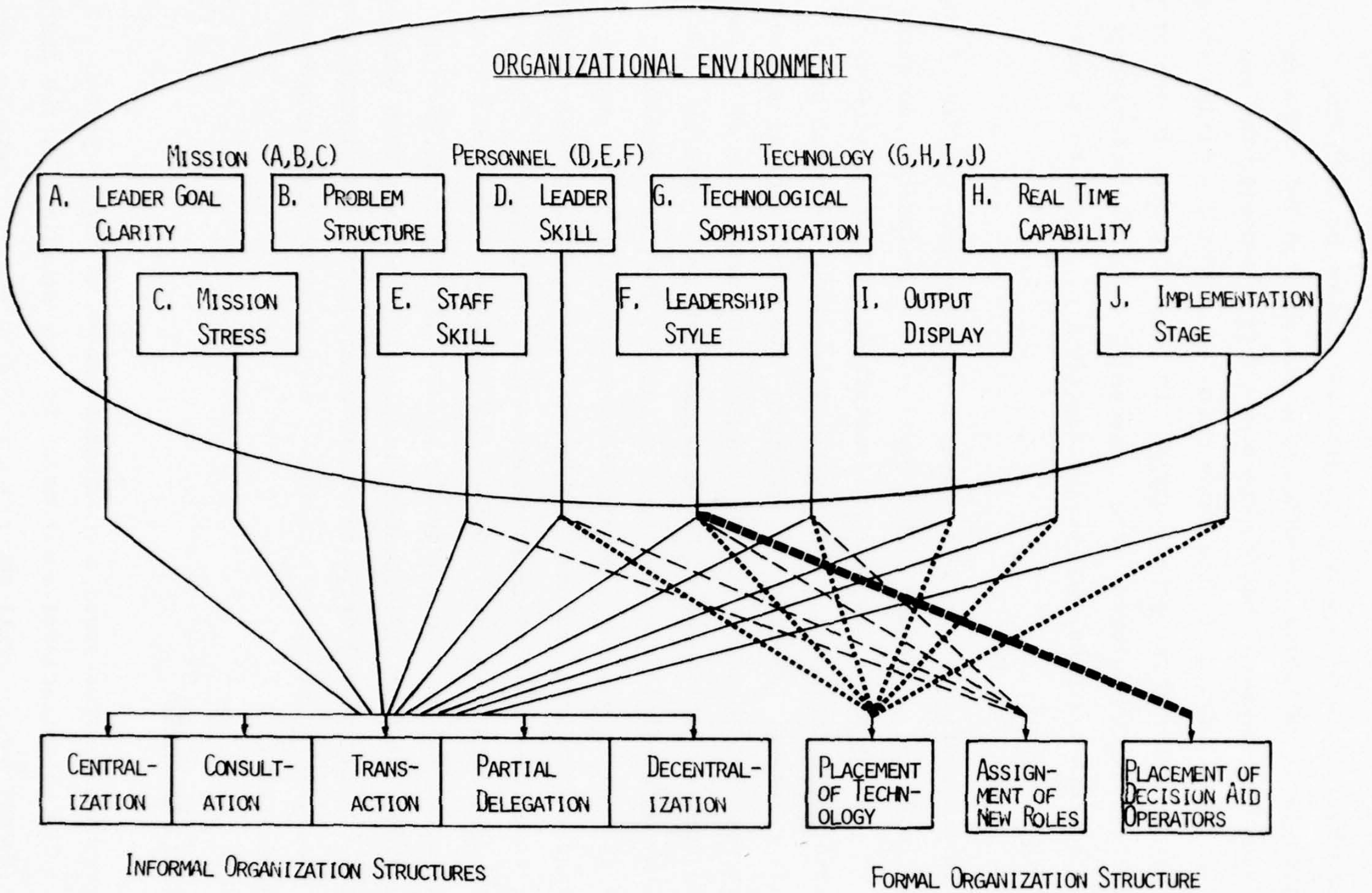


FIGURE 1. A CONTINGENCY MODEL OF ORGANIZATION STRUCTURE IN TECHNOLOGICAL ENVIRONMENTS

The three dimensions are further described by 10 component variables. These variables are included on the basis of three criteria. The most important deals with the relevance of the variables in helping to choose an appropriate organization structure. Interest was focused on specifying only those properties that may have a direct impact on the viability of formal and informal structural types. If, for logical or practical reasons, a particular structure could be eliminated from active consideration as unfeasible or included as highly acceptable as a result of variation in a certain situational factor, that variable was included in the model.

The second criterion for inclusion in the model is prior utilization or speculation on the value of the variable. Inventories of situational variables, assumed by theorists to be crucial in shaping organization structure, were reviewed. Empirical contingency studies were also combed for situational variables that proved to have a significant influence on structure. Since most of these studies were not specifically concerned with the impact of computer-based decision aids, care was taken in reshaping some variables so that they would be relevant to a technological environment.

Finally, the criterion of parsimony entered into the consideration of environmental variables to be included in the model. Many variables discussed in the literature, although labeled differently, appear to measure similar aspects of the situation. Such duplication is eliminated in the model. While the goal of the model is to portray the complexity of the environment upon which structure is contingent, it is also important to develop a model that is practical and manageable in both an analytical and applied sense. Thus, emphasis is placed on including a broad range of highly descriptive environmental variables, while remaining parsimonious concerning choice.

Informal structure types are represented on a continuum from total centralization to total decentralization of authority, communication, and coordination. The formal structure characteristics that are considered by the model assume analysis of a functional decision-making type of organization in which line tasks are performed by external organizations. These organization structure variables are described in Chapter 3.

The model assumes that all 10 climate variables impact on the choice of informal structure, but each formal structure property is influenced by different sets of climate variables. The relationships between environment and structure are developed on the basis of the relevant literature and logical assumptions about how structural choices are made. The <u>leader's personal style and preferences</u> are considered to be a primary causal factor in making organization structure choices. In the final analysis, it is usually the leader who shapes the structure of the organization to his own desires so that he is comfortable in his leadership role and relationships. However, to lesser degrees, other variables in the situation concerned with skills and technological attributes also impact upon these organizational decisions. Each climate variable is not equally important in determining organization structure. A weighting system for these variables is described later in this chapter.

Each of the independent, environmental variables is listed below. The relevant literature on the impact of these variables on structure is reviewed in Appendix A. The variables described are

<u>The Mission Climate</u>

A. Leader Goal Clarity
B. Problem Structure
C. Mission Stress

<u>The Personnel Climate</u>

D. Leader Skill in Technical and Decision Analysis Methods
E. Professional Staff Skill in Technical and Decision Analysis Methods
F. Leadership Style

The Technology Climate

G. Technological Sophistication
H. Real Time Capability
I. Output Display
J. Technology Implementation Stage

On the basis of secondary analysis of the empirical and theoretical literature (see Appendix A), assumptions are postulated on the likely influence of each situational variable on organization structure. These assumptions, which are listed in Table 2, suggest that certain structural types ought to be eliminated from active managerial consideration as unfeasible, and others ought to be included as acceptable given particular organizational profiles. As indicated in the following section, these separate assumptions are combined to constitute an integrated and testable contingency model of organization structure.

The Impact of Environmental Configurations on Organizational Structure

Each of the assumptions in the previous section is concerned with the potential impact of a single situational variable on organization structure. However, the contingency approach demands that these assumptions be integrated in some fashion. A realistic model must enable analysis of the combined effect of situational variables, rather than assuming a simplistic, single-trait approach.

Appropriate Conditions for Informal Structure Types. Table 3 lists the assumed impact of individual situational factors on informal structure. It is merely a tabular display of the verbal assumptions elaborated in Table 2. Each climate variable is stated and its presence noted by a simple yes or no. They are straightforward operational variables, the type that can be considered practically and quickly by managers to assess important aspects of the organizational climate. The columns represent the five types of informal organization structure. "Y" or yes is placed in a cell

TABLE 2

The Impact of the Environment on Organization Structure:
Contingency Model Assumptions

INFORMAL STRUCTURE ASSUMPTIONS:

1. Leaders who have clear mission goals are likely to prefer centralized, consultative, or partially delegated informal organization structures. Leaders who have ambiguous mission goals are likely to prefer transactional or decentralized structures.

2. Missions composed of well-structured problems are likely to be appropriate in centralized or consultative informal organization structures. Missions with unstructured problems are likely to be appropriate in transactional, partially delegated, or decentralized structures.

3. Highly stressful missions are likely to be appropriate in centralized, partially delegated, or decentralized informal organization structures. Nonstressful missions are likely to be appropriate in consultative or transactional structures.

4. Leaders skilled in technical and decision analysis methods are likely to prefer centralized informal organization structures. Leaders that lack such training are likely to prefer consultative, transactional, partially delegated, or decentralized structures.

5. Staffs skilled in technical and decision analysis methods are likely to prefer consultative, transactional, partially delegated, or decentralized informal organization structures. Staffs that lack such training are likely to prefer centralized structures.

6. Leaders with relations-oriented styles are likely to prefer transactional, partially delegated, or decentralized informal organization structures. Leaders with task-oriented styles are likely to prefer centralized and consultative structures.

7. Analytical decision aids are likely to be appropriate in centralized or consultative informal organization structures. Inventory aids are likely to be appropriate in transactional, partially delegated, or decentralized structures.

8. Real time decision aids are likely to be appropriate in centralized, consultative, partially delegated, or decentralized informal organization structures. Non-real time systems are likely to be appropriate in transactional structures.

9. Large screen display units are likely to be appropriate in transactional, informal organization structures. Individual terminal display units are likely to be appropriate in centralized, consultative, partially delegated, or decentralized structures.

TABLE 2 (Cont'd)

10. Fully operational decision aiding systems are likely to be appropriate in centralized or consultative informal organization structures. Transitional systems are likely to be appropriate in transactional, partially delegated, or decentralized structures.

FORMAL STRUCTURE ASSUMPTIONS

A. Placement of the Decision Aids

1. Leaders skilled in technical and decision analysis methods are likely to prefer pyramidal installations over divisional installations.

2. Relations-oriented leaders are likely to prefer divisional installations over pyramidal installations.

3. Analytical decision aids are likely to be appropriate in either pyramidal or divisional installations.

4. Real time decision aids are likely to be appropriate in pyramidal installations, but not in divisional installations.

5. Large screen display units are likely to be appropriate in pyramidal installations, but not in divisional installations.

6. Fully operational decision aiding systems are likely to be appropriate in pyramidal installations, but not in divisional installations.

B. Assignment to New Organizational Roles

1. Skilled leaders are likely to prefer training the existing staff.

2. Skilled staffs are likely to make it unnecessary to assign specially skilled personnel from outside the organization.

3. Relations-oriented leaders are likely to prefer training the existing staff.

4. Analytical decision aids are likely to make assignment of specially skilled personnel from outside the organization preferable, at least initially.

5. Fully operational decision aiding systems are likely to make training of the existing staff preferable.

C. Placement of Decision Aid Operators

1. Relations-oriented leaders are likely to prefer placing decision aid operators in a support status to existing functional personnel rather than in a new division of equal status with other divisions.

TABLE 3

The Ideal Environmental Configurations in Which Informal Organization Structures Are Appropriate

Determining Climate Factors	Centralization	Consultation	Transaction	Partial Delegation	Decentralization
Clear Mission Goals	Y	Y	N	Y	N
Well-Structured Problems	Y	Y	N	N	N
Stressful Mission	Y	N	N	Y	Y
Skilled Leader	Y	N	N	N	N
Skilled Staff	N	Y	Y	Y	Y
Relations-Oriented Style	N	N	Y	Y	Y
Analytical Aid	Y	Y	N	N	N
Real Time Capability	Y	Y	N	Y	Y
Large Screen Display	N	N	Y	N	N
Fully Operational Stage	Y	Y	N	N	N

Key: Encircled variables indicate "crucial conditions" that must be present in the environment to support the associated informal structure.

if the corresponding structural type is feasible given the direction of the environmental question. "N" or no is placed in a cell if the structure is inappropriate within the scope of the environmental question.

Reading across each row offers no new information; it merely states each separate assumption in a schematic form. However, reading down each column provides a new, integrated perspective on the problem. If we assume that the total environment is an additive function of the individual climate descriptors, then each column represents the particular environmental configuration or profile within which a structural type is optimized. Each of these "ideal" profiles describes the conditions under which certain organization structures help to maximize decision aid exploitation and decision-making performance.

For instance, a centralized structure is most appropriate in a total environment where:

- The leader prefers certain mission alternatives, the mission is well-structured, but stressful; and
- The leader has technological expertise, has subordinates who lack such skills, and is task-oriented in style; and
- The technological tools are sophisticated, in a fully operational state, with real time capability, and individual display.

On the other end of the continuum, a decentralized structure is most appropriate when the following total climate exists:

- The leader has no clear preferences among mission alternatives, the mission is basically unstructured, but stressful; and
- The leader lacks technological expertise, has subordinates who possess such skills, and employs a relations-oriented style; and

- The technology tends to be unsophisticated, in a transitional stage of implementation, with real time capabilities, and individual display.

A complete verbal description of each of the five ideal profiles is presented in Appendix B.

Weighting. In Table 3, one climate variable is encircled for each of the five configurations. These represent the climate descriptors that are weighted as more important than others in supporting the organization structures. They denote the conditions within the total environment that are crucial to the appropriateness of each informal organization structure. If these crucial conditions are not present in the environment, it is assumed that the associated informal structure may become unstable and unable to sustain itself.

Appropriate Conditions for Formal Structure Properties. Table 2 presented, in verbal form, the assumptions relating individual climatic factors and formal organization structure. Table 4 displays these same assumptions in tabular form. As before, by reading down each column, one observes the combined impact of these environmental factors on formal structuring. Three sets of configurations, one for each formal structure property, are derived that suggest the total ideal profile within which each structure is most appropriate. For instance, pyramidal installations are most appropriate in the following environment:

- The leader possesses technical and decision analysis skills and has a task-oriented style of leadership; and

- The technology is sophisticated and fully operational, with real time capability and large screen display.

- Neither the leader nor staff is skilled in technical or decision analysis methods, and the leader is task-oriented; and

TABLE 4

The Ideal Environmental Configurations
in Which the Properties of Formal Organization Structures Are Appropriate

1. Location of Decision Aids Installation

Determining Climate Factors	Pyramidal Installations	Divisional Installation
Skilled Leaders	Y	N
Relations-Oriented Style	N	Y
Analytical Aid	Y	Y
Real Time Capability	Y	N
Large Screen Display	Y	N
Fully Operational Stage	Y	N

2. Assignment to New Roles

Determining Climate Factors	Assign Outside Specialists	Train Existing Staff
Skilled Leader	N	Y
Skilled Staff	N	-
Relations-Oriented Style	N	Y
Analytical Aid	Y	N
Fully Operational Stage	N	Y

3. Placement of Decision Aid Operators In Divisional Installation

Determining Climate Factors	New Division of Equal Status	Assist Existing Division
Relations-Oriented Style	N	Y

- The technology is sophisticated and in a transitional stage of implementation.

Finally, if decision aid operators are placed in a divisional installation, their location in the hierarchy should be of equal status with existing staff if the leader is task-oriented. If the leader is relations-oriented, the specialists should be considered as support staff to assist existing divisional personnel. A complete description of Table 4 is presented in Appendix B.

<u>Ideal Versus Real Organizational Profiles: A Methodology to Determine Feasible Sets and Appropriate Organization Structures</u>

The environmental configurations or organizational profiles depicted in Tables 3 and 4 represent the ideal situations in which certain structural choices are most appropriate. It is conceivable, though highly improbable, that actual profiles observed by a manager will mirror these ideal configurations. Practicality necessitates developing a methodology to utilize these ideal types to determine appropriate organization structures in realistic environments.

The total environment, as we have seen, is composed of many factors. The closer actual environments come to replicating ideal environments, the greater the likelihood that the organization structures associated with the ideal settings will be feasible in the actual setting. Slight variation in just a few descriptors (unless they include the weighted "crucial conditions") should not be sufficient to negate totally the assumptions concerning appropriate organization structures. Essentially, the ideal environments can be thought of as baseline frameworks against which realistic environments can be compared.

Thus, the methodology developed to determine the most appropriate organization structures involves <u>similarity testing</u> between actual or projected environments and ideal environments in which particular organization structures are optimized. The following rules comprise this method:

> <u>Rule 1</u>: The closer reality approximates the ideal situation, the more likely that the assumptions about appropriate structures will be reliable. The organization structures associated with these ideal environments can be <u>included</u> in a feasible set of structures.
>
> <u>Rule 2</u>: If ideal and actual environments are highly dissimilar, the associated organization structures can be assumed to be inappropriate. Thus, they can be <u>eliminated</u> from the feasible set.
>
> <u>Rule 3</u>: If the crucial conditions in the ideal environments are violated by the actual environment, it can be assumed that the associated organization structures will be unsuitable. Thus, they can be <u>eliminated</u> from the feasible set of structures.

Abiding by Rules 1-3, the appropriate formal structures can be determined and a feasible set of informal structures derived. Selection can be made from among the reduced set of feasible informal structures on the basis of management values to be maximized. Vroom and Yetton (1973) offer two criteria that can be stated as decision rules stressing two different values of importance to management. The first emphasizes "cost and time efficiency" -- the number of man-hours required to solve a problem -- as the determining factor for choosing among given sets of equally feasible structures.

> <u>Rule 4</u>: If management desires to minimize the investment of man-hours in decision-making, it ought to choose the informal structure within the feasible set that is closest to the centralization end of the continuum.

The assumption is that more centralized structural types ought to reduce the manpower involved in problem-solving over the short run and, thus, should be the most time efficient method.

Alternately, management may desire to maximize the value of "personnel responsibility." Managers can attempt to develop long-term, efficient performance by heightening morale, satisfaction, and a sense of efficiency among personnel.

> Rule 5: If maximum weight is placed on personnel development, managers ought to choose the informal structure within the feasible set that is closest to the decentralization end of the continuum.

It is assumed that decentralized methods will increase participation, involvement, responsibility and, thus, in the long run operational efficiency.

These five rules provide a methodology to determine the appropriate formal and informal structures for organizations on the basis of their total environment. Most importantly, this method of similarity testing can be employed, not only by researchers in an analytical context, but also by active organization managers in a practical setting. By developing a checklist of organizational descriptors that defines the situation, managers can apply similarity testing to the ideal profiles and derive organization structures that will maximize decision aid exploitation and decision-making performance. The manager should treat these derivations as hypotheses that are open to testing in the real world. If the manager's perception of the organizational climate is accurate and these assumptions are valid, the contingency model and similarity methodology can prove invaluable managerial tools in fostering appropriate authority relationships, coordition linkages, and communication networks within an organization.

CONCLUSION

In this chapter, an approach has been developed to determine the proper formal and informal organization structures to be adopted within technological environments. In doing so, the current literature in this field has been reviewed, integrated, and evaluated. The model is based on contingency theory and, thus, emphasizes the impact of the environment on organizational structures. On the basis of 22 separate assumptions, the model enables calculation of the expected combined effects of environment on structure. By means of similarity testing, both analysts and organizational managers can apply the model to actual organizational contexts and formulate hypotheses about the organization structures that maximize decision aid exploitation and decision-making performance. Given the implementation of computer-based decision aids in the task force, the contingency model and similarity testing methodology are applied in Chapter 5 to derive hypotheses concerning appropriate organization structures for the naval task force staff.

CHAPTER 5. APPLICATION OF THE MODEL TO TASK FORCE COMMAND ORGANIZATION STRUCTURE: DEVELOPING TESTABLE HYPOTHESES

SUMMARY

In this chapter, the contingency model is applied to a particular organization -- the naval task force -- to develop hypotheses about the potential impacts of computer-based tactical decision aids on its organization structure. The decision aids have yet to be implemented, so the model can be employed as a tool for planning future organizational design. The hypotheses derived from applying the model to appropriate structures in varying organizational climates can be empirically tested in experiments that attempt to simulate task force operations. Such experiments are scheduled for FY77.

Properties of the task force that have direct bearing on its potential organization structure in increasingly computer-assisted environments are briefly reviewed in this chapter. The organizational climate of the task force is then defined in terms of the 10 organizational descriptors in the model. Some of the variables are fixed, that is, the properties they describe assume a constant value in the task force environment. Other climatic factors are left to vary because they deal with personality, implementation, training, or hardware decisions that are yet to be made. As a result of this variation, 16 viable profiles are enumerated, instead of a single profile defining an "ideal" task force environment. These climates are analyzed in relation to the model and feasible sets of appropriate organization structures. Preferences among them are identified and set forth as testable hypotheses. These hypotheses indicate the structures that are likely to maximize decision aid exploitation and decision-making effectiveness in the task force.

TASK FORCE PROPERTIES RELEVANT TO ORGANIZATION STRUCTURE

Several documents already detail formal as well as informal structural arrangements in typical task force organizations (Office of the Chief of Naval Operations, 1974, 1971; Stanford Research Institute (SRI), 1974; Personal Communication, 1975). Another indepth study of the task force organization is neither attempted nor necessary for applying the contingency model. Our task is not to demonstrate the degree and nature of differences between present and potential structures, but to develop a set of appropriate structures given the combined effect of the task force organizational climate. However, certain facts about task force organization are essential as background information to comprehend the nature and purpose of the group being analyzed and to define the values of various situational factors. These are presented briefly. For more complete discussions, the reader is referred to the documents cited above.

Task Force Missions and Functions

Task forces are temporal organizations formed to accomplish particular types of missions such as air strikes, amphibious assaults, surface warfare, antisubmarine warfare, surveillance and intelligence gathering, blockades, logistics and supply, search and rescue operations, and training (SRI, 1974). A task force can remain in existence for long or short durations depending upon the length of time it takes to fulfill mission objectives. Because some major tasks demand continuous attention, standing task forces may be assigned indefinitely.

To conduct their missions, task forces are generally composed of a commander or CTF (usually a rear or vice admiral) and a staff (usually lieutenant commanders to captains), ships, aircraft, and the personnel needed to staff them. Computer-based decision aids are planned for use by the commander and staff to assist them in making complex and time-limited decisions for all components of the task force. This study focuses solely on the potential impact of system implementation on this relatively small decision-making body (approximately 25 officers), rather than on the entire line and staff organization of the task force. More succinctly defined, we are concerned with organizational consequences in the task force command.

Having been assigned broad mission goals by a superior (usually a numbered fleet commander), the task force command must make many tactical decisions that comprise three general phases of operation. In the planning phase, an estimate of the situation is made, and a particular course of action is plotted in an operations order. In the execution phase, modifications and reoptimizations of the plan may be demanded, supplementary "op orders" required, and new plans generated. In the evaluation phase, changes in mission operations and plans can be recommended. The Stanford Research Institute (1974) enumerates 32 generic decisions that must be contemplated during these three phases.

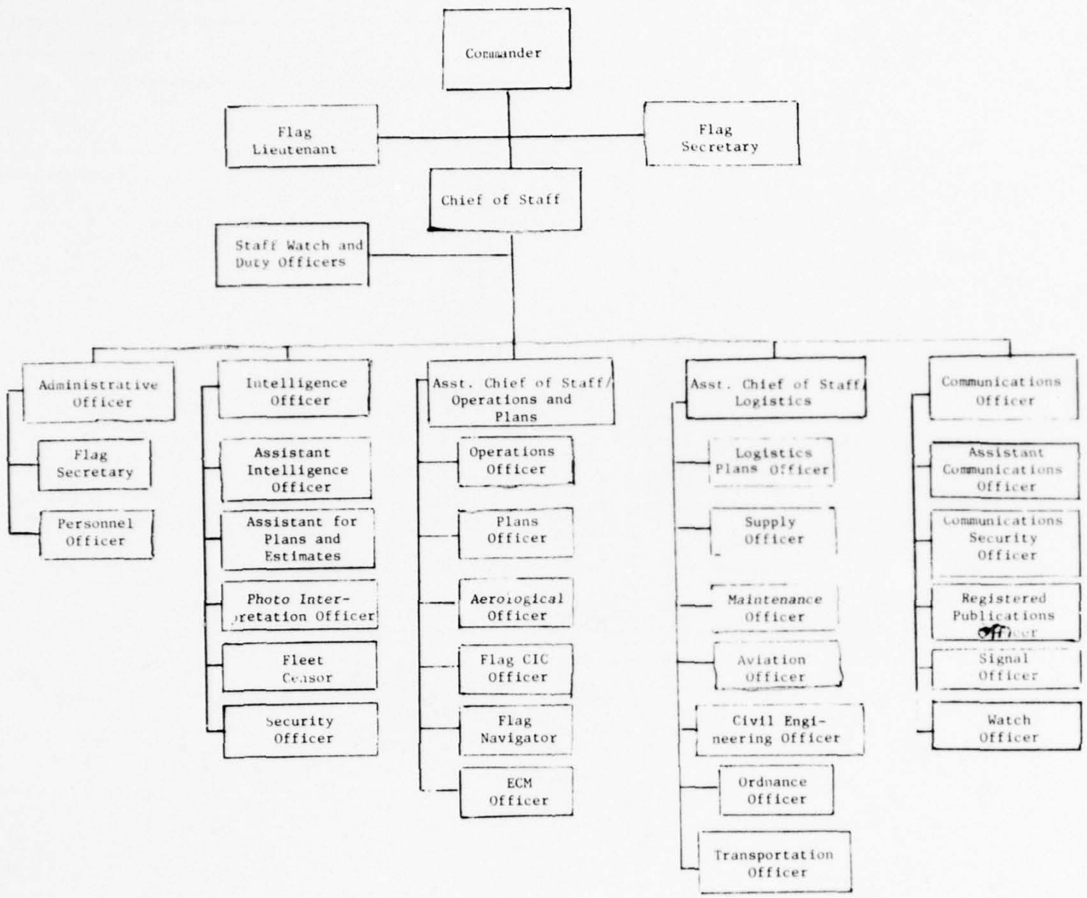
At present, there are few formal tools, let alone computerized decision aids, that the commander and staff can rely on to assist in making these decisions. Two computer-based systems -- the Naval Tactical Data System (NTDS) and the Integrated Operational Intelligence Center (IOIC) -- have been employed by some task force commands. But they are specific to particular functional warfare areas and have sometimes experienced operational difficulties and compatibility problems with other systems (SRI, 1974).

Formal Structure in the Task Force Command

Formal organization structure and procedures in the task force command are detailed in NWP-11(B) (Office of the Chief of Naval Operations, 1974) and NWP-12(B) (Office of the Chief of Naval Operations, 1971). The commander is the seat of authority and responsibility in the organization. While he may choose to delegate authority to subordinates, responsibility officially remains with him. The staff serves the commander as an informational and advisory body in performing administrative and operational tasks. Its personnel are usually experts in particular substantive areas that the task force addresses. In fact, they may be personally requested to participate in the task force staff by the CTF because the commander trusts their knowledge, experience, and judgment. The exact composition of the staff varies, depending upon the personal desires and working habits of each CTF and the specific mission goals to be accomplished. However, most commanders follow the general guidelines in NWP-11(B) and NWP-12(B).

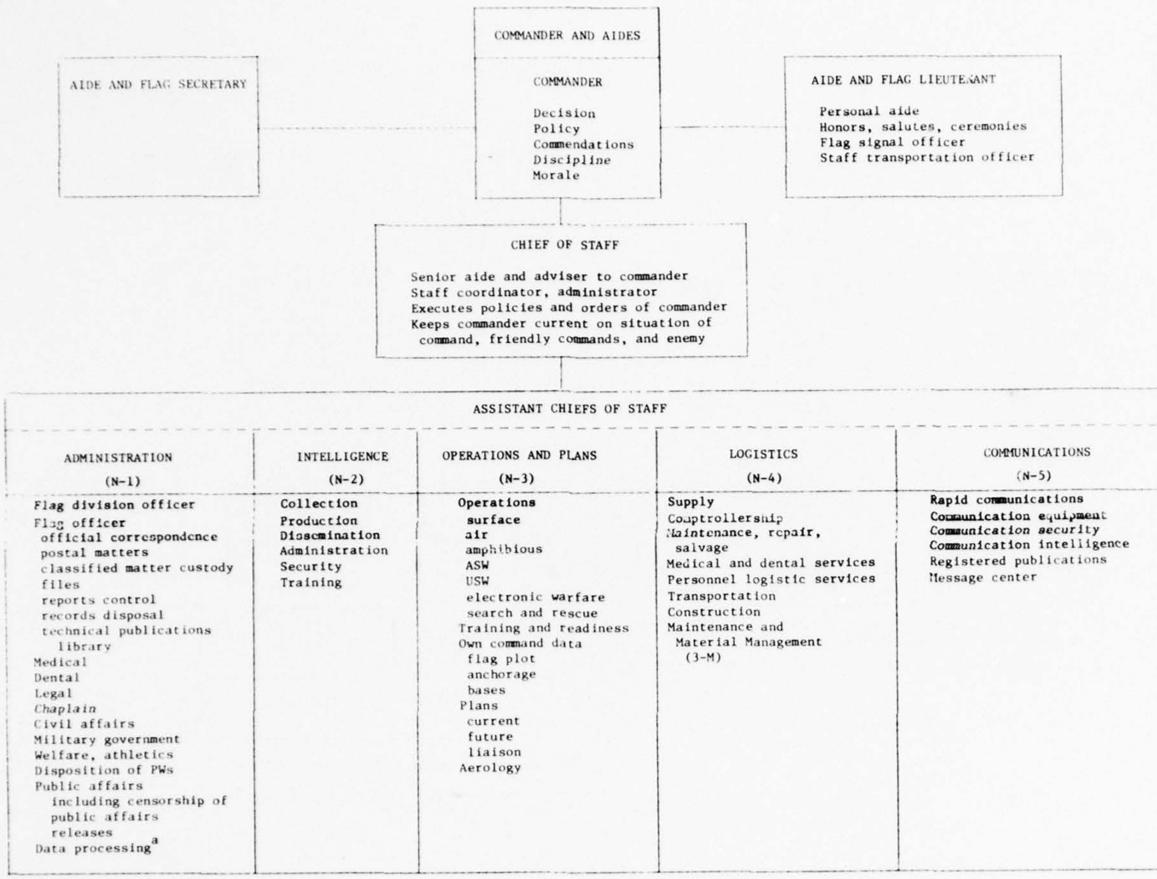
At present, the staff officers assigned to task forces usually possess tactical experience in a particular area, but are unlikely to have decision analysis training. Since assignment to task forces is flexible, personnel can be selected who have both substantive knowledge in fields that hinge on the task force's mission and training in the use and analysis of computer-based decision aids. Thus, attention to staff assignment may eliminate excessive dependence on officers who are primarily decision analysts, that is, those who are technically skilled but substantively naive.

The formal structure of the task force command very closely resembles a functional organization in which related tasks are officially assigned to the same division. The five functional divisions in the task force include administration (N-1), intelligence (N-2), operations and plans (N-3), logistics (N-4), and communications (N-5). In addition, the CTF maintains personal aides and a chief of staff who is the senior advisor and coordinator. Figure 1 presents a detailed formal charting of a typical task force command, indicating official lines of authority and functional divisions in the staff. Actual staffs may not maintain personnel in every role because of mission emphases or command desires. Formal coordination, when it occurs between divisional personnel, can be affected only by action taken by the chief of staff. Figure 2 also depicts a typical task force command, but from a functional perspective, indicating the distribution of tasks. It is interesting to note that according to NWP-12(B), from which Figure 2 was taken, the data processing function is placed within the administration division's baliwick. This document was developed prior to considering an operational decision aid system for the commander. A problem that the contingency model can attempt to deal with is whether formal



Source: NWP-12(B)

Figure 1. Formal Organization Structure of a Typical Task Force Staff



[a] Note well the placement of the data processing function in the administrative division.

Source: NWP-12(B)

Figure 2. A Functional Perspective of a Typical Navy Task Force Staff

placement of these aids, as suggested by this document, will provide maximum exploitation of the decision tools.

In addition to providing structural guidelines, naval tactical publications prescribe various procedures indicating what ought to be the formal relationship among staff officers in the decision-making process. Routine tasks can be fulfilled by fairly well-defined, practiced, and pre-programmed procedures. Standardization of somewhat predictable situations aids in streamlining staff functioning and enables more time to be spent on complex problems; it is not intended to stifle thought processes or personal methods of arriving at sound solutions. In essence, these procedural guidelines provide a checklist of subtasks that must be acomplished to solve task force problems. They also prescribe commander, staff, and combined responsibilities in fulfilling these subtasks. The need for computer-based decision aids in routine situations is minimized by these standardized schedules. However, for complex and unstructured problems that have a high degree of information uncertainty, standardized procedural guidelines can provide only minimal assistance. In these situations, the analytical capabilities of decision aids and informal organization structure are of maximum importance in determining organizational performance.

Informal Structure in the Task Force Command

Dynamic informal structuring in the task force command has been discussed, though with less rigor than formal structure, by NWP-11(B), NWP-12(B), and Stanford Research Institute (1974). Informal structure has generally been considered an organizational attribute that is not prescribed by official manuals. Rather, it is a behavioral dynamic that evolves due to the mix of personal styles among leaders and subordinates. However, recent research has emphasized the concept of planned organizational change in which organizational and management specialists are brought in as active players to intervene in organizational dynamics, thus modifying the informal system and producing more efficient performance (O'Connell, 1968; Bennis, 1969; Galbraith, 1973; Lawrence and Lorsch, 1969). Planned organizational change in the task force command remains a theoretical idea; this report is a first step toward applying the concept. The task force documents cited above are not concerned with bringing about change in the informal structure of organization. Rather, they describe the manifest behavioral decision methods employed by task force personnel. At present, these informal structures remain _ad hoc_ and are derived primarily from the commander's personality and situational characteristics.

Autocratic _centralization_ is rarely used in the task force command as an informal decision structure. The commander almost always depends on his staff for information and guidance and, thus, does not usually make decisions entirely alone. Of course, when making immediate policy decisions in highly stressful situations, commanders often act alone using their own judgment and available information.

The other four types of informal structure described earlier have been observed more frequently in the task force. The structure employed most often is the _consultative_ type. The staff is called in to brief the CTF or senior officer on the current situation and viable action alternatives. The chief of staff or chief of staff for operations sometimes performs decision-maker duties for the CTF. Given this information, the decision is made solely by top officers. In such a structure, the staff is employed as an information base and is excluded from active participation in decision-making.

Sometimes a _transactional_ structure is also observed in task force command operations. In this type, the CTF becomes totally immersed in the information processing, alternative-searching, and judgmental tasks involved in making decisions. Thus, a close working association develops between the commander and his staff. The commander, sensitive to the fact that his very presence may inhibit deliberation and choice processes, may place himself on an equal footing with other staff officers and encourage them to participate openly. This can ease the interchange of ideas and opinions and free communications networks. However, the CTF generally reserves the right, even in a transactional structure, to make the final decision alone.

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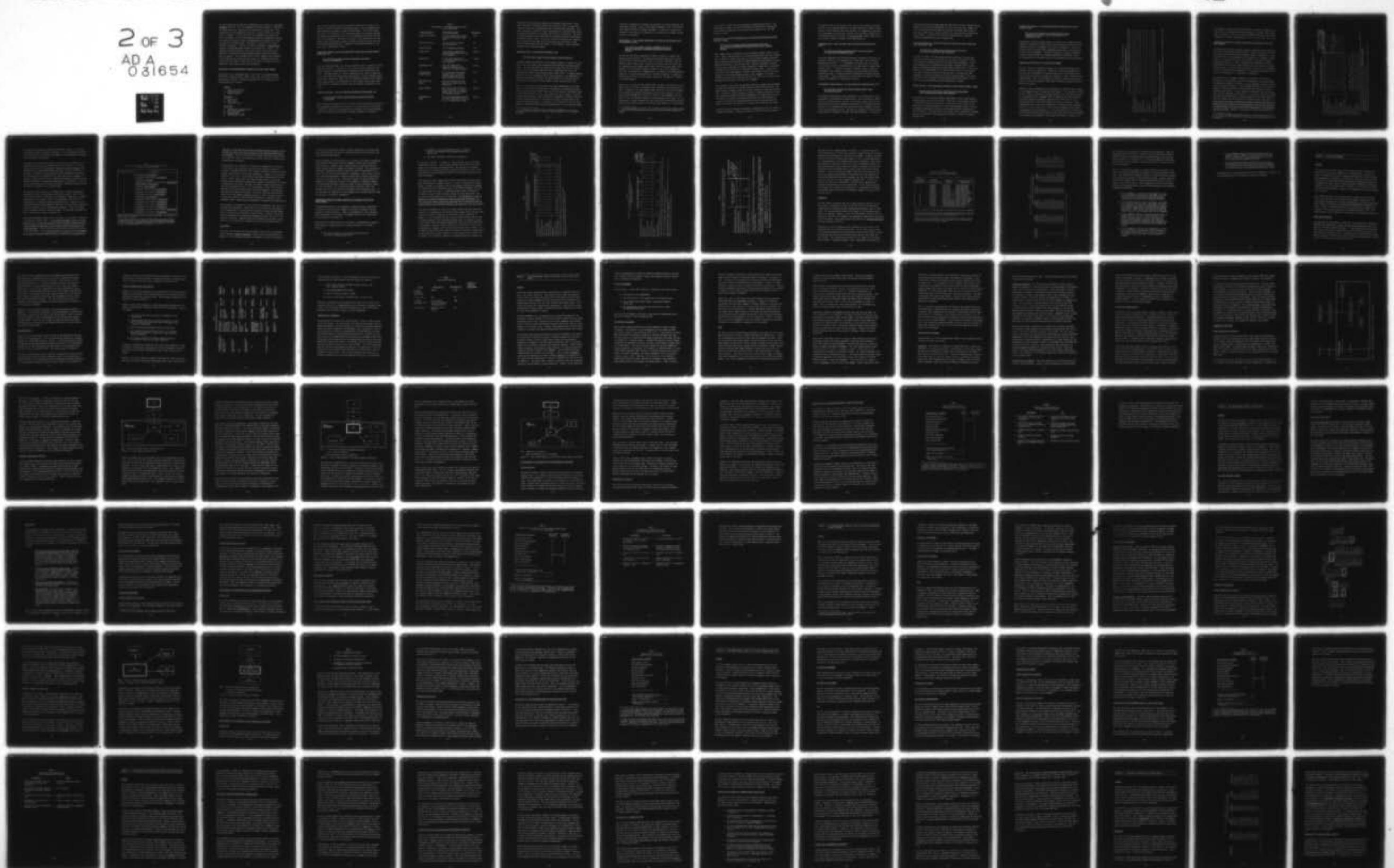

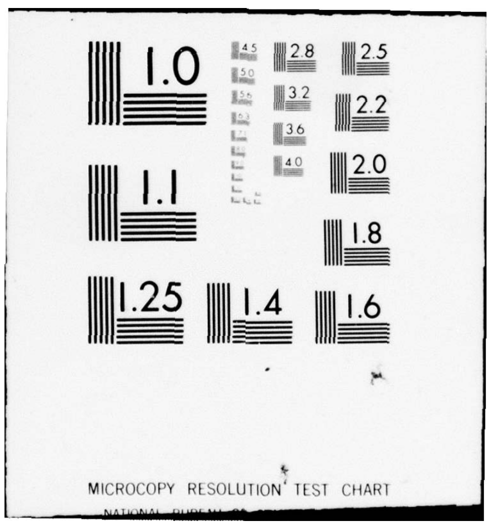
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1.6
MICROCOPY RESOLUTION TEST CHART

In other situations the task force command may place itself in a partially delegated formation. Here the commander allows subordinates to deliberate and decide upon one or several viable alternatives on their own. These alternatives are then presented to the CTF or senior officer to accept, reject, or modify. In this structure, the commander is excluded from active involvement in the decision-making process by delegating authority, but reserves the right to reject recommendations from below and to send them back for reconsideration. This type of structure can be called "command by negation." Finally, an entirely delegated or decentralized structure has sometimes been observed in the task force command. The commander delegates authority to his staff with no strings attached, especially in stressful and threatening situations when quick reaction time is essential. This presumes faith in their judgment and recognition by the commander that, since they are closer to information about the current state of affairs, staff officers are able to respond in the most appropriate fashion given short-time limitations.

DEFINITION OF THE ORGANIZATIONAL CLIMATE IN THE TASK FORCE COMMAND

Application of the contingency model to the task force command demands definition of organizational climate factors that potentially influence organization structure. Values are specified for the following 10 climate variables in the model:

Mission:

1. Leader Goal Clarity
2. Problem Structure
3. Mission Stress

Personnel:

4. Leader Skill
5. Staff Skill
6. Leadership Style

Technology:

7. Technological Sophistication
8. Real Time Capability
9. Output Display
10. Implementation Stage

Each of these variables has been conceptually described in Chapter 4 as having two mutually exclusive operational values. This oversimplifies in some instances, but eases the task of specification. The proper values for some of the variables in the task force context are uncertain because they depend on personal variation or on technological properties that are yet to be determined. These will be allowed to vary between the two categories, thus increasing the number of possible profiles in which the task force might possibly operate. A summary of the climate defined for the task force is presented in Table 1.

Leader Goal Clarity: Does the Leader Have a Clear and Preferred Mission Objective? Yes

> The task force climate contains broad goal preferences made by the commander.

Given an assigned mission, the CTF will usually be able to identify a clear, principal objective. This may be in the form of general guidelines for policy direction or specification of preferred action alternatives (SRI, 1974). Although leaders in civilian organizations may often be ambivalent as to their preference among various alternatives, military missions specify rather clear objectives. While the CTF's preference among various subgoals may be less distinct, the definition of clear, general policy goals indicates specific leadership direction that may influence organization structure.

Problem Structures: Are the Mission's Problems Well-Structured? No

> The task force climate contains many unstructured problems to be solved.

Many problems with which the task force must deal are repetitive and routine. Pre-programmed procedures can be employed to handle these well-structured situations. However, the problems that occupy most of the decision-making time of the CTF and his staff and are likely candidates for computer

TABLE 1

Definition of the Organizational Climate in the Task Force

Climate Variable	Dichotomous Format	Definition
Leader Goal Clarity	Does the leader have a clear and preferred mission objective?	Yes
Problem Structure	Are the mission problems well-structured?	No
Mission Stress	Is the mission stressful?	Yes
Leader Skill	Is the leader experienced in decision analysis and technical methods?	Varies
Staff Skill	Is the staff experienced in decision analysis and technical methods?	Varies
Leadership Style	Does the leader have a relations-oriented style (that is, not task-oriented)?	Varies
Technological Sophistication	Is the decision aid sophisticated (that is, does it perform analytical rather than inventory functions)?	Yes
Real Time Capability	Does the decision aid have real time or near real time capability?	Yes
Output Display	Does the decision aid have a large screen unit to display output (that is, not individual terminal display)?	Varies
Implementation Stage	Is the decision-making technology fully operational (that is, not in a transitional stage)?	Varies

assistance are nonroutine, complex, and therefore unstructured. Given ONR's interest in utilizing computer-based decision aids, it seems reasonable to limit our consideration only to unstructured situations. Complex problems are composed of many subproblems that have nonobvious solutions under conditions of incomplete and uncertain information. NWP-11(B) provides limited tactical guidelines for situations involving uncertainty in several areas at once. In such unstructured situations, the organization structure of the task force and the decision aids assume a great deal of responsibility for the ability of the command to make reasonable decisions in an efficient manner.

Mission Stress: Is the Mission Stressful? Yes

The task force climate contains highly stressful missions.

Tactical operational decisions in the execution phase of a mission are generally made under harsh time constraints and sometimes threatening conditions. The decisions that are chosen often possess high risk in terms of loss of life or equipment damage because of incomplete data about the external environment and uncertainty about enemy action. Although planning phase decisions, on the whole, may be less stressful to the commander and his staff, nonroutine decisions, for which there are no specified guidelines, also may possess a certain degree of time limitation and risk.

While, to date, most of the decision aids under consideration in the ONR project are designed for application in nonstressful planning phase operations, concern has been voiced[1] that insufficient attention has been placed on developing decision aids for use in near real time, stressful, and execution phase decisions. Under conditions of high stress, decision aids can provide crucial assistance to the task force staff by easing some of the load and speeding response. In addition, it is essential to test the reliability of the decision aids and the compatibility of man and machine under

[1] At a meeting of contractors and the Steering Committee for the Operational Decision Aids project, Office of Naval Research, on 11-12 September 1975.

stressful circumstances to measure the potential for system breakdown and utilization problems. Thus, it was judged reasonable to set the value for this climate variable at "highly stressful." In this way, organization structure in the task force command can be analyzed in an extreme, though realistic, environment.

Leader Skill: Is the Leader Experienced in Technical and Decision Analysis Methods? Varies

> The task force climate contains commanders who may or may not be skilled in technical and decision analysis methods.

The CTF has few outlets available for formal training in technical and decision analysis skills.[2] He generally has gained experience from previous billets as chief of staff, chief of staff for operations, and commander of major combat ships. Skills in functional areas of warfare and in command have been gleaned mostly from on-the-job training (SRI, 1974). However, the focus of this climate variable is not on the commander's abilities in substantive or command areas, but rather on his methodological expertise in decision analysis skills. The CTF's capacity to understand and analyze the output of decision aids depends on the degree of training in this methodology.

There is no one value of this variable that can depict the situation in all task forces. CTF's vary in terms of their training in decision analysis skills. Whether or not they possess these skills will have obvious impacts on the formal and informal structure of the task force command. Of necessity, greater dependence on staff will result if the commander lacks the skills to use or interpret analyses of the operational aids alone. On the other hand, a trained commander may lean toward more centralized structures. Efficient and effective use of the decision aids hinges, to a large degree,

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[2] Increasing numbers of officers are enrolling in decision analysis courses at the U.S. Naval Postgraduate School and the Defense Systems Management School.

on the issue of leader and staff training in methodological skills. The type, amount, target, and cost effectiveness of decision aid training are crucial areas, necessary to the success of the decision aids, that ONR has yet to study.

Staff Skill: Is the Staff Experienced in Technical and Decision Analysis Methods? Varies

> The task force climate contains professional staff that may or may not be skilled in technical and decision analysis methods.

This climate factor is identical to the preceding variable except for the actor. Again, staff expertise in decision analysis skills may vary, depending on training. Formal instruction is just recently becoming available and on-the-job training may be too time-consuming and insufficient to enable maximum utilization of the decision aids. However, assignment of staff officers can be refocused to include possession of expertise in these methodological skills as well as in functional warfare areas. A staff with such skills could ably support a CTF who uses decision aids and could participate in the decision-making process if the commander so chooses. A skilled staff would also eliminate the need for a new level of purely methodological specialists in the task force command.

Since access to prior decision analysis training is limited and the degree to which naval officers are already skilled in this field is unknown, the staff expertise variable cannot be set as a constant in task force environment. As with the leader expertise variable, allowing this factor to vary when applying the model will enable inferences to be drawn about the relative merits of formally training the CTF and/or the staff officers in decision aid skills, and assigning specially skilled decision Navy personnel from outside the task force to operate and coordinate the system.

Varying this factor between such absolute categories as "all" or "none" is somewhat unrealistic. Particular officers on the staff who are likely to be frequent users of the decision aids, such as the operations and plans officer, may be assigned especially for their decision aid skills, while the rest of the staff may lack such training. For simplicity, this issue is not developed in this report. However, such questions as Who should be trained among staff officers? and To what extent? demand careful attention by ONR to ensure successful system implementation.

Leadership Style: Does the Leader Have a Relations-Oriented Style? Varies

> The task force climate contains either relations-oriented or task-oriented leadership styles.

Task force commanders have different personal leadership styles that are prominent features of the organizational climate and, thus, influence organization structure. It is improbable to believe that the introduction of decision aids or outside forces will induce them to change their personal styles. In order to examine all possible types of task force environments, this variable is allowed to oscillate between two major leadership styles -- relations-oriented (considerate) and task-oriented (controlling). Thus, inferences can be drawn about the impact of varied personalized commands on organization structure.

Technological Sophistication: Is the Decision Aid Sophisticated? Yes

> The task force climate will contain sophisticated, analytical decision aids.

The decision aids presently under development in the ONR project can be classified as technologically sophisticated. They are planned to assist task force decision-makers, not only by providing a wider and more integrated data base and data management capability (an information inventory system), but by supplementing and enhancing normally judgmental aspects of the decision-making process. The aids are intended to provide an automated analytical capability to task force decision-makers. If decision aids merely possess accessible memories they would be rather unsophisticated. However, the ones under development for use by the task force command consist of sophisticated algorithms that quickly interrelate many facets of past and current data to derive utilities for viable decision alternatives and outcomes. In addition, the aids are computer-driven, requiring advanced programming and output documentation.

Real Time Capability: Does the Decision Aid Have Real Time or Near Real Time Capability? Yes

> The task force climate will contain decision aids with real time (or near real time) capability.

In order to assist in actual problem-solving situations, the data base upon which the decision aids depend will be updated continually to keep it as current as possible with the real world task environment. A real time capability can be engineered by automatic transmittal into a data bank of information picked up by sensory devices aboard ship. Other information can be placed manually into the system as soon as it is received and coded to provide a near real time data base. Although real time capability is often not essential during the planning phase of an operation (SRI, 1974), decision aids that possess this characteristic are crucial to short-term problem-solving during execution phases.

Output Display: Does the Decision Aid Have a Large Screen Display? Varies

> The task force climate will contain decision aids having either individual or large screen displays.

A decision as to the precise hardware requirements of the aiding system's output display has not yet been made. Since each of the possible displays -- individual or large screen units -- will have a direct effect on the potential for group participation in the decision-making process, and thus on informal organization structure, both conditions will be analyzed in the application. The application will provide useful information to examine the cost effectiveness and operational efficiency of these two different display modes.

Implementation Stage: Is the Decision-Making Technology Fully Operational? Varies

The task force climate will contain decision aiding systems that are either fully operational or in a transitional stage.

Implementing a decision aiding system in the task force command initially requires a transitional phase in which the system may be revised and its algorithms altered to accommodate real world contingencies. Later, the decision aids will become fully operational and adapted to the reality of the task force environment. Under each situation, it may be preferable to have different formal and informal organization structures. Since both stages must be traversed, both will be considered in the application.

Organizational Profiles of the Task Force Command

The total task force command environment can be described using the 10 climatic factors in combination. Thirty-two projected configurations of the task force environment are possible since five of the factors have fixed values and five vary between two categories. Table 2 presents these configurations. They all correspond to stressful planning and execution phases of task force missions; they differ in terms of personnel and decision aid attributes.

Sixteen of these environments can be discounted as highly unlikely because of the combined values of leader and staff skills. In a situation in which the Navy desires to implement advanced decision tools into the task force, it is improbable that a commander would be assigned who lacks all skills in decision analysis techniques, and that such a CTF would, in turn, assign professional staff officers who also lack such training. Eight environments that contain this combination of characteristics (configurations 7, 17, 18, 19, 29, 30, 31, and 32) can be eliminated from serious consideration in this application. It is also unlikely that a CTF who has decision analysis skills would select a staff that did not have some degree of training in these methods. Since staff recruitment is largely up to

TABLE 2

Projected Environmental Configurations of the Task Force Command

	Task Force Command Environmental Configurations																														
	1	2	3[b]	4	5	6	7[b]	8	9	10	11[b]	12[b]	13[b]	14	15	16	17[b]	18[b]	19[b]	20	21	22	23[b]	24[b]	25[b]	26	27[b]	28	29[b]	30[b]	31[b]	32[b]
Clear Mission Goals[a]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Well-Structured Problems[a]	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Stressful Mission[a]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Skilled Leader	Y	N	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	N	N	N
Skilled Staff	Y	Y	N	Y	Y	Y	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	N	Y	N	N	N	N
Relations-Oriented Style	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	N	N	N	Y	N	N	N
Analytical Aid[a]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Real Time Capability[a]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Large Screen Display	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	N	Y	N	N	N	N	N	Y	N	N
Fully Operational Stage	Y	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	Y	N

[a] These climatic variables are fixed in the task force command environment.

[b] These configurations are unlikely to occur in the task force command environment because of the combined values of leader and staff skills (Y, N and N, N, respectively).

the commander, officers who could ably assist in utilizing advanced decision tools to the maximum extent would probably be chosen. Thus, eight more environments in Table 2 can be eliminated because they contain this combination of values (configurations 3, 11, 12, 13, 23, 24, 25, and 27).[3]

DETERMINING APPROPRIATE INFORMAL ORGANIZATION STRUCTURES FOR THE TASK FORCE COMMAND

The remaining 16 profiles describe projected conditions within which the task force command might possibly operate. (Verbal descriptions of each of these projected task force environments appear in Appendix C.) Each projected task force environment can be compared for its degree of similarity to the ideal profiles that correspond to each type of informal organization structure. Table 3 presents the 16 remaining task force environments as well as the ideal ones that directly relate to informal structure types. For each ideal configuration, the one factor considered crucial in determining the feasibility of the associated informal structure (the "weighted crucial condition") is indicated.

The feasible set of informal organization structures, those that are appropriate to each specific task force environment, can be ascertained by analyzing the degree of deviation of each projected task force profile from each ideal environment. Thus, applying the model to the task force situations basically involves listing similarities between the model's assumptions and reality. A small number of violations (less than 50 percent) between component characteristics of a task force and ideal environment place the organization structure optimized by that ideal situation into the feasible set for the task force under the given conditions. <u>In other words, the greater the similarity between projected and ideal environments, the more likely that the organization structure that exists in the ideal setting will also be feasible and appropriate in the projected task force setting</u>. However, as the number of violations between task

[3] In essence, examining the combined impact of leader and staff skills in the task force has convinced us to fix the value of staff skill in the affirmative.

TABLE 3

Determination of the Feasible Set of Informal Organization Structures in Various Task Force Command Environments

	Task Force Command Environmental Configurations																Ideal Environmental Configurations				
Determining Climate Factors	1	2	4	5	6	8	9	10	14	15	16	20	21	22	26	28	Centralization	Consultation	Transaction	Partial Delegation	Decentralization
Clear Mission Goals	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N
Well-Structured Problems	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N	N
Stressful Mission	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	Y
Skilled Leader	Y	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	N	Y	N	N	N	N
Skilled Staff	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Relations-Oriented Style	Y	Y	N	Y	Y	N	Y	Y	N	N	Y	N	N	Y	N	N	N	N	Y	Y	Y
Analytical Aid	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N
Real Time Capability	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Large Screen Display	Y	Y	Y	N	Y	Y	N	Y	N	Y	N	N	Y	N	N	N	N	N	Y	N	N
Fully Operational Stage	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N	N	N	N	Y	Y	N	N	N
Violations of:																					
Centralization	$\underline{\underline{4}}$	$\underline{5}^a$	$\underline{\underline{3}}$	$\underline{\underline{3}}$	5^a	$\underline{4}$	$\underline{4}$	$\underline{6}^a$	$\underline{\underline{2}}$	$\underline{\underline{4}}$	$\underline{\underline{4}}$	$\underline{3}$	$\underline{5}^a$	$\underline{5}^a$	$\underline{\underline{3}}$	$\underline{4}$					
Consultation	5^a	$\underline{\underline{4}}$	$\underline{\underline{4}}$	$\underline{\underline{4}}$	6^a	$\underline{\underline{3}}$	$\underline{\underline{3}}$	5^a	$\underline{\underline{3}}$	5^a	5^a	$\underline{\underline{2}}$	$\underline{\underline{4}}$	$\underline{4}$	$\underline{\underline{4}}$	$\underline{\underline{3}}$					
Transaction	6^a	5^a	$\underline{7}^a$	7^a	5^a	$\underline{6}^a$	6^a	$\underline{\underline{4}}$	$\underline{8}^a$	$\underline{6}^a$	6^a	$\underline{7}^a$	$\underline{5}^a$	5^a	$\underline{7}^a$	$\underline{6}^a$					
Partial Delegation	$\underline{\underline{4}}$	$\underline{\underline{3}}$	5^a	$\underline{\underline{3}}$	$\underline{\underline{3}}$	$\underline{\underline{4}}$	$\underline{\underline{2}}$	$\underline{\underline{2}}$	$\underline{\underline{4}}$	$\underline{\underline{4}}$	$\underline{\underline{2}}$	$\underline{\underline{3}}$	$\underline{\underline{3}}$	$\underline{\underline{1}}$	$\underline{\underline{3}}$	$\underline{\underline{2}}$					
Decentralization	5^a	$\underline{\underline{4}}$	6^a	$\underline{\underline{4}}$	$\underline{\underline{4}}$	5^a	$\underline{\underline{3}}$	$\underline{\underline{3}}$	5^a	5^a	$\underline{\underline{3}}$	$\underline{\underline{4}}$	$\underline{\underline{4}}$	$\underline{\underline{2}}$	$\underline{\underline{4}}$	$\underline{\underline{3}}$					

KEY: Circled values are crucial to the feasibility of each informal organization structure ("weighted crucial conditions").

Single underlined values indicate that a violation occurred in the weighted crucial condition.

Double underlined values indicate structures in the feasible set.

[a] Informal organization structure is not in the feasible set because violation rate is 50 percent or more.

force and ideal situations increases (50 percent or more) -- as the two environments become increasingly dissimilar -- the organization structures that are supported by the ideal environments can be discounted as feasible in the task force environments.

The number of violations exhibited by each task force configuration in comparison with each ideal environment is listed in Table 3. If a violation occurred in the environmental component considered crucial to the feasibility of an associated informal structure, that fact is noted in the table. Violation in these weighted factors eliminates the structure from contention for the feasible set in that task force environment. In addition, slight variation in the number of environmental violations among informal structures is considered insignificant to the analysis. Thus, so long as the violation rate is below 50 percent, informal structures can be included in a feasible set on an equal basis.

The outcome of this analysis is a feasible set of informal organization structures for each of the possible task force profiles. Table 4 lists those structures that, on the basis of the model's assumptions, are deemed appropriate for the various task force environments. Each task force environment is incompatible (highly dissimilar) with at least one of the ideal environments, thereby making at least one of the informal organization structures inappropriate in each possible situation. Thus, the feasible sets of informal structures reduce the number of structures from which the Navy or the CTF must choose a preferred one.

Particular assumptions (Rules 4 and 5 in Chapter 4) can assist in choosing from among the feasible sets. If the primary management value to be maximized is "cost and time efficiency," then the preferred informal structure of the feasible set should be the one closest to the centralization end of the continuum. These structures optimize quick and autocratic methods of decision-making. If, on the other hand, the primary value of management is to develop "personnel responsibility" to enable greater organizational

TABLE 4

Feasible Sets and Preferences Among Informal Organization Structures in the Task Force Command Environments

Configuration Number[a]	Feasible Set[b]
1	Centralization, Partial Delegation
2	Consultation, Partial Delegation, Decentralization
4	Centralization, Consultation
5	Centralization, Consultation, Partial Delegation, Decentralization
6	Partial Delegation, Decentralization
8	Consultation, Partial Delegation
9	Consultation, Partial Delegation, Decentralization
10	Transaction, Partial Delegation, Decentralization
14	Centralization, Consultation, Partial Delegation
15	Centralization, Partial Delegation
16	Centralization, Partial Delegation, Decentralization
20	Consultation, Partial Delegation, Decentralization
21	Consultation, Partial Delegation, Decentralization
22	Consultation, Partial Delegation, Decentralization
26	Centralization, Consultation, Partial Delegation, Decentralization
28	Consultation, Partial Delegation, Decentralization

[a] Refer to Table 2 for the characteristics of this task force environment. Each configuration is described verbally in Appendix C.

[b] A single underline indicates that the preferred informal organization structure is the one that maximizes the value of "cost efficiency" and, hence, the one closest to the centralization end of the continuum. A double underline indicates that the preferred informal organization structure is the one that maximizes the value of "personnel responsibility" and, hence, is closest to the decentralization end of the continuum.

efficiency in the long run, then the preferred informal structure of the feasible set ought to be the one closest to the decentralization end of the continuum. These decision methods maximize subordinate participation and a sense of efficacy in formulating solutions that will enhance future organizational performance.

Centralization and consultation structures are appropriate in a majority of task force situations when a quick and cost efficient response is required. The model indicates that in seven situations the most autocratic method (centralization) is the most appropriate. However, in seven other situations it is not; a less autocratic structure (consultation) is preferable. These results allow the organizational planner to make fine, though crucial, distinctions among these situations and optimize the choice of organization structure. Moreover, the model's application informs us that two environments likely to be encountered by a task force are best handled by more participatory types of decision methods -- transactional and partially delegated structures. This is so even when cost efficient values are of the highest managerial priority. Thus, the model allows us to draw some nonobvious and unexpected conclusions to maximize certain management goals, organizational performance, and decision aid exploitation.

When personnel responsibility is the value to be maximized, the results are somewhat more predictable. Eleven out of the 16 task force environments can be managed best via decentralized structures in which decision-making power is effectively distributed to staff officers. However, four situations are handled best by partially delegated structures and one by a consultative structure. Depending upon the circumstances, personnel responsibility can be maximized by implementing different informal structures.

Conclusions

In essence, the feasible sets and preferences based on the two management values represent testable hypotheses. They are fully operationalized in Chapter 12. For different projected environments that may be experienced by task forces, particular types of informal organization structures have been identified that are likely to maximize decision aid exploitation and decision-making performance.

These conclusions are prescriptive; on the basis of the model's assumptions, the preferred organization structures <u>ought</u> to operate most effectively and efficiently. However, these results cannot be considered absolute merely because they are founded on our model of reality. The application's conclusions (essentially Table 4) should be treated as hypotheses to be tested via case study and/or simulation techniques. Each profile can serve as a controlled experimental condition within which informal organization structure is allowed to vary. Employing a measure of organizational performance as the dependent variable, it is possible to determine whether the hypothesized structure actually provides the most appropriate vehicle for decision-making. If the hypotheses appear reasonable after such testing, they will lend a degree of validity to the contingency model. If the hypotheses are disproven, it will suggest that revisions should be made in the body of the model's assumptions.

DETERMINING APPROPRIATE FORMAL ORGANIZATION STRUCTURES FOR THE TASK FORCE COMMAND

A methodology similar to that employed to analyze informal organization structure for the task force command can be used to determine the most appropriate formal structure. Again, the assumptions of the contingency model are applied to the various environments likely to be experienced by the task force (see Table 2).

Three aspects of formal structure that relate to implementing a computer-based decision aiding system are of primary importance to the Navy. They are:

- The formal location of the decision aiding installation in the organizational chart;

- Assignment to new organizational roles to operate, analyze, and interpret the operational aids effectively; and
- The formal placement of decision aid operators.

As depicted in Figure 3 in Chapter 3, these problems can be approached sequentially, and the various choices available to the Navy can be displayed in the form of a decision network. The purpose of the present application is to determine the most appropriate response to each of the three formal structure problems in each of the projected task force command environments.

The contingency model suggests that certain environmental factors determine these aspects of formal structure. In fact, as discussed in greater detail in Chapter 4, different sets of environmental factors are assumed to influence the CTF's decision on each of the formal problems. Our analysis again takes the form of a comparison between ideal environments, in which particular formal structure choices are most appropriate, and the projected environments of the task force. <u>The assumption is that the greater the similarity between the projected and ideal situations, the more likely the formal organization structure that is associated with the ideal setting is also the most feasible in the projected task force setting</u>.

The ideal environments for each of the three formal structure properties, and the set of assumptions and literature that support them, were described in depth in Chapter 4 (especially, see Tables 2 and 4 in Chapter 4). Tables 5, 6, and 7 display the task force and ideal profiles side by side to enable analysis of the differences between them. The number of violations from the ideal environment exhibited by each task force configuration is calculated. When the degree of violation is 50 percent or more, that configuration is deemed to be sufficiently different from the ideal so as to make the associated formal structure property unfeasible or inappropriate in that task force setting. However, if the violation rate is less than 50 percent, the structural property is considered within the feasible set.

TABLE 5

Determination of the Feasible Set of Formal Organization Structures in Various Task Force Command Environments: Location of the Decision Aids Installation

Determining Climate Factors	1	2	4	5	6	8	9	10	14	15	16	20	21	22	26	28	Ideal Environments: Pyramidal	Ideal Environments: Divisional
	Task Force Command Environmental Configurations[b]																	
Skilled Leader	Y	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	N	Y	N
Relations-Oriented Style	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	N	N	Y	N	N	N	Y
Analytical Aids	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Real Time Capability	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Large Screen Display	Y	Y	Y	N	Y	Y	N	Y	N	Y	N	N	Y	N	N	N	Y	N
Fully Operational Stage	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N	N	N	N	Y	N
Violations of:																		
Pyramidal Installation	1	2	0	2	2	1	3[a]	3[a]	1	1	3[a]	2	2	4[a]	2	3[a]		
Divisional Installation	4[a]	3[a]	5[a]	3[a]	3[a]	4[a]	2	2	4[a]	4[a]	2	3[a]	3[a]	1	3[a]	2		

[a] Formal organization structural property is not in the feasible set because the violation rate is 50 percent or more.

[b] These refer to the configuration numbers in the master list in Table 2

Double underlined values indicate structures in the feasible set.

TABLE 6

Determination of the Feasible Set of Formal Organization Structures in Various Task Force Command Environments: Assignment to New Roles

Determining Climate Factors	1 5	2 9	c	4 14	6 16	c	8 20	10 22	c	c	15 26	c	c	21 28	c	c	Ideal Environments: Assign Specialists	Ideal Environments: Train Staff
	Task Force Command Environmental Configurations[b]																	
Skilled Leader	Y	N	Y	Y	Y	N	N	N	Y	Y	Y	N	N	N	Y	N	N	Y
Skilled Staff	Y	Y	N	Y	Y	N	Y	Y	N	N	Y	N	N	Y	N	N	N	-
Relations-Oriented Style	Y	Y	Y	N	Y	Y	N	Y	N	Y	N	N	Y	N	N	N	N	Y
Analytical Aids	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Fully Operational Stage	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	Y	N	N	N	N	N	Y
Violations of:																		
Assign Specialists	4[a]	3[a]	-	3[a]	3[a]	-	2	2	-	-	2	-	-	1	-	-		
Further Train Existing Staff	1	2	-	2	2	-	3[a]	3[a]	-	-	3[a]	-	-	4[a]	-	-		

[a] Formal organization structural property is not in the feasible set because the violation rate is 50 percent or more.

[b] These refer to the configuration numbers in the master list in Table 2.

[c] These configurations are unlikely to occur in the task force command environment because of the combined values of leader and staff skills (Y, N and N, N, respectively).

Double underlined values indicate structures in the feasible set.

TABLE 7

Determination of the Feasible Set of Formal Organization Structures for the Task Force Command: Placement of Decision Aid Operators

Determining Climate Factors	Task Force Command Environmental Configurations[b] I	II	Ideal Environments: New Division	Ideal Environments: Assist Division
Relations-Oriented Style	Y	N	N	Y
Violations of:				
New Division	1[a]	$\underline{\underline{0}}$		
Assist Existing Division	$\underline{\underline{0}}$	1[a]		

[a] Formal organization structural property is not in feasible set because violation rate is 50 percent or more.

[b] Roman numerals I and II represent sets of task force environmental configurations in which the values of leadership style are contained. (See Table 2 for a list of the 16 configurations that are likely to occur in the task force command.)

I: Configurations 1, 2, 5, 6, 9, 10, 16, 22
II: Configurations 4, 8, 14, 15, 20, 21, 26, 28

KEY: Double underlined values indicate structures in the feasible set.

The results of the analysis appear in Table 8. It indicates the preferable alternatives for each formal structure property given the projected organizational environment of the task force command. Pyramidal installations of the decision aiding system appear by far to be most appropriate in a large majority of the possible task force environments. When pyramidal systems are preferred, about half of the environments indicate that existing professional staff should be trained in technical decision analysis skills and serve double-duty in their present roles and as system operators. In five situations, however, the model's application to the task force suggests that pyramidal installations are most appropriate, that outside specialists should be assigned, and that they should serve as part of the CTF's or COS's augmented personal staff. In about one-third of the task force environments, the application indicates that divisional installations are most appropriate. Two of these situations also suggest that training the existing staff is preferable to assigning outside specialists, while three environments consider the latter to be the best policy.

DISCUSSION

The most obvious conclusion that can be drawn from this analysis of formal as well as informal structures in the task force is that different organizational environments require implementing different types of structures. No one organization structure is proper for all projected naval task force commands. However, if the total environment can be fairly well defined for the task force command, then appropriate organization structures can be prescribed. These prescriptions take the form of testable hypotheses that are presented in Table 9.

Essentially, 16 sets of hypotheses are formulated, one for each of the projected task force decision environments. All of these profiles simulate stressful planning and execution mission phases; they differ in terms of personnel and decision aid characteristics that may vary among task force staffs. The organizational profiles can be viewed as the independent variables. Through the model's logic, organization structures that

TABLE 8

Preferred Formal Structure Decisions
in Projected Task Force Command Environments

Task Force Command Environmental Configuration[a]	Location of Decision Aids Installation	Assignment to New Roles	Placement of Decision Aid Operators
1	Pyramidal	Train Staff	Serve Double-Duty[c]
2	Pyramidal	Train Staff	Serve Double-Duty[c]
4	Pyramidal	Train Staff	Serve Double-Duty[c]
5	Pyramidal	Train Staff	Serve Double-Duty[c]
6	Pyramidal	Train Staff	Serve Double-Duty[c]
8	Pyramidal	Assign Specialists	Serve on CTF's Staff[c]
9	Divisional	Train Staff	Remain in Own Division[c]
10	Divisional	Assign Specialists	Assist Division[b]
14	Pyramidal	Train Staff	Serve Double-Duty[c]
15	Pyramidal	Assign Specialists	Serve on CTF's Staff[c]
16	Divisional	Train Staff	Remain in Own Division[c]
20	Pyramidal	Assign Specialists	Serve on CTF's Staff[c]
21	Pyramidal	Assign Specialists	Serve on CTF's Staff[c]
22	Divisional	Assign Specialists	Assist Division[b]
26	Pyramidal	Assign Specialists	Serve on CTF's Staff[c]
28	Divisional	Assign Specialists	New Division[b]

[a] A verbal description of these environmental configurations can be found in Appendix C.

[b] A decision must be made concerning this formal structure property only in cases where both divisional installations and specialist assignment are prior decisions. For the logic behind this, see the decision tree in Figure 3 (Chapter 3).

[c] This is the only choice available to the CTF given the prior two choices of installation type and the need for analysts. Figure 3 (Chapter 3) and its adjoining discussion provide justification for this assumption.

TABLE 9

Summary of Hypotheses Concerning Organization Structure in the Task Force

If These Profiles Describe the Task Force Command[a]:	Then These Organization Structures Are Most Appropriate:				
	To Maximize Cost and Time Efficiency	To Maximize Personnel Responsibility	Location of Decision Aids Installation	Assignment to New Roles	Placement of Decision Aid Operators
1	Centralization	Partial Delegation	Pyramidal	Train Staff	Serve Double-Duty
2	Consultation	Decentralization	Pyramidal	Train Staff	Serve Double-Duty
4	Centralization	Consultation	Pyramidal	Train Staff	Serve Double-Duty
5	Centralization	Decentralization	Pyramidal	Train Staff	Serve Double-Duty
6	Partial Delegation	Decentralization	Pyramidal	Train Staff	Serve Double-Duty
8	Consultation	Partial Delegation	Pyramidal	Assign Specialists	Serve on CTF's Staff
9	Consultation	Decentralization	Divisional	Train Staff	Remain in Own Division
10	Transaction	Decentralization	Divisional	Assign Specialists	Assist Division
14	Centralization	Partial Delegation	Pyramidal	Train Staff	Serve Double-Duty
15	Centralization	Partial Delegation	Pyramidal	Assign Specialists	Serve on CTF's Staff
16	Centralization	Decentralization	Divisional	Train Staff	Remain in Own Division
20	Consultation	Decentralization	Pyramidal	Assign Specialists	Serve on CTF's Staff
21	Consultation	Decentralization	Pyramidal	Assign Specialists	Serve on CTF's Staff
22	Consultation	Decentralization	Divisional	Assign Specialists	Assist Division
26	Centralization	Decentralization	Pyramidal	Assign Specialists	Serve on CTF's Staff
28	Consultation	Decentralization	Divisional	Assign Specialists	New Division

[a] A verbal description of these environmental configurations can be found in Appendix C.

are considered to be optimal for each profile are postulated. They are mediating variables that can be tested in the organizational profiles to determine whether they maximize decision aid exploitation and decision-making performance in the task force. Evaluative measures of performance effectiveness are the dependent variables that must be optimized to validate the hypotheses.

Each set of hypotheses consists of complex multivariate profiles of the task force decision environment that predict effective organization structures. The hypotheses are somewhat difficult to describe verbally because of the multifaceted nature of the task force profile. However, there are several basic threads that run through the hypotheses which can help to pinpoint their major thrusts. These commonalities are stated as simple bivariate relationships between single profile descriptors and maximizing organization structures:

- If the commander is skilled and knowledgeable in decision aid operation and analysis, and rapid, cost efficient decisions are required, centralized informal organization structures provide maximum performance.

- If the decision aids are fully operational, entrenched, and accepted in the task force, and rapid, cost efficient decisions are required, centralized or consultative informal organization structures provide maximum performance. Also, decision aid operators should be formally placed in the personal staff of the commander.

- If the commander employs a relations-oriented style of command, that is, he gives little direction to the staff, encourages them to actively participate in setting decision-making parameters, and values the development of personnel responsibility, decentralized informal organization structures provide maximum performance.

- If the commander is skilled and knowledgeable in decision aid operation and analysis, formal placement of the decision aids under his direct personal control (a pyramidal formal structure) provides maximum performance.

- If the commander employs a relations-oriented style of command, formal placement of the decision aids and decision aid operators in a particular division of the task force staff provides maximum performance.

- If the commander possesses few skills and little knowledge about decision aid operation or analysis procedures, it is preferable to assign Navy specialists from outside the task force staff to coordinate and operate the system.

Each hypothesis is operationalized more fully in Chapter 12 so that it can be tested empirically in real world or simulation settings.

CHAPTER 6. CASE STUDY PROCEDURES

SUMMARY

The second and third major tasks of this project entail the design and execution of several case studies of Navy organizations. Attention is given to organizations in which computer-based decision aids have already been implemented to determine if organization structure has been affected. The products of these case studies are testable hypotheses developed in a multidimensional Navy context concerning suitable organization structures. In addition, the case studies enable validation of the hypotheses derived from the contingency model in Chapter 5 concerning Navy task force organization structure.

This chapter describes the procedures used to conduct the case studies. First, the objectives of the studies are discussed in more detail. The structured discussion guide to develop organizational profiles is described, and rationales are given for choosing those organizations ultimately analyzed. Finally, the methods by which the discussions were conducted are reviewed. The four case studies are documented in Chapters 7-10. The implications of these findings for the task force are presented in Chapter 11.

CASE STUDY OBJECTIVES

The objectives of this phase are threefold. Case studies were conducted to determine the organizational impact of computer-based decision aids on the basis of first-hand, empirical evidence. It was envisioned that these analyses would provide some clarification for the inconclusive, extant literature reviewed in Chapters 3 and 4. Gathering data on organizational climate makes it possible to specify the several factors that simultaneously influence the form of organization structure that evolves.

Case studies of Navy organizations in which computer-based decision aids have already been implemented would also provide the appropriate context for making analogies to the task force setting. Since the goal of the larger research project is to develop testable hypotheses concerning the probable effects of computer-based decision aids on task force command organization structure, Navy organizations are most appropriate for analysis. Most of the existing literature on this subject deals with business and industrial situations that are not directly applicable to the Navy context. Mission, personnel, and decision aids are widely different between the civilian and military sectors. Navy case studies would enable the transfer of experiential knowledge of military organizations couched within a theoretical framework.

Moreover, the case studies would help to validate the model developed in Chapter 4. By collecting information on the multidimensional organizational environment, organization structures, and effectiveness of these structures, it may be possible to test the hypotheses derived from the model against real world data. Thus, the case studies can indicate whether the hypotheses derived from the model are well-founded and worthy of further testing in task force simulations.

DISCUSSION GUIDE

Three of the four case studies were conducted by discussions with Navy personnel in the organizations. One of the studies was developed by secondary analysis of a first-hand observer's account. A structured discussion guide for the interviewers was developed to make sure that all of the information desired for the case studies was obtained; however, the discussions were held with a free, open-ended format. This guide appears in Appendix D.

The goal of each discussion was to develop an organizational profile including both factual and attitudinal information about (a) the organization's mission (b) the role of the decision aid in accomplishing mission objectives, (c) the personnel who employed the aid in their tasks, (d) the formal and informal organization structures that were established or evolved, (e) the effectiveness of these structures in maximizing decision aid exploitation, and (f) strategies that were used to implement the decision aid.

CHOICE OF ORGANIZATIONS FOR ANALYSIS

Members of the steering committee of the Operational Decision Aids project suggested several Army and Navy organizations that are currently using or developing computer-based decision aids. These candidate organizations for analysis are listed in Table 1.

Several criteria were developed to choose among these organizations, primarily to maximize their similarity with the task force setting. They are as follows:

- The decision aids should already be implemented in the organization.
- Organizational missions and objectives ought to be similar to those of the task force, that is, stressful with incomplete information.
- Staff size should approximate task force staff size.
- The organization should function solely as a decision-making body, leaving line functions to other organizations or subunits.
- The decision aids must be computer-based and should be analytical with near real time capability.

In addition, organizations chosen for case study should exemplify a range of different organizational environments so that the aggregate results of the analyses will indicate organizational impact under various circumstances.

Because of the limited number of computer-based decision aids in the military that are beyond a testing and development phase, these criteria could

TABLE 1

Candidate Organizations for Case Study

Organizational Location of Decision Aid	Organization to Be Interviewed	Decision Aid	Type of Aid	Case Study Disposition
Combat Information Center (CIC)	Fleet Combat Direction Systems Training Activity, Dam Neck, Virginia	Naval Tactical Data System (NTDS)	Tactical	Analyzed
Operational Control Center (OpCon)	Naval Air Test Center, Patuxent River, Maryland	Fleet Command Center (FCC)	Strategic	Analyzed
PERS 4	Bureau of Naval Personnel (PERS 4)	Officer Distribution Planning System (AMIS)	Personnel Distribution	Analyzed
Kitty Hawk Flagship Command Center	U.S.S. Kitty Hawk	Outlaw Hawk	Tactical	Analyzed (secondary analysis)
--	Fleet Exercise Reconstruction Activity Lab, NUSC, Newport, Rhode Island	Faroes System	Exercise Evaluation	No constant organization to analyze
--	Naval Air Systems Command	Naval Aviation Logistics Data Analysis (NALDA)	Logistics	Not yet implemented
Naval Materiel Command	Naval Materiel Command	3M System	Logistics	Sufficiently different from choice criteria
--	Army Research Institute	Tactical Operations System (TOS)	Tactical	Not yet implemented

not be adhered to strictly. From the candidate list, the following four organizations and their decision aids were chosen for analysis:

- Fleet Combat Direction Systems Training Activity, Dam Neck, Virginia (NTDS)
- U.S.S. Kitty Hawk (Outlaw Hawk)
- Bureau of Naval Personnel-4 (AMIS)
- Naval Air Test Center, Patuxent River, Maryland (FCC)

The other organizations on the candidate list were still testing their decisions aids prior to implementation, did not possess a permanent organization that continually used their decision aid, or were sufficiently different from the choice criteria to merit elimination.

CONDUCTING THE INTERVIEWS

The discussions were held over a 5-month period. Table 2 lists the dates of the discussions. Two interviewers, the principal investigator and his department manager, went into the field to conduct the discussion sessions. Onsite discussions enabled the interviewers to see the physical layout of the organization, decision aid documentation, and professional personnel and training groups in action using the decision aid. Officers from various levels of the organizational hierarchy were interviewed in each group to gain different perspectives on the organizational profile and structure. Discussions ranged from 4 hours to 45 minutes, with the average time spent with any one officer being a little under 2 hours. All of the discussants were very willing to participate and receptive to questioning. After the discussions were completed, draft write-ups were distributed to the discussants for their review. Each of these documents was approved as an accurate representation of the organizations and decision aids analyzed.

TABLE 2

Discussions Conducted

Dates	Organization	Decision Aid	Number of Officers Interviewed
17 March, 13 April, 20 May 1976	PERS 4	AMIS	3
2 June 1976	ARI	TOS	1
11 June, 10 August 1976	Fleet Combat Direction Systems Training Center	NTDS	4
17 June 1976	Naval Air Test Center	FCC	1

CHAPTER 7. THE ORGANIZATIONAL IMPACT OF THE NAVAL TACTICAL DATA SYSTEM (NTDS)

SUMMARY

Ships must possess adequate defense capabilities to accomplish their missions under combat conditions. The antiair warfare (AAW), antisubmarine warfare (ASW), and surface/subsurface (S/S) surveillance functions aboard ship entail complex command and control decisions that are assisted by a computer-based decision aid, the Naval Tactical Data System (NTDS). This system facilitates the processing and integration of large flows of incoming information during combat, and enables efficient evaluation of threats and effective assignment of weapons.

Although commanders can, and sometimes do, utilize NTDS personally, the system was primarily designed for use by particular operators in the Combat Information Center (CIC), requiring little if any commander participation. Thus, in terms of formal organization structure aboard ship, NTDS is implemented at the division level. Moreover, new organizational roles have been created to coordinate the highly differentiated task structure due to NTDS.

Two informal organization structures have evolved, depending on the degree of threat posed to the ship's defense. NTDS has resulted in a partially delegated informal structure under normal, weapon-free environments. Authority is delegated to the Ship Weapon Coordinator (SWC), but officers higher up in the formal hierarchy still manage by negation. Under extreme combat situations, the decision process may shift to a highly centralized authority structure focused on the commander. This change may decrease organizational and decision aid efficiency. Thus, although <u>information</u> centralization develops as a result of NTDS, <u>authority</u> centralization is not always the most appropriate or efficient organizational form with which to operate it. Especially under stressful conditions, partially delegated authority has been found to be most effective. Finally, it was found that

effective implementation of NTDS is achieved by demonstrations at the test site, intensive formal training on shore, and extended on-the-job instruction in operational situations.

THE CIC ENVIRONMENT

The environment in which NTDS operates is composed of four major factors:

- The mission to be accomplished,
- The characteristics and capabilities of the decision aid,
- The personnel that utilize NTDS to accomplish assigned tasks, and
- The organization structures that have evolved in implementing NTDS aboard ship.

The first three elements are covered in this section; organization structure is the subject of the following section.

The Mission Environment

NTDS assists in making decisions for the air defense of ships in combat situations. This function is the responsibility of the Combat Information Center located in the operations staff (N-3). It must employ the ship's AAW, ASW, and S/S surveillance resources in the most efficient and effective way possible to counter detected enemy attacks and thus enable the ship to accomplish its assigned mission. Although NTDS assists in other defense activities, for purposes of clarity, the rest of this chapter focuses solely on its AAW aspects. The basic functions involved in any AAW command and control system are (a) detection, (b) tracking, (c) identification, (d) electronic support measures (ESM) analysis, (e) threat evaluation and prioritization, (f) weapon assignment, (g) weapon commitment, and (h) evaluation (Forsyth, et al., 1973). Functions (a)-(d) deal with track handling -- identifying friendly and enemy vehicles and estimating track positions -- using surface and air search radars as primary sensors. These activities generate information required to assess the degree of threat and allocate weapon system firepower to detected targets if necessary (functions (e)-(h)). In general, the guidelines for decision and mission accomplishment are fairly clear and straightforward in AAW defense: Counter all enemy vehicles to enable the ship to complete its mission successfully. Although specific engagements may require the direction and guidance of the commander, there is little room for basic modifications in AAW policy and doctrine due to personal preference.

These basic tasks in AAW defense are well-structured and are conducted along preplanned and programmed procedures. A degree of information uncertainty and subjective judgment is present, however, in detection and identification tasks, which are functions that have as yet escaped automation and direct routinization. Although AAW defense tasks become crucial under active combat situations, the stress and tension experienced by CIC personnel may be somewhat reduced due to the structured procedures developed and learned especially for such situations. However, the immediacy of tactical engagements can elicit stressful responses if sufficient firepower is not available to engage each of the targets.

NTDS

The Naval Tactical Data System was developed in the 1950's and first implemented aboard ship in 1962 to enhance AAW defensive capabilities. At present, approximately one-third of Navy ships are equipped with NTDS. Using air and surface search radar sensors as primary sources of real time data, NTDS enables CIC personnel to detect objects, estimate their bearing, establish and update their tracks, assign objects as friendly or enemy, analyze electronic warfare (EW) support measures, evaluate and prioritize the degree of threat posed by hostile objects, and assign weapons to engage those objects. A data link, as well as a voice circuit, helps to communicate track information to and from remote sources (other NTDS and non-NTDS ships). All of this information and analysis is displayed graphically on a small screen at an individual's NTDS station. Each station enables operators to scan the data being input and analyses being performed by other operators.

NTDS symbology is associated with each radar track detected by the operator to distinguish friendly, hostile, and unidentified vehicles, those that are engaged by weapons, and so on. Repeated observations of an object help to establish current tracks and their courses and speeds. Once course and speed are known, NTDS moves the symbol identifying the track; track operators must continually update this NTDS video by reference to the radar of the actual track to correct for any changes in course or speed. NTDS can display many tracks simultaneously, but individual operators can usually attend to only 20-30 tracks at a time.

Monitoring, updating, and augmenting these tracks may push the human factor of vigilance to its threshold. According to several officers who were questioned on this matter, under severe combat or exercise conditions, NTDS track monitoring may be pushed to a saturation point at which human error in detection, identification, and estimation of track positions increases beyond an acceptable level. During such intensive periods, peak vigilance can only be maintained for about 1½-hour intervals. However, even under normal conditions, men are often shifted to different operator consoles every hour.

With tracks established, aided in accuracy by NTDS symbology and tracking techniques, decision and weapon employment functions can be performed. Since 1970, NTDS has been programmed to provide three options to deal with threat evaluation and weapon assignment. The first program option prioritizes each track in terms of its degree of threat. Priorities are set automatically according to an algorithm in NTDS. All weapon assignments and commitments must be undertaken manually. The second option prioritizes tracks, recommends engagements with high threat objects, and chooses the optimal weapon available to make that engagement. The third option is closest to decision <u>automation</u>, rather than decision <u>aiding</u>. Highly threatening tracks, identified as hostile missiles, are prioritized, resources are pulled off less threatening non-missile tracks, and weapons are reassigned. This option may be viewed as an automatic reflex action, bypassing the officer in charge (OIC). It is important to note, however, that in none of the three options are weapons actually fired by NTDS to engage threatening objects; humans still retain veto power over the decision to employ weapons. Engagement of a threatening object might take up to 5-6 minutes aboard a conventional ship, but NTDS allows for a more rapid response. The third option speeds the process even further. Moreover, this automatic option may pinpoint a highly threatening missile that an inattentive operator might have overlooked.

NTDS is continually being updated as problems in the program surface and new innovations are developed that will improve AAW defense capabilities. In general, NTDS programs that are written at the Dam Neck facility remain aboard ship for an average of 2 years without major alteration. One to four conventional radar repeaters are usually put aboard each NTDS-equipped ship in case of system breakdown. Alone, these are incapable of performing all of the tracking and weapon employment functions that are necessary for proper AAW operations and, thus, do not entice staff members to revert to substitutive procedures.

The Personnel Environment

Several aspects of the CIC organizational climate concern personnel skills, training, attitudes, and styles.

Group Size. More people are required to operate NTDS than to fulfill the same tasks via conventional methods. Approximately 15 individuals comprise the NTDS staff, although this number may vary depending on the number of NTDS consoles available aboard ship. These staff members work in teams as on non-NTDS ships, but are more highly trained in systematic procedures. Several new roles including the Force Weapon Coordinator (FWC), the Ship Weapon Coordinator (SWC), and the Anti-Submarine Coordinator have been added to AAW staffs because of NTDS. Several technicians are also required to maintain the hardware.

Skills and Acceptance. The basic initial impression of NTDS is that it appears to be magic, but this opinion fades as understanding of the system's logic develops through the training phase. Staff proficiency in system operations, procedures, and decisions increases with training, practice, and experience. However, ship captains vary in their knowledge and skill in employing NTDS. Over time and with the widespread use of NTDS, CIC officers who are proficient in NTDS skills may be promoted to command positions. But, at present, commanders may not have received formal NTDS training. Five to 10 years ago, when NTDS was in its formative stages, it occasionally met with resistance from some commanders. But now commanders generally prefer to work with the system. The officers who were interviewed have observed that the more scanty a commander's grasp of NTDS's capabilities, the less he will refer to it or use it as a decision aid. Inversely, the greater a commander's skill and understanding of NTDS, the more likely he will trust the system and use it to fullest advantage.

While resistance may be largely due to insufficient training, experience, or knowledge of NTDS capabilities and methods, acceptance may also be hindered by other more substantive aspects of the system. For one, resistance is fostered by the fact that users aboard ship are isolated from NTDS programming. While user suggestions and discoveries of errors are often incorporated in program revisions, implementation of these changes may lag, emphasizing the heavy reliance of users on a programmer who is removed from the realm of action. Moreover, threat evaluation, prioritization, and weapon assignment algorithms are inflexible; users are not offered the facility to modify program parameters to suit their special conditions or styles. This rigidity in the program has especially resulted in resistance to the automatic mode.

Personal Style of Command. Most ship captains do not participate directly in CIC or NTDS operations. However, leader personalities and preferences vary and can influence the effectiveness of NTDS and the ability of the staff to accomplish its goals. A widespread rule of thumb for captains is to allow decisions to be made at the lowest level of the chain of command with authority and then manage by negation. However, this rule may be operationally interpreted in many different ways depending upon leader preferences. For instance, the choice of delegated level and the option to revert to a more directive and controlling formation under stressful circumstances rest with the commander, whose style of leadership is strongly influenced by trust in subordinates and time constraints on decision-making. A current, popular preference is for commanders to be present in the CIC during combat episodes.

Training and Implementation

Instruction in the use of NTDS usually includes 2-3 weeks of formal training at shore-based training facilities followed by at least 1 month of on-the-job operational instruction. Personnel generally rotate their billets every 2 years, so training-through-practice actually proceeds continually. A prerequisite for NTDS training is previous CIC experience and/or officer CIC courses on decision analysis. Background in computer languages or usage, as well as decision analysis, is helpful in understanding the logic behind the system's algorithms and in developing trust in NTDS as a decision aid. Formal training includes not only the operational aspects of the system, but also the conceptual and theoretical aspects that move NTDS. A computer-assisted instruction program, L-Tran (Lesson Translator), has been developed to guide training aboard ship.

It has been found that formal training is required, especially for efficient and effective implementation of the system's third, automatic mode. Officers who were questioned blamed resistance to using this mode on insufficient training in its intent and capabilities. Instruction at Dam Neck takes the form of individual training for specific roles, as well as team training to instill the need for interpersonal interaction and coordination in accomplishing AAW defense objectives during actual combat conditions.

Officers generally receive training in a wide range of NTDS roles, while enlisted training is somewhat more limited to specific role functions.

At least two basic training strategies have been tried. The most effective method, according to the officers interviewed, has been to train personnel formally at a shore site such as Dam Neck and then supplement with operational on-the-job instruction. However, another strategy that has resulted in effective NTDS usage has been to send two instructors to a ship and conduct intensive courses there. While the results have been satisfactory, the instructors often encounter difficulty in drawing regular attendance by the CIC crew due to other priorities aboard ship and the lack of time for "homework." This second strategy is undertaken only under special circumstances, when shore-site training is impractical. This plan is not efficient from the training facility's perspective since it commits two instructors to one task exclusively over an extended period. Physical installation of NTDS aboard ship requires about 5 weeks of effort by a computer programmer, hardware expert, and NTDS instructor, followed by time at sea to adjust the programs and complete crew training.

ORGANIZATION STRUCTURE

Formal Organization Structure

Viewing the ship as a macrosystem, NTDS is physically and operationally located in the CIC of which the Tactical Action Officer (TAO) is the officer in charge. NTDS was designed to serve the needs of this center exclusively, although there is communication and coordination of effort with other related groups, including bridge and weapon controllers. Essentially, NTDS is installed at a division level in the ship's organization structure. Figure 1 depicts a simplified version of the organization chart of a typical NTDS staff.

At the task force level, the FWC is at the top of the NTDS hierarchy. He is in charge of all AAW operations for fleet defense and is located in the

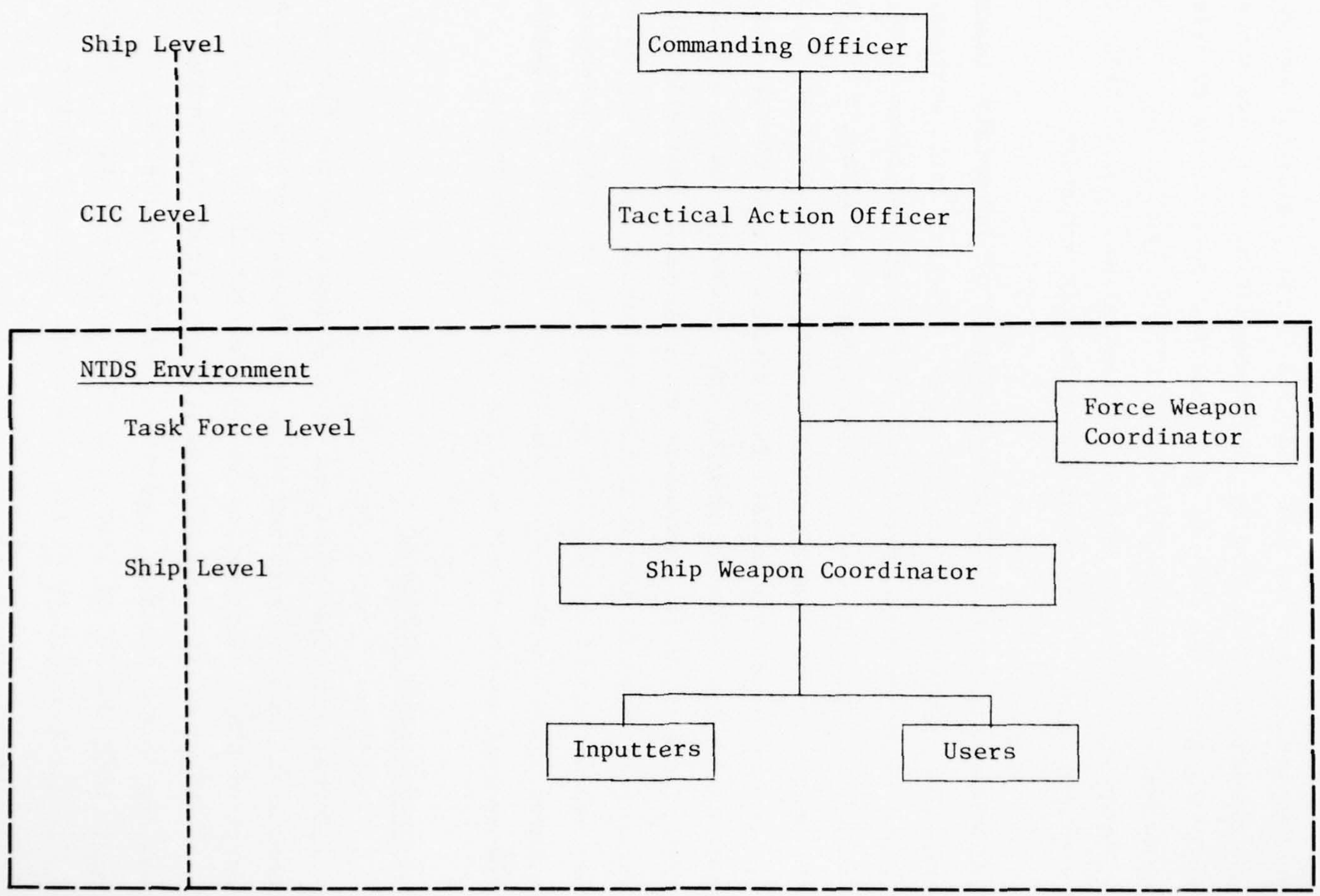


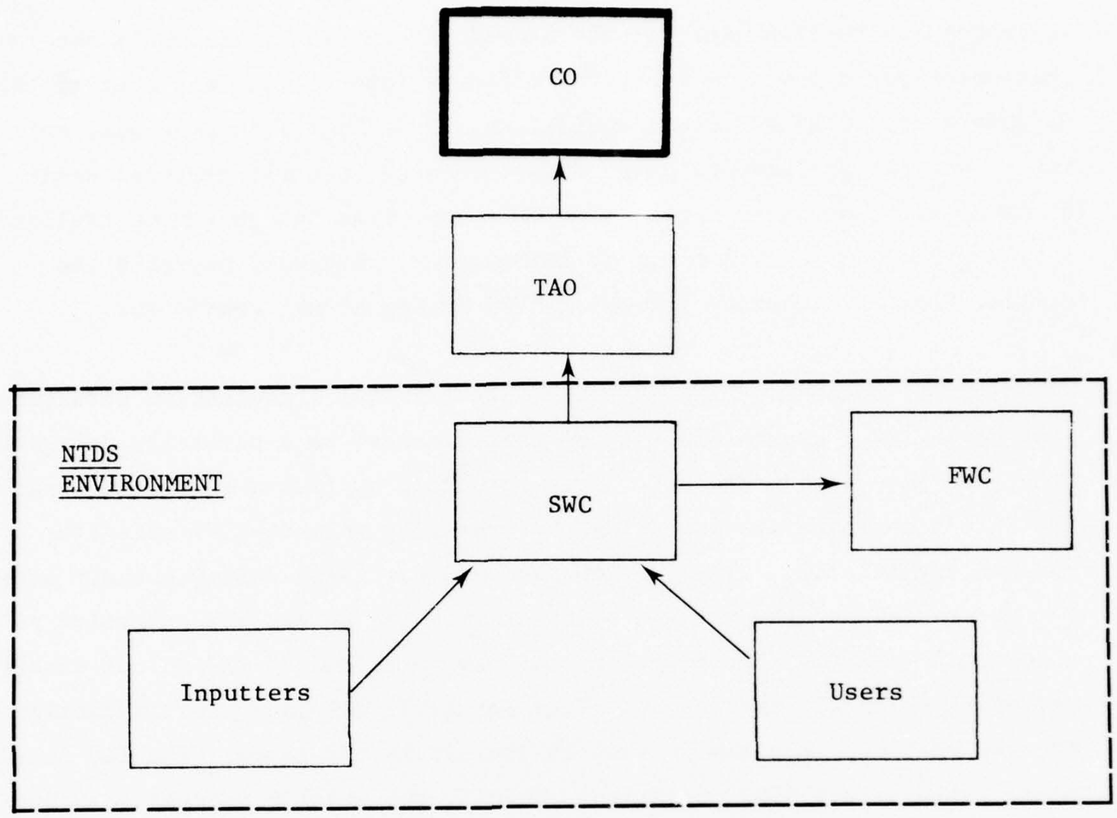
Figure 1. Simplified Organization Chart of a Typical NTDS Staff

NTDS CIC of the flagship. The SWC is responsible for ownship defense in AAW combat. He is directly accountable to the ship's TAO and the FWC. It is the TAO who chooses the NTDS mode for threat evaluation and weapon assignment decisions. Since he has responsibilities for tasks other than those involving NTDS, the TAO can be placed just outside the everyday NTDS environment in the formal hierarchy. The FWC and SWC are new coordinating roles that were necessitated by the introduction of NTDS; the system required change in the formal organization structure.

The basic NTDS staff consists of two categories of personnel: inputters and users. The inputters are the detectors, trackers (air, surface, submarine), and identification operators. They translate tracks on the radar screen into NTDS symbology, and monitor, update, and identify the tracks. This data processing is received and evaluated by the users who include the FWC, SWC, intercept controller, fire control system coordinator, and engagement controller. The FWC and SWC are generally junior officers, while most of the staff is composed of enlisted men. Initially, junior officers were assigned as identification operators, but it was observed that they became bored with the task quickly, and enlisted personnel could perform these roles adequately. Thus, changes in formal organization structure have evolved as experience with the system has increased.

Informal Organization Structure

A basic informal organization structure that describes the flow of authority, communication, and coordination in the decision process has evolved as a result of NTDS. Information has become centralized due to NTDS. Whereas track information was previously transmitted from individual tracking operators to the tracking supervisor and then to the TAO, the TAO can now consult with the SWC or look at an NTDS scope directly to obtain an overall, integrated picture of the situation. Figure 2 depicts the typical information flow involving NTDS data.



Key: Heavy box denotes focus of information flow.

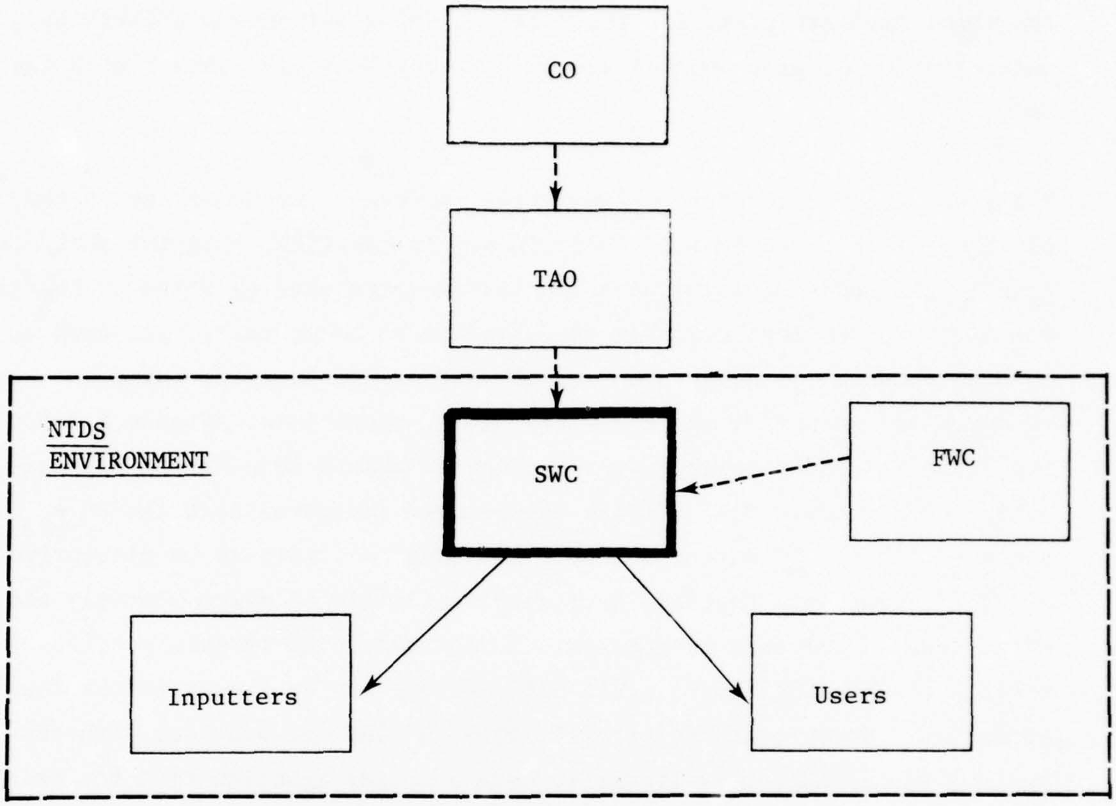
Figure 2. Typical NTDS Information Flow

Aboard a non-NTDS ship, the information flow is less standardized or precise. The CO, TAO, and FWC now have increased capability to retrieve specific and current tactical information rapidly and directly without intermediaries. In fact, aboard some ships, an NTDS console is located on the bridge for the personal use of the commanding officer. (The commander's mode switch has not been used extensively and is being phased out in new versions of NTDS.) Although NTDS makes it easier for the CO to obtain complete information because of centralization, it has made the commander increasingly dependent on his staff. This downward dependency for information increases the importance of the commander's trust in each subordinate.

Increased information centralization does not automatically imply centralization of authority. In fact, the officers interviewed felt that if the CO understands NTDS and its capabilities, it is likely that he will not intervene with the operators or attempt to make specific tactical decisions on his own, under normal circumstances, even though the centralized data sources enables him to do so technically. Figure 3 presents the typical flow of authority involving NTDS during normal conditions.

Given normal operating circumstances, the informal organization structure that has evolved around NTDS can be characterized as a partially delegated structure focusing on the SWC. This structure applies whether one observes the ship's macrosystem, including the commander and non-NTDS officers, or the CIC specifically. The CO, TAO, and FWC partially delegate their authority to the SWC and then manage by negation. The CO and his executive officer generally have other important matters to attend to and do not interfere personally with CIC operations. They partially delegate their authority to the TAO who is physically present in the CIC at all times. The TAO could potentially direct NTDS operations himself, but usually delegates authority to the SWC; the SWC makes decisions and issues orders while the TAO watches, consults, and approves or rejects. Under previous manual procedures for AAW operations, the SWC role did not exist and the TAO maintained authority, communicating directly with the track supervisor and issuing orders personally. Likewise, the FWC generally delegates his force-wide authority for AAW defense to the SWC for ownship tracking and engagements, while maintaining the power to veto decisions. Within the CIC, needs for coordination are satisfied by the SWC, who can integrate information inputs from various sources and develop decisions for engagement in a knowledgeable fashion. No further delegation of authority is maximizing.

There are two rationales for maintaining this informal organization structure. First, in tactical situations, which NTDS is designed to assist, there is little time for participative discussion of alternatives or transmission of large flows of specific information to the commander, who



Key: ---→ Flow of partially delegated authority.

——→ Flow of authority.

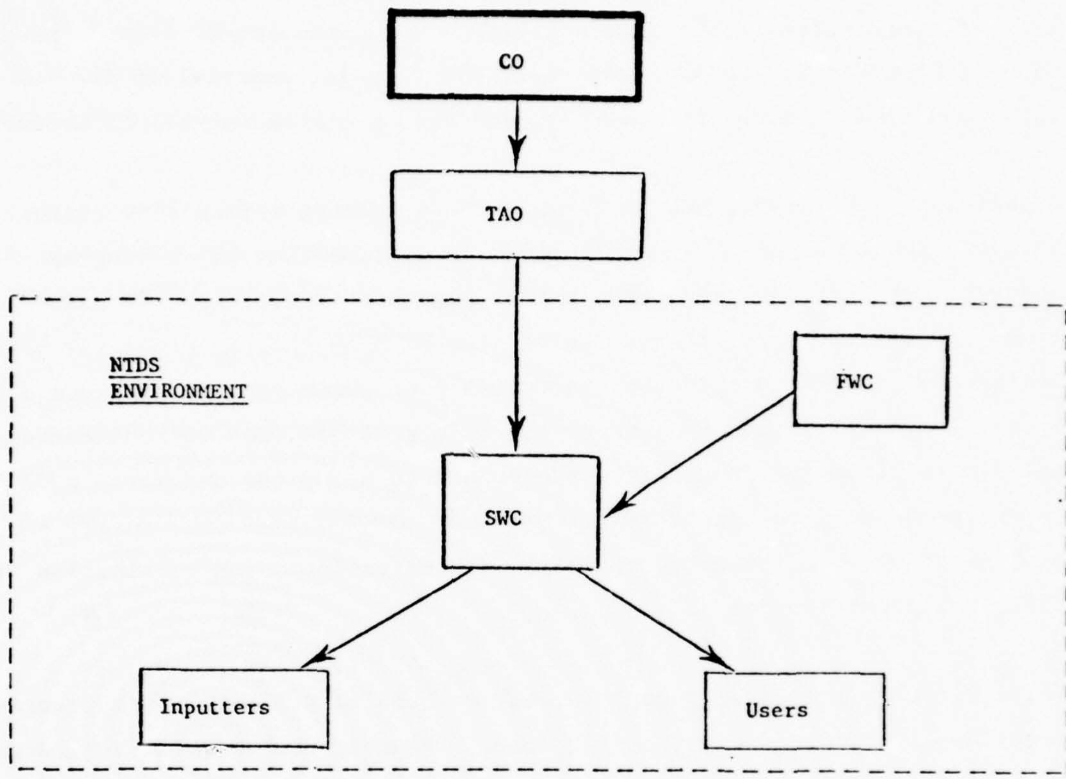
Heavy box denotes focus of authority.

Figure 3. Typical NTDS Authority Flow During Normal Conditions

has many other responsibilities. The only efficient and rational way to deal with an immediate tactical situation is to delegate authority, while maintaining control over the outcome. The basis of the second rationale is the organizational rule of thumb that decisions should be made at the lowest level of the chain of command with authority and then approved from above. The SWC is the lowest coordinating position that would support efficient and satisfactory decision-making. For instance, authority to turn the ship to enable optimal targeting and firing of weapons is delegated by the CO to the TAO and, in turn, to the SWC. The SWC is the baseline officer who could integrate an understanding of the need to turn the ship immediately and its implications for simultaneous activities undertaken by other groups aboard ship (through direct contact with the TAO).

Under extremely hazardous circumstances, however, the CO may go to the CIC and get involved in NTDS operations. In practice, this threshold is usually reached when it is probable that weapons must be fired at hostile targets. The CO may look over the shoulder of an operator, sit down at an NTDS console, or even role play the SWC or TAO himself; thus, he can recentralize authority and direction of AAW operations. Figure 4 depicits the typical informal organization structure aboard ship during extreme combat conditions. The officers interviewed indicated that the CO's presence in the CIC during combat situations is likely to be disruptive of staff procedures that are developed especially to react promptly and effectively under such exigencies. He may take over certain positions entirely, replacing expert staff officers who may be closer to the local situation. Because of his unfamiliarity and lack of practice with the system, the commander is likely to have a longer reaction time to immediate problems and employ the NTDS staff inefficiently. Moreover, communication among CIC personnel is likely to deteriorate and morale among the staff decline. Several officers who have been members of NTDS staffs concur that the normal decision process, which focuses on the SWC (see Figure 3), is probably the most satisfactory informal organization structure under stressful circumstances.

Below the SWC level, the inputters and users tend to function as teams in accomplishing their tasks. The air, surface, and submarine trackers work as separate teams to confirm track detection, identification, and positions. The users also communicate with each other to maximize their tasks of evaluating the tracks and assigning weapons. However, in all cases, individual NTDS consoles are employed; there are no large screen group displays provided. The operators' stations are close enough for easy voice communication.



Key: → Flow of Authority

Heavy box denotes focus of authority

Figure 4. Typical NTDS Authority Flow During Extreme Combat Conditions

EFFECTIVENESS OF THE DECISION AID AND ORGANIZATION STRUCTURE

The Decision Aid

Evaluation of NTDS by several officers who have employed it extensively suggests that it is a widely accepted and useful decision aid, providing structure and integration to a set of previously manual and imprecise tasks. They judged NTDS as effective on the basis of the following criteria: greater speed, increased capacity to track many objects accurately, greater capacity to communicate with and gather data from other ships, greater information storage, and improved command and control capability.

A fundamental problem with NTDS, which detracts from its utility, is the lack of coordination with other activities and tasks aboard ship. Integration of NTDS within the macrosystem of the ship is essential to prevent subgroups from working at cross-purposes and to ensure overall effectiveness.

Technically, the system has an 80-95 percent working reliability ratio. However, there are usually difficulties in implementing major program changes, with extended lag times before bugs are ironed out. In addition, it is anticipated that a new version of NTDS that is presently being installed aboard many ships may encounter some human factors problems due to the increased number of buttons and mode switches that must be coordinated to perform new functions. Resistance to using the automatic mode to assign weapons to high threat objects is another problem that may be eliminated by more intensive training, demonstrations, and elimination of program inconsistencies.

Voice circuits are usually used to back up NTDS data links. This procedure sometimes hinders efficient performance. Probably due to their development at different times by different personnel, the formats for voice communication vary among AAW, ASW, and S/S. Standardization of these formats would ease NTDS operations.

Finally, NTDS display equipment cannot provide the degree of accuracy required for surface/subsurface surveillance and tracking. While an NTDS console exists for this tracking mode, conventional tracking techniques are still relied upon for the ship's defense. Currently, the results of these manual procedures are fed into NTDS purely for bookkeeping purposes. A display console that meets up to the specifications of S/S surveillance should be developed and incorporated into the system.

Organization Structure

The officers who were interviewed maintained a proclivity for informal organization structures that focus on the SWC, that is, partially delegated structures. They feel that organizational configurations focused on the SWC offer the most efficient and effective coordination of staff, and control over NTDS and the AAW functional area in general. The tendency is to keep the commanding officer out of the operation of NTDS. Task accomplishment using NTDS can be maximized if all levels above the SWC delegate their authority and manage by negation. If informal decision structures centralized around the CO are created, effective utilization of NTDS is minimized.

A problem common to many computer-based decision aids, the creation of information overload, is not present in NTDS, in part because of hardware considerations and organization structure. Display switches on each NTDS console enable operators to choose selectively the information to be displayed. Thus, the screen is not overloaded with tracks or symbols that would be difficult to distinguish. Organizationally, AAW tasks have been divided among several functional roles, each with particular responsibilities. Each staff member need only view information pertinent to his task and does not have to deal with irrelevant data. Moreover, creation of a coordinating role in the SWC helps to integrate the more highly differentiated task structure that has developed as a result of NTDS, and thus isolates the potential for information overload to hamper operations in the rest of the staff.

Finally, the organization structure that has evolved facilitates information flow, making it more precise and eliminating personnel filters that might add distortion. It was initially assumed that assigning junior officers to the various inputter and user roles would enhance information flow, the need for experienced judgment, and group performance. However, after some operational experience with NTDS, it was found that enlisted personnel could function at similar levels of effectiveness, and they have since replaced the more senior operators.

APPLICATION OF THE CONTINGENCY MODEL TO THE NTDS CASE STUDY

On the basis of data collected for this case study, values for the 10 organizational elements in the contingency model (Chapter 4) can be specified (see Table 1). Together, these values provide an organizational profile of the CIC and its use of NTDS.

The CIC organizational profile corresponds most closely to Profile 14 projected for the task force (see Chapter 5). The CIC environment differs from the task force in only one respect: Unstructured, uncertain, and complex problems are projected for the task force, while the AAW functions in the CIC are fairly well-defined, routine, and structured. It is important to note that this organizational element is not considered a "crucial" or criterion condition upon which the hypotheses derived from the model depend.

In Chapter 5, an hypothesis concerning maximizing organization structures was derived from the model based on the organizational contingencies specified in Profile 14. Table 2 compares the actual and hypothesized structures for the CIC. In certain respects, these prescriptions correspond favorably to the organization structure that has evolved in the CIC since NTDS was introduced.

A partially delegated informal structure is considered to be the typical and most efficient decision process using NTDS. CIC officers who were interviewed felt that delegating authority, while still maintaining management by negation, was superior to centralized authority and tended to boost staff morale, effectiveness, and responsibility. However, centralized processes are usually employed for extreme combat conditions. Moreover, while the implementation of NTDS has required more technical skills and the development of several new coordinating positions, special attention has been given to training regular CIC personnel to elevate their abilities to use the system.

TABLE 1

Organizational Profile of
the CIC and Its Use of NTDS

Organizational Elements	CIC Profile	Projected Profile 14
Clear Mission Goals	Y	Y
Well-Structured Problems	Y	N
Stressful Missions	Y	Y
Skilled Leader[a]	Y	Y
Skilled Staff[a]	Y	Y
Relations-Oriented Staff[a]	N	N
Analytical Aid	Y	Y
Real Time Capability	Y	Y
Large Screen Display	N	N
Fully Operational	Y	Y

Projected Task Force Profile That
Has Greatest Simlarity..................14

Number of Violations..................... 1

Number of Violations in Crucial
Conditions............................. 0

[a] These variables are weighted more than others in the model in projecting feasible informal organization structures. Therefore, they represent the "crucial conditions" or criteria that must be met by actual organizational profiles for the model's hypotheses to be appropriate.

TABLE 2

Comparison of Hypothesized and CIC Organization Structures

Hypotheses	CIC
1. Centralized informal structure (to maximize cost and time efficiency)	1. Centralized informal structure (during extreme combat conditions)
2. Partially delegated informal structure (to maximize personnel responsibility)	2. Partially delegated informal structure (during normal operating conditions)
3. Pyramidal decision aid installation	3. Divisional decision aid installation
4. Further training of present personnel	4. Further training of present personnel
5. Operators serve double-duty for division and pyramidal decision aid	5. Operators serve as division staff

In other respects, the prescriptions do not match with the actual CIC organization structure. The evolution of a divisional decision aid installation rather than the hypothesized pyramidal form is probably due to the difference in assumed and actual organizational profiles shown in Table 1. The hypotheses assume an unstructured mission in which the commander is likely to want direct control and prefer a pyramidal installation. However, the NTDS mission is well-structured, thus enabling delegation of authority and divisional installations. The discrepancy between the hypothesized and actual placement of decision aid operators can be similarly accounted for by the change in the mission structure assumption.

CHAPTER 8. THE ORGANIZATIONAL IMPACT OF OUTLAW HAWK

SUMMARY

Outlaw Hawk is the code name for the computer-based decision aid that was put aboard the U.S.S. Kitty Hawk to assist the flag commander and his staff in exercises conducted in March 1975. It is a multicomponent system consisting of (a) an ocean surveillance system that correlates and maintains timely data on friendly and enemy ship locations, (b) a management information system to allow easy retrieval, display, and report generation on a wide range of relevant information, (c) the Naval Tactical Data System (NTDS), and (d) small and large screen visual displays.

A secondary analysis of observer reports indicates that Outlaw Hawk was formally placed under the direct control of the commander. This pyramidal structure enabled him to monitor current situations closely from various perspectives. It integrated and centralized the information sources maintained by the decision aid. The informal organization structure was also highly centralized. Information centralization provided the resources for authority centralization. The admiral made all necessary decisions alone, with very limited consultation of staff officers. Both the pyramidal and authority centralization features of organization structure aboard the Kitty Hawk were deemed generally effective by observers in terms of decision aid exploitation and the generation of rapid and high quality decisions.

THE KITTY HAWK ENVIRONMENT

All of the data reported here on Outlaw Hawk were derived from unclassified sections of a recent evaluation (Center for Naval Analyses, 1975) of the decision aiding experiment aboard the U.S.S. Kitty Hawk. Center for Naval Analysis (CNA) representatives observed the functioning of the Kitty Hawk flag commander (Commander Carrier Group One (ComCarGru One)) and staff to evaluate the effectiveness of Outlaw Hawk, an experimental computer-based decision aid, and recommend improvements in the C^3 system. In their report, sufficient data concerning the decision environment and organization structure aboard the Kitty Hawk were provided to support the secondary analysis which follows.

The Mission Environment

The U.S.S. Kitty Hawk participated in the Com Third Flt exercise RimPac (Rim of the Pacific) in March 1975. The CNA authors describe in depth a single 12-hour period of tactical activity in which the "cold" war in the exercise turned "hot," when normal operations turned into crisis conditions. This transitional period describes the mission environment of interest in this case study.

The RimPac exercises were subjected to highly detailed planning that provided the commander with general objectives and guidelines (such as Rules of Engagement) for action. Since most tactical decisions in the exercises were preprogrammed, the planning required by the commander and his staff was reduced substantially, creating a relatively routine, predictable, and well-structured situation. However, this case study focuses on a period in the exercise when the situation became highly unstructured. The problems that arose were unplanned and complex. Responsibility for the resolution of this uncertain and unstructured situation rested largely on the commander, who defined the parameters of the problem and developed a decision path under nonroutine conditions. During the transition from "cold" to "hot" war, the mission became stressful, partly because of the uncertain and unstructured nature of the problem situation and the associated higher risks that develop in such circumstances.

Outlaw Hawk

The Kitty Hawk was equipped with an experimental, computer-based decision aid especially for the RimPac exercises at the request of the flag commander. The anticipated role of the system was to assemble and display believable, accurate, and timely data to ease the decision-making process aboard ship and improve the quality of decisions made by the commander, especially under crisis conditions. The system was composed of four major elements:

1. Multi-Source Correlational Facility (MSCF) and Flag Correlational Facility (FCF): Maintains up-to-date information on ocean surveillance of friendly and enemy ship locations. It enables early warning of potential threats and the location of immediate threats by correlating data from various sources. The ashore and shipboard components provide consistency, accuracy, and timeliness of data and their display.

2. Auxiliary Ships Information System (ASIS): Provides a retrievable data base including information on casualty reports, communication call signs, personnel, and threat characteristics. ASIS is a management information system (MIS) capable of various data manipulations, rapid presentations, and report preparations.

3. Naval Tactical Data System (NTDS): Provides data management and resource control for antiair warfare and other functional areas.

4. Display Systems: The above three components were supported by a large group display (LGD), a closed circuit television system (CCTV), and alphanumeric television monitors. These enabled efficient display of data in the command center and distribution of information between command and staff. The LGD was employed especially by the commander for briefings and to obtain information about the entire current situation without leaving the command center post.

Most of these system components provide data management, storage, retrieval, and display capabilities. However, they are not programmed to offer sophisticated analyses of those data to yield probabilities or utilities of various possible actions and outcomes.[1]

Although there were some delays in entering incoming data from remote sources, raw sensor data and locally available information were continually updated on the FCF system to maintain a near real time capability. Dedicated circuitry between the MSCF ashore and the shipboard FCF enhanced the timeliness of the data base. The ASIS data files were updated periodically, but not kept on a near real time basis.

The Personnel Environment

The flag commander was highly and positively disposed toward the Outlaw Hawk system; he initially requested the computer-based decision aids to upgrade his command facilities. Moreover, the commander and staff possessed sufficient skills to operate the decision tools and interpret their output without the assistance of technical analysts. The system was programmed assuming that users would have no previous computer experience. Data output was displayed in standard, traditional Navy formats.

Although the CNA report does not explicitly consider the commander's personal style of leadership, the account of the decision process indicated that the commander exercised a task-oriented style of command. He was active, directive, and controlling in his relations with subordinates and did not encourage staff participation.

ORGANIZATION STRUCTURE

Formal Organization Structure

Outlaw Hawk was formally located under the direct control of the flag commander on the Kitty Hawk. This pyramidal placement of the system enabled

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[1] NTDS is the only component that provides analytical facilities.

him to monitor the current tactical situation from a wide range of perspectives and maintain centralized control over information flow. While staff officers could request data from Outlaw Hawk, direction over the system's functioning and operational staff fell to the commander. No new organizational roles were considered necessary for maximum exploitation of the experimental system.

Informal Organization Structure

In this case, centralization of information in the commander, facilitated by the computer-based system, generated a centralized informal authority structure. The CNA report indicates that the decision process aboard the *Kitty Hawk* was highly centralized during the crisis period. The commander made all major decisions alone, with very limited staff consultation. To the extent that consultation did occur, it was employed mainly for informational purposes to brief the commander on the current situation and not to involve the staff actively in the decision-making process. Incoming information flowed upward to the central actor, and decisions were made solely by that actor on the basis of his judgment and expertise given available information. During the transition period to a "hot" war, decisions had to be made in the most cost and time efficient manner; a centralized decision process evolved aboard the *Kitty Hawk* that maximized these goals. The flag commander's desire to evaluate Outlaw Hawk personally also contributed to the evolution of a centralized structure.

EFFECTIVENESS OF THE DECISION AID AND ORGANIZATION STRUCTURE

Decision Aid

During the decision period analyzed, Outlaw Hawk aided the flag commander and his staff in performing their functions. The CNA report offered the following system *utilization* statistics, but provided no baseline against which to judge system *effectiveness*. Visual displays supporting the decision system were utilized in 30 percent of the cases to transmit information.

Telephone, intercom, and radio networks were used 53 percent of the time. As a source of information, Outlaw Hawk was employed to provide about 21 percent of the data used to make decisions. Most of the information retrieved dealt with operations matters, but a significant amount was concerned with intelligence matters. The flag commander on the *Kitty Hawk* was the most frequent questioner of the system.

The CNA observers evaluated the data bases as generally being too old for accurate decision-making. Some bottlenecks developed when data generated over voice circuits had to be processed and input into the system's data files. However, the graphic displays, especially the LGD, were very effective in helping the commander to interpret the current tactical situation. In all, the flag commander on the *Kitty Hawk* had the best tactical overview of RimPac due to the Outlaw Hawk system which was unavailable to any other ship in the exercise. Its strength lay in centralizing and integrating available information plus providing the facility to evaluate and display it. Improvement is still needed in data assembly, analysis, and synthesis functions of the decision aid.

Organization Structure

The CNA report indicated that the formal and informal organization structures that evolved aboard the *Kitty Hawk* to employ the decision system were effective. The commander actively used Outlaw Hawk and consulted his staff when further information or technical assistance in operating the system was required. However, the CNA observers suggest that perhaps a more participative or decentralized informal organization structure would employ the expertise of the professional staff more successfully.

APPLICATION OF THE CONTINGENCY MODEL TO THE OUTLAW HAWK CASE STUDY

The data gathered on Outlaw Hawk can help to generate values on the 10 organizational elements in the contingency model (Chapter 4). These values, which describe the organizational profile of the Kitty Hawk flag command center using Outlaw Hawk, are presented in Table 1.

The organizational profile in the Kitty Hawk command center is most similar to profile 15, which describes a projected task force environment (see Chapter 5). The Kitty Hawk profile differs with regard to only one organizational element, which is not a "crucial" factor in the model. The task force context anticipates the development of sophisticated and analytical computer-based decision aids that can calculate utility functions for various alternatives and outcomes based on mathematical or statistical algorithms. Outlaw Hawk, on the other hand, consisted of rather unsophisticated computer-based decision aids (except for NTDS) that were essentially data processing, storage, retrieval, and display tools.

Given the organizational conditions specified in profile 15, a set of prescriptive hypotheses was derived from the contingency model. The hypothesized and actual organization structures are compared in Table 2. Four of these prescriptions correspond favorably with the organization structure that evolved aboard the Kitty Hawk. A highly centralized informal structure was observed in action and considered to be effective. However, the CNA representatives conjectured that a greater degree of participation by professional staff members in the decision-making process -- through a partially delegated informal structure -- would probably yield improved performance because it would enhance personnel morale and responsibility and draw upon all of the available expert resources in the staff. The decision aid was designed to assist the commander specifically, and was located formally under the commander's personal control. The decision aid operators were also members of his personal staff, exclusively.

The prescriptions fail in only one instance: Little, if any, formal training in decision aid operation was provided, and assignment of already skilled personnel was not undertaken. The CNA observers report that Outlaw Hawk was so simple to employ and so similar in format to conventional data

TABLE 1

Organizational Profile of the Kitty Hawk Command Center and Its Use of Outlaw Hawk

Organizational Elements	Kitty Hawk Profile	Projected Profile 15
Clear Mission Goals	Y	Y
Well Structured Problems	N	N
Stressful Missions	Y	Y
Skilled Leader[a]	Y	Y
Skilled Staff[a]	Y	Y
Relations-Oriented Style[a]	N	N
Analytical Aid	N ⟷	Y
Real Time Capability	Y	Y
Large Screen Display	Y	Y
Fully Operational	N	N

Projected Task Force Profile That Has Greatest Similarity................15

Number of Violations...................... 1

Number of Violations in Crucial Conditions..................... 0

[a] These variables are weighted more than others in the model in projecting feasible informal organization structures. Therefore, they represent the "crucial conditions" or criteria that must be met by actual organizational profiles for the model's hypotheses to be appropriate.

TABLE 2

Comparison of Hypothesized and
Kitty Hawk Organization Structures

Hypotheses	Kitty Hawk
1. Centralized informal structure (to maximize cost and time efficiency)	1. Centralized informal structure
2. Partially delegated informal structure (to maximize personnel responsibility)	2. Partially delegated informal structure (suggested by CNA for long-term effectiveness)
3. Pyramidal decision aid installation	3. Pyramidal decision aid installation
4. Assignment of already skilled Navy personnel	4. Regular staff used (no special skills required)
5. Operators located in commander's personal staff	5. Operators located in commander's personal staff

displays that neither special training nor assignments from outside were required. The failure of the hypothesis to predict Kitty Hawk organization structure accurately can be attributed to the dissimilarity in the assumed and actual organizational profiles shown in Table 1. The hypothesis assumed the existence of a complex analytical aid that would require assignment of already skilled Navy personnel to operate the system. However, Outlaw Hawk is a much simpler device, requiring minimal instruction of current staff.

CHAPTER 9. THE ORGANIZATIONAL IMPACTS OF AMIS (AN OFFICER DISTRIBUTION PLANNING SYSTEM)

SUMMARY

AMIS is a computer-based officer distribution planning system developed and employed by PERS 4 in the Bureau of Naval Personnel.[1] It is a static model that considers officer inventory and officer billet requirements to yield a broad, recommended officer placement plan that can be used as a guideline for manual designators.

AMIS is presently located on a divisional level in the organizational hierarchy, but plans are being made to place the system and its staff in a pyramidal location under the commander's personal control. While this move may yield greater leader involvement and support, which are sought by users of AMIS, it may also cause a dysfunctional centralization of decision-making and commander bypass of mid-level officers. This can be avoided if the model's parameters continue to be set by placement officers.

A new technical and coordinating role has been developed to maximize the effectiveness of AMIS -- the AMIS project officer. Although he is at the locus of information flow concerning AMIS data, the project officer does not possess authority over the system or its usage. Authority patterns in the informal organization structure are partially delegated to the placement officers and, sometimes, division directors, who maintain control over setting billet priorities and minimum billet fill rates.

AMIS is considered to be an extremely effective decision aid in assisting PERS 4 mission accomplishment on both a placement officer level and a division director level. In fact, further development is being

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[1] Personnel interviewed in PERS 4 described AMIS as an acronym for Automated Management Information System.

considered to yield an even more sophisticated algorithm to aid PERS 4 personnel. However, some resistance to full exploitation of AMIS capabilities has arisen from the PERS 4 management with regard to using the model's long-term forecasts as policy rather than mere guidelines.

THE PERS 4 ENVIRONMENT

The organizational context in which AMIS is employed determines the type of organization structure that will provide the most efficient and effective utilization of personnel to accomplish mission goals. The PERS 4 organizational environment is described below.

The Mission Environment

AMIS was written expressly for PERS 4, which has responsibility for officer development and distribution. Located in the Bureau of Naval Personnel, the organization must develop a plan for officer distribution that satisfies the joint constraints of officer inventory and billet requirements. PERS 4 uses this plan to guide manual assignment of individual officers throughout the Navy. This mission is nonstressful, well-structured, and routine.

AMIS

AMIS is a computer-based decision aid that facilitates mission accomplishment in PERS 4 by building such an officer distribution plan. AMIS is presently configured as a static model that considers two sets of variables: officer inventory (officer grade and officer designator) and officer billet requirements (billet grade, billet designator, and activity or billet priority). Using linear programming and billet fill priorities that are prepared by PERS 4 personnel, AMIS provides a recommended officer distribution plan for the Navy. The model arrives at this "optimal" plan by matching personnel assets with personnel needs, constrained by changeable priorities for filling each billet and the requirement for filling even low priority billets to an acceptable minimum level.

The results of the model define suggested guidelines for possible changes in officer distribution. It provides a table for each organization or activity in the Navy, indicating current officer placement as well as recommended billet fills for the immediate future. AMIS can be programmed to project its recommendations up to 12 months in advance. It can be used to show how "excess" officers should be employed and how "short" communities should be best utilized. AMIS can help to compare and balance officer allocation among organizations in an objective fashion in accordance with organizational needs and officer availability. Moreover, the system can be used to prepare for mobilization and to identify opportunities for advanced placement of officers.

AMIS was implemented in January 1975 by the Management Information Branch of PERS 4. The initial design of the system was jointly developed by System Automation Corporation, a private research firm, and professors from Texas University and Carnegie-Mellon University under contracts administered by the Office of Naval Research during FY72 and FY73. This original plan for the model was rejected by the PERS 4 management; it appeared to eliminate choice in establishing certain billet priorities and thus limited flexibility in setting policy. The major source of resistance stemmed from a system perceived as automating a formerly human decision process and not allowing for modification of crucial judgmental parameters by its human operators. The model was reincarnated in 1974 by programmers in-house; a working prototype was completed in the fall of 1974. Prior to developing AMIS, PERS 4 placement officers employed a manual system that was not equipped to provide the detailed data necessary for efficient mission accomplishment. With the implementation of AMIS, this manual procedure has been totally discarded.

Operationally, the AMIS model is run each quarter to reflect new requirements, inventories, billet priorities, and fill rates. The date base is updated between quarters. However, because the situation is substantially static, the model may eventually be updated and run only twice a year.

The AMIS project officer is the only individual who technically interfaces with the system. He receives and enters all data and parameter changes from the placement officers and division directors in PERS 4. The quarterly output is distributed to AMIS users in the form of computer hard copy or summary memos prepared by the AMIS project officer.

The Personnel Environment

Leader and Staff Skills. The basic users of AMIS are the AMIS representatives in each of the PERS 4 divisions, the placement officers and division directors who set the billet priorities and minimum fill rates, and the AMIS project officer who serves as a technical operator, coordinator, and distributor of AMIS-generated information. The representatives are placement officers trained to use the system by the AMIS project officer. It generally takes a few weeks to develop some proficiency. They are instructed in the system options and capabilities; some understand the mathematical algorithms that actually move the model. These representatives, in turn, distribute AMIS information to those who need it within their division. Many of the relevant division directors (of which there are four) lack a complete understanding of AMIS capabilities or how the parameters that they set influence AMIS results. They generally do not employ AMIS on a day-to-day basis, though they do receive summary memoranda of its results. The commander at the top of the PERS 4 hierarchy also has little to do with the everyday operation of the system, but he does have a basic understanding of the potential utility and capabilities of AMIS and, if necessary, could probably deal with the computer results.

Acceptance and Resistance. Initially, AMIS representatives were wary of the utility of the model because timely and accurate data were lacking. The fact that the system is not real time was seen as a drawback and resulted in a credibility gap. However, over time, AMIS has gained legitimacy in the eyes of its users. The PERS 4 commander was in favor of implementing AMIS from the start because he saw it as improving management.

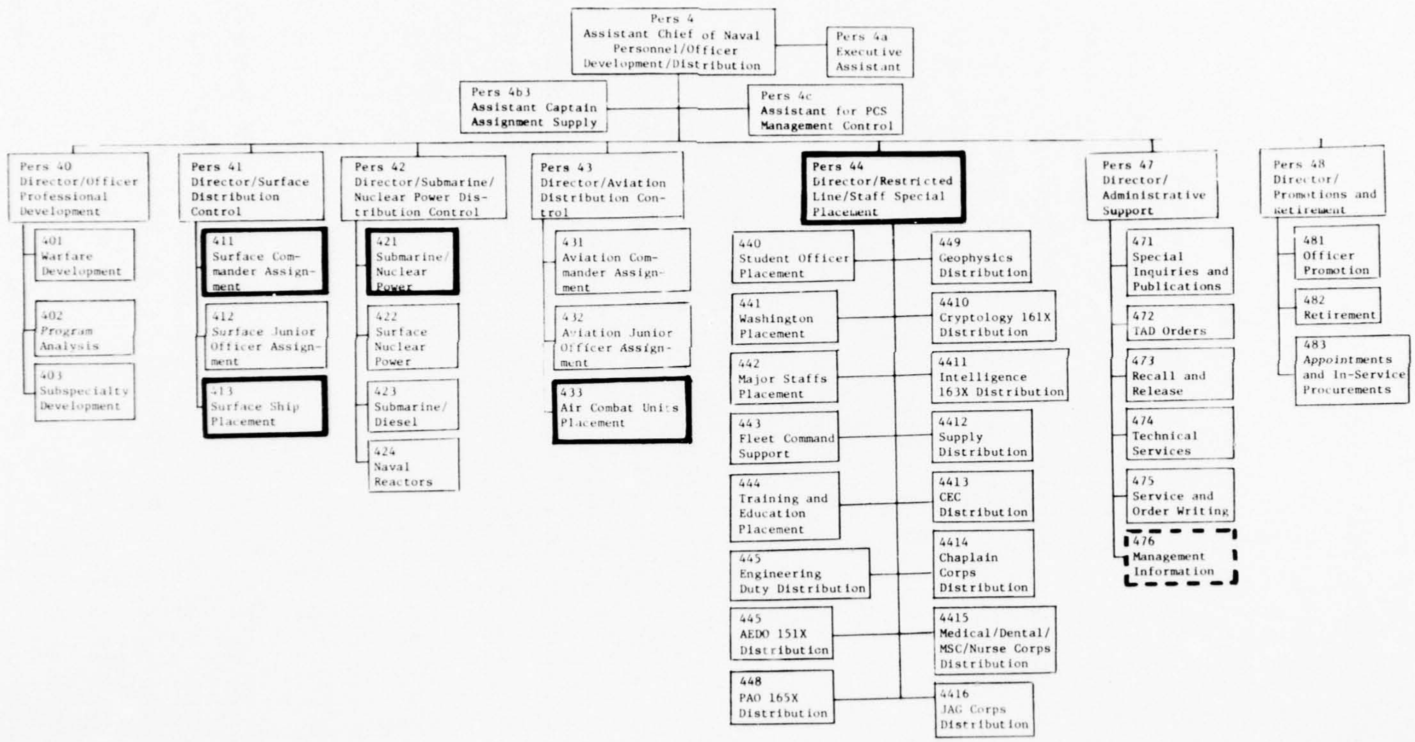
Most of the division directors were initially more cautious in their attitudes, although their concurrence on the value of AMIS has grown with time.

One of the interviewed officers observed that the system is generally accepted as a planning tool, but resistance arises when it is suggested as a policy aiding device or an inflexible distribution plan. One of the great benefits of AMIS is that it can forecast recommended billet fills 6-12 months in advance so that organizations can efficiently adapt to changes in officer placement. However, a commitment to the AMIS plan by PERS 4 so far in advance of actual officer distribution changes has been effectively resisted. Predictions of "bad news" to recipient organizations that they may lose particular billets are likely to elicit complaints; the earlier these forecasts, the greater the barrage of complaints that the PERS 4 commander and division directors will have to answer. By rejecting the use of AMIS as an approved policy tool, the PERS 4 management is not committed to the distribution plan that it recommends, even though it is based on management's own set of priorities! The use of AMIS merely as a planning device enables management to vary from the optimal recommendations, bend to outside bureaucratic pressures, and thus avoid complaints. But in doing so, it reduces the potential value of the system.

ORGANIZATION STRUCTURE

Formal Organization Structure

The AMIS system is technically controlled from the Management Information Branch of the Administrative Support Division (PERS 476) in PERS 4. An organization chart of PERS is depicted in Figure 1. AMIS serves the entire organization from this divisional location in the hierarchy. However, the formal location of AMIS may change in the near future. To obtain closer control over the management of AMIS and to integrate computer usage in the organization, the PERS 4 commander is pulling the system into his own personal staff, along with other ADP systems, transforming it into a pyramidal


Pers 4
Assistant Chief of Naval Personnel/Officer Development/Distribution
Pers 4a
Executive Assistant
Pers 4b3
Assistant Captain Assignment Supply
Pers 4c
Assistant for PCS Management Control
Pers 40
Director/Officer Professional Development
401
Warfare Development
402
Program Analysis
403
Subspecialty Development
Pers 41
Director/Surface Distribution Control
411
Surface Commander Assignment
412
Surface Junior Officer Assignment
413
Surface Ship Placement
Pers 42
Director/Submarine/Nuclear Power Distribution Control
421
Submarine/Nuclear Power
422
Surface Nuclear Power
423
Submarine/Diesel
424
Naval Reactors
Pers 43
Director/Aviation Distribution Control
431
Aviation Commander Assignment
432
Aviation Junior Officer Assignment
433
Air Combat Units Placement
Pers 44
Director/Restricted Line/Staff Special Placement
440
Student Officer Placement
441
Washington Placement
442
Major Staffs Placement
443
Fleet Command Support
444
Training and Education Placement
445
Engineering Duty Distribution
445
AEDO 151X Distribution
448
PAO 165X Distribution
449
Geophysics Distribution
4410
Cryptology 161X Distribution
4411
Intelligence 163X Distribution
4412
Supply Distribution
4413
CEC Distribution
4414
Chaplain Corps Distribution
4415
Medical/Dental/MSC/Nurse Corps Distribution
4416
JAG Corps Distribution
Pers 47
Director/Administrative Support
471
Special Inquiries and Publications
472
IAD Orders
473
Recall and Release
474
Technical Services
475
Service and Order Writing
476
Management Information
Pers 48
Director/Promotions and Retirement
481
Officer Promotion
482
Retirement
483
Appointments and In-Service Procurements

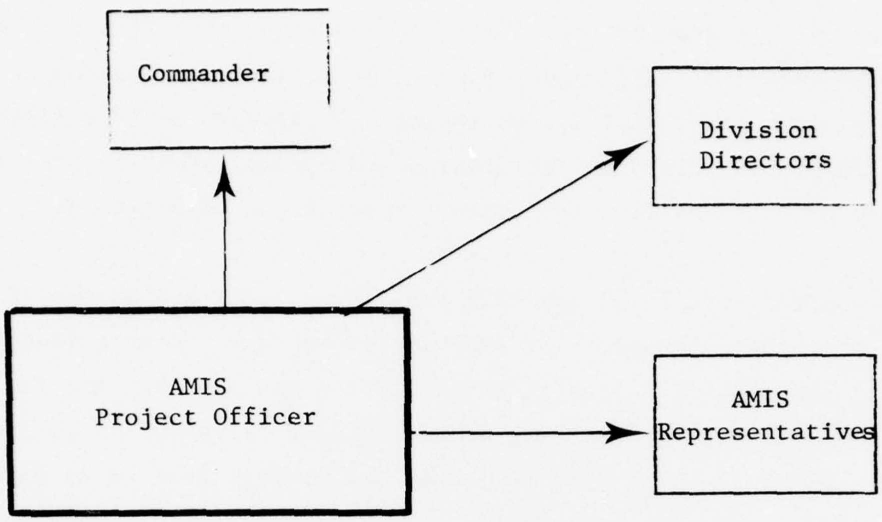
installation. It appears that this organizational move is not so much due to the impact of AMIS alone, but to the growing utilization of computer systems to assist PERS 4 functioning. It appears as if efficiency and economy can be maximized by integrating and centralizing computer management once an organization-wide usage threshold has been passed.

A new organizational role, the AMIS project officer, has developed to manage the technical aspects of AMIS and coordinate communication of its results. The current holder of this position has a background in computer system management and light programming skills. Although he is formally located under a division director, the AMIS project officer is directly responsible to the PERS 4 commander. AMIS representatives are designated placement officers in each division; their current locations are noted in Figure 1. They are regular professional staff especially trained in AMIS who assist in distributing AMIS data to users in their divisions.

Informal Organization Structure

Information flow in PERS 4 concerning AMIS centralizes on the AMIS project officer. Figure 2 depicts the typical communication pattern. The project officer is the only individual who technically interfaces with AMIS. He responds to data and parameter changes and supplies the commander, division representatives, and directors with AMIS results. He serves as the locus of information flow relating to AMIS. New data, priority changes, and requests for special runs are directed to him, and the officer distribution plan that AMIS recommends is distributed by him to the rest of the organization.

While information flow is centralized on the AMIS project officer, who is presently near the bottom of the PERS 4 hierarchy, the flow of authority is partially delegated to the placement officers. They tend to be the AMIS representatives but, in some cases, are divisional directors. The crucial decisions to be made concerning the development of an officer

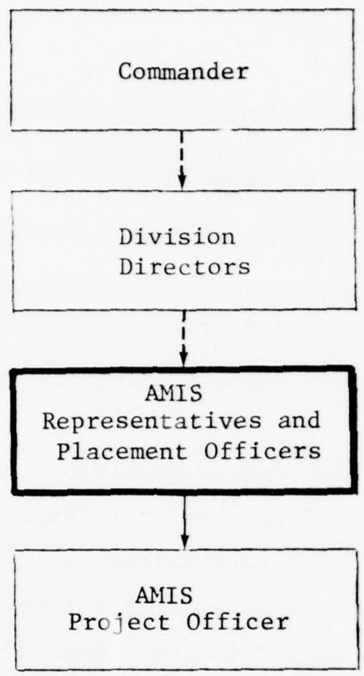


NOTE: Heavy box indicates source of information flow.

Figure 2. Typical Flow of AMIS Information in PERS 4

distribution plan revolve on the setting of billet priorities and minimum billet fill rates. These are the parameters that enable the AMIS algorithm to derive its recommendations. Choices are made by the placement officers (who are sometimes division directors) in coordination with the AMIS project officer, who provides technical guidance as to the possible implications of their decisions. Figure 3 diagrams the typical flow of authority in PERS 4.

Priorities are established by dealing directly with Navy organizations that are affected by the distribution plan developed by AMIS. Placement officers maintain contact with the organizations for whom they are responsible to identify the wants and needs of recipient organizations in terms of officer placement. Thus, priority setting involves a highly subjective judgmental process, determined by interaction with the recipient organizations, the placement officers' knowledge based on experience with the actual needs of those activity areas, and their conception of the supply of appropriate officers to fill particular billets. These priorities must then be transformed into decision tables that are understandable to AMIS.



NOTE: Heavy box indicates focus of authority.

---→ Flow of Partially Delegated Authority

——→ Flow of Authority

Figure 3. Typical Flow of Authority in PERS-4

The tables are subject to approval by the PERS 4 commander and the division directors. They are updated approximately every 6 months. Despite routine consultation with the recipient community to establish billet priorities, the officer distribution plan devised by AMIS is often seen as unacceptable by these same recipients. They do not realize the implications of these parameters because they lack an understanding of the AMIS model. Table 1 summarizes the PERS 4 organization structure.

EFFECTIVENESS OF THE DECISION AID AND ORGANIZATION STRUCTURE

Decision Aid

According to each of the officers who were interviewed, AMIS has become essential in achieving PERS 4 mission objectives. It offers more information, detail, accuracy, and ease of access in performing placement

TABLE 1

PERS 4 Organization Structure

1. Partially delegated informal structure

2. Divisional decision aid installation

3. Assignment of already skilled Navy personnel to coordinate technical aspects

4. Operators serve as division staff

officers' tasks than was previously possible. AMIS predicts well, saves massive amounts of time, and results in a "fair share" placement plan. On the average, the AMIS plan is referred to by most placement officers at least 4-5 times a week and especially during the slating portions of the year. The placement officers interviewed felt it would be impossible for them to revert back to old methods given their experience with AMIS.

One aspect of AMIS that detracts from its effectiveness as a decision aid centers on management's resistance to fully utilizing the recommended plan. As mentioned earlier, AMIS usually forecasts bad news. Since resources are limited, all organizations cannot receive their full allowance of officers. These results cause resistance to AMIS from the recipient community. This resistance is transformed into complaints about being short-changed and pressures brought to bear on the PERS 4 commander and division directors to alter the distribution plan. The longer the projections, the greater the opportunities for complaints. To moderate this situation, the PERS 4 leadership has limited the length of projections for AMIS, modified its use to that of a guidance tool rather than a policy-making device, and manipulated its forecasts to accommodate outside bureaucratic pressures.

Despite this resistance, PERS 4 leadership has recognized the value of AMIS. One division director references AMIS to defend decisions he makes. AMIS provides objectives and numerical evidence to back up his position. Moreover, the AMIS plan can help to support his interests. In disputes over filling interdivisional slots, for instance, AMIS can indicate whether the director has filled his quota so that he does not fill more than his fair share.

Some of the officers felt that AMIS has proved its effectiveness so well that further development is warranted. The current version of AMIS could be extended to include additional variables that would maximize qualification and preference matches between more highly specified officer inventory and billet specification categories. A more sophisticated, interactive computer model is also under consideration that would allow a placement officer to examine a solution and, if desired, change billet priorities and fill rates to compare results and iterate to a satisfactory solution. This model would be capable of performing automatic sensitivity analyses on the significance of the changed assumptions. Finally, a dynamic, longitudinal interactive model is being considered to take into account the impacts of officer rotation, attrition, and promotion on projecting optimal officer distribution plans.

Organization Structure

The officers who were interviewed agreed that the division directors and the PERS 4 commander lack sufficient involvement in the operation of AMIS and felt that greater, clearer, and more direct guidance on their parts concerning the setting of priorities would greatly improve the effectiveness of the decision aid. Increased support of AMIS by PERS 4 management would ensure more accurate policy inputs to the model and add legitimacy to the system and its recommendations.

Greater management involvement in AMIS will be a likely by-product of shifting control of the system to the personal staff of the commander. While not necessarily anticipating negative results, one of the interviewed officers cautioned against the possible centralization of authority caused by the change in formal organization structure that may result from information centralization. In its pyramidal location, AMIS is likely to remain an effective decision tool only if its parameters can continue to be specified at the placement officer level. Without the personal contact and experience that placement officers can attain with various segments of the recipient community, knowledgeable priorities and fill rates cannot be chosen.

Moreover, this pyramidal structure may cause duplication of effort and inefficiency in the organization. The financial management system in PERS 4 was elevated to the commander's personal staff several years ago and, according to one of the interviewed officers, this change has caused communication gaps downward. Rather than receiving filtered information from below, the commander's staff became the source and distributor of information supporting the rest of the organization. This encouraged commander bypass of middle level officers. Thus, the pyramidal hierarchy was turned upside down from a functional perspective. Too, top management often requested staff reliability checks on the computer-based system, necessitating duplicate recordkeeping and causing poor morale and needless, time-consuming effort.

APPLICATION OF THE CONTINGENCY MODEL TO THE AMIS CASE STUDY

The PERS 4 organizational profile is summarized in Table 2. As indicated by the underlined values, the AMIS profile is sufficiently different from any of the projected task force environments listed in Chapter 5. Thus, the hypotheses derived from the contingency model and based on the organizational conditions of the task force cannot be applied in this case. Although many of the specific findings of the AMIS analysis have only limited implications for task force organizational planning, some of the more general results concerning coordinating roles and resistance to computer-based decision aids can be related to potential task force environments.

TABLE 2

Organizational Profile of
PERS 4 and Its Use of AMIS

Organizational Elements	
Clear Mission Goals	Y
Well-Structured Problems	Y[a]
Stressful Missions	N[a]
Skilled Leader[b]	N
Skilled Staff[b]	Y
Relations-Oriented Style[b]	N
Analytical Aid	N[a]
Real Time Capability	N[a]
Large Screen Display	N
Fully Operational	Y

Projected Task Force Profile That Has Greatest Similarity	--
Number of Violations	4
Number of Violations in Crucial Conditions	0

[a] In the model, these variables were held constant at the opposite value to describe the projected task force environment. The greater the number of these dissimilarities in case study profiles, the less useful are the case studies in providing appropriate guidance for task force decision and implementation. These values are underlined.

[b] These variables are weighted more than others in the model in projecting feasible, informal organization structures. Therefore, they represent the "crucial conditions" or criteria that must be met by actual organizational profiles if the model's hypotheses are to be appropriate.

CHAPTER 10. THE ORGANIZATIONAL IMPACT OF THE FLEET COMMAND CENTER (FCC)

SUMMARY

The Fleet Command Center (FCC) is a computer-based decision aid that is currently being developed at the Naval Air Test Center, Patuxent River, Maryland, to assist strategic decision-making activities, especially under crisis conditions. Operational users will be an admiral and his staff in Operation Control (OpCon) centers at the naval component level of the unified commands.

The prototype that is being designed will integrate diverse sources of information in one central location and filter and automate message traffic to enable rapid retrieval and display. Since implementation of the FCC is not planned for at least 2 years, much of what follows is a current description of the system and projections made by the FCC project manager as to the probable organization structure that will prove most satisfactory. The objectives in developing the FCC suggest that maximum exploitation of the system could be attained with a pyramidal formal organization structure under the direct control of the commander. A partially delegated informal structure, which is similar to the current noncomputer-aided organization structure of the OpCon, is projected as most satisfactory for improved decision-making performance and maximum utilization of the FCC, especially under crisis conditions.

The most important findings that can be drawn from this case study are strategies for implementation of new computer-based decision aids in the Navy context. Implementation of the FCC is being modeled after the previous experience of this NavAir unit in implementing another computer-based decision aiding system, the Tactical Support Center. High level officers who will be commanding, assisted by the system, will be briefed and shown a demonstration of the system's capabilities on a fully developed

prototype at the test facility. This step can play a critical role in reducing skepticism and initial resistance and in developing acceptance and trust in the system by top members of hierarchy as well as the entire user organization. Success in this step will be followed by formal training of professional staff at the test facility and then intensive, on-the-job training at the operational site.

THE OPCON ENVIRONMENT

Since implementation of the FCC is not projected for at least 2 years, the description of its environment is primarily based on the expectations of its project manager, who was interviewed.

The Mission Environment

The FCC is designed to assist the admiral and staff in shore-based OpCon centers, especially during high threat crisis situations. The OpCon is located at the naval component level of each unified command and thus deals with decision-making on a strategic level. The key mission of the OpCon is to develop alternatives and make decisions under conditions of information uncertainty concerning broad, strategic combat matters.

FCC

The FCC is being developed to integrate information from superior, lateral, and subordinate commands in a single shore-based source (the OpCon) to facilitate strategic decision-making. This computer-based system interfaces with and coordinates data that are collected by other commands but are not adequately transmitted or readily available to relevant users. In essence, the FCC provides a centralized and automated data retrieval and storage system for large amounts of near real time information. Currently, when this information is needed by an admiral or staff to develop viable alternatives or make decisions, access is obtained through lengthy manual procedures. The FCC would expedite access by storing, cataloguing, integrating, and displaying this data in a single, centralized, and easily retrievable source. Moreover, the system would speed communications by automating and filtering message traffic. The system also screens and preprocesses new data to reduce error and repetition.

The system does not perform sophisticated analyses on these data; however, it does offer a large amount of information which can support idea generation. The system does not provide information that was not previously available; however, it does make that data easier to obtain in a more timely fashion. Operationally, the system will display its results via several cathode ray tube (CRT) terminals located in the OpCon.

Personnel Environment

It is expected that professional staff officers will operate the FCC consoles. The query programs will be simple enough to employ that only a minimal amount of special training will be required.

Training and Implementation

The FCC is being developed by the same organization that developed and implemented the Tactical Support Center (TSC) decision aiding system. The FCC system will benefit from lessons learned in this previous exercise in decision aid implementation. According to the officer interviewed, initial attitudes toward the TSC varied from outright acceptance to resistance and rejection, essentially depending on the degree of training and past experience these personnel had with computer-based systems.

To ensure maximum acceptance and usage by the commander and staff, the TSC was introduced using a three-phased implementation plan. First, high level personnel from the prospective user community were invited to the test and development facility to be briefed and to observe the demonstration of a fully operationalized prototype of the system. The success of this phase was crucial in reducing skepticism and resistance and in building positive attitudes toward the system among those in leadership positions. In the second step, formal training to professional staff was provided at the test site. This was followed by an intensive third phase in which a team of programmers, instructors, and civilian contractors were sent to the actual operational facility to implement the hardware and software, and proceed with on-the-job training.

ORGANIZATION STRUCTURE

Formal Organization Structure

The formal organization chart of the OpCon is not expected to change with the addition of the FCC. No new organizational roles for technical, analytical, or coordinating assistance are deemed necessary at the present pre-implementation phase. Since the system is designed to assist the admiral and his staff directly, the plan is to implement it on a pyramidal level, under the personal control of the commander.

Informal Organization Structure

The FCC is specifically designed to centralize information flow to the commander of the OpCon so that he can make rapid and knowledgeable decisions in crisis conditions. By providing more information to the top of the organizational hierarchy, more alternatives for action and reaction in combat situations can be developed based on data that might otherwise have been overlooked or unavailable. However, the FCC project manager who was questioned cautioned that information centralization should not be used by the commander to direct tactical decisions within the fleet. While the FCC coordinates strategic and tactical data, tactical decision-making can be conducted best on a local level where specific contingencies can be knowledgeably handled. Tactical operations can be monitored by the OpCon commander through the FCC, but the system should not be employed to bypass mid-level tactical commanders. Since the FCC is located at the component command level, high level strategic decisions are more appropriately aided by the system.

In crisis situations, OpCon centers are fully manned with the admiral and his battle watch officer present. Data stored in the FCC will be referenced on the CRT by the watch officer to gather information and generate alternatives for the commander. In performing this sometimes complex task, the watch officer, out of necessity, must consult with the professional staff in the OpCon, which has expertise in various combat functional areas. Then, the watch officer will offer a set of viable alternatives to the admiral for his decision. This projected scenario of OpCon informal organization structure with FCC present closely resembles current noncomputer-aided functioning. However, the partially delegated informal structure that was depicted, given implementation of the FCC, would have access to more information, enabling a more thorough and rapid consideration of alternatives. At the present time, this decision process is viewed by the FCC project manager as providing the most efficient and effective utilization of the computer-based aid.

APPLICATION OF THE CONTINGENCY MODEL TO THE FCC CASE STUDY

The data gathered on the FCC and the OpCon offer a description of the anticipated organizational profile (see Table 1). The OpCon profile corresponds closely to Profile 26, which describes a projected task force environment (see Chapter 5). These profiles agree on each organizational element except the one dealing with the sophistication of the computer-based decision aid. The FCC will basically integrate, store, and display data from a wide variety of sources, but will not perform analyses on these data to suggest the utility of various options and outcomes.

The hypothesis that was derived from the model in Chapter 5 and based on the conditions in Profile 26 indicates that particular organization

TABLE 1

Organizational Profile
of the OpCon and Its Use of FCC

Organizational Elements	OpCon Profile	Projected Profile 26
Clear Mission Goals	Y	Y
Well-Structured Problems	N	N
Stressful Missions	Y	Y
Skilled Leader[a]	Y	Y
Skilled Staff[a]	Y	Y
Relations-Oriented Style[a]	N	N
Analytical Aid	N ⟷	Y
Real Time Capability	Y	Y
Large Screen Display	N	N
Fully Operational	N	N

Projected Task Force Profile That
Has Greatest Similarity................26

Number of Violations.................... 1

Number of Violations in Crucial
Conditions............................ 0

[a] These variables are weighted more than others in the model in projecting feasible informal organization structures. Therefore, they represent the "crucial conditions" or criteria that must be met by actual organizational profiles if the model's hypotheses are to be appropriate.

structures will maximize decision aid exploitation and organizational performance. Table 2 compares these prescriptions with the projected OpCon organization structure.

Only two of these prescriptions match the organization structure that is expected to evolve in the OpCon. Those include the pyramidal formal structure and formal location of decision aid operators in the commander's personal staff. The low predictive power of the hypothesis can be explained in this case by the preliminary nature of the data on OpCon. The FCC is still in a developmental stage; it has yet to be implemented in a Navy organization. The profile is based on expectations, not fact, and uses conservative estimates of organizational change from present noncomputer-aided procedures. Valid inferences from the hypothesis to the actual organization can only be made once the organizational dynamics including the FCC are empirically observed.

TABLE 2

Comparison of Hypothesized and OpCon Organization Structures

Hypotheses	OpCon
1. Centralized informal structure (to maximize cost and time efficiency)	1. Partially delegated informal structure
2. Decentralized informal structure (to maximize personnel responsibility)	2. Not applicable
3. Pyramidal decision aid installation	3. Pyramidal decision aid installation
4. Assignment of already skilled Navy personnel	4. Formal training of present staff
5. Operators located in commander's personal staff	5. Operators located in commander's personal staff

CHAPTER 11. IMPLICATIONS OF THE CASE STUDY FINDINGS FOR THE TASK FORCE

SUMMARY

Several general themes that can be applied to the task force run through the analyzed cases. First, computer-based decision aids create a decision environment of information centralization that facilitates total centralization of authority and decision-making in the commander, who is at the top of the organizational hierarchy. While this might appear to offer improved efficiency, a more participative organization structure, where the task force staff is actively included by the commander in the problem-solving process, might provide the best personnel arrangement for maximum decision aid exploitation.

Second, as the decision environment changes, so does the appropriateness of the organization structure. Under planning phase conditions in the task force, which are neither stressful nor excessively time restrictive, partially delegated informal structures provide the most effective team performance using computer-based decision aids. However, under execution phase conditions, task force informal structures that are more centralized but allow for adequate consultation between commander and staff may be most effective in yielding rapid decisions. Third, a new organizational role to coordinate employment of task force decision aids may increase their efficient utilization.

Fourth, the introduction of computer-based decision aids in an organization that previously relied on expert human judgment alone may cause initial resistance to the new procedures and techniques. This reaction may result in inefficient use of personnel and low morale. Intensive training in the algorithms used by the decision aids and knowledge of the sources and processing of the data should help to instill trust and alleviate resistance. In addition, early involvement of task force commanders and staff members in developing these decision aid algorithms would help to increase

their legitimacy. Fifth, the transition to a computer-based system can be eased by developing planned training and implementation strategies. One of the most successful plans that could be used to assist implementation into the task force involves demonstrations of full-scale prototype decision aids for task force commanders followed by intense, formal on-the-job training. Proving the utility of the decision aids to the very top of the hierarchy in which they will be employed ensures the initial support required for successful training and acceptance.

THE STRAIN TOWARD DECISION-MAKING CENTRALIZATION

One common finding in the case studies was that computer-based decision aids tend to centralize and integrate information in one location where it is easily accessible. This phenomenon is sometimes accompanied by a gradual trend to pull the decision aid and its staff from divisional locations in the hierarchy to a position under the direct personal control of the commander. By physically placing the decision aid installation at the top of the organizational pyramid -- in the commander's personal staff -- the commander maintains direct management and access to valuable data and analyses. Information centralization and a pyramidal formal location for the task force decision aids seem likely on the basis of current plans. The decision aids will bring together for the task force commander a large body of important real time data and message traffic that he can personally retrieve without having to filter his requests for data through various division heads.

The availability of this central source of information makes the centralization of decision-making in the commander more probable. The task force commander has the capability to bypass mid-level officers on his staff and make decisions on the basis of the data he retrieves directly from the decision aid. Especially during crisis situations when important combat choices have to be made, the commander may be enticed by this capability to take over functions that would normally be delegated to staff officers. Although staff would have been trained to react effectively in combat conditions, the commander might feel that his more experienced perspective and his access to the grand picture place him alone in the best position to make decisions.

The case studies caution against the absolute centralization of decision-making. While the task force commander may hold an experienced and informed perspective, he would not possess the extensive training and practice in handling and coordinating the decision aids present in his staff. Bypassing staff's technical, operational, and substantive expertise will yield less than adequate decisions and certainly lower staff morale. Thus, the staff would be used inefficiently, and reaction time is likely to be longer. Moreover, recentralization of authority in the commander would turn the organizational hierarchy upside down, making him the source and distributor of information supporting the rest of the staff. This would prove to be an inefficient use of commander resources and decision aid capabilities.

The case studies suggest that tendencies toward recentralization of authority should be resisted. Instead, the staff to whom authority has been delegated should retain active involvement in decision-making. While it is understandable that task force commanders desire direct involvement in crisis decision-making, recentralization need not be absolute. A large degree of delegated authority can be recentralized in the commander, while extensive consultation and joint problem-solving continues between the commander and staff. Staff participation will yield improved team performance, greater utilization of decision aids, and higher quality solutions to problems addressed by the task force.

Operationally, it may be difficult to restrain the task force commander from pursuing his inclination to recentralize authority under crisis conditions. However, engineering considerations of the physical setup of the command center may help to reduce his desire for recentralization. One of the most frustrating experiences for a commander during combat situations is to lack current data on the total combat picture. This can leave him feeling overly dependent on his staff, inefficacious, and without total authority. Under such circumstances, recentralization is the commander's resort to regain control over his command and participate in crisis decision-making on an active and informed level. However, this recentralization often materializes in a haphazard and unstructured fashion, as indicated by the case studies. Lacking adequate facilities at his own command post to direct problem-solving, the commander may sit down at a staff officer's display and assume staff functions, thus increasing staff anxiety, lowering staff morale, and possibly decreasing organizational efficiency in arriving at a satisfactory outcome.

This scenario may be modified by attacking the source of frustration for the commander. By providing him with his own individual or large screen display, the task force commander can monitor incoming data on the changing environment, as well as the activities and responses of his staff. If need be, he can personally intervene. Essentially, provision of a decision aid display for the commander's own personal use offers him a complete overview of the current situation, decreases possible feelings of overdependence and informational disadvantage, and may alleviate his need to overly recentralize.

ENSURING DECISION AID AND ORGANIZATION STRUCTURE FLEXIBILITY

Task force decision aids will be employed during various phases of a mission. Ideally, the individual tools developed in the ONR program will be integrated into a system of decision aids that will provide flexible assistance to commanders and a variety of staff officers for different purposes under different types of circumstances. The case studies indicate that this built-in flexibility is important to ensure adequate decision aid usage. Aids that attack very narrowly defined problems or limit the user's ability to alter parameters in the model to match actual or perceived levels will not be well-accepted or widely employed. Thus, task force decision aids should be designed to yield useful results regardless of who employs them, what problem areas are addressed, and what mission phases are attended to.

Different officers are likely to use the decision aids in different ways. The data considered relevant to problem solution and the sequencing of the problem-solving process are highly personal matters that will vary from officer to officer. The task force decision aids should be adaptable enough to accommodate such variation in personal styles. Moreover, as the decision aids become more fully incorporated into the standard operating procedures of the task force staff, different users will begin to look to the decision tools to provide a variety of different services. The task force commander, for instance, might seek policy guidance, the operations officer might seek to bolster his own interests or positions, and the assistant intelligence officer might seek to ease processing of incoming data and message traffic. Thus, the task force decision aids must be engineered for adaptability. If such flexible mechanisms are incorporated in decision aid design, task force users at several levels will find utility in employing them.

As the decision environment changes, the appropriateness of particular informal organization structures also varies. Planning phase conditions are generally nonstressful and without major time constraints. During this phase, the "op order" is developed by the task force commander and staff to plan procedures, actions, responses, and contingencies to carry out the entire mission. Under these conditions, the case studies suggest that partially delegated decision processes be employed to maximize effective team performance and optimal solutions. Essentially, this type of informal structure encourages participation of the entire staff in problem-solving, including those who possess valuable expertise in functional warfare areas of concern to mission accomplishment.

Under execution phase conditions, the case studies suggest a different type of informal organization structure to maximize efficient use of computer-based decision aids and effective decision outcomes. Execution tends to be a more stress-laden and time restrictive activity. The task force commander and staff closely monitor the performance of their forces, modify plans, and make crucial, though rapid, decisions that affect ongoing operations. Essentially, time constraints and the sensitivity of decisions during execution have led military organizations to feel that authority should be recentralized in the commander during this phase. However, recentralization should not be absolute; it should include consultation, as time allows, between commander and staff to maximize utilization of the experiential resources of the staff. It is felt that this type of informal organization structure will produce rapid quality decisions in an efficient manner.

Shifting the form of decision process for different mission phases occurs as a fluid change incorporated in the standard operating procedures of the staff. It should not disrupt task force functioning, but rather ease communication, integration, and decision-making processes within the staff to develop improved outcomes.

THE NEED FOR A COORDINATING ROLE

Two of the case studies indicated that a new organizational role was developed to manage the technical and operational aspects of computer-based decision aids and coordinate communication of their results. Such a specialized role in the task force would free professional staff officers from the need for extensive technical training in computer system management and programming skills. The coordinator could manage data input procedures, modify decision aid parameters for specialized analyses, integrate the results of more highly differentiated tasks, and channel information flow to appropriate users.

This billet may be adapted to the task force environment in one of two ways. The coordinator may be seen purely as a technical facilitator, similar to the project officer for AMIS. In this case, the coordinator is not delegated authority to make decisions concerning functional areas of warfare; he is merely the focus of information and technical management for the decision aids. On the other hand, the coordinator can be delegated a certain degree of authority to make substantive choices dealing with areas of warfare. Similar to the SWC in NTDS, this can be developed as a mid-level position of authority in the task force hierarchy. As the integrator of decision aid results, the officer who fills this billet is in an excellent position to make highly informed and accurate decisions. Of course, this officer's authority should be subject to negation by his superiors.

ALLEVIATING RESISTANCE TO COMPUTER-BASED DECISION AIDS

The transition from a decision process primarily based on human expert judgment to one that relies heavily on computer-based decision aids can summon initial resistance to the new procedures. Resistance may stem from various causes:

a. A decision aid may be perceived by officers as a threat to authority.

b. A decision aid may simply be misunderstood, or training may be inadequate.

c. The algorithm that forms the framework of a decision aid may not be trusted or considered adequate.

d. All of the alternatives considered by a decision aid may not be displayed for the user, causing him to feel out of control.

e. A decision aid may lack the facility to be adapted to personal styles of problem-solving or specific problem situations.

f. A decision aid may lack practicality or realism because of improper or narrow focus and design.

g. A decision aid may be seen as generating policy and decisions (decision automation) rather than acting merely as a guidance or planning tool (decision aiding).

h. A decision aid may forecast "bad" news that will yield complaints or be rejected by management because it is seen as policy.

i. Poor performance during an exercise may magnify and reinforce resistance to a decision aid.

Some of these sources of resistance may manifest themselves in the task force context. For instance, a computer-based outcome calculator may predict negative results based on interaction of the current situation with preferred alternatives. This forecast might predict consequences that clash with the experienced judgment of the commander or staff. In such cases, the prediction may be used as a planning aid rather than a policy tool, submitted to the staff for manual double checking, or totally discarded. If the prediction is proven incorrect, trust in the model's algorithm will diminish, and the decision aid will lose its credibility.

Predictions are expectations of the probable future, not guaranteed results. Training of the task force commander and staff should emphasize this fact. Moreover, it should be stressed that the task force decision aids are designed to provide guidance and planning assistance, not to generate policy to which the commander must feel committed. These cautionary points should help to reduce unwarranted expectations of the decision aids and dismissal of the aids when they fail to live up to expectations.

Intensive training, not only in the use or operation of the decision aids, but in the algorithms that are internal to the system's operation is crucial in developing trust in the aids and day-to-day utilization that does not require manual checking. Likewise, it is important to develop trust in data sources, data processing, and the data base. Extensive interaction between task force personnel and the decision aid designers is necessary to incorporate the realism and practicality that will be demanded by the staff for the aids to be legitimated.

TRAINING AND IMPLEMENTATION STRATEGIES

Planned strategies to implement the task force computer-based decision aids can help to reduce potential resistance from the commander and staff. Moreover, strategies to train task force personnel, including the commander, will ensure effective utilization of these tools. Both are important elements toward shaping initial user attitudes.

An effective implementation plan for the task force decision aids can be developed using a full-scale working prototype at the test site. Demonstrations should be aimed at impressing task force commanders and their executive officers with the practicality and utility of the computer-based decision system. Indoctrination of the task force commander as to the value of the decision aids by actual demonstration under simulated conditions is much more convincing than mustering abstract theoretical arguments to support the aids' utility. By going directly to the top of the potential user's organizational hierarchy, primary effort is expended in developing crucial support to ensure the system's legitimacy. Acceptance by the commander is essential for staff acceptance.

Moreover, establishing a fully operating model of the task force decision aids on shore will be valuable in later maintenance control and management functions. System problems and inconsistencies that are found at sea and program improvements suggested by users can be simulated at the test facility for rapid correction or addition on a system prototype. Without an onshore working prototype, locating the source of program bugs and analyzing the effect of program changes would be a more difficult and less precise task.

Training strategies are also essential to prepare for successful implementation of the decision aids. Officers who will manage the system and operators both require intensive training. Instructional programs situated at an onshore facility, preferably where a working prototype of the decision aid is located, appear to be most effective. This physical arrangement isolates trainees from their regular duties aboard ship and provides them with an atmosphere conducive to intensive training and practice.

To reduce the manpower requirements for instructors, computer-assisted instructional (CAI) devices, programmed instruction, and closed circuit television can be employed as learning materials. These will reduce cost, make the trainees somewhat independent of instructors, and make instruction self-paced. The Instructional Systems Development approach (Branson, et al., 1975), designed as a framework for military training, should be employed in building the instructional program for the decision aids.

At the shore facility, formal instruction on the data, algorithms, operation, and maintenance of the decision aids should be accompanied by extensive practice using the operational prototype under simulated task force decision environments. Individual training should be pursued to establish personal understanding and proficiency. Instruction should also include team training to approximate a realistic decision-making atmosphere. The form of team training -- the allocation of responsibility and authority in the group -- should correspond to the findings of this report and subsequent testing of the hypotheses. To maximize team performance in operational situations, it may be cost effective to assign entire teams that are trained together to staff positions in the same task force.

No matter how realistic, onshore training and practice can only attempt to simulate exercises or combat conditions at sea. Decision aid instructors and hardware experts should be sent to each ship to implement the decision aid system. There, they will be able to tackle problems peculiar to the ship, adjust the system if necessary, and continue to train the staff especially during exercises and other periods requiring heavy utilization.

CHAPTER 12. OPERATIONAL HYPOTHESES FOR FURTHER TESTING

SUMMARY

Hypotheses generated from the contingency model in Chapter 5 and substantiated in the case studies are operationalized in this chapter. Major themes drawn directly from the case studies and formed into hypotheses are also presented. Implementation strategies to ease decision aid introduction in the task force are included in this set of hypotheses. The objective of these hypotheses is to achieve effective decision-making performance and maximum utilization of the decision aids.

The components of the hypotheses are operationalized within an experimental context. An important element in these hypotheses, for which potential operational indices are discussed, is a measure of organizational performance effectiveness. This evaluative measure focuses on the organizational effectiveness of decision aid <u>application</u> in the task force environment rather than technical effectiveness of the device. Finally, recommendations are made for further testing that stresses the need for group experiments using the decision aids.

HYPOTHESES

The task force hypotheses generated by the contingency model in Chapter 5 are fairly well substantiated by the case studies in Chapters 7-10. Of the four hypotheses that could be applied to these cases, none simulate task force conditions perfectly, and not all prescriptions were actualized in the organizations described. However, a large number of these hypotheses <u>were</u> validated, providing confidence in their predictions. Table 1 presents the 16 sets of task force hypotheses.

In addition to these hypotheses, another set was directly derived from the case studies. These experientially generated hypotheses are based on

TABLE 1

Summary of Hypotheses Concerning Organization Structure in the Task Force

If These Profiles Describe the Task Force Command[a]:	Then These Organization Structures Are Most Appropriate: To Maximize Cost and Time Efficiency	To Maximize Personnel Responsibility	Location of Decision Aids Installation	Assignment to New Roles	Placement of Decision Aid Operators
1	Centralization	Partial Delegation	Pyramidal	Train Staff	Serve Double-Duty
2	Consultation	Decentralization	Pyramidal	Train Staff	Serve Double-Duty
4	Centralization	Consultation	Pyramidal	Train Staff	Serve Double-Duty
5	Centralization	Decentralization	Pyramidal	Train Staff	Serve Double-Duty
6	Partial Delegation	Decentralization	Pyramidal	Train Staff	Serve Double-Duty
8	Consultation	Partial Delegation	Pyramidal	Assign Specialists	Serve on CTF's Staff
9	Consultation	Decentralization	Divisional	Train Staff	Remain in Own Division
10	Transaction	Decentralization	Divisional	Assign Specialists	Assist Division
14	Centralization	Partial Delegation	Pyramidal	Train Staff	Serve Double-Duty
15	Centralization	Partial Delegation	Pyramidal	Assign Specialists	Serve on CTF's Staff
16	Centralization	Decentralization	Divisional	Train Staff	Remain in Own Division
20	Consultation	Decentralization	Pyramidal	Assign Specialists	Serve on CTF's Staff
21	Consultation	Decentralization	Pyramidal	Assign Specialists	Serve on CTF's Staff
22	Consultation	Decentralization	Divisional	Assign Specialists	Assist Division
26	Centralization	Decentralization	Pyramidal	Assign Specialists	Serve on CTF's Staff
28	Consultation	Decentralization	Divisional	Assign Specialists	New Division

[a] A verbal description of these environmental configurations can be found in Appendix C.

common themes uncovered in the case studies and have implications for the task force situation. Included in these hypotheses are proposed strategies to maximize implementation of the decision aids in the task force. These are discussed in Chapter 11 and presented in Table 2 of this chapter.

The systematically derived hypotheses are composed of three elements: independent or predictor variables, mediating variables, and dependent or evaluative variables. Each element in the operational definition of the hypotheses is important because it specifies those factors that can be either manipulated or measured by an experimenter under controlled laboratory conditions. The <u>independent or predictor variables</u> are the organizational profiles that define the task force decision climate or environment. The <u>mediating variables</u> are the organization structures used by the task force commander and staff to employ the decision aids and make choices. Any of the organizational types defined in the model is eligible as a method of structuring the task force staff. It is likely that almost any of these organization structures will foster mission accomplishment. However, only particular structures will maximize decision aid exploitation and decision-making performance. <u>Dependent or evaluative variables</u> measure the effectiveness of the chosen organization structure in achieving maximum utilization of the decision aids and efficient group performance in the task force. Each of these variables is operationalized to assist further testing of the hypotheses.

OPERATIONALIZING ORGANIZATIONAL PROFILES

The profiles can be dealt with as experimenter-controlled variables in the research design. The experimenter can manipulate and set the values of individual profile descriptors to simulate the projected task force decision environments. Values for two of the mission variables can be set by the terms of the problem scenarios presented to the experimental subjects. <u>Problem structure</u> and <u>mission stress</u> can be developed as characteristics of the combat scenarios to be solved. For instance, the scenario can

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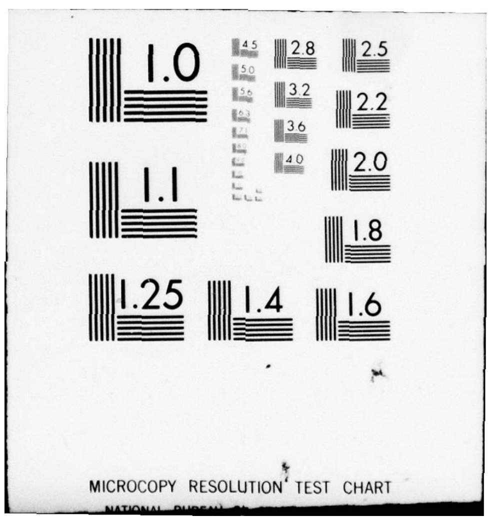
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MICROCOPY RESOLUTION TEST CHART

TABLE 2

Organizational Hypotheses Derived From the Case Studies

1. The availability of information centralization caused by computer-based decision aids is likely to encourage decision-making centralization.

2. Under combat conditions, effective task force performance is maximized by consultative organization structures.

3. Under non-combat conditions, effective task force performance is maximized by partially delegated organization structures.

4. Effective task force performance is maximized by decision aids that can adapt to changing circumstances and individual preference.

5. Effective task force performance is maximized if an administrative and authoritative coordinating role is established.

6. Effective task force performance is maximized and potential resistance reduced if the commander <u>and</u> staff are trained in the operation and internal workings of the decision aids.

7. Effective task force performance is maximized and potential resistance reduced if decision aid designers consult task force personnel in the developmental stage.

8. Decision aid implementation to the task force is maximized if efforts are made initially to convince the commander through demonstration of the systems's practicality and value, and thus, obtain his support.

9. Decision aid implementation to the task force is maximized if training of system managers and operators takes place at an onshore facility where trainees are isolated from their regular duties.

10. Decision aid implementation to the task force is maximized if computer-assisted instructional (CAI) materials or programmed instruction is employed.

11. Decision aid implementation to the task force is maximized if individual training of operators is supplemented by intensive team training.

12. Decision aid implementation to the task force is maximized if instructors and hardware experts continue training aboard ship under exercise conditions.

present the subjects with complex and unstructured problems with incomplete and uncertain information parameters. Time constraints on decision-making and high risk can also be incorporated in the scenario. Clarity of leader goals, the third mission variable, can be set by manipulating the role definition of the task force commander. The description of the CO, used by the subject who is playing that role, can emphasize his preference for particular policies and goals and provide general guidelines for policy direction.

Leader and staff skills can be manipulated by augmenting the standard scenario and experimental guidelines with training in techniques that would assist in operating the decision aids. Thus, if the projected task force profile calls for an unskilled leader and a skilled staff, the training augmentation can be given to the staff role players prior to the experimental task but withheld from the subject role playing the commander. Leadership style can be built into the role description of the commander. He can be developed as a controlling, directive, and autocratic individual or a leader with considerate, relations- and participation-oriented preferences.

The decision aid variables can be set by the experimenter to simulate the types of tools being developed in the ODA project. The computer-based decision aids provided to the experimental subjects should be able to perform analytical tasks, as opposed to mere data processing tasks. New data inputs can be programmed to flow continually into the simulated command center to approximate a real time data base. Displays in the laboratory can be either large or small screens to test the effectiveness of each. Finally, half of the experiments can simulate initial decision aid implementation; the other half can correspond to task forces in which the decision aids are fully operational and entrenched in group procedures. This variable can be manipulated through the experimental scenario.

OPERATIONALIZING ORGANIZATION STRUCTURE

Organization structure is the mediating variable in the hypotheses. In actual practice, allocating responsibility and authority in the task force staff depends heavily on the personal preferences of the commander and evolves naturally rather than being imposed by outside organizational planners. In the experimental context, this natural process should operate freely. Subsequent to evaluative feedback of organizational performance (see measures of effectiveness in the next section), each experimental team will be allowed to maintain or alter the organization structure chosen in the previous trial. Thus, through several iterations, many organization structures can be chosen and played out by the teams. The experimenter can observe the choices and group dynamics, and measure the effectiveness of the structural types employed.[1]

Operationally, experimental subjects can be provided with pretrial instruction in the types of informal decision processes and formal structures that are available. In terms of informal structure, leader-centered (centralization and consultation), subordinate-centered (partial delegation and decentralization), and transactional organization types can be described. In terms of formal structure, instruction can include possible choices for formal placement of the decision aids, assignment to new organizational roles, and operator placement in the hierarchy. Brief descriptions of these structures are adequate to provide the subjects with a wide range of options from which to choose. This instruction leaves the choice of organization structure to team preference. If particular structures are not chosen by the teams but are considered to be highly probable and maximizing options in actual task force environments, incentives can be employed to prod teams toward experimenting with these structural types.

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[1] Learning that usually results from participating in similar problem-solving trials can be controlled, in part, by randomly varying the order of scenario presentation. Another consideration might be to change the composition of each team in every trial.

OPERATIONALIZING MEASURES OF ORGANIZATIONAL PERFORMANCE EFFECTIVENESS

Any measure of decision aid effectiveness would indicate the degree to which the aids provide information of value to the task force commander and staff. It can also evaluate decision aid reliability and compare the utility of various aids.

A measure of organizational performance effectiveness would provide a broader definition. It evaluates decision aids in a more applied sense within the task force decision environment. This measure focuses on how decision tools are employed and to what advantage in the final choice of solutions. It assesses the practical utilization of decision aids -- whether they are exploited to maximum advantage. The measure also attempts to determine whether final solutions are significantly better or arrived at more rapidly than those using conventional means.

Basically, the exploitation of decision aids requires quantitative evaluation. Potential quantitative measures of this concept are listed below. Each measure is relative and must be compared with control groups operating under conventional means.

- Frequency of referral to decision aids.
- Frequency of information originating from decision aids as opposed to other sources (for example, staff officers, other commands).
- Frequency that decision aids initiate activity in the command center.
- Frequency that each actor requests information from the decision aids.
- Frequency that visual displays, audio systems, and face-to-face contact are employed to communicate information (by actor and target).
- Frequency of information flowing into decision aids from various sources.

- Average age of information in decision aids.

- Percentage of information in decision aids by subject matter or content (for example, operations, intelligence, logistics).

- Percentage breakdown of intent of information originator (for example, display update, tactical policy, reactive orders, disseminate information).

A determination of whether decision aid utilization significantly improves the quality and rapidity of solution should also be measured and evaluated. To judge improvement in performance under the experimental condition (that is, decision aid utilization), control groups that deal with the same scenarios using conventional means must be included in the research design. Potential effectiveness measures of this concept are

- Practicality and feasibility of the decision (ability to be accomplished given resources and situation),

- Correctness of the decision (if there is a "schoolbook" solution),

- Probability of success (probability that the intent of the decision will be achieved given the situation and resources),

- Frequency of false alarms,

- Cost of the decision (resources and capacity remaining for the next task, minimization of resource losses),

- Effect of the decision on morale,

- Amount of delay in response time,

- Time required to implement the decision, and

- Time remaining to generate viable alternate actions.

CONCLUSION: THE NEED FOR GROUP TESTING OF THE TASK FORCE DECISION AIDS

One of the major objectives of the ODA project is to achieve effective decision-making performance in the task force through maximum exploitation of the decision aids developed in the program. The decision aids are being designed to assist the task force commander and staff. Thus, realistic testing, evaluation, and improvement of the decision aids should be pursued in the context of a small group problem.

Initial individual testing of the decision aids may be useful to ensure working reliability. However, there is a strong tendency to use individuals rather than small groups to test and evaluate task force performance. Research designs can be simpler, fewer experimental subjects are needed, and experimentation will be less costly and conducted more rapidly. While greater short-run economies may be possible with individual testing, long-run costs may be great. Corrections, adjustments, and restructuring of the aids to accommodate individual usage may not be adequate for group utilization. Reprogramming and hardware changes, undertaken as a result of individual needs, may prove unusable for groups, and group testing will eventually be required to rectify these discrepancies. Empirically, Stein (1975), Smith and Duggar (1971), and others have concluded that individuals behave differently than groups in similar problem-solving situations.

Logically, since practical application of the decision aids will take place in a small group setting, prior experimentation and evaluation will be maximized by simulating this small group setting. Higher short-run costs using the group strategy should be balanced by much lower long-run costs. Thus, small group experiments are recommended to test the effectiveness of task force performance with decision aids. The following suggestions will help to maximize the objectives of these experiments.

- Initially, individual testing of the aids would be useful to uncover and correct program bugs and inconsistencies.
- The decision aids being developed should be combined to form an integrated system of decision aids. This system would provide flexibility and adaptability to changing circumstances and individual preference.

- Small group testing of the integrated system of decision aids should be conducted under highly controlled experimental conditions. Sophisticated subjects should be recruited. The experimenter should attempt to simulate the task force decision environment as closely as possible. The scenarios and task force profile descriptors, operationalized earlier in this chapter, can be used for this purpose.

- An independent contractor, preferably one who does not have a vested interest in any of the decision aids, should conduct the group experiments to ensure the fact and appearance of objectivity. This contractor should develop a set of measures of organizational performance effectiveness as discussed above. A controlled and uniform research design should also be constructed so that the decision aids can be compared and evaluated in terms their positive contribution to task force decision performance. Moreover, formal and informal organization structures that yield maximum decision aid exploitation and decision-making effectiveness should be specified and evaluated.

APPENDIX A: CONTINGENCY MODEL ASSUMPTIONS

INTRODUCTION

The 22 assumptions in the contingency model are substantiated by a review of the literature that follows. The discussion is segmented by each of the 10 organizational climate variables that impact on the choice of formal and informal organization structures. On the basis of secondary analysis of this theoretical and empirical research, the model's assumptions are derived. Each assumption specifies the organization structure that is maximized by the presence of each variable. Each climate variable is defined, the relevant literature surveyed, arguments and research findings presented, and assumptions derived. The integration of these assumptions in the contingency model is developed in Chapter 4.

One final comment should be made about the operational nature of these environmental descriptors. In reality, each is continuous and displays a wide range of values. However, for the sake of simplicity in comprehending the implications of total environments, they are classified into dichotomous categories that are easily operationalized.

A. Leader Goal Clarity. Mission accomplishment is a major dynamic goal of all organizations. Achievement of this objective is the fundamental problem of the decision-making process. Usually more than one alternative exists to attain mission goals; it is the job of the decision-maker to choose among several action alternatives. Leaders may prefer particular options because they comply with organizational norms or activate personal or organizational values that are relevant to the task at hand (such as limiting equipment damage and loss of life or facilitating team morale). In certain circumstances, preferences among various actions may appear clear-cut and unambiguous to a leader. However, under other conditions, the available options may fail to evoke a definitive preference.

Whether or not a leader strongly prefers one alternative over another to accomplish dominant mission objectives can influence the choice of an appropriate informal structure. As the discussion below indicates, a leader with a clear conception of his goal orientation is likely to prefer a centralized structure; one who is ambivalent concerning mission goals will probably consider participatory structures.

According to DeCarlo (1967: 255), the highest priority of a leader is "the stability and long-term health of the organization...." This places the ultimate responsibility for success of a mission at the top of the organizational hierarchy. It is no wonder, then, that when leaders possess clear goal preferences, they tend to create a centralized informal structure and impose their decisions and methods of operation on subordinates. This is especially the case when a leader feels that subordinates cannot be trusted to pursue a solution in line with confirmed organizational goals, or when the information, expertise, or ability of lower level staff members is questionable (Vroom and Yetton, 1973; Tannenbaum and Schmidt, 1958).

A considerable amount of literature suggests that the relationship between leader preferences and structure is mediated by organizational size. In small organizations, there is high level interface between professional personnel and the leader; negotiations, discussions, and consultations are the usual methods of interaction (Blau, 1974). In such an environment, if the leader has no particular goal preference, the group is usually capable of determining an appropriate policy direction for the organization and then participating collectively to achieve these goals. This suggests the choice of a transactional or decentralized informal structure. If the leader has a particular goal preference, on the other hand, it is likely to be known by all members of the group. This collective knowledge may encourage highly efficient group action to achieve the objectives chosen by the leader. Extensive group deliberation may be unnecessary. As a result, centralized informal structures become increasingly appropriate when the leader provides staff members with general policy goals which they must achieve.

The literature indicates that leader goal clarity in large organizations may result in a variety of possible informal structures. Even if the leader has a clear preference, communications difficulties may reduce subordinate comprehension of overall organizational policy. As a result, suboptimal, localized goals, developed by subunits of large organizations, may contradict broader policy preferences. To rectify this problem and bring organizational operations in line with leader preference, a recentralization of structure using computers may be chosen (Leavitt and Whisler, 1958; Sollenberger, 1968; Burck, 1965). A computer-based MIS offers top management a vehicle to synthesize large amounts of information about diverse organizational divisions and communicate orders to subordinates. This technology enables recentralization of informal structure and the capability to regain control and authority over organizational direction and operations.

On the other hand, the computer can provide organizational subunits with access to data concerning not only their own operations but those of the entire organization. Thus, decisions that are made on a local basis need not be ignorant of broad management preferences and goals (Carroll, 1967). Hence, partially delegated structures are possible outcomes when leaders have clear goals and management information systems are available. Other researchers argue that, with the advent of MIS, managers in large organizations can benefit from rapid feedback of subordinate actions, especially in instances where leaders have a clear goal preference. The ability to monitor behavior of lower echelons accurately enables management to intervene when policy directions are not properly followed (Dearden, 1967b). Thus, executive monitoring of delegated informal structures is facilitated by the computer and enables maintenance of partially delegated organizational dynamics. In aggregate, the weight of opinion concerning the effects of leader goal clarity can be subsumed by the following assumption.

Operational Categories: Clear mission goals/ambiguous mission goals.

Informal Structure Assumption 1: Leaders who have clear mission goals are likely to prefer centralized, consultative, or partially delegated informal organization structures. Leaders who have ambiguous mission goals are likely to prefer transactional or decentralized structures.

B. Problem Structure. Informal organization structure tends to vary in direct relation to the degree to which problems are structured. Highly structured problems have known and clear parameters, and the alternatives to resolve them belong to a set of acknowledged methods. Sufficient information is available to formulate a solution by choosing one of the known or preplanned options. These problems tend to be fairly routine and their solutions deterministic. Unstructured problems contain somewhat ambiguous parameters. The information required to develop solutions is widely dispersed and, to a large degree, initially unknown and uncertain. Whether adequate information exists to cope with these problems in a rational and logical fashion is questionable.

Missions are composed of sets of problems; the degree of overall structure in these component problems can be used to characterize the overall mission. While some subproblems may be highly structured, the mix of problems may be such that the parameters of the broad mission are ambiguous and vague. Such missions are complex and accomplishment of their goals is uncertain and probabilistic. Particular types of informal structure are appropriate depending on the structure of the mission's problems. Specifically, highly structured problems tend to be dealt with in an efficient manner by highly centralized organizations; unstructured problems necessitate integrated group decision-making and thus more decentralized organization structures.

Several researchers have dealt with the impact of problem structure on informal relations within organizations that have experienced technological innovation. The literature discusses this relationship in terms of two components of problem structure -- problem complexity and problem uncertainty. Each of these dimensions will be reviewed separately. In an empirical study of 16 health and welfare agencies in a Midwestern metropolis, Hage and Aiken (1972) find that the more routine the task, the more centralized the informal organization structure of the agency. Klahr and Leavitt (1967) and Whisler (1967) reach similar conclusions in separate case studies of organizations using computerized systems. They observe that repetitive, routine tasks foster centralization of operations, especially with the advent of the computer. In contrast, novel and complex tasks, which are not well-structured, seem to generate more participatory and flexible informal organization structures. In another approach to the same problem, Faucheux and MacKenzie (1967) employ an experimental situation to test the relationship between problem structure and organization structure. Their results agree with the conclusions of the studies previously cited. Routine, deductive tasks result in centralization, while nonroutine, inferential tasks do not.

To justify these results, Mohr (1971) and Myers (1967) reason that nonroutine problems are indefinite and uncertain. Consequently, their solutions cannot be programmed or prescribed, and groups of experts must cope with each problem on an individual basis. In specialized, sophisticated, and complex missions, professionals must assume a high degree of responsibility for problem solution. There is a need for lateral communication among expert staff members to cope with unique problems and, thus, a decentralized or transactional structure is essential. Routine problems, on the other hand, minimize the need for professional experts and maximize the need for managerial coordination (Blau, 1974; Carlisle, 1974). These requirements lead to centralization of organization structure.

There are some dissenting opinions on the subject of problem structure and organization structure. Pugh, et al. (1972) argue that routine problems can be dealt with by decentralized processes and Buckingham (1961) concurs. As decision-making becomes more rational and the number of possible and acceptable alternatives narrows, top management may feel more confident in delegating routine tasks to lower echelons. However, the deterministic and preprogrammed nature of these routine decisions makes it questionable as to whether dynamic human choice is actually involved.

Problem uncertainty, characterized by incomplete information, unknown options, and changing conditions, is the other dimension of problem structure that may also influence organization structure. Upon analyzing case studies of three firms, Galbraith (1973) concludes that the extent to which lateral relations are used in organizational decision processes varies directly with the degree of task uncertainty. His results indicate that, in the most uncertain mission environments, decision-making should become decentralized. Slater and Bennis (1964) cite studies that reinforce Galbraith's findings. These authors assert that, for simple tasks under conditions of uncertainty, an autocratic, centralized structure is efficient. However, when conditions are complex, changing, and uncertain, a participatory, decentralized, informal organization structure is most appropriate.

Burns (1971) and Burns and Stalker (1961) put forth two theoretical constructs, mechanistic and organismic organization structures, to explain these results. In conditions of problem certainty and stability, mechanistic and highly centralized structures are well adapted because problem-solving methods, duties, and relationships can be defined precisely, thus minimizing the need for group deliberation. In contrast, organismic and decentralized structures are more efficient when conditions are uncertain and unstable because decision procedures, relationships, functions, and data must be constantly reevaluated and no individual has a monopoly over this information. Thus, delegation of authority, increased lateral communication, and greater coordination within a decision-making group will likely provide a satisfactory organization structure when the task to be solved is uncertain.

From this review, a clear consensus emerges on the relationship between problem structure and organization structure.

Operational Categories: Well-structured problems/ unstructured problems.

Informal Structure Assumption 2: Missions composed of well-structured problems are likely to be appropriate in centralized or consultative informal organization structures. Missions with unstructured problems are likely to be appropriate in transactional, partially delegated, or decentralized structures.

C. Mission Stress. Missions that are exceedingly stressful in terms of time constraints on decision formulation or high risk alternatives are likely to require different informal organization structures than low stress missions. Experimentation has indicated that psychological stress results in high personal anxiety, fear, defensiveness, and adherence to past successful methods of problem-solving even when they are inappropriate (Cowen, 1952; Spector, 1975). Such decision-making rigidity is usually relieved in low stress environments. Special types of personnel arrangements are usually required to cope with the psychological effects of stress.

The stress variable correlates with the planning, execution, and evaluation phases of mission operations. The planning phase generally involves tasks that are nonstressful, although some missions may necessitate short-term planning in a constrained time frame. Execution phases may require high risk choices within the short term. These tasks call for real time or near real time decisions and thus possess high stress. During an actual military operation, for instance, unforeseen events that cause a commander to immediately redefine the course of action may occur, such as accidents, loss of resources, and strong enemy actions. In addition to short-time decisions, such stressful situations may evoke the affective states of pain, fatigue, and sorrow that tend to heighten the complexity of rational decision-making (Stanford Research Institute, 1974). Missions involving evaluation tasks are often of a nonstressful nature. This phase provides feedback to the decision-making team on the planning and execution phases so that lessons for future missions are available. Thus, evaluation tasks generally do not involve excessive time constraints or risk. However, in an ongoing operation, evaluation tasks may involve short-time, stressful behavior to discern the success of previous actions and decide on the course of immediate, subsequent action.

In aggregate, the relevant literature is inconclusive regarding the effects of stressful missions on informal structure. Leavitt and Whisler (1958) take a clear-cut stand on the issue of the organization structure most appropriate for low stress planning missions in technological environments. They predict centralization of operations; the introduction of information technology will shift authority and control upward in the organization. However, Coleman and Riley (1972) take the opposite position. On the basis of more recent literature, they conclude that, given low stress missions, the introduction of MIS will result in more functional performance at lower levels in the organizational hierarchy. In such environments, authority tends to be delegated to middle management, which follows a generally cautious policy and relies heavily on the information system. High risk situations will tend to be handled by top level management, which is more inclined toward intuitive judgments than data analysis.

Sanders (1969) reviews both of the previous theories and adds yet a third. He discusses three schools of thought that hypothesize the organizational consequences of mission stress in technological environments. Researchers such as Coleman and Riley belong to the "greater challenge school" because they see decentralization in low stress situations as giving middle management more responsibility. The "intermediate school" also expects that technological innovation and low stress will result in decentralization, but it predicts a decrease in the number of lower echelon personnel that are charged with planning responsibilities. Finally, the "pessimists school," into which Leavitt and Whisler are placed, foresees a shift upward in responsibility (centralization) in low stress, planning environments. Sanders does not take a position on the relative merit of any one of these schools.

Opinion is also divided on the effects of high stress on informal organization structure. Carlisle (1974) takes the position that when quick on-the-spot decisions are required, authority to make them should be delegated. Those closest to the situation have the most information and can make the most rapid and presumably accurate judgments. Stanford Research Institute (1974) suggests that decentralized informal structures are often employed in naval task forces when commanders are faced with stressful and threatening stimuli. DeCarlo (1967) also advocates a decentralized organization structure in times of stress. He argues that centralized structures are overly efficient and often encourage fixed and rigid responses in stressful situations. Decentralized processes, in contrast, are more adaptable and encourage innovative handling of stressful missions.

While Galbraith (1973) and Myers (1967) acknowledge the value of a decentralized authority structure, they also see limits to its application. In highly stressful missions, including many military operations, a clear line of central authority would provide the most effective decision-making structure. When reaction time is of the essence, centralization ought to be implemented since it leaves decisional authority to those who possess the most responsibility.

No firm consensus of opinion can be found in the literature concerning the effects of stressful missions on the informal structure of organizations. However, it is not inconsistent to hypothesize several different structural consequences that are possible as a result of mission stress. The following assumption is developed on the basis of the preceding literature review.

> Operational Categories: Stressful missions/nonstressful missions.
>
> Informal Structure Assumption 3: Highly stressful missions are likely to be appropriate in centralized, partially delegated, and decentralized informal organization structures. Nonstressful missions are likely to be appropriate in consultative and transactional structures.

D. Leader Skill in Technical and Decision Analysis Methods. The adequacy of a leader's skill in using technologically advanced decision aids may vary. The ability to interpret output and formulate high quality decisions, either alone or with minimal consultation, widens the scope of the leader's active data base and the ability to analyze and manipulate it to his advantage. The greater the extent to which he can exercise the options of the system and interpret its results, the less filtered and biased his perspective on a problem will be and the less dependent he will be on his staff. A leader who is knowledgeable in these respects can at least communicate with the staff on a highly analytical level, reducing the information loss and inaccuracies caused by the need for nontechnical translations. Moreover, expertise in using MIS enables a leader to gain access to a broad and integrated picture of the problem environment.

Technological expertise and the increased access to information that results are power resources that enable leaders to develop independent preferences for particular courses of action and then choose among alternatives. The degree to which leaders possess these skills depends largely upon training in technical and decision analysis methods. How this training should be accomplished is beyond the scope of this report, but it is an important issue to deal with. The U.S. Army Materiel Command (AMC) (1965), for instance, instituted formal ADP training courses for both high level officers and professional staff to provide them with the capability to employ new AMC computer systems efficiently. An outside contractor was brought in to develop and conduct the training program. In addition, the U.S. Naval Postgraduate School and the Defense Systems Management School currently offer programs in decision analysis techniques.

Many authors recommend that leaders be fully trained in the use of computer-based decision aids, but they fail to indicate how skilled leadership will affect the organization structure. In order to maintain real control over their areas of responsibility, managers must be educated continually in the newest decision techniques (Michael, 1966; Buckingham, 1961). Colbert (1974) adds that leader proficiency in decision aid skills is the only way management can maintain an active role in the problem-solving process.

In fact, in a case study of automation in an engineering plant, Emery and Marek (1966) find a decreased demand for substantive managerial skills and increased demand for technical skills.

Several researchers point out that implementing a computer-based MIS is successful and least resisted if there is sincere commitment and involvement by top level organization leaders (Delehanty, 1967; Coleman and Riley, 1973; Beckett, 1967; Kanter, 1972b). Leader commitment and enthusiasm, in turn, depend upon leader training and experience. These can be accomplished, in part, by directly involving operational management in the design of the system (Thurston, 1962; Federico, et al., 1975). Stewart (1971) tested this proposition in an empirical study and found it to be supported. Other studies dealing specifically with implementing MIS in military contexts recommend that proper implementation of these tools demands both leader and staff training in decision analysis and software skills to ensure optimal employment (Chapman and Kennedy, 1955; Genensky and Wessel, 1964).[2]

Despite the acknowledged importance of leader training and skill in decision analysis methods, evidence is sketchy concerning their relationship with appropriate types of informal organization structure. In a theoretical study of noncomputerized industrial organizations, Burns (1971) concludes that one characteristic of mechanistic, centralized structures is the location of knowledge and skills at the top of the structural hierarchy. On the basis of case studies of 13 industrial plants, Bright (1958) found that centralized control, facilitated by the overall skills and expertise of foremen, enabled functions to be integrated rather than departmentalized. Carlisle (1974) and Vroom and Yetton (1973) summarize this school of thought by concluding that if top level officials possess more knowledge and experience than lower level subordinates, centralization of informal structure is a likely outcome.

A somewhat different conclusion is reached by Moan (1973) as he looks at the effects of the computer on inventory control in five major companies

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[2] This point, a crucial criterion for decision aid acceptance, is amply reinforced by the case studies that follow.

He finds that the technical expertise of top management is the most important variable in causing organizational change to occur in the direction of "management by exception." This means that the location of methodological skills at the top of the organizational hierarchy leads neither to complete centralization nor complete decentralization. Rather, it leads to a situation in which those in control establish limits and tolerances within which lower echelons must operate. When a problem fails to be covered by formal prescription, it is sent up the hierarchical ladder to top management for resolution.

The predominant effect of leader skill on informal organization structure can be stated as follows.

> Operational Categories: Skilled leaders/unskilled leaders.
>
> Informal Structure Assumption 4: Leaders skilled in technical and decision analysis methods are likely to prefer centralized informal organization structures. Leaders that lack such training are likely to prefer consultative, transactional, partially delegated, or decentralized structures.

Leadership skills in decision analysis methods also affect aspects of formal organization structure. A report written by the U.S. Army Materiel Command Board (AMC) (1965) speculates that enlightened commanding officers will favor pyramidal computer installations to facilitate handling of computing services for various functional divisions below them. Historically, divisional installations emerged in those functional directorates of the AMC that were the principal consumers of ADP services. However, as computer programs were developed to assist many different functional areas within the AMC and commanders learned more about computer operations, pyramidal and focused ADP installations became more acceptable and cost efficient.

On the basis of his observations in corporate settings, DeCarlo (1967) essentially concurs with this conclusion. As the analytical capabilities of top managers increase, the organization's speed of response will also increase if the computer installation is under the direct control of top management. However, DeCarlo speculates that organizations of the future will evolve into "purpose-centered units," causing pyramidal installations to become obsolete. He feels that divisional computer installations, which operate at the behest of functional and task-oriented subgroups within an organization, will become prominent and overtake pyramidal structures.

The available research literature on computer installations offers the following assumption.

> Formal Structure Assumption (Aid Placement) 1: Leaders skilled in technical and decision analysis methods are likely to prefer pyramidal installations over divisional installations.

The effects of skilled leaders on the need for assigning specially skilled personnel from outside the organization to operate the decision aids are fairly clear. Skilled leaders demand that their professional staffs be trained, rather than employing a new set of specialists. In a large corporation, Williams and Adams (1968) find that skilled top management insists that staffs undergo extensive technical training (a broad conceptual education in information processing and 1-2 years of programming) to assure the success of planned computer implementations. Moan (1973) reaches a similar conclusion but argues that technically competent managers require technically skilled staffs to make "management by exception" feasible. Delegation of authority is possible when top management is confident in the abilities of subordinates to make most decisions alone.

If top management is not skilled in decision analysis techniques, specially skilled personnel are probably required (Colbert, 1974). However, because these personnel are assigned from outside the organization, management must provide them with specific policy guidelines on organizational goals or risk losing control over the organization. Thus, Colbert concludes that leaders in computer-based environments should obtain the requisite skills to deal effectively with technical problems and operations. Federico, et al. (1975) cite a 1970 survey by R.S. Jackson that counters Colbert's claims. They find that, as organizations become more technologically sophisticated, the skill requirements for leaders will decrease! As a result, top management encourages substantive experts already in the organization to develop analytical skills so that they can interpret, analyze, and transmit information back to the upper echelons.

> Formal Structure Assumption (Assignment to New Roles) 1: Skilled leaders are likely to prefer training the existing staff.

E. Professional Staff Skill in Technical and Decision Analysis Methods. In a technological environment, skilled staff members are a valuable asset in maximizing organizational performance. Employing decision aids to the fullest advantage depends upon the knowledge, training, and experience of the leader, the professional staff, or specially skilled personnel who are assigned expressly for their methodological skills. Intuitively, it seems preferable that the existing professional staff possess technical and decision analysis skills so that the substantive and technical aspects of decision-making can be combined in the same individuals. The assignment of outside specialists may infuse sufficient methodological sophistication, but may result in naivete in matters of functional importance to an organization. Moreover, a skilled professional staff, with its knowledge and understanding of organizational policy, could ably assist a skilled or unskilled leader in interpreting decision aid output and choosing among action alternatives.

This variable is treated in a rather absolute manner for the sake of simplicity; either the entire staff possesses sufficient technical skills or none at all. It is possible, of course, that only certain staff members have the necessary skills. While this question is not analyzed here, it emphasizes the need to study the issue of decision analysis training -- who should be trained, to what extent, and by what method. Possessing technical decision analysis skills in an organization vitally influeces the choice of informal and formal structures that is most appropriate. Whether a staff is skilled, combined with the extent of leader skill, affects the type of organization structure that is feasible.

As was the case with leader skills, staff technological expertise has been discussed from various perspectives. Several authors (Williams and Adams, 1968; Huse, 1967; Buckingham, 1961) address the question of whether professional staff should be actively included in designing decision aids. They unanimously conclude that staff involvement is preferable to ease the changeover to computer-based techniques and reduce the possibility of resistance. In addition, such participation is likely to increase staff cognizance of the new system's potential and thus helps to develop its skills.

Discussion has also focused on the relationship between staff training and experience and types of informal organization structure. While much of this literature is concerned with staff skills in noncomputer contexts, conclusions can be assimilated into computer-based environments. Tannenbaum and Schmidt (1958) and Carlisle (1974) conclude that delegation of authority or decentralization of informal structure is probable if subordinates are knowledgeable and experienced in decision-making techniques. Blau (1974), in a theoretical analysis, and Slater and Bennis (1964), on the basis of empirical evidence, find that the same tendency toward decentralization occurs as workers become more professional in their approach to specific tasks and overall goals of the organization. Burns (1971) speculates that the location of knowledge and skill in an organization defines the center of authority. Thus, if subordinates are highly skilled and professional, an organismic type of organization, in which authority tends to be dispersed and decentralized, should be most appropriate.

In the current naval task force environment, Stanford Research Institute (1974) observes that a commander is likely to delegate authority to the staff if he feels it is knowledgeable and experienced in the task force mission <u>and</u> the commander himself is inexperienced. However, it is also possible that, given a knowledgeable staff, a commander who is competent in all aspects of mission performance may also decentralize authority.

Researchers who have analyzed organizations in which MIS has been introduced reach conclusions similar to the studies previously cited: <u>Staff skill contributes to the appropriateness of decentralized organization structures</u>. On the basis of several case studies and a review of relevant literature, Whisler (1967) argues that, in the long run, professionalization of workers in highly differentiated tasks may limit the degree of centralization within organizations. Forrester (1967) also concludes that MIS offers subordinates greater access to the rules and information that are the lifeblood of the organization. Staff members that are knowledgeable about organizational operations, policies, and decision tools usually prefer participatory informal structures.

Several researchers diverge from this consensus of opinion. They predict that neither centralization nor decentralization is the most appropriate informal structure in situations where subordinates are professionally skilled in technical and decision analysis methods. Rather, they argue that a transactional form of informal structure can best deal with an organization having a skilled staff. Colbert (1974) proposes that skilled staffers, who are responsible for interpreting and analyzing computer output and coordinating MIS needs across departmental lines, require a transactional structure in which information flows vertically, as well as horizontally, within the organization. While Colbert does not specify where final decision-making authority should reside in this open communication structure, the responsibility offered to professionally skilled subordinates demands an organizational form that fully integrates them into the decision-making process.

Wilkinson (1955) also prefers a transactional structure in response to high staff skill. His analysis of the Pacific Command (PACOM) ADP system emphasizes the need for active participation and integration of skilled personnel. Although both commander and staff should be effectively immersed in the decision process, the commander is not likely to delegate ultimate authority to make policy decisions, no matter how skilled or policy conscious the staff is. Transactional structures allow for this type of decision-making arrangement. Thus, the literature strongly suggests that the presence of skilled staff members fosters an informal organization structure in which trained professionals significantly contribute to the decision-making process.

> Operational Categories: Skilled staff/unskilled staff.
>
> Informal Structure Assumption 5: Staffs skilled in technical and decision analysis methods are likely to prefer consultative, transactional, partially delegated, or decentralized informal organization structures. Staffs that lack such training are likely to prefer centralized structures.

The formal structure implications of maintaining a technically skilled staff are quite apparent. If an *existing staff* is competent in technical decision analysis methods, the need to assign specially skilled personnel from outside the organization is greatly reduced. In a simulated air defense direction center, Chapman and Kennedy (1955) found that no auxiliary personnel were required to operate the center's systems if the subjects were given an opportunity to use their own skills. As the volume of computer usage in an organization increases, it is preferable to maintain a staff that can integrate functional and technical skills so that organizational policy directions are followed (Colbert, 1974; Federico, et al., 1975; Whisler, 1967). An unskilled staff may resist technological change and force assignment of outside experts to activate system usage (Leavitt and Whisler, 1958; Williams and Adams, 1968).

> Formal Structure Assumption (Assignment to New Roles) 2: Skilled staffs are likely to make it unnecessary to assign specially skilled personnel from outside the organization.

F. Leadership Style. Leaders often prefer particular types of leadership behavior or possess personality traits that motivate them toward certain styles of interaction with subordinates. If a leader feels comfortable with a certain behavioral style, he is likely to choose a decision method or informal structure that is congruent with this style. However, a leader's desires may not yield the most satisfactory structures or outcomes for the organization. While leader style alone has an important impact on the choice of informal structure, its effect is mediated by other situational factors.

Fred Fiedler (1965, 1967) has conducted an extensive amount of research in this area. He views leadership style as a personal approach to managing, coordinating, and motivating group members toward achieving organizational objectives. Style can be equated with leadership preferences or personality. He classifies style into two categories that are simple but convenient to handle. One style emphasizes the task to be performed. The leader is authoritarian and highly directive, telling subordinates what to do and how to do it. This constitutes the traditional leadership approach in which the leader plays a controlling, active, and structured role vis-a-vis the staff. The other style of leadership is a nondirective, group-centered approach. Behaving in an egalitarian, permissive, and passive fashion, the leader is motivated by feelings of consideration and trust for subordinates and a desire to involve them in organizational tasks. Fiedler has labeled the former style task-oriented and the latter style relations-oriented.

Having defined these two leadership personalities, Fiedler attempts to analyze the conditions under which they yield effective organizational task performance. His basic premise is that different situations require different leadership styles, and he attempts to map out precisely the environmental configurations upon which leadership effectiveness is contingent. After extensive testing and observation, he concludes that leadership effectiveness depends upon the relationship between leader style and the degree to which three climatic factors -- task structure, leader-member relations, and leadership position power -- enable the leader to exert influence. Task-oriented leadership styles are most effective under the following favorable conditions: The leader has power, the informal backing of group members, and a relatively well-structured task to perform. Task-oriented leaders are also effective in relatively unfavorable situations in which the leader is not well accepted, does not have sanctions available to enforce commands, and does not possess a clear and definite task to accomplish. It is in moderately favorable organizational situations, in which the leader is accepted as legitimate, his power position is minimal, and the task is unstructured, that a leader who is permissive, considerate, and primarily concerned with interpersonal relations within the staff (relations-oriented style) will be effective. Thus, Fiedler finds a curvilinear relationship between effective leadership style and the configuration of environmental factors in organizations. His results imply that management can ensure effective organizational leadership by actively "engineering" the situation to suit a leader's personality or style.

Fiedler's research, while related, does not directly concern organization structure or computer-assisted functions. However, his dichotomy of task-oriented and relations-oriented leadership styles can be employed to account for leadership preferences or personality that strongly influence the choice of informal and formal organization structures.

The important impact of leader personality and style on informal organization structure is widely recognized. Simon (1965: 104) states that "organization form...must be a joint function of the characteristic of humans and their tools and the nature of the task environment." If any of these components changes significantly one should expect modification in the organization structure. Several authors recognize that leader personality may influence the degree of acceptance of technological innovation and thus impact upon structural adaptability. Highly loyal, conformist, and bureaucratic managers are likely to resist computerization of tasks because it alters secure, ongoing procedures and operations. Adaptable and open managers, on the other hand, tend to accept change in their organizations (Rose, 1969). In a similar vein, Phillips (1970) cites an empirical study concluding that the personality attributes of workers determine their acceptance of computer methods. Burns (1971) argues that introducing computers to assist in task performance may be perceived by managers as threatening to security and advancement in the organization. Such perceived threats may cause resistance to the use of such decision aids, and rigidity in the interaction patterns within the organization (Burns, 1971). Thus, leadership personality may result in maintaining inappropriate, as well as developing, new, flexible, informal organization structures.

Some researchers emphasize the effect of leadership style on informal structure, but they fail to specify the precise nature of the relationship. Myers (1967) and Harris and Erdman (1967) conclude, from a review of the literature, that computers alone cannot determine the proper organization structure for a group; it is the personality and personal preferences of top management that influence the nature of the prevailing informal structure. Empirical tests have indicated that differences in leadership preferences cause variance in the degree to which participative informal structures are chosen (Vroom and Yetton, 1973).

The general impact of personality on informal structure has also been documented in a military environment. Thompson (1962: 16) describes a command headquarters as "the alter ego of the commander." It is the personality of the commander, coupled with the interpersonal relationships among staff officers, that determines the decision method adopted. For instance, the stronger the sense of trust and confidence a naval task force commander has in the abilities of subordinates, that is, the more intense his relations-oriented style, the more likely it is that he will choose to delegate authority to them, creating a decentralized structure (SRI, 1974). From this discussion, we might infer that relations-oriented leaders should favor structures at the decentralized end of the continuum since such organizations stress increased subordinate participation and involvement. Leaders with task-oriented styles, who desire to exercise control over their environments, are likely to choose structures at the centralized end of the continuum.

However, a few authors take the position that introducing MIS will frustrate task-oriented leaders because it lowers the feasibility of an autocratic, centralized organization structure. According to Michael (1966) and Buckingham (1961), leaders in computer-assisted settings need to be flexible, imaginative, and capable of thinking logically and analytically. As a result, Wermuth (1972) predicts that naval commanders will have to become more relations-oriented and informal structures more participatory. DeCarlo (1967) adds that since leaders will be directing more technically competent people as computers become widespread, they will have to permit decentralized decision-making so as not to squelch creative and innovative opinion.

Despite some dissenting views, the following assumption can be made concerning the relationship between leadership style and informal structure.

> Operational Categories: Task-oriented style/relations-oriented style.
>
> Informal Structure Assumption 6: Leaders with relations-oriented styles are likely to prefer transactional, partially delegated, or decentralized informal organization structures. Leaders with task-oriented styles are likely to prefer centralized and consultative structures.

Leadership style is another important determining factor of formal structure. While most researchers acknowledge this relationship, few deal directly with it. However, some inferences can be drawn from their discussions. Rose (1969) distinguishes between two managerial personality types that can be loosely related to task- and relations-oriented leadership styles. Relations-oriented managers trust their subordinates and are comfortable in the presence of information processing specialists; thus, divisional computer installations are usually preferred by these types of managers. Task-oriented leaders, on the other hand, may resist placing a system outside their direct control and, thus, may favor pyramidal installations.

Formal Structure Assumption (Aid Placement) 2:
Relations-oriented leaders are likely to prefer divisional installations over pyramidal installations.

Relations-oriented managers also seem to prefer training existing staff in technical and decision analysis methods (Buckingham, 1961; Tannenbaum and Schmidt, 1958). Human relations become most important when a technological system is implemented that results in a great deal of change. Participation by existing personnel in the technological changeover and technical training is encouraged by relations-oriented leaders to build a sense of common purpose among staff members. Morale would be badly damaged if outside specialists were assigned without first consulting present staff.

Formal Structure Assumption (Assignment to New Roles) 3:
Relations-oriented leaders are likely to prefer training the existing staff.

The placement of decision aid operators in the formal structure is largely determined by the leader's personal desires. It is reasonable to assume that a relations-oriented leader would wish to treat decision aid operators on an equal basis with existing personnel, but not at the expense of the latter with whom they have already developed a rapport. Existing functional staff may feel threatened by the technical expertise of operators if they are assigned from outside the organization. Relations-oriented managers may attempt to alleviate potential intrastaff conflicts by providing operators with lowered status in the hierarchical structure and placing them within a support unit that assists an existing functional staff.

Formal Structure Assumption (Operator Placement) 1:
Relations-oriented leaders are likely to prefer placing decision aid operators in a support status to existing functional personnel rather than in a new division of equal status with other divisions.

G. Technological Sophistication. Computer-based decision aids can be designed at various levels of technological sophistication to assist in performing different functions: to sense perturbations in the environment; store, retrieve and transmit data; manipulate and analyze data; develop alternatives; and disseminate decisions (Thompson, 1962). There are always built-in constraints to any system that limit its capacity to perform each of these functions or that circumscribe the particular functions that can be performed by the system.

The sophistication of a decision aiding system is contingent upon the extent of these designed constraints. Two categories of aids, information inventory tools and analytical decision tools, can be defined with regard to this sophistication criterion. A computer-based inventory aid provides basic data management capabilities for storage, retrieval, and transmittal of data. It offers an accessible and integrated memory to assist in the decision-making process. This type of computer-based aid can be employed to organize and display a central data base gathered from diverse sources. However, developing action alternatives is still the sole responsibility of decision-makers. A more sophisticated analytical aid is capable of projecting utilities to decision alternatives and outcomes by manipulating and correlating relevant variables on the basis of particular statistical and mathematical algorithms. These sophisticated tools operate as simulators of the decision process. Thus, they can assume some of the judgmental functions that were previously reserved exclusively for a professional decision staff.

The degree of decision aid sophistication has a direct effect on management's choice of formal and informal organization structures. However, a review of the literature indicates that aggregate results concerning the effects of technological sophistication on informal organization structure are ambiguous and inconclusive. The researchers studying this issue appear equally divided in their findings. To a large degree, these ambiguous conclusions can probably be attributed to a definitional problem. Decision aid sophistication is a temporally relative term. To a researcher of the early 1960's, sophisticated technology generally constituted an elaborate data processing and inventorying system. Today, sophisticated technology implies a highly analytic system that is capable of simulating actual scenarios, integrating data in accordance with mathematical and statistical algorithms, and developing sets of action alternatives to complex problems. Depending upon the precise definition of sophistication, which is apt to change over the years as technology advances, one researcher's interpretations may be entirely incompatible with those of others. The absence of definitional precision in this body of literature may be responsible for the inconclusive results in aggregate.

Rezler (1964) and Leavitt and Whisler (1958) agree that rather unsophisticated information inventory tools allow data to be transmitted upward in the organization, thus bringing about a centralization of informal interaction patterns. However, as technology becomes more sophisticated and is employed to define and analyze problems, centralized structures may become less valuable (Whisler, 1967). Taking the opposite point of view, Forrester (1967) and Carroll (1967) argue that developing an unsophisticated data processing capability will enable more decentralization within organizations. By allowing an increased flow of vital information to filter down through the organizational hierarchy, such a computer-based system can increase the number of knowledgeable individuals who are capable of making decisions and may result in increased delegation of authority (Buckingham, 1961). On the basis of a case study of computer implementation in a strategic naval command environment, Wilkinson (1975) also concludes that computer-based inventory tools place more authority in the hands of staff advisors.

Several authors suggest that all types of informal structure are equally probable given the introduction of inventory aids in an organization. Delehanty (1967) maintains that, even if unsophisticated data processing systems require a certain type of informal structure, there is not enough evidence to specify which one is best. Colbert (1974) maintains that inventory systems can adapt effectively to either a centralized or decentralized structure.

Opinion is also divided among authors who consider the effect of sophisticated analytical systems on informal organization structure. Mahoney and Frost (1974) conclude, on the basis of descriptive information of 17 business and industrial firms, that less supervisory control and more participative training and development is possible when computer-based decision aids are sophisticated, interactive, and analytic. DeCarlo (1967) also maintains that the extended use of analytical systems will cause centralized structures to disappear and be replaced by decentralized patterns of informal interaction.

Other researchers are not confident enough to posit one informal structure type as preferable to another. Carroll (1967) concludes that implementing analytical decisions aids makes centralization of informal structure possible because top management wants to maintain control over such powerful decision-making tools; however, centralization is not essential to employing sophisticated aids. Klahr and Leavitt (1967) also see no clearly predictable effect of sophisticated decision tools on informal structure. Finally, Galbraith (1973) argues that a decentralized, informal structure is an equally viable alternative to centralization in organizations that possess sophisticated decision aiding systems.

From this review, no assumption can be confidently derived from the literature. However, since technological sophistication is an important climatic factor, a reasonable assumption about its potential effect on informal structure ought to be included in the contingency model, subject to revision if the model, as a whole, appears faulty. Thus, the following assumption is posited.

> Operational Categories: Analytical aids/information inventory aids.
>
> Informal Structure Assumption 7: Analytical decision aids are likely to be appropriate in centralized or consultative informal organization structures. Inventory aids are likely to be appropriate in transactional, partially delegated, or decentralized structures.

Technological sophistication impacts upon two aspects of formal organization structure: the placement of the decision aids in the organization, and assignment to new organizational roles to effectively utilize the decision aids. The literature that deals with locating the aids is concerned entirely with unsophisticated technology. No direct evidence seems to be available on the proper location of sophisticated, analytical systems. Hence, more research on this issue is merited.

The general consensus is that computer-based inventory tools are most effective when placed in a single, separate department close to the source of authority and responsibility in an organization, that is, a pyramidal installation. Whisler (1967) cites two trends that are both directed toward developing pyramidal formal structures. The first is a move toward placing the computer at a higher level than any other division. The second involves transferring the system out of the traditional functional departments and into a "neutral" division. Delehanty (1967) concurs with Whisler on the proper location of inventory aids. The data processing function can be used most effectively if it is placed in a service branch or if a full status computer department is created to support the entire organization.

According to Colbert (1974), offering the data processing manager equal or higher status than other department heads allows impartial allocation of computer services among the departments. Equal status also insures that the computer is employed to serve company objectives and not the goals of any one department. Analysis of a computer-driven inventory system in the Army Material Command (1965) concurs that data processing activities are best utilized if they are under the direct control of the executive commander, thus favoring a pyramidal formal structure.

Although evidence is lacking on the proper placement of an analytical decision aiding system within an organization, it seems reasonable to assume that either a pyramidal or divisional installation would be appropriate. Complexity, cost, and functional utility make a pyramidal structure suitable if sophisticated aids are present. It is cost efficient to maintain a single, complex system (Van Paddenburg, 1972). Moreover, an analytical system integrates division level data to create an overview of the entire situation that can be interpreted by generalists at top levels in the hierarchy. On the other hand, the argument can be made that continued technological development of mini-computers will make several divisional installations more cost efficient then maintaining single, large-scale systems (Colbert, 1974). In addition, placing analytical aids on a divisional level could provide middle and lower level managers with a clear perspective of organizational policy and status, and involve them in decision-making to a greater degree.

> Formal Structure Assumption (Aid Placement) 3: Analytical decision aids are likely to be appropriate in either pyramidal or divisional installations.

The literature concerning assignment to new organizational roles is rather sketchy. In organizations with either data inventory or analytical tools, Beckett (1967) finds a need for people who thoroughly understand and interpret the system and its output. Woodward (1971) and Mahoney and Frost (1974) assert that as technology becomes more advanced and analytical, a more educated staff is required. Whether these staff members should be assigned from outside the organization or trained from within the ranks of existing staff is not dealt with explicitly. However, a study of the Army Materiel Command (1965) specifies that systems analysts, programmers, and operators need to be assigned and integrated into the formal organization structure to interface even with unsophisticated decision tools.

Several assumptions can be derived on the basis of these studies. First, even when technology is relatively unsophisticated, there may be a need for specially skilled personnel from outside the organization to interpret the output. Second, since analytical aids are likely to require more complex input and provide more sophisticated output, the system will probably demand that operators and analysts possess capabilities commensurate with those of the system. Especially in the initial implementation stage, effective utilization of a sophisticated decision aid will probably require highly skilled and experienced operators. However, it is conceivable that existing staff can eventually be trained to replace these analysts, but only after extensive, formal, on-the-job training.

> Formal Structure Assumption (Assignment to New Roles) 4: Analytical decision aids are likely to make the assignment of specially skilled personnel from outside the organization preferable, at least initially.

H. Real Time Capability. The computer-based decision aids discussed in this report are assumed to be in an interactive mode, that is, they require on-line instructions from an analyst at various decision points to define variable parameters. Another important characteristic of decision aids, not to be equated with interactive properties, is concerned with whether they operate in real time or non-real time, that is, whether the computer system operates within the same temporal frame as the real world. A real time system performs its operations on a data base that is kept current by continual and direct input updates from automatic sensing devices and indirect updates from manual data processors. Dynamic, quickly changing situations often require real time or near real time decision aids to assist in formulating immediate choices. Real time systems speed the processing and analysis of up-to-date information so that it is translated into fast and responsive decisions to short-range problems.

Non-real time decision aids, on the other hand, employ historical information as a basis for analysis. While such aids may be interactive and provide quick response turnaround, the non-real time data base employed in their calculations restricts the direct utilization of their outputs to immediate problems. However, non-real time systems can provide analysts with planning assistance to make long-range decisions.

Whether or not a computer-based decision aid possesses real time capability has implications for both formal and informal organization structure. The exact type of informal structure that is most appropriate, given real time systems, is an unresolved issue. Klahr and Leavitt (1967) recognize the importance and growing availability of real time information to upper and lower levels of an organizational hierarchy. However, the kind of informal structure that is most suitable in implementing real time systems is not clear. Federico, _et al_. (1975) review literature on both sides of the question. Some researchers, including Myers (1967), stress the utility of real time systems for centralized management decision-making. But others assert that geographically distributed real time systems can provide information simultaneously to all levels of an organizational hierarchy and thus make decentralization an appropriate form.

Carroll (1967) and Carlisle (1974) base their conclusions on business and military experiences with real time systems and are in basic agreement with the previous authors: Centralized and decentralized informal structures are feasible given a real time system. Harris and Erdman (1967), dealing specifically with military command and control functions, also agree that the nature of technology imposes little constraint on choosing the most appropriate informal organization structure.

Galbraith (1973), on the basis of his experience in manufacturing concerns, indirectly relates real time computer systems exclusively to a decentralized pattern of informal relations within an organization. When there is a high level of uncertainty concerning a particular task, there is a great need for real time data and analysis and rapid dissemination of this information to all relevant members of the organization. Thus, a pattern of lateral relations that emphasizes communication and coordination is most appropriate in a real time environment.

It seems reasonable to assume from the existing literature that real time decision aids can operate efficiently in either centralized or decentralized structures. However, real time systems are usually unsuitable to transactional structures because long-term, rather than immediate, responses are usually the focus of deliberations.

> _Operational Categories_: Real time or near real time capability/non-real time capability.

Informal Structure Assumption 8: Real time decision aids are likely to be appropriate in centralized, consultative, partially delegated, or decentralized informal organization structures. Non-real time systems are likely to be appropriate in transactional structures.

The model assumes that real time capability affects placement of the aiding system in the formal organization structure. Colbert (1974) and Carlisle (1974) concur that, prior to technological improvements in computer memories and information handling speed, data processing activities had to be located at the divisional level where individuals had ready access to accurate and current information about organizational conditions and external forces. But, as technological developments have provided the capacity for real time systems, conditions for a pyramidal data processing installation have become more favorable. Moreover, sensing the power inherent in real time systems to respond rapidly in limited time situations, top management prefers close control over such systems and thus favors pyramidal formal structures. Several other authors, however, suggest that the presence of a real time decision aid does not dictate the formal location of the technology (Klahr and Leavitt, 1967; Federico, et al., 1975).

Formal Structure Assumption (Aid Placement) 4: Real time decision aids are likely to be appropriate in pyramidal installations, but not in divisional installations.

I. Output Display. The form in which output is displayed to decision-makers is a major physical characteristic of computer-based decision aids that has significant impact on organization structure. This variable reflects the direct interface of man and machine; the form in which computer inventory or analytical results are displayed involves software as well as hardware considerations. The format of output documentation is a function of programming forethought and initial coordination between programmers and the needs of users. Obviously, hardware features, such as individual interactive terminals and large screen projections, also determine the nature of data display.

This climate variable focuses on the hardware characteristics of output displays. Individual terminals that display data and results to only one person may have a very different effect on organization structure and the social aspects of small group decision-making than terminals with large screen projection capabilities. With a large screen display, all team members can be made aware of analytical results simultaneously. Moreover, a large screen can enable them to view the output as a group rather than as individuals at separate display terminals.

The literature that deals with the relative utility and efficiency of separate units versus large screen units falls within human factors research, and is generally not concerned with the effects of output display on organization structure. For instance, Jones (1970) and Miller (1969) discuss the relative utility of hard copy as opposed to CRT (cathode ray tube) devices that are capable of graphic presentations. However, they fail to be concerned with the implications of these differences for organization structure.

One study by Smith and Duggar (1971) analyzes the question of whether large shared displays facilitate group participation. Using data collected in laboratory experiments, they compare group problem-solving performance of individuals using small screen displays and groups sharing large screen displays. Their results indicate that the use of small individual displays yields slower group performance. Sharing a large group display results in more rapid performance because it reduces the vested interest each team member has in his own answer; debates and arguments decrease among group members using the large screen display.

The use of individual displays can yield structures at both ends of the organizational continuum. Centralized structures are feasible since individual displays can provide information directly and exclusively to the highest levels of an organization. Decentralized structures are equally feasible since several individual terminals, located in different divisions, can efficiently disseminate information to lower echelons. Large screen installations, on the other hand, make transactional structures most appropriate. Such display units promote total integration and communication among staff members and speed group performance, as Smith and Duggar (1971) conclude.

> Operational Categories: Large screen display unit/ individual display unit.
>
> Informal Structure Assumption 9: Large screen display units are likely to be appropriate in transactional, informal organization structures. Individual display units are likely to be appropriate in centralized, consultative, partially delegated, or decentralized structures.

In terms of formal organization structure, a large screen unit will likely favor a pyramidal installation. It will enable close control by management over use of the decision aid and increased integrative capacity over the staff that views the display. Team viewing that cuts across divisional boundaries is best served if formal coordination comes from the top, rather than if it is dispersed among separate division heads. Individual displays that are located in various organizational divisions can function best as divisional installations since they do not induce interdepartmental teamwork and, therefore, do not require intense integration from top management.

> Formal Structure Assumption (Aid Placement) 5: Large screen display units are likely to be appropriate in pyramidal installations, but not in divisional installations.

J. Technology Implementation Stage. The introduction of technological innovation into an ongoing organization can be conceived as a developmental process. Generally, new technology cannot be integrated into an organization without a transitional phase. The requirements for debugging, reprogramming to meet specific unexpected requirements, potential staff resistance, on-the-job familiarity with system options and limitations, and the need for formal training call for a transitional stage to ease the transfer from previous methods of operation. Once the use of the new technology is routinized, accepted, and understood by the staff, the system is said to be fully operational.

Management decisions during the transitional phase will have important implications for training and assignment of outside specialists during the fully operational stage. If, for instance, experts are brought in initially to implement a new decision aiding system in lieu of training the existing staff, on-the-job training of staff members may allow the experts to be dropped during the fully operational phase. In this case, outside specialists would serve a temporary and provisional purpose. However, on-the-job training of a highly complex decision aid, no matter how prolonged, may be insufficient for effective operation of the system. It may produce heavy reliance on outside experts who are technical specialists rather than substantive experts. On the other hand, although intensive formal training of existing staff may prolong the transitional phase and make it more costly, such initial efforts may yield more qualified personnel in the fully operational stage who combine both technical and functional expertise.

Whether the technology and staff are in a transitional or fully operational stage has direct consequences for formal and informal organization structure. Mann and Williams (1966) study the implications of implementing ADP on informal structure in an industrial setting. During the conversion or transitional phase, decentralization of authority was the most appropriate form of organization. Responsibility and authority were delegated and distributed to lower hierarchical echelons, inducing teamwork and group decision-making. As the ADP system became fully operational and accepted by company personnel, the organization shifted to a recentralized informal structure, enabling more focused control and integration from above. In a similar vein, Rose (1969) contends that the transitional phase of the implementation process ushers in a period of confusion and fluidity. To handle these unstable conditions, there is a need for more decentralized or organismic organization structure. When the environment again becomes stable and predictable, the need for a loose, informal structure diminishes and the organization will assume a centralized, mechanistic form.

> <u>Operational Categories</u>: Transitional phase/fully operational phase.
>
> <u>Informal Structure Assumption 10</u>: Fully operational decision aiding systems are likely to be appropriate in centralized or consultative informal organization structures. Transitional systems are likely to be appropriate in transactional, partially delegated, or decentralized structures.

This climatic variable impacts upon two properties of formal organization structure: the placement of the decision aiding system and the assignment to new organizational roles. There is some consensus that, during the transitional stage of implementation, a decision aiding system should be formally located at the divisional level. Van Paddenburg (1972) relates the initial decision at North American Rockwell Corporation to employ several independent, divisional computer centers. Whisler (1967) also cites the tendency of management to place computer installations in the particular divisions they are expressly intended to help. Similarly, Tomaszewski (1972), an information systems staff member at Western Electric Company, argues that transitional computer systems are often small, localized, and engineered to perform identified functions for specific divisions. However, once ADP is fully operational and personnel members become increasingly familiar with it, a pyramidal installation provides manpower flexibility, data redundance reduction, improved coordination, and standardized system documentation procedures (Tomaszewski, 1972). These advantages of a pyramidal system, plus increased cost reduction, improved workload performance, and greater central control over operations, prompted North American Rockwell to centralize its data processing activities between 1970 and 1972 (Van Paddenburg, 1972). Whisler (1967) also observes the same trend toward developing pyramidal formal structures as computer systems become more routinized and engrained in organizational operations.

Formal Structure Assumption (Aid Placement) 6: Fully operational decision aiding system are likely to be appropriate in pyramidal installations, but not in divisional installations.

If outside personnel with special skills are needed to operate, interpret, and coordinate the results of a computer-based system, Tomaszewski (1972) recommends using them as a "gypsy staff" to bridge the gap between system developers and substantive users. Thus, during the transitional phase, assignment of outside specialists is preferable so that the professional staff that will use the system can become fully aware of its options and mode of operation. This "gypsy staff" provides the necessary interface between the user and system developer, but serves only a temporary role until the system and user staff become fully acclimated.

Formal Structure Assumption (Assignment to New Roles) 5: Fully operational decision aiding systems are likely to make training of the existing staff preferable.

APPENDIX B. DESCRIPTIONS OF THE IDEAL PROFILES IN WHICH ORGANIZATION STRUCTURES ARE APPROPRIATE

ENVIRONMENTS APPROPRIATE TO INFORMAL ORGANIZATION STRUCTURES

These verbal descriptions are derived from the assumptions in Table 3 of Chapter 4.

The appropriate environment for a centralized structure:

- The leader prefers certain mission alternatives, the mission is well-structured but stressful; and
- The leader is skilled in decision analysis methods, has subordinates who lack such skills, and is task-oriented in style; and
- The technological tools are sophisticated and in a fully operational state with real time capability and individual output displays.

The appropriate environment for a consultative structure:

- The leader prefers certain mission alternatives, and the mission is well-structured and nonstressful; and
- The leader lacks decision analysis skills, has subordinates who possess such skills, and employs a task-oriented style; and
- The technological tools are sophisticated and in a fully operational state with real time capability and individual output displays.

The appropriate environment for a transactional structure:

- The leader has no clear preference among mission alternatives, and the mission is basically unstructured and nonstressful; and

- The leader lacks decision analysis skills, has subordinates who possess such skills, and employs a relations-oriented style; <u>and</u>

- The technological tools tend to be unsophisticated and in a transitional stage of implementation with non-real time capability and a large screen output display.

The appropriate environment for a <u>partially delegated structure</u>:

- The leader prefers certain mission alternatives, the mission is basically unstructured and stressful; <u>and</u>

- The leader lacks decision analysis skills, has subordinates who possess such skills, and employs a relations-oriented style; <u>and</u>

- The technology tends to be unsophisticated and in a transitional stage of implementation with real time capabilities and individual output displays.

The appropriate environment for a <u>decentralized structure</u>:

- The leader has no clear preferences among mission alternatives, and the mission is basically unstructured but stressful; <u>and</u>

- The leader lacks decision analysis skills, has subordinates who possess such skills, and employs a relations-oriented style; <u>and</u>

- The technology tends to be unsophisticated and in a transitional stage of implementation with real time capabilities and individual output displays.

<u>THE ENVIRONMENTS APPROPRIATE TO FORMAL ORGANIZATION STRUCTURES</u>

These verbal descriptions are derived from the assumptions in Table 4 of Chapter 4.

The appropriate environment for pyramidal installations:

- The leader is skilled in decision analysis methods and has a task-oriented style of leadership; and
- The technology is sophisticated and fully operational with real time capability and a large screen output display.

The appropriate environment for divisional installations:

- The leader lacks decision analysis skills and has a relations-oriented style of leadership; and
- The technology is sophisticated and in a transitional stage of implementation with non-real time capability and individual output displays.

The appropriate environment for assigning outside specialists:

- Neither the leader nor staff is skilled in decision analysis methods, and the leader is task-oriented; and
- The technology is sophisticated and in a transitional stage of implementation.

The appropriate environment for training existing professional staff:

- The leader is skilled in decision analysis methods and has a relations-oriented leadership style; and
- The technology is unsophisticated and fully operational.

The appropriate environment for placing operators in a new division of equal status with others:

- The leader has a task-oriented style.

The appropriate environment for placing operators in a support unit to assist existing divisional personnel:

- The leader has a relations-oriented style.

APPENDIX C. DESCRIPTIONS OF THE PROJECTED TASK FORCE COMMAND PROFILES

These verbal descriptions are derived from the configurations in Table 2 of Chapter 5. Only the 16 viable environments are considered. The following climatic factors are considered to be fixed in each of the task force command environments:

- The leader prefers clear mission goals.
- The mission is basically unstructured.
- The mission is stressful.
- The decision aid is analytical.
- The decision aid has real time capability.

The projected task force command environments vary in terms of the five other climatic factors.

Environment 1:

- The Commander of the Task Force (CTF) and staff possess decision analysis skills, and the CTF has a relations-oriented style; and
- The technological tools are fully operational and have a large screen output display.

Environment 2:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a relations-oriented style; and
- The technological tools are fully operational and have a large screen output display.

Environment 4:

- The CTF and staff possess decision analysis skills, and the CTF employs a task-oriented style; and
- The technological tools are fully operational and have a large screen output display.

Environment 5:

- The CTF and staff possess decision analysis skills, and the CTF employs a relations-oriented style; and
- The technological tools are fully operational and have individual output displays.

Environment 6:

- The CTF and staff possess decision analysis skills, and the CTF employs a relations-oriented style; and
- The technological tools are in a transitional stage and have a large screen output display.

Environment 8:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a task-oriented style; and
- The technological tools are fully operational and have a large screen output display.

Environment 9:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a relations-oriented style; and
- The technological tools are fully operational and have individual output displays.

Environment 10:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a relations-oriented style; and

- The technological tools are in a transitional stage and have a large screen display.

Environment 14:

- The CTF and staff possess decision analysis skills, and the CTF employs a task-oriented style; and

- The technological tools are fully operational and have individual output displays.

Environment 15:

- The CTF and staff possess decision analysis skills, and the CTF employs a task-oriented style; and

- The technological tools are in a transitional stage and have a large screen output display.

Environment 16:

- The CTF and staff possess decision analysis skills, and the CTF employs a relations-oriented style; and

- The technological tools are in a transitional stage and have individual output displays.

Environment 20:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a task-oriented style; and

- The technological tools are fully operational and have individual output displays.

Environment 21:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a task-oriented style; and
- The technological tools are in a transitional stage and have a large screen output display.

Environment 22:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a relations-oriented style; and
- The technological tools are in a transitional stage and have individual output displays.

Environment 26:

- The CTF and staff possess decision analysis skills, and the CTF employs a task-oriented style; and
- The technological tools are in a transitional stage and have individual output displays.

Environment 28:

- The CTF lacks decision analysis skills, has a staff that possesses such skills, and employs a task-oriented style; and
- The technological tools are in a transitional stage and have individual output displays.

APPENDIX D. ORGANIZATION PROFILE DISCUSSION GUIDE

INTRODUCTION

We are from a research firm named CACI. We are conducting a study for the Office of Naval Research on the potential organizational and sociological impacts of implementing computer-based decision aids for use by task force commanders and their staffs. By the term "decision aid" we mean any new technique or procedure that alters or restructures the way you previously analyzed problems, developed alternatives, and chose among those alternatives. Your system, _______________, seems to fit into this category of decision aids.

We are presently performing case studies of several Navy decision aids to determine how decision-making processes and organization structure have changed as a result of their implementation. For instance, where is the decision aid located organizationally? What officers are in charge of its operation and management? Have decision-making procedures and information flow become more centralized or decentralized?

Some questions are purely factual, while others ask for your attitudes and opinions based on your experience. Your answers will be kept anonymous, so please feel free to state your honest opinions. If you wish, we will send you a summary of our report when it becomes available.

(NOTE: Questions in parentheses are leading questions to assist the interviewee if necessary).

MISSION PROFILE

_____(1) Type of mission: What types of missions are assigned to this organization?

_____(2) Mission stress: Are missions usually stressful, with time constraints on decision formulation or high risk alternatives? Or are missions basically nonstressful in terms of time or risk? (Are stressful missions usually composed of problems for which no preplanned procedures are available?) Do the decision aids and personnel function effectively during high stress situations?

_____(3) Task structure: In most cases, are the problems that the organization must deal with repetitive, routine, and well-structured, or are they unique, complex, and unstructured? Are there preplanned and programmed procedures that help to solve routine problems? (Are such procedures available for nonroutine problems? Must the organization deal with complex problems in conditions of incomplete and uncertain information?)

_____(4) Leader guidelines and goals: Does the OIC usually have a clear and preferred mission objective? (Does he define general guidelines for policy direction and alternative consideration? Or is it often the case that he gives no indication of a clear preference among the available options?)

_____(5) Role of decision aid in mission accomplishment: What role do the decision aids play in achieving mission goals? Do they assist in the planning, execution, or evaluation phases of a mission? Does the organization serve a decision-making function only or does it get directly involved in the operational execution of plans and decisions (that is, line functions?)

TECHNOLOGICAL AND IMPLEMENTATION PROFILES

_____(1) Decision aid description: Please describe your decision system, ________________________. What types of functions does it perform? How does it aid in decision analysis? Who does it help?

_____(2) Real-time system : Is there a need to keep the system on a real time basis? How often is the data base updated?

_____(3) Output display: With what types of output units are the decision aids equipped? (Are there cathode ray tubes (CRT's), hard copy terminals, or large screen displays?) How many of these display units are there? Where are they located and for whose use?

_____(4) When implemented: When was the system first introduced into the organization? Were you involved in its implementation?

_____(5) Implementation stage: Over how long a period were the decision aids tested before becoming fully operational and established decision tools? Or are they still in a transitional or experimental stage?

_____(6) Prior systems: Were other computer-based decision aids or management information systems (MIS) used in your organization prior to implementing the present system? If yes, what kind, and what organizational elements did they serve? What types of functions did they perform?

ORGANIZATIONAL STRUCTURE PROFILE

_____(1) Formal organization chart: Is a current formal organization chart available? Do you also have a chart that indicates the formal organization prior to decision aid installation? If not, can you describe the lines of authority in the organization? Would you characterize the organization as a line, line and staff, or functional organization?

_____(2) Divisional/pyramidal installation of aids in formal structure: What individuals or organizational elements do the decision aids support? Is use and operation of the decision aids split among various divisions? Or are the decision aids centrally located to provide support to all divisions?

_____(3) Informal decision process: How would you describe the actual process of decision-making in the organization? (Who has the authority to make decisions? Describe the flow of information and communication throughout the organization. How are the various tasks performed by the organization coordinated?).

_____(4) Centralization/decentralization: Specifically, which of the following best characterizes the personal patterns and relationships that take place in the decision-making process?

a. Authority is focused and centralized in the OIC who makes all of the decisions alone. He relies on the staff for information input only.

b. The OIC makes decisions alone, but depends on consultations with his staff for advice, guidance, and opinions.

c. The OIC and staff share problems equally by deliberating on the alternatives openly and arriving at a group consensus despite differences in rank and responsibility.

d. The OIC delegates authority to the professional staff but retains the right to review, modify, or reject staff decisions.

e. Decision-making power is totally delegated to staff members with little direct supervision or intervention by the commander.

_____(5) Prior organization structure: Did this process of decision-making emerge after the decision aids were introduced? If so, how would you characterize the process, using these five types, prior to decision aid implementation? What about during the transitional or conversion stage?

_____(6) Do decision aids induce a need for organizational change?: Do you feel that the introduction of computer-based decision aids usually requires a change in the actual way decisions are made by a staff? (Do you think that a change in the decision process is usually necessary to ensure continued efficient performance after computer-based decision tools are introduced?)

PERSONNEL AND IMPLEMENTATION PROFILES

_____(1) Professional/technician ratio: How many decision-making professionals versus administrative and technical staff members work in the organization at present? Has the ratio changed since the decision aids were introduced?

_____(2) Leader skill and training: Does the officer in charge use the aid personally? Was he skilled in using the decision system when it was introduced? If so, do you know if he was formally trained in decision analysis or technical skills? Or did he gradually learn to use the system through on-the-job training? Or does he still lack adequate skills in using the decision system?

_____(3) Leader attitudes toward aids: What were the attitudes of the officer in charge of this decision area toward the decision aids? (Did he view them as a hindrance or a help?) Did he acclimate quickly to the change in methods?

_____(4) Staff skill and training: Was the decision-making staff initially skilled in using the decision tools? If so, did it gain these skills through formal training or previous experience in other billets? Or did the professional staff gradually learn to use the system through on-the-job training? Or does the professional staff still lack adequate skills in using the decision system?

_____(5) Staff attitudes toward aids: What were the attitudes of the staff toward the decision aids? (Did it view them as a hindrance or a help?) Did it acclimate quickly to the change in methods?

_____(6) Need for coordinators/analysts/technicians: Was it necessary initially to recruit personnel for new organizational roles to utilize the decision system properly?

_____(7) Why coordinators/analysts/technicians needed: If so, were these personnel necessary because of the sophistication of the decision tools, the inadequate training of the professional staff in the required skills, or both? Are these personnel still being used? Is the professional staff learning adequate skills from them to be able to utilize the decision aids on their own? If this is so, will these personnel be phased out gradually?

_____(8) Organization location of coordinators/analysts/technicians: If these personnel were recruited, where are they located in the organizational hierarchy? To whom do they report? What is their status in relation to existing staff? (Are they (a) placed in a new division of equal status with others, (b) incorporated into the staff of existing divisions, (c) assigned double-duty to a divisional staff and aid staff, (d) placed in a support unit for an existing division, or (e) located in the personal staff of the officer in charge?)

_____(9) Acceptance/rejection of new personnel: If expert coordinators, analysts, or technicians were recruited, how were they accepted into the organization? (Did they meet resistance or resentment from the existing staff, were they accepted as equal members of the group or were they looked up to?)

_____(10) Leadership style: Describe the OIC's personal style of leadership. (a) Is he permissive and considerate of his subordinates? Does he emphasize their participation in problem-solving? (b) Is he task-oriented, controlling, directive, and structured? Does he prefer centralized control over problem-solving? Did his style change when the decision aids were introduced?

EFFECTIVENESS PROFILE

_____(1) Decision aid effectiveness: Do the decision aids facilitate the decision-making process? How? (By providing a clearer and more complete picture of the situation? By enabling better quality decisions? By enabling faster decisions?) How do the decision aids function under stressful and uncertain conditions?

_____(2) Organization structure effectiveness: Do the current organization structure and informal decision processes enhance effective, efficient, and maximum use of the decision aids? Do they aid performance? How? (Do they enhance authority patterns, information and communication flow, and coordination networks?)

PERSONAL BACKGROUND

_____(1) Age?

_____(2) Rank?

_____(3) Position?

_____(4) Term of service on this billet?

_____(5) Were you present during the technological transition?

_____(6) What is your past experience or training in decision analysis methods and computer usage.

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